Precession Vortex Flow Meter

Converter Operation Manual

(Version3.2)

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Chapter 1. Overview

The intelligent precession vortex flow meter is a new type of gas flow instrument developed and manufactured by our company, possessing leading domestic technology. This flow meter integrates flow, temperature, and pressure detection functions, and can automatically compensate for temperature, pressure, and compressibility factor. It is an ideal instrument for gas metering in industries such as petroleum, chemical, power, and metallurgy.

1.1. Main Product Features

▲No moving mechanical parts, corrosion-resistant, stable and reliable, long service life, no special maintenance required for long-term operation;

▲Uses a 16-bit computer chip, high integration, small size, good performance, and powerful overall functionality;

▲The intelligent flow meter integrates a flow probe, microprocessor, pressure, and temperature sensors into one built-in unit, making the structure more compact. It can directly measure the flow rate, pressure, and temperature of fluids, and automatically track compensation and compressibility factor correction in real time;

▲Dual detection technology effectively improves the detection signal strength and suppresses interference caused by pipeline vibration;

▲Adopts domestically leading intelligent anti-vibration technology, effectively suppressing interference signals caused by vibration and pressure fluctuations;

▲Uses a Chinese character dot matrix display screen with multiple display digits, making readings intuitive and convenient. It can directly display the volumetric flow rate under working conditions, the volumetric flow rate under standard conditions, the total volume, and parameters such as medium pressure and temperature;

▲Uses EEPROM technology, making parameter setting convenient and permanently stored, with the ability to save historical data for up to one year;

▲The converter can output frequency pulses and 4-20mA analog signals, and has RS485 functionality.

▲Interface allows direct network connection to a microcomputer, with a transmission distance of up to 1.2km;

▲Multiple physical quantity parameter alarm outputs, one of which can be selected by the user;

▲The flow meter head can rotate 360 degrees, making installation and use simple and convenient;

▲When used with our FM-type data acquisition unit, remote data transmission can be performed via the Internet or telephone network;

▲Pressure and temperature signals are input via sensors, offering strong interchangeability;

▲Low power consumption, can be powered by an internal battery or an external power supply.

1.2. Main Applications

Intelligent precession vortex flowmeters can be widely used in industries such as petroleum, chemical, power, metallurgy, and urban gas supply to measure the flow rate of various gases. They are currently the preferred product for metering in oilfields and urban natural gas transmission and distribution, as well as for trade metering.

Chapter 2. Structure and Working Principle

2.1. Flowmeter Structure

The flow meter consists of the following seven basic components (Figure 1):

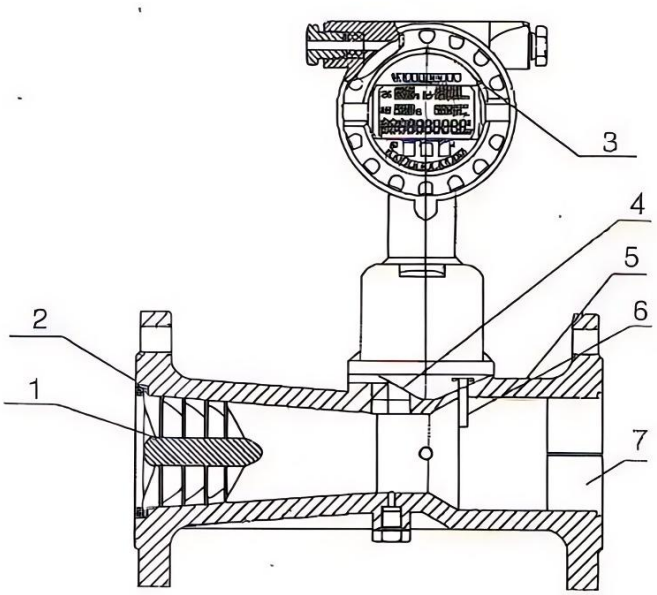


Figure 1

1. Vortex Generator

Made of aluminum alloy, it features angled helical blades fixed to the front of the constriction section of the casing, forcing the fluid to generate a strong vortex flow.

2. Casing

It has flanges and fluid channels of a specific shape. Depending on the operating pressure, the casing material can be cast aluminum alloy or stainless steel.

3. Intelligent Flow Totalizer (Principle shown in Figure 3)

It consists of analog channels for temperature and pressure detection, a digital channel for flow detection, a microprocessor unit, an LCD driver circuit, and other auxiliary circuits, and is equipped with an external signal output interface.

4. Temperature Sensor

Using a Pt100 platinum resistance thermometer as the temperature-sensitive element, its resistance value corresponds to the temperature within a certain temperature range.

5. Pressure Sensor

Using a piezoresistive diffused silicon bridge circuit as the sensitive element, the resistance of its bridge arms changes as expected under external pressure. Therefore, under a certain excitation current, the potential difference between its two output terminals is proportional to the external pressure.

6. Piezoelectric Crystal Sensor

Mounted near the throat of the housing expansion section, it detects the frequency signal of vortex precession.

7. Devortex Filter

Fixed at the housing outlet section, its function is to eliminate vortex flow to reduce its impact on the performance of downstream instruments.

2.2. Working Principle

The flow profile of the flow sensor resembles that of a Venturi tube (Figure 2). A set of helical guide vanes is placed on the inlet side. When fluid enters the flow sensor, the guide vanes force the fluid to generate a violent vortex flow. When the fluid enters the diffuser section, the vortex flow is subjected to backflow and begins to rotate a second time, forming a gyroscopic vortex precession phenomenon. This precession frequency is proportional to the flow rate and is not affected by the fluid's physical properties and density. The detection element can obtain good linearity over a wide flow range by measuring the fluid's second rotation precession frequency. The signal is amplified, filtered, and shaped by a preamplifier into a pulse signal proportional to the flow velocity. This pulse signal, along with temperature and pressure detection signals, is then sent to a microprocessor for integration processing. Finally, the measurement results (instantaneous flow rate, cumulative flow rate, and temperature and pressure data) are displayed on the LCD screen.

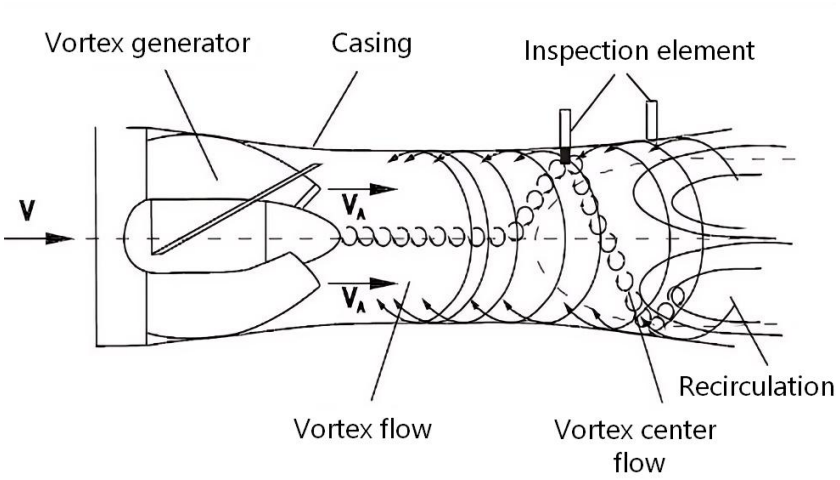


Figure 2

2.3. Working Principle of Flow Totalizer

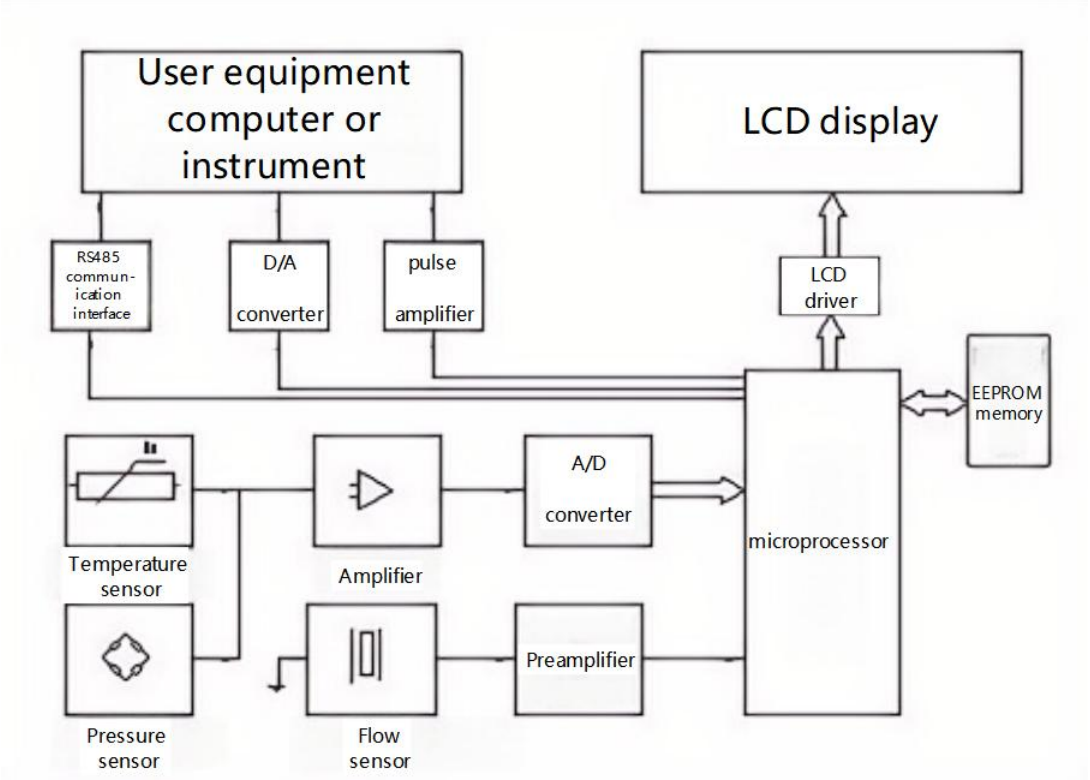


Figure 3

The flow totalizer consists of a temperature and pressure detection analog channel, a flow sensor channel, and a microprocessor unit, and is equipped with an

external output signal interface to output various signals. The microprocessor in the flowmeter performs temperature and pressure compensation according to the gas equation and automatically corrects for the compressibility factor. The gas equation is as follows:

$$Q_N = \frac{Pa + P}{P_N} \bullet \frac{T_N}{T} \bullet \frac{Z_N}{Z} Q_V \qquad \text{……(2)}$$

In the formula:

QN — Volumetric flow rate under standard conditions (m^3/h);

QV — Volumetric flow rate under operating conditions (m^3/h);

Pa — Local atmospheric pressure (kPa);

P — Gauge pressure measured at the flow meter's pressure tap (kPa);

PN — Atmospheric pressure under standard conditions (101.325 kPa);

TN — Absolute temperature under standard conditions (293.15 K);

T — Absolute temperature of the fluid being measured (K);

ZN — Compressibility factor of the gas under standard conditions;

Z — Compressibility factor of the gas under operating conditions;

Note: When calibrating with a bell or negative pressure, ZN/Z = 1. For natural gas, (ZN/Z)1/2 = FZ is the overcompressibility factor. Calculated according to the formula in the China National Petroleum Corporation standard SY/T6143-1996.

Chapter 3. Main Technical Parameters and Functions

3.1. Flowmeter specifications, basic parameters and performance indicators (see Table 1)

Nominal Diameter DN (mm)	Gas Flow Rate Range (m^3/h)	Liquid Flow Rate Range (m^3/h)	Operating Pressure (MPa)	Accuracy Class	Repeatability
15	1~10	0.4-2	1.6 2.5 4.0 6.3 10 16	1.0 1.5	≤2.5MPa Aluminum Alloy ≥4.0MPa Stainless Steel Less than 1/3 of the absolute value of the basic tolerance limit
20	2~20	0.8-4			
25	3~30	1.2-6			
32	4~50	2-10			
40	7~100	4-20			
50	10~150	6-30			
65	15~200	8-40			
80	30~400	16-80			
100	50~700	28-140	1.6 2.5 4.0		
125	60~1000	40-200			
150	150~2000	60-300			
200	240~3600	80-400			

Note: 1. Accuracy: refers to the system accuracy after temperature and pressure corrections;

2. A and B are used to distinguish different flow ranges for the same pipe diameter.

3.2. Standard State Conditions: P = 101.325 kPa, T = 293.15 K

3.3. Usage Conditions:

Ambient temperature: -30℃ ~ +65℃

Relative humidity: 5% ~ 95%

Medium temperature: -20℃ ~ +120℃; -20℃ ~ +180℃; -20℃ ~ +280℃

Atmospheric pressure: 86 KPa ~ 106 KPa

3.4. Electrical Performance Indicators

3.4.1 Operating Power Supply:

A. External Power Supply: +24VDC±15%, ripple <5%, suitable for 4～20mA output, pulse output, alarm output, RS-485, etc.

B. Internal Power Supply: One 3.6V lithium battery (ER26500), undervoltage indication occurs when the voltage is below 3.0V.

3.4.2 Total Power Consumption:

A. External Power Supply: <2W;

B. Internal Power Supply: Average power consumption 1mW, can be used continuously for more than two years.

3.4.3 Pulse Output Methods:

A. Operating Pulse Signal: Directly outputs the operating pulse signal detected by the flow sensor through optocoupler isolation amplification, high level ≥20V, low level ≤1V;

B. Calibration Pulse Signal: Matched with IC card valve controller, high level amplitude ≥2.8V, low level amplitude ≤0.2V, unit pulse represents a settable volume range: 0.001m3~100m3. When selecting this value, please note that the calibration pulse signal frequency should be ≤900Hz.

C. The calibration pulse signal is amplified and output via optocoupler isolation. The high level is ≥20V, and the low level is ≤1V.

3.4.4 RS-485 Communication (Photoisolated), enabling the following functions:

Using an RS-485 interface, it can directly connect to a host computer or secondary instrument to remotely display the medium's temperature, pressure, and standard volumetric flow rate and total standard volume after temperature and pressure compensation.

3.4.5 4～20mA Standard Current Signal (Photoisolated)

Proportional to the standard volumetric flow rate, 4mA corresponds to 0 m^3/h, and 20mA corresponds to the maximum standard volumetric flow rate (this value can be set in the primary menu). System type: two-wire or three-wire. The flow meter can automatically identify and correctly output based on the connected current module.

3.4.6 Control Signal Output:

A. Lower Limit Alarm Signal (LP): Photoisolated, high/low level alarm, alarm level can be set, operating voltage +12V~+24V, maximum load current 50mA;

B. Upper Limit Alarm Signal (UP): Photoisolated, high/low level alarm, alarm level can be set, operating voltage +12V~+24V, maximum load current 50mA;

C. Valve Closure Alarm Output (BC terminal, for IC card controller): Logic gate circuit output, normal output low level, amplitude ≤0.2V; alarm output high level, amplitude ≥2.8V, load resistance ≥100kΩ;

D. Battery Low Voltage Alarm Output (BL terminal, for IC card controller): Logic gate circuit output, normal output low level, amplitude ≤0.2V; alarm output high level, amplitude ≥2.8V, load resistance ≥100kΩ;

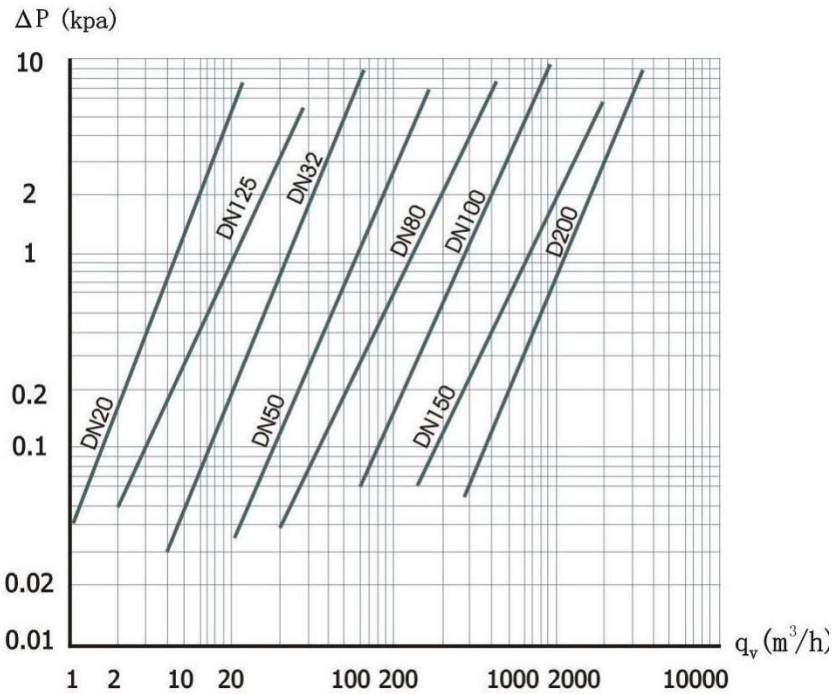
3.5. Explosion-Proof Marking: ExdIIBT4

3.6. Protection Rating: IP65

3.7. Pressure Loss

The formula for calculating the actual pressure loss of a flow meter is as follows:

$$\Delta P1 = \frac{\rho}{1.205}\Delta P \quad \cdots\cdots\cdots\cdots\cdots\cdots (1)$$



In the formula:

ΔP1—Actual pressure loss of the flow meter (KPa);

ρ—Density of the measured medium (kg/m3);

ΔP—Pressure loss of the flow meter when the medium is dry air (KPa), its characteristic curve is shown in the figure below.

3.8. Connection port: The cable outlet is an M20×1.5 internal thread.

Chapter 4. Selection and Installation

4.1 Flowmeter Selection

Two principles should be adhered to during the selection process: ensuring production safety and ensuring operational accuracy. To this end, three selection parameters must be established: the maximum, minimum, and commonly used flow rates for both near and long term (primarily used to select the nominal diameter of the instrument); the design pressure of the measured medium (primarily used to select the nominal pressure rating of the instrument); and the actual operating pressure (primarily used to select the pressure rating of the instrument's pressure sensor).

a. When the measured flow rate is known as the operating volumetric flow rate, a suitable nominal diameter can be directly selected according to the flow range in the table;

b. When the measured flow rate is known as the volumetric flow rate under standard conditions, the standard volumetric flow rate Q_N should first be converted to the operating volumetric flow rate Qv, and then the corresponding nominal diameter should be selected according to the flow range in the technical parameter table;

c. When both flowmeter diameters can cover the minimum and maximum volumetric flow rates, the smaller diameter should be selected as much as possible, provided pressure loss is permissible;

d. The actual minimum flow rate Qmin should not be lower than the lower limit of the selected nominal diameter flowmeter;

e. Special requirements for flow range and nominal pressure can be negotiated and ordered.

f. The selection calculation formula is as follows:

$$Q_V = \frac{Z}{Z_N} \bullet \frac{P_N}{P + P_a} \bullet \frac{T}{T_N} \bullet Q_N = \frac{Z}{Z_N} \bullet \frac{101.325}{P + P_a} \bullet \frac{T}{293.15} \bullet Q_N$$

In the formula: T, P, and Pa have the same meanings as above.

1. Q is the volumetric flow rate, Qn is the standard volumetric flow rate, and the Z/Zn values are listed in the table.

2. Due to the large calculation step size, the data in the table are for reference only.

3. The data in the table are based on the true relative density of natural gas Gr = 0.600.

4. The mole fractions of nitrogen and carbon dioxide are both calculated to be 0.00.

5. When the medium pressure is below 0.1 MPa, it can be estimated using Z/Zn = 1.

Temperature ℃ / Absolute pressure MPa	-20	-15	-10	-5	0	5	10	15	20	25
0.10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.20	1.0034	1.0032	1.0030	1.0029	1.0027	1.0025	1.0024	1.0023	1.0021	1.0020
0.30	1.0069	1.0065	1.0061	1.0058	1.0055	1.0051	1.0048	1.0046	1.0043	1.0041
0.40	1.0104	1.0098	1.0093	1.0087	1.0082	1.0078	1.0073	1.0069	1.0065	1.0061
0.50	1.0140	1.0132	1.0124	1.0117	1.0110	1.0104	1.0098	1.0092	1.0087	1.0082
1.00	1.0325	1.0305	1.0286	1.0269	1.0253	1.0238	1.0223	1.0210	1.0198	1.0186
1.50	1.0518	1.0485	1.0455	1.0426	1.0400	1.0375	1.0352	1.0331	1.0311	1.0293
2.00	1.0722	1.0674	1.0630	1.0589	1.0551	1.0516	1.0484	1.0454	1.0426	1.0400
2.50	1.0936	1.0872	1.0812	1.0785	1.0708	1.0661	1.0619	1.0580	1.0543	1.0510
3.00	1.1162	1.1078	1.1002	1.0933	1.0869	1.0810	1.0757	1.0707	1.0662	1.0620
3.50	1.400	1.1295	1.1200	1.1113	1.1035	1.0963	1.0897	1.0837	1.0782	1.0732
4.00	1.1651	1.1521	1.1405	1.1300	1.1205	1.1119	1.1044	1.0969	1.0904	1.0844
4.50	1.1951	1.1785	1.1618	1.1493	1.1380	1.1278	1.1186	1.1103	1.1027	1.0957
5.00	1.2191	1.2005	1.1839	1.1691	1.1559	1.1441	1.1334	1.1238	1.1150	1.1071
5.50	1.2486	1.2262	1.2067	1.1895	1.1742	1.1606	1.1484	1.1374	1.1274	1.1185
6.00	1.2793	1.2530	1.2302	1.2104	1.1928	1.1772	1.1634	1.1510	1.1399	1.1298
6.50	1.3113	1.2806	1.2544	1.2316	1.2117	1.1942	1.1786	1.1617	1.1522	1.1414

7.00	1.3444	1.3091	1.2790	1.2532	1.2308	1.2111	1.1937	1..1783	1.1645	1.1522
7.50	1.3785	1.3381	1.3010	1.2750	1.2499	1.2280	1.2088	1.1918	1.1767	1.1632
8.00	1.431	1.3673	1.3291	1.2967	1.2689	1.2448	1.2237	1.2051	1.1886	1.1740
Temperature ℃ / Absolute pressure MPa	30	35	40	45	50	55	60	65	70	75
0.10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.20	1.0019	1.0018	1.0017	1.0016	1.0015	1.0014	1.0013	1.0012	1.0012	1.0011
0.30	1.0038	1.0036	1.0034	1.0032	1.0030	1.0029	1.0027	1.0025	1.0024	1.0023
0.40	1.0058	1.0054	1.0051	1.0048	1.0046	1.0043	1.0041	1.0038	1.0036	1.0034
0.50	1.0077	1.0073	1.0069	1.0065	1.0061	1.0058	1.0055	1.0052	1.0049	1.0046
1.00	1.0176	1.0166	1.0156	1.0147	1.0139	1.0131	1.0124	1.0117	1.0110	1.0104
1.50	1.0275	1.0259	1.0244	1.0230	1.0217	1.0204	1.0193	1.0182	1.0171	1.0162
2.00	1.0376	1.0354	1.0333	1.0313	1.0295	1.0277	1.0261	1.0246	1.0232	1.0042
2.50	1.0478	1.0449	1.0422	1.0396	1.0372	1.0350	1.0329	1.0310	1.0292	1.0274
3.00	1.0581	1.0545	1.0511	1.0480	1.0450	1.0432	1.0397	1.0373	1.0351	1.0330
3.50	1.0685	1.0641	1.0600	1.0563	1.0582	1.0495	1.0464	1.0436	1.0409	1.0384
4.00	1.0789	1.0737	1.0690	1.0646	1.0605	1.0567	1.0531	1.0498	1.0467	1.0438
4.50	1.0894	1..0834	1.0779	1.0728	1.0681	1.0638	1.0597	1.0559	1.0523	1.0490
5.00	1.0998	1.0930	1.0868	1.0811	1.0757	1.0708	1.0662	1.0619	1.0579	1.0542
5.50	1.1103	1.01026	1.0956	1.0892	1.0832	1.0777	1.0726	1.0678	1.0633	1.0592
6.00	1.1207	1. 1122	1.1044	1.0972	1.0906	1.0845	1.0788	1.0736	1.0687	1.0641
6.50	1.1310	1.1216	1.1130	1.1051	1.0979	1.0912	1.0850	1.0792	1.0738	1.0689
7.00	1.1411	1.1309	1.1215	1.1129	1.1050	1.0977	1.0910	1.0847	1.0789	1.0735
7.50	1.1511	1.1400	1.1298	1.1205	1.1120	1.1041	1.0968	1.0900	1.0838	1.0780
8.00	1.1609	1.1489	1.1380	1.1279	1.1187	1.1103	1.1024	1.0952	1.0885	1.0823

4.2. Selection Examples

Given a gas supply pipeline with an actual operating pressure range of 0.80 MPa–1.2 MPa, a medium temperature range of -10℃ to +40℃, a peak supply flow rate of 2500 L/min, a valley supply flow rate of 5600 L/min, a natural gas relative density Gr = 0.591, a nitrogen molar percentage of Mn = 1.6%, a carbon dioxide molar percentage of Mc = 0.8%, and a local atmospheric pressure of 101.3 kPa, determine the appropriate flowmeter diameter.

When the medium pressure is 0.8 MPa and the temperature is 40℃, the compressibility factor of natural gas has the least impact, resulting in the maximum flow rate during peak supply periods. Conversely, when the medium pressure is 1.2 MPa and the temperature is -10℃, the compressibility factor has the greatest impact, resulting in the minimum flow rate during valley supply periods.

When Gr = 0.591, Mn = 1.6%, Mc = 0.8%, gauge pressure P = 0.8 MPa, and temperature T = 40℃, according to the formula in SY/T6143, Zn/Z = 1.0127 can be obtained. Therefore, the maximum volumetric flow rate is

$$Q_{\max} = \frac{Z}{Z_N} \bullet \frac{P_N}{P + P_a} \bullet \frac{T}{T_N} \bullet Q_N = \frac{1}{1.0127} \times \frac{101.325}{800 + 101.3} \times \frac{40 + 273.15}{293.15} \times 2500 = 2964.6(m^3 / h)$$

When the gauge pressure P = 1.2 MPa and the temperature T = -10℃, Zn/Z = 1.0355 can be calculated. Therefore, the minimum volumetric flow rate is:

$$Q\min = \frac{Z}{Z_N} \bullet \frac{P_N}{P + P_a} \bullet \frac{T}{T_N} \bullet Q_N = \frac{1}{1.0355} \times \frac{101.325}{1200 + 101.3} \times \frac{-10 + 273.15}{293.15} \text{ x } 5600 =$$

$378(m^3 / h)$

From Table 1, we find that the flow meter diameter is 200mm.

When ordering this product, users should select the appropriate specifications based on the fluid's working pressure, medium temperature, flow range, fluid type, and environmental conditions. For applications requiring explosion-proof performance, please strictly adhere to the explosion-proof rating.

4.3. Flowmeter External Dimensions and Installation Dimensions

The external dimensions of the flowmeter are shown in Figure 3. Dimensions not specified in the figure are listed in Table 1. The flowmeter uses a flange connection, and the flange dimensions comply with GB/T9112～9113-2000 standards.

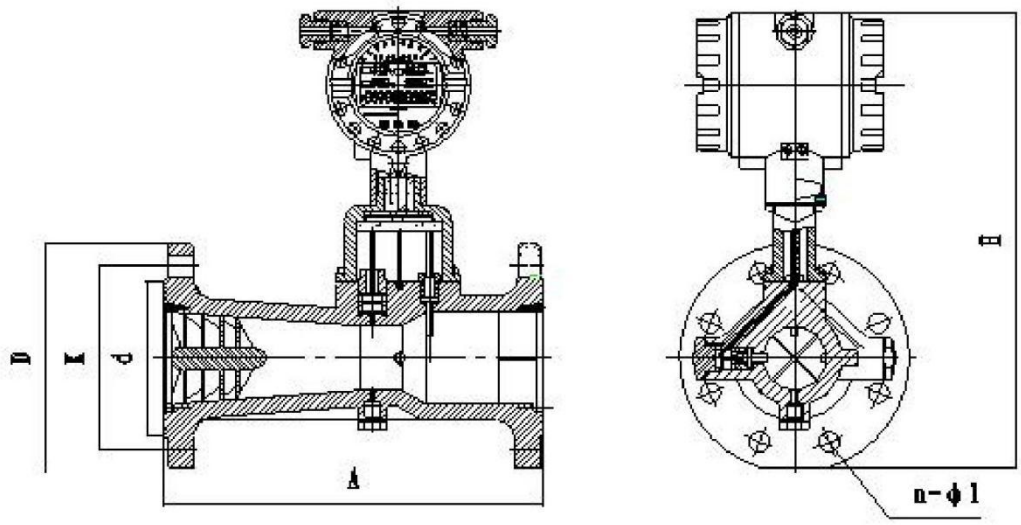


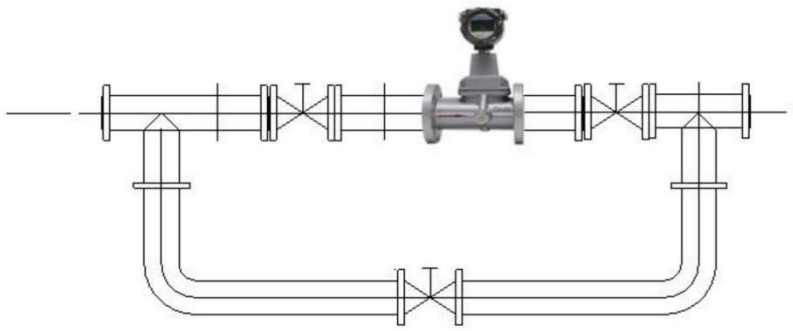
Table 3 Unit: mm

Nominal	Diameter (DN)	Pressure Rating (MPa)	L	H	D	K	n ×d
DN15	15	1.6、2.5、4.0、6.3	162	305	105	75	4-φ14
DN20	20	1.6、2.5、4.0、6.3	162	305	105	75	4-φ14
DN25	25	1.6、2.5、4.0、6.3	183	315	115	85	4-φ14
DN32	32	1.6、2.5、4.0、6.3	200	330	140	100	4-φ18
DN40	40	1.6、2.5、4.0、6.3	234	340	150	110	4-φ18
DN050	50	1.6、2.5、4.0	234	355	165	125	4-φ18
		6.3		365	180	135	
DN065	65	1.6、2.5、4.0	304	370	185	145	4-φ18
		6.3		390	205	160	8-φ22
DN080	80	1.6、2.5、4.0	330	390	200	160	8-φ18

		6.3		400	215	170	8-φ22
DN100	100	1.6	410	410	220	180	8-φ18
		2.5		420	235	190	8-φ22
		4.0		420	235	190	
DN125	125	1.6	517	435	250	210	8-φ18
		2.5		455	270	220	8-φ26
		4.0		455	270	220	8-φ26
DN150	150	1.6	580	470	285	240	8-φ22
		2.5		490	300	250	8-φ26
		4.0		490	300	250	
DN200	200	1.6	700	525	340	295	12-φ22
		2.5		540	360	310	12-φ26
		4.0		550	375	320	12-φ30

4.4. Flowmeter Installation

4.4.1 Flowmeter Installation Diagram



4.4.2 Installation Precautions

▲ The sensor can be installed vertically, horizontally, or at any tilt position according to the flow direction markings;

▲ When the pipeline is long or close to a vibration source, supports should be installed upstream and downstream of the flow meter to eliminate the influence of pipeline vibration;

▲ The sensor installation location should have sufficient space to facilitate flow meter inspection and maintenance, and should meet the environmental requirements of the flow meter;

▲ Interference from strong external magnetic fields should be avoided;

▲ When installed outdoors, it should be covered to avoid exposure to direct sunlight and rain, which could affect the instrument's service life;

▲ During pipeline pressure testing, attention should be paid to the pressure measurement range of the pressure sensor configured on the intelligent flow meter to avoid overpressure damage to the pressure sensor.

▲ The influence of installation stress should be considered. The upstream and downstream pipelines of the flow meter should be coaxial; otherwise, shear stress will occur. The installation location of the flow meter should take into account the thickness of the sealing gasket, or an elastic expansion joint should be installed on the downstream side.

▲ Before installing the flow meter, weld slag and other debris in the pipeline should be removed.

▲ When putting it into operation, the upstream and downstream valves of the flow meter should be opened slowly to avoid the instantaneous airflow damaging the vortex generator.

▲When the flowmeter requires remote signal transmission, it must be connected to an external power supply (8-24VDC) strictly according to the "Electrical Performance Indicators." Direct connection of 220VAC or 380VAC power to the signal output port is strictly prohibited.

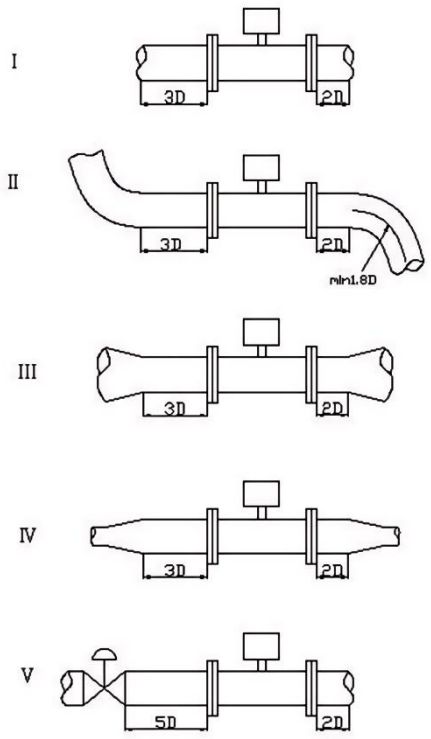
▲Users must not alter the wiring method of the explosion-proof system or arbitrarily twist any output lead connectors.

▲During flowmeter operation, the rear cover must not be opened arbitrarily to modify instrument parameters; otherwise, the normal operation of the flowmeter will be affected.

▲Regularly check for leaks at the flowmeter flange.

4.4.3 Requirements for Straight Pipe Sections

Based on the working principle of the precession vortex flowmeter and the flowmeter's requirements for upstream and downstream straight pipe sections, it is recommended to use the upstream and downstream straight pipe section lengths listed in the figure below for various upstream resistance components, and to keep the inner wall of the straight pipe section smooth and straight.

Illustrate	Diagram
Ensure that the length of the straight pipe section on the upstream side is at least 3D, and the length of the straight pipe section on the downstream side is at least 2D. See Schematic diagram I. (D: Nominal diameter of the precession vortex flowmeter)	
Pipe bends: For pipe bends, ensure that the length of the straight pipe section on the upstream side is at least 3D and the length of the straight pipe section on the downstream side is at least 2D. See diagram II.	
Pipe reduction: For pipe reduction, the length of the straight pipe section on the upstream side must be at least 3D, and the length of the straight pipe section on the downstream side must be at least 2D. See diagram III.	
Pipe expansion: For pipe expansion, the length of the straight pipe section on the upstream side must be at least 3D, and the length of the straight pipe section on the downstream side must be at least 2D. See Schematic diagram IV.	
Valves: If there is a valve on the upstream side, the straight pipe section on the upstream side must be at least 5D in length, and the straight pipe section on the downstream side must be at least 2D in length. See diagram V.	Straight pipe section requirements for flow meter installation

4.4.4 Use and replacement of the built-in battery

● Battery Level Display

When the battery indicator shows only one bar remaining, the user is required to replace the battery within one month. If only the battery symbol is displayed, the battery is depleted and must be replaced immediately.

● Battery Replacement Method

Open the back cover of the intelligent flow totalizer, loosen the three screws on the battery cover, unplug the battery socket, remove the battery, replace it with a new battery, and reinstall it.

4.4.5 Explosion-Proof Installation Requirements

The flowmeter should have reliable grounding. Explosion-proof grounding should not be shared with the protective grounding of the high-voltage system.

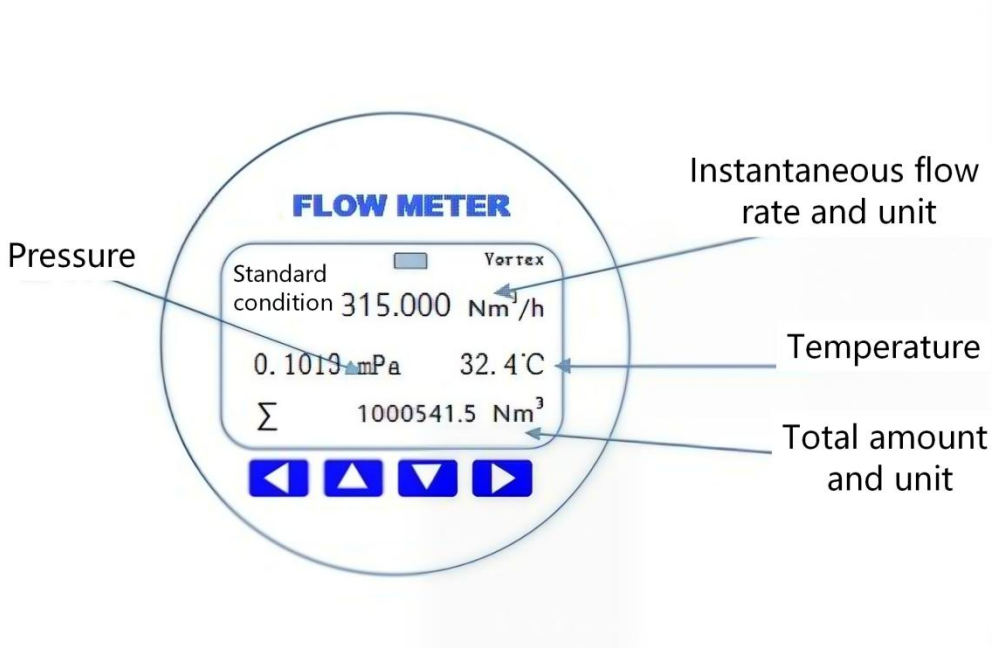
When testing the power supply on-site, AC power grounding is not permitted.

Under no circumstances should the user alter the explosion-proof circuit, components, or explosion-proof type.

The external power supply must be disconnected before opening the converter cover.

Chapter 5. Usage Instructions

5.1. Display Method in Working State (See Figure Below)



LCD screen illustration

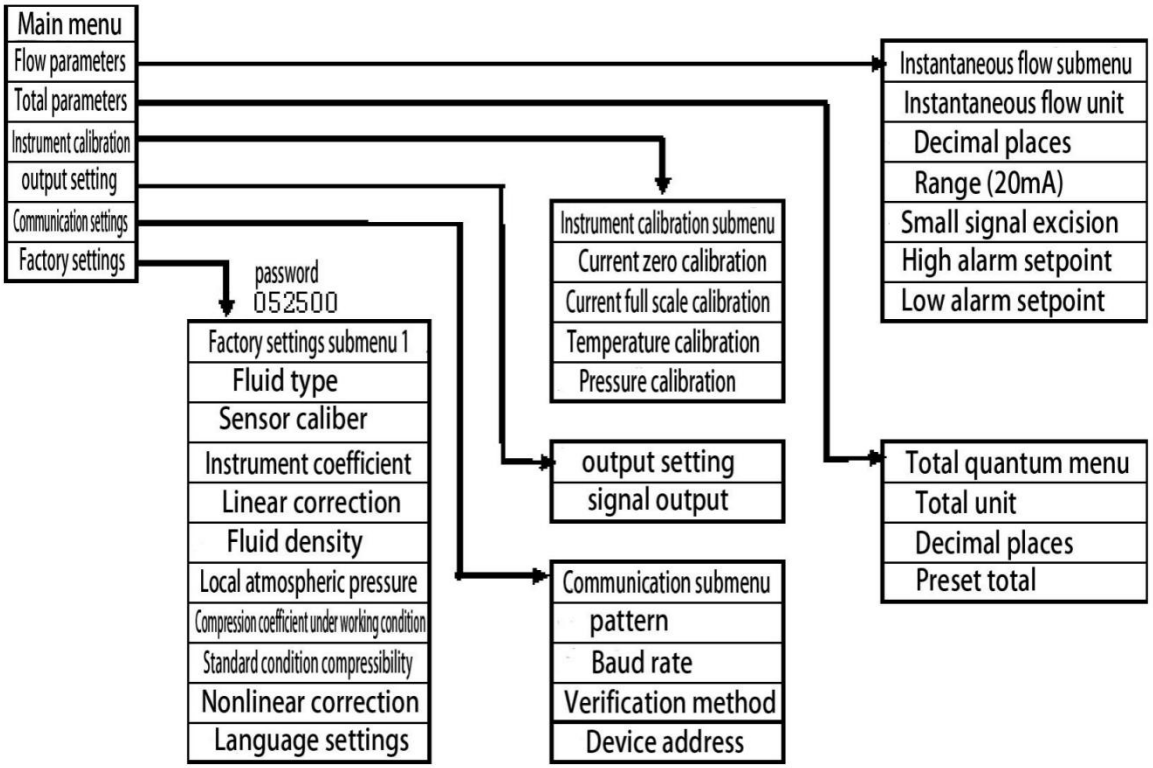
Move left, confirm parameter settings, and exit subdirectory.

The factory is equipped with shortcut keys, down arrow keys, and number decrement keys;

Up and down keys;

Move right to enter parameter settings.

5.2. Converter Menu Structure



5.3. Converter Parameter Description

Flow Unit	Options: L/s L/m L/h m^3/s m^3/m m^3/h Nm^3/h USG/s USG/m USG/h Kg/s Kg/m Kg/h t/s t/m t/h Default value: m^3/h Defines the unit of instantaneous flow rate: L (liters), h (hours), t (tons), s (seconds), m (minutes)
Flow Decimal Places	Options: 0 1 2 3, Default value: 1 Defines the number of decimal places for instantaneous flow rate.
Range	Floating-point value: 99999999.00-0.00 m^3/h, Default value: 100.0 m^3/h. When the instantaneous flow rate reaches the range, the converter outputs 20mA. Changing this parameter will affect the current output, high alarm, and low alarm. Note: When modifying this setting (range), please pay attention to the unit of this parameter (range). You can modify the unit of this parameter (range) as needed.
Small Signal Cut-Off	Floating-point: 9.90 ~ 0.00%, Default: 0.0% This setting is a percentage of the measurement range.
High Alarm	Floating-point value: 99.00 ~ 1.00%, Default value: 90.0% This setting is a percentage of the range. For example, if this value is set to 10, it equals 10% of the range. If the absolute value of the instantaneous flow rate is greater than (range × 10%), the converter outputs a high alarm signal, and the high alarm contact closes.
Low Alarm	Floating-point value: 99.00 ~ 0.00%, Default value: 0.0% This setting is a percentage of the range. For example, if this value is set to 10, it equals 10% of the range. If the absolute value of the instantaneous flow rate is less than (range × 10%), the converter outputs a low alarm signal, and the low alarm contact closes.
Damping Time	Floating-point number: 30.0 ~ 0.1, default value: 1

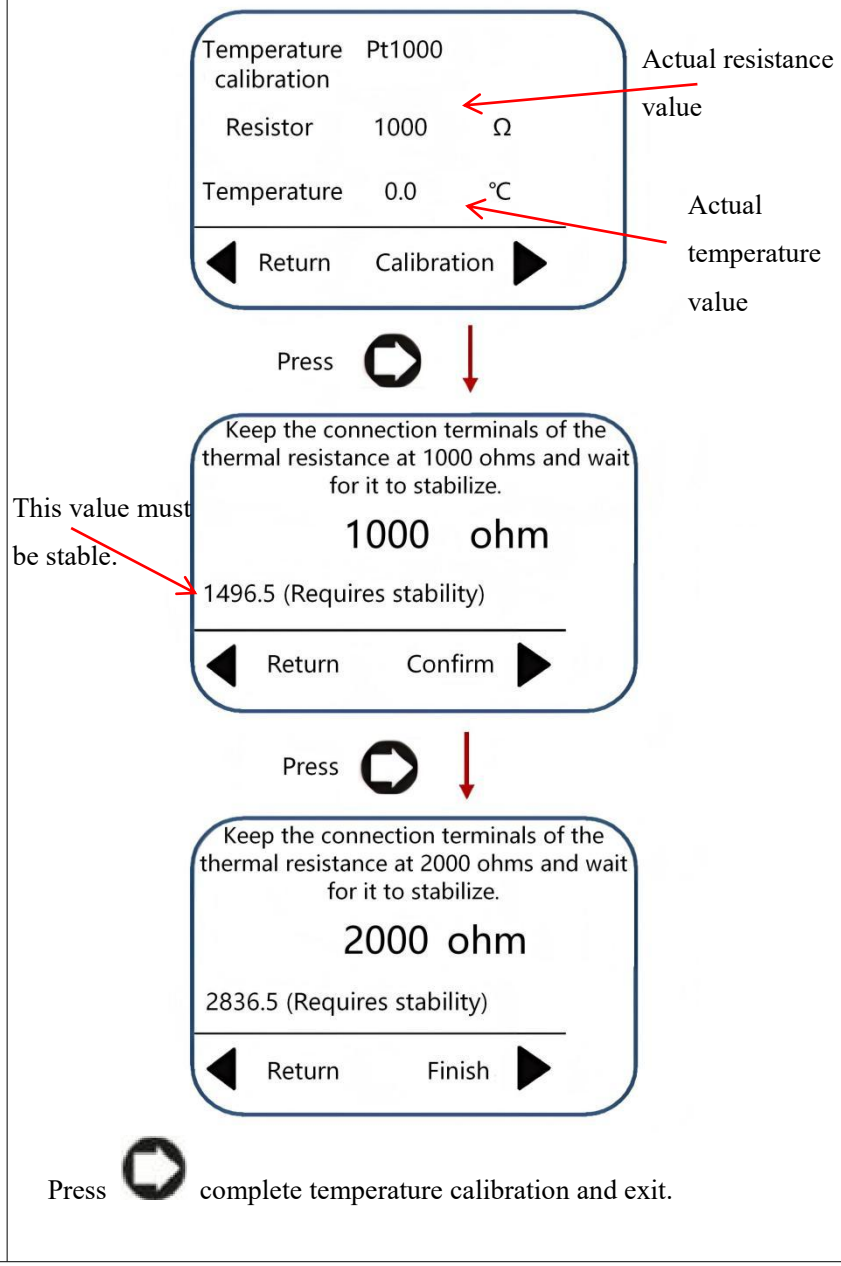
5.4 Parameter Settings

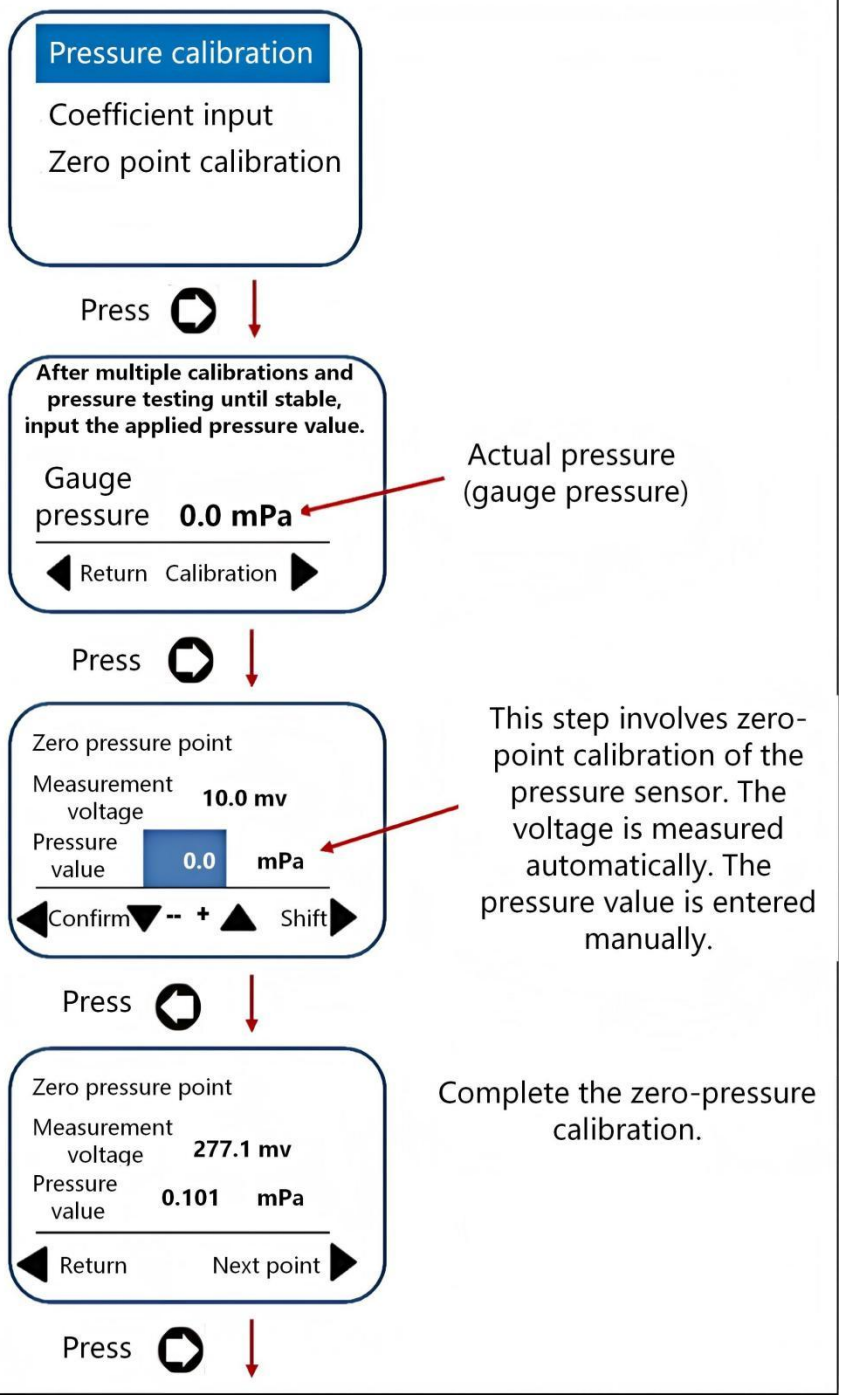
Total quantity settings: Define the relevant parameters for the total quantity.

Total Quantity Unit	Options: L (liter), m^3, Nm^3, USG, Kg, t (ton), Default value: m^3 Defines the unit of total quantity.
Total Quantity Decimal Places	Options: 0 1 2 3, Default value: 1 Defines the number of decimal places in the total amount.
Default Total Quantity	Options: 99999999.00-0.00 m^3/h, Default: 0.0 m^3/h Clear total or set total value.

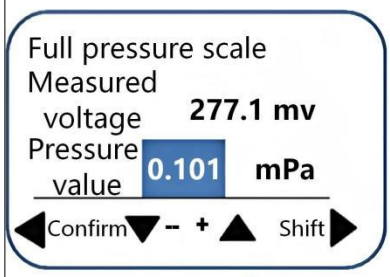
Instrument calibration: Calibrate the current output and calibrate the temperature and pressure measurement circuits.

Zero Point Calibration of Current	Floating-point: 5.0～3.0, Default: 0.0 After entering this submenu, use a multimeter to measure the current output value. If the current value is not equal to 4.0mA, enter the actual value measured by the multimeter, and the converter will automatically complete the 4mA current output calibration. Standard value. Note: If the current output deviation is too large, multiple corrections are required to verify the requirements. The maximum input value for each correction is 5.0.
Full-Scale Calibration of Current	Floating-point: 21.0 ~ 19.0, Default: 0.0 After entering this submenu, use a multimeter to measure the current output value. If the current value is not equal to 20.0mA, enter the actual value measured by the multimeter, and the converter will automatically complete the 20mA current output calibration. Note: If the current output deviation is too large, multiple corrections are required to verify the requirements. The maximum input value for each correction is 21.0.

Temperature Calibration	

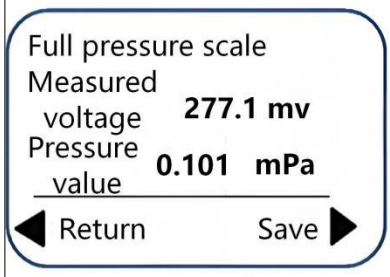
Pressure Calibration	

Pressure Calibration



Pressure sensor range calibration. Input actual pressure value.

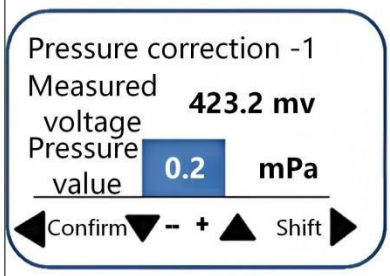
Press



Press Return to the menu and complete the pressure calibration.

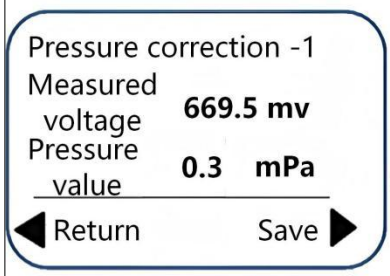
If press Then it enters the pressure nonlinear correction stage.

Press



This is an option; if the pressure sensor is non-linear, you can use the following method to gradually adjust the linearity of the pressure sensor. However, the pressure value must be greater than zero, otherwise an error will occur.

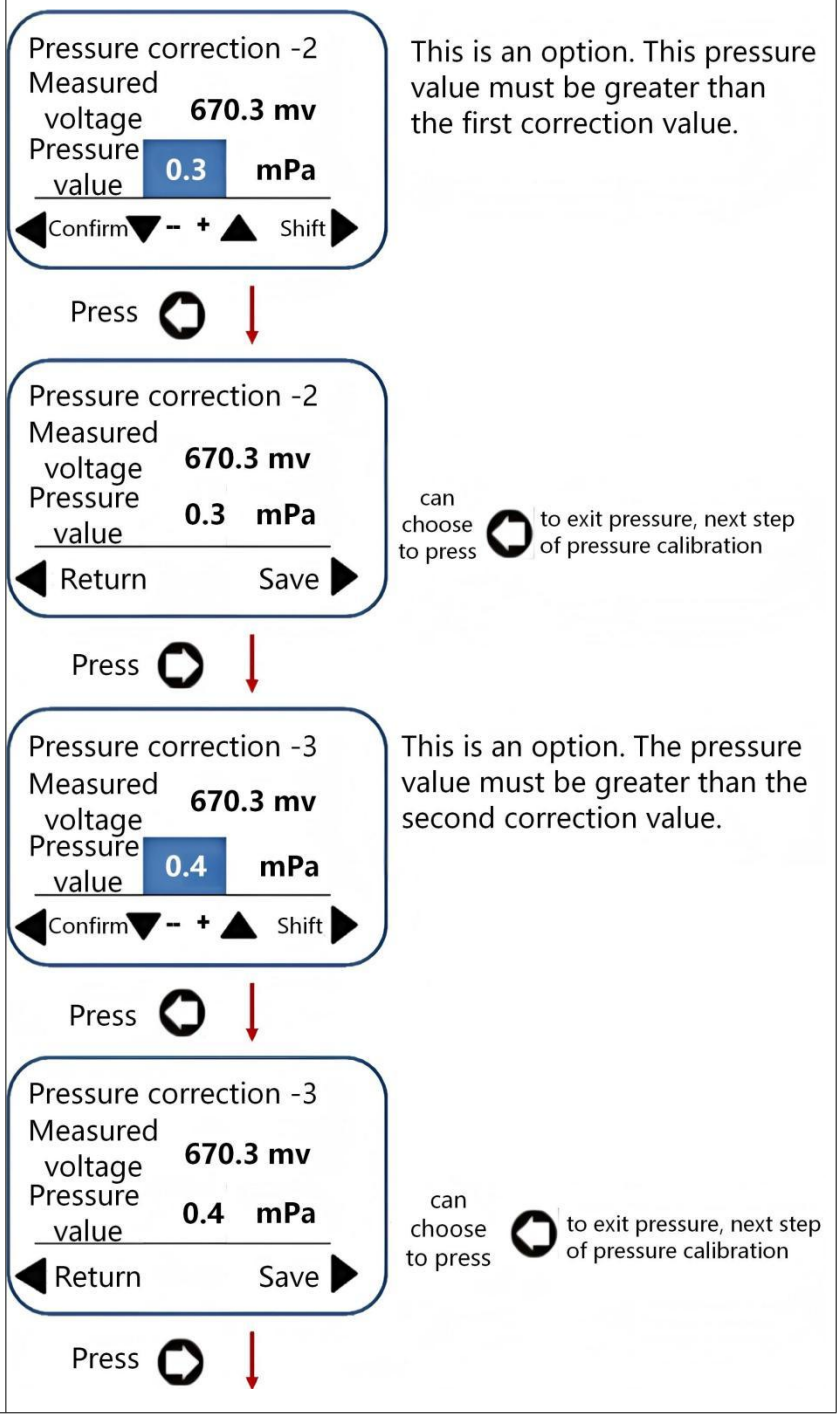
Press

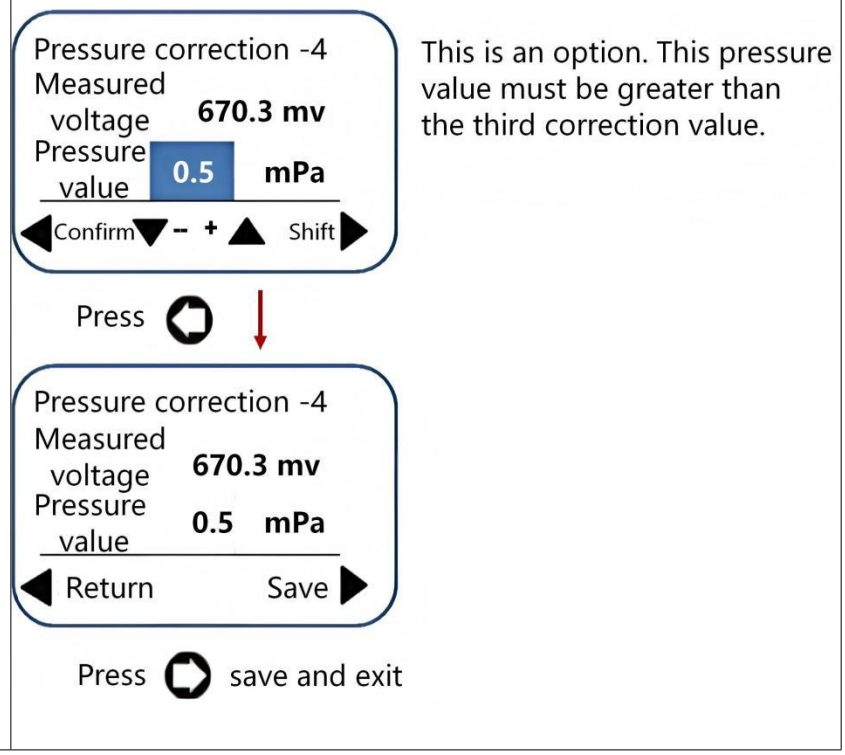


Can press to exit pressure calibration and proceed to the next pressure calibration step.

Press

Pressure Calibration

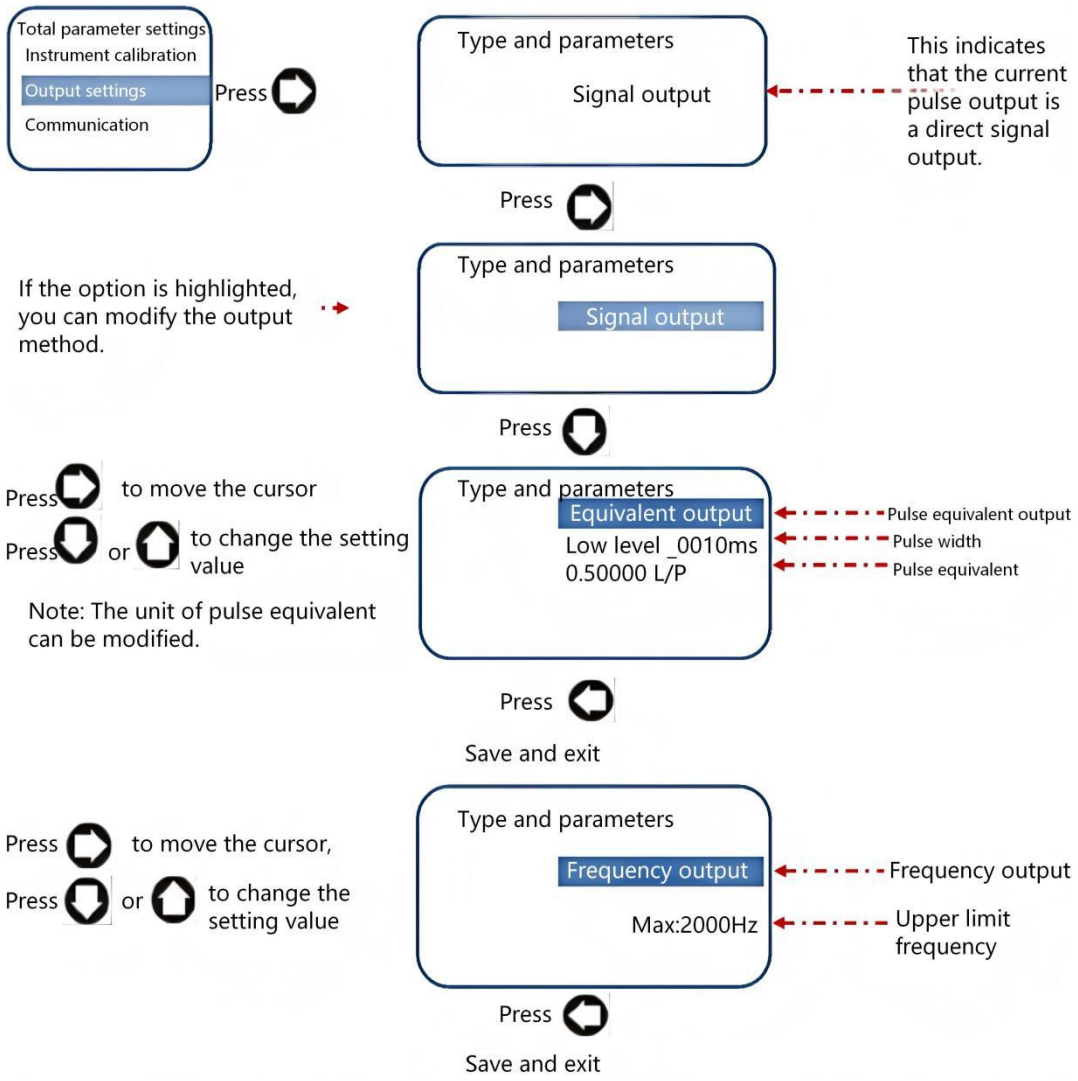


Pressure Calibration	

Output settings: Configure parameters for three output modes: equivalent output, frequency output, and signal output.

Upper Frequency Limit	Floating-point: 5000.0 - 100.0 Hz, Default: 2000.0 Output Frequency (Hz) = Instantaneous Flow Rate (m^3/h) ÷ Range (m^3/h) × Upper Frequency Limit (Hz) For example: If the instantaneous flow rate is 100 m^3/h, the range is 200 m^3/h, and the upper frequency limit is set to 2000 Hz, then the output frequency corresponding to the instantaneous flow rate of 100 m^3/h will be 1000 Hz.
Pulse Equivalent	Floating-point number: 9999.0 – 0.0, Default value: 0.0 The unit of pulse equivalent is: L (liters)/pulse. Users can change the unit of pulse equivalent to: USG/P, Kg/P, t/P, Nm^3/P, m^3/P as needed.
Pulse Width h (ms)	Floating-point: 1000.0 ~ 0.0 ms, Default: 0.0 When the pulse width is set to "0", the pulse duty cycle is: 1:1

Signal Output	Original signal output Note: 1. Only frequency output and equivalent output are distinguished. 2. Nonlinear correction also applies to the original signal output. 3. It is related to the instrument coefficient K. F (HZ) = 3600 / (Q * K), where Q is the instantaneous flow rate (m^3/h) and K is the instrument coefficient.

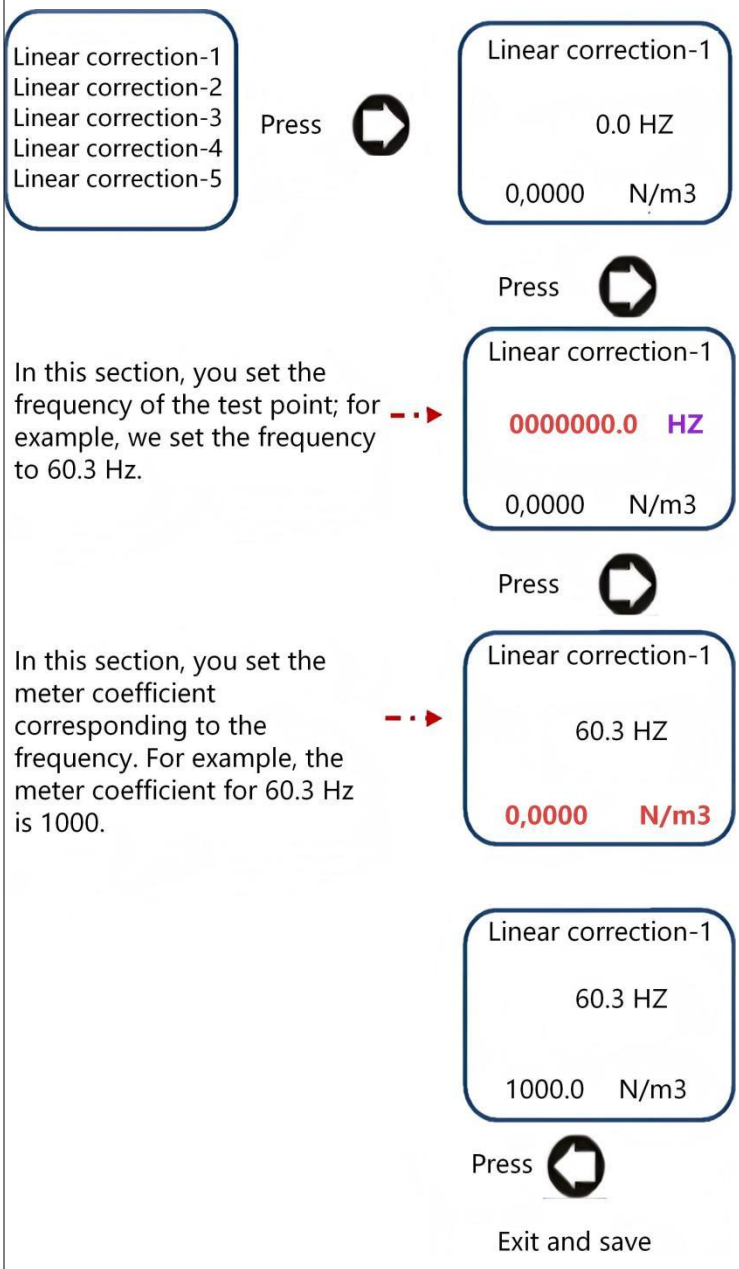


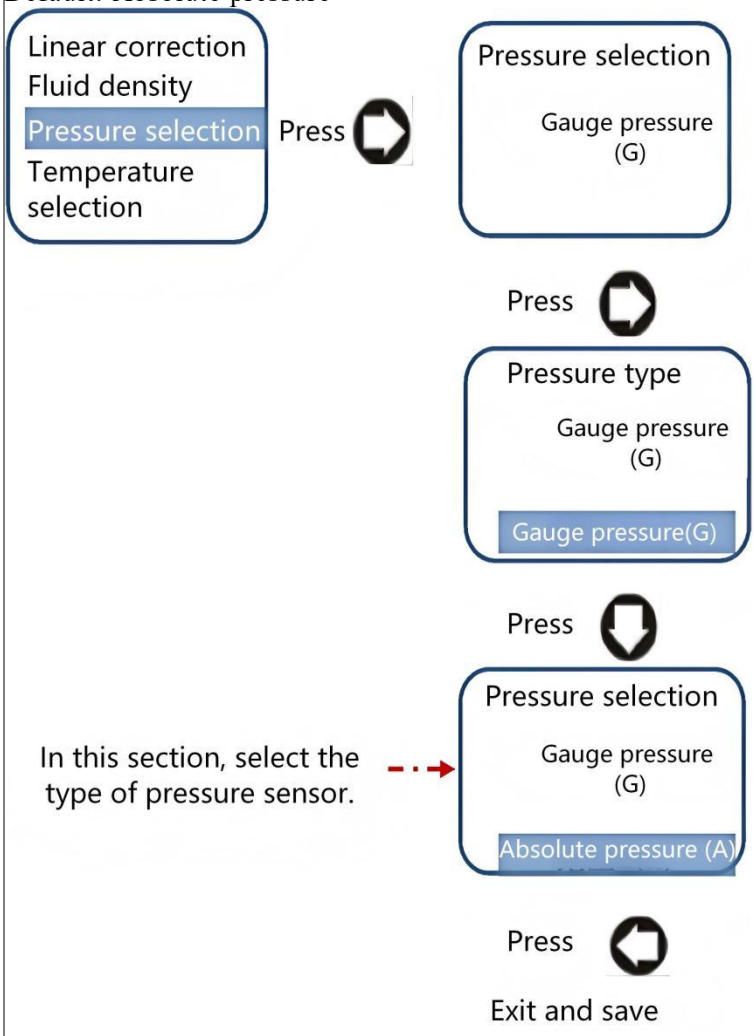
Communication settings: Configure RS485 communication parameters.

Mode	Options: Modbus-RTU Modbus-ASCII Default: Modbus-RTU
Baud Rate	Options: 1200 2400 4800 9600 19200 38400 Default value: 19200 Note: Please set the baud rate no lower than 9600.
Verification Method	Options: No parity, Even parity, Odd parity Default: Odd parity
Device Address	Values: 247 ~ 1, Default value: 1

Factory parameter settings: First password 052500

Fluid Type	Options: Gas operating condition flow rate, Gas standard condition flow rate Default value: Gas operating condition flow rate Select the appropriate medium before calibrating the flow meter or before use. Different options will trigger different algorithms executed by the software.
Caliber	Options: 15, 20, 25, 32, 40, 50, 65, 80, 100, 125, 150, 200 mm Default: 50 mm
Instrument Coefficient	Floating-point number, default value: automatically corresponds to each diameter Q (instantaneous flow rate, m^3/h) = 3600 × F (frequency, Hz) ÷ k (k coefficient) After completing the actual flow test, the final K coefficient needs to be set here. K (k coefficient) represents: the number of pulses output per cubic meter

Linear Correction	 After completing the first linear correction, proceed to "Linear Correction-2". Note: The test point with the highest frequency must be used as the first point. Set the frequencies from highest to lowest.

Pressure Options	Select the type of pressure sensor: Options: Absolute pressure, gauge pressure, and constant pressure Default: Absolute pressure  If you do not have a pressure sensor installed, you can set the "gauge pressure". Please note that the pressure set is the gauge pressure.
Temperature Selection	Select the type of temperature sensor: Options: PT100, PT1000, and set temperature Default value: PT1000 The operation method is the same as the pressure selection method.

Atmospheric Pressure	Floating-point number Default value: 0.101 mPa This parameter has no effect if the medium is selected as liquid.
Standard Condition Compression Coefficient	Floating-point number; Default value: 1; This parameter has no effect if the medium is selected as liquid.
Operating Condition Compression Coefficient	Floating-point number; Default value: 1; This parameter has no effect if the medium is selected as liquid.
Language Settings	Default value: Chinese. You can switch to English.

5.5. How to set parameters

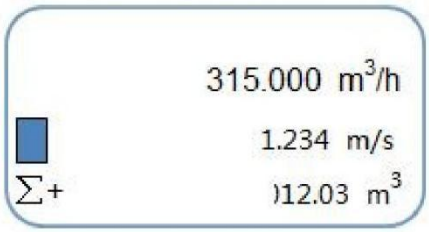


Figure 1 Instantaneous flow rate display interface

Press  to enter the menu settings, as shown in Figure 2:

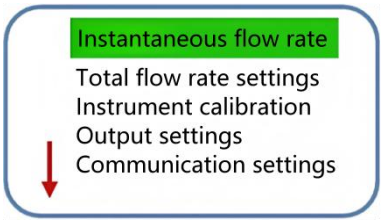


Figure 2

In the interface shown in Figure 2, pressing  or  allows you to select different sub-menus. Pressing  returns you to the traffic display interface, as shown in Figure 1.

Press or select a submenu. Press to enter the submenu to set parameters. For example, if we need to set the "Instantaneous Flow Rate Parameters", when the Instantaneous Flow Rate Parameters submenu is highlighted, pressing will display the following as shown in Figure 3:

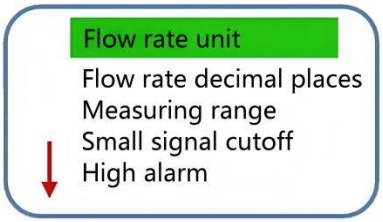


Figure 3

Press or to select the parameter you want to modify. The selected parameter will be highlighted. To return to the menu shown in Figure 2, press to enter the next level menu, press to set the parameter, as shown in Figure 4:

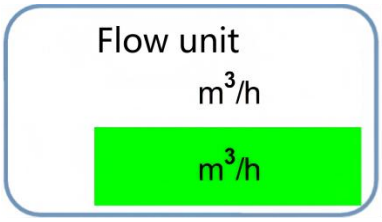


Figure 4

In this case, press or to modify the parameters. For example, as shown in Figure 4, if you need to change the instantaneous flow unit from "m³/h" to "m³/m", press , and the instantaneous flow unit will change to "m³/m", as shown in Figure 5.

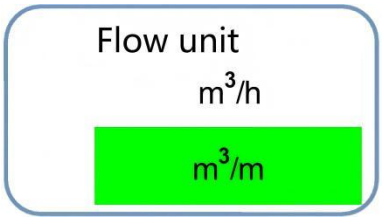


Figure 5

After modifying the parameters, if you need to save the settings, press , and the system will automatically save them, as shown in Figure 6:

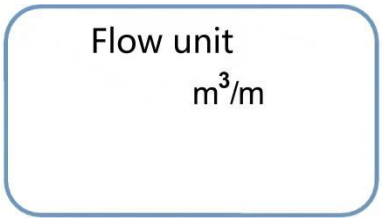
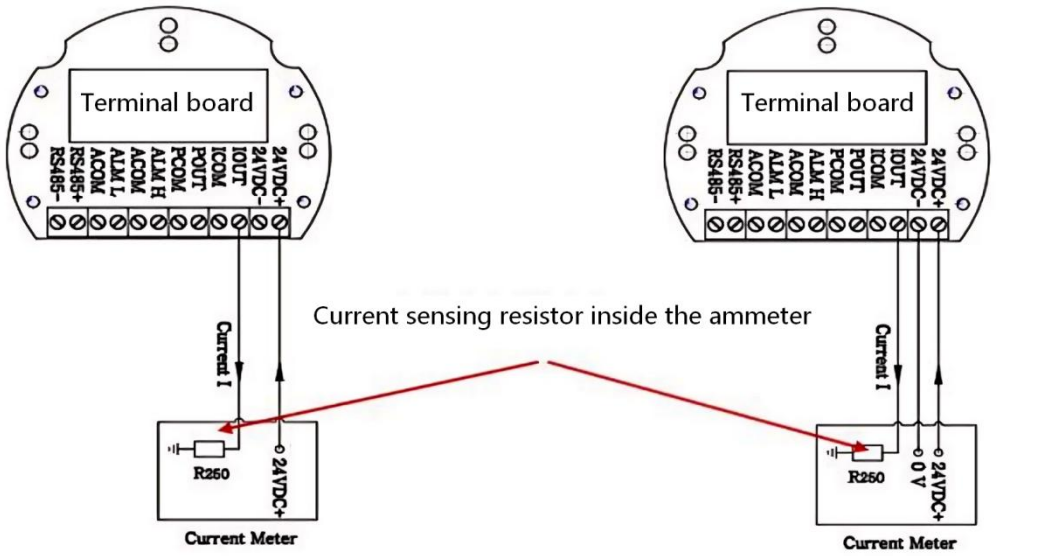


Figure 6

In this case, press , save the settings and exit (as shown in Figure 3).

Chapter 6. Wiring

6.1.4-20mA Current Output Wiring Diagram



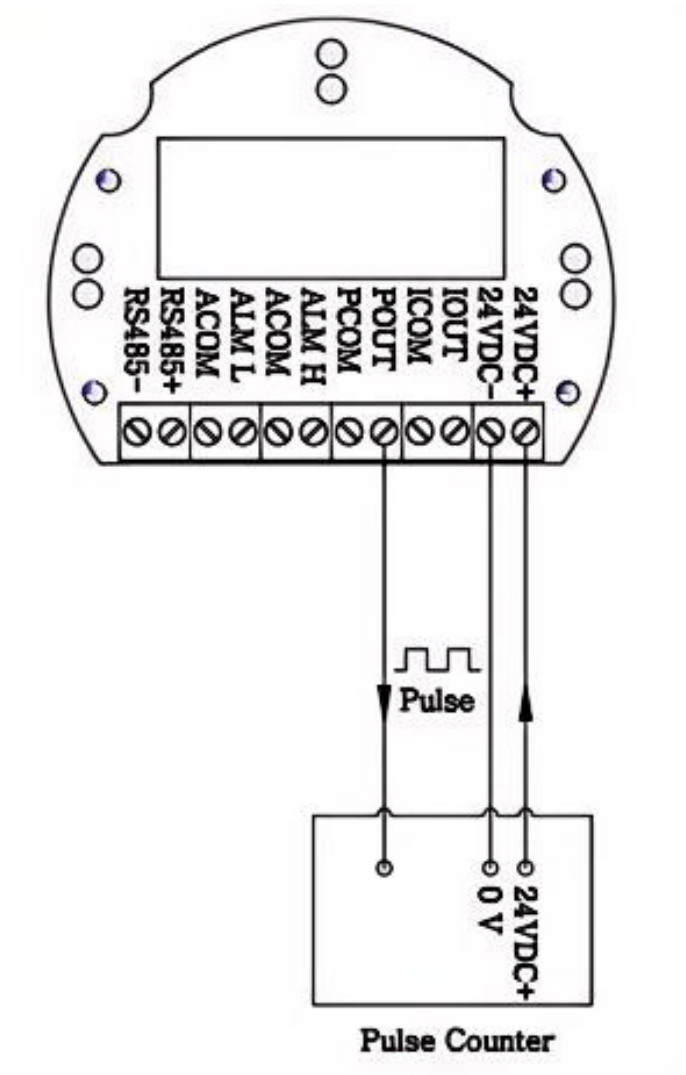
Two-wire wiring diagram

Three-wire wiring diagram

Terminal block definition

Terminal Block Markings	**Function**	**Remarks**
24V +	DC 18 - 36V +	power supply 24V +
24 -	DC 18~36v -	power supply24V -
IOUT	4~20Ma +	Load current <= -500 ohms
ICOM	4~20mA -	
POUT	Frequency & Pulse Output +	
PCOM	Frequency & Pulse Output Common Terminal	
ALM **H**	High alarm +	It is recommended to use a 24VDC intermediate relay with a load current ≤ 30mA.
ACOM	High alarm common terminal	
ALM **L**	Low alarm +	
ACOM	Low alarm common terminal -	
RS+	RS485 +	RS485 terminal block
RS-	RS485 -	

6.2. Pulse Output Wiring Diagram



Channel 1:

1: S1 - Vortex sensor signal +,

2: GND - Vortex sensor signal -

Chapter 7. Fault Phenomena and Troubleshooting Methods

Fault Symptoms	Possible Causes	Troubleshooting Methods
No output signal after power is connected	1. No medium flow in the pipeline or flow rate lower than the starting flow rate; 2. Incorrect connection between power supply and output line; 3. Preamplifier failure (integrator does not count, instantaneous value is "0"); 4. Driver amplifier circuit failure (integrator display is normal).	1. Increase the medium flow rate or replace it with a flow meter of smaller diameter to meet the flow range requirements; 2. Ensure correct wiring; 3. Replace the preamplifier; 4. Replace any damaged components in the driver amplifier.
The flow meter outputs a signal when there is no flow	1. Poor grounding of the flow meter and interference with high-voltage and other grounding wires; 2. Amplifier sensitivity is too high or self-oscillation occurs; 3. Unstable power supply, poor filtering, and other electrical interference.	1. Properly connect the ground wire to eliminate interference; 2. Replace the preamplifier; 3. Repair or replace the power supply to eliminate interference.
The instantaneous flow rate display is unstable	1. Unstable medium flow rate; 2. Amplifier sensitivity is too high or too low, resulting in multiple or missed pulses; 3. Foreign matter inside the housing; 4. Poor grounding; 5. Flow rate below the lower limit; 6. Rear sealing ring extends into the pipe, causing disturbance.	1. Measure again after the flow rate stabilizes; 2. Replace the preamplifier; 3. Remove any contaminants; 4. Check the grounding line to ensure it is functioning correctly.
The cumulative flow reading does not match the actual flow rate.	1. Incorrect input of flow meter parameters; 2. User's normal flow rate is lower or higher than the normal flow rate range of the selected flow meter; 3. Flow meter itself is out of tolerance.	1. Recalibrate and input the correct instrument coefficient; 2. Adjust the pipeline flow rate to normal or select a flow meter of appropriate specifications; 3. Recalibrate.
Display error	The converter buttons may have poor contact or be locked.	Replace the display panel.

The computer crashed after replacing the battery.	The power-on reset circuit is malfunctioning or the oscillation circuit is not oscillating.	Reinstall the battery (discharge for 5 seconds before reinstalling).

Chapter 8. Packaging, Transportation and Storage

8.1. The flow meter should be packed in a sturdy wooden box (medium and small diameter flow meters with foam protection can be packed in a cardboard box). It should not move freely within the box and should be handled with care during transport.

8.2. The transportation and storage conditions for the flow meter should meet the requirements of GB/T 9329-1999 "Transportation of Instruments and Meters - Basic Environmental Conditions and Test Methods for Transportation and Storage".

8.3. The flow meter should be stored under the following conditions:

- Protected from rain and moisture
- Free from mechanical vibration or impact
- Temperature range: 5℃~40℃
- Relative humidity: not greater than 90%
- Environment free from corrosive gases

Chapter 9. Unpacking and Inspection

9.1. Before unpacking, check the outer packaging for integrity, then verify the contents and accompanying documents against the packing list.

9.2. Accompanying Documents and Items:

1. Product Inspection Certificate
2. Instruction Manual
3. Packing List
4. Product Certificate of Conformity

Appendix: RS485 Communication Address Table

Variable Name	Registry Start Address	Registry Length	Instruction Code	Data Type
Instantaneous flow rate	0x01	0x02	0x04	Floating-point number
Instantaneous flow rate unit Total quantity	0x03	0x01	0x04	Integer
Total quantity unit Temperature	0x04	0x04	0x04	Double precision
Pressure	0x08	0x01	0x04	Integer
Total volume (m^3)	0x09	0x02	0x04	Floating-point number
Instantaneous flow rate	0x0b	0x02	0x04	Floating-point number
Instantaneous flow rate unit Total quantity	0x0d	0x02	0x03 0x04	Floating-point number
Continuous reading (with consecutive addresses)				
Instantaneous Flow Rate	0x14	0x02	0x04	Floating-point numbers
Total Volume	0x16	0x02	0x04	Floating-point numbers
Temperature	0x18	0x02	0x04	Floating-point numbers
Pressure	0x1a	0x02	0x04	Floating-point numbers
Instantaneous Flow Rate	0x1e	0x02	0x04	float inverse
Total Volume	0x20	0x02	0x04	float inverse
Temperature	0x22	0x02	0x04	float inverse
Pressure	0x24	0x02	0x04	float inverse

Appendix: Unit Definitions

	Unit	Code	Unit	Code
Instantaneous Flow Rate	Nm3/h	0x00	usg/h	0x09
	Nm3/m	0x01	usg/m	0x0a
	Nm3/s	0x02	usg/s	0x0b
	m3/h	0x03	kg/h	0x0c
	m3/m	0x04	kg/m	0x0d
	m3/s	0x05	kg/s	0x0e
	L/h	0x06	t/h	0x0f
	L/m	0x07	t/m	0x10
	L/s	0x08	t/s	0x11
Total Flow Rate	Nm3	0x00		
	m3	0x01		
	L	0x02		
	usg	0x03		
	kg	0x04		
Temperature	t	0x05		