

Manual of Intelligent Gas Turbine Flow Meter

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Part 1. Overview

LWQ series intelligent gas turbine flow meter is a new generation of high-precision and reliable gas precise measuring instrument, which is self-developed and integrates temperature, pressure, flow sensor and flow totalizer with the advanced technology of flow instruments at home and abroad, and optimized design and the theory of Gas Mechanics, Fluid Mechanics and Electromagnetic. With excellent low and high pressure metering performance, multiple signal output modes and low sensitivity to fluid disturbance, gas turbine widely used in urban pipeline (Network) gas metering, industrial gas metering, gas regulating station metering, energy management and non corrosive gas metering or flow control and other occasions.

Part 2. Specification

- ◆ It can detect the temperature, pressure and flow of the measured gas, can automatically track and compensate the flow, and display the cumulative volume of the gas in the standard state ($P_b=101.325\text{kPa}$, $T_b=293.15\text{K}$);
- ◆ Can query the temperature and pressure values in real time;
- ◆ Wide flow range ($Q_{\min}/Q_{\max}=20:1$), good repetitiveness, high accuracy (up to 1.0 grade), low pressure loss, low initial flow;
- ◆ Adopt special integrated rectifier, which has low requirements for the installation of the front and rear straight pipe sections of the flow meter (the front pipe is $\geq 2\text{DN}$, and the downstream is not required);
- ◆ Built-in pressure and temperature sensors, which has high safety performance, compact structure, beautiful appearance;
- ◆ Self-diagnosed about the faults of pressure and temperature sensor then displays on LCD screen directly;
- ◆ A lithium battery can be used continuously for more than five years, and has a two-level of battery alarm output function when it under voltage, which is more suitable for using with IC card management systems;
- ◆ The intelligent flow totalizer can be positioned at any angle, which makes the reading of the flowmeter more convenient and direct under various installation conditions;
- ◆ With multipoint non-linear correction of intelligent instrument coefficient;
- ◆ The instrument has RS-485 communication interface, equipped with data management software system has powerful function and rich interface, which can print automatically generated charts;
- ◆ The instrument has explosion-proof and protection functions, the explosion-proof mark is Exd II BT6Gb, protection grade is IP65;
- ◆ According to customer's requirements, it can provide functions of setting pressure and temperature value, especially especially suitable for occasions where the medium temperature is relatively stable.

Part 3. Technical performance index

3.1 Standard and Certification

Implementation standard in accordance with GB/T32201-2015;
Compliance with EC standards of PrEN 12261;
Execute JJG1037-2008 of "Verification Regulation of turbine Flowmeter"

3.2 Accuracy class

All flow meters are within their specified flow range, the maximum allowable error is $\pm 1.0\%$ or $\pm 1.5\%$ (accuracy is 1.0 grade or 1.5 grade), when the minimum flow rate is less than $0.2Q_{\max}$, the maximum allowable error is $\pm 2.0\%$ or $\pm 3.0\%$ within the range of $Q_{\min} \sim 0.2Q_{\max}$.

3.3 Application condition

Environment temp.: $-30^{\circ}\text{C} \sim +60^{\circ}\text{C}$;
Medium temp.: $-30^{\circ}\text{C} \sim +80^{\circ}\text{C}$;
Atmospheric pre.: $86\text{KPa} \sim 106\text{KPa}$;
Relative humidity: $5\% \sim 95\%$

3.4 Mechanical performance index

3.4.1 Product model and data sheet

specifications	Nominal diameter (mm)	Starting flow (m³/h)	Flow range (m³/h)	Pressure of work (Mpa)	Shell material	Accuracy
LWQ-25	DN25(R1)	≤0.8	2.5~25	1.6	Stainless steel	At an accuracy of 1.0, the allowable error is: Qmin~0.2Qmax:±2% 0.2Qmax~Qmax:±1%
	DN25(R2)	≤1.3	5~50		Aluminum alloy	
LWQ-32	DN32(R1)	≤1.3	4~40		Stainless steel	
	DN32(R2)	≤1.5	6~60			
LWQ-40	DN40(R1)	≤1.1	5~50			
	DN40(R2)	≤1.5	6~60			
LWQ-50	DN50(R1)	≤1.5	6~65	2.5	Stainless steel Aluminum alloy	At an accuracy of 1.5, the allowable error is: Qmin~0.2Qmax:±3.0% 0.2Qmax ~ Qmax:±1.5%
	DN50(R2)	≤2.0	10~100			
	DN50(R3)	≤3.0	10~160			
LWQ-65	DN65(R1)	≤2.0	10~100	4.0	Stainless steel	
	DN65(R2)	≤5.0	13~250			
LWQ-80	DN80(R1)	≤3.5	8-160		Stainless steel Aluminum alloy	
	DN80(R2)	≤5.0	13~250			
	DN80(R3)	≤6.0	20~400			
LWQ-100	DN100(R1)	≤5.0	13-250	1.6	Stainless steel Aluminum alloy	
	DN100(R2)	≤9.0	20~400			
	DN100(R3)	≤15.0	32~650			
LWQ-125	DN125	≤15.0	40~800	2.5	Stainless steel	
LWQ-150	DN150(R1)	≤10.0	32~650	4.0		
	DN150(R2)	≤14.0	50~1000			
	DN150(R3)	≤16.0	80~1600			
LWQ-200	DN200(R1)	≤14.0	50~1000	1.6	Stainless steel	
	DN200(R2)	≤20.0	80~1600	2.5		
	DN200(R3)	≤25.0	130~2500			

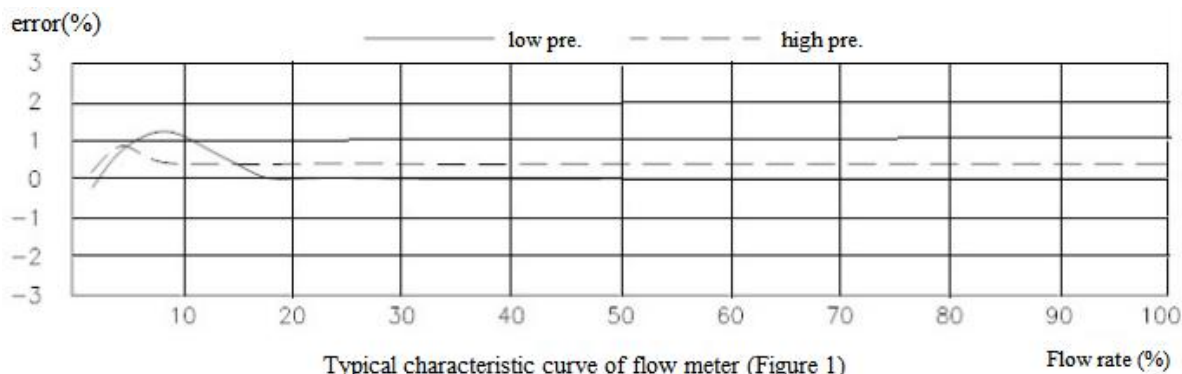
Note:

- (1) The flow range listed in table is the factory inspection value (at normal temperature and pressure: $\rho=1.205\text{kg/m}^3$)
- (2) As the pressure increases, so does the flow range;
- (3) At same diameter, R1: small flow range; R2: middle flow range; R3: large flow range;
- (4) Products leave factory at 1.5 grade without special requirements;
- (5) Please specify other flow range when ordering;

3.4.2 Typical characteristic curve of flow meter

The typical characteristic curve of the flow meter is shown in Figure 1.

The vertical axis represents the basic error, and the horizontal axis represents the percentage of flow.



3.4.3 Pressure loss

The pressure loss of turbine flow meter depends on the energy required to drive the turbine, the loss caused by the internal channel resistance, and the change in flow speed and flow direction.

When turbine flow meter is calibrating (medium: air, density: $\rho=1.205\text{kg/m}^3$), the pressure loss under the different working conditions can be obtained by the following formula:

$$\Delta P = \Delta P_{\max} * \frac{\rho_b}{1.205} * \frac{P}{P_b} * \frac{T_b}{T} * \frac{Z_b}{Z_g} * \left(\frac{Q}{Q_{\max}} \right)^2$$

ΔP ——Pressure loss under working conditions: KPa

$\Delta P_{\max}$ ——Pressure loss of air at maximum flow rate under standard conditions: KPa

ρ_b ——Density of medium under standard conditions (20°C, 101.325 KPa): kg/ m³

P_b ——Standard atmospheric pressure: 101.325 KPa

T_b ——Absolute temperature of medium under standard condition: 293.15K

P ——Absolute pressure of medium under working condition (pressure value of flow meter shows:
 $P=P_a+P_g$): KPa

P_a ——Local atmosphere pressure when calibrating: KPa

P_g ——Pressure value measured with a pressure gauge (gauge pressure): KPa

T ——Absolute temperature of medium under working condition (273.15+t): K

T ——Temperature value of flow meter showed: °C

Z_g ——Gas compression factor under working condition

Z_b ——Gas compression factor under standard condition

Q ——Working flow under working condition: m³/h

$Q_{\max}$ ——Maximum working condition flow of flow meter: m³/h

3.5 Electrical performance index

3.5.1 Power supply:

Internal power supply: A 3.6VDC lithium battery, the battery capacity is displayed on the screen in real time, and there are two levels of battery under-voltage alarm to remind the user to replace the battery in time.

External power supply: (8 ~ 24) VDC, ripple $\leq 50\text{mV}$, the internal power supply is automatically disconnected when the external power supply is connected, the whole machine is powered by the external power supply. (Intrinsically safe instruments need to be powered by Safety barrier).

3.5.2 Power consumption:

Internal power supply: Average power consumption $\leq 0.8\text{mW}$, one lithium battery can be used continuously for more than five year, in the sleep state (the meter displays "0.00m³ / h"), the power consumption is $\leq 0.2\text{mW}$.

External power supply: power consumption $\leq 1\text{W}$.

3.5.3 Output signal:

Flow signal output (the output of logic gate circuit can be set as high level, output amplitude $\geq 2.8\text{V}$. Normally the flow control signal (AL/AH) in upper and lower limit alarm is low level, flow range $\leq 0.2\text{V}$, load resistance $> 100\text{K}\Omega$. Valve closing alarm signal SUM is for IC card controller; normally is low level, amplitude $\leq 0.2\text{V}$, load resistance $\geq 100\text{K}\Omega$. (Signal transmission between intrinsically safe products and non-intrinsically safe products must through safety barrier)

Output signal(three-wire DC+/DC-/FOUT): Directly amplify and output the working condition pulse signal detected by flow sensor, transmission distance $\leq 500\text{m}$, external power + 24VDC;

4~20mA standard analog signal: 4~20mA standard analog signal linearly correspond to (0~ $Q_{\max}$) standard volume flow, transmission distance $\leq 200\text{m}$, two-wire(V+/V-) system or three-wire (V+, V-, I₀) system, external power + 24VDC;

IC standard flow signal: (IC) Output in pulse signal string mode, the pulse amplitude is about 3V, normal state is low level, transmission distance $\leq 50\text{m}$, and each pulse represents 0.1 m³ and 1 m³ respectively (can be set arbitrarily), suitable for use with IC card system;

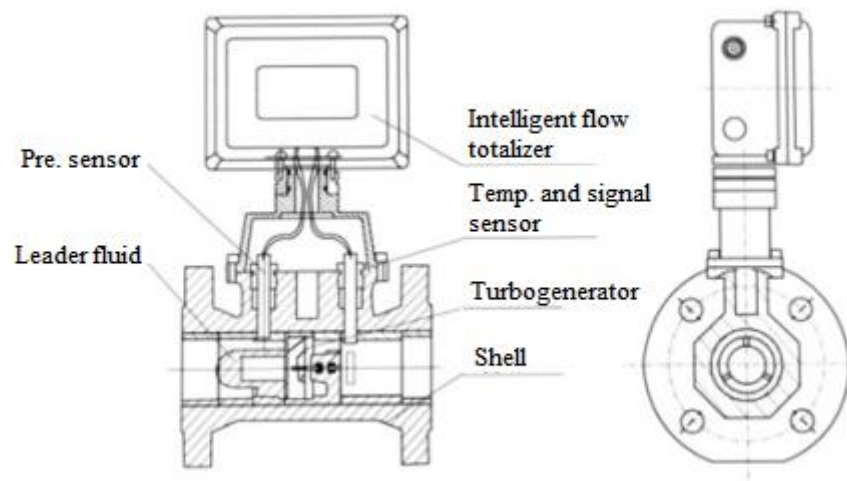
RS-485 interface signal: (A/B/V+/V-) It is directly connected with the host computer, transmission distance $\leq 1200\text{m}$. It can remotely transmit the related parameter of temperature, pressure, instantaneous flow, standard volume and other related parameters, fault codes, and operating status of the measured medium.

Part 4. Principle and structure

4.1 Working principle

When the fluid flows into the flow of time, under the action of air inlet special-purpose rectifier and accelerate, due to the turbine blades and the direction of flow at an Angle, the turbine rotational torque, after overcoming friction torque and fluid resistance moment, the turbine to spin. Within the scope of a certain flow, turbine rotating angular velocity is proportional to the fluid volume flow. According to the principle of electromagnetic induction, the use of magnetic sensor signal from coaxial rotation during induction out with fluid volume flow is proportional to the pulse signal, the signal after amplification, filtering, plastic with temperature and pressure sensor signal into micro processing unit of intelligent flow totalizer, especially for processing and the volume of a gas flow rate and total directly display on the LCD screen.

4.2 Structure

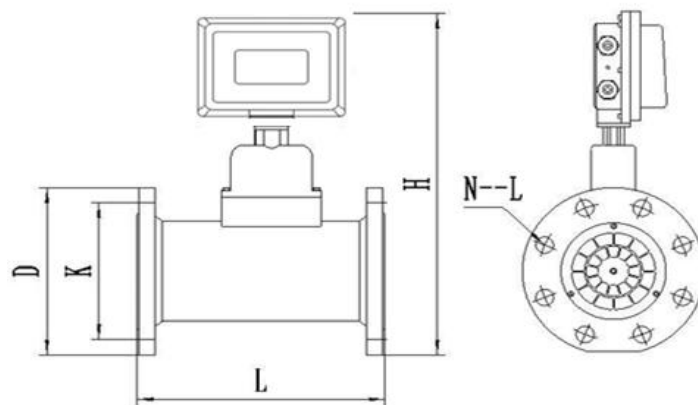


The flow meter consists of the following seven basic components:

1. Air inlet special integrated rectifier is used to adjust the flow velocity distribution and eliminate any fluid disturbance that may affect the measurement accuracy. In this way, only 2DN straight pipe section is required upstream of the flow meter, and no requirement for downstream.
2. Intelligent flow totalizer is composed of temperature and pressure detection analog channel, flow detection digital channel, micro-processing unit, liquid crystal drive circuit and other auxiliary circuits, and is equipped with an external transmission signal interface. The intelligent flow totalizer can rotate freely, which can be easily read in various installation methods.
3. The pressure sensor used piezoresistive diffusion silicon bridge as sensitive element, the bridge-arm resistance will change under the influence of external pressure, so under a certain excitation current, the potential difference between its two output terminals is proportional to the external pressure.
4. Magnetic sensor: a sensor that measures the flow of fluid in a closed pipe with a multi-blade rotor (turbine). The rotor rotation speed proportional to the flow is detected by a magnetic sensor (or magnetoresistive) sensor installed in the housing.
5. Temperature sensor: uses PT1000 RTD as temperature sensitive element, within a certain temperature range, the resistance value is corresponding to the temperature.
6. The shell itself has a flange, and the shell material is made of stainless.
7. Turbine and measuring parts: the turbine speed is proportional to the flow rate of the gas flow, and the gas flow rate and cumulative flow in the working condition are detected by the magnetic sensor; the impeller shaft is installed on two high-precision bearings, and the bearing part uses reverse thrust structure and dust seal structure to ensure the durability and reliability of the bearing.

4.3 Overall dimensions

The flowmeter is connected by flange, flange size is in accordance with GB / T 20592-2009 standard of the Ministry of Chemical Industry. Flow meter appearance is shown in the following figure (table showed is the flange size at PN1.6MPa).



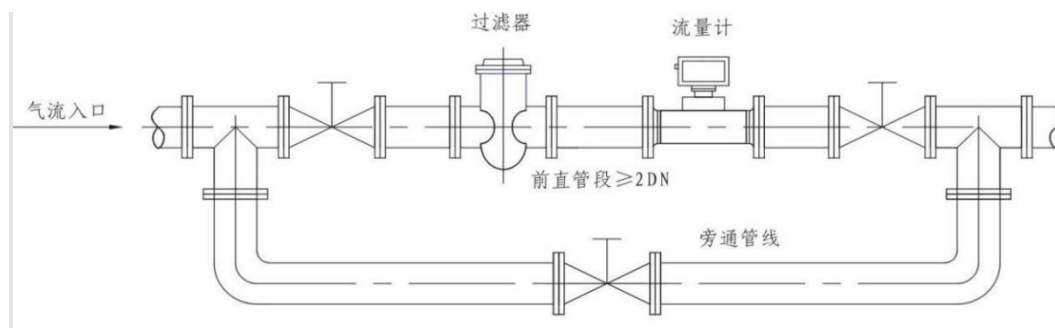
DN	L	H	D	N--L	K
DN25	200	361	115	4-Ø14	85
DN32	200	377	140	4-Ø18	100
DN40	200	385	150	4-Ø18	110
DN50	200	397	165	4-Ø18	125
DN65	200	416	185	4-Ø18	145
DN80	240	430	200	8-Ø18	160
DN100	300	449	220	8-Ø18	180
DN125	300	476	250	8-Ø18	210
DN150	300	510	285	8-Ø22	240
DN200	300	563	340	8-Ø22	295

unit: mm

Part 5. Installation and use and connection

5.1 The installation of the flowmeter

- ◆ Before install, the pipe must purge clean to prevent residual iron affect the normal operation of flowmeter.
- ◆ Before install, the use of tiny air blows the turbine, the turbine can flexible rotation, no randomnoise, counter rotating is normal, uninterrupted card lag phenomenon, the flowmeter can be used to install.
- ◆ Flow meter in the middle of the flange and pipe flange to add sealing washer.
- ◆ Meter shall be equipped with filters, temperament is dirty places places should be equipped with oil filter, before you place an order, can order to me at the same time, it is strictly prohibited to filter and flowmeter directly connected.
- ◆ Mere shall be added by the valve before, during, and after installation.
- ◆ There should be no protrusions connected to the internal passages of the flange connection.
- ◆ When the flowmeter is installed, it is strictly prohibited to directly weld the inlet and outlet flanges to avoid burning out the internal parts of the flowmeter.
- ◆ The flowmeter should not be used in situations where the flow is frequently interrupted and there is strong pulsating flow or pressure pulsation.
- ◆ When the flowmeter is installed outdoors, there should be a cover on the upper part to prevent the rainwater intrusion and the sun from affecting the service life of the flowmeter.
- ◆ The flowmeter can be installed horizontally or vertically, the direction of fluid flow should be consistent with the direction marked on the housing, there should be a straight pipe section no less than 2DN upstream of the flowmeter.
- ◆ In order not to affect the normal flow of fluid, it is recommended to install the bypass pipeline as shown in the figure below. The bypass pipeline valve must be closed during normal use



- ◆ When constructing pipelines, should consider installing telescopic pipes or bellows to avoid serious stretching or breakage of the flowmeter.
- ◆ Make sure that the connection between the pipe and the inlet and outlet of the flowmeter is coaxial, and prevent the gasket and weld from protruding into the pipe, otherwise it will disturb the flow profile.
- ◆ When using an external power supply, the flowmeter must have a reliable ground, but it must not share the ground wire with the strong current system.
- ◆ When installing or repairing the pipeline, the ground wire of the welding system must not be connected to the flowmeter.
- ◆ When the pipeline is installed and the sealing pressure test is performed, pay attention to the maximum pressure that the flowmeter pressure sensor can withstand (that is, the maximum pressure of the medium on the label) to avoid damaging the pressure sensor.

5.2 Use of flow meter

5.2.1 Caution

After installation, leak detection and installation shall comply with the following regulations:

- (1) Close the outlet valve and inlet valve first.
- (2) Slightly open the outlet valve, then slowly open the inlet valve to slowly start the watch, and then slowly open the outlet valve to achieve normal operation, to prevent sudden start and damage to the watch movement.
- (3) When the gas is stopped, the outlet valve should be closed, and then the inlet valve should be closed again, and the above regulations should be followed every time it starts.

Flowmeter movement (clean temperament) should be cleaned and maintained once every six months; (dirty temperament) should be cleaned and maintained once a month.

If the core is put back into use again after being disassembled and repaired, the sealing test shall be conducted first according to the maximum pressure. And inject T4 precision instrument oil or transformer oil into the core.

During the use, the user shall not change the connection mode of the explosion-proof system and modify the lead interface at will.

The impurities in the pipeline will affect the service life of the turbine flowmeter. Therefore, when the impurities contained in the measured medium are more than 50 μm , it is recommended to install a filter (our company can provide) in the upstream ($\geq 2\text{DN}$) of the flowmeter, and replace or clean the filter element (net) in time to ensure that the filter is in good working condition.

5.2.2 Use and replacement of built-in battery

Battery power display: when there is only one cell left in the battery display, user is required to replace battery within one month; when only the battery shape symbol is displayed, the battery power is exhausted and the battery must be replaced immediately.

How to replace the battery:

Open the back cover of the intelligent flow totalizer, remove the battery, replace it and reinstall it. Pay attention to the positive and negative poles of the battery during installation.

5.2.3 Wiring instruction

1	2	3	4	5	6	7	8	9	10	11	12
A	B	I-	I+	V+	V-	PL	DL	IC	BC	BL	GND

A: RS-485 communication A

B: RS-485 communication B

I-: current input

I+: current output

V+: power supply DC24V+

V-: power supply 0V

FL: pulse output

DL: equivalent output

IC: equivalent output (IC card controller equivalent input)

BC: (IC card controller)

BL: (ICcard controller)

GND: Ground (IC card controller)

IC card controller connection:

IC: equivalent output

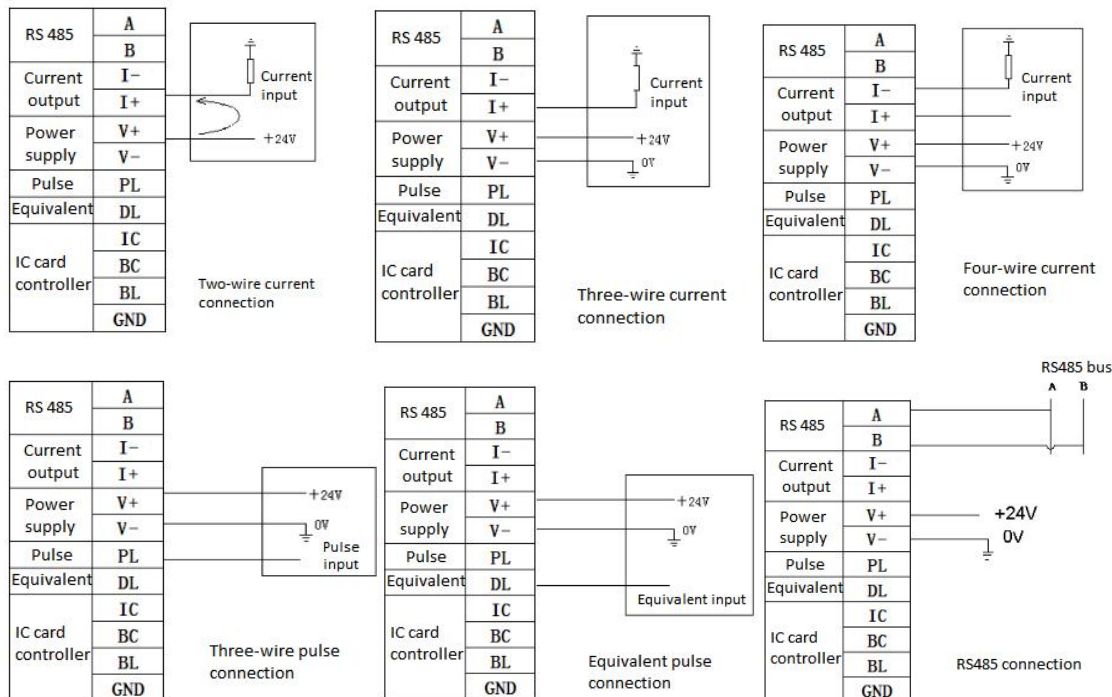
GND: output

5.2.4 System wiring

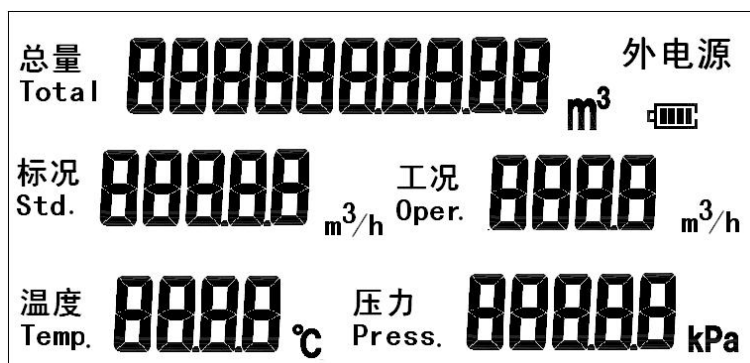
Current output dial switch setting

There are three types of 4-20mA current output (two lines, three lines, four lines). The circuit board needs to adjust the jumper cap switching current output type. The setting method is as follows:

Current output type	Dial code	wiring
Two-wire current	1/2 short	+24V、I+
Three-wire current	1/2 short	+24V、0V、I+
Four-wire current	2/3 short	+24V、0V、I+、I-



Part 6. Display of flow meter



- 1 Total: Cumulative flow, the display value can retain 4 decimal places, the maximum value is 9999999999; when the display display condition accumulates, m3 will be displayed. When the display shows the accumulated condition, m3 will not be displayed;
- 2 Oper. flow: The displayed value is kept at least 3 decimal places, and the maximum value is 9999m3/h;
- 3 Std. flow: The display value is a minimum of 3 decimal places, and the maximum value is 99999Nm3/h;
- 4 Pressure: The displayed value is a minimum of 3 decimal places. The maximum value is 9999. The unit has Kpa for selection. The pressure range is 0-20000Kpa (gauge pressure). When this range is exceeded, the pressure will flash;
- 5 Temperature: The displayed value range is -50 °C - 300 °C. Outside this range, the temperature (Temp) will flash;
- 6 External power: Power supply mode display, display when DC24V power supply
- 7 “” : Runs the power mode display, provides a battery power prompt, and displays the battery level.

Part 7. Notes on the use of explosion-proof products

7.1 Precautions for the use of intrinsically safe explosion-proof products

- a. The product shell is equipped with a ground terminal, so users should connect with ground wire when using the product.
- b. This product must be matched with the safety barrier approved by the explosion-proof inspection agency to constitute this explosion-proof system. The connecting cable is shielded cable, the shielding layer is grounded in a safe place, and the cable distribution parameter is controlled within 0.05 μ F / 1mH.

- c. The safety barrier must be installed in a safe place, and its installation and maintenance must follow the safety barrier instruction manual.
- d. User can not replace electrical element in products at will.
- e. The user must comply with the relevant safety regulations of GB3836.1, GB3836.4-2000 electrical equipment for explosive gas environment when installing, using and maintaining the product.

7.2 Precautions for installation and use of flameproof products

- a. The product shell is equipped with a ground terminal, so users should connect with ground wire when using the product.
- b. During installation and maintenance on site, the warning of "open the cover after power off" must be observed.
- c. There should be no harmful gases corrosive to aluminum alloys at the installation site.
- d. The maximum temperature of the explosion-proof enclosure shall not exceed 130 °C.
- e. Maintenance must be carried out in a safe place, and only carried out when the installation site confirms that no flammable gas.
- f. The user must comply with the relevant safety regulations of GB3836.1, GB3836.4-2000 electrical equipment for explosive gas environment when installing, using and maintaining the product.

Part 8. Maintenance and troubleshooting

If the measured indication value and actual flow value do not match during operation, the pipeline system shall be checked first to see whether it meets the installation requirements of the flowmeter.

8.1 Troubleshooting

Failure phenomenon	Reason	Solution
No output signal after power on	1. The pipeline has no medium flow or flow lower than the initial flow 2. Check whether the power supply and output cable are connected correctly 3. The preamplifier is damaged (the totalizer does not count, the instantaneous value is "0") 4. The circuit of the driving amplifier stage is damaged (the totalizer count is normal)	1. Increase the medium flow to meet the requirements 2. Correct wiring 3. Replace the preamplifier 4. Replace damaged components in the drive amplifier stage
Flow meter has signal output when there is no flow	1. Poor grounding of the flowmeter and interference of strong electricity and other ground wires 2. The amplifier sensitivity is too high or self-excited 3. Unstable power supply, poor filtering and other electrical interference	1. Connect the ground wire correctly to eliminate interference 2. Replace the preamplifier 3. Repair and replace the power supply to eliminate interference
Instantaneous flow rate display unstable	1. The sensitivity of the amplifier is too high or too low, there are multiple meter and leak meter pulses 2. The impeller speed of the flowmeter is unstable, and the gas flow rate is unstable 3. Poor grounding 4. Power supply is unstable	1. Replace the preamplifier, adjust the medium flow and wait for stability 2. Reinstall the impeller or remove dirt 3. Check the grounding circuit to make it normal 4. Repair and replace the power supply to eliminate interference
The cumulative flow value does not match the actual flow	1. The meter coefficient of the flowmeter is incorrectly entered 2. The user's normal flow rate is lower or higher than the normal flow range of the selected flowmeter 3. The flow meter itself is out of tolerance	1. Enter the correct meter factor after recalibration 2. Adjust the pipeline flow to make it normal or choose the appropriate specification 3. Recalibration
The converter displays abnormally	Poor contact of the conversion button	Replace button
Crash occurs after replace new battery	The power-on reset circuit is abnormal or the vibration circuit does not vibrate	Re install the battery (it needs to be discharged for 5 seconds and then re installed)

Part 9. Package, transportation and storage

9.1 Package

The flowmeter should be packed in a solid wooden box (medium and small-caliber flowmeters can be installed in a carton when protected by foam), it should not move freely in the box, and should be handled with care when handling.

9.2 Transportation and storage conditions of flowmeter

It should meet the requirement of GB/T 9329-1999 in “Basic environment conditions and testing methods for transportation and storage of instruments”

9.3 The storage of the flowmeter shall meet the following conditions:

- 1) Protect from rain and moisture
- 2) Free from mechanical vibration or shock
- 3) Temperature range: -30℃ ~ 50℃
- 4) Relative humidity is no more than 80%
- 5) No corrosive gas in the environment

Part 10. Open-package inspection

Check the integrity of the external packaging when open-package, check the number and specifications of the items in the box, check the integrity of the instrument and accessories according to the packing list.

10.2 Documents

- 1) Packing list
- 2) Manual of instrument
- 3) Product certificate (verification certificate)

Part 11. Selection of flow meter

- 1) When selecting the type, the user shall reasonably select the model and specification of the flowmeter according to the nominal pressure of the pipeline, the maximum pressure of the medium, the medium temperature, the composition of the medium, the flow range and the signal output requirements.
- 2) In order to optimize the performance of the flowmeter, the flow rate of the flowmeter should be within the range of (20% ~ 80%) Q_{max} .
- 3) The standard output mode of factory setting for flowmeter: with pulse signal output under working conditions. If other output functions are required, please specify when ordering.

11.1 Example

There is a actual working pressure of a gas supply pipeline is 0.8MPa ~ 1.2MPa (gauge pressure) , the medium temperature range is -5℃ ~ +40℃, and the gas supply is 3000 ~ 10000Nm³ / h (standard condition flow rate), now required to determine the specification and model of flowmeter without considering the natural gas components.

Analysis: The flow range given in the specification is under working condition, while the flow range given in this example is under standard condition. Therefore, the flow under standard condition must be converted into the flow under working condition according to the gas state equation, and then choose the appropriate caliber.

Gas equation is as following:

$$Q_b = Q * \frac{P * T_b}{P_b * T} * \frac{Z_b}{Z_g} = Q * C * F_z^2$$

Q_b —— Standard condition flow: m^3/h

Q —— Working condition flow: m^3/h

C^* —— Scaling factor

$F_z = \sqrt{\frac{Z_b}{Z_g}}$ —— Gas compression factor, Calculated according to SY / T 6143-1996 standard of

China National Petroleum Corporation.

The data in Appendix B is only for reference. Data is calculated according to the real relative density $GR = 0.600$ of natural gas, and the mole fraction of nitrogen and carbon dioxide is 0.00. When the medium pressure is lower than 0.5MPa, it can be estimated according to $ZB / ZG = 1.00$.

Calculation: (1) When the medium pressure is the lowest (0.8MPa) and the temperature is the highest (+ 40 °C) (in the peak period of gas supply), it shall have the maximum standard condition volume flow (the impact of FZ may not be considered temporarily during selection, and the local atmospheric pressure is

$$101.325kpa) \quad Q_{\max} = Q_b \frac{P_b}{P} * \frac{T}{T_b} = 10000 \times \frac{101.325}{101.325 + 800} \times \frac{273.15 + 40}{293.15} = 1200.87 m^3/h$$

Or estimate with following formula: (C^* is conversion factor in the formula as Appendix A)

$$Q_{\max} = \frac{Q_{b\max}}{C^*} = \frac{10000}{8.33} = 1200.5 \quad m^3/h$$

(2) Medium pressure is the highest (1.2MPa) and the temperature is the lowest (-5 °C) (gas supply trough), it should have the minimum standard volume flow:

$$Q_{\min} = 3000 \times \frac{101.325}{101.325 + 1200} \times \frac{273.15 - 5}{293.15} = 213.51 \quad m^3/h$$

Or estimate with following formula:

$$Q_{\min} = \frac{Q_{b\min}}{C^*} = \frac{3000}{14.0} = 214.3 m^3/h$$

Selection: From the above estimate results, it can be seen that the flow range of the flowmeter to be selected is (213.5-1200) m^3/h , according to the instruction, there are two flow rate ranges that meet this requirement, that is, LWQ-150R3 flow rate Meter (80 ~ 1600 m^3 / h) or LWQ-200R2 flowmeter (80 ~ 1600 m^3 / h). The user can choose a corresponding flow according to the actual situation on site

Appendix A

Conversion coefficient C * calculated by gas equation

C* Temp.		Pre.	MPa													
		0.01	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	
(°C)	-20	1.27	1.70	2.30	2.87	3.34	4.02	4.59	5.16	5.73	6.30	6.87	7.44	8.02	8.59	
	-15	1.25	1.70	2.26	2.82	3.38	3.94	4.50	5.06	5.62	6.18	6.74	7.30	7.86	8.42	
	-10	1.22	1.66	2.21	2.76	3.31	3.86	4.41	4.96	5.51	6.06	6.61	7.16	7.71	8.26	
	-5	1.20	1.63	2.17	2.71	3.25	3.79	4.33	4.87	5.41	5.95	6.49	7.03	7.57	8.11	
	0	1.18	1.60	2.13	2.66	3.19	3.72	4.25	4.78	5.31	5.84	6.37	6.90	7.43	7.96	
	5	1.16	1.57	2.09	2.61	3.13	3.65	4.17	4.69	5.21	5.73	6.25	6.77	7.29	7.81	
	10	1.14	1.55	2.06	2.57	3.08	3.59	4.10	4.61	5.12	5.63	6.14	6.66	7.17	7.68	
	15	1.12	1.52	2.02	2.52	3.03	3.53	4.03	4.53	5.03	5.54	6.04	6.54	7.04	7.54	
	20	1.10	1.49	1.99	2.48	2.97	3.47	3.96	4.45	4.95	5.44	5.93	6.43	6.92	7.42	
	25	1.08	1.47	1.95	2.44	2.92	3.41	3.89	4.38	4.86	5.35	5.84	6.32	6.81	7.29	
	30	1.06	1.44	1.92	2.40	2.88	3.35	3.83	4.31	4.78	5.26	5.74	6.22	6.69	7.17	
	35	1.05	1.42	1.89	2.36	2.83	3.30	3.77	4.24	4.71	5.18	5.65	6.12	6.58	7.05	
	40	1.03	1.40	1.86	2.32	2.78	3.25	3.71	4.17	4.63	5.09	5.56	6.02	6.48	6.94	
	45	1.01	1.38	1.83	2.29	2.74	3.19	3.65	4.10	4.56	5.01	5.47	5.92	6.38	6.83	
	50	1.00	1.35	1.80	2.25	2.70	3.15	3.59	4.04	4.49	4.94	5.38	5.83	6.28	6.73	
C* Temp.		Pre.	MPa													
		0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.20	1.40	1.60	2.00	2.50	3.00	4.00	
(°C)	-20	9.16	9.73	10.3	10.9	11.4	12.0	12.6	14.9	17.2	19.4	24.0	29.7	35.4	46.9	
	-15	8.98	9.54	10.1	10.7	11.2	11.8	12.3	14.6	16.8	19.1	23.6	29.1	34.8	46.0	
	-10	8.81	9.36	9.91	10.5	11.0	11.6	12.1	14.3	16.5	18.7	23.1	28.6	34.1	45.1	
	-5	8.65	9.19	9.72	10.3	10.8	11.3	11.9	14.0	16.2	18.4	22.7	28.1	34.5	44.3	
	0	8.49	9.20	9.55	10.1	10.6	11.1	11.7	13.8	15.9	18.0	22.3	27.6	32.9	43.4	
	5	8.33	8.86	9.38	9.90	10.4	10.9	11.5	13.5	15.6	17.7	21.9	27.1	32.3	42.1	
	10	8.19	8.70	9.21	9.72	10.2	10.7	11.3	13.3	15.3	17.4	21.5	26.6	31.7	41.9	
	15	8.05	8.55	9.05	9.55	10.1	10.6	11.1	13.1	15.1	17.1	21.1	26.1	31.1	41.2	
	20	7.91	8.40	8.90	9.39	9.88	10.4	10.9	12.8	14.8	16.8	20.7	25.7	30.6	40.5	
	25	7.78	8.26	8.75	9.23	9.72	10.2	10.7	12.6	14.6	16.5	20.4	25.2	30.6	39.8	
	30	7.65	8.12	8.60	9.08	9.56	10.0	10.5	12.4	14.3	16.2	20.1	24.8	30.1	39.1	
	35	7.52	7.99	8.46	8.93	9.40	9.87	10.3	12.2	14.1	16.0	19.7	24.4	29.6	38.5	
	40	7.40	7.87	8.33	8.79	9.25	9.71	10.3	12.0	13.9	15.7	19.4	24.0	29.1	37.9	
	45	7.29	7.77	8.20	8.65	9.11	9.56	10.3	11.8	13.7	15.5	19.1	23.7	28.6	37.3	
	50	7.17	7.62	8.07	8.52	8.96	9.41	9.86	11.7	13.4	15.2	18.8	23.3	27.8	36.7	

Note: 1. The value in the table is calculated with the local atmospheric pressure as 101.325KPa;
2. Pressure: gauge pressur

Appendix B

Gas compression factor Fz

Fz Temp. °C) Pre. (MPa)	30	35	40	45	50	55	60	65	70	75
0.50	1.0048	1.0046	1.0043	1.0041	1.0039	1.0036	1.0034	1.0032	1.0031	1.0029
1.00	1.0097	1.0092	1.0087	1.0082	1.0077	1.0073	1.0069	1.0065	1.0061	1.0058
1.50	1.0147	1.0138	1.0130	1.0123	1.0116	1.0109	1.0103	1.0097	1.0091	1.0086
2.00	1.0197	1.0185	1.0174	1.0164	1.0154	1.0145	1.0137	1.0129	1.0121	1.0114
2.50	1.0247	1.0231	1.0217	1.0204	1.0192	1.0181	1.0170	1.0160	1.0151	1.0142
3.00	1.0297	1.0278	1.0261	1.0245	1.0230	1.0216	1.0203	1.0191	1.0180	1.0169
3.50	1.0347	1.0325	1.0305	1.0286	1.0268	1.0252	1.0236	1.0222	1.0208	1.0196
4.00	1.0397	1.0372	1.0348	1.0326	1.0305	1.0286	1.0269	1.0252	1.0236	1.0222
4.50	1.0447	1.0418	1.0391	1.0366	1.0343	1.0321	1.0301	1.0282	1.0264	1.0247
5.00	1.0497	1.0464	1.0434	1.0405	1.0379	1.0355	1.0332	1.0311	1.0291	1.0272
5.50	1.0547	1.0510	1.0476	1.0444	1.0415	1.0388	1.0363	1.0339	1.0317	1.0297
6.00	1.0596	1.0555	1.0517	1.0483	1.0450	1.0420	1.0393	1.0367	1.0343	1.0320
6.50	1.0644	1.0599	1.0558	1.0520	1.0485	1.0452	1.0422	1.0394	1.0368	1.0343
7.00	1.0692	1.0643	1.0598	1.0557	1.0519	1.0483	1.0451	1.0420	1.0392	1.0365
7.50	1.0738	1.0686	1.0637	1.0593	1.0552	1.0514	1.0478	1.0446	1.0415	1.0387
8.00	1.0748	1.0727	1.0675	1.0627	1.0583	1.0543	1.0505	1.0470	1.0438	1.0407
Fz Temp. °C) Pre. (MPa)	-20	-15	-10	-5	0	5	10	15	20	25
0.50	1.0088	1.0083	1.0078	1.0073	1.0069	1.0065	1.0061	1.0058	1.0054	1.0051
1.00	1.0180	1.0169	1.0159	1.0149	1.0140	1.0132	1.0124	1.0117	1.0110	1.0103
1.50	1.0276	1.0258	1.0242	1.0227	1.0213	1.0200	1.0188	1.0176	1.0166	1.0156
2.00	1.0375	1.0351	1.0328	1.0307	1.0287	1.0269	1.0252	1.0237	1.0222	1.0209
2.50	1.0479	1.0446	1.0416	1.0389	1.0363	1.0340	1.0318	1.0298	1.0280	1.0263
3.00	1.0587	1.0546	1.0508	1.0473	1.0441	1.0412	1.0385	1.0360	1.0337	1.0316
3.50	1.0700	1.0649	1.0602	1.0560	1.0521	1.0485	1.0453	1.0423	1.0396	1.0370
4.00	1.0818	1.0756	1.0699	1.0648	1.0602	1.0506	1.0521	1.0486	1.0454	1.0425
4.50	1.0941	1.0866	1.0799	1.0739	1.0685	1.0635	1.0591	1.0550	1.0513	1.0479
5.00	1.1069	1.0980	1.0902	1.0831	1.0768	1.0712	1.0660	1.0614	1.0571	1.0533
5.50	1.1201	1.1089	1.1006	1.0926	1.0853	1.0789	1.0730	1.0678	1.0630	1.0587
6.00	1.0339	1.1218	1.1113	1.1021	1.0939	1.0866	1.0800	1.0741	1.0688	1.0640
6.50	1.0480	1.1342	1.1222	1.1117	1.1025	1.0943	1.0870	1.0805	1.0746	1.0693
7.00	1.1624	1.1467	1.1332	1.1214	1.1111	1.1020	1.0943	1.0867	1.0803	1.0745
7.50	1.1770	1.1593	1.1442	1.1311	1.1197	1.1097	1.1008	1.0929	1.0859	1.0796
8.00	1.1917	1.1719	1.1551	1.1407	1.1282	1.1172	1.1075	1.0990	1.0913	1.0845