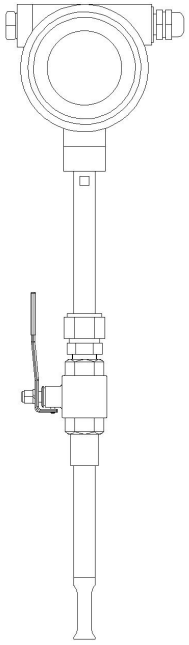
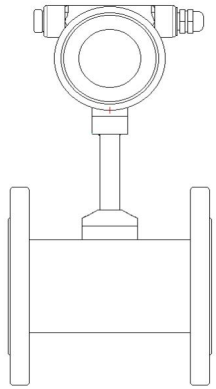
Thermal Mass Flowmeter





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Preface

Thank you for purchasing this product. Please read this manual carefully before operating and using it correctly to avoid unnecessary losses caused by wrong operation.

Note

- Modification of this manual's contents will not be notified as a result of some factors, such as function upgrading.
- We try our best to guarantee that the manual content is accurate, if you find something wrong or incorrect, please contact us.
- This product is forbidden to use in explosion-proof occasions.

Version

U-SUP-MF-EN4.1

Safety Precautions

For the safe operation of this product, please strictly follow the outlined safety precautions.

About this manual

- Please ensure the instrument operators have a careful reading of this manual.
- Prior to operation, please study this manual in detail to ensure a thorough comprehension of the device's functionality.
- This manual only describes the product's functions. The responsibility as to the device's suitability for any specific purpose lies solely in the operator.

Precautions for product protection, safety, and modification

- For your safety and the normal operation of the product and its controlling systems, the guidelines and precautions specified in this manual are supposed to be fully observed. Operating the instrument in ways not specified in this manual may compromise its protective features. Our company shall not be liable for any malfunctions or accidents resulting from non-compliance with the precautions described.
- When equipped the product and its controlling systems with lightning protection or separate safety protection circuits, it needs to be implemented by other devices.
- If you need to replace components or fittings of the product, please use the model specified by the company.
- This product is not designed for use in systems directly related to personal safety, such as nuclear power facilities, radioactive equipment, railway systems, aviation equipment, marine equipment, and medical equipment. If applied, it is the user's responsibility to implement additional equipment or systems to ensure personal safety.
- Do not modify this product.
- The following safety symbols are used in this manual:

Hazard: Failure to take appropriate precautions may result in serious personal injury, product damage, or major property loss.

Warning: Pay special attention to critical information related to the product or specific sections of this user manual.

- Confirm whether the supply voltage is consistent with the rated voltage before operation.
- Do not use the instrument in a flammable and combustible or steam area.
- To prevent electric shock and operation errors, ensure proper grounding protection is in place.
- Thunder prevention engineering facilities must be well managed: the shared grounding network shall be grounded at the correct electric level, shielded, with wires properly routed, and an SPD surge protector applied as needed.
- Some internal components may carry high voltage. To avoid the risk of electric shock, do not open the front square panel unless it is being handled by trained personnel or maintenance staff authorized by our company.
- To avoid electric shock, disconnect the power before performing any checks.
- Check the condition of the terminal screws regularly. If loose, please tighten them before use.
- Unauthorized disassembly, modification, or repair of the product is not allowed, as it may lead to malfunctions, electric shock, or fire hazards.
- Wipe the product with a dry cotton cloth. Do not use alcohol, benzine, or other organic solvents, and avoid exposing the product to any liquids. If the product falls into the water, please cut off the power immediately to prevent leakage, electric shock, or fire hazards.

- Please check the grounding protection regularly. Do not operate the product if you think that the protection, such as grounding protection and fuses, is inadequate.
- Ventilation holes on the product housing must be kept clear to avoid malfunctions due to high temperatures, abnormal operation, shortened life, and fire.
- Please strictly follow the instructions in this manual; failure to do so may damage the product's protective devices.

- Do not use the instrument if it is found damaged or deformed upon opening the package.
- Prevent dust, wire end, iron fines, or other objects from entering the instrument during installation, as this may cause abnormal operation or failure.
- During operation, to modify the configuration, signal output, startup, stop, and operation safety shall be fully considered. Improper operation may lead to failure and even destruction of the instrument and control equipment.
- Each part of the instrument has a certain service life, which must be maintained and repaired on a regular basis for long-term use.
- If the product comes to the end of its service life, it should be disposed of as industrial waste as a way of environmental protection.
- Disconnect the instrument when it is not in use.
- If you find smoke from the product, smell odor, abnormal noise, etc., please turn off the power switch immediately and contact the company in time.

Disclaimer

- The company does not make any guarantees for the terms outside the scope of this product warranty.
- This company is not responsible for damage to the instrument or loss of parts or unpredictable damage caused directly or indirectly by improper operation of the user.

No.	Name	Quantity	Note
1	Thermal mass flowmeter	1	
2	User manual	1	
3	Certificate	1	

After opening the box, please confirm the package contents before starting the operation.If you find that the model and quantity are incorrect or there is physical damage in appearance, please contact us.

Contents

1 Introduction

1.1 Introduction

Thermal gas mass flow meter is designed on the basis of thermal dispersion, and adopts method of constant differential temperature to measuring gas flow. It has advantages of small size, easy installation, high reliability and high accuracy, etc.

The meter contains two platinum resistance temperature sensors. The thermal principle operates by monitoring the cooling effect of a gas stream as it passes over a heated sensor. Gas flowing through the sensing section passes over two sensors one of which is used conventionally as a temperature sensor, whilst the other is used as a heater. The temperature sensor monitors the actual process values whilst the heater is maintained at a constant differential temperature above this by varying the power consumed by the sensor. The greater the gas velocity, the greater the cooling effect and power required to maintain the differential temperature. The measured heater power is therefore a measure of the gas mass flow rate.

The format of gas velocity and power is shown as below:

$$V = \frac{K\left[Q / \triangle T\right]^{1.87}}{\rho_g} \quad \text{.....(1)}$$

Where : ρ_g--specific gravity of medium

V--velocity

K--balance coefficient

Q--heater power

ΔT--is differential temperature

As the sensor temperature is invariably 30° higher than the automatic constant temperature, the thermal gas mass flowmeter does not need temperature compensation in theory.

The medium temperature range of meter is -40℃～300℃.

In the format (1), the specific gravity of medium is related to the density:

$$\rho_g = \rho_n \times \frac{101.325 + P}{101.325} \times \frac{273.15 + 20}{273.15 + T} \quad \text{.....(2)}$$

Where: ρ_g---medium density in working condition (kg/m^3)

ρ_n-- medium density in standard condition, 101.325kPa and 20℃ (kg/m^3)

P--pressure in working condition (kPa)

T--temperature in working condition (℃)

In the formats (1) and (2), there is a certain functional relationship between the velocity and pressure in working condition, medium density,
the temperature in working condition.

Due to the sensor temperature is always 30℃ higher than the medium temperature (environment temperature), and the meter adopts method of constant differential temperature, therefore the meter do not
need to do temperature and pressure compensation in principle.

1.2 Features

- Measuring the mass flow or volume flow of gas.Do not need to do temperature and pressure compensation in principle with accurate measurement and easy operation.
- Wide range: 0.1Nm/s～ 120Nm/s for gas. The meter also can be used for gas leak detection.
- Good vibration resistance and long service life. No moving parts and pressure sensor in transducer, no vibration influence on the measurement accuracy.
- Easy installation and maintenance. If the conditions on site are permissible, the meter can achieve a hot-tapped installation and maintenance. (Special order of custom-made)
- Digital design, high accuracy and stability.
- Configuring with RS485 or HART interface to realize factory automation and integration

2 Technical Parameters

Table 1 Technical parameters

Parameters	Technical Parameters	
Structural form	Insertion type	Inline type
Nominal diameter	DN65～ DN1000	DN10～ DN300
Velocity range	(0.1～100) Nm/s	
Flow range	See Table 2	
Accuracy	±2.5%	
Response time	1s	
Transmitter output	(4 ~ 20) mA , photoelectric isolation, maximum load 500 Ω	
Communication output	RS485 interface, photoelectric isolation , Mod bus protocol	
	Hart	
Call the police	1 ~ 2 line Relay, Normally Open state	
Power supply	AC 220V/ DC 24V, power supply should be greater than 18W	
Power consumption	≤7W	
Measuring medium	Common steady-state gas (medium moisture content less than 5%) Note: Unstable media such as acetylene and boron trichloride cannot be measured	
Operating temperature	Sensor: (-40 ～ 300) ℃ Converter: (-20 ～45) ℃	
Work Pressure	Medium pressure ≤2.5MPa	Medium pressure ≤1.6MPa
Display	4 lines LCD: Mass flow, Volume flow in standard condition, Flow totalizer, Date and Time, Working time, and Velocity, etc.	
Protection level	IP65	
Sensor Material	Stainless steel	Stainless steel, carbon steel

Table 2 Reference range of standard flow rate of the flowmeter

Meter diameter (mm)	Air basic range (Nm^3 /h)	Air expansion range (Nm^3 /h)	Oxygen basic range (Nm^3 /h)	Basic range of combustible gas (Nm^3 /h)
10	0.5-28	0.03-30	0.5-14	0.5-5
15	0.5-65	0.07-65	0.5-32	0.5-10
20	0.5-100	0.12-110	0.5-55	0.5-20
25	0.5-175	0.18-180	0.5-89	0.5-28
32	0.5-290	0.3-290	0.5-144	0.5-45
40	0.5-450	0.5-450	0.5-226	0.5-70
50	1-600	0.5-700	0.7-352	0.7-110
65	1.5-1000	1-1200	1.2-600	1.2-185
80	2-1500	1.5-1800	2-900	2-280
100	3-2300	3-2800	3-1420	3-470
125	4.5-3500	4-4400	4.5-2210	4.5-700
150	6.5-5200	6-6300	6.5-3200	6.5-940
200	12-9000	12-11500	12-5650	12-1880
250	18-14500	18-17500	18-8830	18-2820
300	25-21000	25-25000	25-12720	25-4060
350	35-28000	35-34500	35-17000	35-5600
400	45-36500	45-45000	45-22600	45-7200
450	60-46500	60-57000	60-29000	60-9200
500	70-57000	70-70000	70-35300	70-11280
600	100-81000	100-101000	100-50600	100-16300
700	140-110000	140-138000	140-69000	140-22100
800	180-150000	180-180000	180-90000	180-29000
900	230-185000	230-230000	230-115000	230-36500
1000	290-230000	290-280000	290-140000	290-45500

Reference conditions: flow rate at temperature of 20°C and pressure of 101.325KPa.

Note: The unit of instantaneous flow rate can be selected as Nm^3/h, Nm^3/min, L/h, L/min, t/h, t/min, kg/h and kg/min.

Conversion between operating flow and standard flow:

$$Q_S = \frac{0.101325+P}{0.101325} * \frac{273.15+20}{273.15+T} * Q_n$$

In formula 1:

Q_s: standard flow rate (Nm^3 /h)

Q_n: working condition flow rate (m^3 /h)

T: operating medium temperature (℃)

P: Working medium pressure (gauge pressure, kPa)

Flow rate calculation formula 2:

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

In formula 2:

V: Standard flow rate of medium (Nm/S)

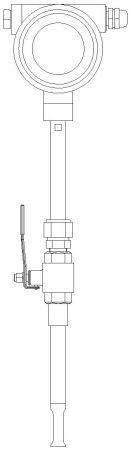
Q: Standard flow rate (Nm^3 /h)

D: Measuring pipe diameter (mm)

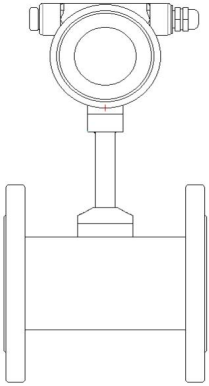
3 Structure and Dimensions

3.1 Types

Thermal gas mass flowmeter falls into two types: insertion-type and inline-type.



Insertion-type



Inline type

Fig.1 Standard Insertion Flow Meter

Structure description:

The insertion-type thermal gas mass flowmeter is suitable for pipe diameters ranging from DN65 to DN1000. For pipes with diameters less than DN1000, the probe should be inserted to the center axis of the pipe (the insertion depth is the 1/2 of the pipe diameter), so the length of the measuring rod is determined by the pipe size.

The in-line thermal mass flowmeter is suitable for pipe diameters DN10 to DN300. It is composed of flange, threaded, and clamp connections. The flange connection complies with the national standard HG/T 20592 for steel pipe flanges; other connections are supplied according to the agreement.

3.2 Dimensions

3.2.1 Insertion type

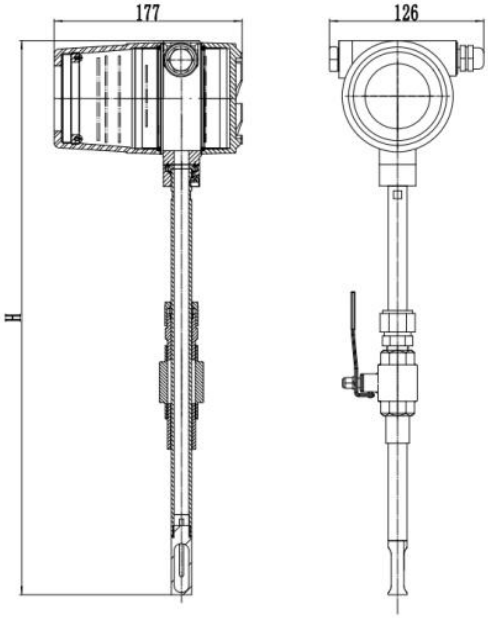


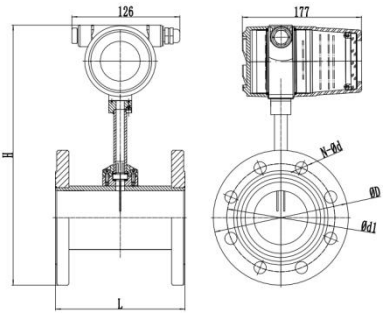
Fig.2 Insertion flow meter (Unit: mm)

Table 3

DN（mm)	H（mm）
DN65~DN200	400
DN250	520
DN300	520
DN350	520
DN400	520
DN450	520
DN500	520
DN500 and above	780

3.2.2 Inline-Type Dimensions

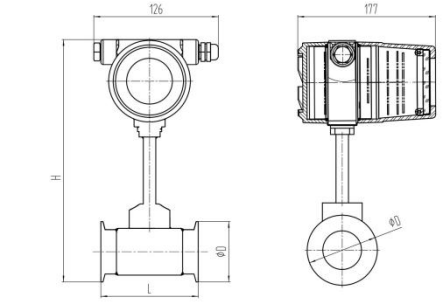
Table 4 Size of the flange-connected flowmeter



Size (mm)	L (mm)	ΦD (mm)	H (mm)	Φd1 (mm)	N (mm)	Φd (mm)
DN10	170	90	329	60	4	14
DN15	170	95	332	65	4	14
DN20	170	105	337	75	4	14
DN25	170	115	342	85	4	14
DN32	170	140	354	100	4	18
DN40	170	150	359	110	4	18
DN50	170	165	370	125	4	18
DN65	190	185	388	145	8	18
DN80	190	200	378	160	8	18
DN100	200	220	388	180	8	18
DN125	200	250	403	210	8	18
DN150	200	285	421	240	8	22
DN200	200	340	448	295	12	22
DN250	240	405	481	355	12	26
DN300	240	460	503	410	12	26

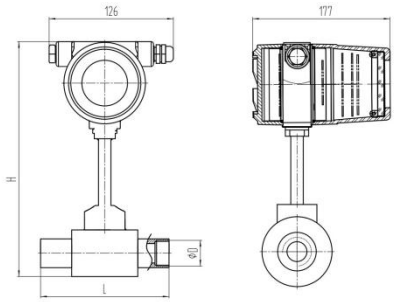
Flange standard: HG/T20592-2009 steel pipe flange

Table 5 Size of the clamp-on flowmeter



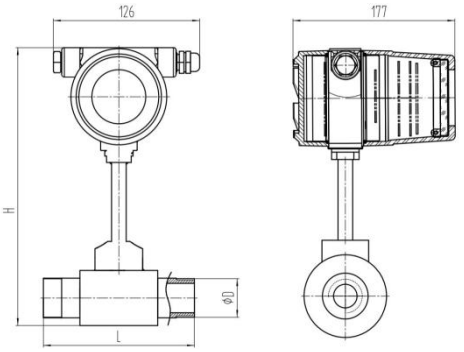
Size (mm)	L (mm)	Internal thread(mm)	H (mm)
DN 15	110	50.5	310
DN 20	110	50.5	310
DN 25	110	50.5	310
DN 32	110	50.5	310
DN 40	125	64	316
DN 50	125	77.5	327

Table 6 Size of the internal-thread flowmeter



Size (mm)	L (mm)	Internal thread (mm)	H (mm)
DN15	146	G1/2	310
DN20	146	G3/4	310
DN25	146	G1	310
DN32	146	G1-1/4	310
DN40	160	G1-1/2	311
DN50	170	G2	322

Table 7 Size of the external-threaded flowmeter



Size (mm)	L (mm)	Internal thread (mm)	H (mm)
DN 15	146	G1/2	310
DN 20	146	G3/4	310
DN 25	146	G1	310
DN 32	146	G1-1/4	310
DN 40	160	G1-1/2	310
DN 50	170	G2	317

4 Installation

4.1 Installation Position

- If the instrument is installed outdoors, the instrument sunshade should be added to avoid sunlight and rain.
- Prohibit installation in strong vibration
- It is forbidden to be exposed to an environment containing a large
- amount of corrosive gas.
- Do not share power with frequency converters, electric welders and other devices that pollute the power source. If necessary, install a clean power source for the converter.

4.2 Installation Location and Requirements for Pipeline

When installing the instrument, keep away from elbows, obstacles, variable diameters, and valves to ensure a stable flow field. One side requires a longer upper limit straight pipe, the Inlet run length is greater than 10D, and Outlet run length is greater than 5D. The following figure shows the length of straight pipe required for several situations frequently encountered on site:

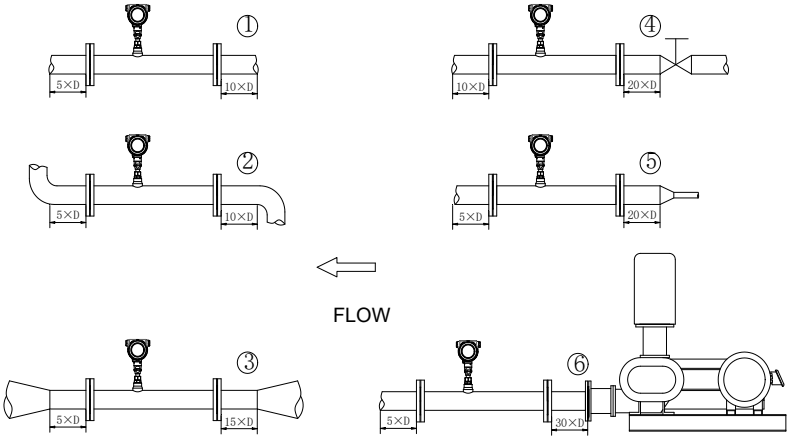


Fig.3

Table 8

Pipeline installation type	NO.	Inlet run	Outlet run
Horizontal tube	1	10D	5D
Elbow	2	10D	5D
Expander	3	15D	5D
Downstream valve	4	20D	5D
Reducer	5	20D	5D
Downstream of pump	6	30D	5D

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

4.3 Welded Base of the Insertion Type Flowmeter

The Welding base of the thermal flowmeter

Fig.4 The base of the insertion type

Note：

- Welding operations are strictly prohibited in explosive environments.
- In environments with special welding requirements, operations must be carried out in accordance with relevant safety standards.

The insertion-type thermal base is designed for welded installation. During installation, the base should be positioned at the highest point along the pipe cross-section, with the center axis of the base's through-hole perpendicular to the pipe axis. The ideal welding position and procedure for the base are shown in the figure below.

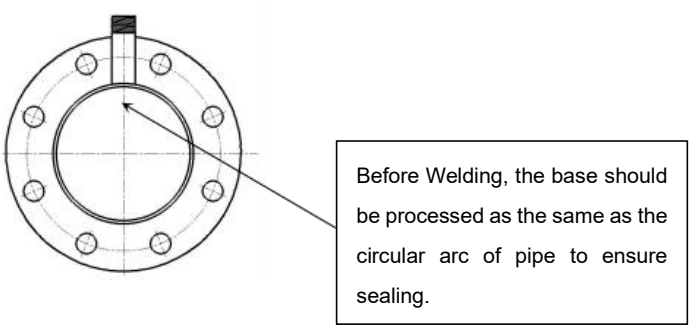


Fig.5 Ideal welding location of base

4.4 The Installation Method of the Insertion Type Thermal Mass Flowmeter

(1) Please confirm the actual inner diameter and wall thickness of the pipe before installing the plug-in thermal gas mass flowmeter.

(2) Put the rest of the thermal gas mass flowmeter into the special ball valve together, and calculate the depth to be inserted according to the actual pipe inner diameter and wall thickness. In 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 the same as the flow direction of the medium.

(4) Convert the corresponding scale on the sensor connecting rod according to the data measured on the spot, and then tighten the nut.

4.5 The Installation Method of the Insertion Type Thermal Mass Flowmeter

(1) Refer to the installation dimensions of the inline thermal gas mass flowmeter. Before pre-installation, please reconfirm the pipe connection type and prepare the necessary items for flange installation, such as gaskets and bolts.

(2) Before installation, the production line must be shut down, and all relevant factory regulations must be strictly followed.

(3) The inline thermal gas mass flowmeter is factory-assembled with the sensor correctly installed on a dedicated pipe section. Therefore, compared with on-site insertion-type installation, this method is relatively simpler. First, select a suitable installation point on the pipeline. Then, cut the pipe according to the required length of the matching pipe section, and install the corresponding flanges and bolts. Ensure that the direction of fluid flow matches the flow direction indicated on the flowmeter. The display screen must be positioned perpendicular to the horizontal plane, and the pipe axis should be parallel to the horizontal plane with a deviation of no more than ±2.5°. Finally, tighten the instrument using bolts.

5 Electrical Connections

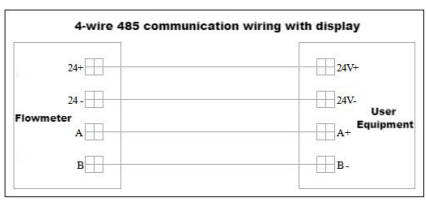
5.1 Instruction of Sensor Wiring

1	2	3	4
RT1	RT2	RH1	RH2

Temperature sensor (Pt300)

Heater (Pt20)

5.2 Terminal Description and Wiring Method



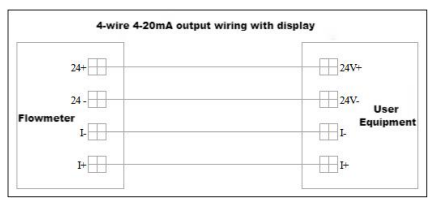
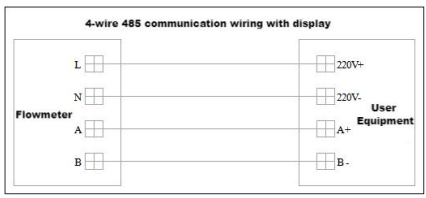


Fig.6



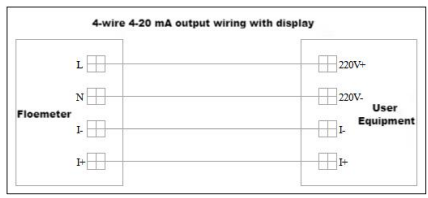


Fig.7

Note:

(1) It is recommended to use branded power supplies with a power of less than 50W when providing 24V power on site.

(2) When using a 4-20mA output, the circuit board prohibits the 2-wire current connection.

6 Operation

6.1 Main Interface Under Working conditions

The prompt line:

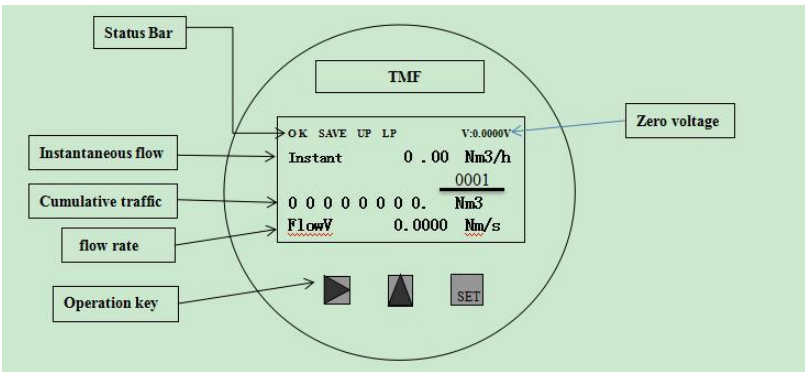


Fig.8 Main interface

1. The meter will perform self-check after power on, if the meter is running normally, it will prompt **OK**.

2. Different units can be selected according to different needs, including: NL/h, t/m, Nm³/h, NL/m, t/h, kg/m, g/s, L/h, Nm³/m, kg/h, and many other units.

3. The maximum accumulated flow is an 8-bit integer, and it will be automatically reset to zero after exceeding it, and the accumulated number of times will be accumulated in the overflow flag in the common parameter query

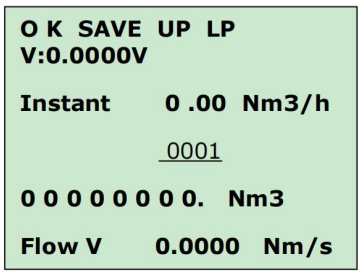
4. If the unit is changed during use, if it is not cleared to zero, the previous accumulated flow value will not automatically switch, but the accumulated value afterwards is after the change.

5. The instrument has three buttons. The main function of SHIFT is the shift function, which is the function of modifying the value. SET is the function of confirming the change. For specific use, please refer to the following introduction.

Note: Non-air media may require zero point calibration. Refer to page 15 for operation.

6.2 Parameters Setup

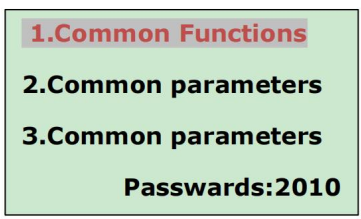
6.2.1 Main Menu



Under this interface, press (Shift) button to enter the setup menu;

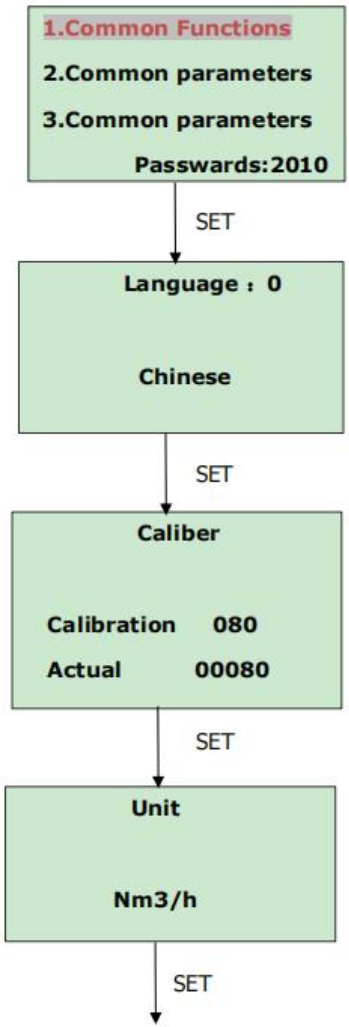
6.2.2 Parameter Setting Main Interface

Press (Shift Select Menu)key



In the main interface, press the SHIFT key to enter the main menu interface. You can use the SHIFT key to select the corresponding menu item and press the SET key to enter. Frequently used function query does not require a password, the other two have to enter the password, press the SHIFT key to transfer to the corresponding menu item, then press SET to enable the password input, then press to adjust the password, and then the SET key to shift and confirm.

6.2.3 Parameter Setting

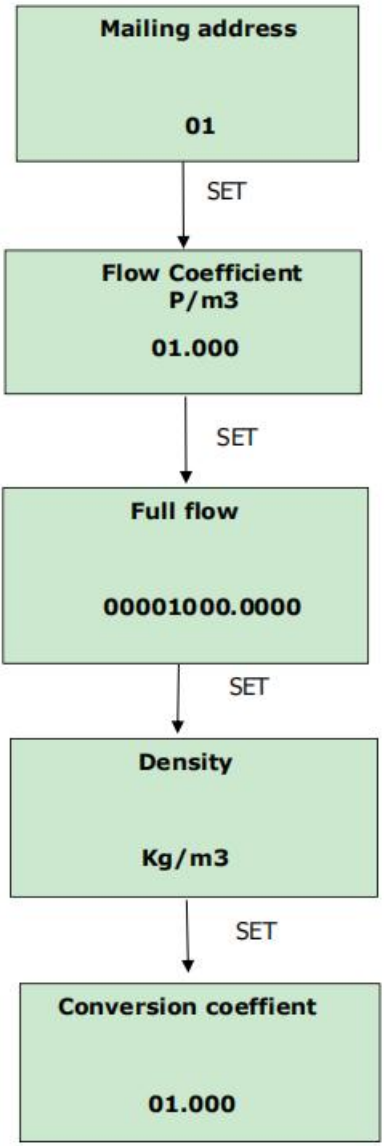


In the main interface, press the SHFIT key to enter the main menu interface. Press the SET key to move the cursor to the password, then press the key to change the corresponding password, and then press the SET key again to shift, and enter the password 2010 in sequence.

In the main interface, press the SHFIT Language selection, to set the language of the setting and display interface, select by pressing the key, there are English and Chinese.

Equivalent pipe inner diameter, set the inner diameter of the pipe measured by the instrument, the square pipe needs to be converted into the equivalent inner diameter input. The unit is millimeters. During the modification process, only need to change the actual column, do not change the calibration column at will

The final unit of the instrument is selected, and the unit can be adjusted by modifying the value behind the unit.



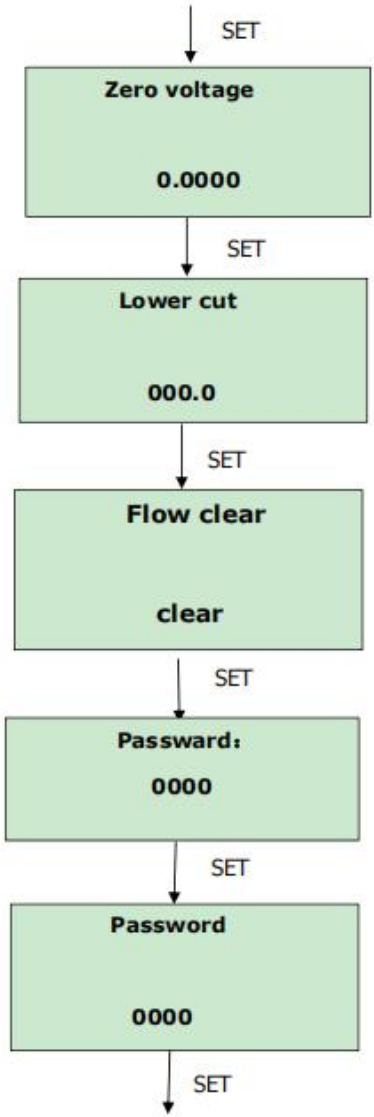
485 communication address, it is meaningful only if it is set on the instrument with 485 communication function.

The meter correction coefficient K, the coefficient defaults to 1, if you want to adjust the flow rate as a whole, you can adjust this position, and the final flow rate
Q=Q original*K

Full-scale flow, mainly the maximum value corresponding to 20mA at 4-20mA output, does not affect the meter display

The density of the medium is mainly used when calculating the mass flow rate of the medium.

Conversion coefficient, due to the air calibration used during calibration, flow conversion is required in actual use. The coefficient is obtained by experiment, and the conversion coefficient of common gases has been attached in the manual.



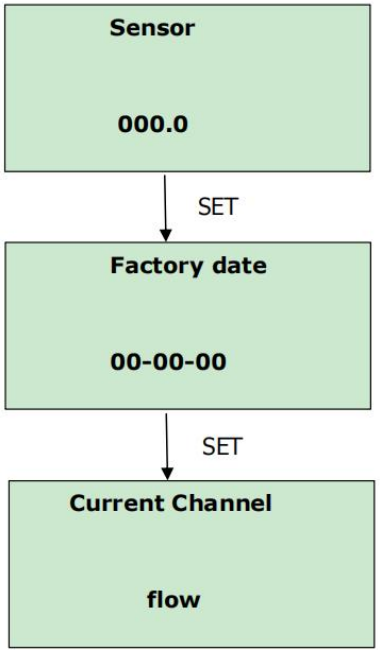
The zero-point voltage value when the meter is in a static state, used to adjust the zero drift of the meter.

The zero-point voltage value when the meter is in a static state, used to adjust the zero drift of the meter. The lower limit is cut off, and there is a part of the static flow caused by interference or other factors in the static state. By appropriately modifying this parameter, the flow rate lower than this parameter is not displayed.

Clear the accumulated flow. In this interface, directly press the middle button to reset.

The instrument password can be modified here. Press SET again to complete the setting and exit to the main interface.

Under the clear menu, press to save and enter the password setting menu. Press to save and go to the next menu, press to move the cursor position, and to modify the parameters. This menu sets the password for the frequently used function setting menu. Press under this menu to return to the main page.



The manufacturer's parameters cannot be modified when the customer uses them on site

Used to set the factory time

Current channel: you can choose the flow or flow rate corresponding to the 4-20mA full scale, pay attention to use with the full flow item

Press the set button again to return to the main interface

6.3 Steps to Calibrate Zero Voltage Value:

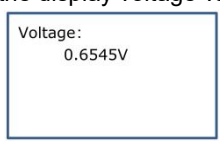
1. Install the instrument on the pipeline.

2. Close the back valve, and then open the front valve to fill the pipeline with the medium.

3. Press SHIFT on the main interface, then the menu interface appears

4. Press the SHIFT key to select common function query

5. Press the SET key to enter the display voltage value interface, as follows



6. When the voltage value is stable, then press.

Note: Do not perform zero point calibration in any running state, otherwise the flow may be seriously inaccurate

7 Troubleshooting

Table 9 Troubleshooting and solution

Issues	Possible causes	Solutions
No display	No power supply	Get power supply
	SMPS is damaged	Get power supply, if the power indicator light is out, it means that the SMPS is damaged, Please contact supplier.
	The wirings of DC24V are reversed	Check the wirings, make the wirings right
	The position of LCD is wrong	Reinstall the LCD
	The LCD is damaged	Check the power indicator light. If the light is on, it means that the LCD is damaged. Please contact supplier
Low velocity	The wirings of sensor are reversed	Rewiring or reinstall the sensor
	The sensor is dirty	Clean sensor
	The sensor is damaged	Return to supplier
	Some parameters of flow setting are wrong	Check the parameters setting
Abnormal velocity and large fluctuation	Some parameters of velocity setting are wrong	Check the parameters setting
	Fluid properties is pulsating in turn	Adjust the system filter

Issues	Possible causes	Solutions
	The sensor is dirty	Clean sensor
	The sensor is damaged	Return to supplier
Abnormal 4-20mA output	The setting of 20mA range is wrong	Right settings
	The Transmitter has fault	Return to supplier
	The connection is not a loop circuit	Check the connection
Abnormal frequency output	Some parameters of frequency setting are wrong	Right settings
	The Transmitter has fault	Return to supplier
	The connection cable is damaged	Check the connection
Abnormal alarm	Some parameters of setting are wrong	Right settings
	The meter has no alarm function	Contact supplier
	The relay is damaged	Return to supplier
Abnormal RS485 output	The settings of baud rate and address are wrong	Right settings
	The wirings are reversed	Rewiring
	The connection cable is damaged	Check the connection

8 Warranty & After-Sales Service

We promise that during the warranty period, any product with quality issues will be covered under our unconditional warranty service of repair, replacement, and refund. All non-customized products are eligible for return or exchange within 7 days (excluding products damaged by misoperation). For customized products, the warranty terms will be based on the agreement specified in the contract.

Disclaimer:

During the warranty period, product malfunction caused by the following reasons is not in the scope of the warranty service of repair, replacement, and refund:

(1) Product malfunction resulting from improper use by customers.

(2) Quality issues caused by disassembly, repairing, and refitting the product.

9 Communication Protocol

Mod bus Poll software RTU connection:

Display Option Floating Pt;

Command 03: HOLDING REGISTER;

Device ID: The internal address of the instrument;

Address: The starting address of the instrument parameters, from 0 to 14;

Length： Data length Length＋Address <= 14.

Parameter address:

40001-2: The medium temperature, liquid turbine and thermal gas flow meter always read 0 in this section;

40003-4: instantaneous flow rate;

40005-6: Instantaneous flow velocity (in Nm/s);

40007-8: Sensor voltage value;

40009-10: Accumulated traffic in hundreds or more (1234);

40011-12: Accumulated traffic below the hundredth (87.89);

Accumulated traffic=1234 * 100+87.89=123487.89;

40013-14: Medium Pressure, unit: kPa

This parameter address has a default offset added; the actual parameter address is the given address minus 1.

Appendix A The Density and Conversion Coefficient of Common Gas

According to different gas on site, the calibration in lab translates the flow rate of actual gas on site into flow rate of air, and then begins to calibrate the flow rate at present. Therefore, when using the meter on site, the meter displays mass flow or volume flow of actual gas. When translating the flow rate of gas into flow rate of air, there is a conversion coefficient table of different gas.

Table 10 The Density and Conversion Coefficient of Common Gas

	Gas	Specific heat (Kal/g*℃)	Density (g/l, 0℃)	Conversion Coefficient
0	Air	0.24	1.2048	1.0000
1	Argon (Ar)	0. 125	1.6605	1.4066
2	Arsine (A_SH_3)	0. 1168	3.478	0.6690
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 (BF_3)	0. 1779	3.025	0.5050
6	Borane (B_2H_6)	0.502	1.235	0.4384
7	Carbon Tetrachloride (CCl_4)	0. 1297	6.86	0.3052
8	Carbon Tetrafluoride (CF_4)	0. 1659	3.9636	0.4255
9	Methane (CH_4)	0.5318	0.715	0.7147
10	Acetylene (C_2H_2)	0.4049	1.162	0.5775
11	Ethylene (C_2H_4)	0.3658	1.251	0.5944
12	Ethane (C_2H_6)	0.4241	1.342	0.4781
13	Ally lene (C_3H_4)	0.3633	1.787	0.4185
14	Propylene (C_3H_6)	0.3659	1.877	0.3956
15	Propane (C_3H_8)	0.399	1.967	0.3459
16	Butyne (C_4H_6)	0.3515	2.413	0.3201

	Gas	Specific heat (Kal/g*℃)	Density (g/l, 0℃)	Conversion Coefficient
17	Butene (C_4H_8)	0.3723	2.503	0.2923
18	Butane (C_4H_{10})	0.413	2.593	0.2535
19	Pentane (C_5H_{12})	0.3916	3.219	0.2157
20	Carbinol (CH_3OH)	0.3277	1.43	0.5805
21	Ethanol (C_2H_6O)	0.3398	2.055	0.3897
22	Trichloroethane ($C_3H_3Cl_3$)	0. 1654	5.95	0.2763
23	Carbon Monoxide (CO)	0.2488	1.25	0.9940
24	Carbon Dioxide (CO_2)	0.2017	1.964	0.7326
25	Cyanide ($C_2 N_2$)	0.2608	2.322	0.4493
26	Chlorine (Cl_2)	0. 1145	3. 163.	0.8529
27	Deuterium (D_2)	1.7325	0. 1798	0.9921
28	Fluoride (F_2)	0. 197	1.695	0.9255
29	Germanium tetrachloride ($GeCl_4$)	0. 1072	9.565	0.2654
30	Germane (GeH_4)	0. 1405	3.418	0.5656
31	Hydrogen (H_2)	3.4224	0.0899	1.0040
32	Hydrogen Bromide (HBr)	0.0861	3.61	0.9940
33	Hydrogen Chloride (HCl)	0. 1911	1.627	0.9940
34	Hydrogen Fluoride (HF)	0.3482	0.893	0.9940
35	Hydrogen Iodide (HI)	0.0545	5.707	0.9930
36	Hydrogen Sulfide (H_2S)	0.2278	1.52	0.8390
37	Helium (He)	1.2418	0. 1786	1.4066
38	Krypton (Kr)	0..0593	3.739	1.4066
39	nitrogen (N_2)	0.2486	1.25	0.9940
40	Neon (Ne)	0.2464	0.9	1.4066
41	Ammonia (NH_3)	0.5005	0.76	0.7147

	Gas	Specific heat (Kal/g*℃)	Density (g/l, 0℃)	Conversion Coefficient
42	Nitric Oxide (NO)	0.2378	1.339	0.9702
43	Nitrogen Dioxide (NO_2)	0. 1923	2.052	0.7366
44	Nitrous Oxide (N_2O)	0.2098	1.964	0.7048
45	Oxygen (O_2)	0.2196	1.427	0.9861
46	Phosphorus Trichloride (PCl_3)	0. 1247	6. 127	0.3559
47	Phosphorane (PH_3)	0.261	1.517	0.6869
48	Phosphorus Pentafluoride (PF_5)	0. 1611	5.62	0.3002
49	Phosphorus Oxychloride ($POCl_3$)	0. 1324	6.845	0.3002
50	Silicon Tetrachloride ($SiCl_4$)	0. 127	7.5847	0.2823
51	Silicon Fluoride (SiF_4)	0. 1692	4.643	0.3817
52	Silane (S iH4)	0.3189	1.433	0.5954
53	Dichlorosilane (SiH_2Cl_2)	0. 1472	4.506	0.4095
54	Trichlorosilane ($SiHCl_3$)	0. 1332	6.043	0.3380
55	Sulfur Hexafluoride (SF_6)	0. 1588	6.516	0.2624
56	Sulfur Dioxide (SO_2)	0. 1489	2.858	0.6829
57	Titanium Tetrachloride ($TiCl_4$)	0. 1572	8.465	0.2048
58	Tungsten Hexafluoride (WF_6)	0.0956	13.29	0.2137
59	Xenon (Xe)	0.0379	5.858	1.4066

Appendix B Upper Range Value of Common Gas

According to different gas on site, the calibration in lab translates the flow rate of actual gas on site into flow rate of air, and then begins to calibrate the flow rate at present. Therefore, when using the meter on site, the meter displays mass flow or volume flow of actual gas. When translating the flow rate of gas into flow rate of air, there is a conversion coefficient table of different gas.

Table 11

Flow range				
Nominal Diameter(mm)	Air（Nm^3/h）	Extended range	Oxygen（O_2）	Combustible gas
10	0.5-28	0.03-30	0.5- 14	0.5-5
15	0.5-65	0.07-65	0.5-32	0.5- 10
20	0.5- 100	0. 12- 110	0.5-55	0.5-20
25	0.5- 175	0.18- 180	0.5-89	0.5-28
32	0.5-290	0.3-290	0.5- 144	0.5-45
40	0.5-450	0.5-450	0.5-226	0.5-70
50	1-600	0.5-700	0.7-352	0.7- 110
65	1.5- 1000	1- 1200	1.2-600	1.2- 185
80	2- 1500	1.5- 1800	2-900	2-280
100	3-2300	3-2800	3- 1420	3-470
125	4.5-3500	4-4400	4.5-2210	4.5-700
150	6.5-5200	6-6300	6.5-3200	6.5-940
200	12-9000	12- 11500	12-5650	12- 1880
250	18- 14500	18- 17500	18-8830	18-2820
300	25-21000	25-25000	25- 12720	25-4060
350	35-28000	35-34500	35- 17000	35-5600
400	45-36500	45-45000	45-22600	45-7200
450	60-46500	60-57000	60-29000	60-9200
500	70-57000	70-70000	70-35300	70- 11280

Flow range				
Nominal Diameter(mm)	Air（Nm^3/h）	Extended range	Oxygen（O_2）	Combustible gas
600	100-81000	100- 101000	100-50600	100- 16300
700	140- 110000	140- 138000	140-69000	140-22100
800	180- 150000	180- 180000	180-90000	180-29000
900	230- 185000	230-230000	230- 115000	230-36500
1000	290-230000	290-280000	290- 140000	290-45500
2000	1150-900000	1150- 1130000	1150-560000	1150- 185000

(Unit: Nm^3/h. The follow table can be extended)

The flow rate in standard condition: The flow rate is in the condition of 20℃ temperature and 101.325kPa pressure.

The unit of flow rate is optional : Nm3/h, Nm3/min, L/h, L/min, t/h, t/min, kg/h or kg/min.

The reduction formula of flow rate in working condition and flow rate in standard condition:

$$Q_{\mathrm{s}} = \frac{0.101325 + P}{0.101325} \times \frac{273.15 + 20}{273.15 + t} \times Q_{\mathrm{n}}$$

Flow velocity calculation

formula :

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

Q_s : The flow rate in standard condition (Nm^3/h).

Q_n : The flow rate in working condition (m^3/h).

T: The medium temperature in working condition (℃).

P: The medium pressure in working condition (Gauge pressure, MPa).

V: Medium standard condition flow rate (Nm/s)

Q : Standard state flow rate (Nm^3/h)

D: Measuring pipe diameter (mm)