AET control

HLUG Smart Vortex Flowmeter

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I APPLICATION & FEATURES

HLUG series smart vortex flowmeter is mainly used for measuring flow of industrial pipeline fluid, such as gas, liquid and steam, etc. It has little pressure loss, broad span range and high accuracy. It is not under influence of density, pressure, temperature and viscosity when measuring volumetric flow. It has no movable mechanical parts with high reliability and little maintenance.

II OPERATION PRINCIPLES

Setting vortex generation body (bluff body) in fluid, regular vortexs will alternately generate from two sides of vortex generation body. This kind of vortex is called Karman vortex. See picture 1. Vortex is at downstream of vortex generation body, unsymmetrical array. Set occurrence to be f , avarage flow speed of measured medium U, face width d and diameter D. According to Karman principle, exsiting following relation : $f = StU_1/d = StU/md$

U_1 - avarage flow speed at two sides of vortex generation body,

m/s St - Strouhal number

m – ratio of segment area and pipeline cross sectional area

$$m = 1 - \frac{2}{\pi}[d/D\sqrt{1-(d-D)^2} + \sin^{-1}\frac{d}{D}]$$

:

Instantaneous volumetric flow q_v

$$q_v = \pi D^2U/4 = \pi D^2 mdf/4St$$

$$K = f/q_v = [\pi D^2 mdf/4St]^{-1}$$

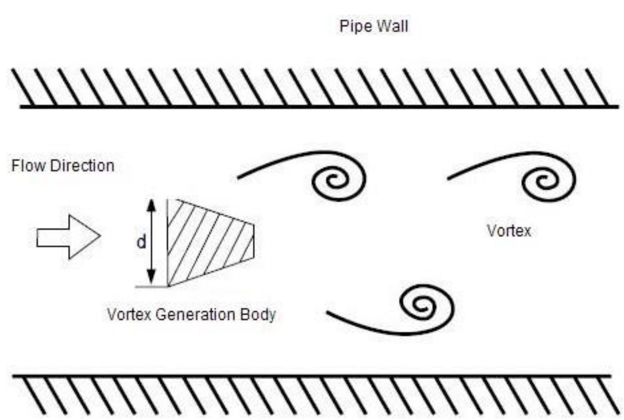


Diagram 1 Karman Vortex

In the formula K --- Instrument Coefficient, pulse number/m3 (P/m3)

K has relation with vortex generation body, pipeline dimension and Strouhal nember. Strouhal nember is a parameter without dimension. It has something to do with shape of vortex generation body and reynolds number. Seeing from the picture, in the range of Re = 2 * 10$_4$ ~ 7 * 10$_6$, St can be seen to be a constant. When measuring gas flow, flow calculation formula of HLUG is

$$Q_{vn} = Q_v \frac{PT_n Z_n}{P_n TZ} = \frac{f}{K} \frac{PT_n Z_n}{P_n TZ}$$

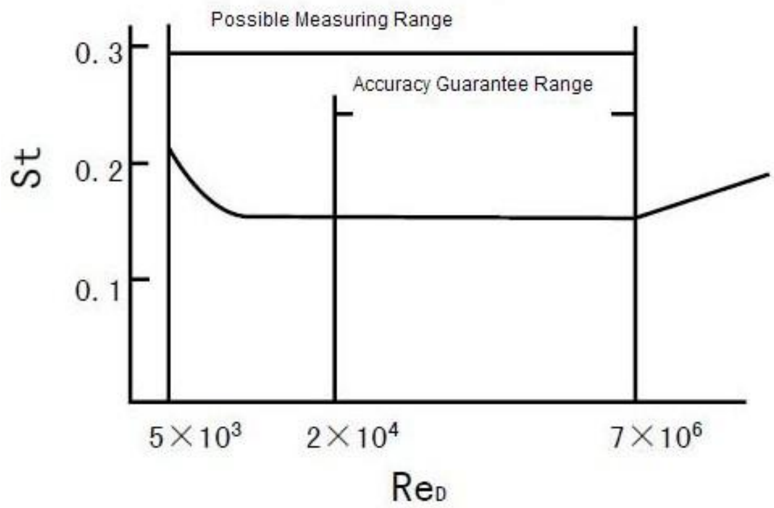


Diagram 2 Relation Curve of Strouhal number and reynold number

In the formula, Qvn, Q --- volumetric flow under standard conditions and working conditions, m3/h Pn, P --- absolute pressure under standard conditions and working conditions, Pa.

Tn, T --- thermodynamics temperature under standard conditions and working conditions, K
Zn, Z --- gas compression coefficient under standard conditions and working conditions
Seeing from the above formula, pulse frequency signal output by HLUG is not influenced by fluid physical properties and component changes, that is, instrument coefficient only has relation with vortex generation body and dimension of pipeline in a certain range of reynold number. But the flowmeter must measure mass flow in material balance and energy measurment, here output signal of flowmeter should monitor volumetric flow and fluid density, therefore, fluid physical properties and component have direct influence on flow measurement.

III MAIN TECHNICAL PARAMETERS

1. Main Technical Data sheet 1

Standard		Q/320831AHH003-2004 JB/T6807-93
Medium		Gas, liquid, steam
Diameter	Flange holding (wafer) type	25, 32, 50, 80, 100, 150, 200, 250, 300
	Flange connection type	100, 150, 200, 250, 300
Measuring Range	Normal range of flow speed	Reynold number 1.5 * 104 ~ 4 * 106; gas 5~50m/s; liquid 0.5~7m/s
	Normal range of flow rate	Liquid, gas flow range-sheet2; steam flow range-sheet 3
Accuracy		Class 1.5
Temperature		Normal temperature -25℃~100℃ High temperature -25℃~150℃ -25℃~250℃
Output Signal	Pulse voltage output signal	Square wave pulse
	Current remote signal	4 ~ 20 mA, transmission distance 100m
Environmental Conditions		Temperature: -25℃~+55℃ humidity: 5~90%
Material		SS, Aluminum Alloy
Power		24 V DC or lithium battery 3.6V
Ex		Exd II BT4
Protection Class		IP65
Requirements to front & back straight tube section		See Diagram 14

2. Flow range of liquid, gas under working conditions sheet 2

Nominal Diameter(mm)	25	32	50	65	80	100	150	200
Liquid (m3/h)	1~10	1.5~18	4~55	6.3~72	9~135	14~200	32~480	56~800
Gas (m3/h)	25~60	15~150	35~350	60~390	90~900	140~1400	300~3000	550~5500

3. Mass flow range of saturated water steam vapour sheet 3 Unit: (kg/h)

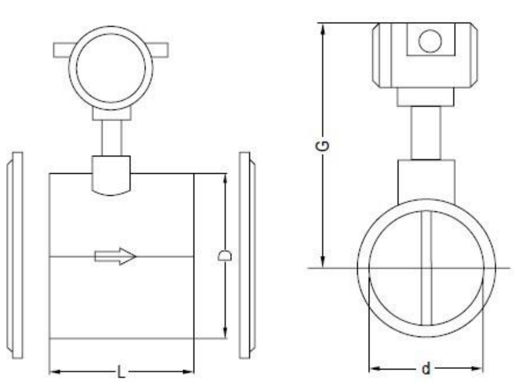
Absolute Pressure P/Mpa Temperature T/℃ Density ρ (kg/m3)	0.2 120.23 1.129	0.3 033.54 1.651	0.4 143.62 2.163	0.5 151.84 2.669	0.6 158.94 3.170	0.7 164.96 3.667	0.8 170.41 4.162
DN25 Qmin Qmax Extendable Max Upper	14 140 140	17 170 204	19 190 267	22 220 330	23 230 391	25 250 453	27 270 541
DN32 Qmin Qmax Extendable Max Upper	31 310 357	38 380 522	44 440 684	48 480 844	53 530 1003	57 570 1160	60 600 1317
DN50 Qmin Qmax Extendable Max Upper	52 520 558	63 630 816	73 730 1069	81 810 1320	88 880 1568	95 950 1813	101 1010 2058
DN65 Qmin Qmax Extendable Max Upper	67.8 678 900	99 990 1326	131 1310 1741	160 1600 2134	180 1800 2535	200 2000 2733	215 2150 3330
DN80 Qmin Qmax Extendable Max Upper	122 1220 1429	148 1480 2090	170 1700 2738	188 1880 3379	205 2050 4013	221 2210 4642	235 2350 5269
DN100 Qmin Qmax Extendable Max Upper	175 1750 2233	212 2120 3266	242 2420 4278	269 2690 5279	293 2930 6270	315 3150 7254	336 3360 8233
DN150 Qmin Qmax Extendable Max Upper	350 3500 5025	423 4230 7348	484 4840 9627	538 5380 11879	586 5860 14019	631 6310 16321	672 6720 15824
DN200 Qmin Qmax Extendable Max Upper	700 7000 8933	846 8460 13064	969 9690 17115	1076 10760 21119	1176 11730 25083	1261 12610 29016	1344 13440 32993
Absolute Pressure P/Mpa Temperature T/℃ Density ρ (kg/m3)	0.9 175.36 4.655	1.0 179.88 5.147	1.2 187.96 6.127	1.4 195.04 7.106	1.6 201.37 8.085	1.8 207.11 9.065	2.0 212.37 10.05
DN25 Qmin Qmax Extendable Max Upper	28 280 575	30 300 636	33 330 757	35 350 878	37 370 999	40 400 1120	42 420 1242

DN32 Qmin Qmax Extendable Max Upper	64 640 1473	67 670 1629	73 730 1939	79 790 2249	84 840 2559	89 890 2869	94 940 3180
DN50 Qmin Qmax Extendable Max Upper	107 1070 2302	112 1120 2545	122 1220 3030	132 1320 3514	140 1400 3998	149 1490 4483	157 1570 4970
DN65 Qmin Qmax Extendable Max Upper	220 2200 3724	225 2250 4117	235 2350 4902	245 2450 5685	255 2550 6470	265 2650 7252	275 2750 8038
DN80 Qmin Qmax Extendable Max Upper	249 2490 5893	261 2610 6515	285 2850 7757	307 3070 8996	328 3280 10235	347 3470 11476	365 3650 12723
DN100 Qmin Qmax Extendable Max Upper	355 3550 9208	374 3740 10181	408 4080 12120	439 4390 14057	468 4680 15993	496 4960 17932	522 5220 19880
DN150 Qmin Qmax Extendable Max Upper	711 7110 20719	747 7470 22909	815 8150 27270	878 8780 31628	936 9360 35985	992 9920 40347	1044 10440 44732
DN200 Qmin Qmax Extendable Max Upper	1421 14210 36834	1494 14940 40727	1630 16300 48481	1756 17560 56228	1873 18730 63794	1983 19830 71729	2088 20880 79523

IV STRUCTURE & DIMENSION

This series vortex flowmeter has two types of connection forms and dimension

1. Wafer Type 2. Flange Connection Type



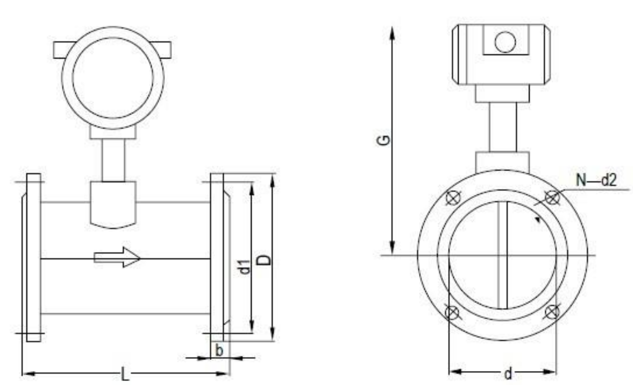


Diagram 3 **Diagram 4**

Dimension of Vortex Flowmeter—flange holding type & flange connection type

Sheet 4

	DN (mm)	Pressure MPa	L mm	G		D mm	dl mm	N-d2	d mm	b mm	Weight Kg
				Normal Temp.	High Temp.						
Wafer Type	25	2.5~4.0	80	342	500	76	-	-	25	-	7
	32	2.5~4.0	80	342	505	76	-	-	32	-	10
	50	2.5~4.0	80	337	515	86	-	-	50	-	12.5
	65	-	80	345	530	102	-	-	65	-	28
	80	1.6~2.5	100	350	540	112	-	-	80	-	25
	100	1.6~2.5	110	330	550	132	-	-	100	-	35
	150	1.6	140	355	575	203	-	-	150	-	40
	200	1.6	150	380	600	259	-	-	200	-	46
Flange Connection Type	100	1.6	250	310	530	125	180	8-Ø18	100	26	30
	150	1.6	300	335	555	280	240	8-Ø23	150	28	34
	200	1.6	320	370	590	335	295	12-Ø23	200	30	41

V MODEL SELECTION & CALCULATION

1. Caliber of flowmeter should be chosen according to max working flow Q_v; to get much wider working flow range, max working flow should be not less than 1/2 of rated max flow Q_{max}. Corresponding reynold number range of linear flow range is $2 * 10^4$ ~ 7 $8*10^6$.

For liquid, please look up in sheet 2 according to picture 9; for gas please work out flow range under working conditions according to picture 10, looking up in sheet 2.

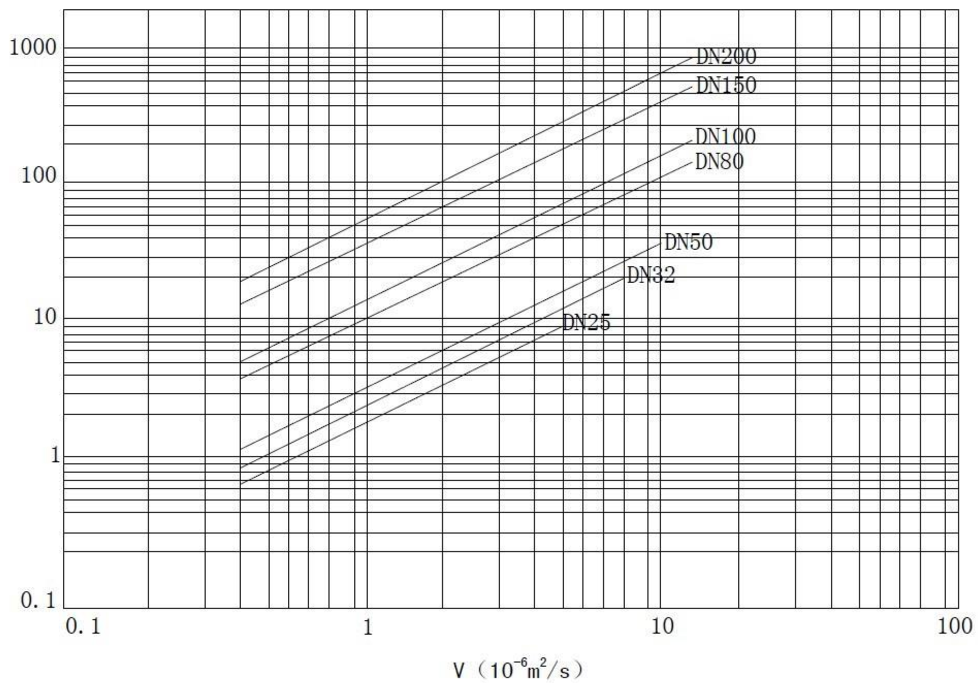


Diagram 5 Relation between Min flow of liquid and moving viscosity

2. Change flow under standard conditions into flow under working conditions

(1) Change density ρn under standard conditions into ρ under working conditions

$$\rho = \rho_n \times \frac{0.1013+P}{0.1013} \times \frac{273.15+20}{273.15+T}$$

(2) Calculate flow Q under working conditions

a. Find out Qv by Qn under standard conditions

$$Q_V = Q_n \times \frac{\rho_n}{\rho}$$

b. Find out Qv by mass flow Qm

$$Q_V = Q_m / \rho$$

3. Conversion between Dynamic viscosity μ and moving viscosity v

$$V = \frac{\mu}{\rho}$$

ρ ─ density under working conditions (kg/m3)

ρn- density under standard conditions (kg/m3)

P – pressure under working conditions (MPa)
T – temperature under working conditions (℃)
Qv – flow under working conditions (m3/h)
Qn – flow under standard conditions (m3/h)
Qm – mass flow (kg/h)
μ– dynamic viscosity
(Pa · S) V – kinematic
viscosity (m2/s)

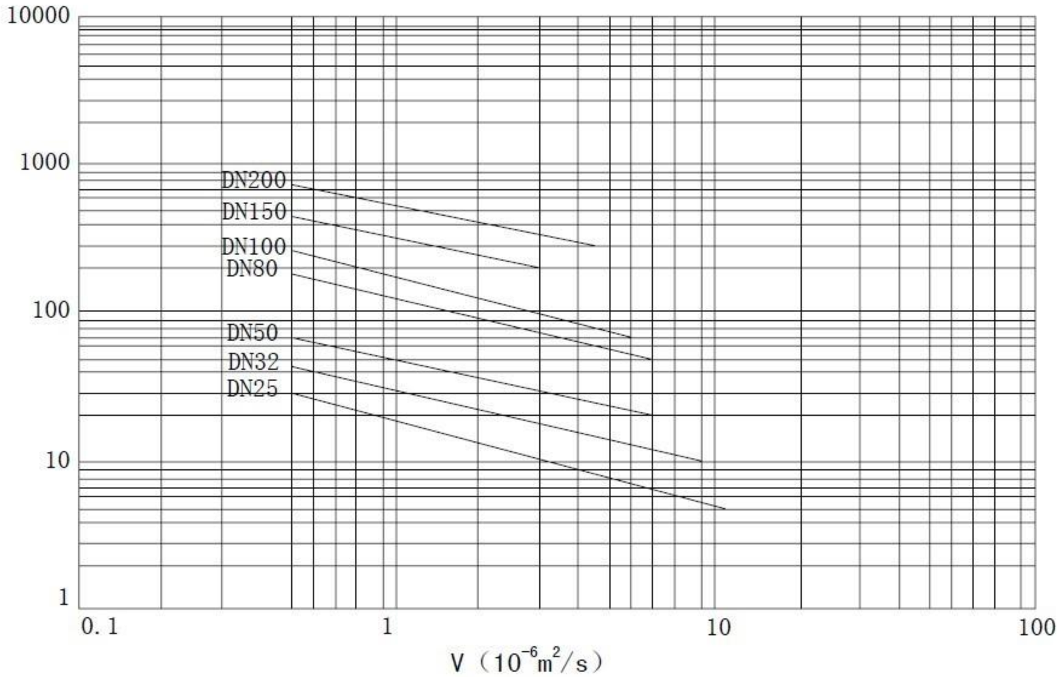


Diagram 6 Relation between Min flow of Gas/superheated steam and density

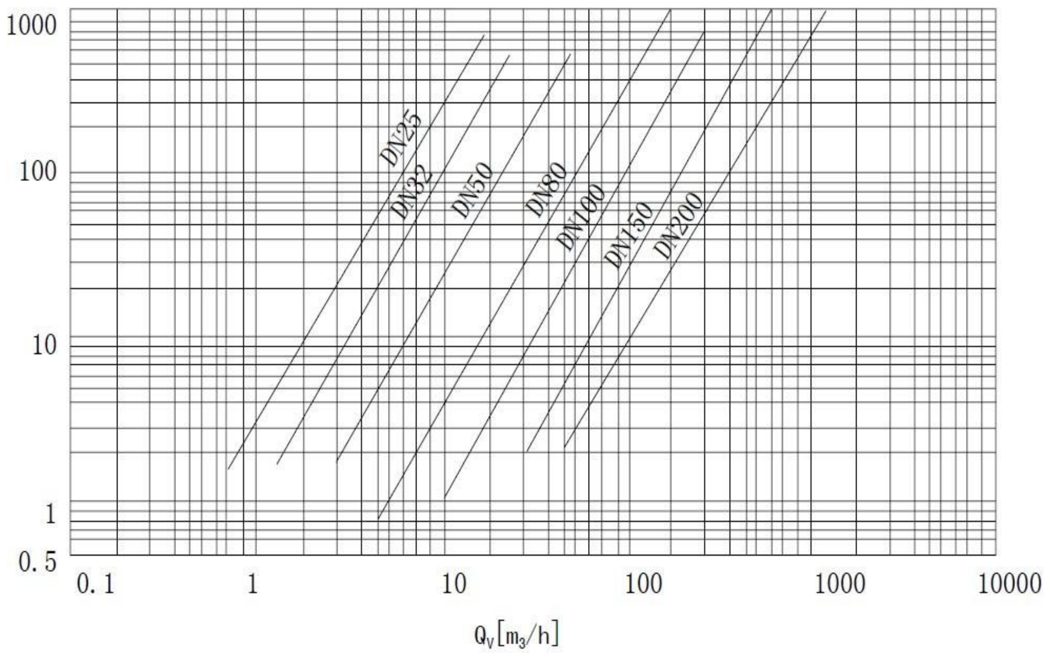


Diagram 7 Pressure loss for medium of water (20℃，1013mbar, ρ=998kg/m3)

4. Density of commonly used gas under standard conditions (0.101325Mpa, 20℃) sheet5

Gas	Density (Kg/m3)	Gas	Density(Kg/m3)	Gas	Density (Kg/m3)
Acetylene	1.083	Normal Butane	2.4163	Ethane	1.2500
Ammonia	0.7080	Ethylene	1.1660	Methane	0.6669
Propane	1.8332	Neon	0.83914	Natural Gas	0.776
Air	1.2041	Argon	1.6605	Carbon Dioxide	1.829
Carbon Monoxide	1.165	Hydrogen	0.0838	Oxygen	1.3302
Propylene	1.7459	Nitrogen	1.1646		

5. Pressure Loss

i Pressure loss at measuring liquid

Diagram 7 is the relation of pressure loss and flow at measuring flow of water (20℃, 1013mbar, ρ = 998kg/m3) At measuring other liquid with density of ρs, calculating pressure loss according to following formula:

$$\Delta P' = \frac{\rho_s}{998} \times \Delta P$$

$\Delta P'$ —pressure loss of measured liquid (mbar)

ΔP—pressure loss of water found from Diagram 7

ii Pressure loss at measuring gas (overheated steam)

Diagram 8 is pressure loss at measuring air (20℃, 1013mbar, ρ = 1.2kg/m3). Using the following formula to calculate density ρs of other gas:

$$\Delta P' = \frac{\rho_s}{1.2} \times \Delta P$$

$\Delta P'$ —pressure loss of medium (mbar)

ΔP—pressure loss of air found from Diagram 8

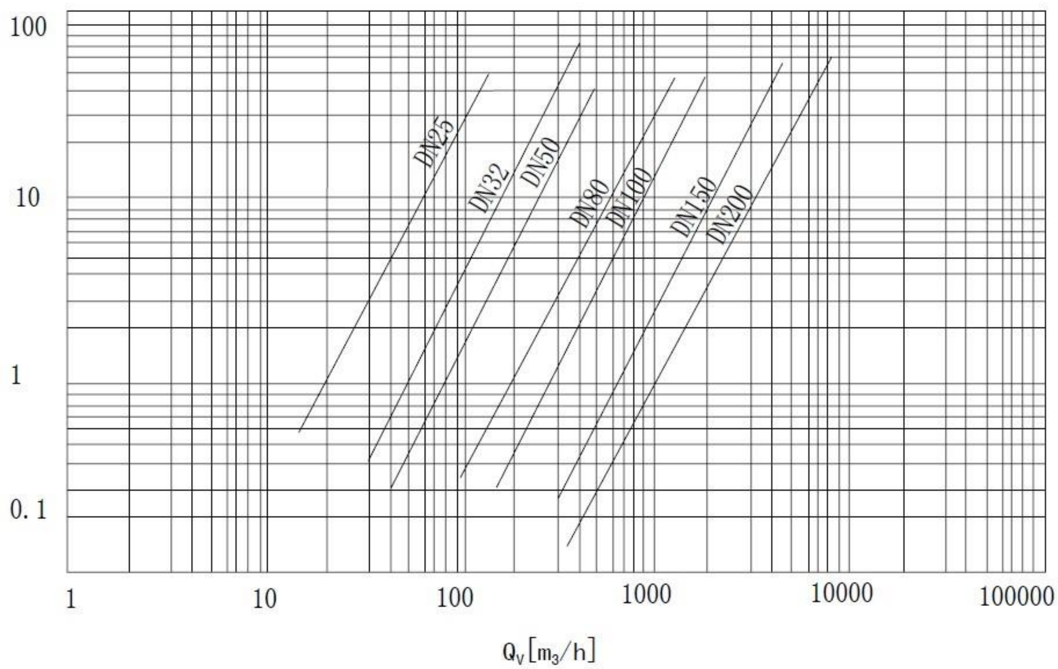


Diagram 8 Pressure Loss of Air （20℃, 1013mbar, ρ = 1.2kg/m3）

VI MODEL SELCETION

Code	Nominal Diameter (mm)	Flow Range (m3/h)		Remarks
HLUG-25	DN25	1~12(L)	10~100(G)	1. Make reference to sheet 3 for steam flow range
HLUG-32	DN32	1.5~23(L)	15~150(G)	2. DN250 ~ DN600 can be provided according to customers' requirements
HLUG-40	DN40	2.4~32(L)	23~230(G)	3. For DN300 and above, we recommend Insertion Type Vortex Flowmeter
HLUG-50	DN50	4~50(L)	35~350(G)	
HLUG-65	DN65	6.3~84(L)	60~600(G)	
HLUG-80	DN80	10~130(L)	90~900(G)	
HLUG-100	DN100	20~200(L)	140~1400(G)	
HLUG-125	DN125	31~310(L)	220~1450(G)	
HLUG-150	DN150	45~450(L)	300~3000(G)	
HLUG-200	DN200	80~800(L)	550~5500(G)	

Code	Function 1
N	No Temperature & Pressure compensation
Y	Temperature & Pressure compensation provided

Code	Output
F1	4 ~ 20 mA (two wires)
F2	4 ~ 20 mA (three wires)
F3	RS 485 communication interface
F4	Pulse / Frequency

Code	Medium
J1	Liquid
J2	Gas
J3	Steam

Code	Connection
L1	Wafer Type
L2	Flange Connection Type

Code	Function 2
E1	1.0
E2	1.5
T1	Normal temperature
T2	High Temperature
T3	Steam
P1	1.6 MPa
P2	2.5 MPa
P3	4.0 MPa
P0	Special pressure
D1	Internal 3.6 V
D2	24V DC
B1	SS
B2	CS

HLUG-25 Y F1 J1 L1 E1T1P1D2B1