Vortex Flowmeter FB400 series



FTI Company has the world's largest variety of high-quality vortex flowmeter series to meet the different needs of users, including conventional, compensated, and DSP series. Innovative DSP technology greatly improves the signal processing ability of the product and improves its reliability, offering accurate measurement of the flow of gas, liquid, and steam over a wide flow range.

Main features of the product:

- Able to accurately measure the flow rates of gas, liquid, and vapor over a wide range of flow rates, unaffected by the physical properties of the fluid;
- No moving parts, no wear, no need for mechanical maintenance;
- Simple mechanical installation and electrical connection;
- Diverse output signals, with the option to choose a two

wire (4-20)mA output or three wire pulse output according

to user' s requirements;

- With excellent nonlinear correction function, greatly improving the linearity of the instrument;
- With independent password settings, different levels of password can be set for parameter, total reset, and calibration, convenient for user management;

• Self inspection function, with rich self inspection information, convenient for user maintenance and debugging;

• Equipped with software spectrum analysis function, improving the anti-interference and vibration resistance of the instrument;

- LCD dot matrix Chinese character display, intuitive and convenient, with simple and clear operation;
- Equipped with a fully functional HART protocol, including special commands;
- Configurable RS485 communication protocol;
- Able to be equipped with temperature and pressure sensors for compensation;

Wide range of measurement media, capable of measuring steam, liquid, general gas, natural gas, etc.
 With exceeding compressibility factor for correction while measuring natural gas;

- With two language versions available for users to choose from, Chinese and English;
- Optional battery power supply, one battery can maintain full performance operation for at least 2 years.





1.Working principle

FB400 series vortex flowmeter is mainly composed of body, probe, and circuit board (signal converter). The basic working principle is Carmen vortex street principle. When the medium flows through a vortex generator (triangular cylinder) at a certain speed, two regular rows of vortices alternately generates on both sides of the cylinder. The vortices are arranged asymmetrically downstream of the cylinder, and the separation frequency of the vortices can be measured by a probe (piezoelectric sensor) placed at the rear end of the cylinder (Figure 1).



Figure 1 Working Principle

The vortex separation frequency f is proportional to the flow velocity v and inversely proportional to the width d of the

vortex generator body:

$$f = St \times \frac{\mathbf{v}}{d}$$

St is the Strouhal number, which is dimensionless. When the geometry and size of the vortex generator are designed properly, St is a constant in a wide range of Reynolds number (Figure 2).

$$\operatorname{Re} = v \times \frac{D}{v}$$

- V: Kinematic viscosity of fluids
- D: Caliber of flow meter





Fig. 2 Variation Relationship between Strouhal number St and Reynolds number Re The measured vortex separation frequency varies with flow velocity and is unaffected by fluid density and viscosity. The local pressure pulsation generated by vortex separation is detected by the probe and converted into a pulse signal corresponding to the vortex frequency in the detection circuit. The circuit board (signal converter) converts this pulse signal into flow and outputs it.

2.Technical parameters

2.1 Power supply and output interface



2.2 Functional parameters



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Installation form		Clamp type	Flange connection type	Plug-in type			
illustration							
Sensor							
Measuring media			liquid/gas/steam				
Caliber	[DN15~DN300	DN15~DN400	≥DN300			
Pressure class				≪PN1.6MPa			
Temperature range		-	-40℃~130℃				
Body meterial		Carbon steel, 304, 316L, Hastelloy alloy					
Probe material		304, 316L, Hastelloy alloy					
Explosion proof type		Exd II CT4, Ex ia II CT4					
Protection class		IP65, IP67, IP68					
Measuring accuracy		±1.0% (standard) , ±0.5% (customized)					
Range ratio		1:10~1:20					
Converter							
Conveter type			One-piece type/split type	One-piece type/split type			
Converter design nui	mber	S50	S51	S60			
Function		Conventional	Compensational, With temperature and voltage compensation circuit	DSP technology			
Power supply	24V DC , 3.6V (Battery power supply)		, 3.6V (Battery power supply)	24V DC			
Communication	HART , RS485 (Modbus) HART			HART			
Housing material	Aluminum housing (standard) , 316L housing						
Measuring parameters	Instantaneous flow rate /total flow		Instantaneous flow rate/total flow Optional temperature and pressure measurement	Instantaneous flow rate/total flow			
Temperature and pressure compensation			Able to connect to temperature and pressure inputs				



Signal output		$(4\sim 20)$ mA, Pulse output				
Protection class		IP65, IP67				
Power consumption		≤5W				
Environment condition						
Temperature		-30 ℃~60℃				
Relative humidity		5%~90%				
Atmospheric pressure		(40~106) kPa				

3.Installation instructions

The installation position and method of the flow meter directly affect the service life of the flow meter, and even permanently damage the flow meter. Please refer to the following items during installation.

3.1 Requirements for front and rear straight pipe sections

When installing the flow meter, it is necessary to ensure the minimum requirements for the front and rear straight pipe sections, as shown in Figure 3. Otherwise, it will seriously affect the measurement accuracy and even cause the flow meter to malfunction.



Figure 3: Length of straight pipe sections at the inlet and outlet of the flow meter (D refers to the nominal diameter of the flow meter).



3.2 Installation of high-temperature pipelines

When the instrument is installed in a horizontal pipeline and the medium temperature is above 180 °C, it is recommended to choose a split flow meter or use a side mounted flow meter, that is, the head of the flow meter is at an angle of 45 ° to 60 ° in the vertical direction, otherwise excessive temperature will damage the signal converter. The correct side installation method is shown in Figure 4.



Figure 4 Installattion of High Temperature Pipeline (Temperature>180 °C)

3.3 Installation of gas or steam pipelines

When the measuring medium is gas or steam, the instrument should be installed at the position shown in Figure 5 and cannot be installed at the lowest point of the pipeline. At the lower part of the pipeline, liquid may accumulate and form water vapor two-phase flow, leading to increased measurement errors and even inability to function properly. In addition, when steam is turned on at the lower part of the pipeline, water hammer impact may occur, damaging the triangular column or probe.



Figure 5 Gas or Steam Pipeline Installation



3.4 Liquid pipeline installation

When measuring liquid, the pipeline should be filled up with the liquid, and the instrument should be installed at the position shown in Figure 6, not at the highest point of the pipeline. At the higher part of the pipelines, bubbles may accumulate, seriously affecting measurement accuracy. When the instrument is installed in a vertical pipeline, the direction of liquid flow cannot be from top to bottom, otherwise it will cause insufficient pipe, seriously affecting measurement accuracy.



Figure 6 Liquid Pipeline Installation

3.5 Insulation layer thickness

When insulation is required for pipelines, the thickness of the insulation layer for the instrument part cannot exceed 50mm, as shown in Figure 7. An excessively thick insulation layer can increase the temperature of the converter and easily cause damage to the signal converter.



Figure 7 Insulation layer thickness



3.6 Maintenance space

During installation, a minimum clear space of 200mm or more must be left above the flowmeter for disassembly and maintenance, as shown in Figure 8.



Figure 8 Maintenance space

3.7 Installation of plug-in flow meters

Firstly, weld the installation base onto the pipeline, and then install each part from bottom to top. Ball valves may not be installed, as shown in Figure 9.



Figure 9 Installation diagram of plug-in flow meter

3.8 Installation of split flow meter

The installation of the split flow meter body is the same as that of the one-piece flow meter. The installation base of the converter must be firmly fixed on the wall, inside the box, or on the instrument bracket. The maximum transmission distance between the converter and the sensor is 5m, and the connecting cable is shielded cable. Try to shorten the cable length as much as possible according to actual needs to reduce signal attenuation and external interference. See Figure 10.





Figure 10 Installation diagram of split flow meter

3.9 Avoiding Vibration

The installation position of the flow meter should avoid vibration, as the vibration of the pipeline can affect the measurement. If necessary, supports can be installed on both sides of the instrument on the pipeline or flexible connections can be used to isolate the instrument from the vibration source.

3.10 Long pipeline installation

In longer pipelines, considering the possibility of pressure fluctuations at zero flow rate, which may cause mismetering, it is recommended to install gate valves before and after the flow meter. Generally, the valves used for switches are installed at the front end of the instrument, and the valves used for adjustment are installed at the back end of the instrument.

3.11 Gas-liquid two-phase flow

If the measured medium is gas-liquid two-phase, a gas-liquid separation device should be installed at the front end of the instrument.

- 4. Installation dimensions
 - 4.1 Flange connection type







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National standard series

Nominal diameter mm	Nominal pressure MPa	Length mm	Height mm	Outer diameter of flange mm	Bolt hole center distance mm	Bolt aperture mm	Quantity of bolt	Flange thickness mm	Weight kg
DN	Ρ	L	Н	D	k	d1	Ν	b	Weight
15	4.0	150	312	95	65	14	4	14	5
20	4.0	150	312	105	75	14	4	16	5
25	4.0	150	312	115	85	14	4	16	5
32	4.0	155	312	140	100	18	4	18	6
40	4.0	160	318	150	110	18	4	18	7
50	4.0	175	320	165	125	18	4	20	9
65	4.0	175	328	185	145	18	8	22	10
80	4.0	200	335	200	160	18	8	24	13
100	1.6/4.0	250	345	220/235	180/190	18/22	8	22/26	14/18
125	1.6/4.0	250	360	250/270	210/220	18/26	8	22/28	20/26
150	1.6/4.0	300	372	285/300	240/250	22/26	8	24/30	25/34
200	1.6/2.5	350	400	340/360	295/310	22/26	12	26/32	45/66
250	1.6/2.5	450	425	405/425	355/370	26/30	12	28/35	67/106
300	1.6/2.5	500	455	460/485	410/430	26/30	12/16	32/38	77/123



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ANSI series

Nominal diameter mm	Nominal pressure LB	Length mm	Height mm	Outer diameter of flange mm	Bolt hole center distance mm	Bolt aperture mm	Quantity of bolt	Flange thickness mm	Weight kg
DN	Cl s	L	Н	D	k	d1	N	b	Weight
	150			88.9	60.5	15.9		11.2	5
	300			95.2	66.5	15.9		14.2	5
15	600	200	315	95.3	66.5	15.9	4	20.6	5
	900			120.6	82.5	22.3		28.8	8
	150			108	79.4	15.9		14.2	6
0.5	300	200	0.4.5	124	88.9	19		17.5	7
25	600	220	315	124	88.9	19	4	23.9	7
	900	240		149.3	101.6	25.4		34.8	11
	150	200		127	98.4	15.9		17.5	9
40	300	200	220	155.6	114.3	22.6	1	20.6	11
40	600	235	320	155.6	114.3	22.6	4	28.8	12
	900	260		177.8	123.9	28.4		38.2	17
	150	200		152.4	120.6	19	4	19.1	10
50	300	200	200	165	127	19	8	22.4	12
50	600	240	322	165	127	19		31.8	14
	900	300		215.9	165.1	25.4		44.5	27
	150	200		190.5	152.4	19	4	23.9	18
80	300	265	335	209.5	168.3	22.2		28.4	22
80	600		335	209.5	168.3	22.2	8	38.2	26
	900	305		241.3	190.5	25.4		44.5	35
	150	250		228.6	190.5	19		23.9	20
100	300	250	211	254	200	22.2	0	31.8	29
100	600	315	344	273.1	215.9	25.4	0	44.5	41
	900	340		292.1	234.9	31.7		50.8	51
	150	300		279.4	241.3	22.2	8	25.4	33
150	300	300	371	317.5	269.9	22.2		36.6	50
150	600	365	571	355.6	292.1	28.4	12	54.2	82
	900	410		381	317.5	31.7		62	107
	150	350		343	298.4	22.2	8	28.4	
200	300	550	133	381	330.2	25.4		41.1	
200	600	415	433	419.1	349.3	31.8	12	62	
	900	470		469.9	393.7	38.1		69.9	_
	150	450		406.4	362	25.4	12	30.2	
250	300	430	458	444.5	387.3	28.4	16	47.7	_
	600	470		508	431.8	35.1	10	69.9	_
	150			482.6	431.8	25.4	12	31.8	_
300	300	500	483	520.7	450.8	31.7	16	50.8	
	600	1		558.8	489	35.1	20	72.9	_



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4.2 Clamping type



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	MARRIED DEPENDING

Nominal diameter	Nominal pressure	Length	Height	Outer diameter	Weight
mm	MPa	mm	mm	of body mm	kg
DN	PN	L	Н	D	Weight
15	4.0	65	316	39	4
20	4.0	65	316	50	4
25	4.0	65	318	57	4
32	4.0	65	318	65	5
40	4.0	65	306	75	5
50	4.0	65	311	87	6
65	4.0	65	321	109	7
80	4.0	65	326	120	8
100	4.0	65	342	149	9
125	2.5	65	355	175	11
150	2.5	65	368	203	13
200	2.5	100	398	259	22
250	1.6	100	423	312	31
300	1.6	120	448	363	40



5. Determination of flow range and caliber

The actual available flow range of the flowmeter needs to be determined through calculation, and the following operating parameters must be clearly defined first:

- Media name, composition, and status;
- Maximum, commonly used, and minimum flow rates under working conditions;
- Maximum, common, and minimum working pressure and temperature.

5.1 Gas medium

The measurement of gas flow rate by flow meters is generally not affected by medium pressure and temperature. The selection of instrument caliber can be based on the operating flow rate of air. The range of air operating flow rate is shown in Table 1.

caliber	measuring range (m³/h)	optional measuring range (m³/h)	notes
DN15	5~30	5~36	The second s
DN20	6~50	6~60	for the applicable flow
DN25	9~60	8~120	range in the table are:
DN32	13~130	11~170	- ·
DN40	18~180	18~290	Temperature
DN50	30~300	30~400	$I_0=20$ C
DN65	50~500	50~700	P ₂ =0 1013MPa
DN80	70~700	70~1000	Density
DN100	110~1000	100~1750	$\rho_0 = 1.205 \text{kg/m}^3$
DN125	150~1500	140~2800	Viscosity
DN150	200~2000	200~3700	u₀=15mm²/s
DN200	400~4000	320~7500	
DN250	600~6000	550~13000	
DN300	1000~10000	800~18400	

 Table 1 Air Flow Range under Operating Conditions



Gas name	Density (kg/m ³)	Gas name	Density (kg/m ³)
dry air	1.2050	H2	0.0838
C2H2	1.0950	CH4	0.6680
NH3	0.7190	C2H6	0.3324
O2	1.3320	C3H8	1.8687
СО	1.1650	C4H10	2.5192
CO2	1.8430	N2	1.1656
F2	1.6627	Ne	0.8388
C2H4	1.1747	NO	1.2490
C3H6	1.7838	NO2	1.9153

Table 2 Common Gas Density (0.1013MPa, 20°C)

5.2 Liquid media

The measurement of liquid flow rate by flow meter can refer to Table 3.

Caliber	Measurement range (m³/h)	Optional measurement range (m ³ /h)	Notes
DN15	0.6~5	.5~6	(1) The liquid in the
DN20	1.5~12	~12	table is water.
DN25	2~16	1.6~16	(2) The reference
DN32	2.5~25	.5~30	conditions for the
DN40	3~30	2.4~36	applicable flow range
DN50	4~40	3~55	o 0=1000kg/m3
DN65	8~80	6~100	(3) The maximum
DN80	13~130	0~170	flow rate of liquid
DN100	20~200	5~270	should generally be \leq
DN125	36~360	5~450	7m/s.
DN150	50~500	0~630	
DN200	100~1000	80~1100	
DN250	150~1500	120~1800	
DN300	200~2000	180~2500	

Table 3 Flow Range of Liquid (ν =1cSt)

FTI.Inc.1013 Centre Road, Suite 403S, Wilmington, DE 19805 USA .Telephone: 302 300 1919 • Mail:sales@ftisensors.com • www.ftisensors.com