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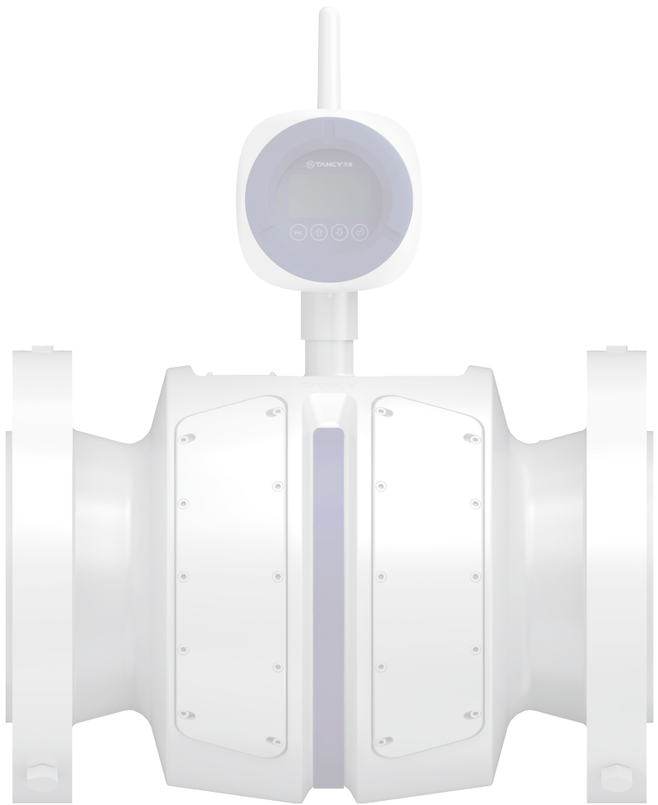
TUS Ultrasonic Gas Meter

Operating Instruction Manual

Tancy Instrument Group Co.,Ltd.



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1、General Introduction

With independent intellectual property rights, TUS ultrasonic gas meter is featured with high precision, reliability and stability. The product meets different users' demand with its multiple soundtrack layouts and supporting of multiple communication modes. The meter is equipped with built-in temperature sensor which measures temperature inside pipes and automatically corrects the expansivity of meter's housing so as to avoid the measuring inaccuracy caused by thermal expansions and contractions of meter's housing.

Based on the international standard ISO 17089, the US standard AGA9 and national standard GB/T 18604, being an ideal meter for users to achieve measurement with high precision and reliability, the product is suitable for utilizing in the long distance pipeline, city combustion gas, petroleum, chemical, electrical, and metallurgical industries.

2、Key Feature

Soundtrack Layout

The meter provides two types of layout including 6 and 8 soundtracks for users' selections and demands.

Structure Feature

Designed as full bore without any moving mechanical components and pressure loss, the meter is able to do bidirectional measurement.

Diameter Range

DN80 ～ DN1200 (3" ～ 48")

Ultrasonic Transducer

Made of Titanium alloy, the housing can effectively enhance the corrosion resistance of ultrasonic transducer and suppress reverberation with high sensitivity, high impedance and maximum working pressure up to 40 MPa.

Temperature Compensation

A temperature sensor is installed inside the meter to automatically correct the expansivity of the housing.

Cloud Service

With wireless communication technology, the meter can upload date to cloud platform to facilitate user's management on product life cycle.

Self-diagnostics

The meter can help users analyze meter's running state fast and accurately by collecting and diagnosing data, or analyze abnormalities by downloading historical data of product life cycle from cloud platform.

3、Operating Principle and Structure

3.1 Operating Principle

The ultrasonic gas meter measures the relation between the time of acoustic wave propagation in flowing medium and flow rate, which is its operating principle. Generally, the actual velocity of acoustic wave propagating in gas flow can be calculated by the component of the velocity of acoustic wave propagating in stationary medium (Cf) and average axial velocity of flow (Vm) on the propagation direction of acoustic wave. Picture 1 has shown the relation among propagation time of downstream as well as upstream and all variables.

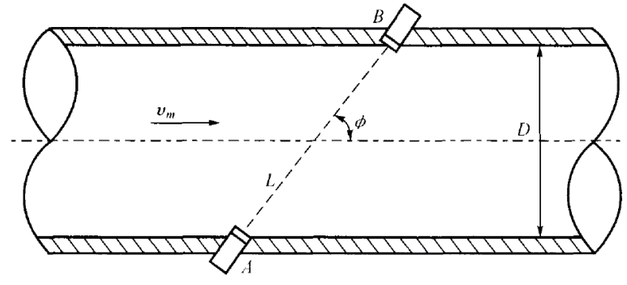
$$t_{down} = t_{AB} = \frac{L}{(C_f + V_m \cos\phi)} \qquad t_{up} = t_{BA} = \frac{L}{(C_f - V_m \cos\phi)} \qquad (1)$$

In formula:

t_{up}——The time that acoustic wave propagates upstream in gas flow　　V_m——Average axial velocity of flow

t_{down}——The time that acoustic wave propagates downstream in gas flow　　ϕ——Soundtrack angle

C_f——The velocity that acoustic wave propagates in gas flow



Picture 1 Operating Principle

The representation of flow can be figured out by formula 1.

$$V_m = \frac{L}{2\cos\phi}\left(\frac{1}{t_{down}} - \frac{1}{t_{up}}\right) \qquad (2)$$

The estimated value of average velocity of pipeline ($\bar{V}$) can be figured out by combining velocities of flow in different soundtracks V_i ($i = 1,2, k$) together into functional relationship. Then, the q_v can be calculated by multiplying with overflow area (A).See Formula 3.

$$q_v = A\bar{V} \qquad \text{Formula 3}$$

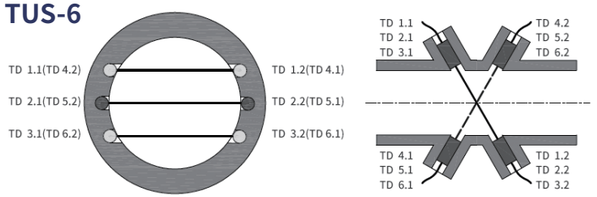
In formula:　　$\bar{V} = f(V_1, \cdots, V_k)$　　Formula 4

K is the quantity of soundtrack.

3.2 Soundtrack Layout

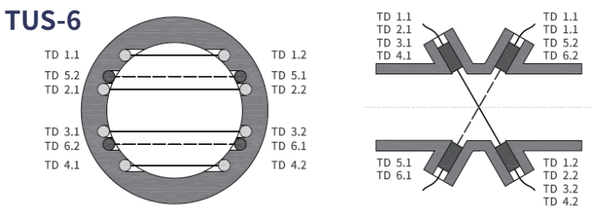
TUS ultrasonic gas meter provide several soundtrack layout for user to select according to actual demand. Picture 2 is the soundtrack layout of TUS ultrasonic gas meter.

TUS-6



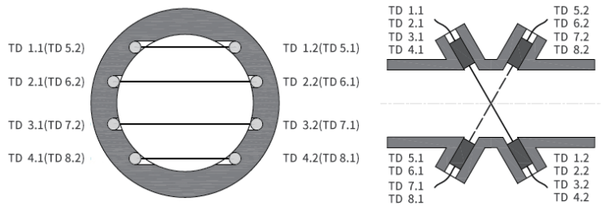
6 soundtracks arranged by symmetric cross reflection suits for the ultrasonic gas meter with diameter of DN 80 and DN 100. Reliable 6 soundtracks can monitor the flow pattern inside pipe and provide adequate measuring accuracy,which meets the demand of most users.

TUS-6



6 soundtracks arranged by asymmetric cross reflection suits for the ultrasonic gas meter with diameter over DN 150. Reliable 6 soundtracks designed with more soundtrack surface further enhance the measuring accuracy, which meets the demand of users with higher request of measuring accuracy.

TUS-8

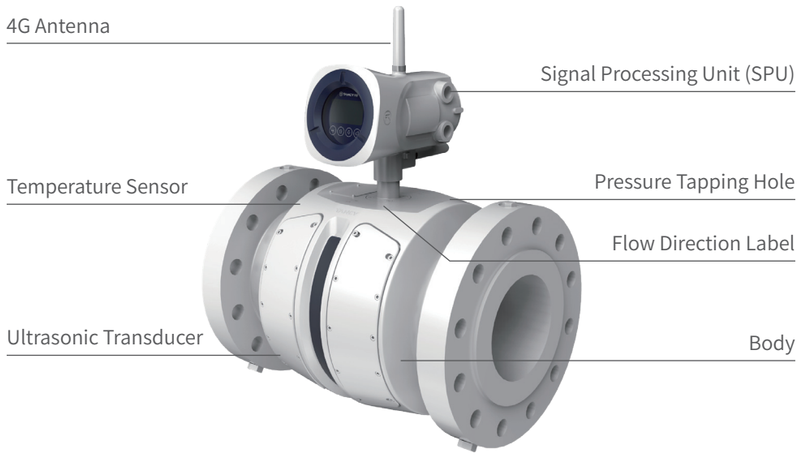


8 soundtracks arranged by symmetric cross reflection suits for the ultrasonic gas meter with diameter over DN 150. The meter has the highest measuring accuracy and can better monitor the flow pattern. The impact of flow change inside pipe on the measurement is also minimized. Being the first choice of high-end users, the meter suits for the place which requires high accuracy and short section of straight pipe in both former and latter part of the meter, which can be utilized as inspection meter.

Picture 2 Soundtrack Layout of Ultrasonic gas meter

3.3 Main Structure

TUS ultrasonic gas meter consists of meter body, SPU, ultrasonic transducer, temperature sensor and telecommunication module(option on request).



Picture 3 Structure of TUS Ultrasonic Gas Meter

3.3.1 Body Assembly

Flanges are installed in the former and latter part of body. The body material depends on the demand of customer, including carbon steel, low temperature carbon steel and stainless steel.

3.3.2 SPU

Protected by an explosion protection shield, SPU processes all the signals came from ultrasonic transducer and temperature sensor. Additionally, SPU is equipped with different interfaces, which is utilized to process signal output, meter diagnosis, and DCS or SCADA communication.

3.3.3 Ultrasonic Transducer

Made of Titanium alloy, the housing can effectively enhance the corrosion resistance of ultrasonic transducer and suppress reverberation with high sensitivity, high impedance and maximum working pressure up to 40 MPa.

3.3.4 Temperature

Installed inside meter, temperature sensor can automatically correct meter’s expansivity by monitoring temperature of meter’s body to improve the measuring accuracy of meter under different working condition.

⚠ **Caution: temperature sensor must not serve as a transducer of volume flow.**

3.3.5 Telecommunication Module (Option on Request)

TUS ultrasonic gas meter is equipped with IoT technology, which can achieve remote data telecommunication.
After receiving the data transmitted through Internet, the cloud platform will examine and analyze the data, which can facilitate users to check current working condition of the meter so as to achieve the remote monitor and malfunction diagnosis. Users can also comprehensively analyze meter’s operating state by historical data of meter’s life cycle downloaded from cloud platform.

4、Technical Specification

4.1 Sheet 1 is the detailed technical specification of TUS ultrasonic gas meter.

Sheet 1

Technical Specification of TUS Ultrasonic Gas Meter			
Type		TUS-6	TUS-8
Soundtrack Qyt’		6	8
diameter	mm	DN80 ～ DN400，other sizes depending on requests	DN150 ～ DN400，other sizes depending on requests
	inch	3" ～ 16"，other sizes depending on requests	6" ～ 16"，other sizes depending on requests
Measuring Principle		超声波时差法测量	
Measuring Medium		天然气	
Repeatability		⩽ 0.05%	
Accuracy		0.5 级、1.0 级	
Pipe Requirement	with rectifier	Former straight length ⩾ 5D, latter straight length ⩾ 3D	
	without rectifier	Former straight length ⩾ 10D, latter straight length ⩾ 5D	
Medium Temperature		–40°C～ +110°C	
Operating Pressure		0.5MPa ～ 16MPa，the maximum 40MPa on request	
Pressure Level		Optional 2.5MPa,5.0MPa,10.0MPa 和 16.0MPa	
IP Protection		IP67	

Temperature Condition	
Environmental Temperature	-40°C～ +70°C
Storage Temperature	-20°C～ +50°C
Relative Humidity	⩽ 95%，without condensation

Standard Compliance and Licence	
Standard Compliance	OIML R 137-1&2:2012 OIML D 11:2013 GB/T 18604-2014 JJG 1030-2007 ISO 17089-1 AGA-Report No. 9 MID: 2014/32/EU PED: 2014/68/EU ATEX: 2014/34/EU RED: 2014/53/EU GOST 8.611-2013 GOST 8.733-2011
Explosion-proof Level	Ex d ia IIB+H2 T6 Gb

Interface		
Analog Output (AO)	2	4mA ～ 20mA，electrical isolation
Analog Input (AI)	2	4mA ～ 20mA
Digital Output	4	• 2 status output, 2 pulse output f_{max} = 10kHz，⩽ 30 Vd.c.,50 mA • Negative push-pull output, with electrical isolation
Communication interface	RS485	3 个 RS485 接口，ModBus RTU
	Ethernet	1 个以太网接口，MQTT TCP/IP
	Remote Communication	4G

Electrical Connection		
Voltage	applied voltage	Electrical isolation 24±4 Vd.c.@0.75A
power waste		2.8W in average (6W during 4G communication)

Data Storage		
Data	Meter	• 7200 data record per minute • 10000 data record per hour • 5000 data record per day
	Cloud	• 7200 data record per minute in one day on request • 10000 data record per hour in one day on request • limitless data record per day
Log	Meter	• 10000 Event Logs • 10000 Alarm Logs
	Cloud	• limitless Event Logs • Limitless Alarm Logs

4.2 Flow Range

Sheet 2 shows the flow range of TUS ultrasonic gas meters.

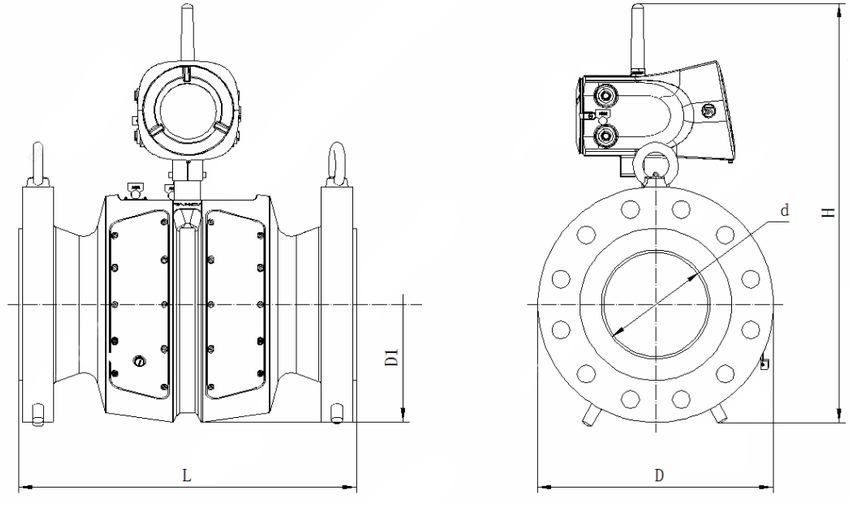
Sheet 2

NPS	DN	q_{min_ex} (m^3/h)	q_{min} (m^3/h)	q_t (m^3/h)	q_{max}(m^3/h)	q_{max_ex}(m^3/h)
3″	80	4.5	7.5	40.0	530.0	633.0
4″	100	7.7	12.0	70.0	900.0	1072.0
6″	150	16.6	30.0	80.0	2000.0	2328.0
8″	200	29.0	50.0	145.0	3400.0	4064.0
10″	250	46.8	80.0	230.0	5500.0	6558.0
12″	300	61.8	100.0	310.0	7200.0	8657.0
14″	350	81.5	135.0	405.0	9500.0	11412.0
16″	400	106.9	180.0	535.0	12500.0	14966.0

Meters over 18″ (DN450) are custom products.
Meters with extended minimum flow rate (qmin_ex) are custom products.
Meters with extended maximum flow rate (qmax_ex) are custom products.

5、Types and Installation

5.1 External Dimension



Picture 4 External Dimension

5.2 External Dimension Sheet of TUS Ultrasonic Gas Meter

Sheet 3-1

Dimension		Class150/PN20				
Inch	DN	L(mm)	H(mm)	D(mm)	D1(mm)	d(mm)
3”	DN80	240	545	190	212	73
4”	DN100	300	577	230	249	95
6”	DN150	450	642	280	212	140
8”	DN200	600	713	345	419	185
10”	DN250	750	770	405	578	235
12”	DN300	900	827	485	501	270
14”	DN350	1050	859	535	550	310
16”	DN400	1200	865	595	623	355

Sheet 3-2

Dimension		Class300/PN50				
Inch	DN	L(mm)	H(mm)	D(mm)	D1(mm)	d(mm)
3”	DN80	240	555	210	212	73
4”	DN100	300	590	255	249	95
6”	DN150	450	662	320	212	140
8”	DN200	600	730	380	419	185
10”	DN250	750	790	445	578	235
12”	DN300	900	827	520	501	270
14”	DN350	1050	871	585	550	310
16”	DN400	1200	892	650	623	355

Sheet 3-3

Dimension		Class600/PN110				
Inch	DN	L(mm)	H(mm)	D(mm)	D1(mm)	d(mm)
3”	DN80	240	555	210	212	73
4”	DN100	300	600	275	249	95
6”	DN150	450	680	355	212	140
8”	DN200	600	750	420	419	185
10”	DN250	750	823	510	578	235
12”	DN300	900	847	560	501	270
14”	DN350	1050	882	605	550	310
16”	DN400	1200	909	685	623	355

Sheet 3-4

Dimension		Class900/PN150				
Inch	DN	L(mm)	H(mm)	D(mm)	D1(mm)	d(mm)
3”	DN80	320	570	240	212	73
4”	DN100	300	607	290	249	95
6”	DN150	450	692	380	212	140
8”	DN200	600	775	470	419	185
10”	DN250	750	840	545	578	235
12”	DN300	900	872	610	501	270
14”	DN350	1050	899	640	500	310
16”	DN400	1200	919	705	623	355

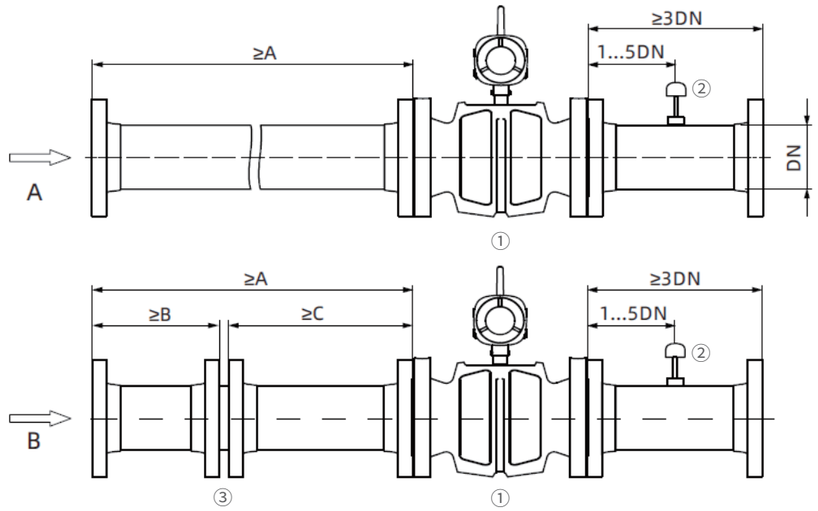
5.2 Installation

5.2.1 Mechanical Installation

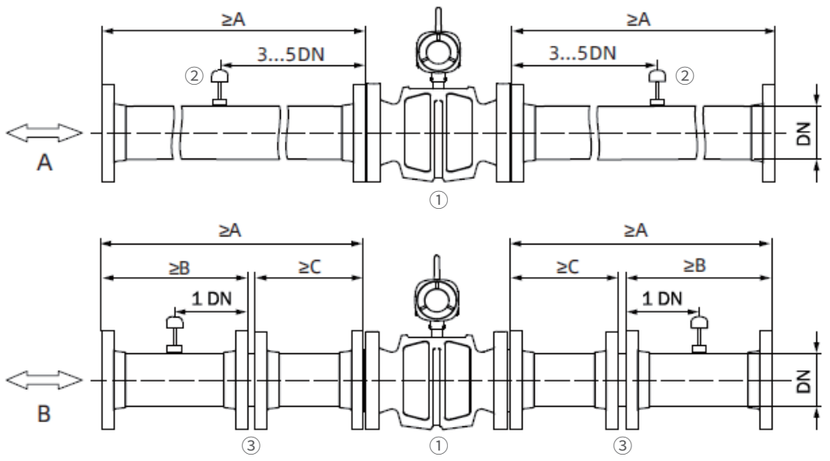
TUS ultrasonic gas meter is placed tightly in wooden case. After open the case, the meter shall be moved to installation site by connecting lifting eyes in two ends of meter with lifting equipment and be installed in accordance with design requirement. The installation requirement of upstream and downstream shall be followed during installation in order to ensure the best operation of meter.

- When connecting meter with flange, pipe flange, bolt and gasket shall satisfy maximum operating pressure, maximum operating temperature and environment as well as utilization requirement of meter.
- The nominal diameter of pipeline must comply to that of measuring body, while the internal diameter of pipeline must comply to that in data sheet and the deviation of internal diameters of pipeline and measuring body shall be controlled within 3%.
- The possible existing welding slag and bulge in the inlet-end of flange shall be smoothed.
- TUS ultrasonic gas meter can be installed horizontally and vertically. When horizontally installed, the measuring body of the meter shall be kept in horizontal position. Vertical installation can only be utilized in measuring dry gas without condensate.
- The gas flow must not contain any foreign object, dirt and liquid, otherwise a filter or depositor must installed.
- Any devices disturbing gas flow shall not be installed before TUS ultrasonic gas meter.
- Lifting eyes are only designed to transport the meter. Any other load on it is unacceptable.
- During transportation, TUS ultrasonic gas meter shall not be swung or tilted when lifted by lifting equipment.
- It is not allow to bind SPU or other positions of TUS ultrasonic gas meter to lifting equipment.
- During transportation, the SPU and flange sealing face shall not be collided.
- Flow direction is marked on TUS ultrasonic gas meter. When meter operating unidirectionally, TUS ultrasonic gas meter shall be installed to pipeline on the basis of the direction of arrow sign; when meter operating bidirectionally, the arrow sign shall mark the forward direction of gas flow.
- More installation requirement can be seen in *GB50540-2009 Code for Construction of Pipe Process in Oil and Gas Transmission Pipeline Station.*

⚠ **Warning: please ensure that lifting equipment is able to bear the weight of meter in case of accident. (the weight of meter is marked in the nameplate)**



Picture 5-1 Installation Instruction on Operating Unidirectionally



Picture 5-2 Installation Instruction on Operating Bidirectionally

① TUS Ultrasonic Gas Meter；② Temperature Measuring Point；③ Installation Position of Rectifying Plate

Sheet 4

Pipe Configuration		Configuration A	Configuration B		
Soundtrack	Accuracy	A	A	B	C
6	1.0	10DN	8DN	3DN	5DN
6	0.5	20DN	15DN	5DN	10DN
8	0.5	10DN	8DN	3DN	5DN

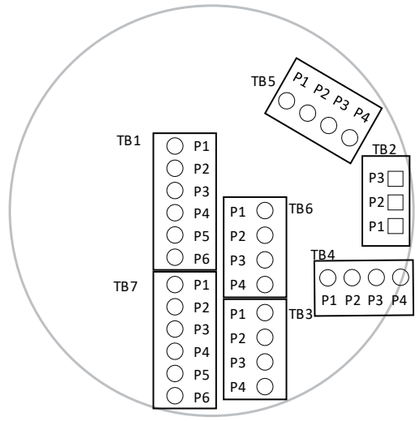
5.2.1 Electrical Installation

Meter’ s SPU is equipped with 4 electrical connection holes with sealing plugs.
Armored cables or cables with shielding layers are recommended during connection so as to effectively avoid interference of signal. Additionally, the requirement of length, diameter and inner core resistance is shown in Sheet 5.

⚠ Warning: Cables with insulation shield is strongly recommended. It is also recommended to charge meter with UPS power supply.

Sheet 5

Power Cord	
Minimum/Maximum Cross Section of Cable	0.5mm^2/2.5mm^2
Applied Voltage	24±4 Vd.c.
Power	20 W
Signal Communication Cable	
Minimum/Maximum Cross Section of Cable	0.5mm^2/1mm^2



Picture 6 TUS Electrical Interface

Sheet 6

Connector	Pin	Definition	Function
TB1	P1	RS485A+	Circuit A RS485 Communication Interface Signal, Positive
	P2	RS485A-	Circuit A RS485 Communication Interface Signal, Negative
	P3	RS485B+	Circuit B RS485 Communication Interface Signal, Negative
	P4	RS485B-	Circuit B RS485 Communication Interface Signal, Positive
	P5	RS485C+	Circuit C RS485 Communication Interface Signal, Negative
	P6	RS485C-	Circuit C RS485 Communication Interface Signal, Positive
TB2	P1	Power+	24V Positive Pole of Power Supply
	P2	Power-	24V Negative Pole of Power Supply
	P3	Earth	Ground Wire/Body Wire
TB3	P1	CurrentInA+	Circuit A 4-20mA Analog Input Signal, Positive
	P2	CurrentInA-	Circuit A 4-20mA Analog Input Signal, Negative
	P3	CurrentInB+	Circuit B 4-20mA Analog Input Signal, Positive
	P4	CurrentInB-	Circuit B 4-20mA Analog Input Signal, Negative

TB4	P1	V12OutA+	A Circuit 12V Signal Output, Positive
	P2	V12OutA-	A Circuit 12V Signal Output, Negative
	P3	V12OutB+	B Circuit 12V Signal Output, Positive
	P4	V12OutB-	B Circuit 12V Signal Output, Negative
TB5	P1	Ethernet TX-	Ethernet Data Transmission Signal, Negative , Orange
	P2	Ethernet TX+	Ethernet Data Transmission Signal, Positive , White Orange
	P3	Ethernet RX-	Ethernet Data Receiving Signal, Negative , Green
	P4	Ethernet RX+	Ethernet Data Receiving Signal, Negative , White Green
TB6	P1	CurrentOutA+	Circuit A 4-20mA Analog Output Signal, Positive
	P2	CurrentOutA-	Circuit A 4-20mA Analog Output Signal, Negative
	P3	CurrentOutB+	Circuit B 4-20mA Analog Output Signal, Positive
	P4	CurrentOutB-	Circuit B 4-20mA Analog Output Signal, Negative
TB7	P1	PulseA+	Circuit A Output Signal of Flow Pulse, Positive
	P2	AlarmA+	Circuit A Alarm Signal, Positive, Alarm Type depending on Software Configuration
	P3	PulseB+	Circuit B Output Signal of Flow Pulse, Positive
	P4	AlarmB+	Circuit B Alarm Signal, Negative, alarm type depending on software configuration
	P5	Gnd	Digital Output Signal Gnd, shared with other interfaces of TB 7
	P6	PullUpInput	Power Supply Input of Push-pull Output of Digital Signal, Maximum Input Voltage 24V, shared with otherinterfaces of TB7

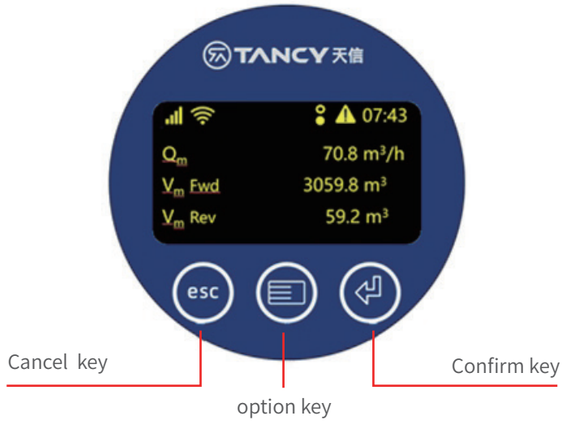
6、Using Instruction

The OLED screen on SPU can show current measuring value, alarm information and diagnosis information. The meter is equipped with SmartLink®, which can read and show the current information of measuring and operating status. At the same time, it also can configure the parameter of meter.

6.1 OLED Screen

Picture 7 shows that OLED screen consists of three parts including status bar, information bar and button bar.

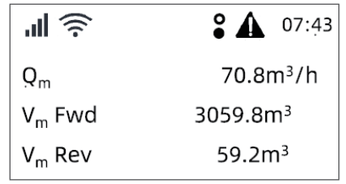
- Status Bar: shows 4G signal, Wi-Fi signal, alarm prompt and current time.
- Information Bar: shows the information of meter.
- Button Bar: including 3 buttons, Esc, Select and Enter from left to right respectively.



Picture 7 User Interface

6.2 Main Page

In Picture 8, Main page shows flow rate , forward cumulative volume and reverse cumulative volume under working condition.



Picture 8 Main Page

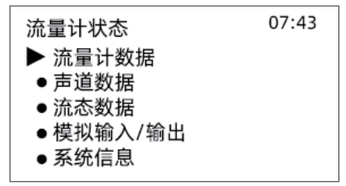
6.3 Main Menu

The main menu can be entered by pressing Enter button in main page. Picture 9 shows main menu.

Picture 9 Main Menu

► Meter Status

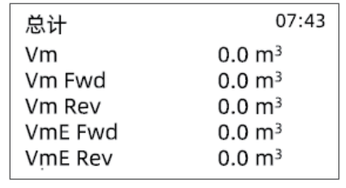
In Picture 10, meter status menu shows the data of meter, soundtracks, flow pattern, analog input and output, and system information.



Picture 10 Meter Status Menu

► Total Data Menu

In Picture 11, total data menu shows cumulative volume under working condition, cumulative forward and reverse volume and cumulative forward and reverse volume of malfunction.



Picture 11 Total Data Menu

► Configuration Menu

In Picture 12, Configuration menu shows the configuration of Ethernet, communication interface, analog input, analog output and meter parameters.

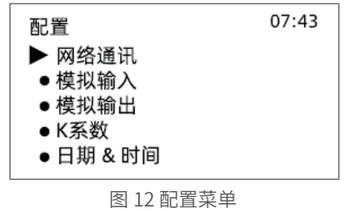


图 12 配置菜单

- Alarm Information Menu

  Alarm Information Menu shows working status of soundtrack, flow pattern, analog input and analog output.

- Language Menu

  In Picture 13, Language can be set between English and Chinese.

Picture Language Menu

6.4 SmartLink® Software

SmartLink software is utilized to configure meter and monitor working status of meter.

Picture 14 SmartLink® Software

In Picture 15, when any problem of meter occurs, users can apply the software function of data record (by pressing red button at lower right corner) to generate packet of diagnosis data for users themselves or factory to check meter’ s failure causes.

Picture 15 Record on Packet of Diagnosis data

Further information on SmartLink, please contact Goldcard-Tancy professional personnel.

7、Meter Cleaning

After long-term operation, the inwall and probe will be contaminated by impurity and dirt, which will affect measuring accuracy. The dirt and impurity at inwall and probe can be cleaned by compressed air or be wiped by clean soft cloth with alcohol. **Detergent containing with gasoline or corrosive detergent is not allowed to clean the meter.**

8、Meter Maintenance

Ultrasonic gas meter has no mechanical component inside and needs no lubrication. All malfunction status will be shown at OLED screen. Users can process relevant maintenance according to malfunction status or record data diagnosis files for factory personnel to assist maintenance.

9、Packing, Transport and Storage

- Meter shall be packed in tight wooden case, avoiding flipping inside case. Meter shall be handled with care and shall not be violently treated during loading and unloading.
- The transport and storage of meter shall accord with the request in GB/T25480 *Basic Environmental Conditions and Testing Methods for Instrument Transportation and Storage in the Transportation*.
- Storage Condition of Meter:

  a. avoiding rain and damp
  b. no mechanical vibration and impact
  c. temperature: -20℃～ +50℃
  d. less than 95% relative humidity
  e. no erosive gas in surrounding area

10、Open and Check

- The integrity of outside package shall be checked before opening; then the product and attachment papers inside case shall be checked on the basis of packing list.
- Attachment papers:

  a. Approved Certificate for Product
  b. Inspection Certificate
  c. Operating Instruction Manual
  d. Packing List

11、Order Instruction

11.1 During ordering, users need to select suitable specification of meter by fully considering the nominal diameter of pipes, maximum pressure of medium, medium temperature, flow range and environment.
11.2 Please filling in the type and specification correctly in accordance with following format during ordering.

TUS -□-□□□-□□□□□□□-□□-□□□□-□□-□

IoT:
- 4G
- N (Basic type with RS485 and Ethernet Communication)

Material:
- CS (Carbon Steel)
- SS (Stainless Steel)
- LC (Low Temperature Carbon Steel)

Schedule:
- SC40
- SC60
- SC80

Flange:
- RF (Raised Face)
- RJ (Ring Type Joint)

Class:
- CL150
- CL300
- CL600
- CL900

inch:
- 3
- 4
- 6
- 8
- 10
- 12

Number Path:
- 6
- 8

roduct No.

For example, a user needs an ultrasonic gas meter ① TUS ultrasonic gas meter; ② 6 number paths (soundtrack); ③ DN80(3″); ④ Pressure Class 600; ⑤ raised face flange ⑥ Schedule 40; ⑦ low temperature carbon steel of surface material; ⑧ 4G remote telecommunication; then filling in following format during selection.

TUS-6-3-CL600-RF-SC40-LC-4G