principle characteristics

The FM330 thermal gas flow sensor is designed based on the thermal principle.

- digital menu programmable
- measure stability and vibration resistance
- mass flow measurement without temperature and pressure compensation
- unique design, can meet the water, oil and impurities of the medium
- maintenance free, high precision, long life
- wide range ratio, multiple display units are optional

product application

Can be used for a variety of gas measurement, such as: compressed air, gas, natural gas, liquefied gas, torch gas, hydrogen, argon, ammonia, etc., can be used for gas leak detection.

Mainly used in: petrochemical, electric power, metallurgy, electronics, hvac, water treatment, food and other industries.

Plug-in Outline Drawing

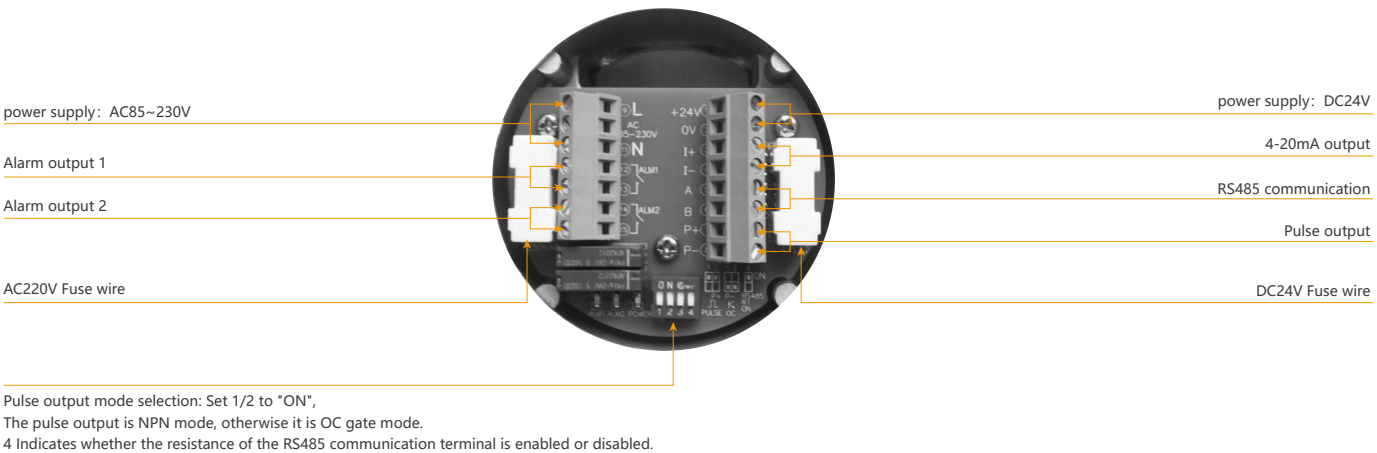
(DN50...DN1000mm)

(DN1000...DN4000mm)

Technical parameters

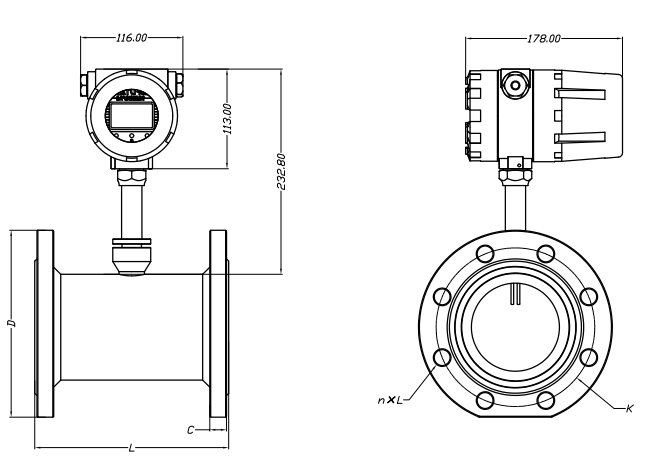
- measuring range: 0.1Nm/s... 120 nm/s
- Duct diameter range: duct type (DN10... 2000 mm)
  Insert type (DN50... 4000 mm)
- measurement accuracy: ±1..... 2.5% FS
- Power supply: DC24V/AC220≤18W
- output signal: pulse /4... 20 ma/RS485 (HART)
  Support 1 or 2 relay output
- Working pressure: tube type ≤ 2.5Mpa/insert type ≤ 4.0Mpa
- Response speed: 1s
- medium temperature: -40... 450 ℃
- storage temperature: -20... 65 ℃
- field display: LCD screen
- protection level: IP65
- Body material: pipe type (carbon steel, stainless steel)
  Insert type (stainless steel)

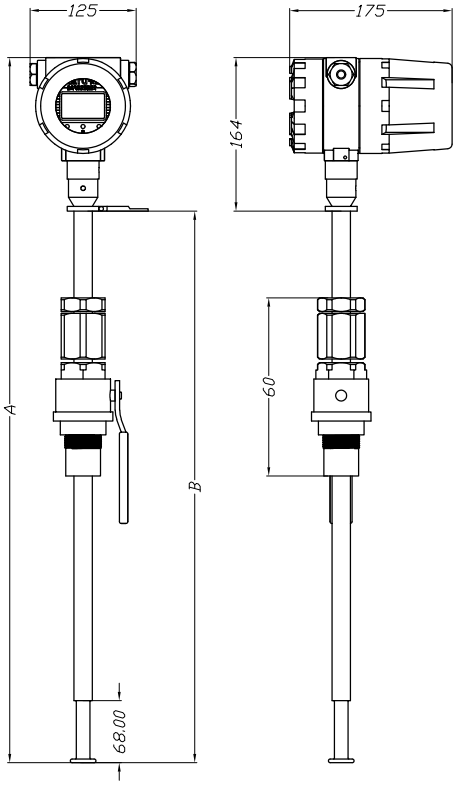
wiring diagram



Pulse output mode selection: Set 1/2 to "ON",
The pulse output is NPN mode, otherwise it is OC gate mode.
4 Indicates whether the resistance of the RS485 communication terminal is enabled or disabled.

Size chart (mm)





口径	A	B
≤DN500	565	370
> DN500	825	630

caliber (DN)	Flange outside diameter (D)	Center hole diameter (K)	Screw hole (n×L)	Overall length (L)
15	95	65	4 × 14	200
20	105	75	4 × 14	200
25	115	85	4 × 14	200
32	140	100	4 × 18	200
40	150	110	4 × 18	200
50	165	125	4 × 18	200
65	185	145	8 × 18	220
80	200	160	8 × 18	220
100	220	180	8 × 18	220
125	250	210	8 × 18	220
150	285	240	8 × 22	220
200	340	295	12 × 22	220
250	405	355	12 × 26	220
300	465	410	12 × 26	220

Range table (unit: Nm³/h)

CAL	Nitrogen/air	oxygen	hydrogen
15	65	32	10
25	175	89	28
32	290	144	45
40	450	226	70
50	700	352	110
65	1200	600	185
80	1800	900	280
100	2800	1420	470
125	4400	2210	700
150	6300	3200	940
200	10000	5650	1880
250	17000	8830	2820

CAL	Nitrogen/air	oxygen	hydrogen
300	25000	12720	4060
400	45000	22608	7200
500	70000	35325	11280
600	100000	50638	16300
700	135000	69240	22100
800	180000	90432	29000
900	220000	114500	77808
1000	280000	141300	81120
1200	400000	203480	91972
1500	600000	318000	101520
2000	700000	565200	180480

Selection table

FM330-	G	15	A	DC	S	...	Detailed description
FM330-							FM330 thermal gas flow sensor
	G						Pipeline type
	T						Insertable
		15					Pipe diameter (DN
			A				Output signal: 4... 20mA
			AR				Output signal: 4... 20mA+RS485
			ARC				Output signal: 4... 20mA+RS485+ relay
				DC			Power supply: DC24V
				AC			Power supply: AC110... 220V
					S		Stainless steel material
						Z	Special customization with suffixes is available

Installation Precautions

⚠ If the instrument is installed outdoors, the instrument shade should be added to avoid the sun and rain.

⊘ Do not install in the occasion of strong vibration.

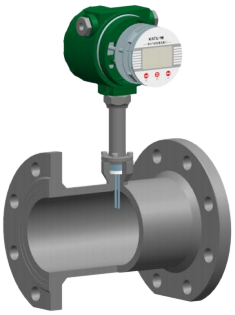
⊘ Do not be exposed to the environment containing a large amount of corrosive gases.

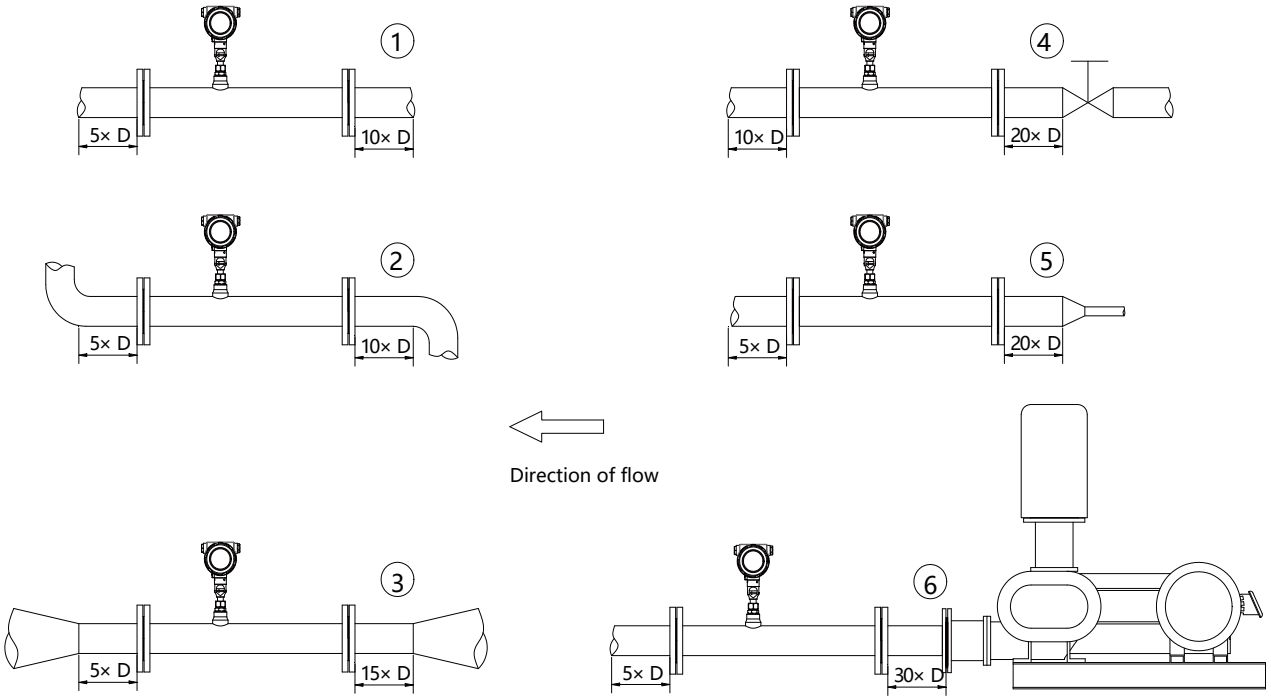
⊘ Do not share power with converter, welder and other equipment that pollute the power supply. If necessary, install purification power for the converter.

Installation location and piping requirements

1, the instrument should be far away from the elbow, obstacles, diameter, valve, to ensure a stable flow field, one side requires a long upper limit straight pipe, the front straight pipe length is greater than 10D, The length of the straight back pipe was greater than 5D.

The following figure shows the length of straight pipe required by several situations frequently encountered in the field:



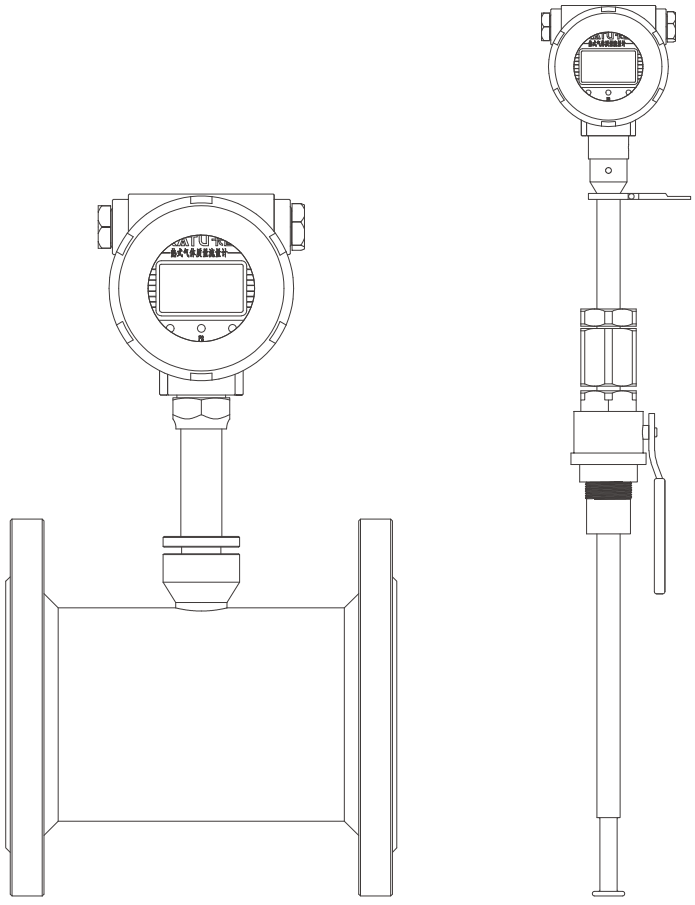


Type of pipe installation	serial number	Straight pipe before	After the straight section
Horizontal tube	1	10D	5D
Bend pipe	2	10D	5D
Expanding head of pipeline	3	15D	5D
Downstream of the valve	4	20D	5D
Shrinkage tube	5	20D	5D
Downstream of the pump	6	30D	5D

2、If the requirements for straight pipe segment cannot be met on site, the gas rectifier can be connected in series to reduce the requirements for straight pipe segment.

KATU 卡图

Operating Instructions
Thermal gas flow sensor
FM330 Series



1、Product Introduction

Principle and characteristics

The FM330 thermal gas flow sensor is designed based on the thermal principle
The sensor accurately measures the gas by using the constant temperature difference method.
The digital menu is programmable
- Stable measurement and vibration resistance
- Mass flow measurement, no need for temperature and pressure compensation
Unique design can meet the requirements of media containing water, oil and impurities
- Maintenance-free, high-precision, and long-lasting
Wide range ratio and multiple display units are available for selection

Product application

It can be used for various gas measurements, such as compressed air, coal gas, natural gas, liquefied gas, flare gas, hydrogen, argon, ammonia, etc., and can be used for gas leak detection.
It is mainly applied in industries such as petrochemicals, power, metallurgy, electronics, HVAC, water treatment, and food.

Technical parameters

◇ Measuring range: 0.1Nm/s... 120Nm/s
◇ Pipe diameter range: Pipeline type (DN10...) "2000mm
Insert type (DN50...) 4000mm
◇ Measurement accuracy: ±1... 2.5% FS
◇ Power supply: DC24V/AC220≤18W
◇ Output signal: Pulse /4... 20mA/RS485 (HART
Supports 1 or 2 relay outputs
◇ Working pressure: Pipeline type ≤2.5MPa/ insertion type ≤4.0MPa
◇ Response speed: 1 second
◇ Medium temperature: -40... 450 ℃
◇ Storage temperature: -20... 65 ℃
◇ On-site display: LCD liquid crystal display screen
◇ Protection grade: IP65
◇ Body material: Pipeline type (stainless steel)
Insertable type (stainless steel

2、Product installation

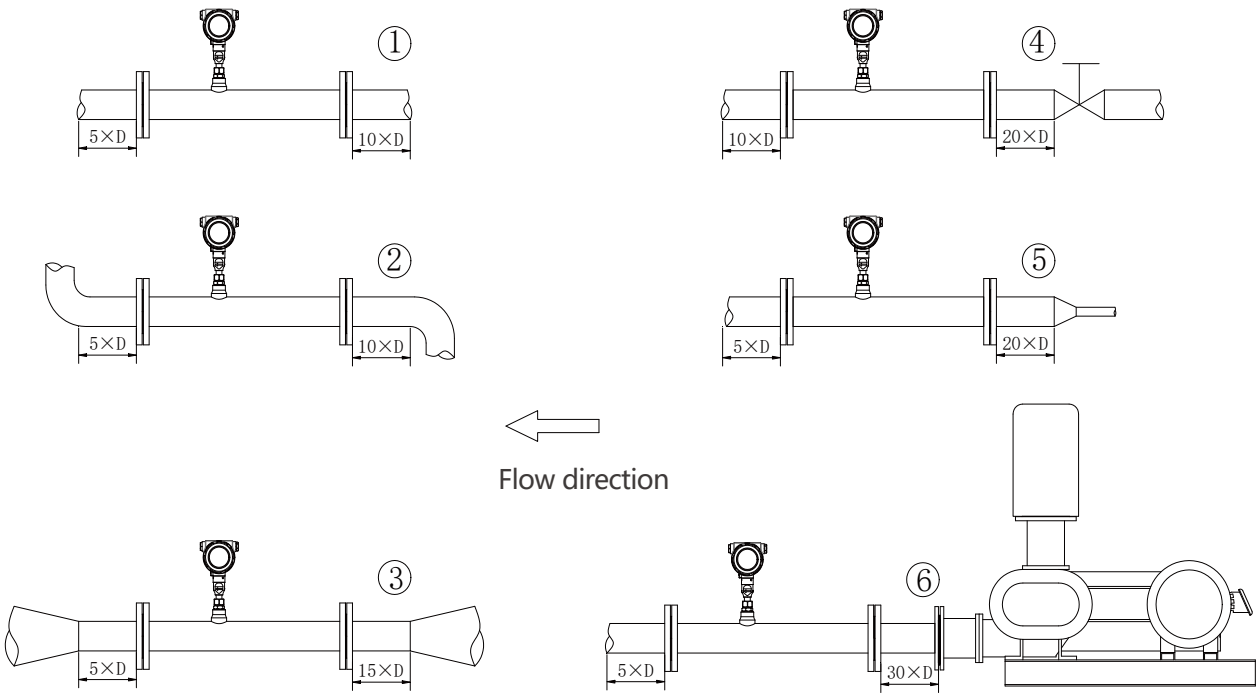
⚠ If the instrument is installed outdoors, a sunshade for the instrument should be added to prevent it from being exposed to the sun and rain.

- Do not install in places with strong vibration.
- Do not expose to an environment containing a large amount of corrosive gas.
- Do not share power supply with devices that pollute power sources such as frequency converters and welding machines. If necessary, install a purified power supply for the converter.

Installation location and requirements for pipelines

When installing the instrument, it should be kept away from elbows, obstacles, reducers and valves to ensure a stable flow field. One side requires a longer upper limit straight pipe, with the length of the front straight pipe greater than 10D and the length of the rear straight pipe section greater than 5D.

The following figure shows the required lengths of straight pipe sections for several frequently encountered situations on site:



Straight pipe section diagrams before and after installation

Pipe installation type	NO.	Front straight pipe section	Rear straight pipe section
Horizontal pipe	1	10D	5D
Elbow pipe	2	10D	5D
Expanded head pipe	3	15D	5D
Downstream of the valve	4	20D	5D
Shrink tube	5	20D	5D
Downstream of the pump	6	30D	5D

When the requirements for straight pipe sections cannot be met on site, a gas rectifier can be connected in series to significantly reduce the requirements for straight pipe sections.

Base of thermal gas mass flowmeter

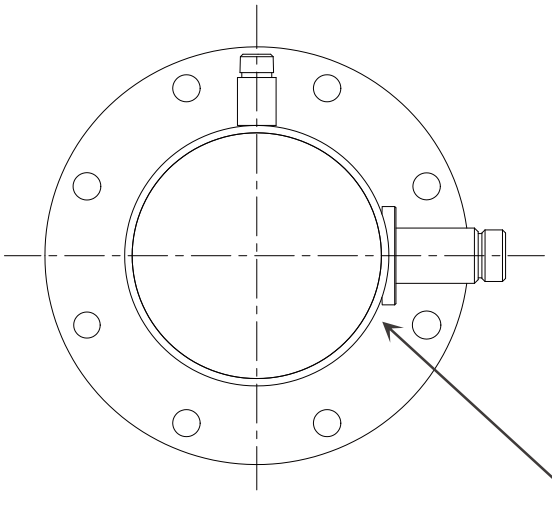
Online installation type welded base

Simplified welding

Welding operations are prohibited in explosive environments.

In environments with special requirements for welding, operations should be carried out in accordance with relevant requirements.

The base is classified into standard type and simplified type according to different installation methods. During installation, the base should be placed at the very top of the pipe cross-section direction, and the axis of the base's through hole should be perpendicular to the pipe's axis. The ideal welding position and process for the base. (As shown in the following figure)



Ideal welding position for the base

Before welding, the base must be processed into an arc with the same outer diameter as the pipe by wire cutting to ensure the sealing of the welding

Refer to Figure 1 in Appendix (Simplified Thermal Gas Mass Flowmeter)

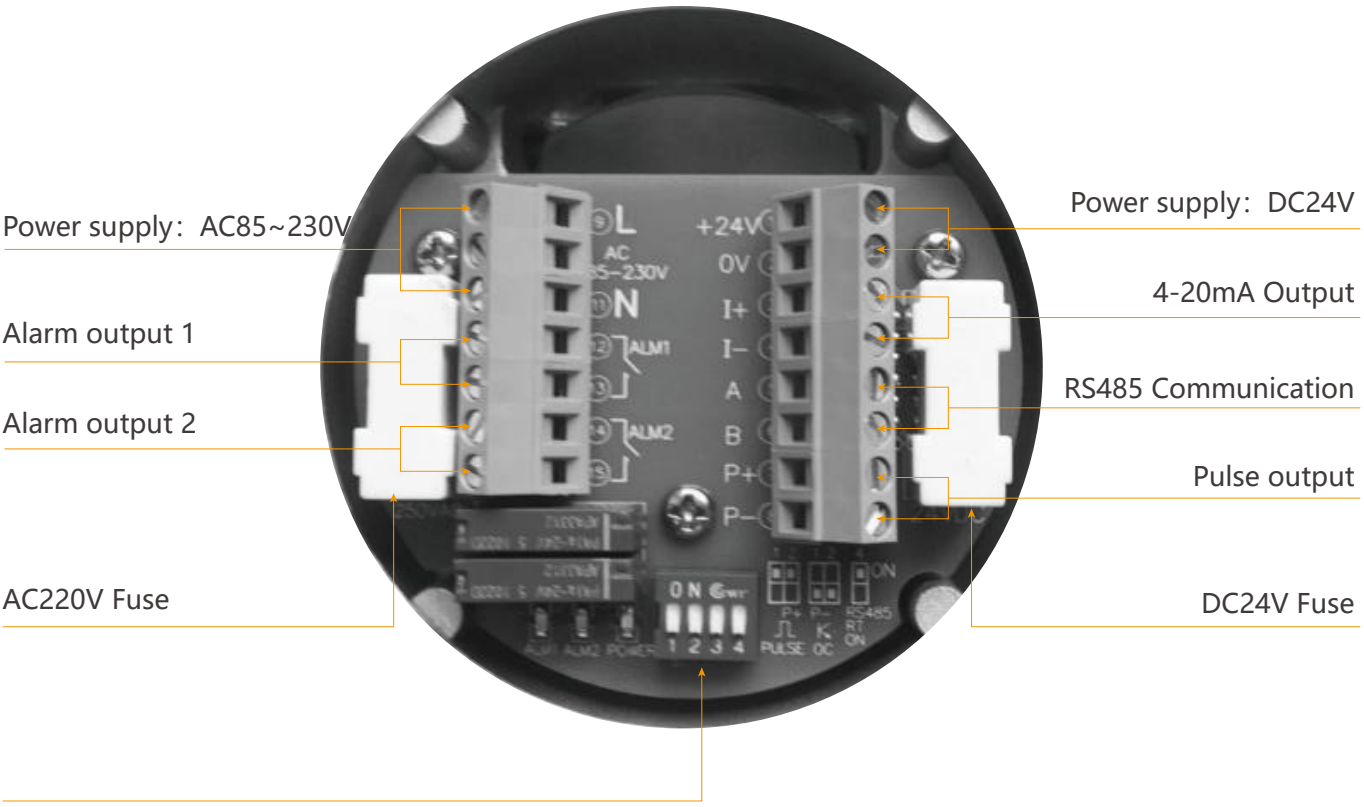
1) Before installing the simplified thermal gas mass flowmeter, please confirm the actual inner diameter and wall thickness of the pipeline.
2) Install the remaining parts of the thermal gas mass flowmeter together into the dedicated ball valve, and calculate the insertion depth based on the actual inner diameter and wall thickness of the pipeline. At this step, you can insert a rough size and tighten the nut by hand.
3) Rotate the sensor connecting rod so that the marked arrow is in the same direction as the medium flow.
4) Based on the data measured on site, calculate the corresponding scale on the sensor connection rod and then tighten the nut. 5) If you install this instrument horizontally, the display screen can be flexibly installed at 90°, 180° or 270°.
Meet your actual on-site needs.

Refer to Figure 2 in Appendix (Full Tube Thermal Gas Mass Flowmeter)

⚠ Please confirm again before pre-installation. Prepare the connection method of the pipe section and the relevant items for flange connection, such as gaskets and bolts, etc.
⚠ Production must be halted before installation and the relevant regulations of the factory must be strictly followed.
The full-pipe type instrument has the sensor correctly installed on the dedicated pipe section before leaving the factory. Users only need to assemble the pipe to the site, so it is relatively simpler than the on-site insertion type installation. First, select the appropriate installation point on the pipeline, then cut the pipe according to the length of the required pipe section, and install the corresponding flange and bolts. Ensure that the fluid flow rate is consistent with the flow rate indication on the full-tube hot gas mass flowmeter. Moreover, the display screen should be perpendicular to the horizontal plane, and the pipe axis should be parallel to the horizontal plane, with an error not exceeding ±2.5°. Finally, lock the instrument with bolts.

3、Wiring diagram

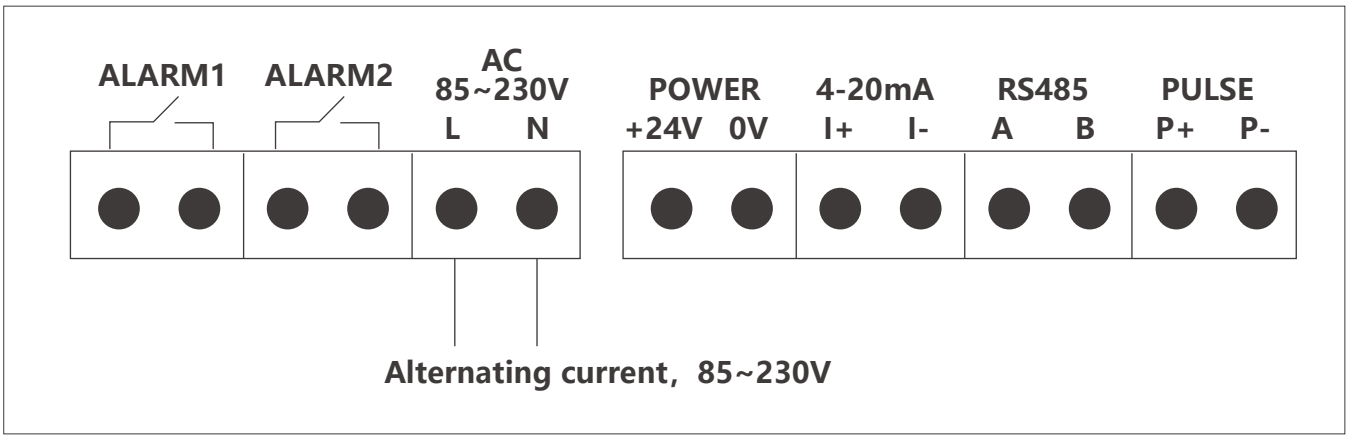
Terminal block description and wiring method:



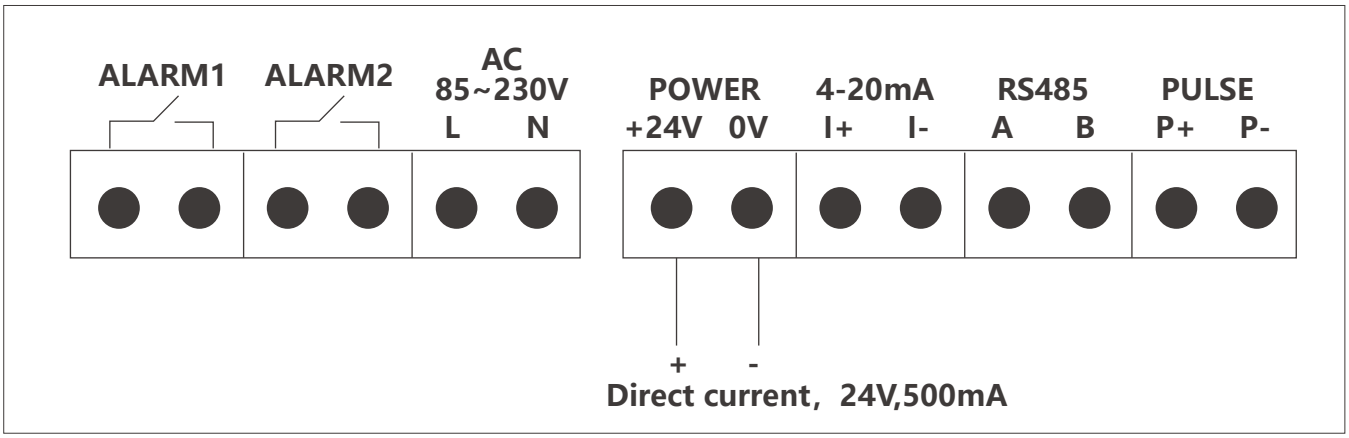
Pulse output mode selection: 1/2 switch to "ON"
The pulse output is in NPN mode; otherwise, it is in OC gate mode.
4 indicates whether the RS485 communication terminal resistor is present or absent.

The connection method of the power supply

Connection method for AC power supply:

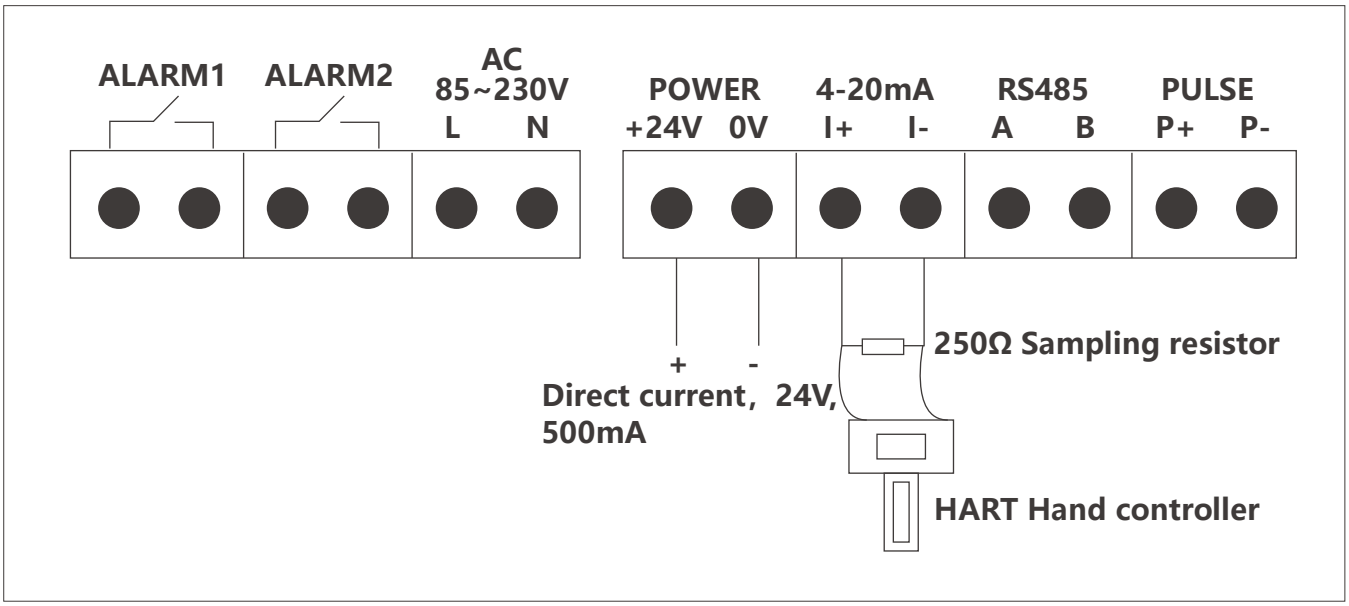


Connection method for 24V DC power supply:

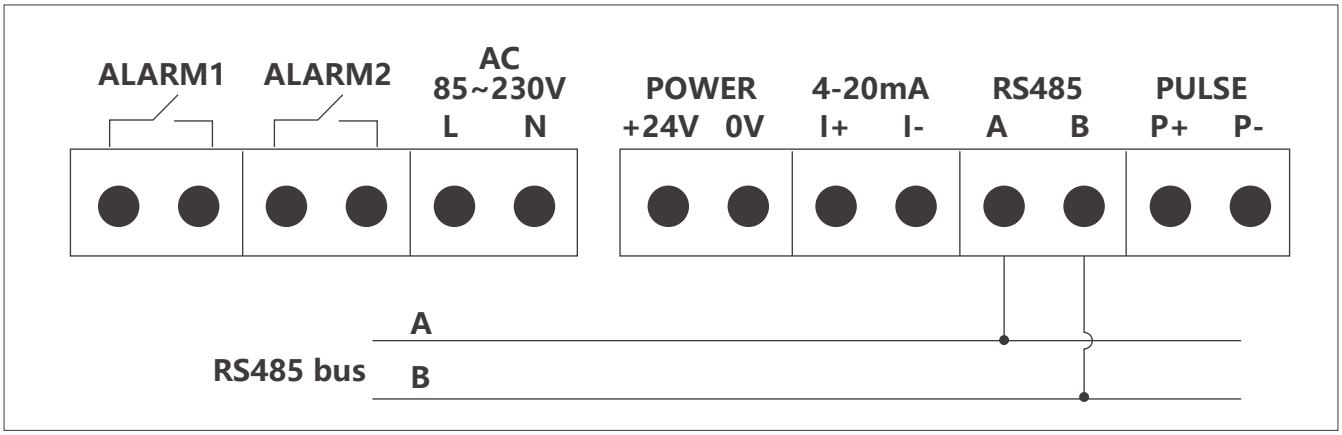


Instrument output wiring

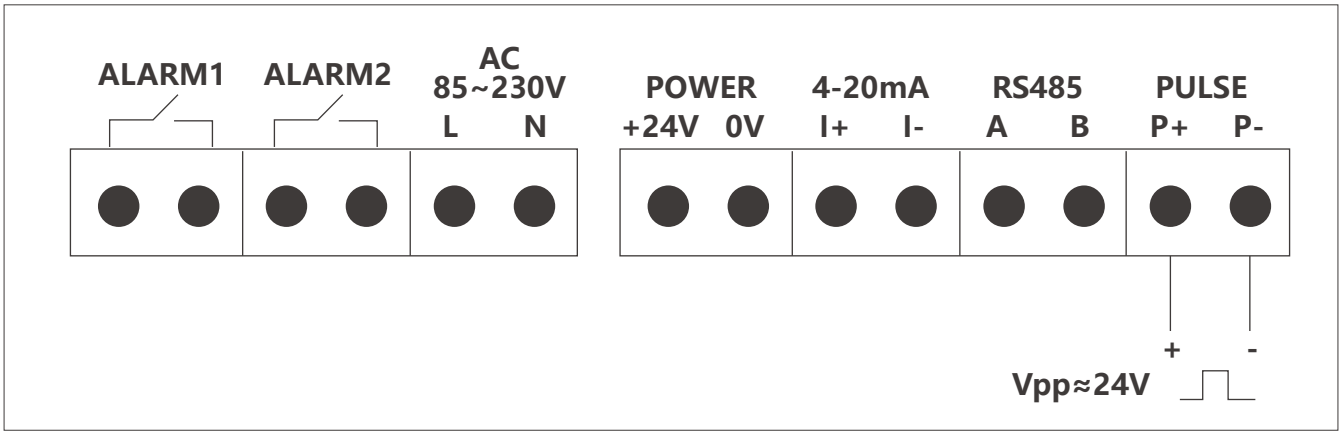
Connection method of four-wire 4-20mA current output and HART hand controller:



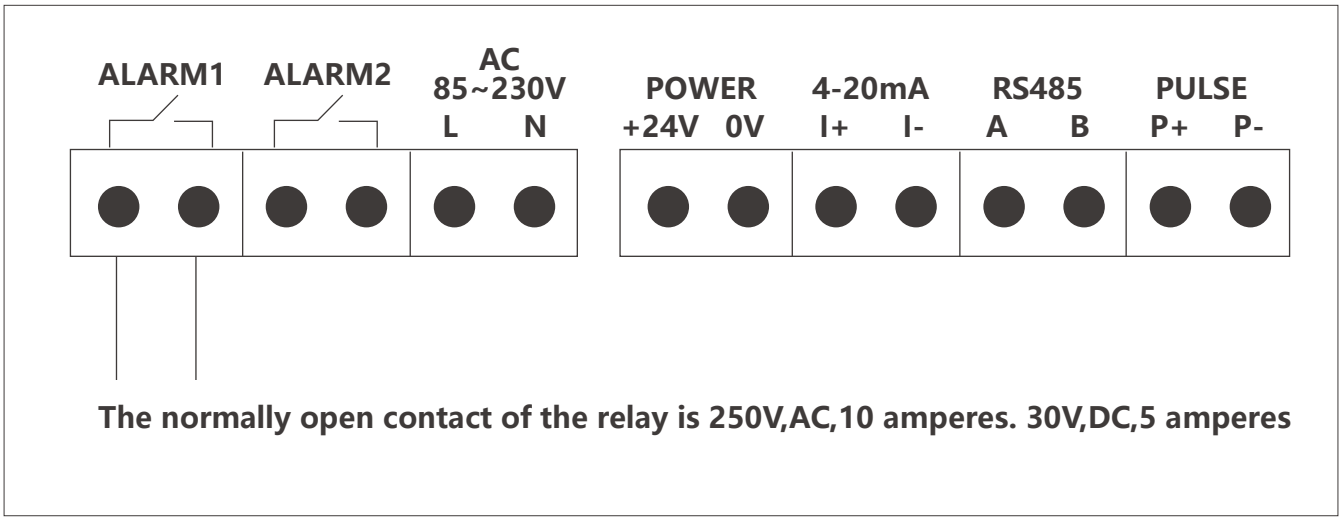
RS485 Connection method for communication:



Connection method of pulse output:

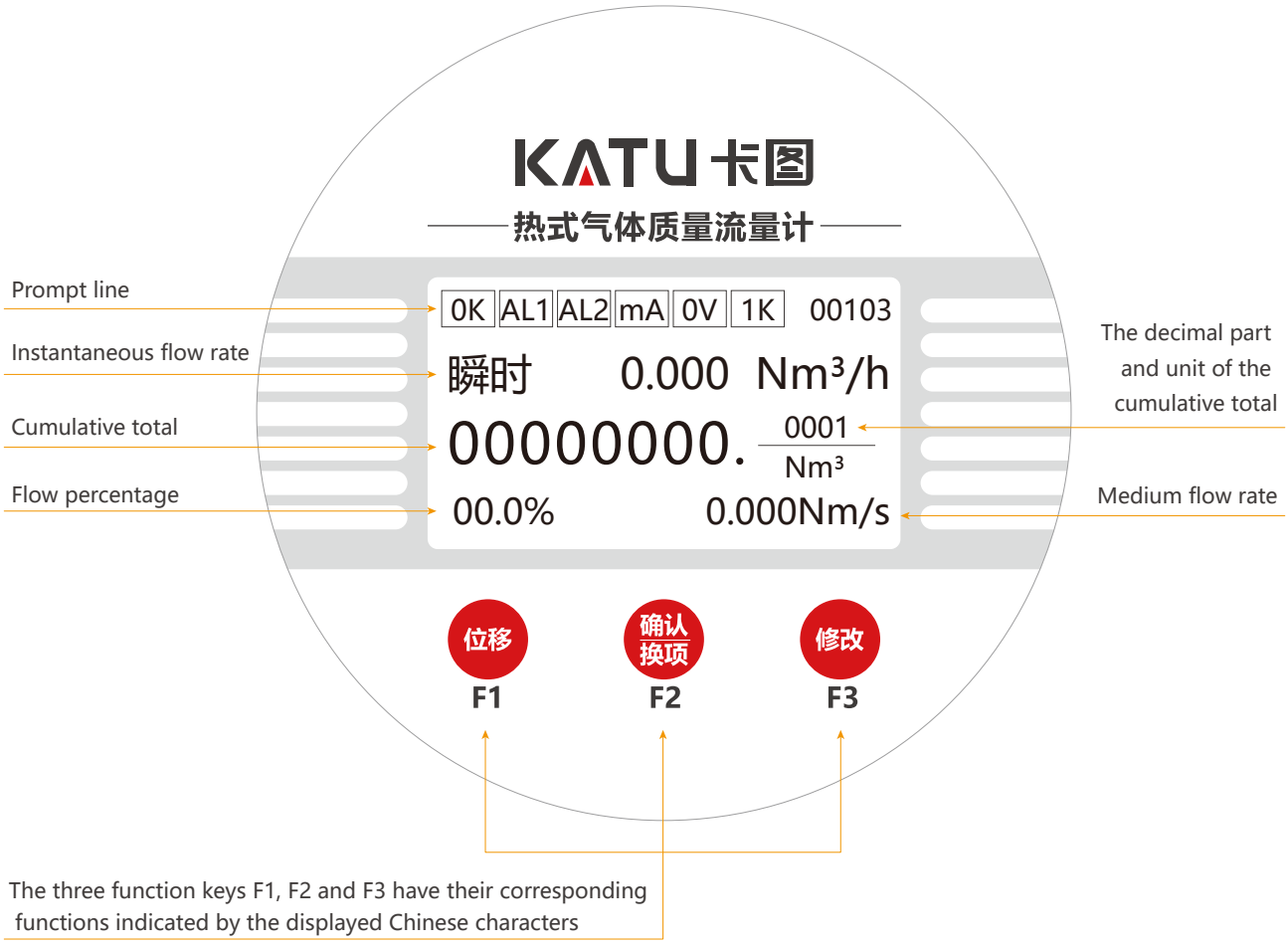


Connection method of alarm output:



The normally open contact of the relay is 250V,AC,10 amperes. 30V,DC,5 amperes

4、Debugging and Application

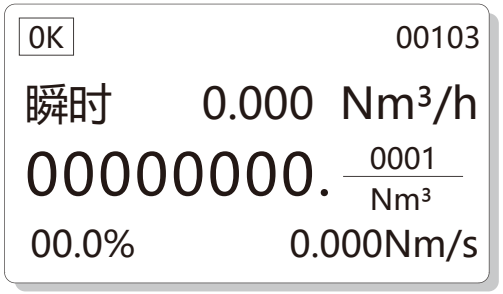


Prompt line:

1.When the instrument is working normally and powered on, it will perform a self-check. If the self-check is normal, it will prompt "OK". If an error occurs, it will prompt "ERR". You can view the error prompt in the self-check menu.
2. Instrument alarm channel prompt: AL1 indicates channel 1 alarm. AL2 indicates Channel 2 alarm;
When the flow current output of the instrument exceeds 20mA, the prompt line will display mA, indicating current overflow. If it is normal, the display will be empty.
4. The operating parameters of the instrument overflow. If the operating parameters of the instrument overflow, it will display 0V; if it is normal, it will display empty.
5. For the convenience of display and reading, when the cumulative flow exceeds 10,000,000, the cumulative flow data of the instrument is the value divided by 1000, and the prompt line indicates 1K. When reading, it needs to be multiplied by 1000.
6. The communication status information of the instrument is displayed. The first three digits represent the meter number, and the fourth digit represents the parity bit. 0: No parity. 1: Odd parity; 2: Even check; The fifth digit represents the baud rate,0:1200; 00 unto them; Chief 00; 3:9,600 When the table number is 1, the check is no check, and the baud rate is 9600, the prompt line on the display interface shows "00103". When the instrument is powered on, it performs a self-check. If the self-check is abnormal, a self-check error interface will be displayed (refer to the self-check menu for the description of the self-check interface). After approximately 1 to 2 seconds, it will jump to the main interface. Otherwise, it will directly jump to the main interface. The instrument's parameters are set through buttons. Generally, during installation, some parameters need to be manually set using the buttons. The instrument has three buttons, from left to right, they are F1, F2 and F3. Usually, F1 is the shift key, F2 is the confirmation key or the substitution key, and F3 is the modification key. If there are any special functions for the keys, please refer to the key function description at the bottom of the LCD screen interface when using them.

Parameter Settings

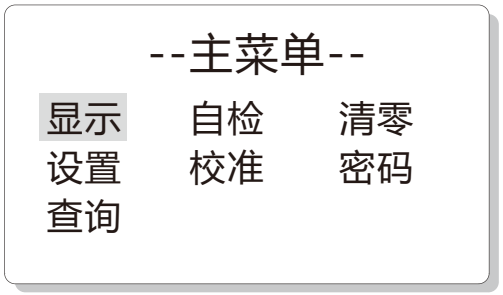
The main page displays



On this interface, press the F2 (Confirm/Change) key. You can then enter the Settings menu.

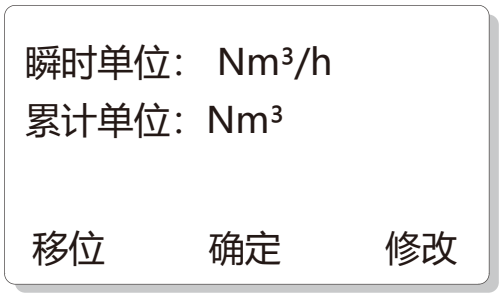
The main interface for parameter Settings

Press the F2 (Confirm/Switch) key



On the main interface, press the F2 key to enter the main menu interface. You can select the corresponding menu item by pressing the F1 shift key and then press the F2 key to enter.

显示单位



On the main interface, press the F2 key to enter the main menu interface. Press F2 to enter the display unit Settings, press F1 to move the cursor position, and press F3 to modify the unit.

Instantaneous flow units: Instantaneous units include Nm3/h, Nm3/min, NL/h, NL/min, t/h, t/min, kg/h and kg/min.

Cumulative units: The cumulative flow units include Nm3, NL, t, and kg.

The display unit option can change the unit used by the instrument during calculation. Enter the display unit interface, if it is the instantaneous flow rate

To display the mass flow rate, simply change the instantaneous flow rate unit to the mass unit, and the instrument flow display interface will then show the mass flow rate.

Self-check

On the main interface, press the F2 key to enter the main menu interface. Press the F1 key to move the cursor to the self-check, and press the F2 key to enter the self-check menu.

When the normal operation prompt line of the instrument shows "ERR", you can enter this option by pressing the key to query the specific operation error of the instrument. A tick indicates normal operation, while a cross indicates error. When the instrument starts up, it performs a self-check. If there is an error, this interface will be displayed. When the instrument is in operation, you can also enter this option to query the operating status of the instrument.

Reset to zero

On the main interface, press the F2 key to enter the main menu interface. Press the F1 key to move the cursor to the reset position, then press the F2 key to enter the reset menu. Enter the reset password (the factory default password is 000000), press the F1 key to shift, and press the F3 key to change the size of the number. After entering, press the F2 key to enter the reset menu.

Press the F2 (Confirm/Switch) key

The accumulated flow value is reset to zero. On the reset interface, to prevent accidental operation, both hands are used to press the F1 and F3 keys simultaneously for the reset operation. The reset success screen is displayed

Press the F2 (Confirm/Switch) key

The operation time is reset to zero. The operation time is in minutes. Record the startup operation time of the instrument, with a maximum of 8 digits (the reset operation is the same as the cumulative flow reset). After zeroing, press the F2 key to return to the main interface.

Parameter setting

On the main interface, press the F2 key to enter the main menu interface. Press the F1 key to move the cursor to the Settings position, then press the F2 key to enter the Settings menu. Enter the reset password (the factory default password is 000000), press the F1 key to shift, and press the F3 key to change the size of the number. After entering, press the F2 key to enter the reset menu.

Press the F2 (Confirm/Switch) key

Equivalent inner diameter of the pipe: Set the inner diameter of the pipe measured by the instrument. For square pipes, it needs to be converted into an equivalent inner diameter for input.
Unit: millimeters.
Valid range: 0000.000-9999.999.

The filtering coefficient can be increased when the on-site flow display fluctuates too much and affects the reading to stabilize the reading.
The input range is 0 to 09, with 0 indicating no filtering.

The small flow removal of instantaneous flow, the small flow that needs to be removed according to the actual situation. The unit is the same as the instantaneous flow rate.
Unit: Nm3/h.
Valid range: 0000.0000 to 9999.9999.

Medium standard density, used for instantaneous mass flow display. The standard density of the medium at 20℃ and 101.325KPa Density. Unit: Kg/m

The conversion coefficient of the medium: Since the laboratory cannot calibrate the flow rate based on the actual gas used by the customer, it is usually calibrated by converting the flow rate of the actual gas used by the user into the flow rate of air. When in use, the conversion coefficient of the measured medium relative to air needs to be set to ensure measurement accuracy. The instrument comes with a built-in conversion coefficient as a reference value. If modification is necessary, it can be re-entered. The instrument is equipped with conversion coefficients for 59 gases inside. When the medium is a mixed gas, the conversion coefficients need to be calculated. For the conversion coefficient table and the calculation of the mixed gas conversion coefficient, please refer to Appendix 2.

Flow correction coefficient, instrument coefficient = standard flow/instrument display flow;

Current output: Set output variables, with instantaneous flow rate and flow velocity available for selection. Instantaneous flow rate unit: Nm3/h, flow velocity unit: Nm/s. When setting, move the cursor to the flow rate position, press F3 to change it to flow rate, press F1 to move the cursor to the number position, and press F3 to change the size of the value. Effective range of measurement: 0000.0000 to 9999999.999. Appendix 4 of the Flow Velocity Calculation Formula

RS485 communication setting, the meter number is the communication address of the instrument, valid range: 0 ~ 255. The baud rates are 1200, 2400, 4800, and 9600, and the check mode checks are null, even, and odd checks.

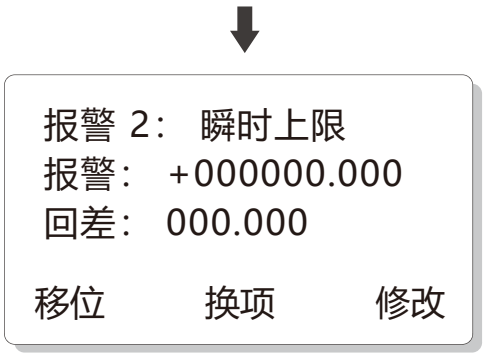
HART communication Settings: The HART short address is the communication address of the instrument. Valid range: 00-15. When the HART write protection is off, data can be written using the HART controller; when it is on, data cannot be written.

Frequency output includes pulse and equivalent output. When choosing pulse output, the frequency and range should be set, with the maximum frequency being 5000.

For frequency output, when choosing the equivalent, the equivalent coefficient should be set, and the maximum value of the equivalent coefficient is 1000.

Press the F2 (Confirm/Switch) key

Alarm Channel 1 setting: Set the value of the alarm output, including instantaneous upper limit, instantaneous lower limit, temperature upper limit, and temperature lower limit/no option. The hysteresis value is designed to prevent the current alarm variable from generating control oscillations when the upper limit alarm is greater than or close to the critical control value. Setting the hysteresis can keep the generated oscillations within the allowable range, but it simultaneously reduces the control accuracy. The actual application should set this value based on the on-site conditions and experience.



The setting of alarm channel 2 is the same as that of Alarm Channel 1.

Clock setting: Calibrate the current running date and time. This parameter has been calibrated at the factory. Clock setting affects data storage and query. Before running, it must be set to the current date. Otherwise, it will cause confusion in record storage.

Parameter setting

The calibration option sets some parameters required for instrument correction. The parameters are set to engineer-level parameters, and changing the parameters affects the flow rate Measurement: Non-professionals are not allowed to touch.

On the main interface, press the F2 key to enter the main menu interface. Press the F3 key to move the cursor to the calibration position, then press the F2 key to enter the calibration menu. Enter the calibration password (the factory default password is 000000), press the F1 key to shift, and press the F3 key to change the size of the number. After entering, press the F2 key to enter the reset menu.

按 F2（确认/换项）键

Zero-point voltage value: Set the voltage value of the instrument at zero flow and display the flow voltage value in real time. When calibrating the zero point, please confirm that there is no flow in the pipeline. After stabilizing for about half a minute or more, press the F1 and F3 keys simultaneously. The display interface will prompt that the zero point setting is successful. The zero-point voltage value can also be manually entered. In the zero-point setting interface, move the cursor to the flow rate position, press the F3 key to switch to input, and after entering the calibrated zero-point voltage value, press the F2 key to change the item. Note: During use, please do not set the zero voltage value.

Press the F3 (Modify) key

零点电压值：输入
0.6500 V
请 确 认 流 量 为 零 ！
移位　　换项　　修改

Press the F2 (Modify) key

测温电阻值（0℃）：
1000.000Ω
移位　　换项　　修改

The temperature measurement resistance value, the resistance value input into the temperature measurement sensor.

流速表：　当前段 01
电压：00.0000 V
流速：000.000 Nm/s
移位　　返回　　修改

Segmented flowmeter, set the flow velocity and voltage values for segmented calibration, with up to 40 segments available. After calibration through the flow calibration device, the segmented voltage and flow velocity are input in ascending order (the 0th section is the zero point, and the flow velocity is fixed at zero). Note: The instrument calculates the flow rate through a flowmeter. Please do not modify the data in the flowmeter at will, as it will affect the measurement accuracy.

流量修正：当前段 0
流量：0000000.000
系数：000000.0000
移位　　返回　　修改

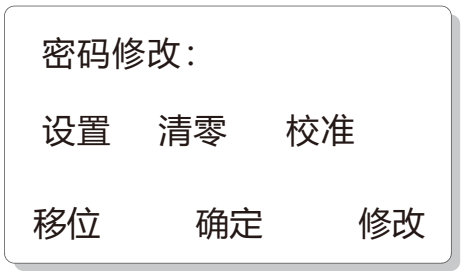
Flow correction, secondary flow correction, can be divided into five stages for flow correction.
The segmented flow coefficient = the actual flow rate of each section/the flow rate displayed by the instrument of each section
When making segmented corrections, the input flow value should be 10% larger than the flow displayed by each section of the instrument during calibration.
When inputting, input the instrument in sequence from small flow to large flow, with at least three segments valid.

Current calibration: When there is a deviation in the current output, the current output can be calibrated through this interface. Calibration requires the preparation of relevant measuring instruments such as multimeters. Do not calibrate the current without measuring instruments. Calibration current: Select 4mA. At this time, input the data measured by the standard instrument into the actual
To measure the current value, move the cursor to 4mA and press the F3 key to select 20mA. At this point, input the data measured by the standard instrument into the actual current measurement Press the F2 key to switch items. On the next interface, you can see the zero point of the current and the current coefficient.

The zero point and coefficient of current calibration, the values calculated by the current calibration instrument. Note: During operation, please do not change the value here at will, as it will affect the accuracy of the current output.

Password setting

This option can be used to modify the passwords for zeroing, setting, and calibration respectively

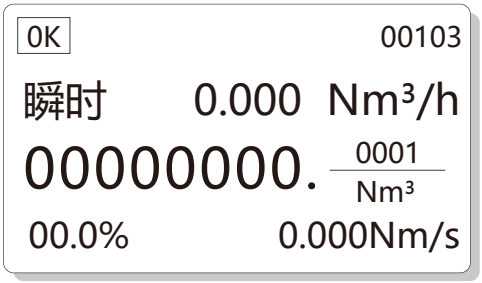


On the main interface, press the F2 key to enter the main menu interface. Press the F1 key to move the cursor to the password area, and then press the F2 key to enter the password menu. The methods for setting, resetting and modifying the calibration password are the same. Here, only the password setting modification is introduced.

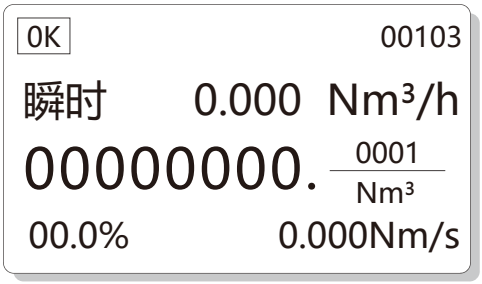
In the password setting menu, move the cursor to the Settings position and press the F2 key to enter the password modification interface. Set the old password for input, then enter the password to be modified in the new password field and press the F2 key. The instrument will prompt that the password modification is successful and jump to the main interface.

Press the F2 (Confirm) key

In the password setting menu, move the cursor to the Settings position and press the F2 key to enter the password modification interface. Set the old password for input, then enter the password to be modified in the new password field and press the F2 key. The instrument will prompt that the password modification is successful and jump to the main interface.

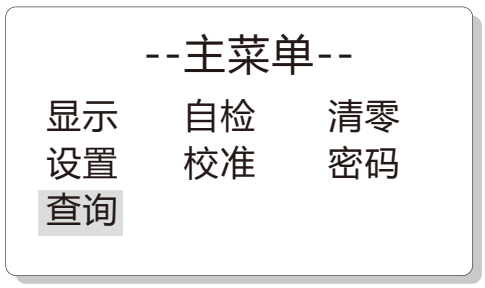


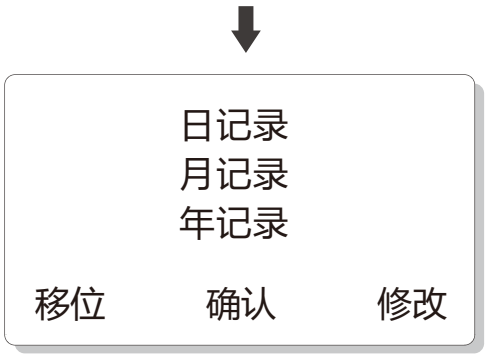
查询



On the main interface, press the F2 key to enter the main menu interface. Press the F1 key to move the cursor to the query area, and then press the F2 key to enter the query menu.

Press the F2 key





In the query menu, press the F1 key, move the cursor to the record you need to query, and press the F2 key to enter. The query methods for daily records, monthly records and annual records are the same. Here, only the query for daily records is introduced.

In the daily record menu, press the F1 key to move the cursor position, and press the F3 key to modify the date. Then you can query the data you need to query. The "80.03 Nm3" below represents the cumulative amount as of April 2, 2012.

Appendix 2 Troubleshooting

Problem	Possible causes	The method of handling
No display	1. There is no power supply	Turn on the power.
	2. The internal switch power supply of the instrument is damaged	When the 22VAC power supply is connected, if the power indicator light does not light up, it indicates that the switching power supply is damaged
	3. The DC24V power supply is connected in reverse	Detect the polarity of the power supply
	4. The display screen is misaligned	Re-insert the screen
	5. The display screen is damaged	Check the power indicator light. If the indicator light is on, it indicates that the screen is damaged. Please contact the supplier
Low flow rate	1. The probe direction is reversed	Install the probe in the correct direction
	2. The sensor is dirty	Clean the sensor
	3. Sensor damage	Return to the supplier
	4. The flow parameters are set incorrectly	Check the parameter Settings
Abnormal flow velocity Large fluctuations	1. The flow rate parameter was set incorrectly	Check the flow rate parameter Settings
	2. The nature of the fluid is pulsating and alternating	Adjust the filtering coefficient
	3. The sensor is dirty	Clean the sensor
	4. Sensor damage	Return to the supplier
4-20mA Output abnormal	The 20mA range setting is incorrect	Set the 20mA range value correctly
	2. Converter failure	Return to the supplier
	3. The wiring is not in a loop	Check the connection
Frequency Output abnormal	1. The frequency parameter setting is incorrect	Set the frequency parameters correctly
	2. Converter failure	Return to the supplier
	3. The connection line is damaged	Check the connection lines
Alarm Output abnormal	1. The instrument parameters are set incorrectly	Set the alarm parameters correctly
	2. The instrument is not equipped with an alarm output function	Contact the supplier
	3. The relay is damaged	Return to the supplier
RS-485 Output abnormal	1. The baud rate and station number Settings are incorrect	Correct input
	2. Reverse polarity connection	Change polarity
	3. The connecting wire is damaged	Check the connection lines

Appendix 3 Table of Density of General Gases and Conversion system Relative to Air

	Gas	Specific heat (calories/g ℃)	Density (g/l at 0℃)	Conversion coefficient
0	Air	0.24	1.2048	1.0000
1	Ar	0.125	1.6605	1.4066
2	Arsine	0.1168	3.478	0.669
3	Boron tribromide BBr_3	0.0647	11.18	0.3758
4	Boron trichloride BCl^3	0.1217	5.227	0.4274
5	Boron trifluoride B plus or minus 3	0.1779	3.025	0.4384
6	Borane B^2H^6	0.502	1.235	0.505
7	Carbon tetrachloride CCl^4	0.1297	6.86	0.3052
8	Add or subtract 4 from carbon tetrafluoride C	0.1659	3.9636	0.4255
9	Methane CH^4	0.5318	0.715	0.7147
10	Ethylene C^2H^4	0.3658	1.251	0.5944
11	Ethane C^2H^6	0.4241	1.342	0.4781
12	Propyne C^3H^4	0.3633	1.787	0.4185
13	Propylene C^3H^6	0.3659	1.877	0.3956
14	Propane C^3H^8	0.399	1.967	0.3459
15	Butyne C^4H^6	0.3515	2.413	0.3201
16	Butene C^4H^8	0.3723	2.503	0.2923
17	Butane C^4H^{10}	0.413	2.593	0.2535
18	Pentane C^5H^{12}	0.3916	3.219	0.2157
19	Methanol CH^3OH	0.3277	1.43	0.5805
20	Ethanol C^2H^6O	0.3398	2.055	0.3897
21	Trichloroethane $C^3H^3Cl^3$	0.1654	5.95	0.2763
22	Carbon monoxide CO	0.2488	1.25	0.9940
23	Carbon dioxide CO^2	0.2017	1.964	0.7326
24	Cyanide gas C^2N^2	0.2608	2.322	0.4493
25	Chlorine gas Cl^2	0.1145	3.163.	0.8529
26	Deuterium gas D^2	1.7325	0.1798	0.9921
27	Fluorine gas MENU	0.197	1.695	0.9255
28	Germanium tetrachloride $GeCl^4$	0.1072	9.565	0.2654
29	Germane GeH_4	0.1405	3.418	0.5656
30	Hydrogen H_2	3.4224	0.0899	1.0040
31	Hydrogen bromide HBr	0.0861	3.61	0.9940

32	Hydrogen chloride HCl	0.1911	1.627	0.9940
33	Addition and subtraction of hydrogen fluoride H	0.3482	0.893	0.9940
34	Hydrogen iodide HI	0.0545	5.707	0.9930
35	Hydrogen sulfide H_2S	0.2278	1.52	0.8390
36	Helium gas He	1.2418	0.1786	1.4066
37	Krypton gas Kr	0..0593	3.739	1.4066
38	Nitrogen N_2	0.2486	1.25	0.9940
39	Neon gas Ne	0.2464	0.9	1.4066
40	Ammonia gas NH_3	0.5005	0.76	0.7147
41	Nitric oxide NO	0.2378	1.339	0.9702
42	Nitrogen dioxide NO_2	0.1923	2.052	0.7366
43	Nitrous oxide N_2O	0.2098	1.964	0.7048
44	Oxygen O_2	0.2196	1.427	0.9861
45	Phosphorus trichloride PCl_3	0.1247	6.127	0.3559
46	Phosphorane PH_3	0.261	1.517	0.6869
47	Add or subtract 5 from phosphorus pentafluoride P	0.1611	5.62	0.3002
48	Phosphorus oxychloride $POCl_3$	0.1324	6.845	0.3002
49	Silicon tetrachloride $SiCl_4$	0.127	7.5847	0.2823
50	Add or subtract 4 from silicon tetrafluoride (Si)	0.1692	4.643	0.3817
51	Silane SiH_4	0.3189	1.433	0.5954
52	Dichlorosilane SiH_2Cl_2	0.1472	4.506	0.4095
53	Trichlorosilane $SiHCl_3$	0.1332	6.043	0.3380
54	Sulfur hexafluoride (S) plus or minus 6	0.1588	6.516	0.2624
55	Sulfur dioxide SO_2	0.1489	2.858	0.6829
56	Titanium tetrachloride $TiCl_4$	0.1572	8.465	0.2048
57	Tungsten hexafluoride W plus or minus 6	0.0956	13.29	0.2137
58	Xenon gas Xe	0.0379	5.858	1.4066

Appendix 4 Upper Limits of Commonly Used Gas Ranges (Nm^3/h)

(The table below can be expanded)

Caliber（mm）	Air	Nitrogen（N_2）	Oxygen（O_2）	Hydrogen（H_2）
15	65	65	32	10
25	175	175	89	28
32	290	290	144	45
40	450	450	226	70
50	700	700	352	110
65	1200	1200	600	185
80	1800	1800	900	280
100	2800	2800	1420	470
125	4400	4400	2210	700
150	6300	6300	3200	940
200	10000	10000	5650	1880
250	17000	17000	8830	2820
300	25000	25000	12720	4060
400	45000	45000	22608	7200
500	70000	70000	35325	11280
600	100000	100000	50638	16300
700	135000	135000	69240	22100
800	180000	180000	90432	29000
900	220000	220000	114500	77807
1000	280000	280000	141200	81120
1200	400000	400000	203480	91972
1500	600000	600000	318000	101520
2000	700000	700000	565200	180480

Standard state flow rate: The flow rate at a temperature of 20℃ and a pressure of 101.325KPa.
Note: The units of instantaneous flow can be selected as Nm3/h, Nm3/min, L/h, L/min, t/h, t/min, kg/h and kg/min.

Conversion between operating condition flow and standard condition flow

$$Q_{\text{"Condition"}} = \frac{0.101325+p}{0.101325} * \frac{273.15+20}{273.15+t} * Q_{\text{Working condition}}$$

Q Standard condition: Standard state flow rate (Nm3/h)
Q operating condition: Operating condition state flow rate (m^3 /h)
t: Working medium temperature (℃)
P: Working medium pressure (gauge pressure MPa)

Flow velocity calculation formula

$$V=Q/(\pi*(\frac{D}{2}/1000)^2)/3600$$

V: Standard flow rate of the medium (Nm/S)
Q: Standard state flow rate (Nm3/h)
D: Measure the pipe diameter (mm)

Communication protocol (RTU)

1. Data format description

1.1 Communication Mode

This instrument adopts the MODBUS RTU format.

The protocol is used for data communication in the master-slave query mode.

1.2 Data Format

The data format is n, 8, 1 (1 start bit, 8 data bits, no check, 1 stop bit).

There are four selectable baud rates: 1200, 2400, 4800, 9600, 19200, and 38400.

Start	Address	Function	Data	CRC	END
T1-T2-T3-T4	8 bit	8 bit	n*8 bit	16 bit	T1-T2-T3-T4

Among them: T1, T2, T3, and T4 are the time intervals between each frame. The transmission between two frames must be greater than the interval time.

1. 3 Address

The agreement stipulates that the address of the instrument is "0-255". The "0" address is used for broadcasting and this agreement does not support broadcasting. The remaining addresses are reserved.

2 Command Description

2.1 This instrument uses one instruction in the MODBUS protocol:

Command 03	Read a single or multiple holding registers

2.2 Data format The data in the protocol includes integers and floating point numbers Integers are represented as 16-bit unsigned integers. The 32-bit single precision floating point number FLOAT is IEEE754, which is equivalent to 4 bytes and arranged in the order of 3-4-1-2. After being converted to the order of 1234, the highest to the lowest bit is the 31st, 30th, 29th,..., and 0th bit.

31	30-23	22-0
S	scale	mantissa

The 31st bit is the sign bit (S), where 1 means the number is negative and 0 means the number is positive; 30-23 bits, a total of 8 bits are the order code; 22-0 is the last digit, and there are 23 digits in total. The format of the command 3 is as follows (read register command):

MODBUS request

Instrument address	1 BYTE	01-255
function code	1 BYTE	03
start address	2 BYTE	0-FFFF
Read quantity	2 BYTE	1-20
CRC low-order	1 BYTE	
CRC high-order	1 BYTE	

MODBUS respond

Instrument address	1 BYTE	01-255
Function code	1 BYTE	03
Byte count	1 BYTE	N
Input status	N*2 BYTE	
CRC low-order	1 BYTE	
CRC high-order	1 BYTE	

give an example

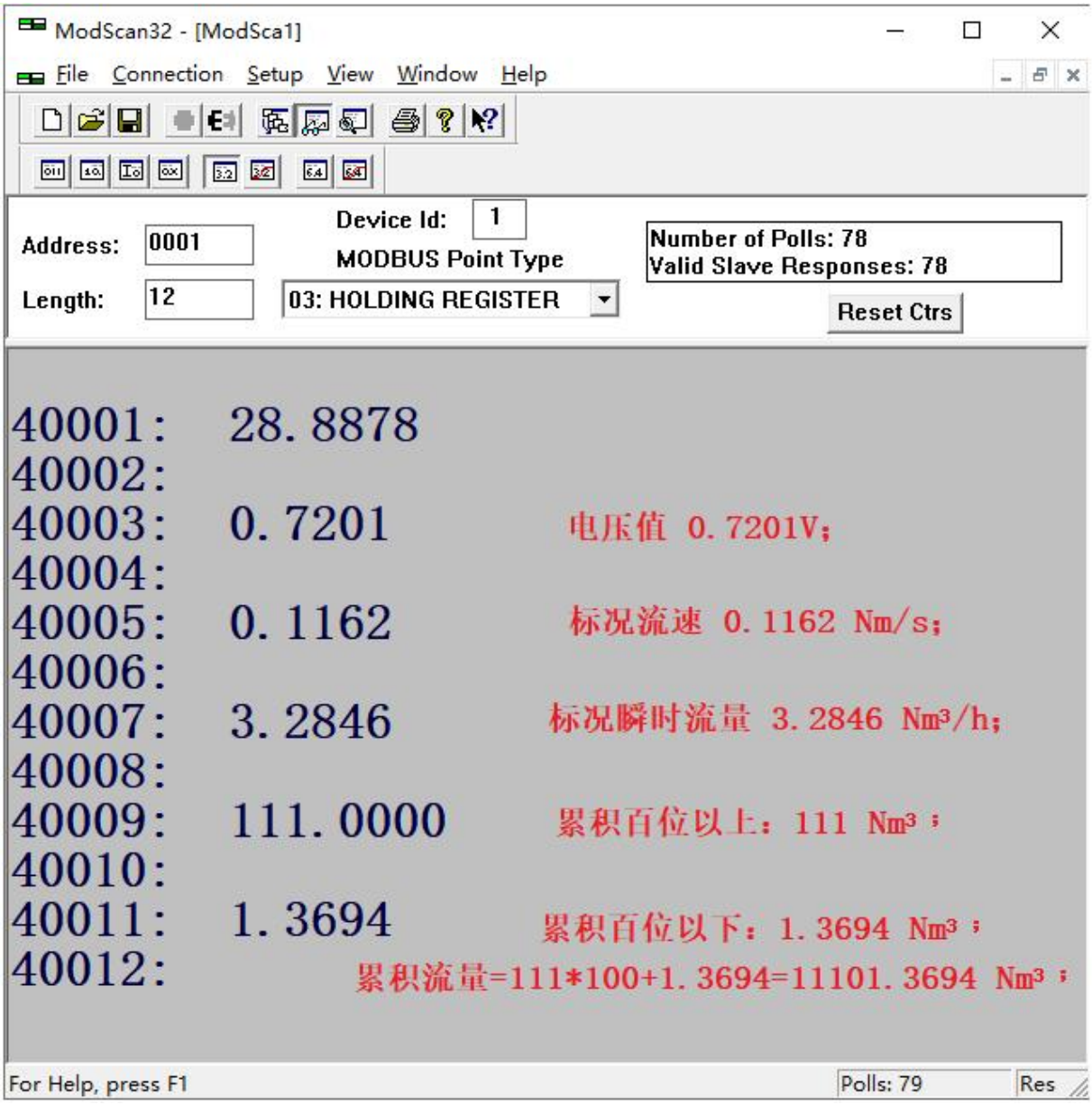
request		respond	
Domain name	Data (HEX)	Domain name	Data (HEX)
Instrument address code	01	Instrument address code	01
Function code	03	Function code	03
Starting address height (bytes)	00	Number of bytes	08
Low starting address (bytes)	00	Register height (0001)	0C
High data reading volume (in bytes)	00	Register low (0001)	E8
The amount of data read is low (in bytes	04	Register High (0002)	C2
		Register low (0002)	FB
		Register height (0003)	C9
		Register low (0003)	26
		Register height (0004)	C3

attribute	address	Read the address (HEX)	register length	data type	explain
R	40001-2	0x00	2		Retain
R	40003-4	0x02	2	FLOAT	Voltage value (V)
R	40005-6	0x04	2	FLOAT	Standard flow velocity (Nm/s)
R	40007-8	0x06	2	FLOAT	The instantaneous flow rate under standard conditions (default Nm3/h) refers to the display unit
R	40009-10	0x08	2	FLOAT	Reference display units for cumulative traffic of over 100 digits (default Nm3)
R	40011-12	0x0A	2	FLOAT	Refer to the display unit for cumulative traffic below the 100th digit (default Nm3)

		Register low (0004)	7B
CRC check	check code	CRC check	check code

2 Data item definition

MODSCAN32 communication interface (03 command) ：



Read the register data (in this example, read the data displayed in the current header)

Master station request: 01 03 00 00 00 0C 3C 0F

address | function code | start | length | CRC

Slave station response frame：01 03 28 00 00 41 B4 21 FF 3F 6D 16 84 40 A0 01 6A 42 32 00 00 40 40 74 5E 42 86 35 09

01 03 28 : Address, function code, number of bytes

00 00 41 B4 : Retain

21 FF 3F 6D : 0.9263V; magnitude of voltage

16 84 40 A0 : 5.002 Nm/s; Standard flow rate

01 6A 42 32 : 44.5013 Nm^3/h; Standard instantaneous flow
00 00 40 40 : 3.0 Nm^3, Cumulative flow is in the hundreds;
74 5E 42 86 : 67.2272 Nm^3, Cumulative flow below 100;
cumulative flow=3.0*100+67.2272=367.2272 Nm^3
35 09 : CRC check

32 The single precision floating point data is arranged in bytes 3-4-1-2, as shown above the flow rate (16 84 40 A0), and the parsing order is 40 A0 16 84, resulting in a parsing of 5.002 Nm/s.