W-V1500 Vortex Flow Meter

User's Manual

3.2013

CONTENTS

Part I：Manual

1.Series

(W-V1500)series is suitable for oil,chemical industry,metallurgy,heating power,spinning,papermaking ,etc. Be use of control: over-heating vapor, saturation vapor, compressed air, ordinary air(oxygen, nitrogen, hydrogen, natural gas, coal gas ,etc),water and liquid (water, petrol , alcohol, benzene ,etc.)

2.Working Principle

Non-streamline vortex-maker be set in fluid （anti-flow part） ,then two regular vortex would be come out ,from two sides of the vortex-maker in turn，so this kind of vortex be called as Karman vortex street，Chart I as follow。

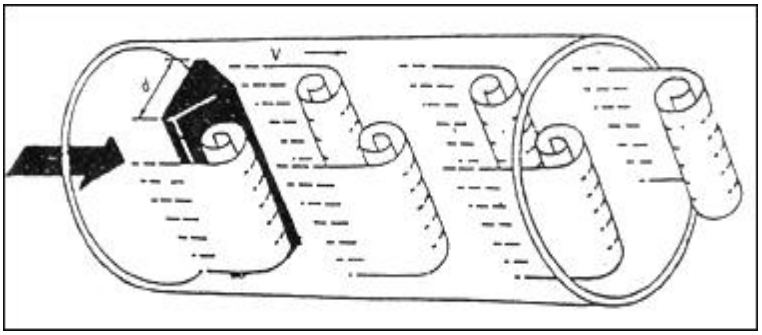


Chart I

Vortex is not flowing symmetrically under vortex-maker set .As if, set frequency of vortex is f,the speed of test medium is V,inlet face width of vortex-maker is d,Past part diameter is D，as the principle of Karman vortex street ,as follow:

$$f=StV/d \qquad (1)$$

Factor：

f—The Karman vortex street frequency which one side of vortex-maker

St—Strouhal number（dimensionless number）

V—mean flow rate

d—the width of vortex-maker

So, check the separate frequency of Karman vortex street to know the instant capacity(flow) .among, Strouhal number（St）is dimensionless number，

Chart II　Show the relation of, Strouhal number（St） & Reynolds number (Re)

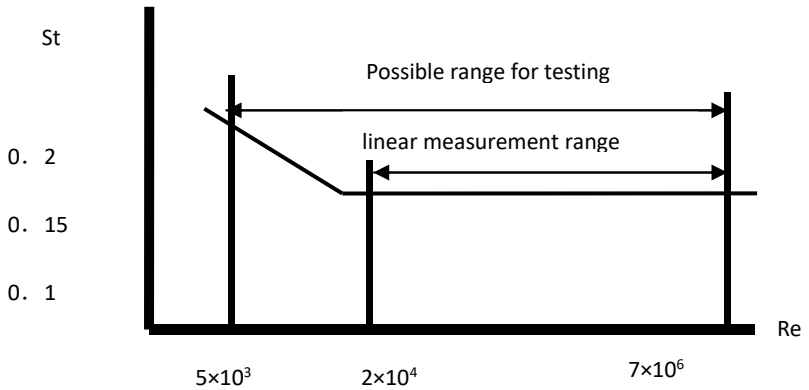


Chart II

Straightness part in curve(St=0.17),free frequency & flow rate of vortex is direct ratio, it means flow sensor range. so just check out frequency (f),we can get the flow rate inside pipe， then as the flow rate(V) to take volume flow, the ratio record of impulse & volume, called as（K），as follow（2）

K＝N/Q（1/m³） （2）

Model：K＝instrument constant（1/m³）.

N＝impulse number

Q＝volume flow（m³）

3. The key technical indexes

Inside nominal diameter (mm)	25，40，50，65，80，100，125，150，200，250，300，(300～1000 plug-in)
Nominal pressure (MPa)	DN25-DN200 4.0(>4.0 order by agreement)， DN250-DN300 1.6(>1.6 order by agreement)
Medium temperature (℃)	Piezoelectric type：-40～250，-40～320；Capacitance： -40～300, -40～400，-40～450（Order by agreement）
Noumenon	1Cr18Ni9Ti,(Order by agreement if need other material)
Vibrating acceleration	Piezoelectric type:0.2g Capacitance:1.0～2.0g
Range	±1%R，±1.5%R，±1FS；Plug-in：±2.5%R，±2.5%FS
Range degree	1：6～1：30
Service voltage	Sensor：+12V DC,+24V DC；Transmitter：+12V DC ,+24V DC；Battery supply feed：3.6V battery
Output signal	Square wave pulse (non- battery supply feed)：high level≥5V，low level≤1V；urrent：4～20mA
Loss coefficient	JB/T9249 Cd≤2.4
Anti-explosion sign	Ben-an type：ExdⅡia CT2-T5 anti-explosion type：ExdⅡCT2-T5
Protection grade	Ordinary type IP65 Dive type IP68
Environment condition	Tem-20℃～55℃,Relative humidity 5%～90%,Atm press 86～106kPa
Medium	Gas、Liquid、Vapor
Transmission range	Three-wire system flow sensor：≤300m，electric sign of two-wire system transmitter (4～20mA)：load resistance≤750Ω

Part II : Model selection & Installation of meter

It is important for selecting model, the key to use, so client must read this chapter carefully, and if find question, you can contact us.

I. Ensure the diameter of meter

According to the flow range to choose diameter. Different diameter hold different test range. Even if the same diameter, the test range is different if medium is not same. Practical test range must be confirmed by figure.

1.1 Flow range of air and water under reference condition，as chart II，reference condition as follow:

1)．Air：Normal Temp & press，t=20℃，P=0.1MPa（absolute pressure）,ρ=1.205 kg/m3，υ=15×10-6 m2/s.

2).Liquid： Normal temperature water,t=20℃，ρ=998.2kg/m3，υ=1.006×10-6m2/s.

1.2 Basic step to ensure diameter of meter and flow range：

1)．Working parameter clearly.

(a) Name & component of testing medium

(b) Min, Nor and Max capacity under working condition

(c) Min, Nor & Max Press & Temp of medium

(d) Viscosity of medium under working condition

2)． Meter test the flow capacity of medium under working condition, so as the technological parameter to know the flow capacity of medium under working condition, as follows：

(a) If know air capacity under standard condition, we can get the capacity which under working condition, as follow;

$$Q_v = Q_O \times \frac{0.101325}{0.101325 + P} \times \frac{273.15 + t}{293.15}$$ formula（3）

(b) If know air density under standard condition ρ，as follow;

$$\rho = \rho_o \times \frac{0.1\grave{0}1325 + P}{0.101325} \times \frac{293.15}{273.15 + t}$$ formula（4）

(c) Mass flow rate Qm charge to volume flow Qv

$$Qv = Q_m \times 10^3 / \rho$$ formula（5）

Among formula(5)：

Qv: Volume flow of medium under working condition (m3/h)

（Qv=3600f/K K: Coefficient of meter ）

Qo : Volume flow under standard condition(Nm3/h)

Qm: Mass flow rate (t/h)

ρ: Density of medium under working condition(kg/m3)

ρ_0: Density of medium under normal state(kg/m3)，common air medium density under normal state，as chart III

P: Gage pressure under working state (MPa)

t: Temp under working state(℃)

3). To ensure lower limit capacity. For the upper limit capacity of flow meter may be not counted under ordinary condition，so that just count its lower limit for choosing caliber. Shall meet two conditions：Minimum Reynolds number shall be not less than limited（Re=2×104）；for vortex street flow meter with stress type set, it take vortex intensity from lower limit capacity shall be more than limited sensor intensity（vortex intensity and lift force, as scaling relation as ρv2）. Relation as follow:

For density to test measurable lower limit flow：

$$Q_\rho = Q_O \times \sqrt{\rho_O / \rho}$$ formula (6)

For kinematic viscosity to test linear lower limit flow：

$$Q_\upsilon = Q_O \times \upsilon / \upsilon_O$$ formula(7)

medium：

Qρ: Meet request of vortex intensity, the minimum volume flow (m³/h)

ρ_0: Medium density under reference condition

Qu: Meet request of Min-Reynolds number, the minimum linear volume flow (m³/h)

ρ: The density of tested medium under working condition（kg/m³）

Q_0: Minimum volume flow of meter under working condition (m^2/s)

υ_0: Kinematic viscosity of medium under reference condition (m^2/s)

by means of formula（6）&（7）to come out Qρ& Qv: Compare with Qρ& Qv， to ensure measurable range of lower limit flow & linear lower limit flow :

Qυ≥Qρ：measurable range= Qρ～Qmax ， linear flow range= Qυ～Qmax

Qυ<Qρ：measurable range & linear flow range Qρ～Qmax

Qmax：upper limit volume flow (m^3/h)

4). The standard of upper limit flow ,See(II). gaseous upper limit flow velocity shall be less than 70m/s, liquid shall be less than 7m/s.

5). When tested gas is vapor，often use quality flow as unit of measurement quality flow， as ： t/h or Kg/h. because of vapor （overheating & saturated）,density would be changed under different temp & press， so to ensure the flow range, see (8)

$$Q_s = 1.5Qa \times \rho \times 10^3 \times \sqrt{\rho_o / \rho}$$ formula（8）

TIPS：

ρ: Density of vapor（kg/m³）

ρ_0: 1.205kg/m³

Q_s : Quality flow of vapor（t/h）

6)． For pressure loss， check the effect of reference condition (m^3/h)

υ: Kinematic viscosity of medium under

pressure loss to craft pipeline，(Unit：Pa)：

$\Delta p = Cd\rho V^2/2$ formula（9）

Tips：

Δp: Pressure loss（Pa）

Cd: Coefficient of pressure loss

ρ:Density of medium under working condition（kg/m³）

V：Mean flow rate（m/s）

7)． If tested medium is liquid, to avoid gasification and loss, shall make the press of pipeline as follow:

$p \geq 2.7\Delta p + 1.3p_0$ formula（10）

Tips：

Δp: Pressure loss（Pa）

p_0:Saturated vapor pressure of liquid which under working temperature.

（Pa absolute pressure）

Po: Fluidic vapor pressure

(Pa absolute pressure)

8)．Vortex street flow meter is not suitable for testing high viscosity liquid. if counted measurable lower limit flow is not suitable for designing, pls select and use other meter type..

9)．If as the counted parameter, the two or more kinds of meter can be used, then use less caliber, cheaper. Tips: as far as possible tested range during upper limit of about 1/2～2/3.

Table(I):Extent table of reference condition under working condition

Caliber (mm)	Liquid		Gas	
	Range(m^3/h)	Output frequency range (Hz)	Measurement range (m^3/h)	Output frequency range (Hz)
15	0.3～5	35～600	2.2～20	260～2000
20	0.6～10	29～420	4～36	210～1900
25	1.2～16	25～336	8.8～55	190～1140
32	1.8～20	18～264	10～150	156～1080
40	2～40	10～200	27～205	140～1040
50	3～60	8～160	35～380	94～1020
65	4～85	6～120	35～800	94～940
80	6.5～130	4.1～82	86～1100	55～690
100	12～220	4.7～69	133～1700	42～536
125	15～350	3.2～57	150～2000	38～475
150	20～450	2.8～43	347～4000	33～380
200	45～800	2～31	560～8000	22～315
250	65～1250	1.5～25	890～11000	18～221
300	95～2000	1.2～24	1360～18000	16～213
(300)	100～1500	5.5～87	1560～15600	85～880
(400)	180～3000	5.6～87	2750～27000	85～880
(500)	300～4500	5.6～88	4300～43000	85～880
(600)	450～6500	5.7～89	6100～61000	85～880
(800)	750～10000	5.7～88	11000～110000	85～880
(1000)	1200～1700	5.8～88	17000～170000	85～880
>(1000)	agreement		agreement	

Tips：above table the caliber (300)～(1000) is plug-in

Table(II):The density of common gas under normal state（0℃，absolute pressure P=0.1MPa）

Name	Density (kg/m^3)	Name	Density (kg/m^3)
Air(dry)	1.2928	Acetylene	1.1717
Nitrogen	1.2506	Ethylene	1.2604
Oxygen	1.4289	Propylene	1.9140
Argon	1.7840	Methane	0.7167
Ne	0.9000	Ethane	1.3567
Ammonia	0.7710	Propane	2.0050
Nydrogen	0.08988	Butane	2.7030
Carbon monoxide	1.97704	Natural gas	0.8280
Carbon dioxide	1.3401	Coal gas	0.8020

2. Design & installation

It is important to install meter，if not installed well, then would affect precision, use-life and damage.

2.1 Environmental request for installation:

1). To avoid strong current, high frequency and powerful switch set, power supply of meter shall be avoided to near by these equipment.

2). To avoid high-Temp & radiation source. if have to install it, need heat insulation & ventilated measure.

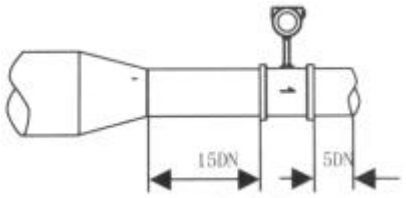
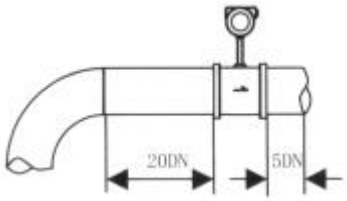
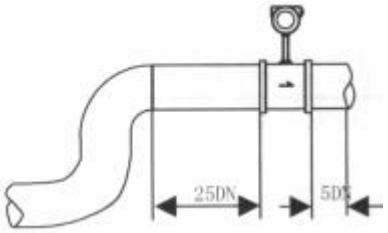
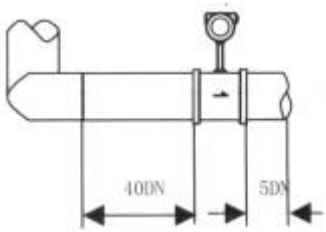
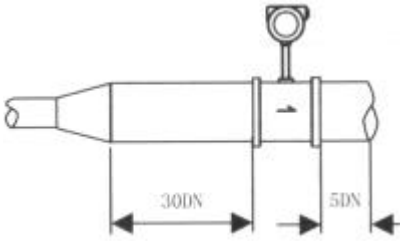
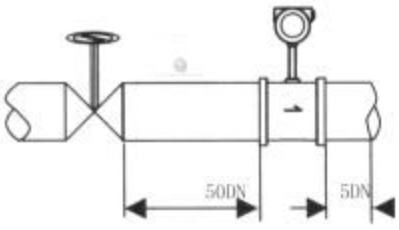
3). To avoid high-Temp & etchant gas, if have to install it, need ventilated measure.

4). Vortex street flow meter shall be avoided to install on shaking part of pipeline. if have to install on it，shall add clamp device and vibration pad which located on 2D to enhance shake proof . meter has better to installed indoors, pay attention to waterproof when installing meter outdoors， special notice the joint, make cable conductor to U shape to avoid water get into the amplifier body Around installing place shall save enough space，so that install connection line and maintenance routine.

2.2 Request for installation of pipeline meter：

1) .Vortex street-flow meter need a request for about installing point up-down stream pipe，if not flow field of medium will be affected in pipeline，refer to measurement accuracy of meter。up-down stream pipe of meter as chart(III)

DN is nominal caliber of meter UNIT: mm

Sensor upstream pipe type	Front and back straight pipe length	Sensor upstream pipe type	Front and back straight pipe length
Concentric contract opening-valve		90 degree elbow	
Two 90 degree Elbow which on a same plane		Two 90 degree Elbow which not on a same plane	
Concentric expanded pipe		Control valve half open the vale (not recommend)	

chart(III)

Tips: control valve shall not install on upstream of meter, it better to the downstream 10D.

2). Up-down internal diameter of pipe shall be same. if not，than internal diameter of pipe Dp and vortex street meter inner diameter Db, shall be as follow

$$0.98Db \leq Dp \leq 1.05Db$$

Up-down internal diameter of pipe shall be concentric with inner diameter of flow meter，The non- axiality

shall be less than 0.05Db.

3). Sealing gasket which between meter with flange，can not joint inside pipe when installing，and its inner diameter shall more than meter `s about 1~2mm.

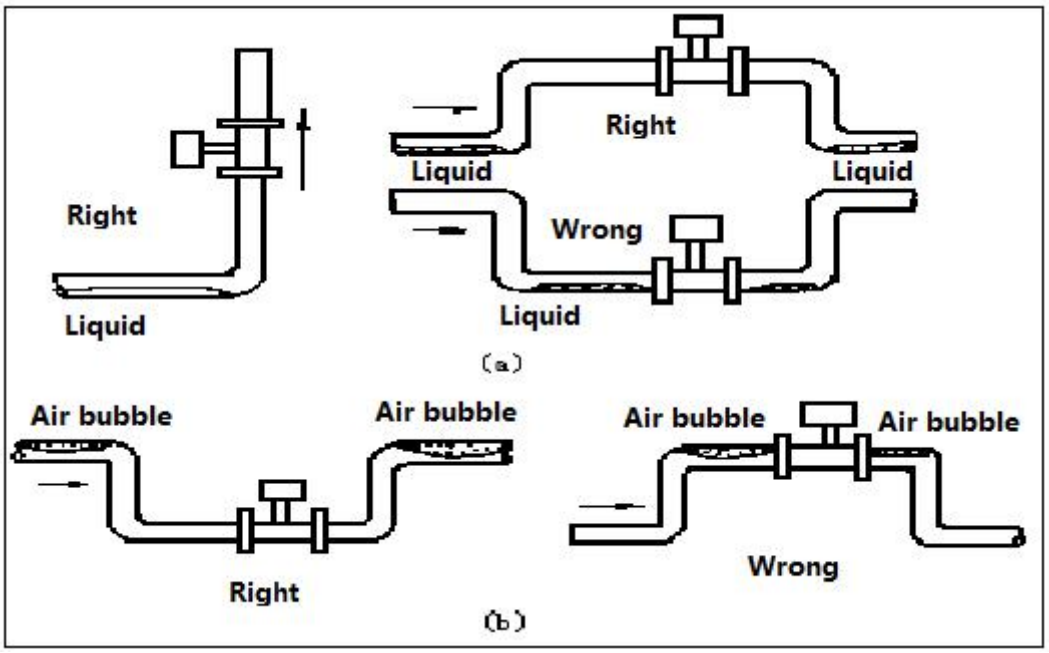
4). Design for temp & press point. When test pipeline need install temp & pressure transmitter，pressure tap may be downstream of 3-5D，thermometer hole may be downstream of 6-8D，see chart（VII）。D is nominal caliber，Unit：mm.

5). Meter can be installed by horizontal, vertical and bias ways on pipeline.

6). When test air, gas can flow anywhere when under uptake pipe to install. if there some air inside pipe ,to prevent liquid into the test pipe，so the air may from below to top, as list（IV）a.

7). When test for liquid， to ensure pipeline filled full， so install meter under vertical or bias working condition，shall ensure liquid flow from below to top。If there are some air inside of pipeline，meter may be installed under pipeline to prevent air into it.

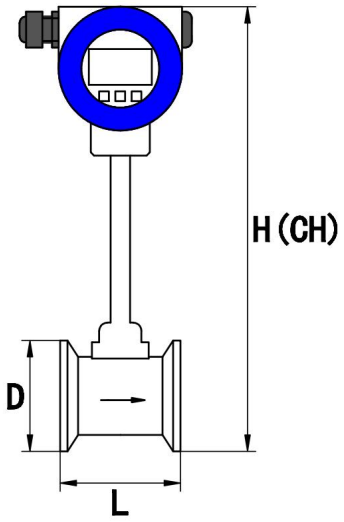
As chart（IV）as follow:



8). when test high& low temp medium，may pay attention to heat preservation. inside changer（inside body of gauge outfit）must be not more than 70℃；if low temp inside will produce water into meter and reducing insulation.

2.3 Overall dimension installation of meter：SEE（V）&（VI）

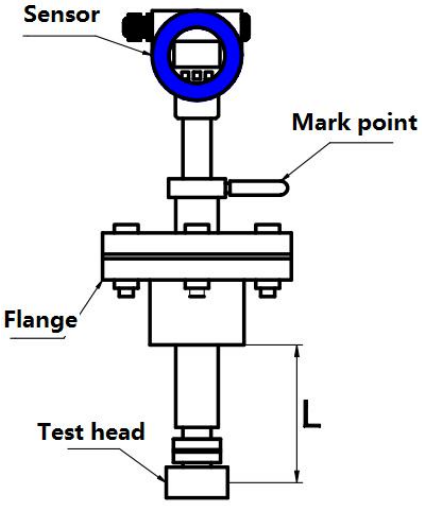
2.3.1 Flange wafer type vortex flowmeter

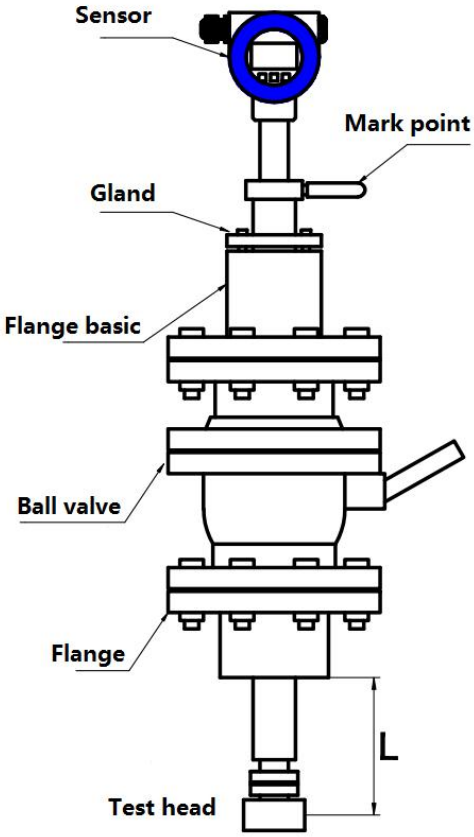


DN （mm）	L	D	H	CH
15~25	70/90	54	325	385
32	85	69	325	385
40	85	79	325	385
50	85	89	330	390
65	85	104	340	400
80	90	119	360	420
100	90	139	380	440
125	95	168	405	465
150	100	194	430	490
200	102	248	485	545
250	115	300	540	600
300	130	350	590	650

Chart（V）

2.3.2 Plug-in vortex flow meter





Chart（VI）

DN (mm)	DN250	DN300	DN400	DN500	DN600	DN800
L （mm）	125	150	200	250	300	400

2.4 The steps of installing plug-in vortex street meter:

1). Use gas welding to get a near ϕ100mm circular hole， and clear it so that make the measuring head would be work fine.

2). The flange which from manufacturer would be burned-on round hole of pipeline.

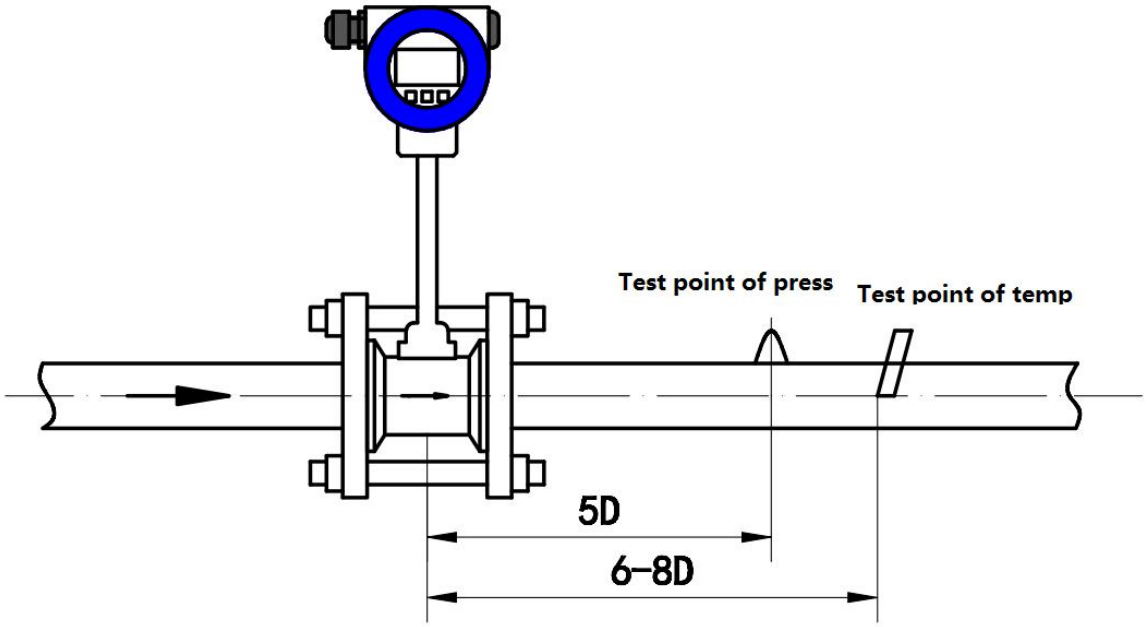
3). Take ball valve and sensor install on the flange.

4). Balance screw, so that insertion depth is pass muster(ensure central axis dead in line between test head with pipeline), fluid flow direction must be stay the same with arrows.

5). Balance gland screw.(Notice: lead screw swirl and seal degree is decided to gland screw elasticity)

6). Check every steps, opening valve slowly to ensure leakage (take care of body), if find leakage, do step 5,6 once more.

2.5 Pt100 installing sketch map of PT100 and pressure transmitter



Part III: Parameter set

1.Button 1 S, button 2 +, button 3 <, button 4 ENTER(E)

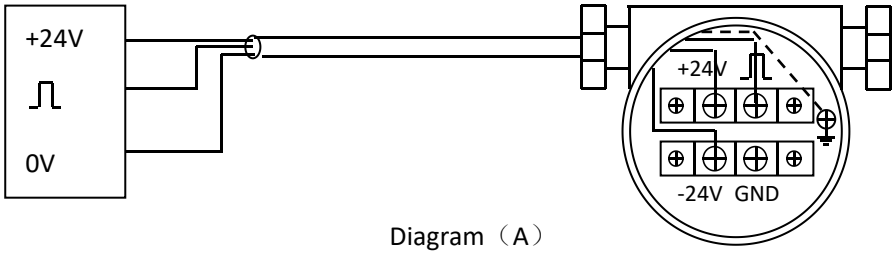
Press button 1 S, the LCD will display input password, press button 4 E to enter the password input status. Press three times button 2 +, < password shows to be xxxx, and press button 4 E to determine the password. And then switch the parameter menu by pressing (button 2 +)/(button 3 <), and then switch to the need to modify the parameter, press button 4 E to enter the modified status (the black box is the item needed to modify), if it is a numeric parameter, to modify the number of the cursor by pressing button 2 +, to move the cursor position through pressing button 3 <; If the parameter is optional type, press button 4 E into modify status to modify the item (the black box is the item needed to modify), the item can be modified through (button 2 +)/(button 3 <) .After the modification, press button 4 E for 3 seconds to confirm the input, the circuit board automatically updates the setting parameter and store. After all the parameters were modified, press button 1 S to return to the first order menu.

Menu No.	Menu display	Meaning	Options or Value Scope
1	Algorithm selection	Algorithm selection	0：The volume flow of the standard gas 1.Normal gas mass flow (the fluid density set into standard condition density) 2.Saturation steam temperature compensation 3.Saturation steam pressure compensation 4.Overheat steam temperature and pressure compensation 5.Normal volume flow (the working condition flow regardless of gas or liquid) 6.Normal mass flow (the density of fluid set into working condition density)
2	Unit option (Selected intelligently according to mass or volume)	Flow unit option (When the algorithm selection is 0, the selected unit automatically adds N to the standard flow unit)	0：m3/h 1：t/h or kg/h 2：t/h or kg/h 3：t/h or kg/h 4：t/h or kg/h 5：m3/h 6：t/h or kg/h
3	Flow factor K [P/m3]	Flow factor	Flow factor setting
4	Full output flow (the same as set on the system)	Full output flow	This value has to be set, and it can not be set to be 0, Its unit has to be in line with the unit of flow, the instant flow exceeds the full flow.
5	Density setting kg/m3	Density setting	The unit of both algorithm 1 and 6 has to be set kg/m3, 0 is not allowed.
6	Temperature setting ℃	Present temperature	When choose algorithm 2,3,4 temperature sensor or pressure sensor has to be installed, pressure parameter has to be set manually.
7	Absolute pressure setting kPa	Present absolute pressure 0 is not allowed	
8	Low cut-off flow %	Percentage of set cut-off flow and full flow	Value 0~20
9	Cumulative flow zero clearing	Cumulative flow zero clearing	If zero clearing is needed, just press right button.
10	485 address	485 address	0~31
11	HART address	HART address	0~31
12	Code input	Modify code for entering parameter menu	Default XXXX, which can be modified by user.

Part IV: Wiring design

1. Three-wire frequency output vortex flowmeter wiring design

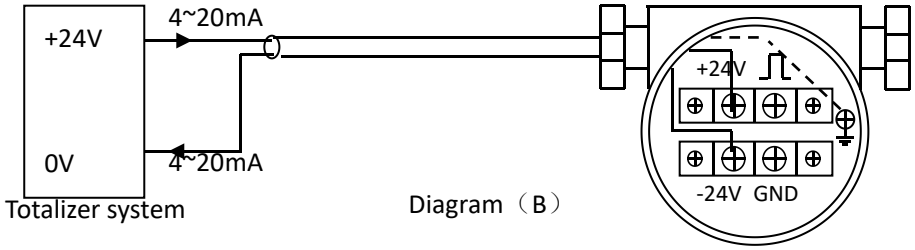
Three-wire frequency output flow transmitter adopted DC24V power supply or DC12V power supply, usually connected with indicated converter or computer by three-core shielded cable (RWP3 x 0.5 mm), shielding layer should be reliably connected with the grounding screw on the enclosure of amplifier. The selection of shielding cable should be suitable for the on-site condition, and the shielding cable should be separated from other stronger power wires and parallel-wired is not allowed. Transmitter terminals wiring diagram (A)



Diagram（A）

2. Two-wire 4-20mA output vortex flowmeter wiring design

Two-wire 4-20mA output flow transmitter adopted DC24V power supply, usually connected with indicated converter or computer by two-core shielded cable (RWP2 x 0.5 mm), shielding layer should be reliably connected with the grounding screw on the enclosure of amplifier. The selection of shielding cable should be suitable for the on-site condition, and the shielding cable should be separated from other stronger power wires and parallel-wired is not allowed. Transmitter terminals wiring diagram (B)



Diagram（B）

3. RS485 communication vortex flowmeter wiring design

RS485 communication vortex flow meter adopted DC24V power supply, adopted four-wire transmission method.Transmitter terminals wiring diagram (C)

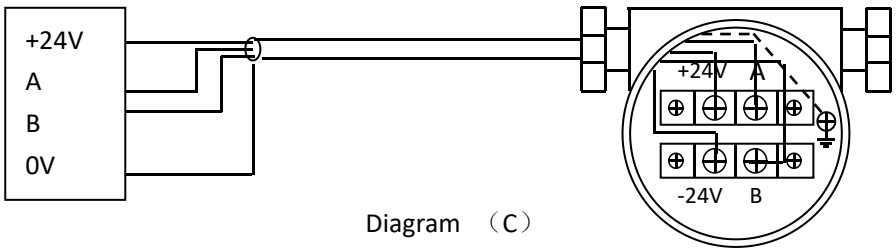
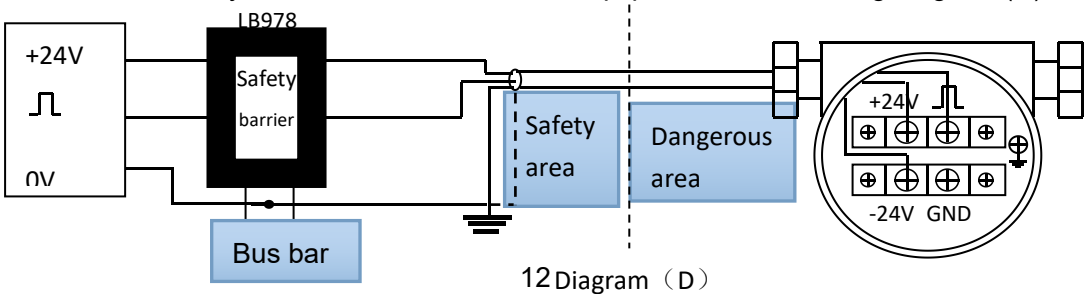


Diagram （C）

4. Explosion-proof type vortex flowmeter wiring design

Three-wire pulse output type vortex flow meter connected with LB978 Zener safety barrier, LUGB/E two-wire standard 4 ~ 20mA output type vortex flow meter connected with LB987S Zener safety barrier which can intrinsically consist of safety type explosion-proof system, the symbol of explosion-proof Ex ia Ⅱ CT2 - T5. Terminals wiring of safety explosion-proof vortex flow sensor/transmitter with explosion-proof safety barrier and totalizer system and other associated equipment, shown wiring diagram (D)



Diagram（D）

Part V: Calculation formula

Calculation formula of flow

（1） Instantaneous flow rate $$L=\frac{3.6\times\rho\times F}{1000K}$$ (t/h)

Formula:

F：The pulse frequency of vortex flow sensor;

K：The flow coefficient of vortex flow sensor (1/L);

ρ：Set density of medium（kg/m^3）。

（2） Cumulative flow Σ=∫(L/3600)dt （t）

Formula:

L: Instantaneous flow;

Part VI: Troubleshooting

Fault	Cause	Solution
No output signal after power on	1. No fluid flowing or the flow rate is under starting flow. 2. The connections of power supply and output are incorrect. 3. The pre-amplifier is damaged (The calculator can't count, and the flow rate is 0). 4. The circuit of driving amplifier is damaged (The display of calculator is normal).	1. Increase the flow rate or replace a flow meter with smaller nominal diameter to meet the requirement of flow range. 2. Make the connection correct. 3. Replace the pre-amplifier. 4. Replace the damaged components in the circuit of driving amplifier.
The meter outputs signal when no flow	1. The interference of bad grounding of meter, strong electricity and interference of other grounding. 2. The higher sensitivity of amplifier or it may produce self excitation. 3. Unstable power supply, bad filtering or other electrical disturbance.	1. Make the grounding well 2. Replace the pre-amplifier. 3. Repair or replace the power supply.
Unstable display of flow rate	1. Unstable flow in pipe 2. The higher or lower sensitivity of amplifier make the output pulses are more counted or less counted. 3. There is debris in the shell of meter. 4. Bad grounding. 5. The flow rate is under the low limit. 6. The downstream seal ring reaches into pipe, and make disturbance.	1. Begin to measure after the flow rate is stable. 2. Replace the pre-amplifier. 3. Remove the debris. 4. Check the grounding, make the grounding well.
The displayed total flow is inconsistent as actual total flow	1. The flow coefficient of meter is incorrect. 2. The flow rate on site is higher than the maximum flow of meter. 3. The bad quality of the flow meter.	1. Recalibrate the meter and input the new flow coefficient. 2. Reduce the flow rate in pipe or replace the flow meter. 3. Recalibration
Abnormal display	Bad contact of the key or dead lock the key	Replace the display board.
System halts after replacement new battery	The electrify reset circuit is abnormal, or the oscillating circuit can't afford to boost.	Reinstall the battery (Before reinstall the battery, the meter is needed to discharge more than 5 seconds)