MICROCYBER

# MC0310

# Modbus to HART Built-in Core Module

## User Manual

# Warning

1. It is forbidden for users to disassemble components by themselves.
2. Please check whether the power supply voltage of the gateway is in accordance with the power supply voltage requirement in the user manual.

**Version：V1.2**

**Disclaimers**

The contents of this manual have been checked to confirm the consistency of the hardware and software described. Since errors cannot be completely excluded, absolute consistency cannot be guaranteed. However, we will periodically check the data in this manual and make the necessary corrections in subsequent versions. Any suggestions for improvements are welcome.

**Microcyber Corporation**

Technical data is subject to change at any time.

# Company Profile

**Microcyber Corporation** is a high-tech enterprise initiated and founded by Shenyang Institute of Automation, Chinese Academy of Sciences, mainly engaged in networked control system, industrial communication and instrumentation, development, production and application. Microcyber Corporation has undertaken a number of national science and technology projects such as the National Science and Technology Major Project, National High Technology Research and Development Program (863 Program), Smart Manufacturing Equipment Development Project, etc. It is the unit for the construction of National Engineering Research Center for Networked Control System.

Microcyber Corporation successfully developed the first internationally certified fieldbus protocol master stack, the first nationally certified fieldbus instrument, the first domestic safety instrument certified by TÜV Germany, and co-hosted with other units the formulation of the first domestic industrial Ethernet protocol standard EPA and the first industrial wireless communication protocol standard WIA-PA, which became an IEC international standard.

Our products and technologies have won two National Science and Technology Progress Awards, one National Science and Technology Invention Award, one First Prize of Science and Technology Progress of Chinese Academy of Sciences, one First Prize of Science and Technology Progress of Liaoning Province, and our products have been exported worldwide. We have successfully completed more than 200 large-scale automation projects.

Microcyber Corporation is a member of FCG organization; a member of PNO.

Microcyber Corporation has successfully passed ISO9001:2008 quality management system certification and ISO/TS16949 quality system certification for the automotive industry. Excellent R&D team, rich experience in automation engineering design and implementation, industry-leading products, large market network and excellent corporate culture have laid a solid foundation for the company's start-up and sustainable development.

Carrying employees' ideals, creating customer value and promoting corporate development.

# Terminology Introduction

- **Common Commands** - the set of HART commands that the HART device must support.
- **General Commands** - the set of HART commands that the HART device can choose to support.
- **Special Commands** - HART command sets customized by the HART device manufacturer.
- **HART master device** - can be a device such as a PC, a hand operator or a HART module of a DCS, the initiator and issuer of HART communications.
- **DD file** - The electronic description file of HART devices, which describes the HART commands and processing methods supported by the devices in a proprietary format, mainly used for the tuning and configuration of HART devices by other manufacturers' HART master stations.
- **Polling Address** - i.e., short address, takes a value in the range 0-63 (0-15 for HART 5.0). Only used in HART digital communication when the master device takes turns asking for the presence or absence of a slave device on the bus.
- **Device variables** - variables inherent to HART devices, such as instantaneous flow, cumulative flow, flow rate, media density, media temperature and other variables in flow meters.
- **Dynamic Variables** - A collective term for four variables that can only be operated directly in HART commands, namely, the primary variable (PV), the second variable (SV), the third variable (TV), and the fourth variable (QV), HART devices have an initial correspondence between dynamic variables and device variables, which can also be changed by general commands, such as a flow meter: the primary variable is assigned to instantaneous flow rate, the second variable is assigned to the flow rate, the third variable is assigned to the medium temperature, and the fourth variable is assigned to the cumulative flow rate.
- **Upper limit of the primary variable range** - stored in the HART device (in this case the HART module) to indicate the maximum value of the primary variable range.
- **Current output devices** - can be flow, level, temperature and other measuring instruments, in the control system as a parameter input devices, with the output 4-20mA analog signal to the control system to transmit the primary variable measurement value of a class of equipment.
- **Two-wire devices** - Field devices with only two bus connections, both to power field devices and to achieve 4-20mA analog and HART digital communication. Used for field devices whose current consumption is not greater than 4mA, such as common temperature and pressure transmitters. Currently, HART modules do not support field devices that expect to be made into a two-wire connection.
- **Three-wire devices** - Field devices are powered by two power lines, with an additional line forming a HART bus with the positive power line, passing 4-20mA analog and HART digital communications. Used for field devices with current consumption greater than 4mA, such as Koch force mass flow meters, most electromagnetic flow meters.
- **Four-wire devices** - Field devices are powered by two power lines, and two other lines are

connected to the HART bus for 4-20mA analog output and HART digital communication. The use is the same as the three-wire device.

- **Single point mode** - In the whole HART system, there is only one HART slave device connected on the HART bus with polling address '0', when the 4~20mA analog signal of HART is valid and can represent the value of the master variable PV.
- **Networking mode** - The entire HART system has multiple HART devices connected to the HART bus with polling addresses '1~63', when all HART devices output current of 4mA, and the analog current does not represent the value of the primary variable PV.

# Table of Contents

# Chapter 1 Product Overview

Microcyber Corporation (hereinafter referred to as 'Microcyber') has customized a variety of embedded protocol conversion modules for field device manufacturers to support linking Modbus RTU protocol (hereinafter referred to as 'Modbus' protocol) slave devices to various fieldbus systems. The MC0310 built-in Modbus to HART module (hereinafter referred to as 'HART module') is designed to convert Modbus protocol slave devices to HART protocol slave devices.

## 1.1 Conversion Logic

The HART module can convert the flow and level meter of Modbus protocol into the flow and level meter of HART protocol.

The HART module (MC0310) is a built-in conversion module that converts input type devices in the Modbus device category into HART current output type devices.The HART module is embedded in Modbus protocol input type devices (flow, level, etc. measurement instruments) and runs the Modbus application layer protocol via TTL level signals.The HART module acts as a Modbus The HART module acts as a Modbus master and HART slave to convert data from data registers (such as input registers and holding registers) in Modbus devices to dynamic variables used in HART commands. For example, the holding register in a flowmeter with address 30000 (range 1-65536) stores the instantaneous flow value, so we can configure the holding register to device variable 0 (range 0-5) of the HART module, and then assign device variable 0 as the master variable (or the second, third, or fourth variable), and the conversion logic is shown in the figure below.

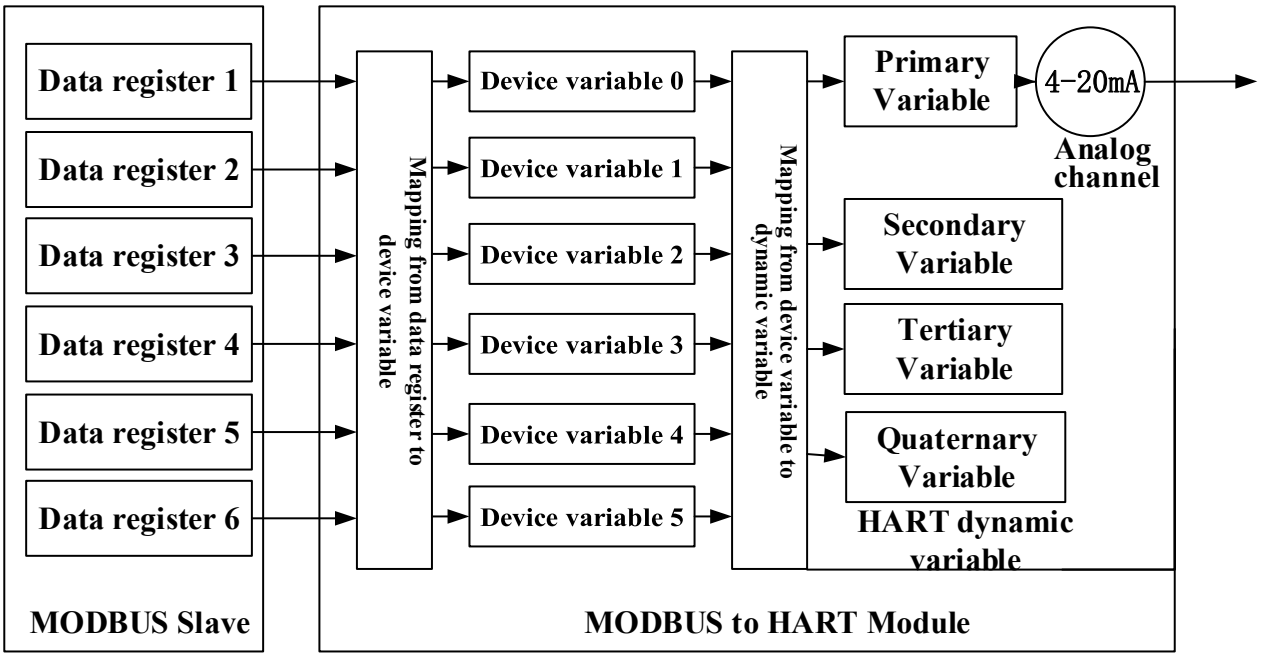


Figure 1.1 Data mapping logic diagram

As a general-purpose product, HART module has to deal with different interface characteristics (slave address, communication rate, communication checksum method, etc.), data storage methods (data

register address, data type, byte arrangement order, etc.) of various Modbus devices and end-user requirements for HART dynamic variable assignment (data register mapping to device variable, device variable mapping to dynamic variable). These can be reconfigured by the device manufacturer.

The above configuration can be done by using the upper computer configuration software provided by Microcyber, or the HART master with DD file parsing capability (e.g. PC, hand controller) can import the DD file of HART module provided by Microcyber, and also do the above configuration. The HART master is configured by means of HART communication to determine the interface characteristics between the HART module and Modbus devices, the data storage method and the mapping of device variables to HART dynamic variables.

After the above configuration, the HART master device can access the dynamic variables of the HART module using the HART command, which enables the digital transfer of data from the Modbus data registers (such as storing the instantaneous flow rate value of the flow meter) to the HART master.

## 1.2 Analog current output

The 4-20mA analog current output value in the HART module conveys the measured value of the primary variable (PV) in the HART dynamic variable. For example, the instantaneous flow rate of the flow meter is designated as the HART primary variable, and the HART module outputs 12.000mA when the instantaneous flow rate value reaches half of the range. the HART module continuously compares the primary variable value with the upper and lower limits of the primary variable range during continuous operation, and when the primary variable value reaches the upper limit of the primary variable range, the HART module outputs the corresponding analog current of 20.000mA, and when reaching the upper limit of the range of the primary variable, the HART module outputs an analog current of 20.000mA.

When the primary variable value is outside the upper and lower range of the primary variable, the HART module outputs a fixed current to indicate that the primary variable is outside the range, and the current value at this time is called the saturation output current. When the primary variable value is higher than the upper limit of the primary variable range, the HART module outputs a fixed current of 20.800mA; when it is lower than the lower limit of the primary variable range, the HART module outputs a fixed current of 3.800mA.

The HART module also has a set of fault alarm fixed current output function, and the high and low alarm currents of the module can be set by the configuration software. When the high current alarm is selected and the HART module detects a fault, 21.750mA is output; when the low current alarm is selected and the HART module detects a fault, 3.70mA is output.

Table 1.1 List of two fixed output current values for HART modules

| **primary variable overrun direction (not optional)** | **saturated output current value** |
|---|---|
| over range lower limit | 3.800mA |
| over range limit | 20.800mA |
| **fault alarm method (two options)** | **alarm output current value** |
| low current alarm | 3.70mA |
| high current alarm | 21.750mA |

When the HART module polling address is set to a value other than '0', the HART module analog channel outputs a fixed current of 4.000mA, regardless of the measured value of the primary variable within the range. module to output a 4-20mA analog current corresponding to the primary variable only when the polling address is set to '0'.

## 1.3 Configuring the interface

The HART module is between the HART bus and Modbus devices, and is plugged into the main control board (hereinafter referred to as user board) of the field device through the back socket, with an external HART bus and an internal connection to the field device, as shown in the following figure.

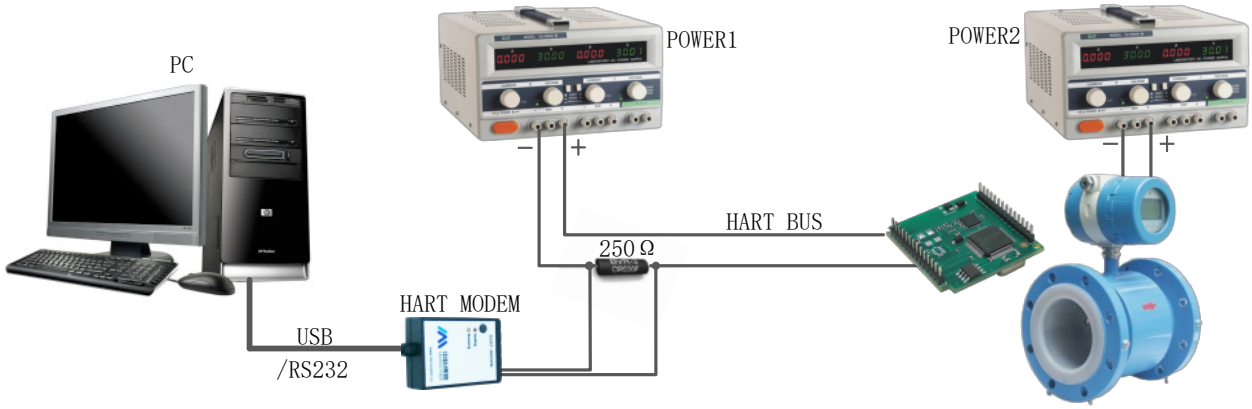


Figure 1.2 Configuration HART module wiring diagram

Take the PC as the master device and connect the field devices through HART bus (4-wire system) as an example. A DC regulated power supply (POWER1: 9-36VDC) is connected to a matching resistor (250Ω) in series to form a HART bus, which is connected to the HART module; the field devices are powered by the other two power cables. The HART module can be configured by a PC running Microcyber's host configuration software. The configured HART module and the field device as a whole become HART field devices that can be connected to other HART networks.

When using a hand controller with DD file parsing capability for configuration, simply replace the PC and HART modem in the above figure with the hand controller.

## 1.4 Hardware user interface

The HART module adopts a 2.0mm spacing, and two rows of single row 14P pins are connected to the user board. The pin serial number definition is shown in the figure below, and the pin function description is shown in Table 1.2. When the HART bus is routed on the user board, the HART bus is introduced into the HART module by two pins in the socket.

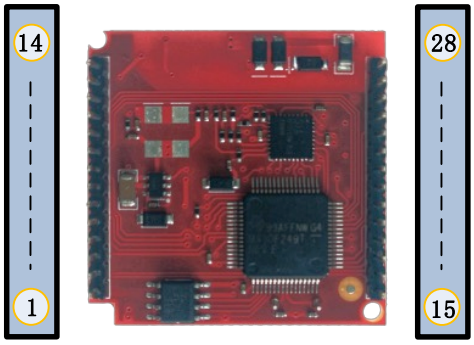


Figure 1.3 Hardware user interface schematic

Table 1.2 List of HART module socket pin definitions

| Pin | Name | Description |
|---|---|---|
| **1** | TDO | JTAG debug interface |
| **2** | TDI | JTAG debug interface |
| **3** | RESET | Reset signal, active low level |
| **4** | GND | Reference place |
| **5** | TMS | JTAG debug interface |
| **6** | RXD | UART input TTL level |
| **7** | TXD | UART output TTL level |
| **8** | TCK | JTAG debug interface |
| **9** | SPISTE | GPIO, SPI interface |
| **10** | SOMI | GPIO, SPI interface |
| **11** | SIMO | GPIO, SPI interface |
| **12** | SPICLK | GPIO, SPI interface |
| **13** | VCC-3.3V | Power output, accuracy ±1% (conventional products) |
| **14** | VCC-5V | 5V power output, accuracy ±10% (needs to be customized) |
| **15** | GPIO | GPIO, BSLTXD interface |
| **16** | GPIO | GPIO, BSLRXD interface |
| **17** | GPIO | GPIO |
| **18** | GPIO | GPIO |
| **19** | GPIO | GPIO |
| **20** | GPIO | GPIO |
| **21** | GPIO | GPIO |
| **22** | I2CSCL | GPIO, I2C interface |
| **23** | I2CSDA | GPIO, I2C interface |
| **24** | GPIO | Modbus communication status indicator light, active low level |
| **25** | GPIO | HART communication status indicator light, active low level |

| | | |
|---|---|---|
| **26** | GND | Reference place |
| **27** | BUS+ | Bus power positive |
| **28** | BUS- | Bus power negative |

As shown in Figure 1.3, the module is designed with a 2-wire HART circuit with a TTL level interface and no electrical isolation from the HART bus. This core module can be designed based on 2/3/4-wire HART products.

## 1.5 Software User Interface

The HART module and the user board use the link layer and application layer specification of Modbus protocol. The supported common commands and general commands are shown in the following table.

Table 1.3 Table of commands supported by HART bus interface

| General command number | Command Name | General command number | Command Name |
|---|---|---|---|
| 0 | Read unique device identification | 33 | Read device variables |
| 1 | Read primary variable units, primary variable values | 34 | Write the primary variable damping value |
| 2 | Read the primary variable current value and percentage | 35 | Write the upper and lower limits of the primary variable range |
| 3 | Read dynamic variables and primary variable currents | 36 | Set the upper range of the primary variable with the current value |
| 6 | Write polling address | 37 | Set the lower range limit of the primary variable with the current value |
| 7 | Read polling address and current mode | 40 | Entering/Exiting Fixed Current Output Mode |
| 8 | Read dynamic variable categories | 41 | Device performs self-test |
| 9 | Read device variables and status | 42 | Device performs a self reset |
| 11 | Read the unique identification of the equipment with the equipment station number | 43 | Set the master variable zero with the current value |
| 12 | Read the message | 44 | Write primary variable units |
| 13 | Read tags, descriptions, dates | 45 | Adjust the current value at the low end of the current loop (4.000mA) |
| 14 | Read the primary variable sensor information | 46 | Adjustment of the current value at the high end of the current loop (20.000mA) |
| 15 | Read the primary variable output information | 47 | Write primary variable transfer function |
| 16 | Read final assembly number | 49 | Write master variable sensor serial number |
| 17 | Write a message | 50 | Read dynamic variable assignment |
| 18 | Write labels, descriptions, dates | 51 | Write dynamic variable assignment |
| 19 | Write final assembly number | 53 | Write device variable units |
| 20 | Read long tags | 59 | Number of leading characters to write |
| 21 | Read device unique identification with long tags | 105 | Read burst mode configuration |
| 22 | Write long tags | 107 | Write array-emitting device variables |
| 38 | Reset configuration change flag | 108 | Write array mode command number |
| 48 | Read additional transmitter status | 109 | Burst mode control |

The HART module is shipped from the factory with a default polling address (short address) of '0'.

The serial transmission mode supported by the HART module is Modbus RTU mode, and the serial communication interface features supported are shown in the following table.

Table 1.4 Table of Modbus communication interface characteristics

| | Default Parameters | Available range |
|---|---|---|
| Slave Address | 1 | 1-247 |
| Baud rate | 9600 | 1200,2400,4800,9600, 9200,35700,38400,57600 |
| Data bits | 8 | 7, 8 (only ModbusRTU is supported in this version, so setting 8 bits is valid) |
| Stop bit | 1 | 1, 2 |
| Calibration | EVEN | ODD, EVEN, NONE |
| CRC Checksum | Low-High Order | Low-High Order, High-Low Order |

Modbus commands supported by the Modbus communication interface of the HART module, as shown in the following table.

Table 1.5 Table of commands supported by Modbus communication interface

| Command number | Command Name | Command number | Command Name |
|---|---|---|---|
| 1 | Read coil status | 4 | Read input register value |
| 2 | Read discrete input state | 5 | Write Coil |
| 3 | Read holding register value | 16 | Write multiple register values |

## 1.6 Mechanical dimensions

HART module printed circuit board is 1.6mm thick and rectangular in shape. The front side (the figure below shows the front side) the highest component is 5mm from the board height. The back side the highest component is 9mm from the board height, the rest are surface mount components with height less than 4mm. The HART module length, width, fixing hole position etc. are shown in the figure below.

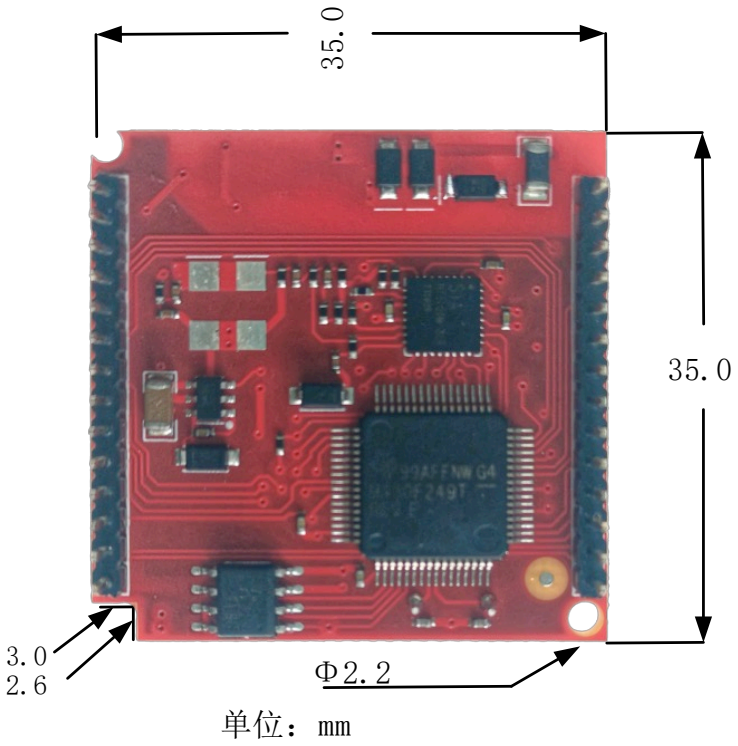


Figure 1.4 Mechanical dimensions of the front of the HART module（unit：mm）

# Chapter 2 Quick Configuration

## 2.1 Introduction to Configuration Tools

As mentioned before, the configuration of HART module can be done by using the upper computer configuration software provided by Microcyber, or the HART master with DD file parsing capability (such as PC or hand controller) can import the DD file of HART module provided by Microcyber and also do the above configuration. Here is an example of PC running Microcyber's upper unit configuration software, the hardware connection is shown inFigure 1.2 The hardware connection is shown in Figure 1.2, and the connection is explained in1.4.

For instructions on the use and status of the HART modem, please refer to the "HART Modem Instructions for Use" from Microcyber.

For the installation and general operation of the upper unit configuration software, please refer to the HART Configuration Software User's Manual of Microcyber. Only the configuration and simple general operation of HART module are introduced here.

After wiring and powering on the field devices with HART modules according to Figure 1.2, double-click the desktop shortcut icon 

(or run "C:\Program Files\Microcyber\HartMPT\HartMPT.exe") on the PC with HART configuration software (HartMPT.exe) installed to enter the HART The initial interface of the upper computer configuration software, see the following figure.

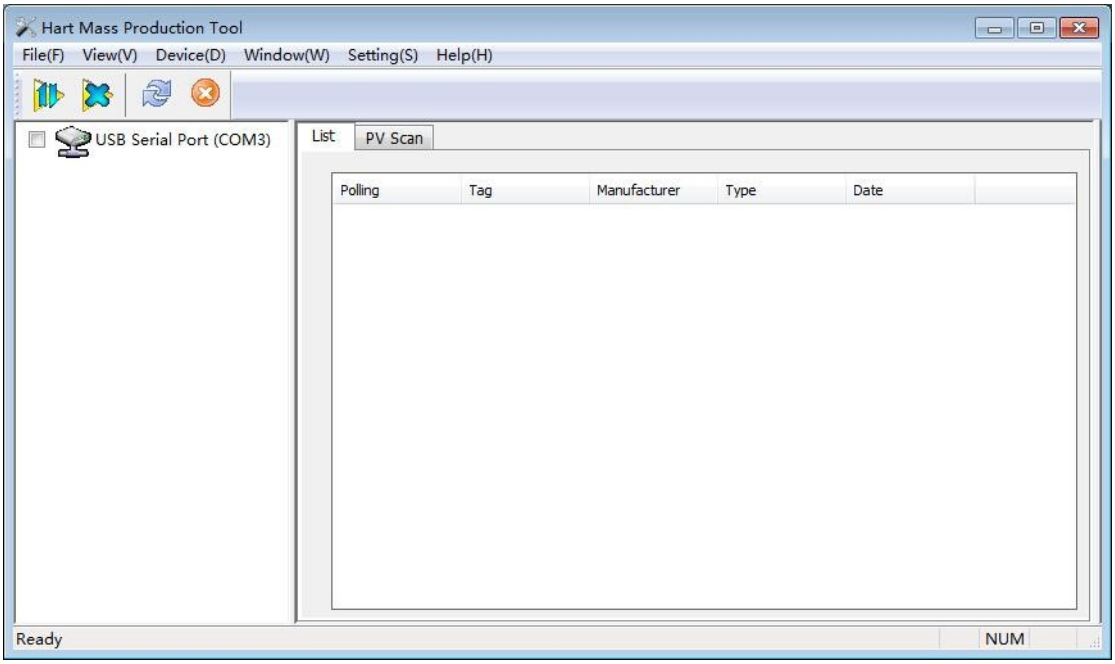


Figure 2.1 Configuration software icon and initial interface

The 'COM3' shown above is the virtual serial port for the USB interface HART modem by Windows OS. If the driver of HART modem (virtual serial chip) is installed correctly, the green light will be on after the USB interface HART modem is plugged into the PC; otherwise, check the wiring and driver installation

results.

In the network view of the initial interface, right-click the serial node (COM3) and select 'Single Node' → 'Node 0'. The configuration software sends

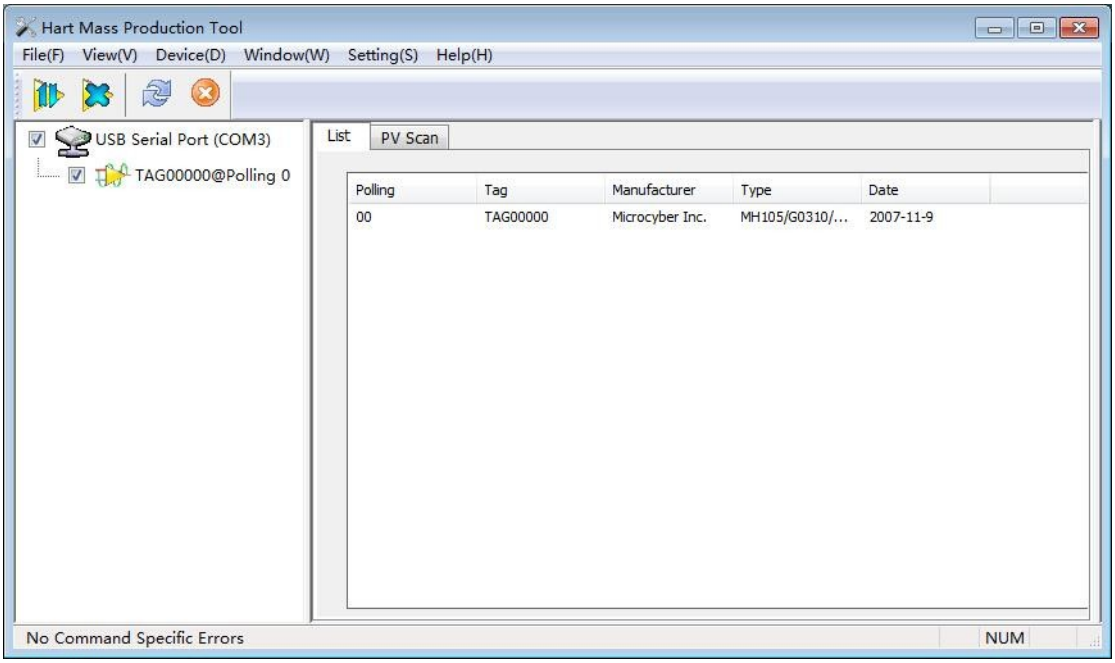


Figure 2.2 Polling online HART module

the '0' general command asks whether the HART device with short address '0' is online or not. HART module is shipped with default short address '0', and there is no error in wiring and power supply. If there is no error in wiring and power supply, the HART configuration software will list the query result as shown in Figure 2.2. The device with short address '0' (hereinafter referred to as device 0) is online, left click on device 0, after the configuration software communicates with the HART module continuously, the tab view changes as shown in the figure below.

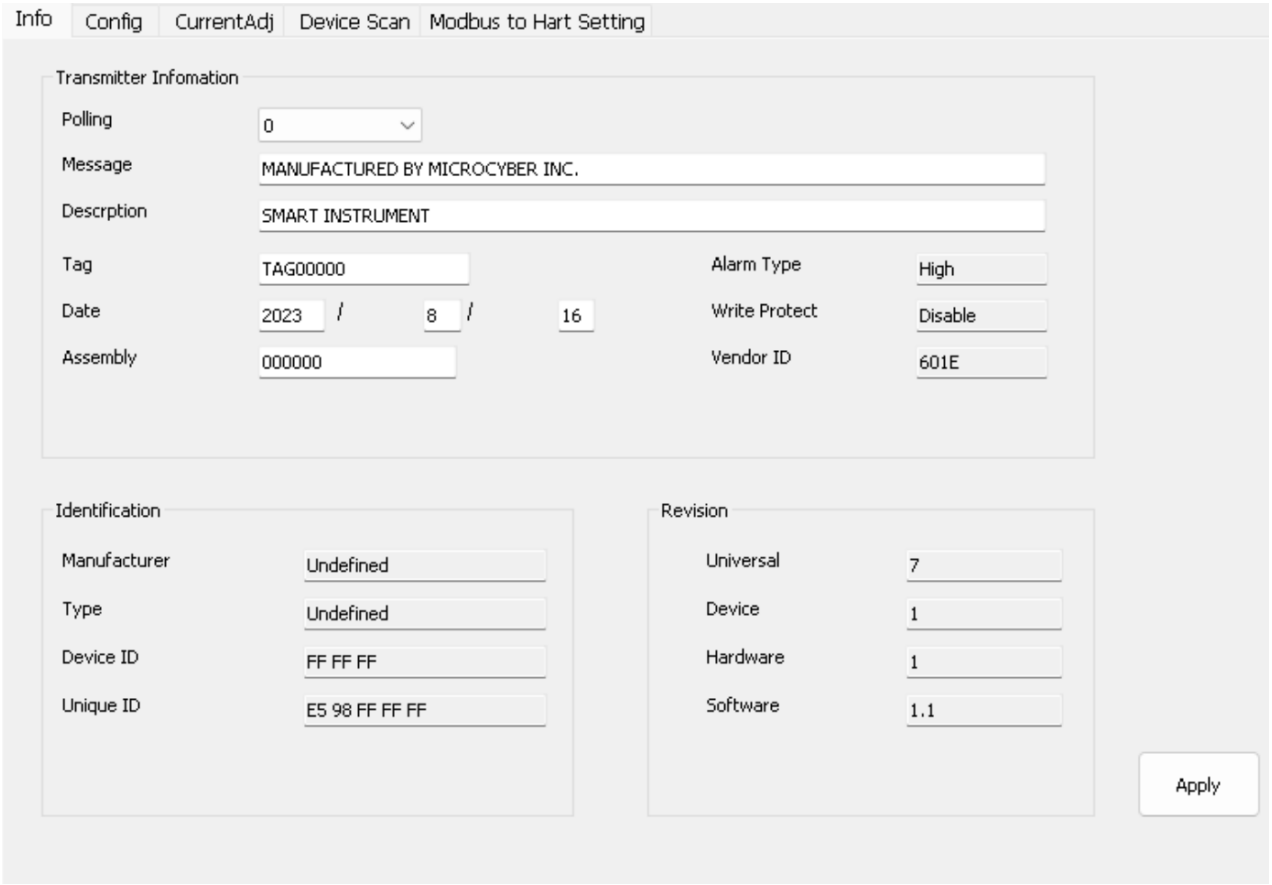


Figure 2.3 HART module tab

The tab 'Gateway Configuration' is unique to HART modules compared to other types of HART devices, the other 4 tabs in the above diagram are common to all HART devices. Only the 'Gateway Configuration' of the HART module is highlighted here, as shown in the following figure.

**Note: The setting of high and low alarms is in the "Configuration Information" interface.**

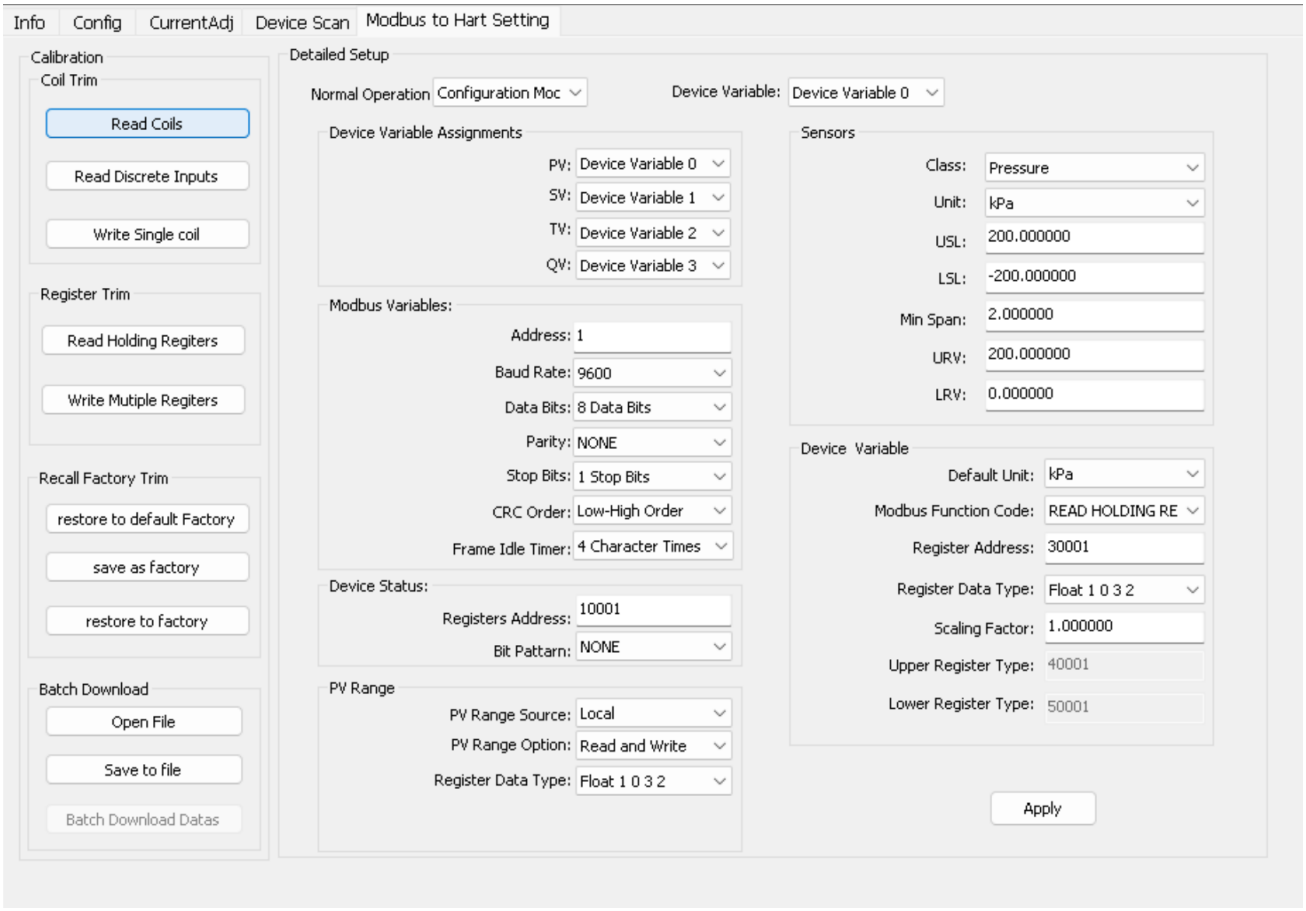


Figure 2.4 Gateway Configuration tab

If you want to configure the HART module, first change the 'Gateway Configuration \ Detailed Settings \ Operation Mode' option group to 'Configuration Mode', in this mode, the user can operate other function items in the detailed settings; in the configuration mode, the HART module will not send Modbus packets to the user board actively and cyclically.

Configure the HART module in three steps: 1. configure the Modbus interface; 2. configure the device variables; 3. configure the dynamic variables.

Step 1 Configure the Modbus interface, i.e. configure the Modbus interface by different Modbus device interface characteristics using the 'Gateway Configuration \ Detailed Settings \ Modbus Variables' option group. Step 2 Configure device variables, i.e. use the 'Gateway configuration \ Detailed settings \ Device variables' option group to configure device variables according to different Modbus device data storage methods, i.e. data registers mapped to device variables. Step 3 Configure dynamic variables, i.e., use the 'Gateway Configuration \ Detailed Settings \ Device Variable Assignment' option group to configure dynamic variables according to different end-user requirements for HART dynamic variable assignment, i.e., device variables are mapped to dynamic variables.

As mentioned before, the configuration function of configuration software can also be realized by HART master (such as PC and hand controller) with DD file parsing ability. The function described by DD file of HART module is basically the same as that of HartMPT configuration software, and the figure below shows the function menu tree of DD file, through which users can quickly find the parameters that need to be configured in hand controllers such as 475.

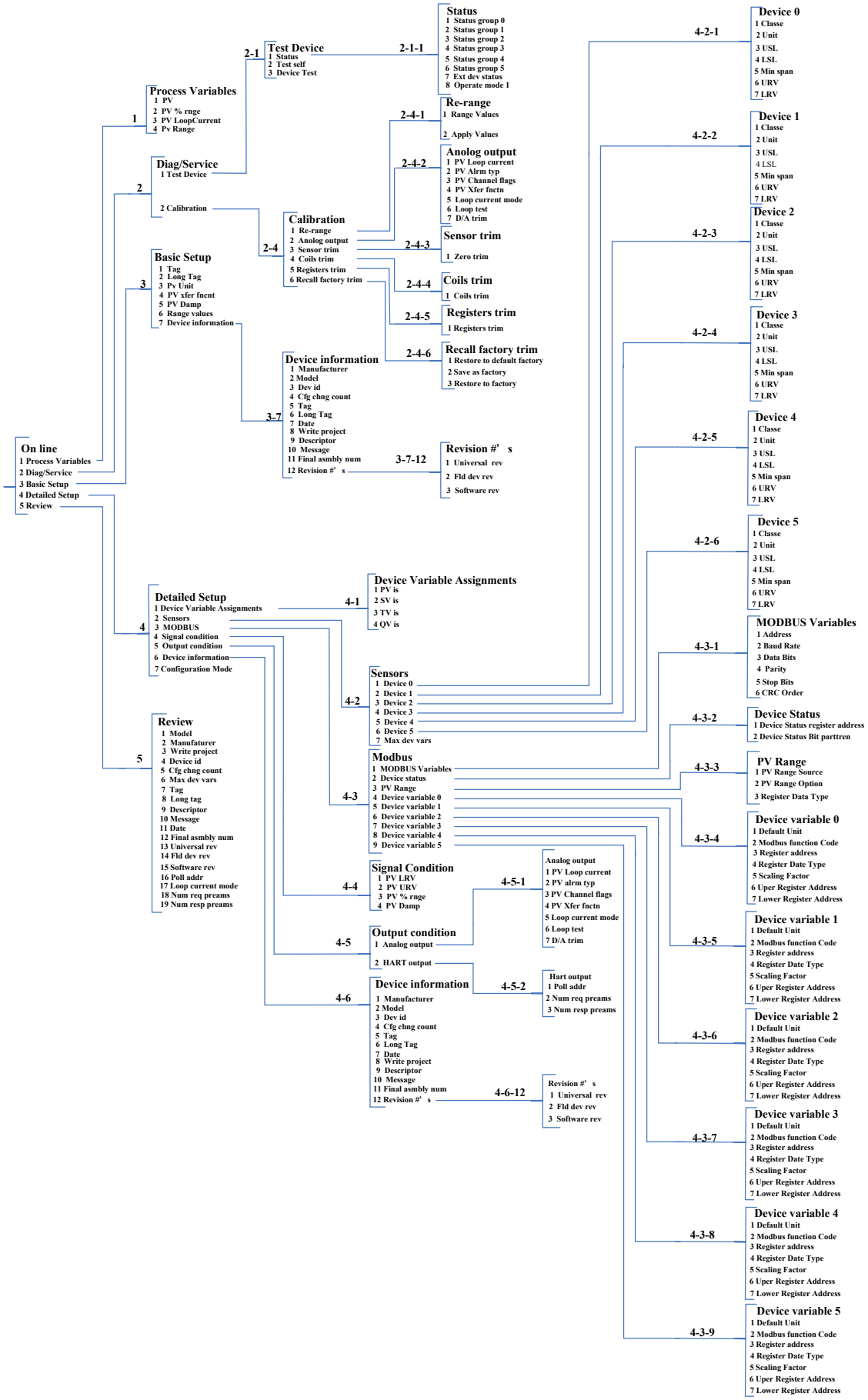


Figure 2.5 DD function menu tree

## 2.2 Configuring the Modbus Interface

The key for HART modules to be able to communicate correctly with user boards is to first unify the communication parameters, and the communication between them adopts Modbus-RTU protocol, using the 'Gateway Configuration \ Detailed Settings \ Modbus Variables' option group of the configuration software, users can according to their Modbus devices (user boards) interface characteristics to configure the Modbus interface, asFigure 2.6 Shown in.

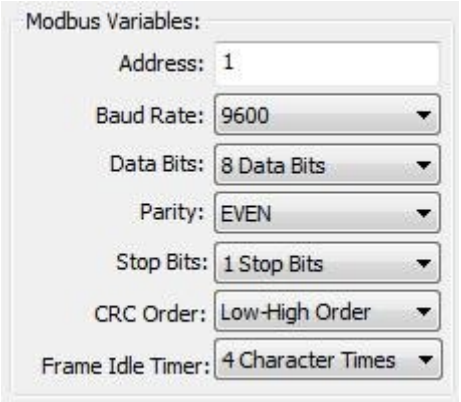


Figure 2.6 Modbus communication parameters

Parameter meaning:

Table 2.1 Modbus communication parameters

| Function Name | Use | Default Parameters |
|---|---|---|
| Address | Address of the user's Modbus slave device | 1 |
| Baud rate | Baud rate used by the HART module to communicate with the user board | 9600bps |
| Data bits | Length of data bits when the HART module communicates with the user board | 8 |
| Calibration | Checksum method used for bytes: odd-check, even-check, no checksum | EVEN |
| Stop bit | Number of stop bits | 1 |
| CRC Byte Order | The order of sending the last 2 bytes of CRC of Modbus protocol packets | Low-High Order |

Only whenTable 2.1 all communication parameters in Table 2.1 are fully compatible with the user's Modbus device interface characteristics, the communication is guaranteed to be normal. After the user sets the parameters, click the 'Apply' button to save the configuration data to the HART module. In the future, when the HART module exchanges data with the user board, it will use the data as shown inTable 2.1 to communicate.

Attention: After configuring the Modbus communication parameters, the module needs to be re powered on to ensure the accuracy of the data.

## 2.3 Configuring device variables

The configuration of device variables is to configure the device data (such as instantaneous flow rate, cumulative flow rate, flow rate, medium density, medium temperature and other variables in the flowmeter) from the user's Modbus device to the device variables of the HART module, and the HART module can support the configuration of 6 device variables. The HART module can support the configuration of 6 device

variables. Use the 'Gateway Configuration\Detail Settings\Device Variables' option group of the configuration software to configure, the specific information to be configured is as followsFigure 2.7 shown:

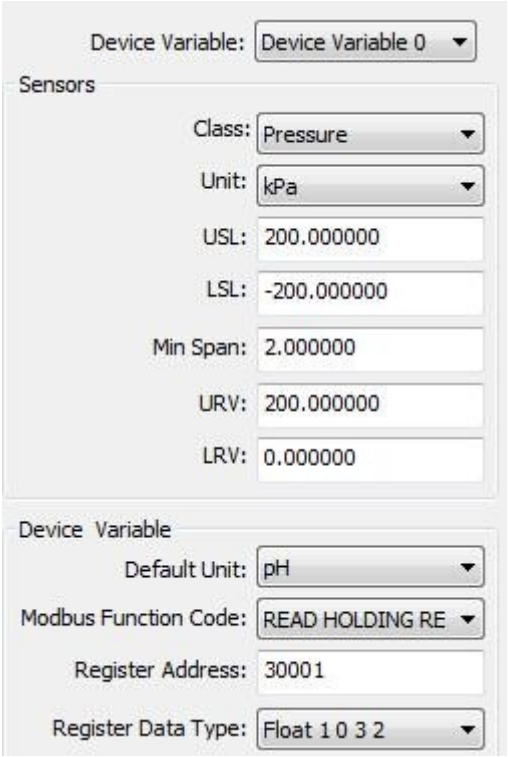


Figure 2.7 Device variable configuration

The meaning of each item used in the quick configuration is as followsTable 2.2 is shown in Table 2.2.

Table 2.2 Device variable configuration

| Device variable n (n=0~5) | |
|---|---|
| **Function Name** | **Use** |
| Type | Type of user Modbus device data, select the corresponding item in the 'Type' drop-down list according to the different types (e.g. volume flow, temperature, pressure, density, etc.). |
| Unit | Units currently used and displayed for HART device data (units of PV) |
| Sensor range upper limit | The maximum limit of device variables n that can be collected by the user's Modbus device |
| Lower limit of sensor range | Minimum limit of device variables n that can be collected by the user's Modbus device |
| Minimum span | Range span, generally set to the upper limit of the sensor range divided by 100 |
| Maximum range | Between the upper/lower limits of the sensor range |
| Lower range limit | Between the upper/lower limits of the sensor range |
| Default Unit | Units of variable values read from Modbus devices |
| Modbus function code | Function code to be sent when reading device variable n |
| Register Address | Address of the data register where the device variable n is located in the Modbus device |
| Register Data Type | Byte order of device variable n in the Modbus data register |

Among them, the upper range limit and lower range limit can be modified only when the current device variable is mapped to the primary variable; the upper/lower range limit of the device variable here is the same parameter as the upper/lower range limit in the HART device.

Users can configure their Modbus devices to these six device variables according to the number and importance of the device data in their Modbus devices, and after configuration, click the 'Apply' button to save the data to the HART module.

Note: The (**data register address = data register address + 1 in the user device**) used in this configuration software. For example, if the device variable 0 (flow rate) in the user device corresponds to the register with address 30000, then 30001 should be filled in the configuration software.

Table 2.2 The units in are associated with the default units as follows.

HART device master variable value (PV) = HART device variable n (converted value from default units to currently used units)

## 2.4 Configuring dynamic variables

This function selects up to 4 device variables from the 6 device variables configured in the previous step and maps them to 4 dynamic variables, using the 'Gateway Configuration \ Detailed Settings \ Device Variable Assignment' option group of the configuration software to configure them, as shown inFigure 2.8 shown in Figure 2.8.

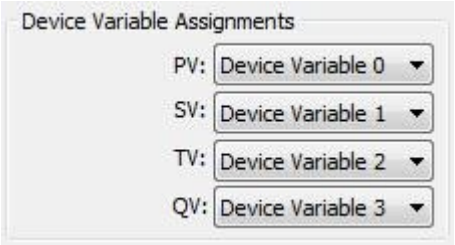


Figure 2.8 Device variable to dynamic variable assignment

As mentioned earlier, there are four dynamic variables specified in the HART protocol, the first variable (i.e., the primary variable PV), the second variable (SV), the third variable (TV), and the fourth variable (QV); the user is0 The six device variables configured by the user in section 2.3 can be mapped to these four dynamic variables without restriction; however, it is worth noting that PV is related to the analog current output to the HART bus, which is described in1.2 As described in Section 1.2, the user can map one of the 6 device variables to PV according to the system needs so that the value of this device variable can be passed to the control system in the form of 4~20mA analog current. It should be noted that the analog current is valid in single point mode. The mapping of device variables to dynamic variables can be seen inFigure 1.1 .

## 2.5 Operational tests

If you have read this far, you have completed the first 3 steps of the HART module quick configuration steps, Configure Modbus Interface, Configure Device Variables and Configure Dynamic Variables. If you are sure that the first 3 steps are correctly configured, please change the option group 'Gateway

Configuration \ Detailed Settings \ Operating Mode' to 'Operation mode', after this step is completed, the HART module will actively and cyclically send Modbus protocol packets to the user board to request the values of the 6 device variables. At this point, the user can switch to the 'Variable Monitoring' interface in the configuration software, as shown inFigure 2.9 Shown in.

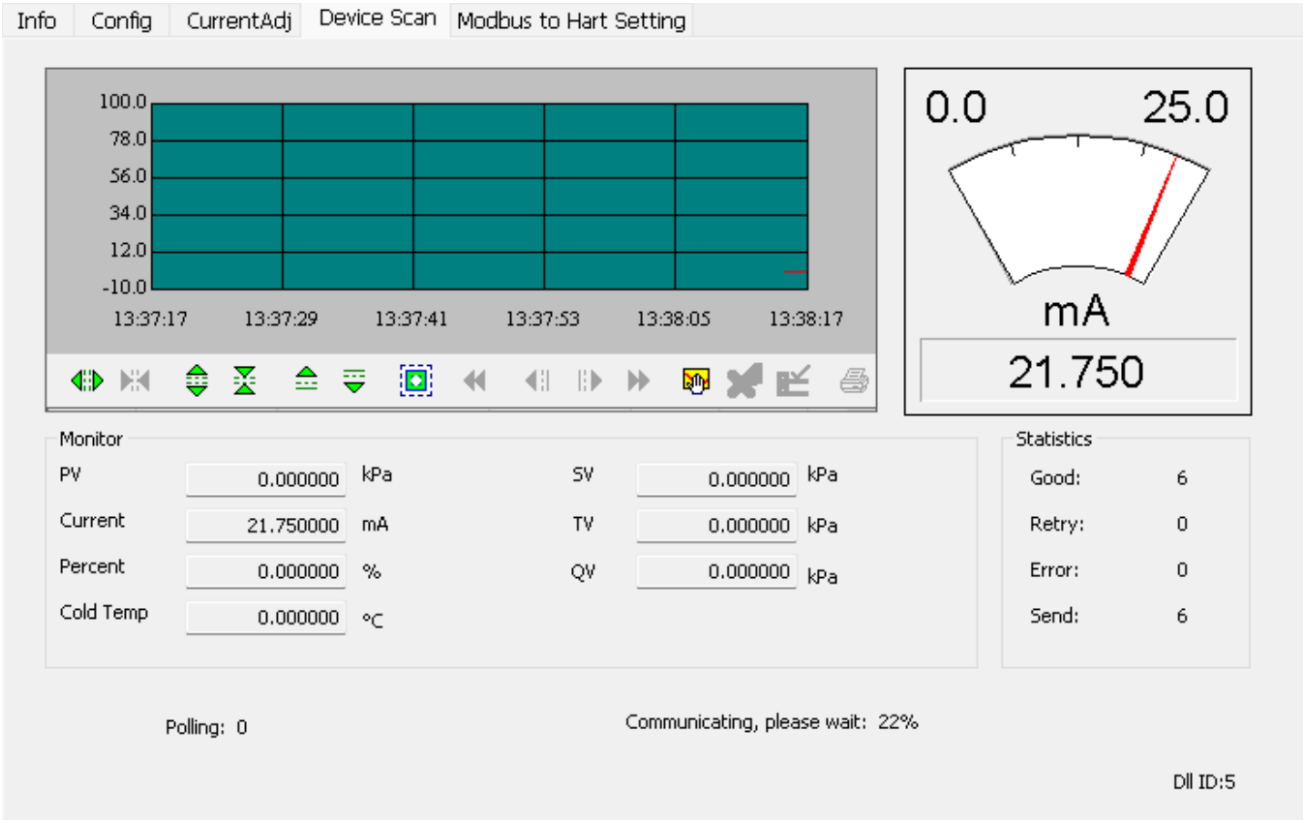


Figure 2.9 Variable monitoring

From this interface, users can monitor their variables in real time.

# Chapter 3 Other configurations

For the configuration of the HART module, the user can convert Modbus device variables to HART device variables by a simple and quick configuration of the Modbus device as described in the Quick Configuration section, and finally send the values of these variables to the HART control system for upper-level system decision making.

In addition to the above quick configuration functions, this configuration software provides seven special sections for users to configure the HART module in more depth, which are described in detail below.

## 3.1 Configure device status

HART device status reflects part of the current HART module status. There are 8 states of HART device status, which are represented by 8 bits and form a byte, 1 represents the state occurrence; this byte of HART device status is represented by the first two bytes of the response frame data field when the HART slave device replies to the master's request. Users can open the device status area through the 'View \ Hide Alarm Window' menu item of the configuration software, as shown inFigure 3.1 The upper right area shown in Figure 3.1.

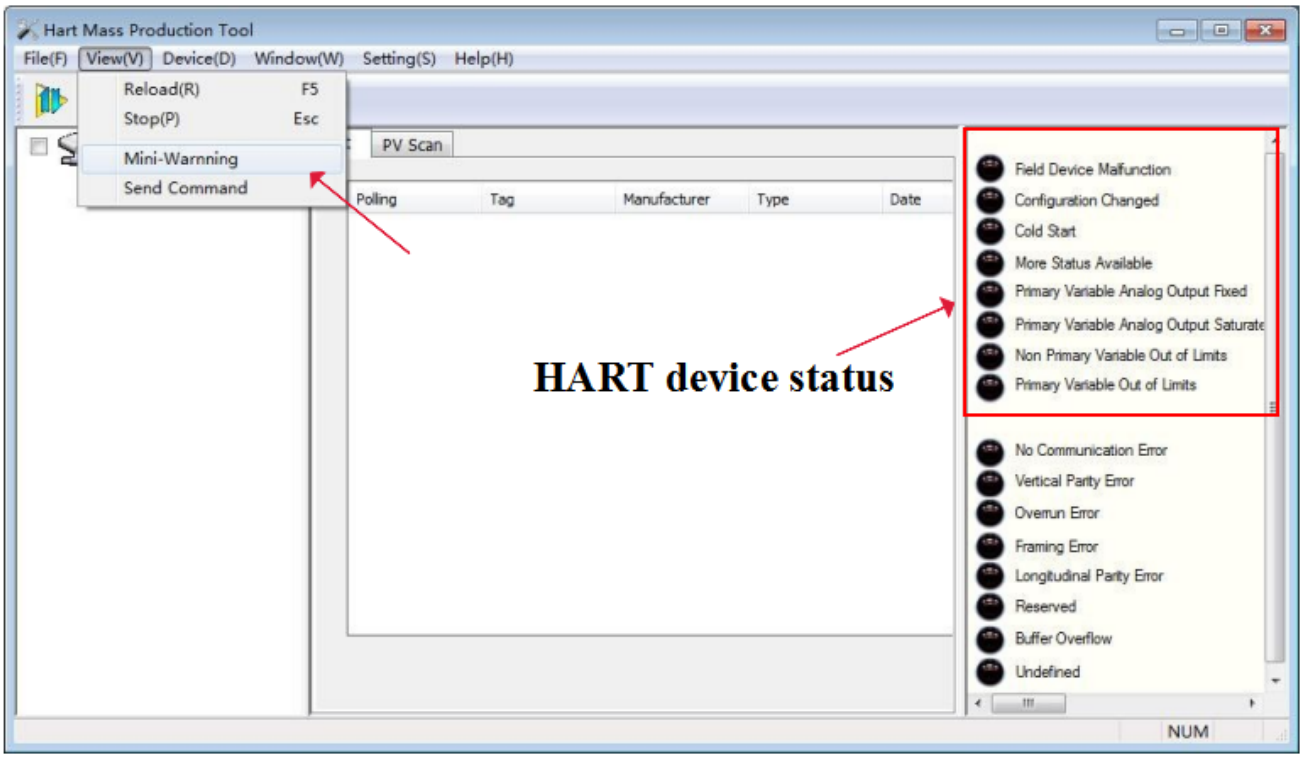


Figure 3.1 HART device status

HART device status can only reflect 8 specific states of HART module, which is not enough to reflect some special device states of user's Modbus device; therefore, user can configure the state of Modbus device to HART additional through the 'Gateway Configuration \ Detailed Settings \ Device Status' option group of configuration software. The device state parameter can be used to reflect some current states in the user's Modbus device.

In the HART module, the first 3 bytes of the additional device status are used. The low 6 bits of the

first byte represent the success of reading the channel values of the 6 device variables respectively (0: success, 1: fault or configuration error); the other 2 bytes represent the 16 states of the user Modbus device respectively.

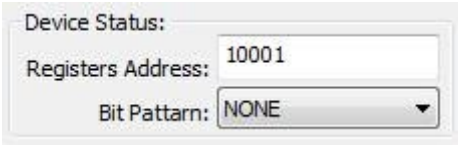


Figure 3.2 Device Status

The device status parameter is mapped from a register representing the device status of the user device, each bit can represent two states, the specific use of which bits of the device status is determined by the 'Bit mode', using Bit (1~8) corresponding to 8 bits of HART additional device status byte 2, respectively, Bit (9~16) correspond to the 8 bits of HART additional device status byte 3, respectively, from low to high, as shown inFigure 3.3 As shown in Figure 3.3.

'Register address' is the register address where the user's device status is located plus 1. After the configuration is completed, click the 'Apply' button to save the configuration to the HART module, then, when the HART module is in normal operation mode, the user's device status will be read by the HART module periodically sends Modbus request packet (default read coil) to read the status value.

In this configuration software, for the time being, there is no graphical interface support for reading the device status from the user's Modbus device, which can be read by sending HART general command 48. However, the user can visualize each bit of the HART attached device status by the software that can parse the DD file, as shown inFigure 3.3 shown in Figure 3.3.

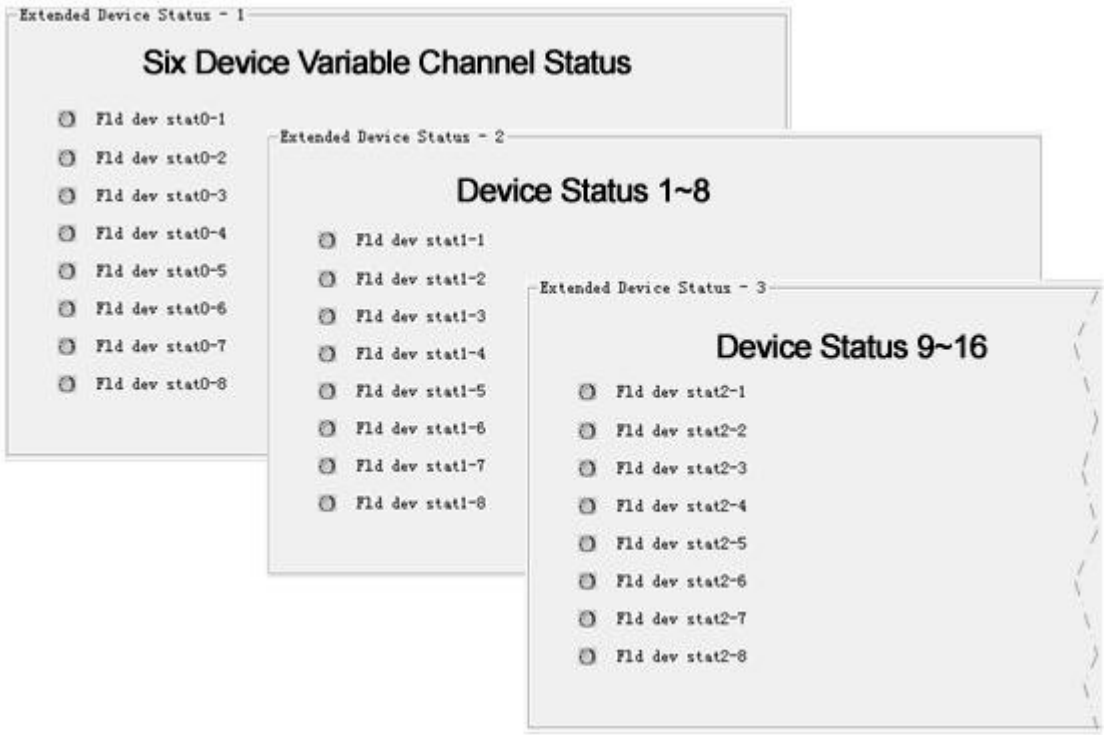


Figure 3.3 HART add-on device status

The HART module is a generic module, so the DD file we provide is also a generic version, for each bit of the HART additional device status is provided in the form of '**Fld dev stat**B-b'; if users need to assign a name to each status, they can provide the name to us. We can customize the DD file that belongs to you

exclusively.

## 3.2 Configure PV range

Users can configure the source and read/write mode of the upper and lower limits of the primary variable range through the 'Gateway Configuration \ Detailed Settings \ PV Range' option group.

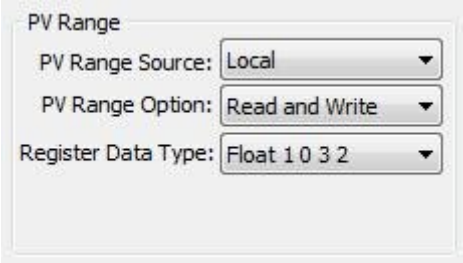


Figure 3.4 PV range operation

'PV range source' represents whether the upper and lower range limits of the primary variable are configured manually by the configuration software or read remotely from the user's Modbus device. 'PV range operation mode' means whether the upper and lower range limits stored in the user's Modbus device can be read or written in the remote mode. 'Register data type' refers to the format in which the upper and lower range limits stored in the user's Modbus device are stored in the register in remote mode.

BelowFigure 3.5 briefly depicts the mapping of device variable 0 to the primary variable PV in the case of both 'local' and 'remote' modes.

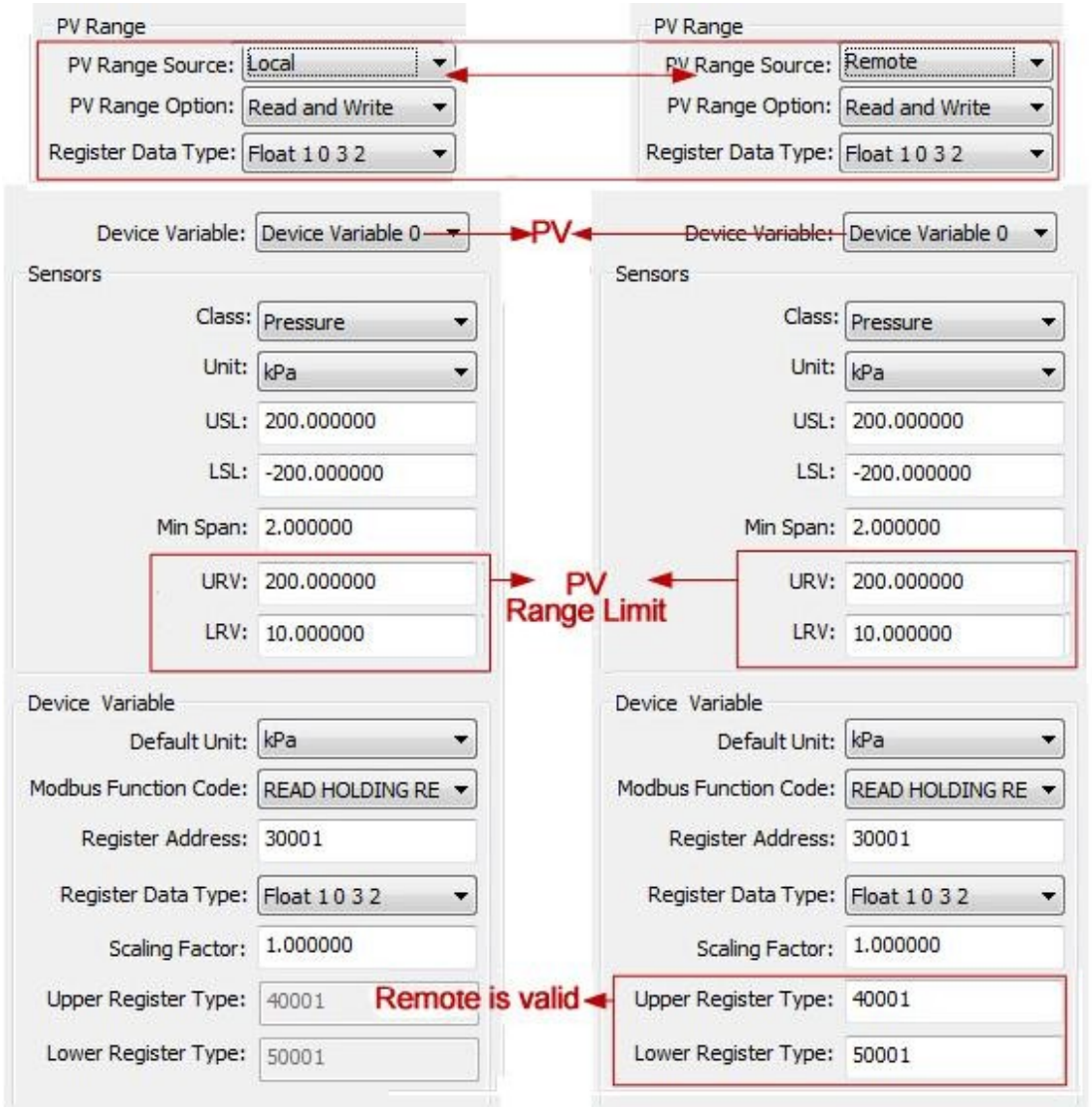


Figure 3.5 Example of PV range operation

In the above figure, if the device variable 0 is not mapped as the primary variable, the upper and lower range limits and their register addresses are not operable. When 'PV range source' is set to 'Remote' and the operation mode is set to 'Read and Write', the user sets the values of upper and lower range limits and their register addresses, and then clicks the After 'Apply' button, the HART module will send the upper and lower range values to the user's Modbus device with the set data type (default with function code 16, write multiple registers); when it is 'Read Only', the HART module will periodically When it is 'read-only', the HART module will periodically read the upper and lower range values from the upper and lower range registers specified in the user's device (default read hold register).

## 3.3 Configure the scaling factor

The HART module is also specially equipped with a scaling factor parameter for each device variable to facilitate user scaling of the data, converted as follows

**HART device variable n = Modbus device variable n * Scaling factor**

If the user does not need to perform numerical scaling, the value of the scaling factor does not need

to be modified and the factory default is 1.0.

## 3.4 Commissioning calibration area operations

The function of the debug and calibration area is for the user to use when configuring the HART module for the first time, through the 'Coil' and 'Register' in the 'Gateway Configuration \ Calibration' option group of the configuration software to debug the device. ' to debug the device, the function area is shown inFigure 3.6 Shown in.


Figure 3.6 Debugging the calibration function

When users use the HART module for the first time, after completing the hardware connection and configuring all the communication parameters in the 'Gateway Configuration \ Detailed Settings \ Modbus Variables' option group, users can use the following optionsFigure 3.6 If the returned and written data are correct, it means the hardware connection and Modbus communication parameters between HART module and user's device are correct; if not, further check the hardware connection or software configuration is needed.

## 3.5 Data Retention and Recovery

The data saving and restoration function is implemented through the 'Gateway Configuration \ Calibration \ Restore Factory Settings' option group of the configuration software, as shown inFigure 3.7 shown.


Figure 3.7 Data saving and recovery

- ***Restore to factory default value***: restore all configuration data in the HART module to the initial value of the system, users need to use caution, after the implementation of this function, all user-

configured data will be lost.

- ***Save to factory settings***: all configuration information of the user is saved to factory values (the data has a backup in the HART module).
- ***Restore to factory settings***: restores the user configuration information backed up in the HART module when 'Save to factory' was last executed to the current state of use.

## 3.6 Batch Download

The batch download feature is a quick configuration feature designed for manufacturers to facilitate the configuration of multiple HART modules. This is achieved through the 'Gateway Configuration \ Batch Download' option group of the configuration software, as shown inFigure 3.8 shown in.

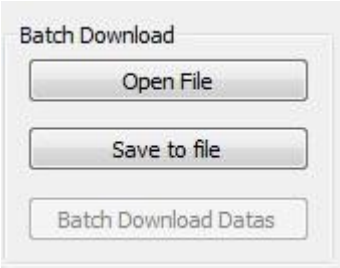


Figure 3.8 Batch Download

When users have more than one HART module needing the same configuration operation, just finish configuring one HART module, then click 'Save to file' button to save the configuration information of the current HART module as a file; when configuring other HART modules again, just click 'Open File' button to read in the configuration information saved in the file, and then click 'Batch Download Data' button to download all the configuration information displayed in the current page to the HART module to complete the configuration.

# Chapter 4 Technical Specifications

## 4.1 Basic parameters

| Serial number | Content | Indicators |
|---|---|---|
| 1 | Bus power | 11.9~35V |
| 2 | Bus Interface | 2-wire 4-20mA+HART |
| 3 | Modbus interface | TTL (supports MODBUS RTU master communication protocol) |
| 4 | Isolation | No isolation of the bus from the Modbus interface |
| 5 | Show | None |
| 6 | Temperature range | -40～85 ℃ |
| 7 | Humidity range | (5 to 95)%RH |
| 8 | Storage temperature | -40 ~ 85℃ |
| 9 | Start-up time | ≤5 seconds |
| 10 | Update time | 0.2s |
| 11 | Damping adjustment | Time constants 0 to 32 seconds |
| 12 | Alarm signals | High and low alarm current 21.75mA/3.7mA; upper/lower limit current 20.8mA/3.8mA |
| 13 | Current accuracy | 0.03%FS (room temperature) |
| 14 | Current temperature drift | 50PPM/°C |
| 15 | Intrinsically safe level | Ex ia IIC T4/T6 Ga |
| 16 | Electromagnetic compatibility | In combination with the base plate it is possible to design and implement equipment that meets the following requirements.<br>Comply with the immunity requirements for industrial sites in GB/T 18268.1-2010 "Electromagnetic Compatibility Requirements for Electrical Equipment for Measurement, Control and Laboratory Use Part 1: General Requirements |

Table 4.1 Basic parameters

# Chapter5 Problem Solving

Table 5.1 Problem Solving

| Serial number | Phenomenon | Reason | Exclusion method |
|---|---|---|---|
| 1 | Output current is 0 | a. Power failure<br>b.Wire break | a. Repair power supply<br>b.Check the wire |
| 2 | Current fixed at 21.75mA or 3.70mA | Modbus device and HART module communication failure | Check Modbus communication |
| 3 | Current fixed at 4 mA | The meter is in multi-point mode | Changing the slave address in standalone mode |
| 4 | The instrument cannot communicate | a.Connection failure<br>b.Multi-point mode | a. Check the circuit connection<br>b.Perform network checks |
| 5 | HART communication light is not on | a.No HART communication<br>b.Power supply failure | a. Check the HART host device and HART debugging demodulator<br>b. Check the power supply and connection |
| 6 | Modbus communication light is not on | a.No Modbus communication<br>b. From equipment failure | a.Check the Modbus device<br>b. Checking from equipment and connections |
| 7 | Modbus communication works, but dynamic variable readings are incorrect | a. The configuration of the device variable corresponding to the dynamic variable is incorrect<br>b.Incorrect configuration of Modbus communication parameters | a. Check the data register address and data type parameter of the corresponding device variable<br>b. Check baud rate, parity bits |

# Appendix 1 Selection Code Table

| MOD-HART | MC0310 Modbus to HART Built-in Module |
|---|---|

| Code | Master-Slave |
|---|---|
| M | Master Station |

| Code | Module format |
|---|---|
| N | General |

| Code | Hardware Interface |
|---|---|
| T | TTL level |

| Code | Software Interface |
|---|---|
| M | Modbus RTU |

| Code | Bus interface on module |
|---|---|
| N | No bus interface |

MOD-HART- M N T M N -- Selection Example

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