

F4001-Smart Vortex Flowmeter

INTRODUCTION

GPE F4001-Smart Vortex Flowmeter (also called a Vortex Shedding Flowmeter) is a versatile instrument that calculates the mass flow, volumetric flow rate, temperature, and pressure and density of any liquid, gas, or steam through a pipeline. Wide spread application is found in several industries including Petrochemical, Chemical, Pharmaceutical, Food and Beverage, Water, and Wastewater Treatment

MEASURING PRINCIPLE

Karman Vortex Street

This flowmeter operates on the principle of Karman Vortex Street, any medium passing through the pipeline flows around the bluff body and sheds a series of alternating vortices on each side of the body. This phenomenon is referred to as Vortex Shedding. These vortices shed downstream of the bluff body and dissipate as they flow further. This pattern of vortices is called a Karman Vortex Street (also called a Von Karman Vortex Street, see pictures in right side Fig. 1.1).



Fig. 1.1 Von Karman vortices

Calculation of the Mass Flow Rate

The frequency of the vortices, i.e. the number of vortices shed per second, is directly proportionate to the velocity of the medium. This Vortex Shedding Frequency is used to calculate the mass flow.

The sensor assembly records the pressure and velocity oscillations generated on each side of the bluff body by the vortices and generate a digital linear output signal. The Vortex Shedding Frequency is calculated using the following formula:

$$f = St * V/d$$

Where:

f= Frequency of Vortex shedding

St=Strouhal Number

V=Flow Velocity

d=Width of the Bluff Body

Strouhal Number St

The Strouhal Number in the above formula is also called as “reduced frequency”. It is a dimensionless parameter that is a measure of the Vortex Shedding Frequency and the velocity of the flow medium. It is calculated using the formula:

$$St = fd/U$$

Where:

F=Frequency of the Vortex Shedding

U = Velocity of the Flow Medium

d=Width of the Bluff Body

The Strouhal Number is a function of the Reynold’s Number. Reynold’s Number is also a dimensionless parameter that is used to determine how the flow pattern of different fluids will change. The Strouhal Number should remain constant when the Reynold’s Number ranges from 2×10^4 to 7×10^6 .

FEASTURES

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GPE™ F4001-Smart Vortex Flowmeter

- Smart integral structure with pressure and temperature compensation
- Suitable for a wide variety of applications with steam, gas, and liquid medias
- No moving parts, high reliability and durability
- Piezo-electric sensor isolated from the process fluid
- Error messages displayed for or erratic flows and flows outside of calibrated ranges
- Field calibration possible with integral or remote electronics and keypad
- True 2-wire 4-20 mA interface
- Wide measuring range, turn-down ratio of 10:1
- Insertion meters can be installed vertically, horizontally or in angled pipelines
- Available and an integrated mass flow vortex
- F4001 (insertion) can be hot-tapped with ball valve and retractable assembly



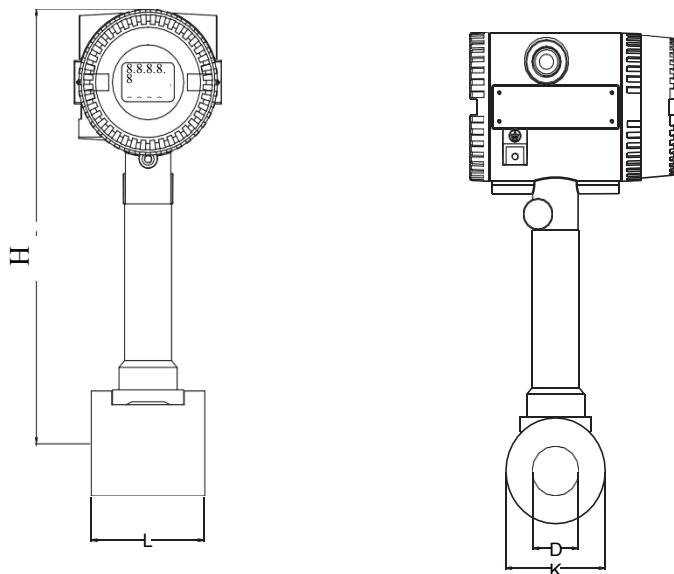
Smart integral structure with pressure and temperature sensor

TECHNICAL SPECIFICATION

- SIZE: 1/2" to 12" (DN15mm to DN300mm)
- Process Connections: wafer(standard), Flanged; Insertion;
- Process temperature : 23~482 °F (-5~+250 °C) (with LCD display)
- Operating pressure : 232 psi (1.6MPa) std; up to 928 (6.4 MPa) optional
- Velocity Range:
Liquids : 2~20ft/s(0.6~6 m/s).
Gas& Steam: 23~ 148ft/s (5~65m/s)
Accuracy:1.0% for liquid; 1.5% for gas and steam
- Repeatability : 0.33% for liquid, 0.5% for gas
- Turn down ratio: 10:1 (liquids)
- Materials: Stainless steel # 304
- Signal output: Pulse output, 2-wire 4-20mA Dc, Vdc, RS484(Modbus RTU) , HART foundation fieldbus.
- RAM Back-up: Lithium Battery, 3.6Vdc
- Housing protection : IP65; IP67 for options
- Class I, Div. 1, Groups B, C and D listed for hazardous zone
- Display units : m3/h, kg/hr
- Keypad : Rate, Total
- Power supply : isolated 14~36 VDC or Battery for local
- NIST traceable : YES
- Data storage : EPROM storage up to 5 years
- Data logger : Reading, sampling Times 0.5 S

INSTALLATION DIMENSION

A.1)wafer type installaton dimension A.1.1



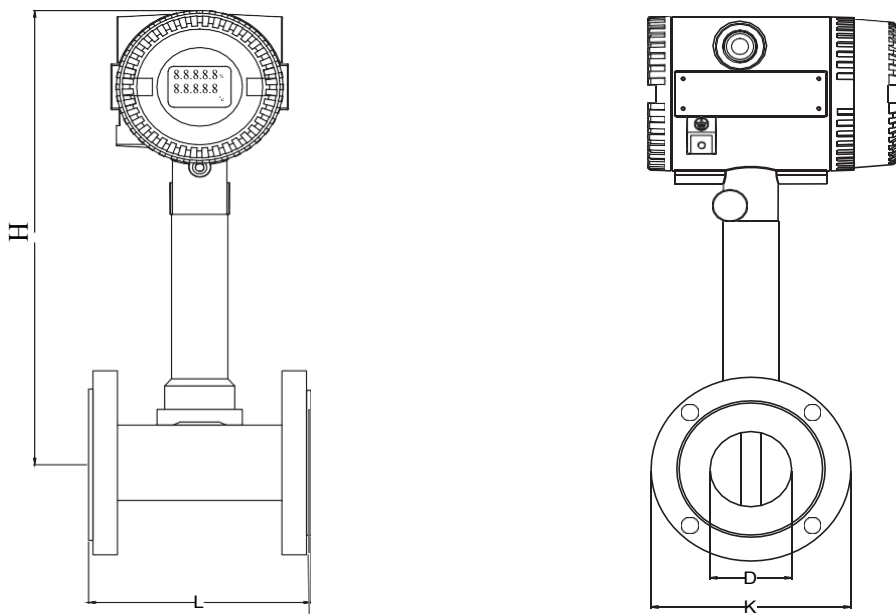
A.1.1 Wafer connection dimension

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GPE™ F4001-Smart Vortex Flowmeter

Size In. (mm)	K Pipe OD In. (mm)	L Pipe Length In. (mm)	Flange Screw Hole Distance In. (mm)	Flange Thickness In. (mm)	Screw Hole Diameter In. (mm)	Screw qty.	H Meter Height In. (ft)
1/2" 15	3.58" 91	2.55" (65)	3.94" (100)	0.46" (11.6)	0.62" (16)	4 4	11.56" (293.5)
1" 25	3.58" (91)	2.55" (65)	3.94" (100)	0.57" (14.7)	0.62" (16)	4 4	11.35" (288.5)
1½" (40)	3.31" (84)	2.55" (65)	4.72" 120	0.70" (17.9)	0.62" (16)	4	11.63" (295.8)
2" (50)	3.7" (94)	2.55" (65)	5.19" (132)	0.76" (19.5)	0.74" (19)	4	11.85" (301)
3" (80)	4.27" (120)	2.55" (65)	6.29" (160)	0.95" (24.3)	0.74" (19)	4	12.44" (316)
4" (100)	5.51" (140)	3.54" (90)	7.48" (190)	0.95" (24.3)	0.74" (19)	8	12.87" (327)
6" (150)	7.48" (190)	2.55" (65)	9.44" (240)	1.01" (25.9)	0.86" (22)	8	13.89" (353)
8" (200)	9.44" (240)	3.34" (85)	11.65" (296)	1.14" (29)	0.86" (22)	8	14.88" (378)
10" (250)	11.41" (290)	3.93" (100)	13.93" (354)	1.20" (30.6)	0.86" (22)	12	15.90" (404)
12" (300)	13.38" (340)	4.72" (120)	16.22" (412)	1.26" (32.2)	0.86" (22)	12	16.88" (429)

A.2)General flange type connection installation diemension(A1.2) for ANSI/ASME 150LB RF

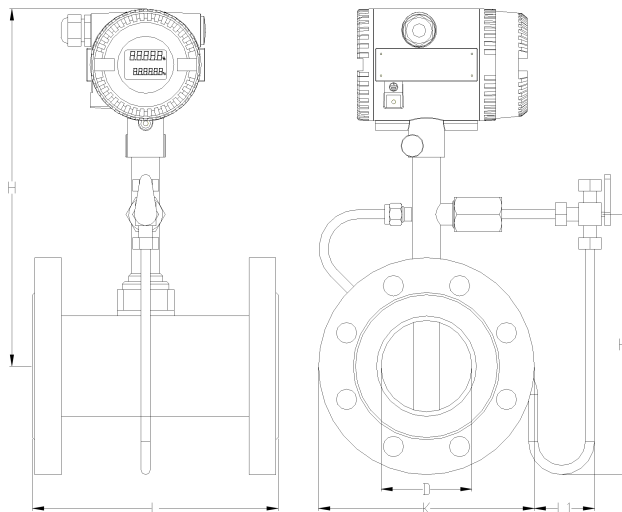


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GPE™ F4001-Smart
Vortex Flowmeter

D Size In. (mm)	K Pipe OD In. (mm)	L Pipe Length In. (mm)	Flange Screw Hole Distance In. (mm)	Flange Thickness In. (mm)	Screw Hole Diameter In. (mm)	Screw qty.	H Meter Height In. (mm)
1/2" (15)	3.54" 90	7.08" 180	2.37" 60.3	0.46" 11.6	0.62" 16	4 4	11.87" 301.5
3/4" (20)	3.94" 100	7.08" 180	2.75" 69.9	0.52" 13.2	0.62" 16	4 4	11.77" 299
1" (25)	4.33" (110)	7.08" (180)	3.12" (79.4)	0.57" (14.7)	0.62" (16)	4	11.63" (295.5)
1½" (40)	4.92" (125)	7.08" (180)	3.87" (98.4)	0.70" (17.9)	0.62" (16)	4	11.90" (302.5)
2" (50)	5.90" (150)	7.08" (180)	4.75" (120.7)	0.76" (19.5)	0.74" (19)	4	12.08" (307)
3" (80)	7.48" (190)	7.87" (200)	6" (152.4)	0.95" (24.3)	0.74" (19)	4	12.86" (326)
4" (100)	9.05" (230)	8.66" (220)	7.5" (190.5)	0.95" (24.3)	0.74" (19)	8	13.22" (336)
6" (150)	11.02" (280)	8.66" (220)	9.5" (241.3)	1.01" (25.9)	0.86" (22)	8	14.17" (360)
8" (200)	13.58" (345)	8.66" (220)	11.75" (298.5)	1.14" (29)	0.86" (22)	8	15.15" (385)
10" (250)	15.94" (405)	9.84" (250)	14.25" (362)	1.20" (30.6)	0.86" (22)	12	16.24" (412.7)
12" (300)	19.09" (485)	11.81" (300)	17" (431.8)	1.26" (32.2)	0.86" (22)	12	17.53" (445.4)

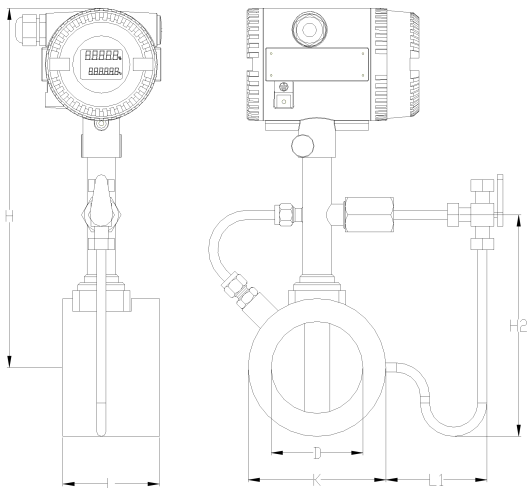
A.3) Smart type flanged connection installation dimensions



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Table A.3 Smart compensation type installation dimensions

D Size In. (mm)	K Pipe OD In. (mm)	L Pipe Length In. (mm)	Flange Screw Hole Distance In. (mm)	Flange Thickness In. (mm)	Screw Hole Diameter In. (mm)	Screw qty.	H Meter Height In. (mm)
1/2 " (15)	3.54" 90	7.08" 180	2.37" 60.3	0.46" 11.6	0.62" 16	4 4	11.87" 301.5
3/4" (20)	3.94" 100	7.08" 180	2.75" 69.9	0.52" 13.2	0.62" 16	4 4	11.77" 299
1" (25)	4.33" (110)	7.08" (180)	3.12" (79.4)	0.57" (14.7)	0.62" (16)	4	11.63" (295.5)
1½" (40)	4.92" (125)	7.08" (180)	3.87" (98.4)	0.70" (17.9)	0.62" (16)	4	11.90" (302.5)
2" (50)	5.90" (150)	7.08" (180)	4.75" (120.7)	0.76" (19.5)	0.74" (19)	4	12.08" (307)
3" (80)	7.48" (190)	7.87" (200)	6" (152.4)	0.95" (24.3)	0.74" (19)	4	12.86" (326)
4" (100)	9.05" (230)	8.66" (220)	7.5" (190.5)	0.95" (24.3)	0.74" (19)	8	13.22" (336)
6" (150)	11.02" (280)	8.66" (220)	9.5" (241.3)	1.01" (25.9)	0.86" (22)	8	14.17" (360)
8" (200)	13.58" (345)	8.66" (220)	11.75" (298.5)	1.14" (29)	0.86" (22)	8	15.15" (385)
10" (250)	15.94" (405)	9.84" (250)	14.25" (362)	1.20" (30.6)	0.86" (22)	12	16.24" (412.7)
12" (300)	19.09" (485)	11.81" (300)	17" (431.8)	1.26" (32.2)	0.86" (22)	12	17.53" (445.4)

A.4) Smart type wafer connection installation dimensions


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Table A.4 Smart meter wafer connection installation dimensions.

Size In. (mm)	K Pipe OD In. (mm)	L Pipe Length In. (mm)	Flange Screw Hole Distance In. (mm)	Flange Thickness In. (mm)	Screw Hole Diameter In. (mm)	Screw qty.	H Meter Height In. (mm)
1/2" 15	3.58" 91	2.55" (65)	3.94" (100)	0.46" (11.6)	0.62" (16)	4	11.56" (293.5)
1" 25	3.58" (91)	2.55" (65)	3.94" (100)	0.57" (14.7)	0.62" (16)	4	11.35" (288.5)
1½" (40)	3.31" (84)	2.55" (65)	4.72" 120	0.70" (17.9)	0.62" (16)	4	11.63" (295.8)
2" (50)	3.7" (94)	2.55" (65)	5.19" (132)	0.76" (19.5)	0.74" (19)	4	11.85" (301)
3" (80)	4.27" (120)	2.55" (65)	6.29" (160)	0.95" (24.3)	0.74" (19)	4	12.44" (316)
4" (100)	5.51" (140)	3.54" (90)	7.48" (190)	0.95" (24.3)	0.74" (19)	8	12.87" (327)
6" (150)	7.48" (190)	2.55" (65)	9.44" (240)	1.01" (25.9)	0.86" (22)	8	13.89" (353)
8" (200)	9.44" (240)	3.34" (85)	11.65" (296)	1.14" (29)	0.86" (22)	8	14.88" (378)
10" (250)	11.41" (290)	3.93" (100)	13.93" (354)	1.20" (30.6)	0.86" (22)	12	15.90" (404)
12" (300)	13.38" (340)	4.72" (120)	16.22" (412)	1.26" (32.2)	0.86" (22)	12	16.88" (429)

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F4001-Smart Vortex Flowmeter

Flow Range

Mass flow of saturated stream(kg/hr)

Pressure	0.3MPa		0.4MPa		0.6MPa		0.7MPa		0.8MPa		1MPa		1.2MPa		1.5MPa	
Temp	133.5deg C		143.6deg C		158.9deg C		165deg C		170.7deg C		179.88deg C		187.96deg C		198.4deg C	
Density	1.615Kg/m3		2.163Kg/m3		3.17Kg/m3		3.667Kg/m3		4.162Kg/m3		5.147Kg/m3		6.127Kg/m3		7.602Kg/m3	
1/2"																
DN15	11	63	12	73	14	88	15	85	16	101	18	112	19	123	23	136
3/4"																
DN20	13	102	15	116	18	141	19	151	20	161	22	179	24	196	27	218
1"																
DN25	17	133	19	153	23	185	25	199	27	212	30	236	32	257	36	287
1 1/2"																
DN40	34	340	39	390	47	470	51	510	54	540	60	600	66	660	73	730
2"																
DN50	63	630	73	730	88	880	95	950	101	1,010	112	1,120	122	1,220	136	1,360
2 1/2"																
DN65	106	1,060	121	1,210	146	1,460	158	1,580	168	1,680	187	1,870	204	2,040	227	2,270
3"																
DN80	148	1,480	170	1,700	205	2,050	221	2,210	235	2,350	262	2,620	285	2,850	318	3,180
4"																
DN100	222	2,220	242	2,420	293	2,930	315	3,150	336	3,360	374	3,740	408	4,080	454	4,540
5"																
DN125	318	3,180	363	3,630	440	4,400	473	4,730	504	5,040	561	5,610	612	6,120	681	6,810
6"																
DN150	423	4,230	484	4,840	586	5,860	631	6,310	672	6,720	747	7,470	815	8,150	908	9,080
8"																
DN200	847	8,470	969	96,900	1,173	11,730	1,262	12,620	1,344	13,440	1,495	14,950	1,631	16,310	1,815	18,150
10"																
DN250	1,270	12,700	1,453	14,530	1,769	17,690	1,892	18,920	2,016	20,160	2,242	22,420	2,446	24,460	2,725	27,250
12"																
DN300	2,116	2,160	2,422	24,220	2,932	29,320	3,154	31,540	3,360	33,600	3,737	37,370	4,077	40,770	4,541	45,410

*Note: The pressure in table is gauge pressure

Mass flow of saturated stream(lb/hr)

Pressure	3bar		4bar		6bar		7bar		8bar		10bar		12bar		15bar	
Temp	272.3deg F		290.48deg F		318.02deg F		329deg F		339.26deg F		355.78deg F		370.33deg F		389.12deg F	
Density	1.615Kg/m3		2.163Kg/m3		3.17Kg/m3		3.667Kg/m3		4.162Kg/m3		5.147Kg/m3		6.127Kg/m3		7.602Kg/m3	
1/2"																
DN15	24	139	26	161	31	194	33	187	35	223	40	247	42	271	51	300
3/4"																
DN20	29	225	33	256	40	311	42	333	44	355	49	395	53	432	60	481
1"																
DN25	37	293	42	337	51	408	55	439	60	467	66	520	71	567	79	633
1 1/2"																
DN40	75	750	86	860	104	1036	112	1124	119	1190	132	1323	146	1455	161	1609
2"																
DN50	139	1389	161	1609	194	1940	209	2094	223	2227	247	2469	269	2690	300	2998
2 1/2"																
DN65	234	2337	267	2668	322	3219	348	3483	370	3704	412	4123	450	4497	500	5004
3"																
DN80	326	3263	375	3748	452	4519	487	4872	518	5181	578	5776	628	6283	701	7011
4"																
DN100	489	4894	534	5335	646	6460	694	6945	741	7408	825	8245	899	8995	1001	10009
5"																
DN125	701	7011	800	8003	970	9700	1043	10428	1111	11111	1237	12368	1349	13492	1501	15013
6"																
DN150	933	9326	1067	10670	1292	12919	1391	13911	1482	14815	1647	16469	1797	17968	2002	20018
8"																
DN200	1867	18673	2136	213628	2586	25860	2782	27822	2963	29630	3296	32959	3596	35957	4001	40014
10"																
DN250	2800	27999	3203	32033	3900	39000	4171	41711	4445	44445	4943	49428	5393	53925	6008	60076
12"																
DN300	4665	4762	5340	53396	6464	64640	6953	69534	7408	74075	8239	82387	8988	89882	10011	100112

*Note: The pressure in table is gauge pressure

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F4001-Smart Vortex Flowmeter

Flow range in Metric units

Mass flow of superheated steam (kg/hr)

Size, in	min flow		max flow	
1/2"	8	$\sqrt{\rho}$	49.5	$\sqrt{\rho}$
3/4"	10	$\sqrt{\rho}$	79	$\sqrt{\rho}$
1"	13	$\sqrt{\rho}$	104	$\sqrt{\rho}$
1 1/4"	23	$\sqrt{\rho}$	184	$\sqrt{\rho}$
1 1/2"	27	$\sqrt{\rho}$	265	$\sqrt{\rho}$
2"	49	$\sqrt{\rho}$	494	$\sqrt{\rho}$
2 1/2"	82	$\sqrt{\rho}$	585	$\sqrt{\rho}$
3"	115	$\sqrt{\rho}$	823	$\sqrt{\rho}$
4"	165	$\sqrt{\rho}$	1,153	$\sqrt{\rho}$
5"	247	$\sqrt{\rho}$	1,647	$\sqrt{\rho}$
6"	329	$\sqrt{\rho}$	2,471	$\sqrt{\rho}$
8"	659	$\sqrt{\rho}$	3,294	$\sqrt{\rho}$
10"	988	$\sqrt{\rho}$	6,588	$\sqrt{\rho}$
12"	1647	$\sqrt{\rho}$	21786	$\sqrt{\rho}$

*Note: ρ ---density of the superheat steam under operating condition (Kg/m3)

Volumetric flow of gas (Nm3/hr)

Size, in	Q.min	Q.max
1/2"	5	30
3/4"	6	50
1"	7.1	105
1 1/4"	12	174
1 1/2"	9	280
2"	14	426
2 1/2"	24	716
3"	36.2	1084
4"	56.6	1694.9
5"	88	2648
6"	127	3818
8"	226	6780
10"	353	10593
12"	508	15254

Volumetric flow of liquid (m3/hr)

Size, in	Q.min	Q.max
1/2"	1.5	6
3/4"	1.2	8
1"	0.5	12.4
1 1/4"	0.9	20.2
1 1/2"	1.4	31.6
2"	2.1	49.4
2 1/2"	3.6	83.5
3"	5.4	126.6
4"	8.5	197.7
5"	13.2	309
6"	19.1	444.9
8"	33.9	791
10"	53	1235.9
12"	76	1780

Note: Standard condition 20°C, 0.1MPa absolute pressure), or under atmosphere at 20°C

Flow range in US units

Mass flow of superheated steam (lb/hr)

Size, in	min flow		max flow	
1/2"	18	$\sqrt{\rho}$	109	$\sqrt{\rho}$
3/4"	22	$\sqrt{\rho}$	174	$\sqrt{\rho}$
1"	29	$\sqrt{\rho}$	229	$\sqrt{\rho}$
1 1/4"	51	$\sqrt{\rho}$	406	$\sqrt{\rho}$
1 1/2"	59	$\sqrt{\rho}$	584	$\sqrt{\rho}$
2"	109	$\sqrt{\rho}$	1089	$\sqrt{\rho}$
2 1/2"	182	$\sqrt{\rho}$	1290	$\sqrt{\rho}$
3"	254	$\sqrt{\rho}$	1814	$\sqrt{\rho}$
4"	363	$\sqrt{\rho}$	2542	$\sqrt{\rho}$
5"	545	$\sqrt{\rho}$	3631	$\sqrt{\rho}$
6"	726	$\sqrt{\rho}$	5448	$\sqrt{\rho}$
8"	1452	$\sqrt{\rho}$	7262	$\sqrt{\rho}$
10"	2179	$\sqrt{\rho}$	14524	$\sqrt{\rho}$
12"	3631	$\sqrt{\rho}$	21786	$\sqrt{\rho}$

*Note: ρ ---density of the superheat steam under operating condition (Kg/m3)

Volumetric flow of gas (MMSCFD)

Size, in	Q.min	Q.max
1/2"	0.0042	0.0254
3/4"	0.0051	0.0424
1"	0.0060	0.0890
1 1/4"	0.0102	0.1475
1 1/2"	0.0076	0.2373
2"	0.0119	0.3611
2 1/2"	0.0203	0.6068
3"	0.0307	0.9187
4"	0.0480	1.4365
5"	0.0746	2.2443
6"	0.1076	3.2360
8"	0.1915	5.7464
10"	0.2992	8.9781
12"	0.4306	12.9286

Volumetric flow of liquid (GPM)

Size, in	Q.min	Q.max
1/2"	6.60	26.42
3/4"	5.28	35.22
1"	2.20	54.60
1 1/4"	3.96	88.94
1 1/2"	6.16	139.13
2"	9.25	217.50
2 1/2"	15.85	367.64
3"	23.78	557.40
4"	37.42	870.45
5"	58.12	1360.49
6"	84.09	1958.84
8"	149.26	3482.67
10"	233.35	5441.50
12"	334.62	7837.10

Note: Standard condition 68°F, 1bar absolute pressure), or under atmosphere at 68°F

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F4001-Smart Vortex Flowmeter

Ordering code

** Please contact your local GPE application engineer when ordering.

You also need to provide the following information when ordering :

Fluid type liquid , air or stream	Process temperature and pressure	Flange type	Full scale flow	Line Size

F4001 Series Vortex Flow meter				
F4001	Ordering codes			Description
Flanged	F			Process connection
Wafer	W			
Insertation-fixed	I			
Insetation with ball valve	V			
Liquid	L			Medium
Gas	G			
Steam	S			
1/2"/DN15mm	015			Size
1"/DN25mm	025			
1½"/DN40mm	040			
2"/DN50mm	050			
2½"/DN65mm	065			
3"/DN80mm	080			
4"/DN100mm	100			
6"/DN150mm	150			
8"/DN200mm	200			
10"/DN250mm	250			
12"/DN300mm	300			
Integral with digital display(standard)	C			
Remote with 5m cable	R			
13.5 to 45Vdc-standard	D			Power supply
3.6v lithium battery-no outout	B			
No output	0			Output
Pulse output	1			
Two wires 4-20mA Dc output	2			
No communication	N			Communication
RS485(modbus), without 4-20mA	R			
HART+4-20mA	H			
Standard -40~482 ° F (-40 ~ 250 ° C)	S			Pressure
High Temp 382~660 ° F (250~350 ° C)	H			
232Psi(1.6MPa)	1			Communication
363psi(2.5MPa)	2			
580psi(4.0MPa)	3			
928psi(6.4MPa)	4			
Not for hazardous application	N			Explosion proof
Explosive isolated	G			
Intrinsically safe	B			
Standard material-SS#304	NN			Options
Special material-SS#316	316			
Mass flow without PT 100 RTD and pressure transmitter	MS			
Mass flow with PT100 RTD and pressure transmitter	MT			
Flow computer-24VDC power, 4-20mA output, LED display	FC			

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