VORTEX FLOWMETER

Operation Manual

Version:2012-6V01

2012.06

I. Summary

Vortex Flowmeter is one kind of main flowmeters in the international for detection and metering the liquid, gas and steam. It is widely used in Petroleum, chemical, metallurgy, heat supply industry, etc.

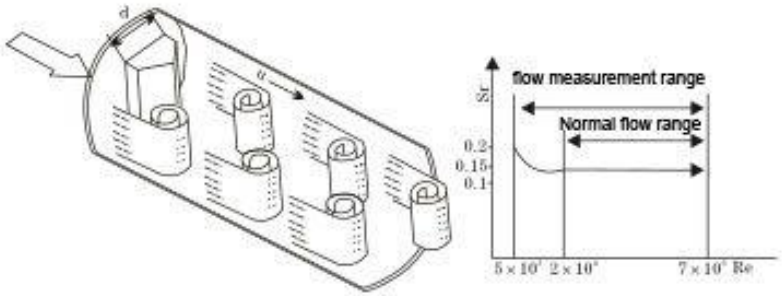
Features:

- Detecting element does not touch with flow medium, with high reliability yand strong flexibility for medium
- No moving parts, wear resistance, structure is simple and fastness
- Good earthquake resistance
- The allowed working temperature is wide from -40℃ to +350℃
- Wide range, High accuracy
- Pulse signal output or two-wire system 4-20mA current signal output

Ⅱ. Working principle

Setting a triangular prism vortex generator in the flowmeter, regular vortex will be generated at both the sides of triangular prism, which is called Karman swirl. As showed on the drawing 1.1, vortex are arranged regularly at the downstream of vortex generator. Suppose the vortex generation frequency is F, the average flow velocity of medium is V, d is the width of the surface of triangular prism incident flow, and D for the nominal diameter of flowmeter. Then we get the computation formula:

$$f=Sr\frac{\overline{V}}{(1\sim1.25d/D)\,d}$$



PIC 1: The working principle of Vortex flowmeter

III. Basic Parameter

Measured Medium	Liquid, Gas, Steam
Medium Temp.	-40～＋200℃；-40～＋280℃；40～＋350℃

Nominal Pressure	1.6MPa；2.5MPa；4.0MPa；64MPa(Other pressure can be custom)	
Accuracy	±1.0%,±1.5%	
Measuring range ratio	1:8-1:30(Standard air condition as reference), 1:8-1:40(Normal Temperature as reference)	
Flow range	Liquid:0.4-7.0m/s; Gas:4.0-60.0m/s; Steam:5.0-70.0m/s	
Specifications	DN15～DN600	
Material	1Cr18Ni9Ti	
Reynolds number	Normal $2x10^4-7x10^6$	
Resistance coefficient	Cd≦2.6	
Vibration acceleration allowed	LUGB≦0.2g	
Ex-proof class	IP65 ExiaIICT6 Ga	
Ambient condition	Ambient Temp.	-40℃-65℃(Non Display on site); -20℃-55℃(Display on site)
	Relative humidity	≦5%～93%
	Pressure	86-106kPa
Power Supply	12-24V/DC or 3.6V battery powered	
Signal Output	Pulse frequency signal2-3000Hz,Low level≦1V,high level≧6V	
	Two-wire system 4-20 signal(isolated output),Load≦500	

3.1 Flow Range

Full tube vortex flowmeter measuring range (Check table 1,table2,table 3,table 4)

Table 1: Vortex flowmeter for gas:

Diameter mm	Meter factor/m3	Normal Gas and Steam			
		Measuring range m³/h	Frequency Setting Hz	CH Selection	Amplification factor
15	350000	3-50	300～3900	CH3	500
20	145000	5-80	200～3000	CH3	500
25	80000	6-120	150～2500	CH3	500
32	35000	10-150	100～2200	CH3	500
40	19000	16-320	80～2000	CH3	500
50	9100	25-500	50～1200	CH3	500
65	4260	40-800	40～900	CH3	500
80	2300	60-1250	30～800	CH3	500

40	19000	16-320	80～2000	CH3	500
50	9100	25-500	50～1200	CH3	500
65	4260	40-800	40～900	CH3	500
80	2300	60-1250	30～800	CH3	500
100	1200	100-2000	25～600	CH3	500
125	580	150-3000	20～500	CH3	500
150	345	200-4500	15～400	CH3	500
200	145	300-8000	10～320	CH3	500
250	73	500-12000	8～240	CH3	500
300	43	800-18000	7～200	CH3	500
350	27	1000-24000	6～180	CH3	500
400	18	1500-30000	5～150	CH3	500
450	13	2000-40000	4～130	CH3	500
500	9	2500-50000	4～120	CH3	500
600	5	3000-70000	3～100	CH3	500

Table 2: The flow range of vortex flowmeter for liquid.

Size mm	Meter factor/m3	Liquid(Water)			
		Measuring range m^3/h	Frequency Setting Hz	CH Selection	Amplification factor
15	350000	0.8-9	40～800	CH2	500
20	145000	1.2-15	30～600	CH2	500
25	80000	2-18	18～360	CH2	500
32	35000	2.5-30	15～300	CH2	500
40	19000	3 -48	10～250	CH2	500
50	9100	5-75	9～190	CH2	500
65	4260	8-120	8～160	CH2	500
80	2300	14-180	51～20	CH2	500
100	1200	22-300	4～100	CH2	500
125	580	40-450	3～90	CH2	500
150	345	56-660	2～60	CH2	500
200	145	100-1200	2～50	CH2	500
250	73	150-1800	2～40	CH2	500
300	43	200-2500	2～35	CH2	500
350	27	280-3500	1～30	CH2	500
400	18	380-4500	1～25	CH2	500
450	13	480-6000	1～20	CH2	500
500	9	600-7000	1～18	CH2	500
600	5	800-10000	1～15	CH2	500

Table 3: The flow range of vortex flowmeter for saturated steam.

Abs Pre.P(Mpa)	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0
Temp.T(℃)	120.2	133.5	143.62	151.84	158.94	158.94	170.41	175.36	179.68	187.96	195.04	201.37	207.11	212.37
Density kg/m³	1.129	1.651	2.163	2.669	3.170	2.669	4.162	4.665	5.147	6.127	7.106	8.085	9.065	10.05
DN20 Qmin	9	11	12	13	15	16	17	18	19	20	22	24	25	26
QMax	60	83	108	134	158	183	208	233	257	306	355	404	453	503
Measurable Up Limit	80	102	130	160	190	220	250	279	309	368	426	485	544	603
Measurable Low Limit	9	11	12	13	15	16	17	18	19	20	22	24	25	26
DN25 Qmin	14	17	19	21	23	25	27	28	30	33	35	37	39	42
QMax	93	133	173	215	254	293	333	372	412	490	568	647	725	804
Measurable Up Limit	136	198	260	320	380	440	499	559	618	735	853	970	1088	1206
Measurable Low Limit	14	17	19	21	23	25	27	28	30	33	35	37	39	42
DN40 Qmin	35	42	48	54	59	63	67	71	75	82	88	94	99	104
QMax	233	332	433	534	634	733	832	931	1029	1225	1421	1617	1813	2010
Measurable Up Limit	400	498	649	801	951	1100	1249	1397	1544	1838	2132	2426	2720	3015
Measurable Low Limit	32	38	44	48	53	57	60	64	67	73	79	84	89	94
DN50 Qmin	52	64	73	81	88	95	100	107	112	122	132	140	149	157
QMax	400	498	649	801	951	1100	1249	1397	1544	1838	2132	2426	2720	3015
Measurable Up Limit	667	826	1080	1335	1585	1834	2081	2328	2574	3054	3553	4043	4533	5025
Measurable Low Limit	52	64	73	81	88	95	100	107	112	122	132	140	149	157
DN65 Qmin	88	106	121	135	147	158	168	178	187	204	220	234	248	261
QMax	667	826	1080	1335	1585	1834	2081	2328	2574	3054	3553	4043	4533	5025
Measurable Up Limit	933	1320	1730	2135	2536	2934	3330	3724	4118	4902	5685	6468	7252	8040
Measurable Low Limit	88	106	121	135	147	158	168	178	187	204	220	234	248	261
DN80 Qmin	140	170	194	215	235	252	269	284	299	326	350	375	397	418
QMax	1166	1650	2160	2700	3170	3660	4160	4655	5150	6130	7100	9080	9060	10000
Measurable Up Limit	1400	1980	2596	3240	4015	4644	5270	5896	6520	7760	9000	10240	11480	12730
Measurable Low Limit	105	127	145	161	176	189	201	213	224	345	263	280	298	313
DN100 Qmin	175	212	242	269	293	315	336	355	374	408	439	468	496	522
QMax	1166	1650	2160	2700	3170	3660	4160	4655	5150	6130	7100	8080	9060	10050
Measurable Up Limit	2332	3300	4320	5400	6430	7320	8320	9310	10300	12260	14200	16160	19120	20100
Measurable Low Limit	175	212	242	269	293	315	336	355	374	408	439	468	496	522
DN125 Qmin	262	317	363	404	440	473	504	533	560	611	658	702	744	783
QMax	1866	2640	3460	4270	5070	5870	6660	7450	8240	9800	11370	12940	14500	16080
Measurable Up Limit	3500	4950	6490	8000	9510	11000	12500	14000	15440	18400	21300	24260	27200	30200
Measurable Low Limit	262	317	363	404	440	473	504	533	560	611	658	702	744	783
DN150 Qmin	437	529	605	673	733	788	840	888	934	1091	1097	1171	1239	1305
QMax	292	4130	5408	6670	7930	9170	10400	11640	12870	15320	17770	20210	66000	25120
Measurable Up Limit	4666	6600	8650	10680	1268	14670	16650	18620	20590	24500	28420	32340	36260	40200
Measurable Low Limit	350	423	484	538	586	631	672	711	747	815	878	936	990	1044
DN200 Qmin	700	847	969	1076	1173	1261	1344	1421	1494	1630	1756	1873	1983	2088
QMax	4666	6600	8650	10680	12680	14670	16650	18620	20590	24500	28420	32240	36260	40200
Measurable Up Limit	9330	13200	17300	21360	25360	29340	33300	37240	41180	47000	56850	64680	72520	80400
Measurable Low Limit	610	740	848	942	1026	1104	1176	1243	1308	1427	1536	1638	1735	1827
DN250 Qmin	1050	1270	1614	1759	1892	2016	2132	2241	1446	2634	2808	1453	2975	3132
QMax	6998	9906	12980	16010	19020	22000	24970	27930	30880	36760	42640	48500	54390	60300
Measurable Up Limit	13997	19810	25960	32030	38040	44000	49940	55860	61760	73520	85270	97000	108780	120600
Measurable Low Limit	875	1056	1210	1345	1466	1577	1680	1776	1868	2038	2195	2340	2480	2610

DN300 Qmin	1750	2116	2422	2690	2932	3153	3359	3550	3736	4076	4389	4682	4958	5220
QMax	11664	16510	21630	26690	31700	36670	41620	46550	51470	61270	71010	80850	90650	10050
Measurable Up Limit	20995	29720	38930	48040	57050	66000	74900	83800	92650	110300	127900	145530	16320	180900
Measurable Low Limit	1050	1270	1453	1614	1759	1892	2016	2132	2241	2446	2634	2808	2975	3132

Table 4:Density and Relative Pressure and Temperature of superheated steam(Kg/m³)

Absolute pressure MPa	Temperature（℃）					
	150	200	250	300	350	400
0.1	0.52	0.46	0.42	0.38		
0..15	0.78	0.70	0.62	0.57	0.52	0.49
0.2	1.04	0.93	0.83	0.76	0.69	0.65
0..25	1.31	1.16	1.04	0.95	0.87	0.81
0.33	1.58	1.39	1.25	1.14	1.05	0.97
0.35	1.85	1.63	1.46	1.33	1.22	1.13
0.4	2.12	1.87	1.68	1.52	1.40	1.29
0.5		2.35	2.11	1.91	1.75	1.62
0.6		2.84	2.54	2.30	2.11	1.95
0.7		3.33	2.97	2.69	2.46	2.27
0.8		3.83	3.41	3.08	2.82	2.60
1..0		4.86	4.30	3.88	3.54	3.26
1.2		5.91	5.20	4.67	4.26	3.92
1.5		7.55	6.58	5.89	5.36	4.93
2.0			8.968	7.97	7.21	6.62
2.5			11.5	10.1	9.11	8.33
3.0			14.2	12.3	11.1	10.1
3.5			17.0	14.6	13.0	11.8
4.0				17.0	15.1	13.6

VI. Vortex flowmeter mode selection and installation

The choice of flow range at working condition:

Different caliber, different medium, the vortex flow sensor and flow transmitter’s flow range is different too. The model selection for special medium needs to calculate for settlement.

4.1 The choice for Gas flow range

The upper limit of vortex flowmeter does not influenced by the temperature and pressure of medium. Flow range is depended on the medium's density and viscosity at working condition. Thus, the confirmation of flow range is calculation the available lower limit flow.

Calculation 1:First of all, using Q_p formula to calculate the working condition lower limit flow, which is determined by viscosity

$$Q_p = Q_{0x}\sqrt{\rho_o / \rho} \quad (m^3/h)$$

In the formula:

Q_p:The medium's lower limit flow at working condition density

Qo: The lower limit flow of flowmeter at reference condition

ρ_o: Reference the air density,ρ_o=1.205kg/m³

ρ: Working condition density of medium to be measured

Calculation 2 Qv formula for calculation the lower flow limit by kinematic viscosity

$$Q_v = Q_o \times v/v_o \quad (m^3/h)$$

In the formula:

Qv : Lower limit flow of the medium

Qo: Low flow limit at reference condition

Vo: Reference viscosity,15kgm/S²

V: The working condition viscosity of medium(kgm/S²)

Compare Qo and Qv, the larger flow as the real low flow limit of gas.

4.1.1 The choice for liquid flow range

As shown on flow range table 2

4.1.2 The choice of steam flow range

Saturated steam: Reference to table 3 to choose

Superheated steam: Through table 4 to get the pressure, temperature and corresponding density, taking the similar density's flow range from table six to confirm the flow range of superheated steam.

4.2 Installation Condition

4.2.1Flow sensor should be horizontal or vertical installed(the liquid flow direction should be

from bottom to top) on the pipeline, which is corresponding to the flow sensor nominal diameter.

4.2.2The definite straight pipeline length at upstream and downstream of flow sensor is required. The length should meet below table's requirements:

Straight Pipeline Configuration

Upstream Straight pipe form	The Straight length of upstream	The Straight length of downstream
Concentric tube fully open valve	≧12DN	≧5DN
Concentric contraction fully open valve	≧15DN	
Single quarter bend	≧20DN	
Two quarter bends on the same surface	≧25DN	
Two quarter bends on the different surface	≧40DN	
Regulating valve、Half-open gate valve	≧50DN	

4.2.3At the upstream of flow sensor should not install a flow regulating valve.

4.2.4If the length of upstream can not meet the requirement, we suggest that customer install a flow regulator at the side pipeline of upstream.

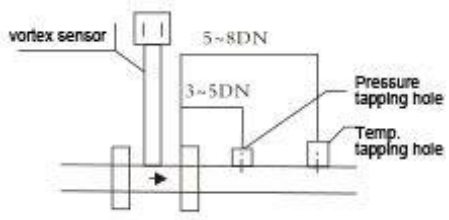
4.2.5In order to avoid the accuracy, Flow sensor should be not installed on a strong vibration pipeline. If installation the flow sensor on a vibration pipeline, there are following methods to decrease the disturbing of vibration:

A. Installing a fixed support on pipeline at 2D upstream of flow sensor.

B. At the condition of meeting the straight length, install a hosepipe as a transmission.

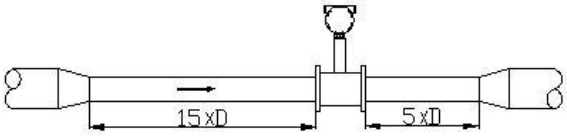
4..2.6 Installation flow sensor on high temperature pipeline, if the heat preservation not good, the flow sensor should be installed downward vertical.

4..2.7When the amendment is needed for temperature and pressure,it should install pressure tapping points at 3-5D downstream of flow sensor and temperature taking point at 5-8D downstream of flow sensor.(As the PIC 2)

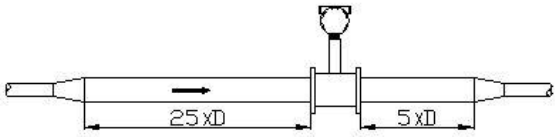


PIC 2

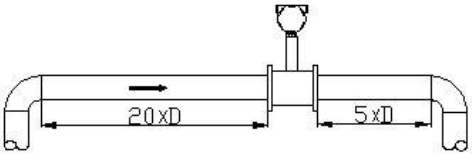
4.2.8No collision by hard subject, when the flow sensor is installing, otherwise, the accuracy will be influenced, even flowmeter damaged.



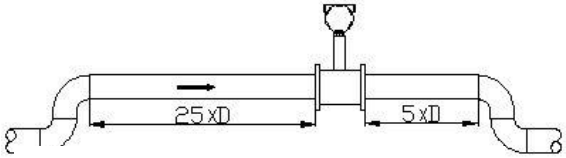
Concentric Reducers Pipeline



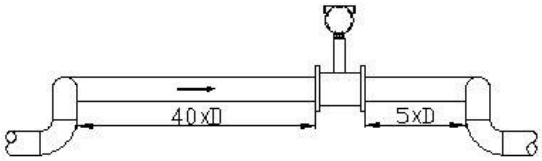
Concentric expansion pipeline



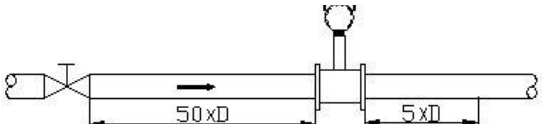
Single quarter bend



Two quarter bends on the same surface

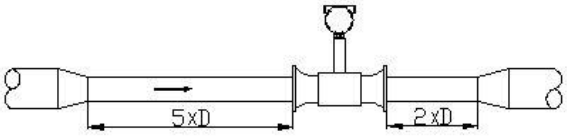


Two quarter bends on the different surface

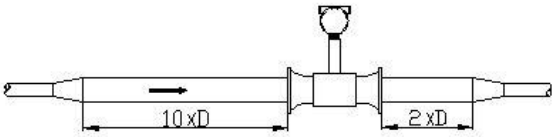


Regulating valve 、 Half-open gate

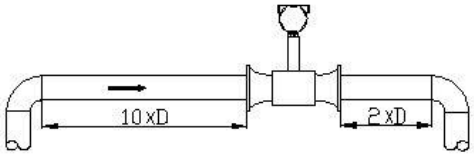
Pic 3 :Normal Pipeline



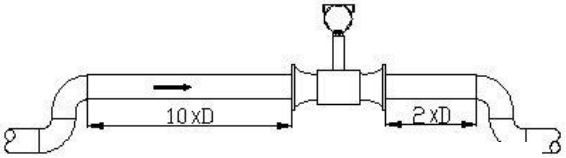
Concentric Reducers Pipeline



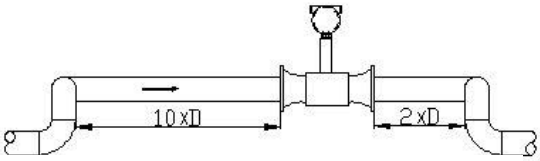
Concentric expansion pipeline



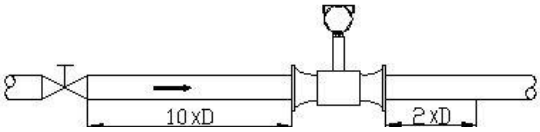
Single quarter bend



Two quarter bends on the same surface



Two quarter bends on the different surface



Regulating valve 、 Half-open gate

PIC 4 : With flow rectifier

4.2.9 Overall Size

Overall Size check the PIC 5 and table 5

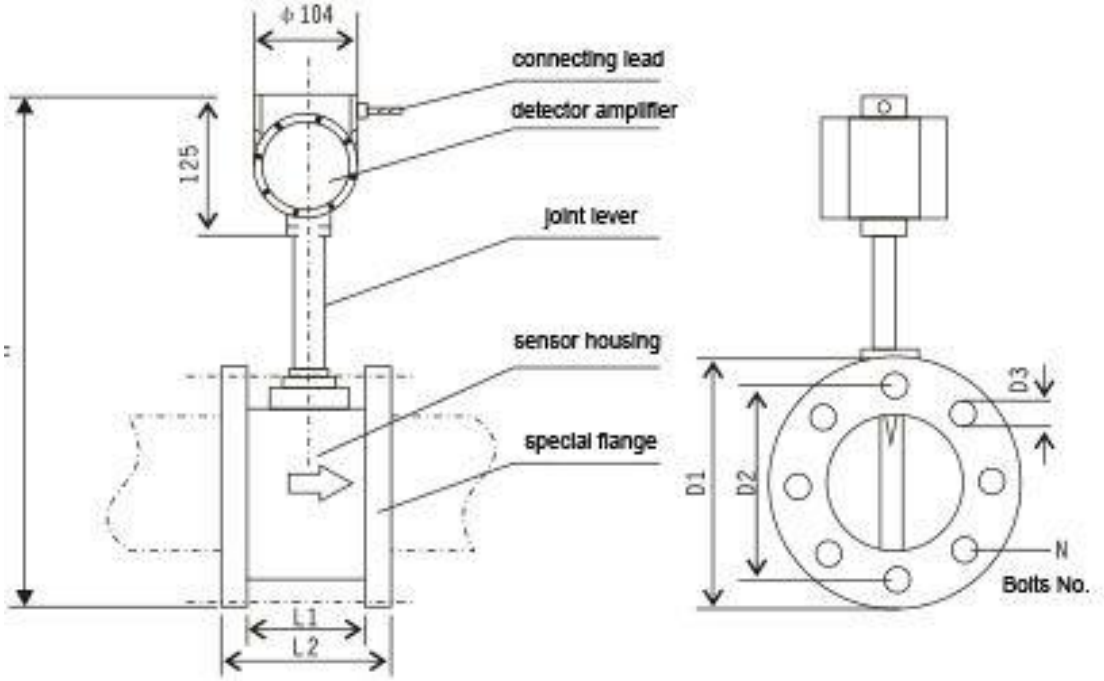


Table 5:Overall size of vortex flowmeter（mm）

Diameter	L1	L2	D1	D2	H	D3	N
DN15	65	95	125	100	460	14	4
DN20	65	95	125	100	460	14	4
DN25	65	95	125	100	460	14	4
DN40	75	109	145	110	470	18	4
DN50	75	109	160	125	480	18	4
DN65	75	117	180	145	497	18	4
DN80	80	122	195	160	510	18	8
DN100	90	132	230	190	544	18	8
DN125	100	146	245	210	564	18	8
DN150	120	170	280	240	594	22	8
DN200	150	200	335	295	646	22	12
DN250	160	214	405	355	708	22	12
DN300	170	224	460	410	760	22	12

4.3 Installing a insertion vortex flowmeter

On the pipeline should insure the upstream≧15D, downstream≧5D

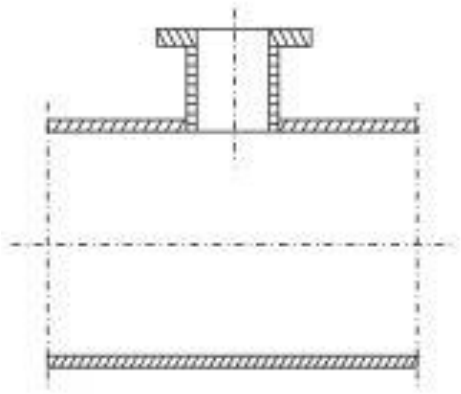
1.Opening a Φ100mm circular hole on the pipe line by gas cutting. the hole without rag to insure that the probe passes smoothly.

2.Welding flange short tube on the pipeline hole, pay attention to the vertical direction when welding. the effect after welding requires the axis and pipeline axis orthogonality and the extended line of flange short tube passing the cross-section circle center.

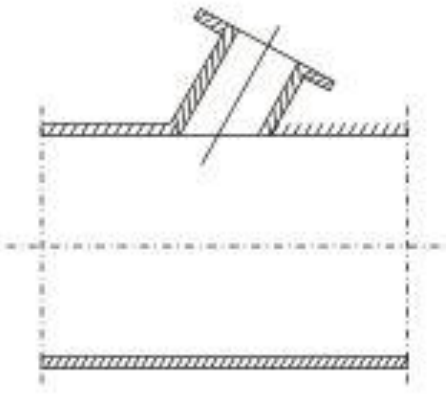
3.The Y length of Insertion rod below vortex flowmeter down connection flange, should be prevail to the real external workshop. The users do not need to adjust it. In the special condition, computing the insertion depth should consider the length of straight pipeline and working condition medium, then making proper adjustment. When the straight pipeline length is enough and pipeline diameter above 400mm,can adopting average flow spot measurement, this method does not influence by the Reynolds number changing, probe insertion depth is 1/4D-1/3D(D for the diameter of pipeline).When the pipeline straight length is short and pipeline diameter less than or equal to 400mm,adopting center velocity flow spot measurement, the insertion depth Y=0.5D(Reference drawing 6).After the measurement depth confirmed, adjusting insertion rod length, settling erosion point direction mark to make sure that the direction of vortex generator and flow direction in the pipeline is same, then connecting the flowmeter and bolts fixed joint on the flange short pipe.

4.Should install sealing gasket between flanges, rubber plate for normal temperature, high temperature can adopt the asbestos pad etc. heat-resisting material.

5.Assembling and dissembling method at the condition of non flow cutoff(with ball valve),when disassembling, first unscrewing stopper screw, then loosening the lock nut, pushing insertion rod upward until the probe is located the limiting position of ball valve top, now ball valve is closed. Then dissembling the top connecting flange, bolt and nut, finally taking the flowmeter away. The process of assembling is opposite to dissembling.



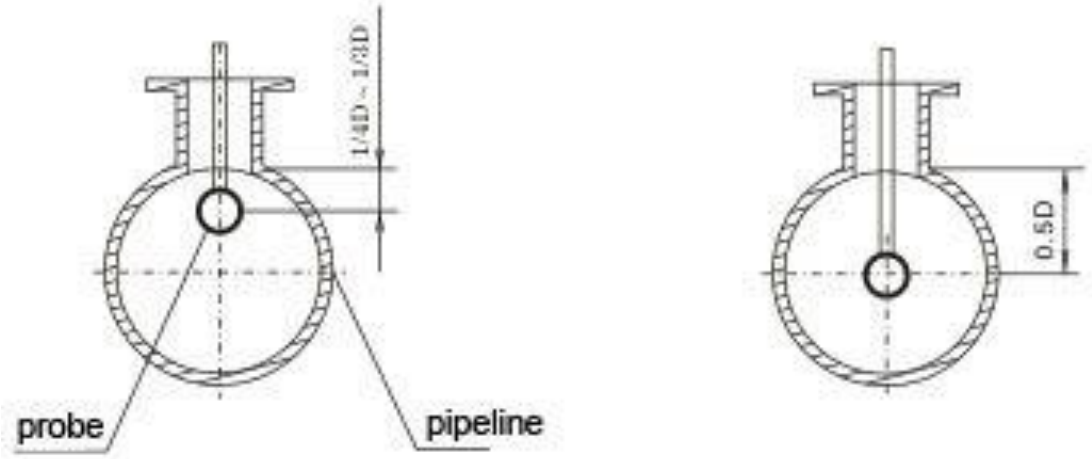
Right



Wrong

Right **Wrong**

PIC 6 The flange position of Insertion Vortex Flowmeter installed on pipeline.



PIC 7 Insertion Position
(Insertion Depth is according to reservation real calibration)

4.3.1 Attention for installation:

1.The flow direction must be same as the flow indication rod, strictly forbidden to wrench the flow rod;

2.Flow transmitter is seted according to medium, flow range and nominal diameter, before using, it must inspect the parameter setting.

3.Removing burr and welding slag.

4.After wiring, make sure the flow converter cover and lead collar tight, in order to make sure the water proof and moisture proof.

5.Make sure that the shell of vortex flowmeter and lead shielding layer well grounded.

Ⅴ.User Instruction of Local Display Vortex Flow Transmitter.

5.1. Summary:

Our company's vortex flowmeter flow transmitter panel mainly include UZ3036、UZ3024.That is

4-20mA,Pulse output,HART,RS485,Temperature and pressure compensation function, etc, which can be choosen by the customer.

5.2. Power Supply:12V～32V DC/3.6V battery(Optional)

Power influence：Not more than 0.01%/V；

The change of output loading: Not more than0.05%（50～1000 ohm,Low limit and flow range variable quantity)

Working Temperature:－20℃～+70℃(With backlit LCD dislay)；

－40℃～+85℃（Without LCD Display）；

5.3 Main function

Output and communication：4～20mA，pulse output，HART，RS485 interface (Optional)；

Configuration： Engineering units, measured medium, medium density, range ,display, alarm, etc Configuration; And with the cumulative flow reset function;

Alarm function：Set the alarm upper and lower limit. below the lower limit output 3.8mA; above the upper limit output 22mA.

Monitoring the dynamic variable function: instantaneous flow, precent, current output, accumulated flow, frequency, temperature, pressure etc.

Flow demarcate function:The instrument coefficient K value can be 2 ~ 5 point correction

On the configuration features: the engineering unit, measured medium, medium density, range, display and alarm value configuration and have reset for the accumulated flow ,data recovery function ；

LCD display function:with back-light, tape symbol , double row shows. The first behavior 6 digit LCD display, can be display the instantaneous flow. The second behavior 8-bit digital display, can be display the accumulated flow, percentage, output current, temperature, pressure, density value, etc. At the same time on the LCD screen can also display a variety of engineering unit.

Temperature pressure compensation function:support the two-point temperature calibration and two-point pressure calibration. Temperature and pressure can be set to manual input or automatic acquisition (optional)

Data backup and recovery:the manufacturer can be backup of the configuration information such as the range before it leave the factory, the user scene illegally adjust the instrument can not work normally,damping input"005678" can be restored to the factory

Instrument has the function of power-fail protection and flow accumulation.

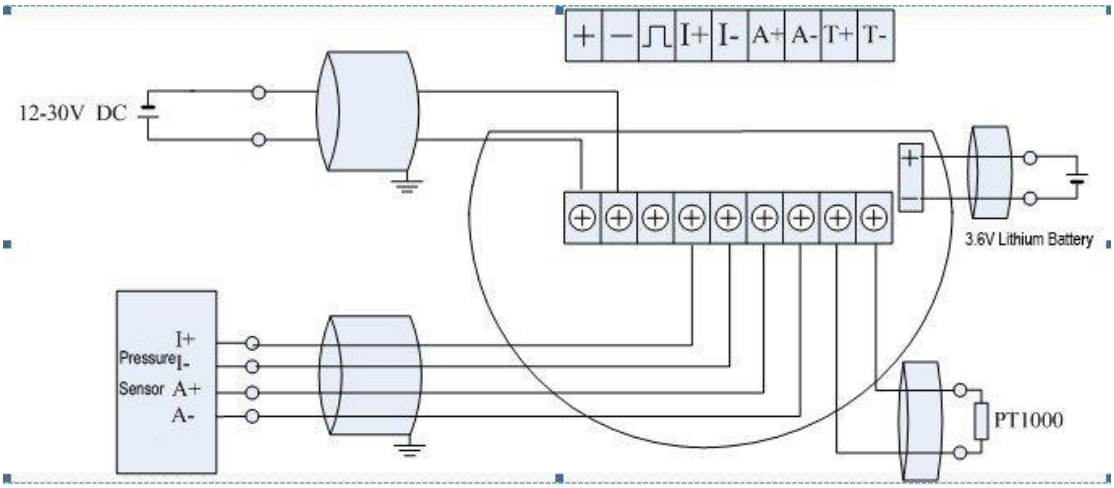
5.4 Wiring connection

5.4.1Terminal board wiring instructions

several common wiring modes as follows:

5.4.1.1 power supply+pressure sensor+temperature sensor（ H880TBR board card， H880BR board card without temperature-pressure compensation)

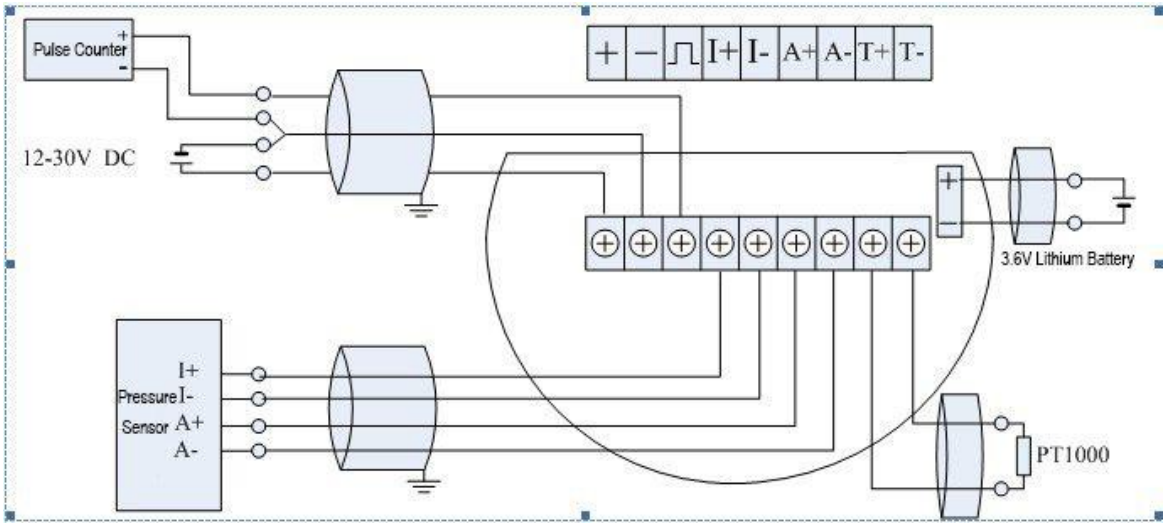
as shown in pic 8



PIC 8 power supply+pressure sensor+temperature sensor wiring connection

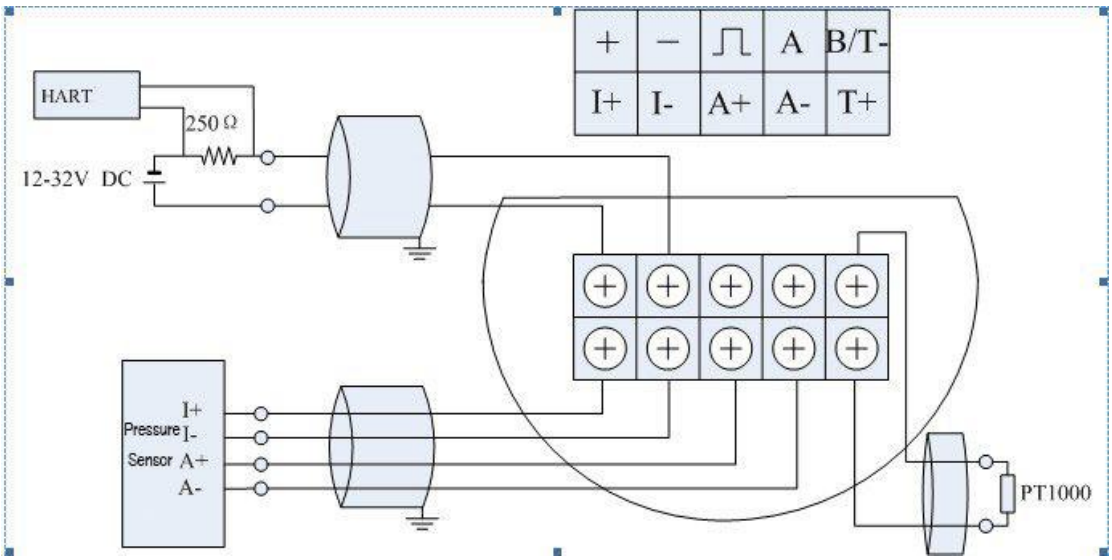
5.4.1.2 power supply + pulse output + pressure sensor（ H880TBR board card， H880BR board card without temperature-pressure compensation)

as shown in pic 9



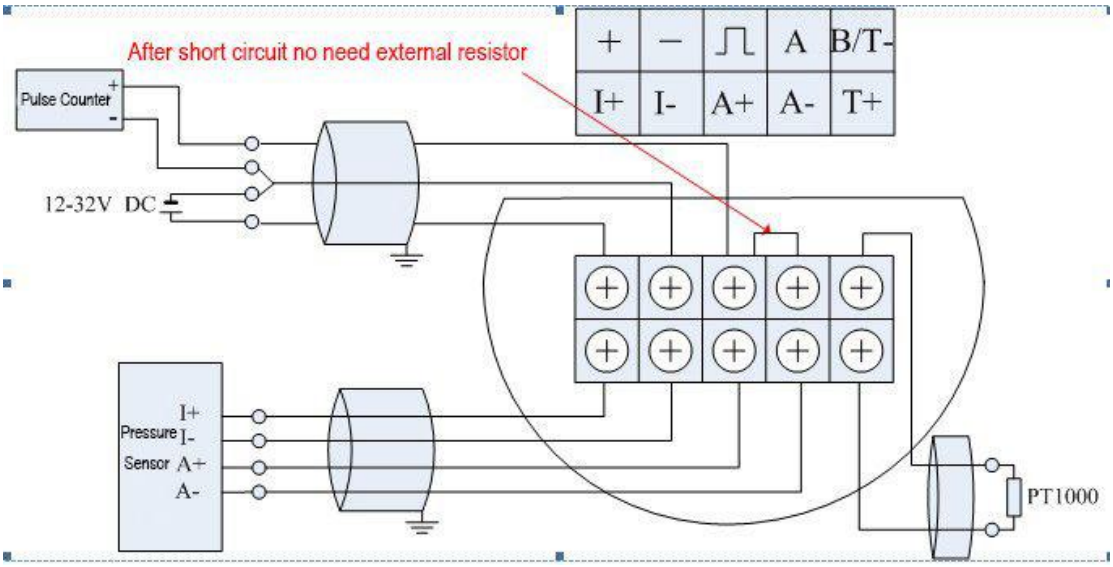
PIC 9 power supply + pulse output + pressure sensor wiring connection

5.4.1.3 4～20mA output + HART + pressure sensor + temperature sensor (H880TH board card)，as shown in pic 10



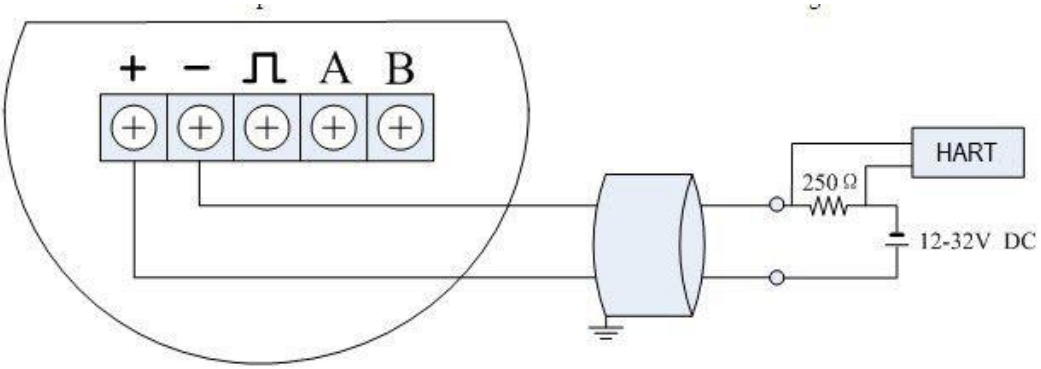
PIC 10　4～20mA output + HART + pressure sensor + temperature sensor wiring connection

5.4.1.4 pulse output + pressure sensor + temperature sensor (H880TH board card)， as shown in pic 11



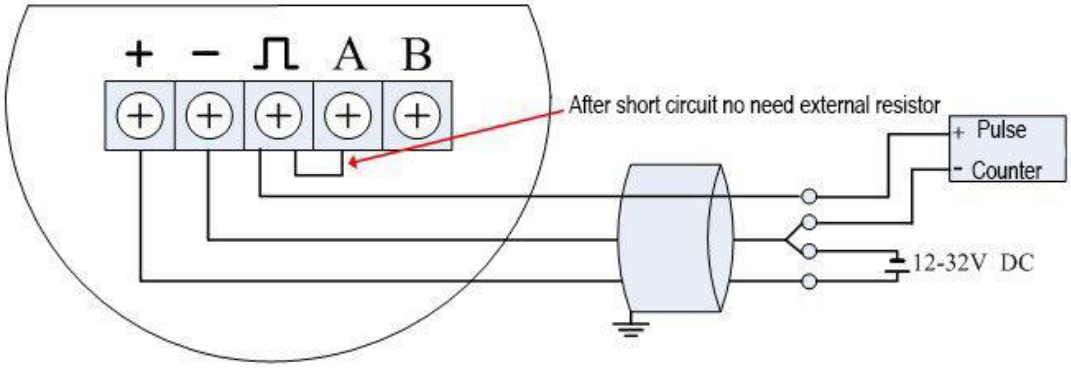
PIC 11　pulse output + pressure sensor + temperature sensor wiring connection

5.4.1.5　4～20mA output+ HART（H880WJ board card)，as shown in pic 12



PIC 12　4～20mA output+ HART wiring connection

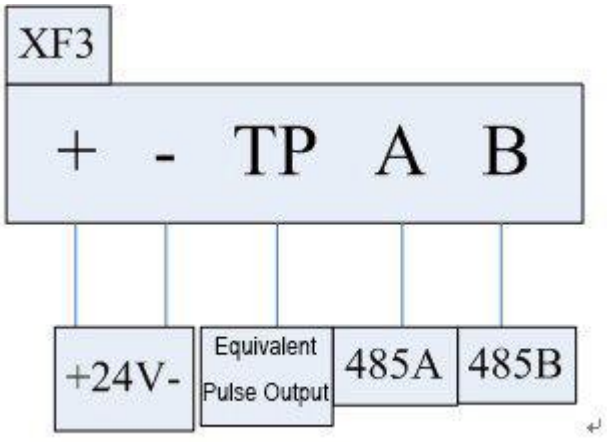
5.4.1.6　pulse output（H880WJ board card），as shown in pic 13



PIC 13　pulse output wiring connection

5.4.1.7　Power supply + RS485（H880BR、H880TBR board card ）communication interface XF3 socket used to connect the external power supply, the output pulse and 485 communication, power supply voltage range for the board card DC12V ~ 30 v.

XF3 are defined as follows: as shown in pic 14



PIC 14　Power supply + RS485 wiring connection

6.4.2 Sensor Wiring Illustration

6.4.2.1 Vortex Flowmeter Sensor

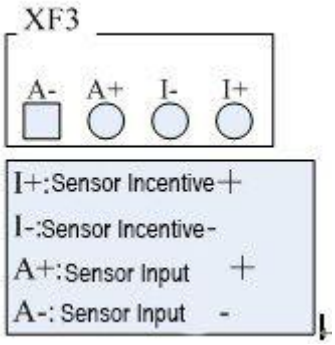
Vortex flowmeter sensor insert into socket (2p terminal)of H880 vortex flowmeter board card.

6.4.2.2 Pressure Sensor

Pressure sensor connect with the main board socket I+, I－, A+, A－ of XF3, I+ , I－ used for connecting the power supply input terminal of sensor, A+, A － is the sensor signal output terminal.

It requires the bridge circuit impenance of pressure sensor better around 3~6K Ω. This circuit power supply current for spread silicon sensor is around 0.3mA, it is applicable if the sensor input not exceed 50mV@0.3mA.

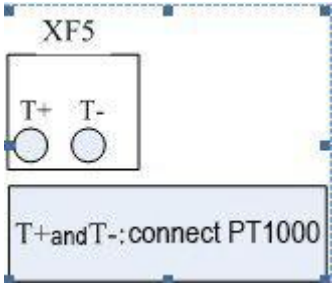
Socket XF3 definition as below: see PIC 15



PIC 15 Pressure Sensor Connection

6.4.2.3 Temperature Sensor

Temperature sensor adopt PT1000, Two-wire connection applicable, connect with the T+ and T- of the XF5, see PIC 16.



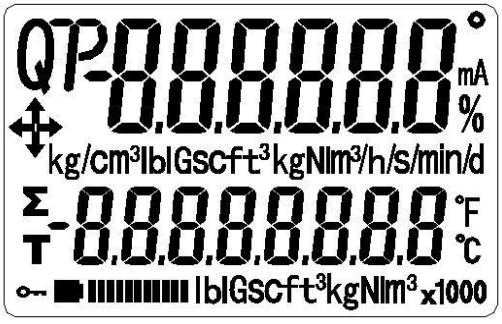
PIC 16 Temperature Sensor Connection

Installation instruction: Main circuit board should connect the shell dependable (aim to connect the earth dependable), then carry out the test!

6.5 Display Interface

LCD Overall display interface as below:

See PIC 17



PIC 17

The above line display instantaneous flow while display is normal.
The bottom line display accumulated flow, see PIC 18

Under normal display condition, set the display frequency, pressure, temperature, density, current, percentage at the bottom line through short press key M.

PIC 18

The bottom line display virable quantity distinguish by indictor sign, see table 7

C Table 7 Indictor Sign

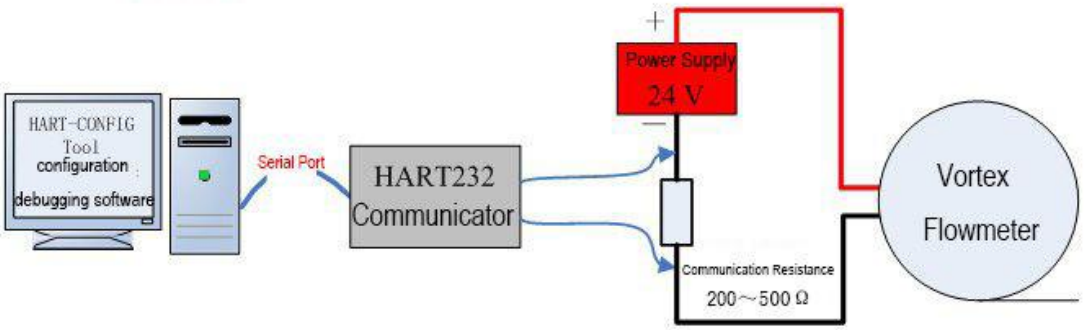
Indictor Sign	Σ	F	d	P	t	C	r
Display virable quantity	Accumulated flow	Frequency	Density	Pressure	Temperature	Current	Percentage

Other display Illustration :

- If start write-protection, the LCD left corner show 。
- If the measure value lower than alarm limit, blink & display "↓"
- If the measure value higher than alarm limit, blink & display "↑"
- If start collecting pressure automatically, and pressure signal abnormal(sensor fault), blink & display "←"
- if start collecting pressure automatically, and the pressure signal abnormal(sensor fault), blink & display "→"

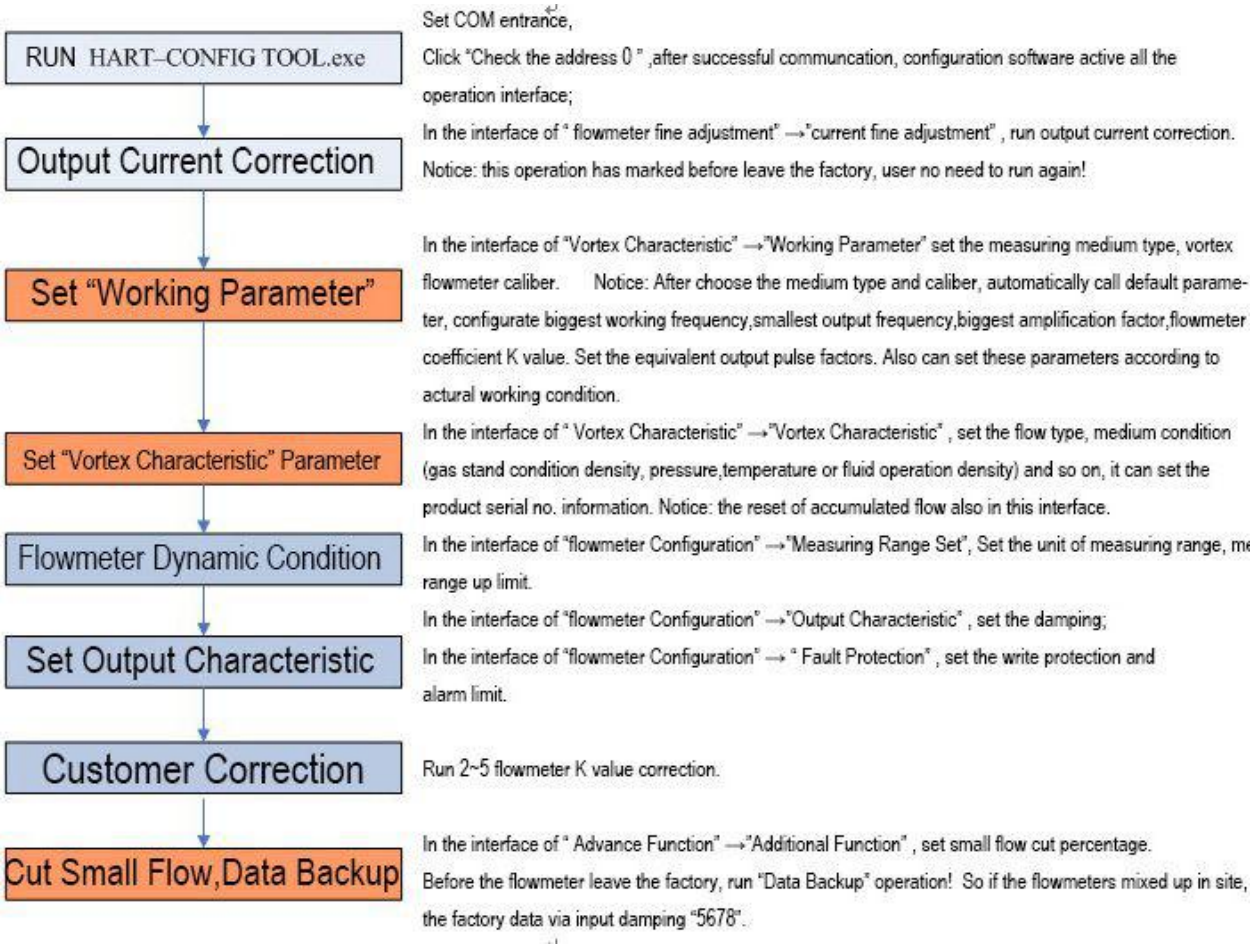
6.6 HART Configuration Illustration

Connect the flowmeter according to PIC 19.



PIC 19 Vortex Flowmeter and HART connection schematic diagram

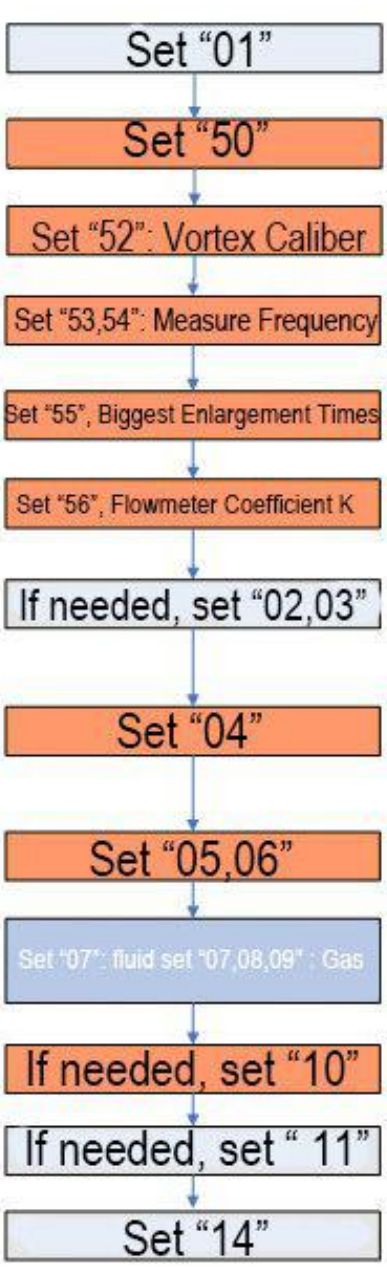
HART CONFIGURATION ILLUSTRATION



Notice: MUST ITEM MUST CARRY OUT, EASY FORGET OR MISTAKE ITEM.

6.7 Flowmeter Button apply

While use the button, suggest follow the below operation process.



Make sure current write protection is " OFF", then change the setting is allowed. Through "Page Up" and "Page Down" button, when the left corner display "50", input the operate code. Input the operate code "50", enter "51", "Page Down" enter set " Votex Caliber Menu".

Select Correct Caliber and measuring medium type.

Set suitable biggest and smallest measuring frequency according to measuring medium type and caliber. Notice: it can be decrease the measuring frequency range according to actural needs.

Set the enlargement times accord to smallest measuring frequency (the minimum signal) , usually around 500 is ok.

Make sure according to caliber and measuring medium.

If needed, set the alarm limit (unit is %).

Set the flow mode, the selection as below:

Llq_0: Liquid Volume, Llq_1: Liquid Quality GAS_0: Gas Volume, GAS_1: Gas Quality ST_0: Steam Volume, ST_1: Steam Quality, ST_2: Saturated Steam Quality (temperature Compensation) ST_3: Saturated Steam Quality (Pressure Compensation)

Set instaneous flow unit and measuring upper limit, measuring the lower limit is 0, accumulated flow unit according to instaneous flow unit.

According to the measuring medium type, the liquid set as 07(density), gas set as 07(density), 08(gas pressure),09(gas temperature)

If needed, set the small signal removal quantity(unit is %)

If needed, set damping time (unit is S)

Reset the accumulated flow.

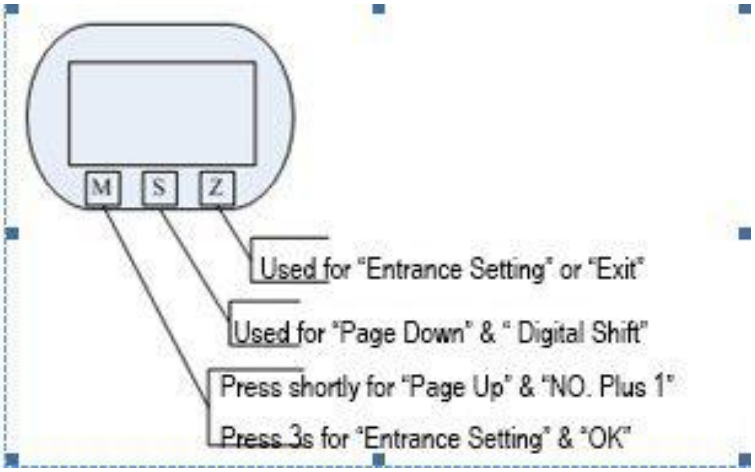
Notice: 1. MUST ITEM MUST CARRY OUT, EASY FORGET OR MISTAKE ITEM.

2. NO. “52”、“04”means need seted menu, display on the left corner of LCD.

6.8 Flowmeter button function detailed illustration

6.8.1 Button basic function illustration

Flowmeter is “three button” operate mode, the basic function of three button as PIC 20:



PIC 20 Three button basic function

6.8.2 Flowmeter entrance & exit

6.8.2.1 Entrance configuration

Under "NORMAL WORK" condition, press "Z", enter " CONFIGURATION" condition. "CONFIGURATION" parameter can set by " NO. INPUT DIRCETLY" and " MENU CHOICE".

6.8.2.2 Exit configuration

Under "CONFIGURATION" condition, press "Z", exit "CONFIGURATION", enter " NORMAL WORK" condition.

NOTICE: This flowmeter record last time exit button set condition, press "Z" can return to the last time exit condition.

6.8.3 Parameter setting

Site setting parameter has two types, first is " NO INPUT DIRECTLY" and " MENU CHOICE".

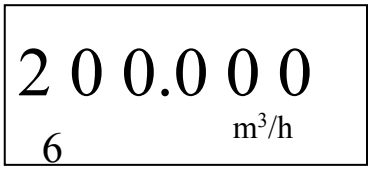
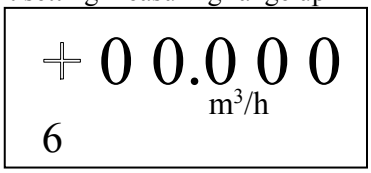
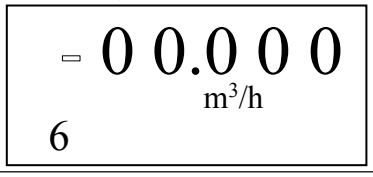
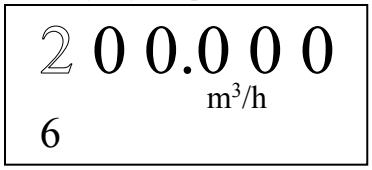
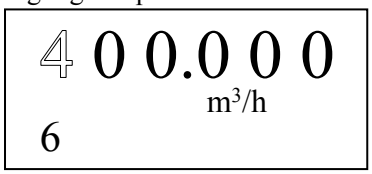
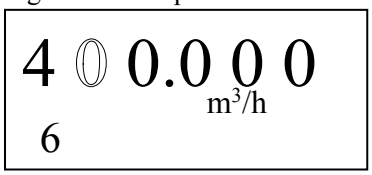
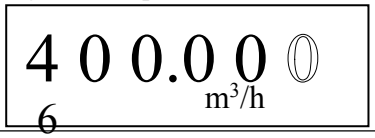
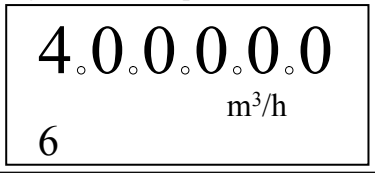
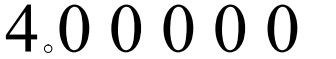
6.8.3.1 " NO. INPUT DIRECTLY" setting method.

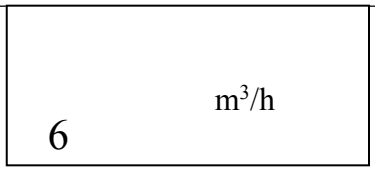
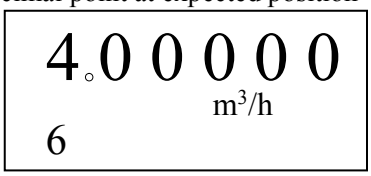
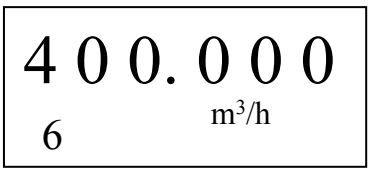
- Press key M until it blink, it can change the setup.
- Press key M shortly, switch the sign.
- Press key S, shifting ,the first no. start blink, indicate amendable, press key M, no. plus one.
- Press key S again, can set the second no. to the sixth no., exactly same with the first no. setting.
- After set the sixth no. press key S, start to set decimal point. Five decimal point start the blink at the same time, indicate to set the decimal point, press the key M shortly at this time, the decimal point position switch cyclically.
- During the date setting process, it can press the key M for long time at any time to save the setting; or press key Z exit setting.

For example, previous measuring range limit is 200, new input measuring range limit is 400. See

table 8.

Table 8

➢ First press“Z”, enter button setting function. ➢ Press “M”, setting item move to front place; press “S”, setting item move to back place. When the left corner display “6”,indicate the setting function is “ measuring range up limit”, see left PIC.	Set measuring range up limit interface 
Press “M” for longer than 3s, enter setting measuring range up limit function, at this time, the left sign position start blink, indicate start setting.	Start setting measuring range up limit 
➢ Press “M” at this time, it will switch between “+”and“ — ”,if display“ — ”,indicate the input will be negative no.(data less than 0, vortex flowmeter measuring range up limit must be the positive no.)	Setting negative no.(flowmeter should not set the negative no.) 
➢ Press “S”at this time, the first “2” start blink, indicate can input new data.	Start setting highest position interface 
➢ Press “M” continuously, until the highest position display “4”.	Setting highest position interface 
➢ Press “S”, the second “0” start blink, indicate can input data. If needs amendment, press “M” then input new data.	Setting the second position interface 
➢ Press “S”, No. from the second to the six blink in turns. It can input the needed data.	Setting the fifth position interface 
➢ Press “S” again, all decimal point blink, indicate can input decimal point position.	Setting the decimal point interface 
➢ Press “S”, the decimal point in the highest position start	Decimal point at highest position 

blink, indicate the current setting decimal point position ➢ Press “M”continuely , the decimal point position move to right.	 Decimal point at expected position 
➢ While arrive at expected position, press “M” for 3s, finish the data setting.	Setting measuring range up limit interface. 

6.8.3.2 Method setting of “Menu selection”

Long Press the key M to the setting content flashing, indicating to change settings.
Short Press the key M , page up the option, or press the key S , page down the option.
During the process of the data setting, long press the key M to the setting content not flashing to save the settings;

Illustration:
During the process setting, long press the key "M" for three seconds to save and end the data setting;
During the process setting, press the key “Z” to exit the current settings without saving.
After completing or exiting the settings, stay at the current setting interface.

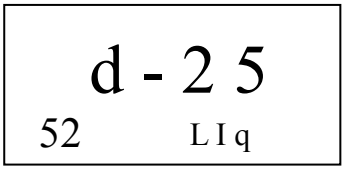
6.9 Parameter setting menu

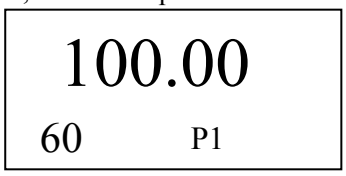
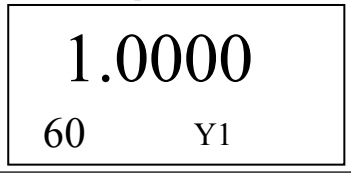
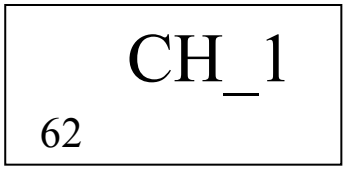
H880 Series Vortex Flow Transmitter have 77 parameter items in total, when using the meter, the user should set the parameters according to the specific circumstances. Parameters List as following in Table 9：

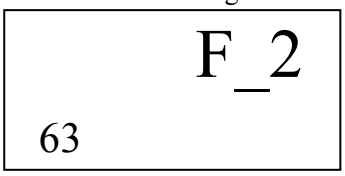
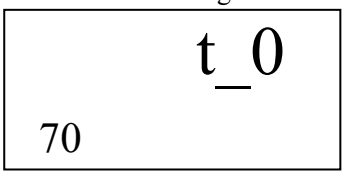
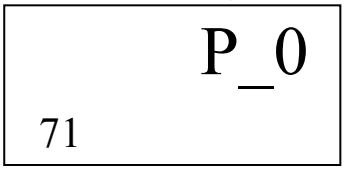
Table 9 Parameters setting menu list

Lower left corner "88" character display	Set the variable	Set the method	Remark
01	Write-protection	Long press the key	ON/OFF

		M to switch	
02	Low limit alarm	Direct digital input	Unit:%
03	Upper limit alarm	Direct digital input	Unit:%
04	Flow mode	Menu selection	LIq_0：Liquid volume LIq_1：Liquid mass GAS_0：Gas volume GAS_1：Gas mass ST_0：Steam volume ST_1：Steam mass ST_2：Saturated Steam mass (Temperature compensation) ST_3：Saturated Steam mass(Pressure compensation)
05	Instantaneous flow units	Menu selection	Nm3/h，Nm3/m，Nm3/s，m3/d，m3/h，m3/m，m3/s，l/h，l/m，l/s，t/d，t/h，t/m，kg/d，kg/h，kg/m，kg/s，g/h，g/m，g/s， Remark:The cumulative flow units should confirm according to the instantaneous flow unit , seeing the <<instantaneous flow units and cumulative flow units correspondence table>>
06	Range up limit	Direct digital input	
07	Density	Direct digital input	Gas density (Unit: kg / m3) Liquid density (unit: g / cm3)
08	Gas pressure(gage pressure)	Direct digital input	Unit:kpa, measuring the liquid,there is no this unit
09	Gas temperature(centigrade)	Direct data input	Unit: ℃， measuring the liquid,there is no this unit
10	Little flow to remove	Direct digital input	Range: 0% ~ 20%
11	Damping	Direct digital input	Range: 0 ~ 64S
14	Accumulative flow reset	Menu selection	Lcd displaying ACC-y, Long press the key M to relize the accumulative flow reset
15	Cumulative flow times of overflows	Read only	When the cumulative flow is over 9999999, the times of overflows add one.
50	Operation code	Direct input	Input ****50,you can enter the setting to set from 51to 57. Input **** 50, you can enter the setting to set from 40 to 41. Input **** 50, you can enter the setting to set from 40 to 41. Input **** 62, you can enter the setting to set

			62. Input **** 63, you can enter the setting to set 63. Input **** 70, you can enter the setting to set 70~77.
51	Signal strength	Read only	LCD display: 450.00 51 2 - 1 Including: 450.00 for the magnification 51 for the prompt 2 for the channel number 1 for the signal strength
52	Vortex caliber and medium status	Menu selection	Choices: 15mm，20mm，25mm，32mm，40mm，50mm，65mm，80mm，100mm，125mm，150mm，200mm，250mm，300mm，350mm，400mm，450mm，500mm，600mm; Remark:LCD displays d-15: 15mm When the medium type is gas,the setting interface as follows:  When the medium type is liquid,the setting interface as follows:  After changing vortex caliber or medium status, you must be re-set from 53 to 56, and there is a detailed "special instructions"behind the table.
53	Maximum measurement frequency	Direct digital input	Determined according to the measuring medium and caliber.
54	Minimum measurement frequency	Direct digital input	Determined according to the measuring medium and caliber.
55	Maximum magnification	Direct digital input	Suggestion is between 200 to 1000.Generally is about 500.
56	Meter	Direct digital input	Determined according to the measuring

	coefficient(K value)		medium and caliber.
57	Coefficient of Output pulse	Direct digital input	Input 1m3 corresponding to the number of output pulse
60	Five-point correction	Direct digital input	Among this ,P for the current frequency, Y for the K correction coefficient, the specific setting refers to item 6.2. Input frequency value, the lower right corner shows Pi, i for 1,2,3,4,5. If i = 1, the example interface as follows:  Input frequency value, the lower right corner shows Yi, i for 1,2,3,4,5. If i = 1,the example interface as follows: 
40	4mA calibration		Calibration step: Long press the key “M” for three seconds to enter the calibration; Short press the key “M” to decrease the electricity;press the key “S” to increase electricity, the step is 12μA; Long press the key “M” for three seconds to save calibration; or press the key “Z” to exit without saving.
41	20mA calibration		
62	Channel setting	Menu selection	There are three choices:CH_1，CH_2，CH_3. CH_3 is the maximum magnification; CH_1 is the minimum magnification; CH_1 interface as follows:  Illustration:

			CH1 is generally used for liquid measurement, which corresponds to the configuration software, select X0 and X1. CH_3 generally used for gas volume measurement, which corresponds to the configuration software, select X1, X2 and X3.
63	Mode setting	Menu selection	There are four choices:F_1，F_2，F_3，F_4. F_2 interface as following:  Illustration: Generally select F_2.
70	Temperature collection mode setting	Menu selection	There are two choices:t_0，t_1. t_0 expresses the manually input, according to Article 9 of the input table t_1 expresses the automatic collection, which needs to connect pt1000; t_0 interface as following: 
71	Pressure collection mode setting	Menu selection	There are two chices: P_0，P_1. P_0 expresses the manually input, according to Article 8 of the input table; P_1 expresses the automatic collection, which needs to connect the enternal pressure sensor; P_0 interface as following: 
72	Low temperature calibration	Direct digital input	Input the calibration electric resistance value,unit: Ω
73	High temperature calibration	Direct digital input	Input the calibration electric resistance value,unit: Ω
74	Pressure zero calibration	Direct digital input	Input the calibration pressure value,unit:kpa

75	Pressure full point calibration	Direct digital input	Input the calibration pressure value,unit:kpa
76	Little pressure to remove value	Direct digital input	unit:kpa If the measuring pressure value is less than the “little pressure to remove value”,it is considered to be 0kpa.
77	Pressure Migration at any point	Direct digital input	unit: kpa, Through inputting the reality pressure valve to relize the migration of any point.

Special illustration:

After Using the button to modify the “vortex caliber”, you must reset the “Maximum measuring frequency” 、 “minimum measuring frequency” 、 “maximum magnification”and“meter coefficient K” according to the caliber and measuring medium, or the meter may work abnormally.[if you change the caliber through the configuration software, these parameters are automatically adjust the default values

The set of frequency range、CH selection and manification is quite important for vortex to work well or not, please carefully set according to the actual application.

H880 Series practical work range is: 70% of the lower limit frequency setting - 200% of maximum frequency setting, frequency setting range requirement is not more than 1:30.

The user should set the frequency range reasonablly according to the actual use conditions and other conditions, especially in the vortex precession, inserted type vortex, or steam measurements.

Magnification setting range is : 20 to 2000 times, which can be adjusted according to the scene signal, noise, vibration, etc.

"Caliber" and "maximum measurement frequency", "minimum measurement frequency", "maximum magnification" and "meter factor K", measuring range relationship can refer to Table I:

6.10 Common Parameter Illustration

6.10.1 Flowmeter Coefficient K value confirmation.

Flowmeter coefficient K value indicate the flow of how much pulse correspond to $1M^3$.

The configuration software default flowmeter coefficient K value is confirmed according to the occurrence of theoretical design. For different occurrence, the difference of this flowmeter

coefficient K value (unit: $1/m^3$) is huge, need to input according to actual situation.

Generally speaking, we can make sure the tested flowmeter coefficient K value according to the relationship of standard flowmeter output pulse no. and tested flowmeter output pulse no. in fixed time.

6.10.2 Confirmation of user calibration flowmeter coefficient value K and correction coefficient.

In different flow section, actual flowmeter coefficient K value has some changes for vortex flowmeter. That is to say, when the flow is different, same quantity pulse actual corresponding accumulated flow has some difference. In order to advance the accuracy of vortex flowmeter, this circuit board provide 2～5 point flowmeter coefficient K value correction.

For example, for D=80MM vortex flowmeter, the testing medium is liquid, the actual flowmeter coefficient value as table 10 in different flow section.

Table 10

<20 Hz	40	80	> 100
2200	2100	2100	2000

Select the 4 point user calibration and in “VORTEX CHARACTERISTICS”→ “WORK PARAMETER”, the flowmeter coefficient K value is 2100, then the input correction data as table 11.

Table 11

Frequency	K Correction Coefficient	Calculation Formula
20	0.954545	2100/2200=0.954545
40	1	2100/2100=1
80	1	2100/2100=1
100	1.05	2100/2000=1.05

Combined above examples, it indicate the “K CORRECTION COEFFICIENT” of user calibration means, use 2100 pulse as standard, when flow frequency is bigger than 100, every 2000 pulse will correspond to 1m3 flow, so the instaneous flow is larger while calculate by 2100 pulse (2100-2000)/2000=0.05%. the K correction coefficient will input 2100/2000=1.05

6.10.3 Equivalent pulse factor setting instructions

There are two ways to set the pulse factor through the HART software :

I the way to set $1m^3$ to the number of output pulse

II the way to set one pulse to correspond the number of the m^3.

Because the calculation is based on the equivalent pulse through the meter factor K value corrected, therefore, it will get higher accuracy when take the pulse test.

Through the key settings of 57, that is the number of output pulses of 1m^3, comple the equivalent pulse factor setting.

6.10.4 Instruction of original pulse output

If you need to output the original pulse, you can follow the following steps:

6.10.4.1 According to the current meter factor K value，setting the number of pulses output Of 1 m^3, namely setting the buttong “56” and “57” items to be equal numbers.

6.10.4.2 Through the HART configuration software to cancel the correction of the meter factor K,or through the button to enter “60”, and set the five correction factors of K to be “one”.

Output at this time is the original pulse signal. "

If you keep the meter coefficient K value correction, the pulse accuracy will be much higer and more conducive to test.

6.10.5 Temperature pressure compensation illustration

6.10.5.1 Agreement

The pressure sensor adopt the diffusion silicon sensor, the temperature sensor use PT1000.

While correct the pressure sensor or set “ DEFAULT WORKING PRESSURE” manually, both need input “ FLOWMETER PRESSURE”, and the unit is fixed as KPA. The relationship between absolute pressure and gage pressure is : Absolute pressure = gage pressure +101.325kpa.

While correct the temperature sensor or set the “ DEFAULT WORKING TEMPERATURE” manually, input unit fixed as ℃.

6.10.5.2 Pressure sensor calibration

While carry out the pressure sensor calibration, must make sure “ PRESSURE ACQUISITION METHODS” and “ FLOW MODE” as table 12.

Table 12

The lower left corner of "88" character display	Set a variable	Set the content
04	Flow mode	Set one of the following ：【The remaining modes do not collect pressure】 GAS_0：Gas volume： GAS_1：Gas mass： ST_0：Volume of steam ST_1：steam quality ST_3 ： Saturated steam quality （ Pressure Compensation）
71	Pressure acquisition mode	Automatic acquisition：P_1，

		Need an external pressure sensor

Pressure sensors provide a two point calibration. Can pass HART configuration software under the "advanced features" of "temperature pressure sensor" page to complete the calibration; Or through 75 and 74 items manually enter the calibration pressure value, pressure calibration

The key process of calibration：

1） Set up 04 and 07 items

2） Sensor give zero pressure，enter the 74 item,input the current pressure value（kPa），and confirm ；

3） Ssensor give the full point pressure,enter 75 item，input the current pressure value（kPa），and confirm；

Note ： 74 and 75 items must be calibrated ，to insure the correct collection pressure 。

6.10.5.3 remove the small pressure

If the small pressure signal is not stable ，Can be set by buttons the 76th item of "little pressure to remove value" (kPa), small stress removal. When measuring the pressure value is less than "a little pressure to remove values," as a 0 kpa

6.10.5.4 Pressure at any point of the migration

If fixed deviation exists on pressure value can be set by buttons the 77th item of "migration" arbitrary point pressure (kPa) for the unit, at any point in the migration. Input the actual pressure value, eliminate the deviation.

6.10.5.5 The temperature sensor calibration

When calibrating the temperature sensor，must ensure that the "temperature acquisition mode" and "traffic mode" as shown in table 13:

Table 13

The lower left corner of "88" character display	Set variable	Set the content
04	Flow mode	Set one of the following ：【The remaining modes do not collect temperature】 GAS_0：gas volume ： GAS_1：gas mass： ST_0：Volume of steam ST_1：steam quality ST_2 ： Saturated steam quality （ temperature Compensation ）
70	Temperature acquisition mode	automatic collection：t_1 ； to be an ecternal pt1000；

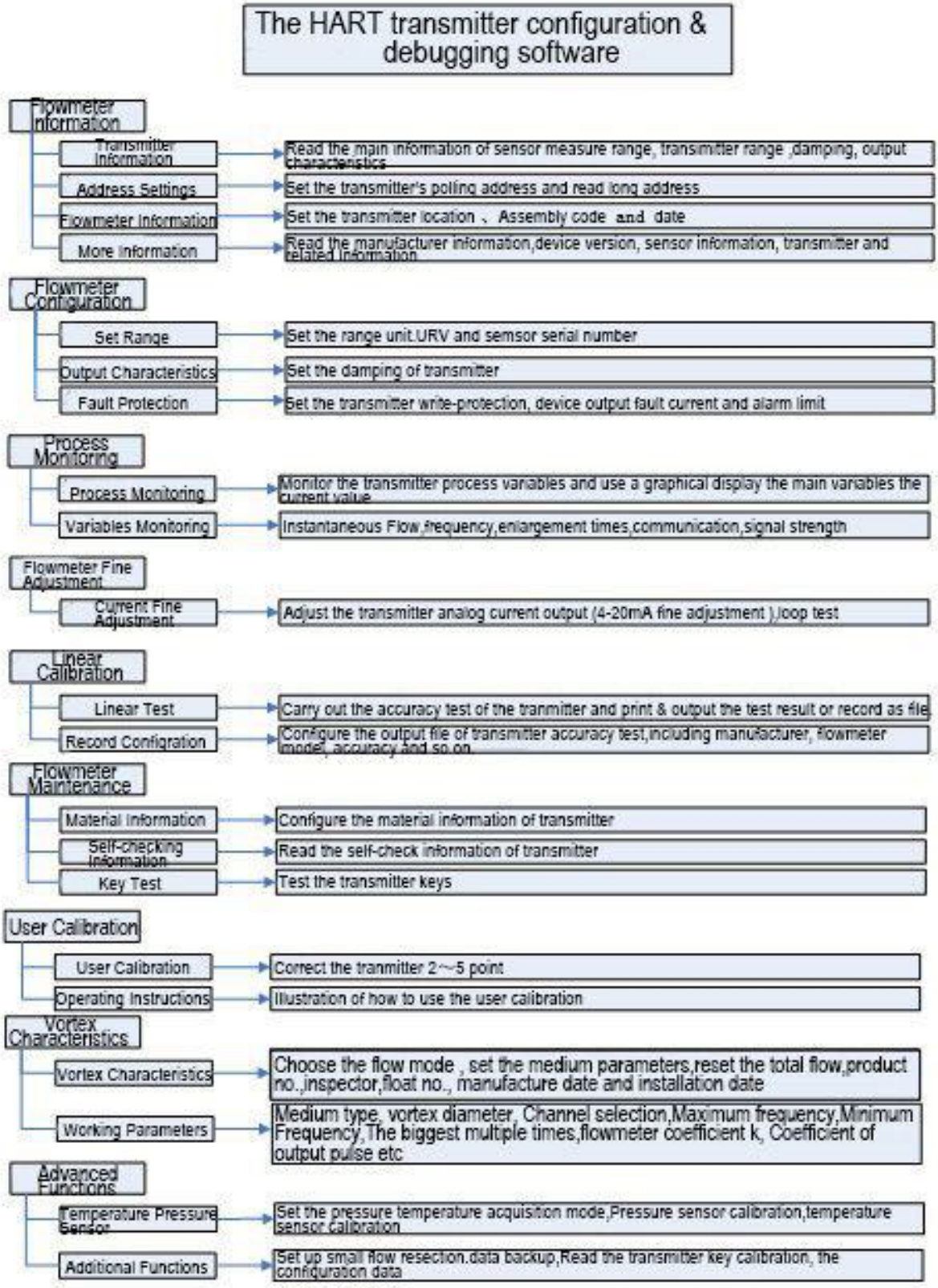
Temperature pressure provide 2 point calibration。Can use “1000”ohm 和“2500ohm Resistance to calibration。

Can pass the HART configuration software via the "Advanced Features" under the "Temperature and Pressure complete the calibration； or pass 72 and 73items imput manul calibration Resistance,completer the remperature calibration。

The key process of calibration：

1) Set up 04 and 70 item；
2) Give low point **Corresponding to the resistance value** 【such as ： 1000Ω】，enter 72，imput the current （Ω），confirm；
3) Give high point **Corresponding to the resistance value**【such as ： 2500Ω】enter 73 item，imput the current resistance value (unit : Ω)，confirm；
4) Note: 72, 73 must be calibrated, in order to ensure the correct temperature acquisition.

Attached one ： HART Configuration Tool manual


The HART transmitter configuration & debugging software
Flowmeter Information
Transmitter Information
Read the main information of sensor measure range, transmitter range ,damping, output characteristics
Address Settings
Set the transmitter's polling address and read long address
Flowmeter Information
Set the transmitter location 、 Assembly code and date
More Information
Read the manufacturer information,device version, sensor information, transmitter and related information
Flowmeter Configuration
Set Range
Set the range unit,URV and semsor serial number
Output Characteristics
Set the damping of transmitter
Fault Protection
Set the transmitter write-protection, device output fault current and alarm limit
Process Monitoring
Process Monitoring
Monitor the transmitter process variables and use a graphical display the main variables the current value
Variables Monitoring
Instantaneous Flow,frequency,enlargement times,communication,signal strength
Flowmeter Fine Adjustment
Current Fine Adjustment
Adjust the transmitter analog current output (4-20mA fine adjustment),loop test
Linear Calibration
Linear Test
Carry out the accuracy test of the tranmitter and print & output the test result or record as file
Record Configration
Configure the output file of transmitter accuracy test,including manufacturer, flowmeter model, accuracy and so on
Flowmeter Maintenance
Material Information
Configure the material information of transmitter
Self-checking Information
Read the self-check information of transmitter
Key Test
Test the transmitter keys
User Calibration
User Calibration
Correct the tranmitter 2~5 point
Operating Instructions
Illustration of how to use the user calibration
Vortex Characteristics
Vortex Characteristics
Choose the flow mode , set the medium parameters,reset the total flow,product no.,inspector,float no., manufacture date and installation date
Working Parameters
Medium type, vortex diameter, Channel selection,Maximum frequency,Minimum Frequency,The biggest multiple times,flowmeter coefficient k, Coefficient of output pulse etc
Advanced Functions
Temperature Pressure Sensor
Set the pressure temperature acquisition mode,Pressure sensor calibration,temperature sensor calibration
Additional Functions
Set up small flow resection,data backup,Read the transmitter key calibration, the configuration data