G0312

Ethernet-APL Gateway

User Manual

MICROCYBER

Warning

1. Users are prohibited from disassembling or installing the gateway on their own.
2. Please check whether the power supply voltage of the equipment meets the power supply voltage requirements in the user manual.

Version: V1.0

Disclaimer

This manual has been reviewed to ensure consistency with the hardware and software described. Since errors cannot be completely eliminated, absolute consistency cannot be guaranteed. However, we will regularly review the data in this manual and incorporate any necessary corrections in subsequent editions. Suggestions for improvement are welcome.

Company Profile

Microcyber is a high-tech enterprise founded by the Shenyang Institute of Automation, Chinese Academy of Sciences. Microcyber specializes in the development, production, and application of networked control systems, industrial communications, and instrumentation. Microcyber has undertaken numerous national science and technology projects, including major national science and technology projects, the National High Technology Research and Development Program (863 Program), and the Intelligent Manufacturing Equipment Development Special Project. Microcyber serves as a supporting organization for the National Engineering Research Center for Networked Control Systems.

Microcyber has successfully developed the first fieldbus protocol master stack in China that has passed international certification, the first fieldbus instrument that has passed national certification, and the first safety instrument in China that has passed German TÜV certification. Together with other units, Microcyber presided over the formulation of the first industrial Ethernet protocol standard EPA and the first industrial wireless communication protocol standard WIA-PA in China, which have become IEC international standards.

Microcyber's products and technologies have won two second-class National Science and Technology Progress Awards, one National Science and Technology Invention Award, one first-class Science and Technology Progress Award of the Chinese Academy of Sciences, and one first-class Science and Technology Progress Award of Liaoning Province. The products are exported to developed countries such as Europe and the United States. Top companies in the industry such as Emerson in the United States, Rotork in the United Kingdom, and Bifold in the United Kingdom have all adopted Microcyber's key technologies or key components in their products and successfully completed more than 200 large-scale automation engineering projects.

Microcyber is a member of FCG organization and a member of Profibus User Organization (PNO).

Microcyber has successfully passed ISO9001:2008 quality management system certification and ISO/TS16949 quality system certification for the automotive industry. Its outstanding R&D team, extensive experience in automation engineering design and implementation, industry-leading products, extensive market network, and excellent corporate culture have laid a solid foundation for the company's entrepreneurship and sustainable development. We strive to carry the aspirations of our employees, create customer value, and promote corporate development.

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

Table of contents

Chapter 1 Overview

The G0312 Ethernet-APL gateway, developed by Microcyber, complies with the 10BASE-T1L (IEEE 802.3cg) standard. It supports bus power, a communication rate of 10 Mbps, and a maximum communication distance of 1000 meters. The G0312 Ethernet-APL gateway software protocol supports Modbus-RTU master and HART-IP slave functions, allowing users to quickly upgrade their Modbus devices to HART-IP devices supporting the APL physical layer. The G0312 is also part of the Microcyber G series of gateways. This series of gateways features the same size, interfaces, easy upgrades, and simple configuration, making it an ideal choice for users to quickly develop fieldbus devices. The G0312 Ethernet-APL gateway is shown in Figure 1 below:

Figure 1 G0312 Ethernet-APL gateway

1.1 Gateway features

1.1.1 Same dimension

The Microcyber G series gateways have the same dimensions: 112mm*99mm*22.5mm.

1.1.2 Easy to upgrade

By replacing different gateways in the Microcyber G series, you can implement devices with different protocols.

1.1.3 Easy to configure

Use Microcyber's dedicated configuration tool for configuration, which is simple to operate and easy to use.

1.2 Dimension

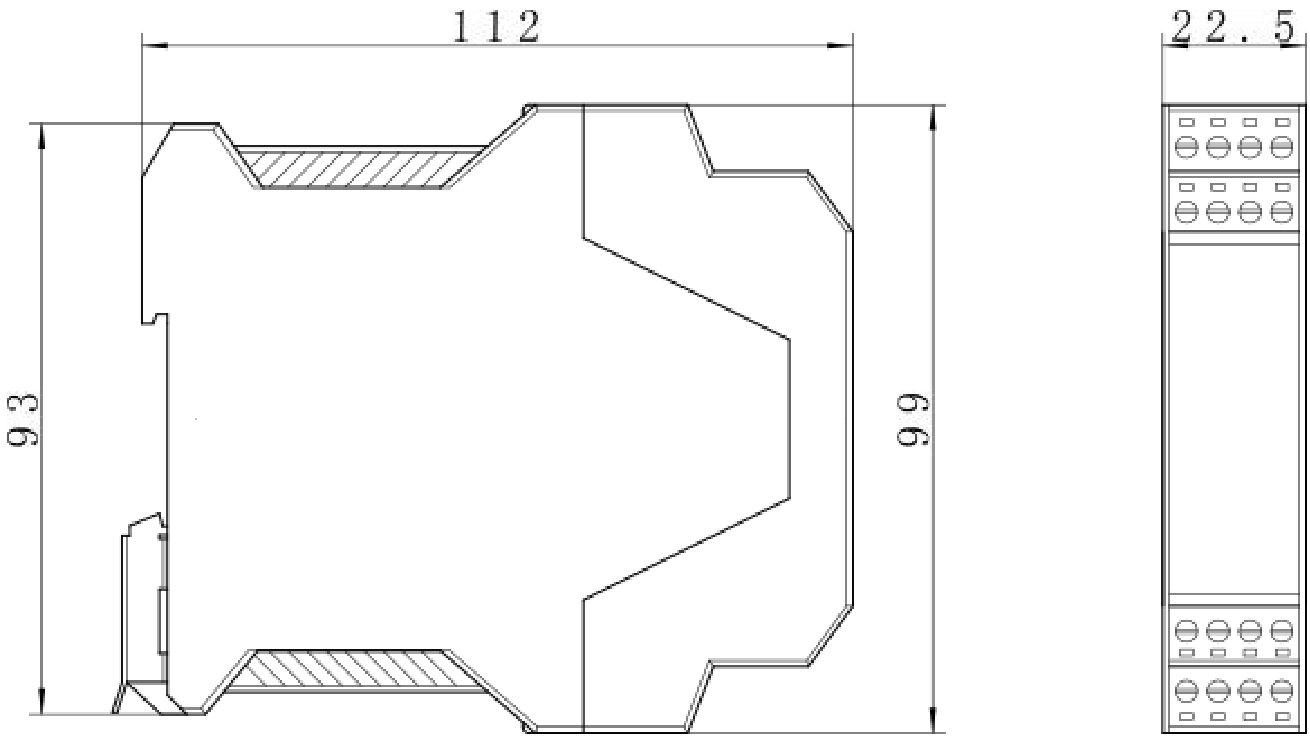

Figure 2 G0312 dimension (Unit: mm)

Chapter 2 Gateway installation and working principle

2.1 Gateway external interface

The interface distribution and definition of the G0312 Ethernet-APL gateway are shown in Table 1 below:

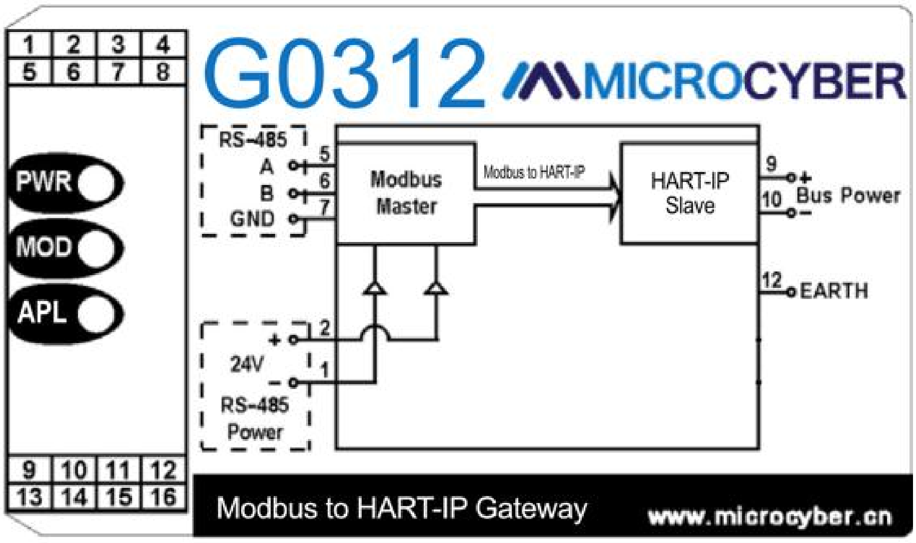

Table 1 Interface definition

1	24VDC -	2	24VDC +
3	NC	4	NC
5	RS-485A	6	RS-485B
7	RS-485GND	8	NC
9	BusPower+	10	BusPower-
11	NC	12	EARTH
13	NC	14	NC
15	NC	16	NC

2.2 Conversion logic

The G0312 Ethernet-APL Gateway converts Modbus devices into HART-IP devices supporting the Ethernet-APL physical layer. The G0312 Gateway supports four dynamic variables and six device variables. Data collected by Modbus devices is configured into the gateway's device variables via Modbus registers. This data is then mapped from device variables to dynamic variables, and then output to the device. The conversion logic is shown in Figure 3 below:

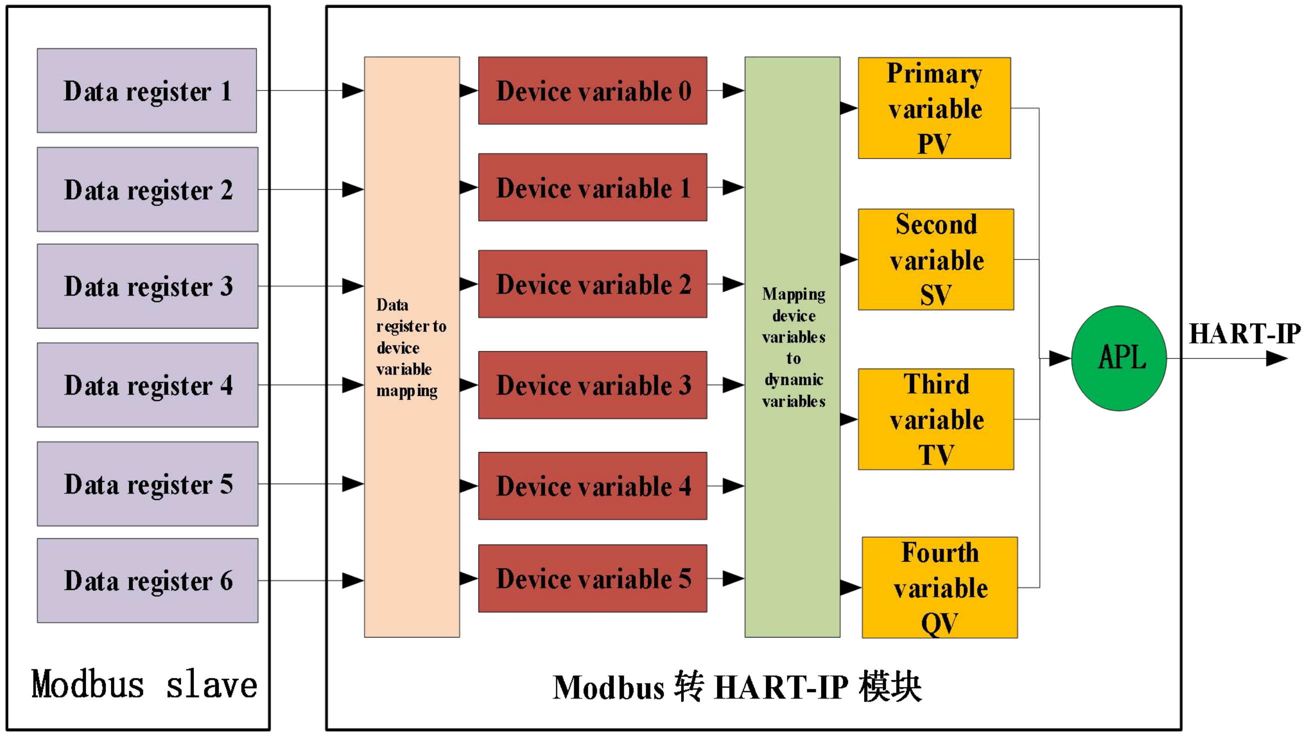

Figure 3 G0312 Data mapping logic diagram

As a universal gateway, the G0312 gateway can adapt to all Modbus instruments on the market. When using the G0312 gateway, users can use the HART-IPMPT configuration software provided by Microcyber to complete the relevant function configuration of the gateway. The specific configuration information includes the following:

- Configure Modbus communication parameters, such as slave address, communication rate, and communication verification method
- Configure data storage method, including data register address, data type, byte order, etc.
- Configure HART-IP dynamic variable data registers to map to device variables, and device variables to map to dynamic variables
- Configure IP address, etc.

After the above configuration, the HART-IP master device can access the dynamic variables in the G0312 gateway using HART-IP commands, thereby realizing the digital transmission of data in Modbus data registers (such as the instantaneous flow value of the flow meter) to the HART-IP master.

2.3 Configure interface

The G0312 gateway can realize the conversion function between Modbus protocol and HART-IP protocol. The gateway can be connected to the user device through RS485 and externally connected to the HART-IP master device through the Ethernet-APL physical layer. The gateway configuration wiring diagram is shown in the figure below.

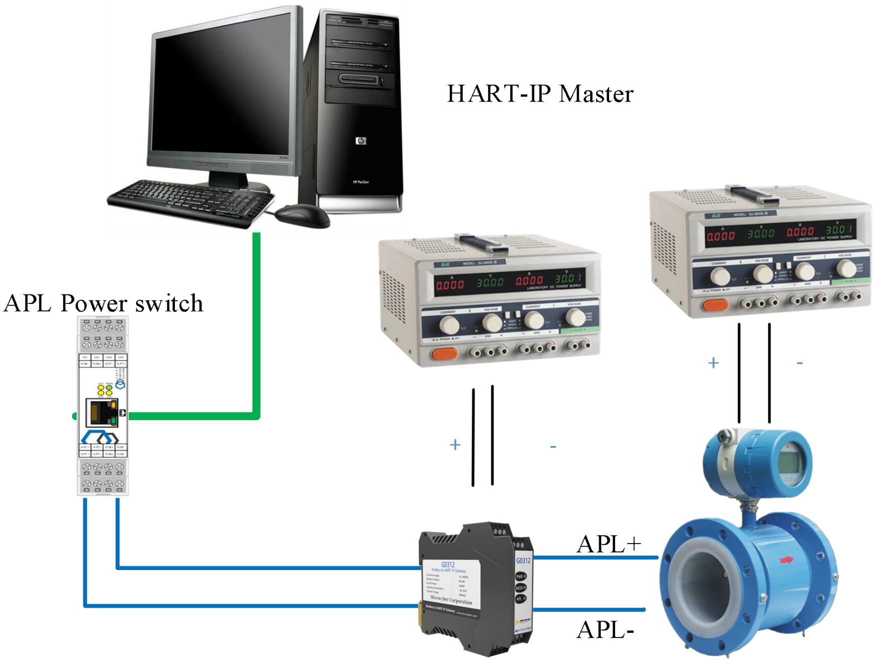

Figure 4 G0312 Gateway Configuration Wiring Diagram

Using a PC as the client device and running Zhongkebowei's HART-IP MPT configuration software, the APL power switch is connected to the PC via conventional Ethernet. The Ethernet-APL interface of the power switch is connected to the gateway device and powers the gateway. The gateway is connected to the on-site Modbus device via RS485. Once connected, the HART-IP MPT configuration software can be used to configure the G0312 gateway.

Chapter 3 Device configuration

3.1 Configuration tools introduction

The HART-IP MPT host configuration software is a configuration tool specifically developed for the G0312 gateway. It features HART-IP client functionality, enabling communication and configuration with the G0312 gateway via the HART-IP protocol. The HART-IP MPT configuration software initialization interface is shown in Figure 5 below. The software can only access one device at a time.

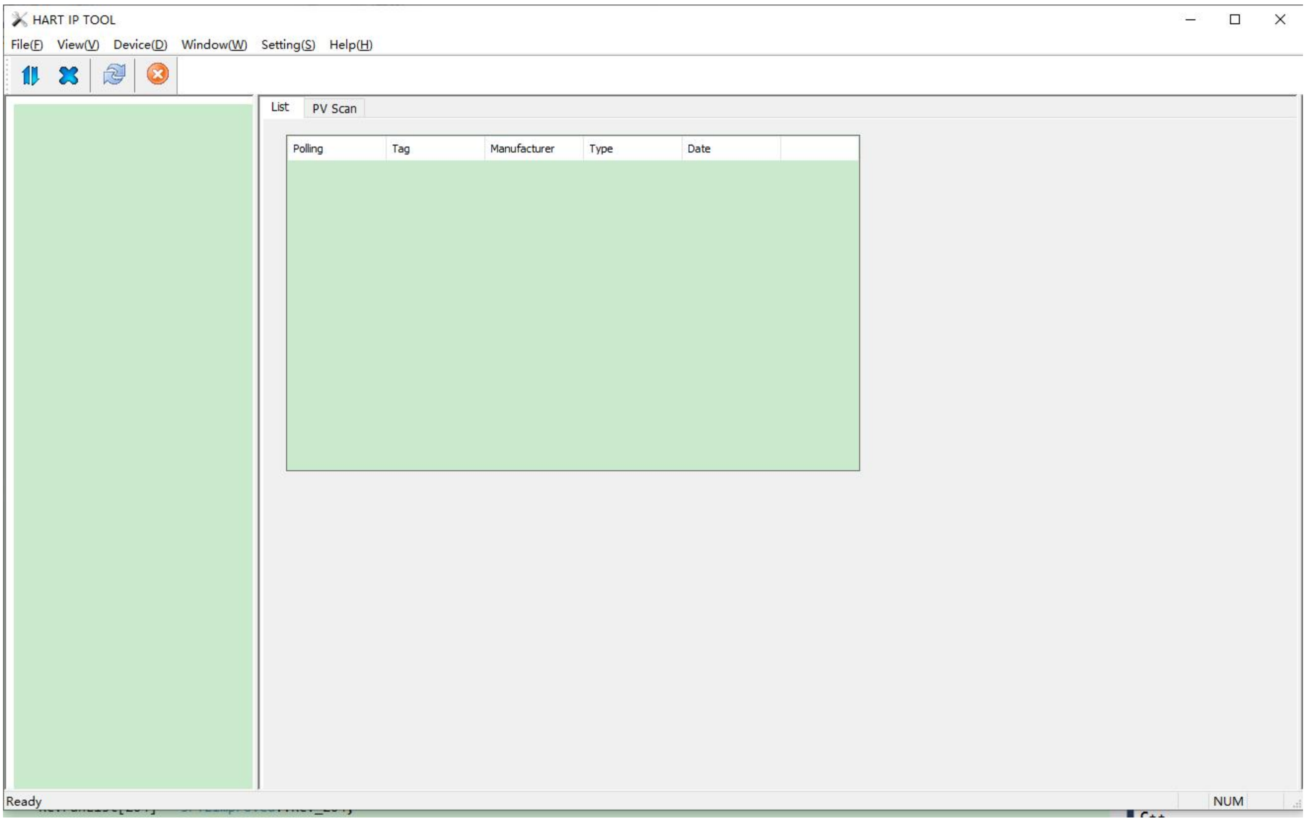

Figure 5 Configuration software icon and initial interface

Click Settings and select Network Settings from the pop-up menu, or click the icon to bring up the Network Settings dialog box. In the Network Settings dialog box (see the figure), set your network information. You can select the network protocol, TCP or UDP. After selecting the network protocol, enter the device IP address, for example: 192.168.2.151. The default port is 5094. Click OK to connect to the network. If the connection is successful, the device information will be displayed in the list on the left, formatted as the IP address and port number. Figure 7 below shows the device display when the connection is successful.

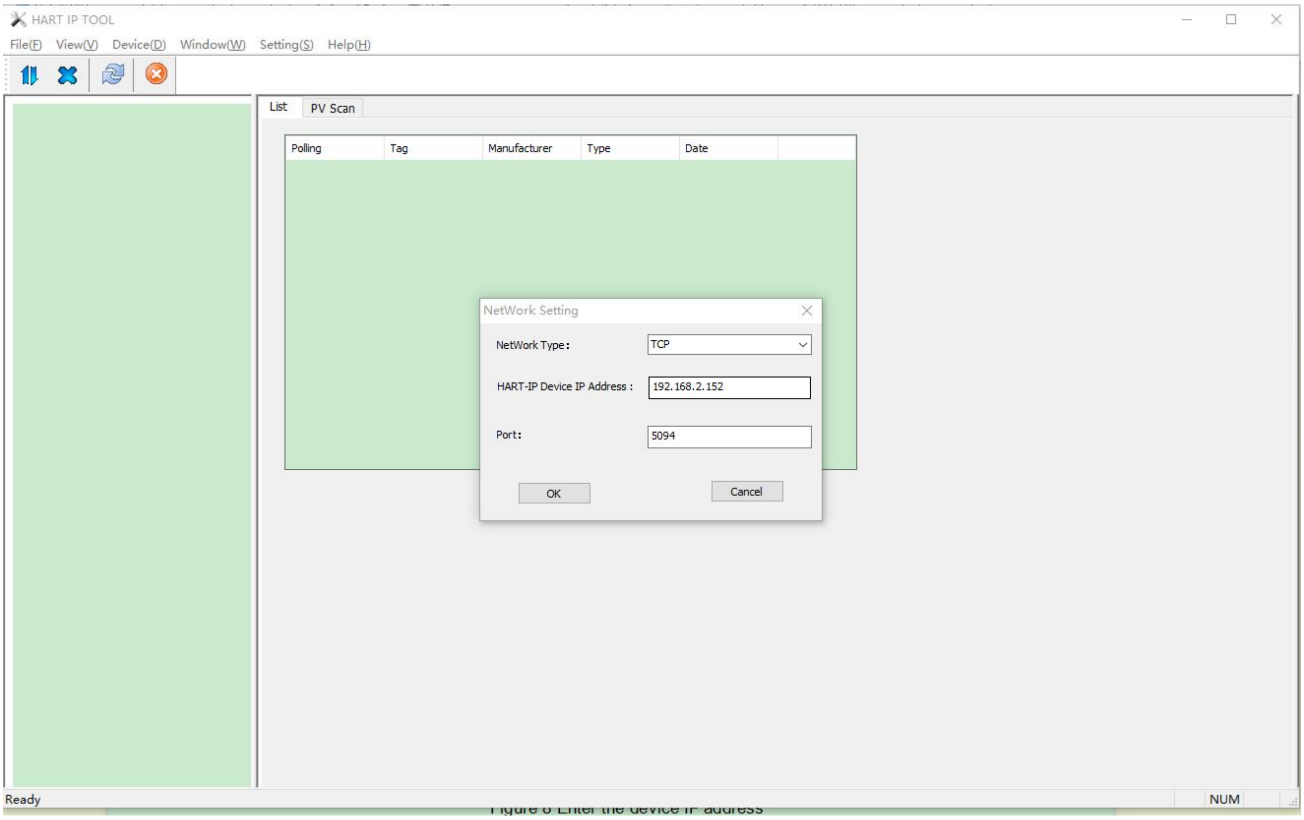

Figure 6 Enter the device IP address

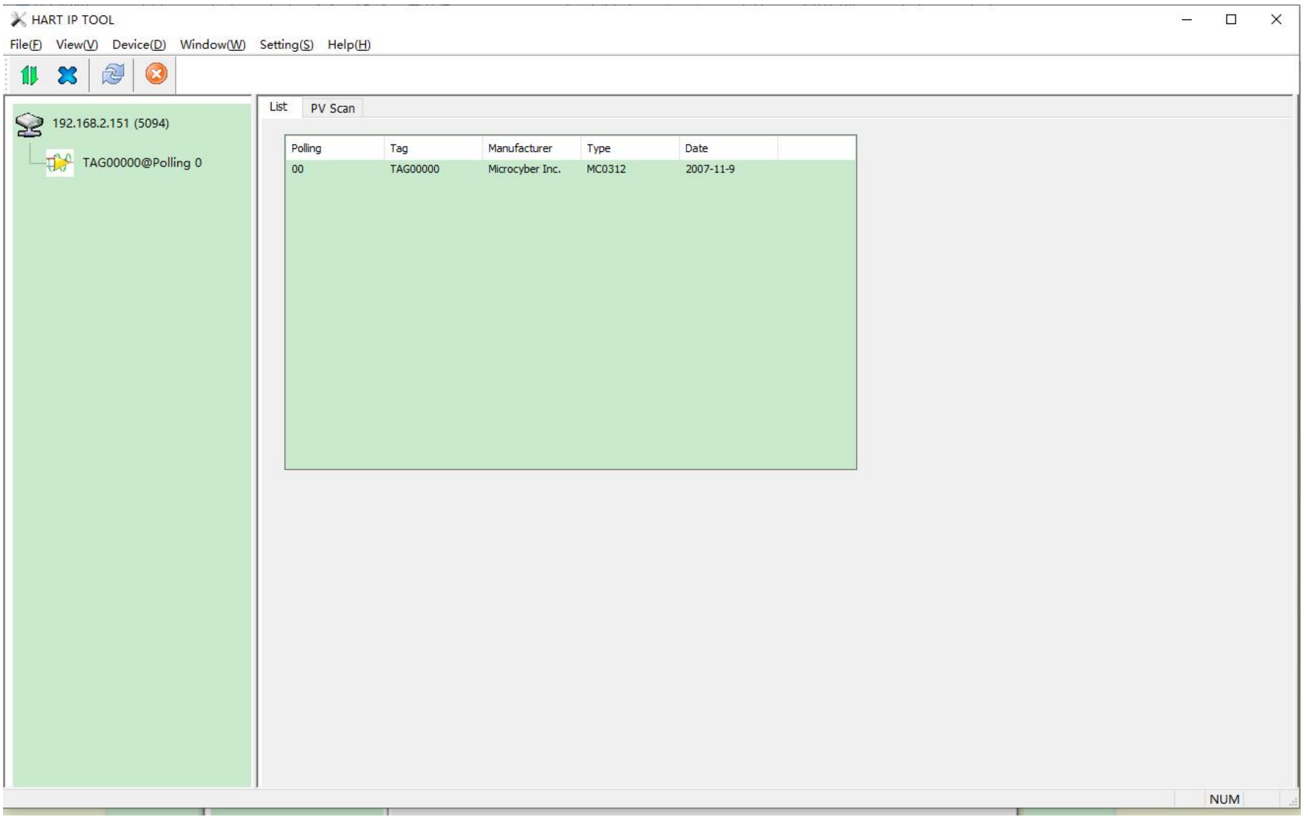

Figure 7 Display successfully connected devices

Click the Basic Information tab and the view changes as shown below:

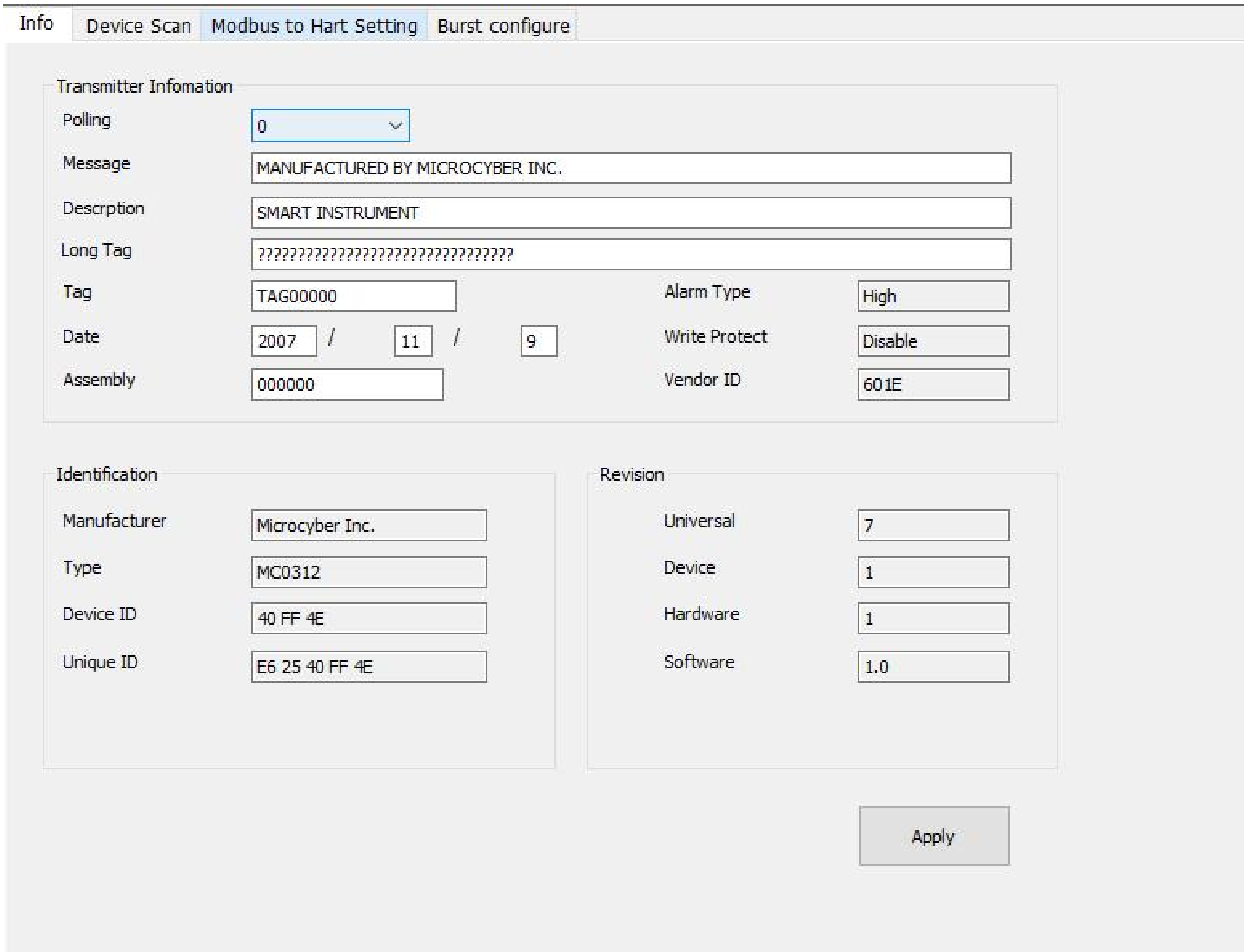

Figure 8 G0312 Gateway basic information page

The "Gateway Configuration" option is mainly used to configure the Modbus communication parameters of G0312. After configuration, G0312 can communicate with Modbus instruments and obtain instrument data. The gateway configuration interface is shown in the figure below:

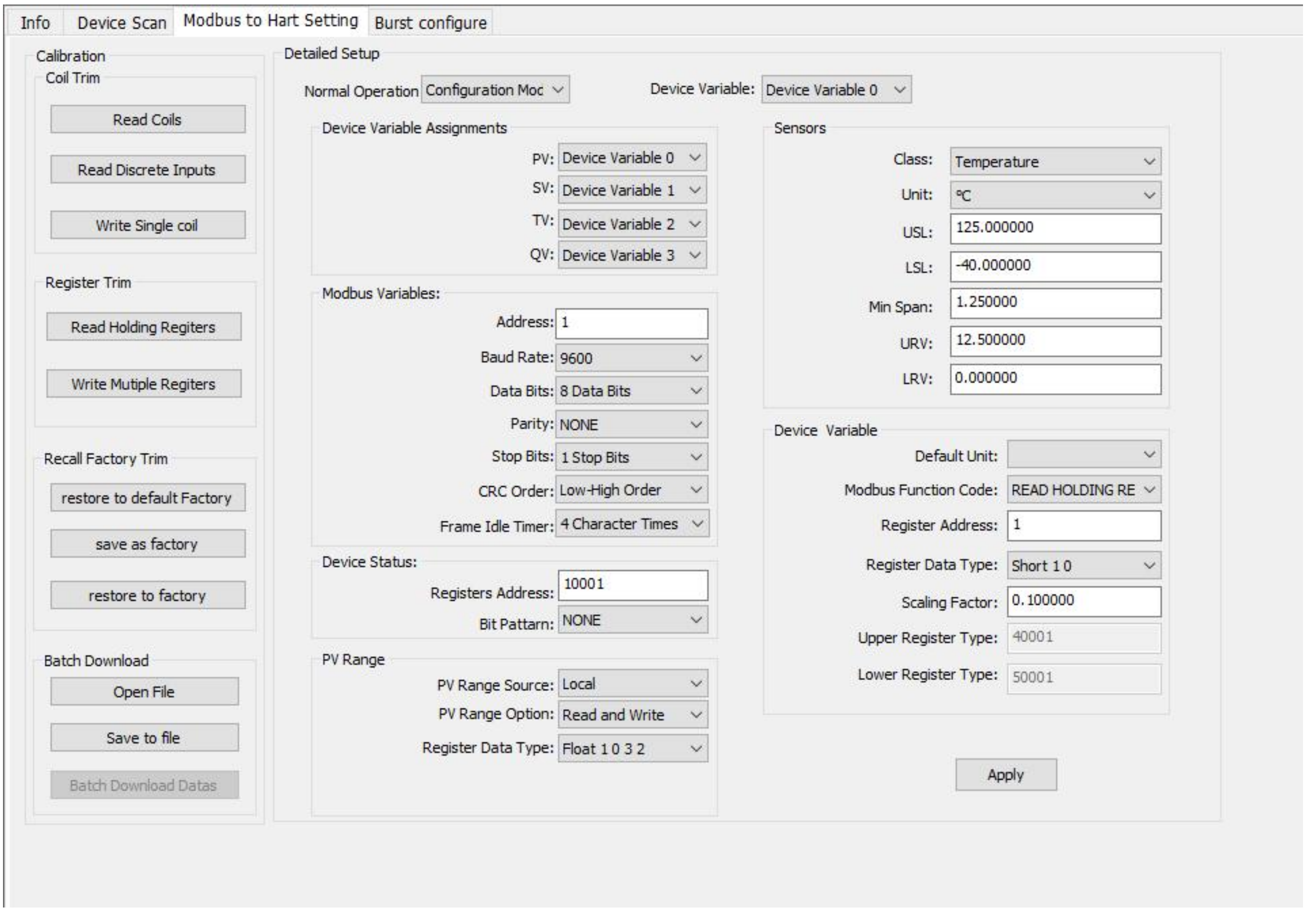

Figure 9 Gateway configuration tab

Note: If you want to configure the G0312 gateway, 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 configuration mode, the G0312 gateway will not actively send Modbus request data packets to the user device in a loop.

After the configuration is complete, you need to set the operation mode to operation mode.

3.2 Configuring the Modbus interface

In order to ensure that the G0312 gateway can communicate normally with the user's Modbus instrument, it is necessary to use the host computer configuration software to configure the Modbus communication parameters. Using the configuration software's 'Gateway Configuration\Detailed Settings\Modbus Variables' option group, users can configure the Modbus communication parameters according to their own Modbus device interface characteristics, as shown in Figure 10:

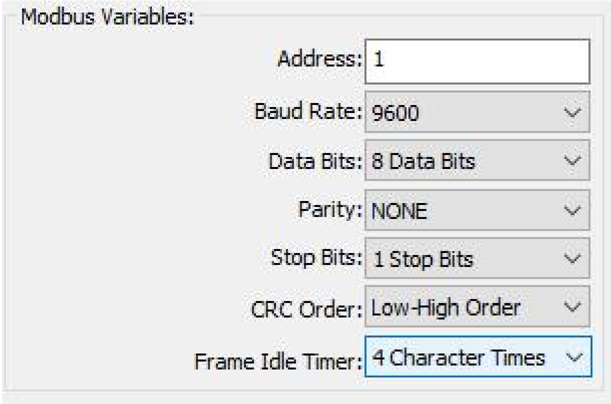

Figure 10 Modbus communication parameters

Parameter meaning:

Table 2 Modbus communication parameter meaning

Function nsme	Use	Default parameters
Address	User Modbus slave device address	1
Baud rate	G0312 Communication baud rate between gateway and user equipment	9600bps
Data bits	G0312 Length of communication data between the gateway and the user equipment	8
Verify	Verify mode: odd verify, even verify, no verify	NONE
Stop bit	Numbers of stop bit	1
CRC Byte order	The sending order of the last 2 bytes CRC of the Modbus protocol data packet	Low-High Order

Normal communication is guaranteed only when all communication parameters in Table 2 are fully consistent with the user's Modbus device interface characteristics. After setting the parameters, click the 'Apply' button to save the configuration data to the G0312 gateway.

3.3 Configure device variables

Device variable configuration involves assigning process variable data (e.g., instantaneous flow, cumulative flow, flow velocity, medium density, medium temperature, and other variables) from the user's Modbus device to the HART-IP device variables of the G0312 gateway. The G0312 gateway supports the configuration of six device variables. This is done using the 'Gateway Configuration\Detailed Settings\Device Variables' option group in the HART-IP MPT configuration software. The specific information to be configured is shown in Figure 11:

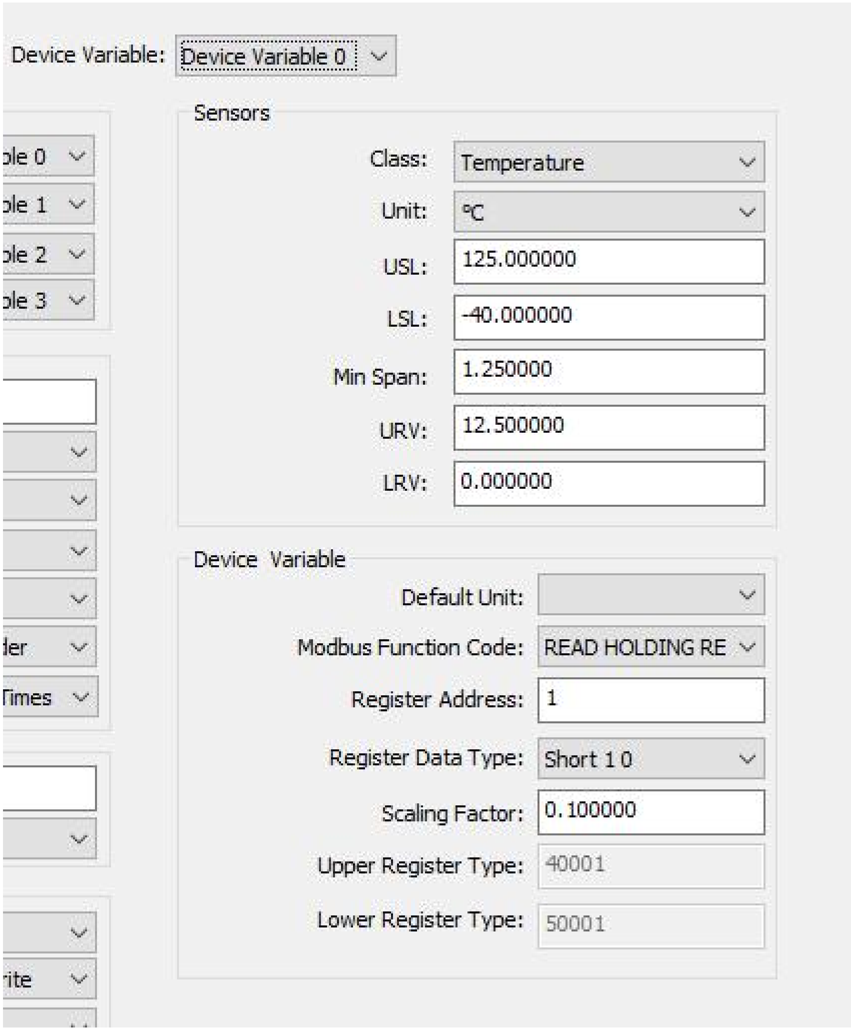

Figure 11 Device variable configuration

The meaning of each item used in quick configuration is shown in Table 3.

Table 3Device variable configuration

Device variable n (n=0~5)	
Function name	Use
Type	User Modbus device data type, select the corresponding item in the 'Type' drop-down list according to different types (for example: volume flow, temperature, pressure, density, etc.).
Unit	The unit currently used and displayed for HART-IP device data (PV unit)
Sensor range upper limit	The maximum limit value of the device variable that the user's Modbus device can collect
Sensor range lower limit	The minimum limit value of the device variable that the user's Modbus device can collect
minimum span	The range span is generally set to the upper limit of the

	sensor range divided by 100
Upper range limit	Between the upper and lower limits of the sensor range
Lower range limit	Between the upper and lower limits of the sensor range
Default unit	The unit of the variable value read from the Modbus device
Modbus function code	Function code to be sent when reading device variable n
Register address	Data register address of device variables in Modbus device
Register data type	Byte order of device variables in Modbus data registers

The upper and lower limits of the range can only be modified when the current device variable is mapped as the primary variable. The upper and lower limits of the range of the device variable here are the same parameters as the upper and lower limits of the range in the HART-IP device.

Users can configure the process variables in their Modbus devices to these 6 device variables according to their number and importance. After configuration, click the 'Apply' button to save the data to the G0312 gateway.

Note: The configuration software uses the data register address = the data register address in the user device + 1. For example, if the device variable 0 (flow) in the user device corresponds to the register address 30000, then the configuration software should enter 30001.

3.4 Configure dynamic variables

HART-IP supports four dynamic variables: PV, SV, TV, and QV. Using the HART-IP MPT configuration software, any four of the six device variables can be mapped to the four dynamic variables of HART-IP. Use the configuration software's 'Gateway Configuration\Detailed Settings\Device Variable Assignment' option group to configure, as shown in Figure 12.

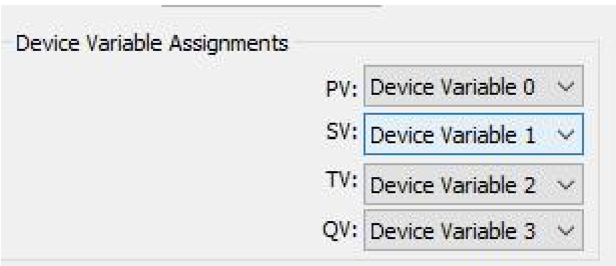

Figure 12 Assigning device variables to dynamic variables

The HART-IP protocol specifies four dynamic variables: the primary variable (PV), the secondary variable (SV), the tertiary variable (TV), and the fourth variable (QV). The six device variables configured by the user in the node can be mapped to these four dynamic variables without any restrictions

3.5 Variable monitoring

After completing the Modbus communication parameter configuration, device variable configuration, and dynamic variable configuration in the above configuration steps, change the 'Gateway Configuration\Detailed Settings\Operation Mode' option group to 'Operation Mode'. After completing the configuration, the G0312 gateway will cyclically send Modbus protocol request data packets to the user device to obtain the values of the six device variables. Open the 'Variable Monitoring' interface of the configuration software to monitor the dynamic variables of HART-IP, as shown in Figure 13:

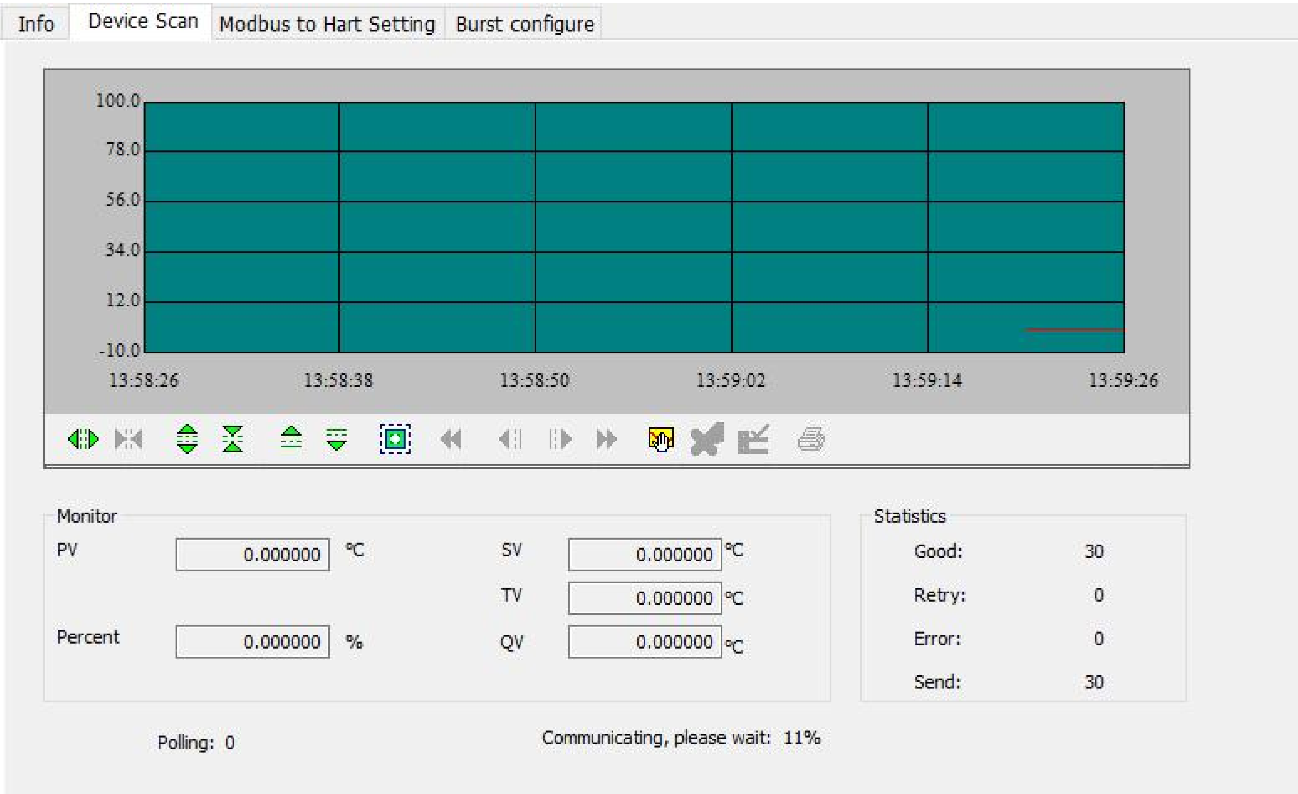

Figure 13 Variable monitoring

3.5.1 status monitoring control

Drag the right side to display this interface, which displays the status information of the device.

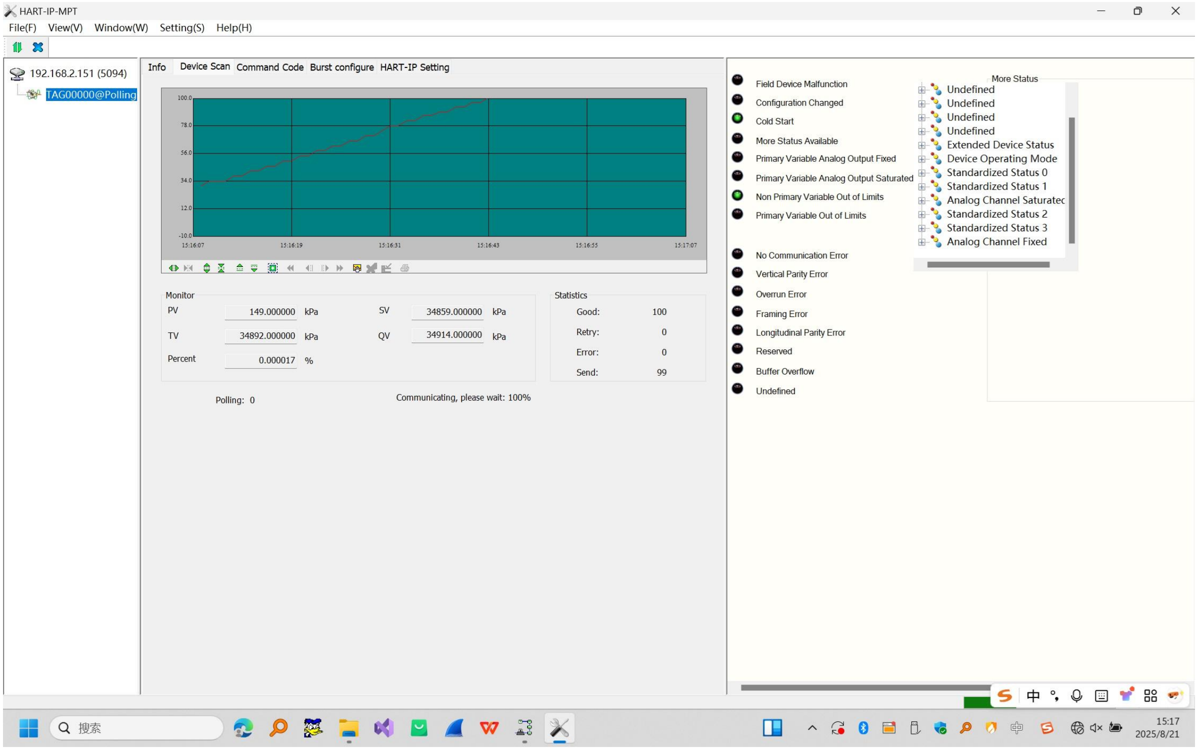

Figure 14status monitoring control

3.6 HART-IP Set up

Click the HART-IP tab to enter the IP configuration interface, as shown in Figure 15. The operations are as follows.

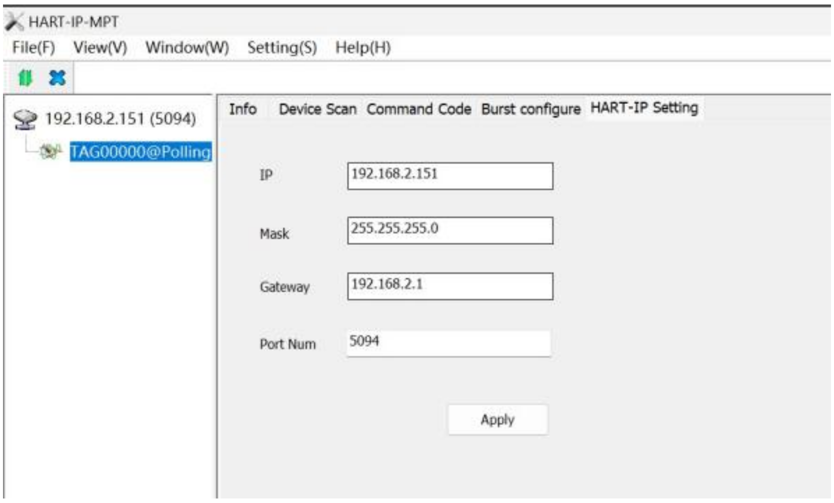

Figure 15 IP set up

Click the input box to freely configure the IP address, port number, subnet mask, gateway, etc. After clicking Apply, if the IP, port number, subnet mask, gateway, etc. are in correct format, the software will be switched to the initialization open state and you will need to reconnect. Because the IP and other information have changed, the previous connection will automatically become invalid. The configuration of the parameters in the HART-IP settings must comply with normal usage rules.

If the IP, port number, subnet mask, gateway, etc. are not in the correct format, the interface will give a corresponding prompt. For example, if the IP format is set incorrectly, as shown in Figure 16, you can modify the format to the correct one before you can perform IP settings and other functions. The default IP is 192.168.2.151. The default port is 5094.

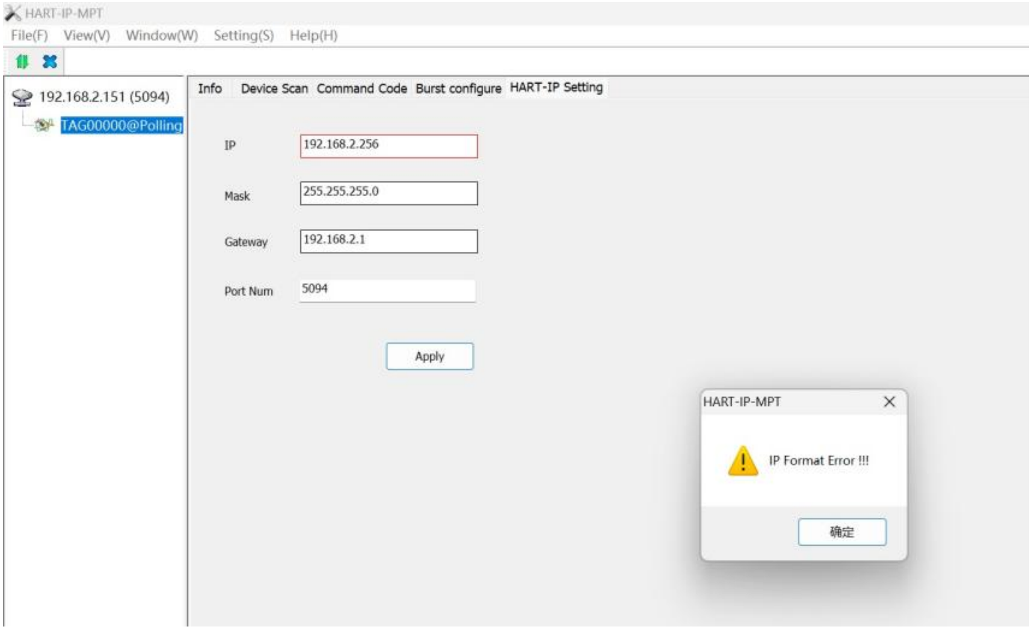

Figure 16 IP Formatting error

3.7 Burst configuration

Click the Burst Configuration tab to enter the Burst Configuration interface, as shown in Figure 17. The operations are as follows. The Burst mode is not supported in TCP mode.

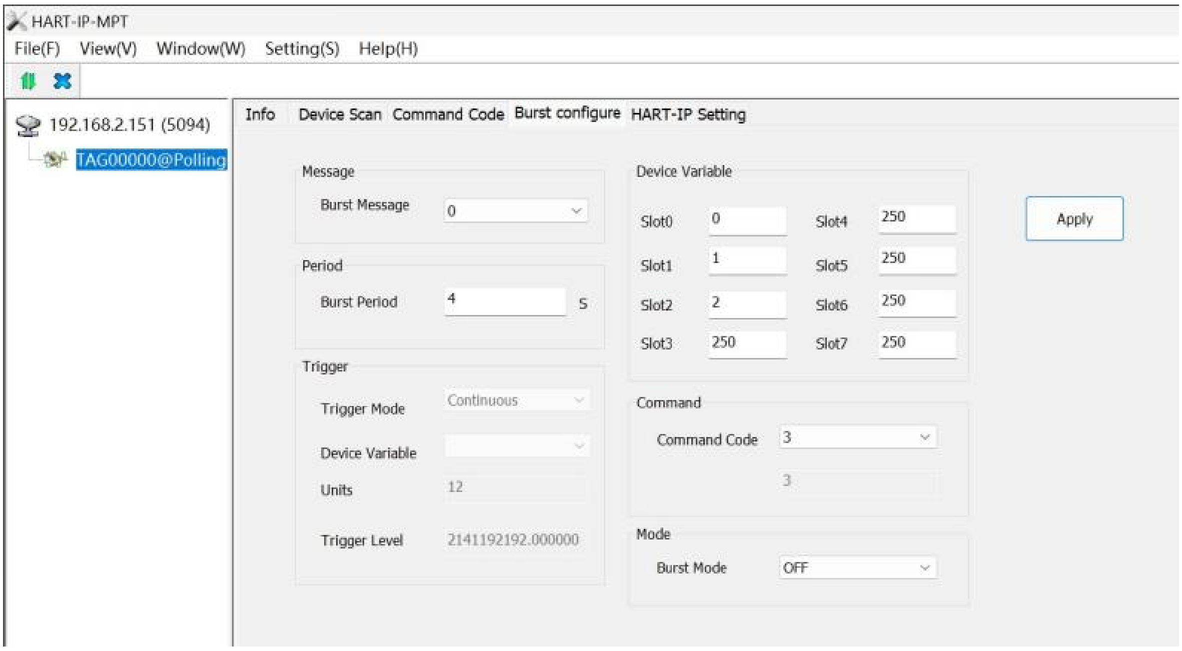

Figure 17 Burst configuration interface

Up to four burst messages can be configured based on the burst message index, as shown in Figure 18. Switching between different indexes allows you to configure different messages. Device variables can be configured, with values ranging from 0 to 5 or 246 to 250, inclusive. If you enter an incorrect range, the interface will display a corresponding prompt, as shown in Figure 19. As shown in Figure 20, commands of 1, 2, 3, 9, 33, and 48 are currently supported. You can also set the burst message sending period and enable or disable burst mode. The burst mode can be configured from 1 to 3600 seconds.

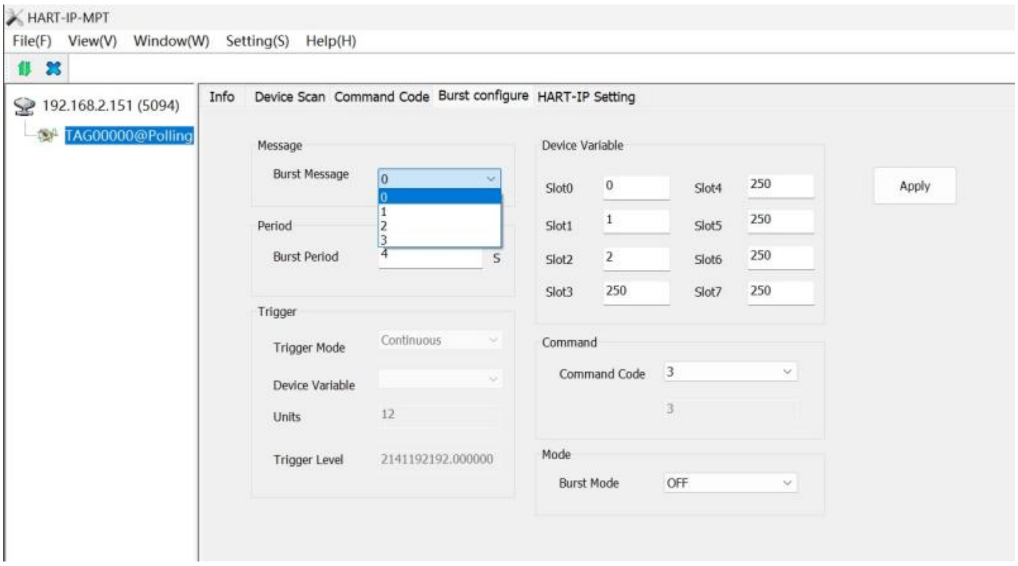

Figure 18 Burst message index

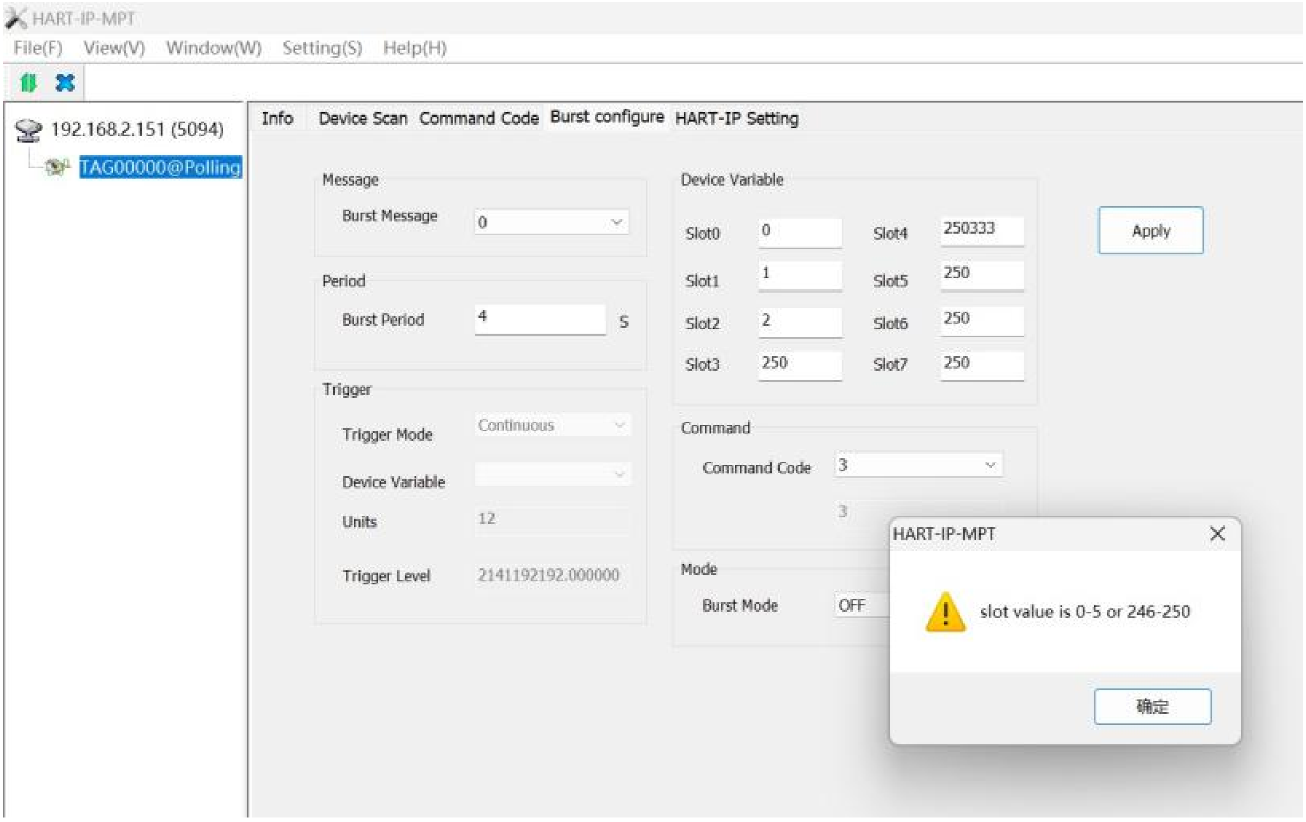

Figure 19 Burst device variable setting error

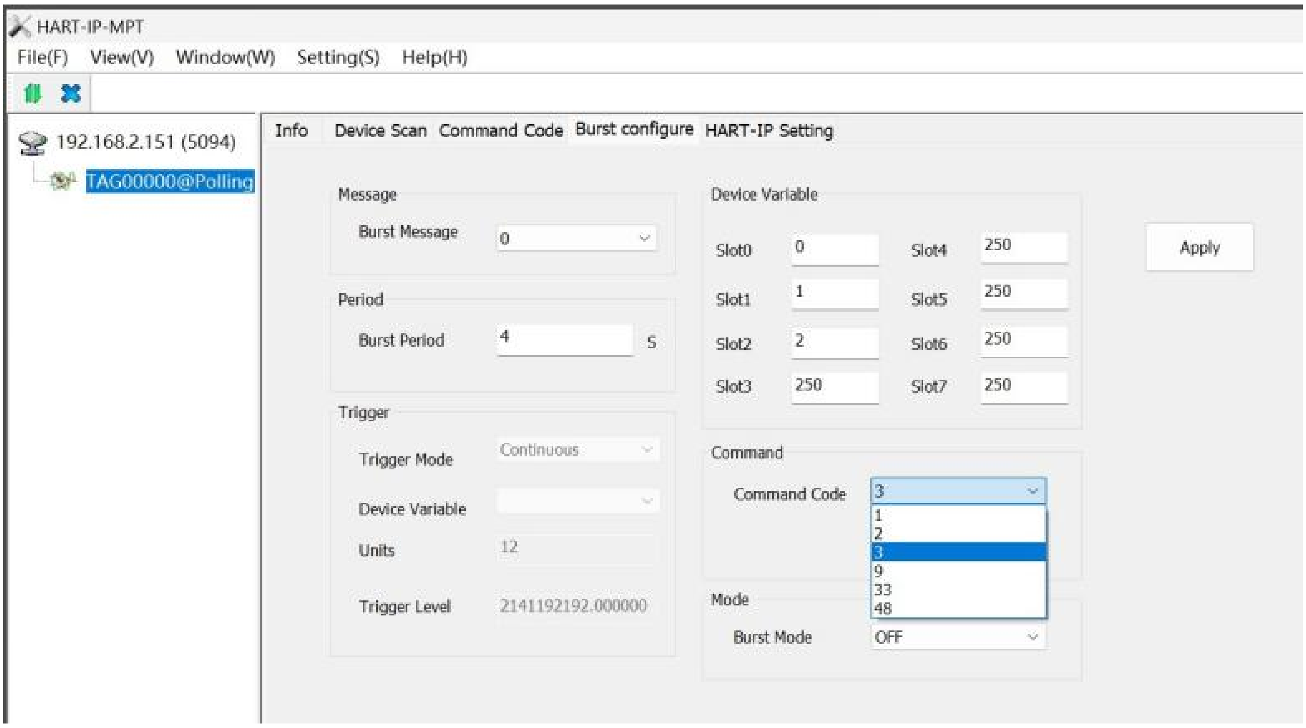

Figure 20 Burst command code

Chapter 4 Other configurations

The HART-IP MPT configuration software also provides five special configuration functions for users to use the G0312 gateway more deeply. These functions are described in detail below.

4.1 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.

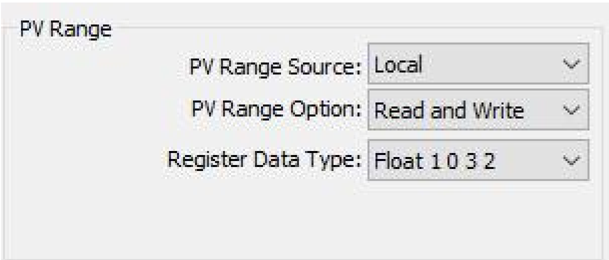

Figure 21 PV range operation

'PV Range Source' indicates whether the primary variable's upper and lower range limits are manually configured via the configuration software or read remotely from the user's Modbus device. 'PV Range Operation Mode' indicates whether the upper and lower range limits stored on the user's Modbus device can be read or written in remote mode. 'Register Data Type' indicates the format in which the upper and lower range limits stored on the user's Modbus device are stored in registers in remote mode.

The following briefly describes how device variable 0 is mapped to primary variable PV in both ‘local’ and ‘remote’ modes.

If device variable 0 is not mapped to a primary variable, the upper and lower range limits and their register addresses are inoperable. When PV Range Source is set to Remote and Operation Mode is set to Read and Write, after the user sets the upper and lower range limits and their register addresses and clicks Apply, the G0312 gateway will send the upper and lower range limits to the user's Modbus device using the specified data type (Function Code 16 is used by default to write multiple registers). When set to Read Only, the G0312 gateway will periodically read the upper and lower range limit values from the specified upper and lower range limit registers in the user's device via the Modbus interface (the default is to read holding registers).

Note: Currently the host computer software does not read periodically, and the range reading value can only be viewed by changing the operation mode.

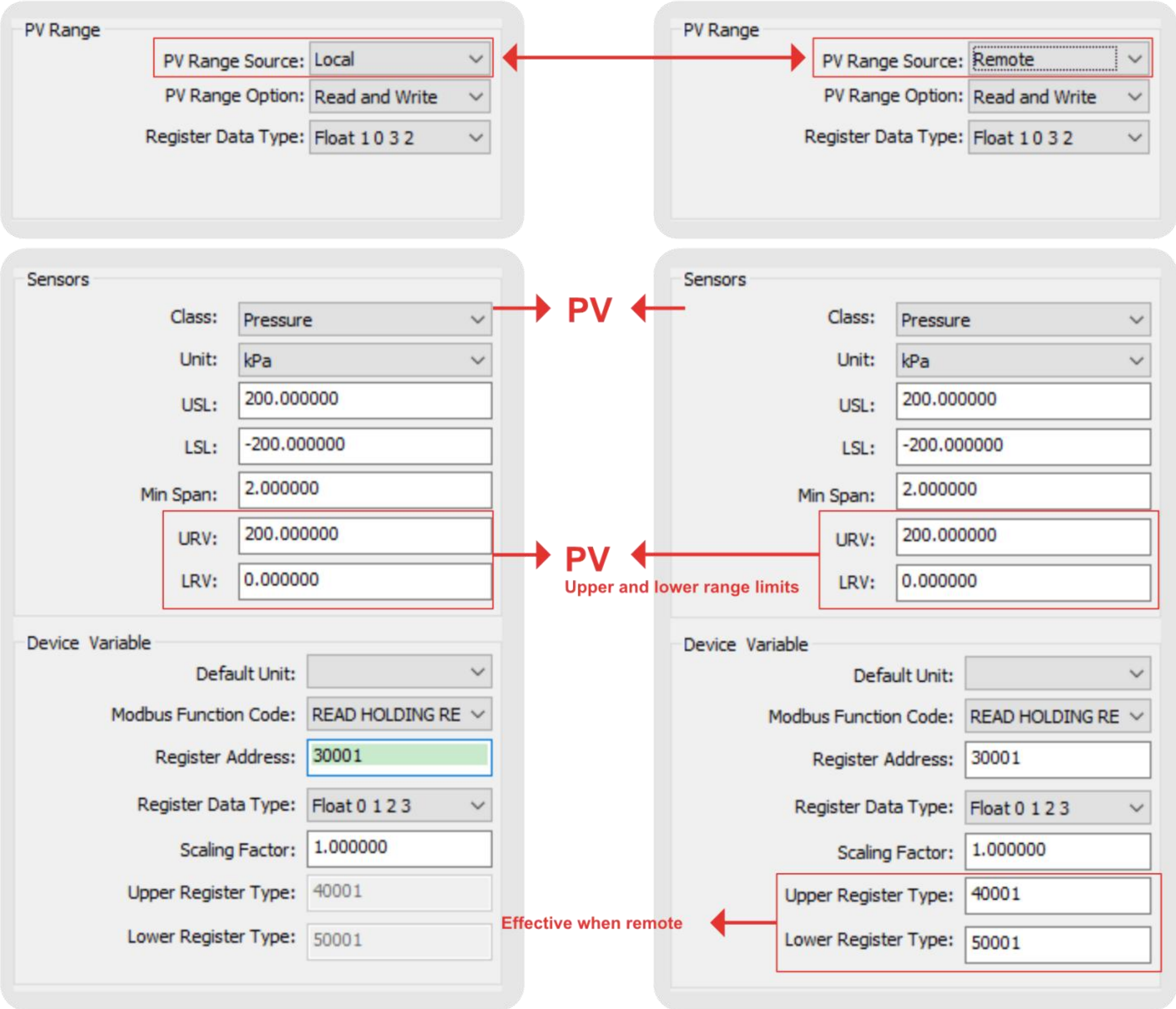

Figure 22 PV range operation example

4.2 Configure scaling factor

The G0312 gateway also has a special scaling factor parameter for each device variable to facilitate users to scale the data. The conversion method is:

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

If the user does not need to perform numerical scaling, there is no need to modify the scaling factor value, and the factory default is 1.0.

4.3 Debugging calibration area operations

The function of the debug and calibration area is for users to debug the G0312 gateway when they first use it. The device can be debugged through the "Coil" and "Register" options in the "Gateway Configuration\Calibration" option group of the configuration software. The function area is shown in Figure 23:

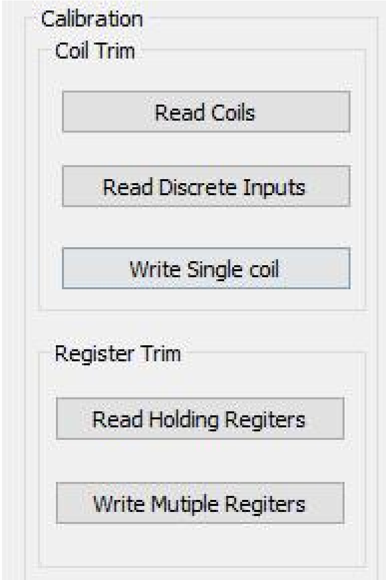

Figure 23 Debug calibration function

When the user uses the G0312 gateway for the first time, after completing the hardware connection and configuring all communication parameters in the 'Gateway Configuration\Detailed Settings\Modbus Variables' option group, the user can use the functions shown in Figure 25 to read and write data to the Modbus device. If the returned and written data are correct, it means that the hardware connection and Modbus communication parameters between the G0312 gateway and the user device are correct; otherwise, further inspection of the hardware connection or software configuration is required.

4.4 Data preservation and recovery

The data saving and restoring functions are realized through the ‘Gateway Configuration\Calibration\Restore Factory Settings’ option group of the configuration software, as shown in Figure 24:

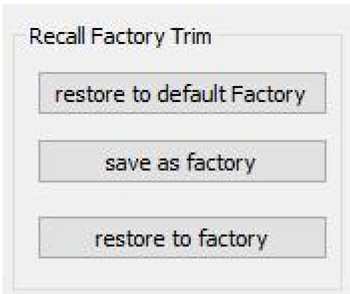

Figure 24 Data preservation and recovery

- **To restore to factory defaults:** Restore all configuration data of the G0312 gateway to the initial value of the system. Users should use it with caution. After executing this function, all user-configured data will be lost.
- **Save to factory settings:** Save all user configuration information to factory defaults (the data has a backup in the G0312 gateway)
- **Restore to factory settings:** Restore the user configuration information backed up when the last "Save to Factory Defaults" operation was executed in the G0312 gateway to the current usage status;

4.5 Batch download

The batch download function is a quick configuration function specially provided for manufacturers to facilitate the configuration of multiple G0312 gateways. It is achieved through the 'Gateway Configuration\Batch Download' option group of the configuration software, as shown in Figure 25:

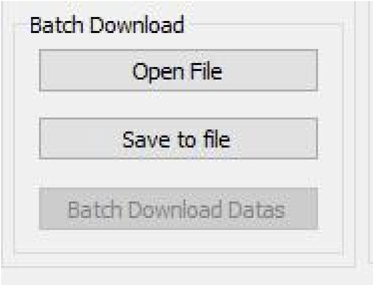

Figure 25 Batch download

When the user has multiple G0312 gateways that need to perform the same configuration operation, they only need to complete the configuration of one G0312 gateway, and then click the 'Save to File' button to save the configuration information of the current G0312 gateway as a file; when configuring other G0312 gateways, they only need to click the 'Open File' button to read the configuration information saved in the file, and then click the 'Batch Download Data' button to download all the configuration information displayed on the current page to the G0312 gateway to complete the configuration.

Chapter 5 Ethernet-APL Device Development Solution

5.1 G0312 Gateway application on pressure transmitter

The G0312 Ethernet-APL gateway is compatible with all types of instruments on the market, including temperature, pressure, flow, level, and actuators. It can quickly upgrade traditional instruments to Ethernet-APL field devices without writing a single line of code. It enables pressure transmitters to support the Ethernet-APL communication interface and the HART-IP communication protocol.

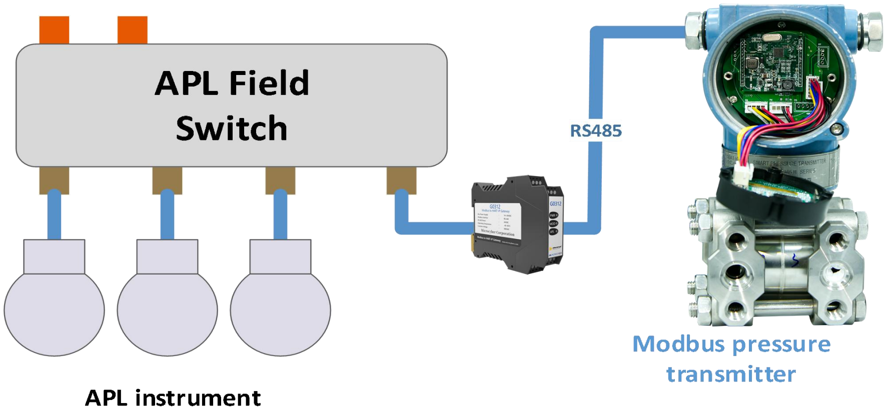

Figure 26 G0312 Gateway application on pressure transmitter

5.2 G0312 Gateway application in flow meter

The G0312 Ethernet-APL gateway is compatible with all types of instruments on the market, including temperature, pressure, flow, level, and actuators. It can quickly upgrade traditional instruments to Ethernet-APL field devices without writing a single line of code. It uses the customer's flow meter to support the Ethernet-APL communication interface and the HART-IP communication protocol.

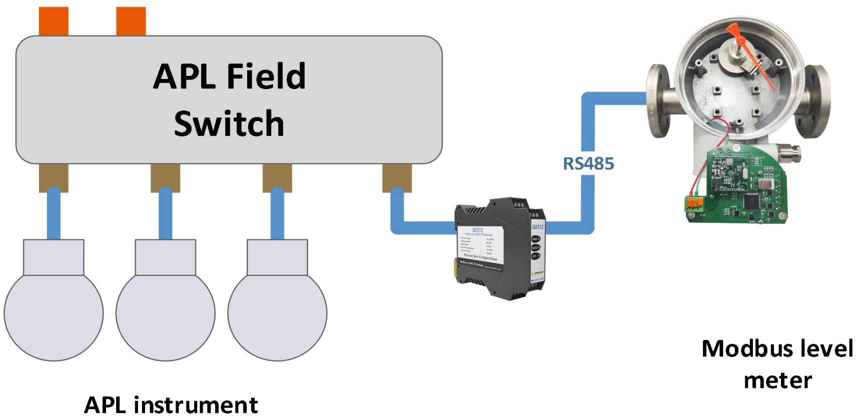

Figure 27 G0312 Gateway application in flow meter

5.3 Ethernet-APL Gateway application cases

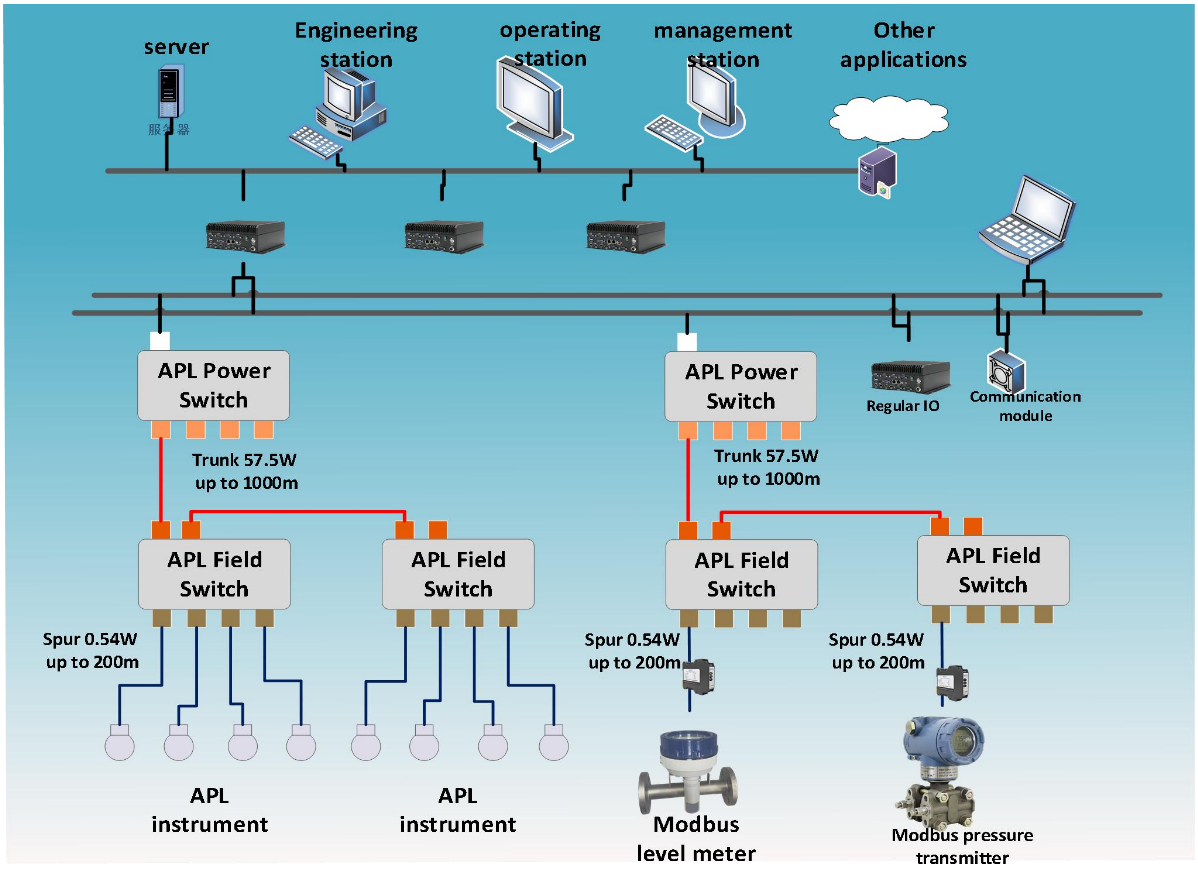

Figure 28 APL application cases

Chapter 6 Maintenance

- **Simple maintenance**

Table 4indicator light

<table>
<tr><th>LED indicator light</th><th>Color</th><th>Normal state</th><th>Abnormal state</th><th>Abnormal cause</th><th>Correction method</th></tr>
<tr><td rowspan="5">HART-IP Communication</td><td rowspan="5">orange</td><td rowspan="5">flashing</td><td rowspan="3">light goes out</td><td>No HART-IP communication</td><td>Check the HART-IP host device and HART-IP interface device</td></tr>
<tr><td>power supply failure</td><td>Check the power supply and connections</td></tr>
<tr><td>Internal failure</td><td>Contact technical support</td></tr>
<tr><td rowspan="2">light on</td><td>No HART-IP communication</td><td>Check the HART-IP host device and HART-IP interface device</td></tr>
<tr><td>Internal failure</td><td>Contact technical support</td></tr>
<tr><td rowspan="4">Modbus Communication</td><td rowspan="4">red</td><td rowspan="4">flashing</td><td rowspan="2">light goes out</td><td>power supply failure</td><td>Check the power supply and connections</td></tr>
<tr><td>Internal failure</td><td>Contact technical support</td></tr>
<tr><td rowspan="2">light on</td><td>No Modbus communication</td><td>Checking Modbus slave devices</td></tr>
<tr><td>Internal failure</td><td>Contact technical support</td></tr>
</table>

- If you forget the IP address or port number, you can restore the factory settings through the S/E dial switch on the universal baseboard.
- Daily maintenance is limited to cleaning the equipment
- Fault repair: If a fault is found, please return it to the factory for repair

Chapter 7 Technical specifications

7.1 Basic parameters

Measurement object	Modbus RTU slave device
Bus power	9-15VDC
Modbus interface	RS485 (supports MODBUS RTU master communication protocol)
Isolation	No isolation between bus and Modbus interface
Bus protocol	HART-IP
Temperature range	-40℃～85℃
Humidity range	5%～95%RH
Start time	≤5 seconds
Electromagnetic compatibility	IEC 61000-4-4 Burst（±2 kV (5 kHz or 100 kHz)） IEC 61000-4-5 Surge（±2 kV line-to-ground） IEC 61000-4-6 Conducted RF（3 V (150 kHz to 80 MHz)）

7.2 Physical properties

Weight	16 g
Structural materials	Coating: polyester epoxy resin

Address: 17-8 Wensu Street, Hunnan New District, Shenyang, China

Website: http://www.microcyber.cn/en

Phone: +86-24-31217278/+86-24-31217280

Fax: +86-24-31217338

Email：sales@microcyber.cn