

MADECO METAL TUBE FLOWMETER

MADECO MDVB-S Series



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1 General

MDVB-S metal cone variable area flowmeters (see fig. 1-1, fig. 1-2) are used to measure instantaneous and accumulated flow rate of liquid, gas and steam in closed pipelines. It is suitable for metering flow value on site or electronic remote. The measuring principle is hydrodynamic effects. This makes the float moving from bottom to top. As the displacement of the float is related to the flow rate, which can be read from the indicator by means of the magnetic drive system in non-contact form. Also, flowmeters output electrical signal (4-20)mA / Hart communication protocol with high / low limit Warning switches/integrating flow PCB board can be configured.

Features:

P8 Mechanical indicator: fig. 1-1

- ◆ Stainless steel housing, punch forming, surface finish.
- ◆ Machinery pointer indicates flow value on site.
- ◆ Lightly and beautiful appearance.

P10 Indicator: fig. 1-1

- ◆ Modularization design, Exi, Exd explosion protection.
- ◆ 2-wire electrical signal output (4-20)mA / Hart communication protocol.
- ◆ Optional limit switches combination.

P10I indicator: fig. 1-2

- ◆ Mechanical indicator with explosion protection housing.
- ◆ One or two limit switches are selectable.

P10B Indicator: fig. 1-2

- ◆ P10B indicator with LCD display, power supply: 3.6V lithium battery

Typical applications:

Flow measuring and process control of Liquids, gases, vapors in petroleum, chemical industry, metallurgy, electric power, food processing industry, pharmacy, papermaking, etc.

2 Operating principle

MDVB-S series variable area flowmeters (fig. 2-1) is made up of flow sensor and flow indicator. The float is placed vertically inside of the conical measuring tube and can freely move up and down along the conical tube owing to hydrodynamic effects. A high-performance permanent magnet is set inside the float, by this way the magnetic field around the permanent magnet will change along with the float moving up and down. When fluid keeps a stable flow value and the float locates in a dynamic balance state in position, the magnetic field around the permanent magnet keeps constant also. The magnetic signal will be transmitted in non-contact form by means of the flow indicator mechanically connected to the conical tube. In another word, the indicator is able to detect and process the flow value of liquid by the magnetic drive system and finally the corresponding flow rate value can be read from the scale on site. Also, it can indicate outputs as standard electrical signal (4-20)mA / Hart communication protocol.

Measurement of gases

- 2.1 When the valve is opened suddenly in pipeline or pressure is unstable during metering gases, airflow will be pulsating. As a result, the float moves up and down along the conical tube ceaselessly. In the meantime, the system is out-of-control since the pointer swinging constantly leads to output signal instability. In this condition, a damping device must be installed inside the measuring tube (see fig. 2-2). The damping device becomes a self-centering damper of preventing block through special design and precision work of numerical control machine center. The damping device consists of aluminum oxide ceramic (purity is 99.99%) and is characterized by a long service life, resistant to corrosion, structure novelty, practicality better.

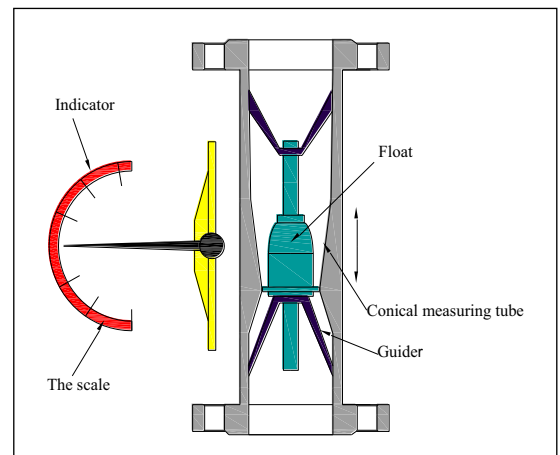


Fig.2-1

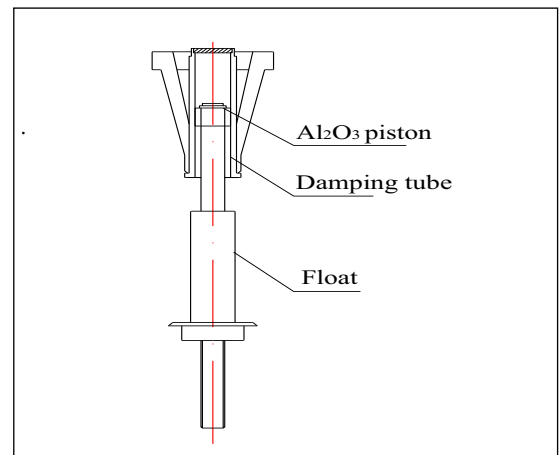


Fig.2-2

3 Technical data

Type	MDVB-S		
Medium	Liquids, gases, vapors		
Rang(conversion to 100% value of reference fluid)	Water : 20℃	(10-300000)L/h , Special order on request	
	Air : 0.1013MPa, 20℃	(0.7-3000)Nm ³ /h, Special order on request	
The turn-down ratio	10 : 1		
Accuracy class	Mechanical indicator	1.0, 1.5, 2.0, 2.5	
	Mechanical indicator with LCD (battery powered, service life: 2 years)	1.0, 1.5, 2.0, 2.5	
	Mechanical indicator with two-wire signal output (4-20)mA/hart communication	1.0, 1.5, 2.0, 2.5	
Medium temperature	protocol Machinery indicator with LCD (battery powered, service life: 2 years)	-80℃~+300℃ (PTFE:0~80℃) High temperature 400℃	
	Mechanical indicator (battery powered, service life : 2 years)	-40℃~+120℃ (PTFE:0~80℃) High temperature 400℃	
	Mechanical indicator with two-wire signal output (4-20)mA/hart communication protocol	-40℃~+120℃ (PTFE:0~80℃) High temperature 400℃	
Ambient temperature	Mechanical indicator	-40℃~+120℃	
	Mechanical indicator with LCD (battery powered, service life: 2 years)	-20℃~+60℃	
	Mechanical indicator with two-wire signal output (4-20)mA/hart communication	-20℃~+60℃	
Viscosity of fluid	DN15: F15.00~F15.03 η<5 mPa.s, F15.04~15.30 η<30 mPa.s; DN25: η<250 mPa.s; DN50~250: η<300 mPa.s		
Nominal pressure	DN15~DN50	4.0MPa (Max DN15: 42MPa, DN25: 42MPa, DN50: 32MPa)	
	DN80~DN250	1.6MPa (Max DN80: 10MPa, DN100: 6.4MPa, DN125: 4.0MPa, DN150: 4.0MPa, DN200: 2.5MPa, DN250: 2.5Mpa)	
Process connection	Flange connection, Standard: DIN2501, ANSI, JIS ,(priority select DIN)		
	Hygiene clamp, screw joint are selected in the order		
Electrical connection	M20×1.5 1/2"G 1/2"NPT 3/4"G 3/4"NPT		
Installation	Vertical mounting (bottom in up out and up in bottom out, Horizontal mounting (left in right out and right in left out) bottom in side out, side in side out		
Straight unimpeded inlet run	≥ 5D		
Straight unimpeded outlet run	≥ 250 mm		
Degree of protection	IP67(Others need specify in the order)		
Ex marking	EEx ia II CT5		
	EEx d II CT6		
Ex electrical data	Ui = 28V Ii = 93mA Pi = 0.65W Ci ≤ 5nF Li =0mH		
Safety barrier data	Uo ≤ 28V Io ≤ 93mA Po ≤ 0.65W Co ≥ Ci+Cc Lo ≥ Li+Lc		
Carried Standard	JB/T 6844 -93		

4 Materials

Type	Measuring tube	Flange	Float
R56/PI, R56/UP R56/HI, R56/BO R56/SO	304/304SS, 304L/304LSS 316/316SS, 316L/316LSS 317/317SS, 317L/317LSS	304/304SS, 304L/304LSS 316/316SS, 316L/316LSS 317/317SS, 317L/317LSS	304/304SS, 304L/304LSS 316/316SS, 316L/316LSS 317/317SS, 317L/317LSS Al, Ti
R56/SP	1Cr18Ni9Ti With PTFE liner	1Cr18Ni9Ti	PTFE Hastelloy-B1, B2, C4 Ti
R56/PV	PV	PV	PV
R56/PP	PP	PP	PP
R56/Ni	Hastelloy-B1, B2, C4 N6	Hastelloy-B1, B2, C4 N6	Hastelloy-B1, B2, C4 Ti N6
R56/Ti	Ti	Ti	Ti Hastelloy-B1, B2, C4
R56/Zr	Zr	Zr	Zr
R56/Cu			Cu
R56/Al			Al

5 Dimensions

5.1 Flange connection dimensions (mm)

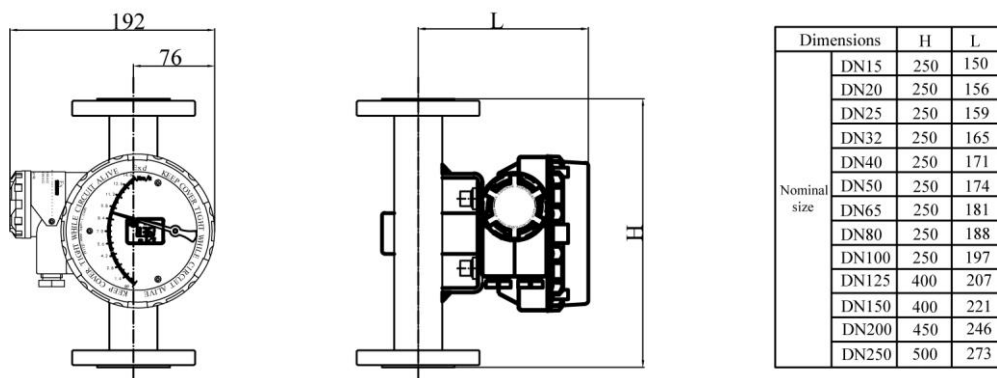


Fig. 5-1 Vertical mounting

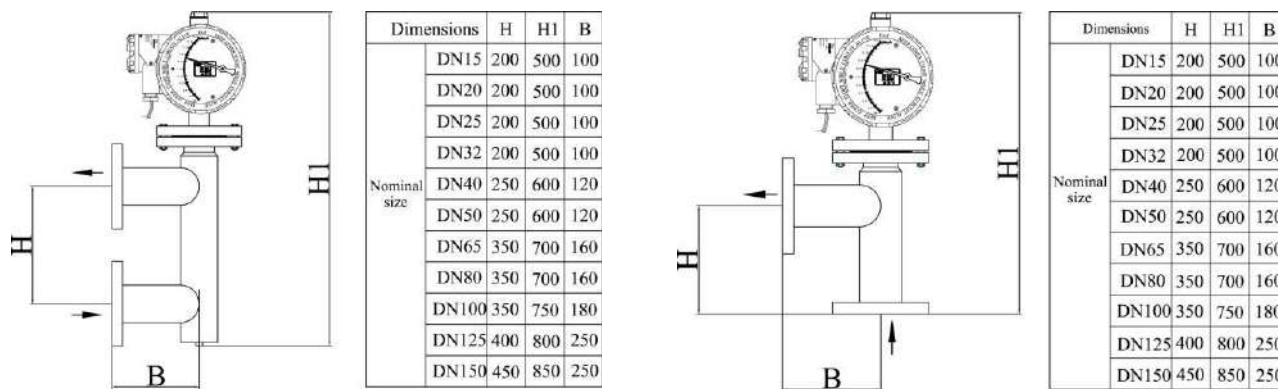


Fig. 5-2 Side in side out mounting

Fig. 5-3 Bottom in side out mounting

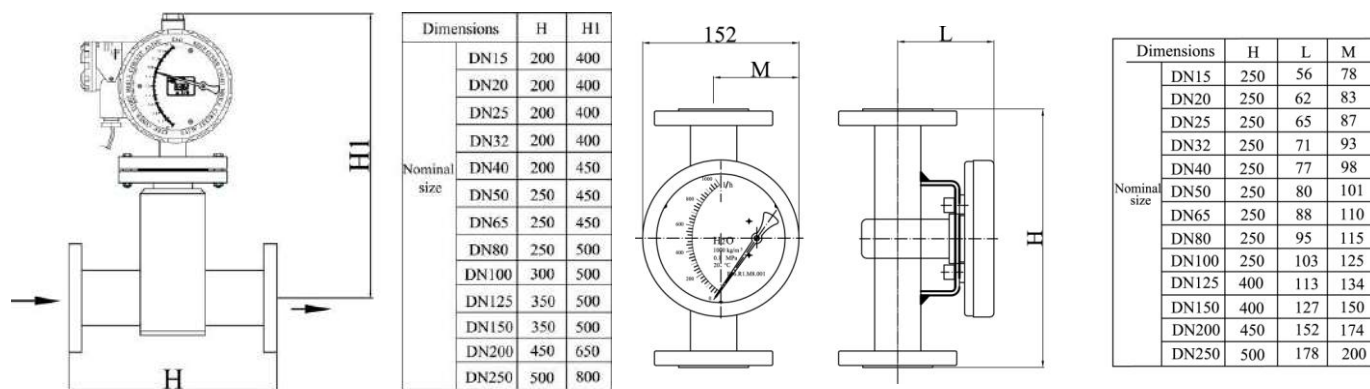
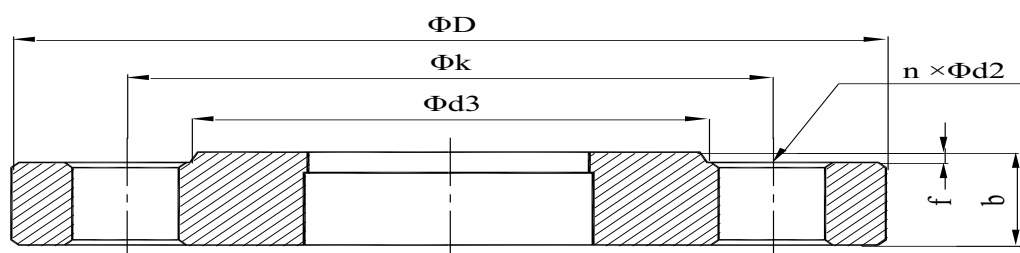


Fig. 5-4 Horizontal mounting

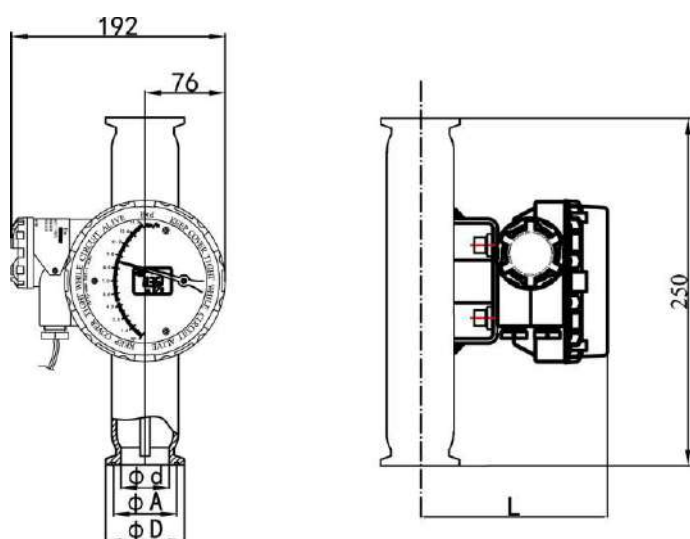
Fig. 5-5 P8 mounting

Flange dimensions and table



Nominal size	Flange dimensions (Standard :ANSI B 16.5 150 lb RF)						Nominal size/pressure	Flange dimensions (Standard :DIN2501)					
DN	D	k	d3	f	n	d2	DN/PN	D	k	d3	f	n	d2
1/2"	88.9	60.5	35.1	1.6	4	15.7	15/4.0	95	65	45	1.5	4	14
3/4"	98.6	69.9	42.9	1.6	4	15.7	20/4.0	105	75	55	1.5	4	14
1"	108.0	79.2	50.8	1.6	4	15.7	25/4.0	115	85	65	1.5	4	14
1-1/4"	117.3	88.9	63.5	1.6	4	15.7	32/4.0	140	100	76	1.5	4	18
1-1/2"	127.0	98.6	73.2	1.6	4	15.7	40/4.0	150	110	86	1.5	4	18
2"	152.4	120.7	91.9	1.6	4	19.1	50/4.0	165	125	100	2.0	4	18
2-1/2"	177.8	139.7	104.6	1.6	4	19.1	65/1.6	185	145	120	2.0	4	18
3"	190.5	152.4	127.0	1.6	4	19.1	80/1.6	200	160	136	2.0	8	18
4"	228.6	190.5	157.2	1.6	8	19.1	100/1.6	220	180	156	2.0	8	18
5"	254.0	215.9	185.7	1.6	8	22.4	125/1.6	250	210	186	2.0	8	18
6"	279.4	241.3	215.9	1.6	8	22.4	150/1.6	285	240	212	2.0	8	22
8"	342.9	298.5	269.7	1.6	8	22.4	200/1.6	340	295	268	2.0	12	22
10"	406.4	362.0	323.9	1.6	12	25.4	250/1.6	405	355	320	2.0	12	26

5.2 Hygienic Clamp connection dimensions (mm)



Dimensions		D	A	d	L
Nominal size	DN15	34	28	15	150
	DN20	34	28	19	155
	DN25	51	44	24	159
	DN32	51	44	30	164
	DN40	51	44	36	170
	DN50	64	57	48	174
	DN65	91	84	64	181
	DN80	106	97	78	188
	DN100	119	110	97	197

6 Process connection installation guide

6.1 Process connection

◆ Vertical: see fig. 6-1:

Flowmeter is must be ensured less than 2 degrees of included angle between center vertical line and vertical line during mounting.

A straight unimpeded inlet run before the flowmeter and straight unimpeded outlet run behind the flowmeter are recommended.

In addition, straight pipe bores should be the same nominal size as

the flowmeter.

Length of straight unimpeded run:

L1 (Straight unimpeded inlet run) $\geq 5 \times \text{DN}$ (Nominal size of inlet),

L2 (Straight unimpeded outlet run) $\geq 250 \text{ mm}$,

L3: Magnetic filter . Dimensions see fig. 6.2:

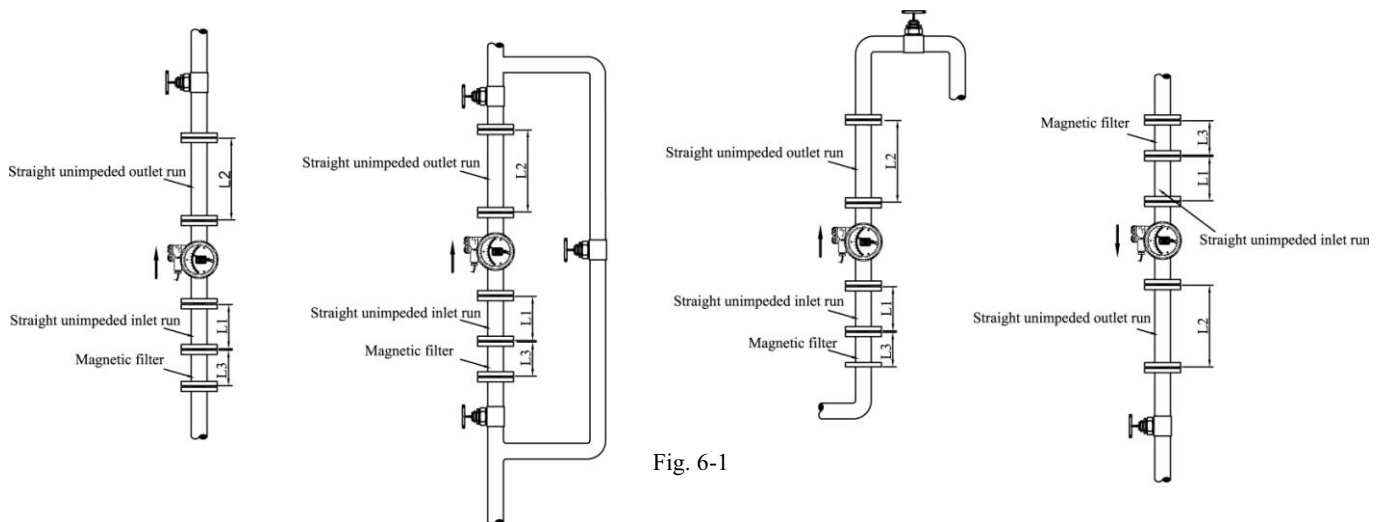


Fig. 6-1

6.2.1 Before mounting:

Flowmeter belongs to precision instrument so it must be carefully and gently moved during the progress of transportation, installation, storing and using, forbidding wild transport, overstressing installation as well as ensuring the holistic position of indicator and sensor because flowmeter has been calculated, checked, tested when it leaves factory. If indicator and sensor are disassembled, the measuring accuracy will be influenced. Indicator and sensor may be disassembled under the direction of after sales service personnel or contacting manufacturer. Remove all packing from the flowmeter body, check the delivery for damage prior to mount on pipeline. Before the flowmeter is installed, pipeline should be cleared, blown any foreign matter preventing magnetic particles which would be attached to flowmeter. A magnetic filter is to be installed in the flow direction before the flowmeter so as to avoid float locking. Magnetic filter see fig. 6-5:

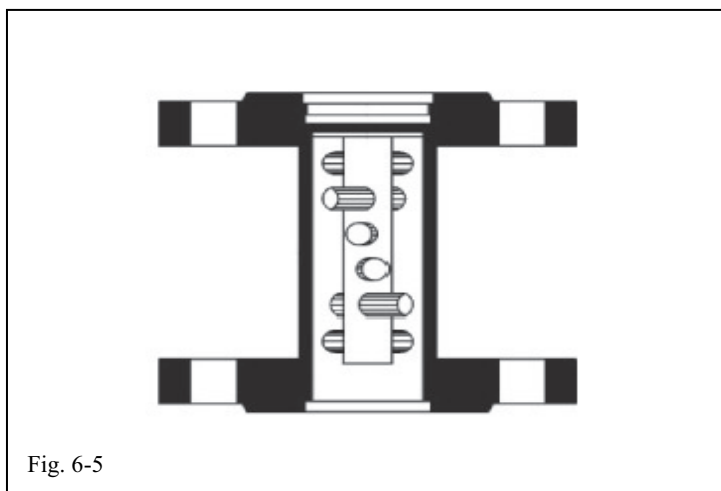


Fig. 6-5

Flange standard is same as flowmeter's, selecting concave-convex sealing face: Sealing face of flange is convex up / concave down.

(1) Mounting height: 100mm

Nominal size: DN15, DN20, DN25, DN32, DN40, DN50 , DN65, DN80,
DN100

Pressure: PN1.6MPa~4.0MPa

(4.0MPa doesn't include DN80 and DN100)

(2) Mounting height: 120mm

Nominal size: DN80, DN100

Pressure: PN2.5MPa~4.0MPa

(3) Mounting height: 150mm

Nominal size: DN125, DN150, DN200, DN250

Pressure: PN1.0MPa~2.5MPa

If measuring gases, a valve must be mounted in outlet of flowmeters so as to set desired flow value. When calibration pressure is kept above float, gases will expansion at valve.

Flowmeters may not be subjected to tensile or compressive stresses through the pipeline.

So support frame is to be set up in inlet and outlet of flow meters. thus flowmeters are in minimum stress state.

6.2.2 Matters need attention during mounting :

Since the switching mechanism of variable area flowmeters adopts magnetic transmission, the ferromagnetic substances are not allowed to exist at least in 200 mm periphery so as to ensure accuracy of flowmeters. Otherwise, a measuring error will be easily appeared even out of commission.

Please be careful while flowmeter with PTFE liner is mounted. Because PTFE is easily deformed under low-temperature and bolt-on in pressure condition, the flange nut should not be optionally fastened but shifting angle slightly fixed according to diagonal way in order to avoid damaging PTFE liner. For the relevant maximum torque refer to table 6-1.

6.2.3 Start up for the first time

Measurement of liquids:

During start up, in order to avoid damaging flowmeters from water hammer, open valves slowly!

Measurement of gases:

Before opening the valve, do not press the pipeline, or else , the float will run up to upper limit even probably damaging flowmeters if valve (example: magnetic valve) is suddenly turned on. Must slowly open valve!

The flowmeters of measuring gases may be equipped an air damper for the sake of decreasing float vibration as far as possible . To further ensuring the stability of float, a throttle or proper orifice can be mounted in the outlet of flowmeters.

Regarding intelligent-type and hart indicator, first of all the electrical wiring should be ensured correctly, then power on .

Program debugging asks for operating instructions.

7 Flow table, scale conversion and accuracy class

7.1 Flow table

Nominal size	Float number	Flow range: H ₂ O (water)		Flow range: Air	pressure loss (kPa) lower pressure loss need connect to manufacturer for order	
		Material: 1 CrNiSteel	Material: 2 PTFE	Material: 1 CrNiSteel	Material: 1	Material: 2
DN15	F15.00	10 l/h	25 l/h	0.30 Nm ³ /h	1.5	1.5
	F15.01	15 l/h	30 l/h	0.45 Nm ³ /h	1.5	1.5
	F15.02	20 l/h	35 l/h	0.60 Nm ³ /h	1.5	1.5
	F15.03	25 l/h	40 l/h	0.75 Nm ³ /h	1.5	1.5
	F15.04	30 l/h	45 l/h	0.90 Nm ³ /h	1.5	1.5
	F15.05	35 l/h	50 l/h	1.05 Nm ³ /h	1.5	1.5
	F15.06	40 l/h	55 l/h	1.20 Nm ³ /h	1.5	1.5
	F15.07	45 l/h	60 l/h	1.35 Nm ³ /h	1.5	1.5
	F15.08	50 l/h	70 l/h	1.50 Nm ³ /h	1.5	1.5
	F15.09	55 l/h	80 l/h	1.65 Nm ³ /h	1.5	1.5
	F15.10	60 l/h	90 l/h	1.80 Nm ³ /h	1.5	1.5
	F15.11	70 l/h	100 l/h	2.10 Nm ³ /h	1.5	1.5
	F15.12	80 l/h	120 l/h	2.40 Nm ³ /h	1.5	1.5
	F15.13	90 l/h	160 l/h	2.70 Nm ³ /h	1.5	1.5
	F15.14	100 l/h	200 l/h	3.00 Nm ³ /h	1.5	1.5
	F15.15	120 l/h	220 l/h	3.60 Nm ³ /h	1.5	3.0
	F15.16	160 l/h	250 l/h	4.80 Nm ³ /h	1.5	3.0
	F15.17	200 l/h	280 l/h	6.00 Nm ³ /h	1.5	3.0
	F15.18	220 l/h	300 l/h	6.60 Nm ³ /h	3.0	3.0
	F15.19	250 l/h	350 l/h	7.50 Nm ³ /h	3.0	3.0
	F15.20	280 l/h	400 l/h	8.40 Nm ³ /h	3.0	3.0
	F15.21	300 l/h	450 l/h	9.00 Nm ³ /h	3.0	3.5
	F15.22	350 l/h	500 l/h	10.50 Nm ³ /h	3.0	3.5
	F15.23	400 l/h		12.00 Nm ³ /h	3.0	
	F15.24	450 l/h		13.50 Nm ³ /h	3.5	
	F15.25	500 l/h		15.00 Nm ³ /h	3.5	
	F15.26	600 l/h		18.00 Nm ³ /h	3.5	
	F15.27	700 l/h		21.00 Nm ³ /h	3.5	
	F15.28	800 l/h		24.00 Nm ³ /h	3.5	
	F15.29	900 l/h		27.00 Nm ³ /h	3.5	
	F15.30	1000 l/h		30.00 Nm ³ /h	3.5	
DN20	F20.00	800 l/h	400 l/h	24.0 Nm ³ /h	1.5	1.5
	F20.01	1000 l/h	600 l/h	30.0 Nm ³ /h	1.5	1.5
	F20.02	1200 l/h	800 l/h	36.0 Nm ³ /h	2.0	2.0
	F20.03	1600 l/h	1000 l/h	48.0 Nm ³ /h	2.0	2.0
	F20.04	2000 l/h	1200 l/h	60.0 Nm ³ /h	3.5	3.0
DN25	F20.05	2500 l/h	1600 l/h	75.0 Nm ³ /h	4.0	3.0
	F25.00	1000 l/h	600 l/h	30.0 Nm ³ /h	1.5	1.5
	F25.01	1200 l/h	800 l/h	36.0 Nm ³ /h	1.5	1.5
	F25.02	1600 l/h	1000 l/h	48.0 Nm ³ /h	3.0	1.5
	F25.03	2000 l/h	1200 l/h	60.0 Nm ³ /h	3.0	1.5
	F25.04	2500 l/h	1600 l/h	75.0 Nm ³ /h	3.5	3.0
	F25.05	3000 l/h	2000 l/h	90.0 Nm ³ /h	3.5	3.0
	F25.06	3500 l/h	2500 l/h	105.0 Nm ³ /h	8.0	3.5
	F25.07	4000 l/h	3000 l/h	120.0 Nm ³ /h	8.0	3.5
	F25.08	4500 l/h	3500 l/h	135.0 Nm ³ /h	8.0	8.0
	F25.09	5000 l/h	4000 l/h	150.0 Nm ³ /h	16.0	10.0
DN32	F25.10	5500 l/h		165.0 Nm ³ /h	16.0	
	F25.11	6000 l/h		180.0 Nm ³ /h	16.0	
	F32.00	4000 l/h	4000 l/h	120.0 Nm ³ /h	8.0	8.0
	F32.01	5000 l/h	5000 l/h	150.0 Nm ³ /h	10.0	10.0
DN40	F32.02	6000 l/h		180.0 Nm ³ /h	12.0	
	F32.03	8000 l/h		240.0 Nm ³ /h	16.0	
	F40.00	5000 l/h	5000 l/h	150.0 Nm ³ /h	8.0	6.0
	F40.01	6000 l/h	6000 l/h	180.0 Nm ³ /h	10.0	10.0
DN50	F40.02	8000 l/h		240.0 Nm ³ /h	12.0	
	F40.03	10000 l/h		300.0 Nm ³ /h	14.0	
	F50.00	6000 l/h	6000 l/h	180.0 Nm ³ /h	3.0	3.0
	F50.01	8000 l/h	8000 l/h	240.0 Nm ³ /h	3.0	3.0
	F50.02	10000 l/h	10000 l/h	300.0 Nm ³ /h	4.0	4.0
	F50.03	12000 l/h	12000 l/h	360.0 Nm ³ /h	4.0	4.0
	F50.04	14000 l/h	14000 l/h	420.0 Nm ³ /h	4.0	6.0
	F50.05	16000 l/h	16000 l/h	480.0 Nm ³ /h	8.0	6.0
	F50.06	18000 l/h		540.0 Nm ³ /h	8.0	
DN65	F50.07	20000 l/h		600.0 Nm ³ /h	16.0	
	F50.08	25000 l/h		750.0 Nm ³ /h	16.0	
	F65.00	12000 l/h	12000 l/h	360.0 Nm ³ /h	6.0	6.0
	F65.01	16000 l/h	16000 l/h	480.0 Nm ³ /h	8.0	8.0
	F65.02	20000 l/h	20000 l/h	600.0 Nm ³ /h	10.0	12.0
DN80	F65.03	25000 l/h		750.0 Nm ³ /h	14.0	
	F65.04	30000 l/h		900.0 Nm ³ /h	20.0	
	F80.01	25000 l/h	25000 l/h	750.0 Nm ³ /h	14.0	14.0
	F80.02	30000 l/h	30000 l/h	900.0 Nm ³ /h	14.0	14.0
	F80.03	35000 l/h	35000 l/h	1,050.0 Nm ³ /h	14.0	20.0
	F80.04	40000 l/h	40000 l/h	1,200.0 Nm ³ /h	22.0	25.0
	F80.05	50000 l/h		1,500.0 Nm ³ /h	22.0	
DN100	F80.06	60000 l/h		1,800.0 Nm ³ /h	25.0	
	F80.07	65000 l/h		1,950.0 Nm ³ /h	25.0	
	F100.0	50000 l/h	50000 l/h	1,500.0 Nm ³ /h	30.0	25.0
	F100.1	60000 l/h	60000 l/h	1,800.0 Nm ³ /h	30.0	25.0
	F100.2	70000 l/h		2,100.0 Nm ³ /h	30.0	
	F100.3	80000 l/h		2,400.0 Nm ³ /h	30.0	
DN125	F100.4	90000 l/h		2,700.0 Nm ³ /h	40.0	
	F100.5	100000 l/h		3,000.0 Nm ³ /h	40.0	
	F125.0	100000 l/h	100000 l/h	3,000.0 Nm ³ /h	45.0	35.0
DN150	F125.1	125000 l/h	125000 l/h	3,800.0 Nm ³ /h	45.0	40.0
	F125.2	150000 l/h			48.0	
	F150.0	125000 l/h	125000 l/h	3,800.0 Nm ³ /h	45.0	42.0
DN200	F150.1	150000 l/h	150000 l/h	4,500.0 Nm ³ /h	50.0	50.0
	F150.2	160000 l/h			50.0	
	F150.3	180000 l/h			60.0	
	F150.4	200000 l/h			60.0	
DN250	F200.0	160000 l/h	160000 l/h		60.0	60.0
	F200.1	180000 l/h	180000 l/h		60.0	70.0
	F200.2	200000 l/h			65.0	
	F200.3	250000 l/h			65.0	
DN250	F250.0	220000 l/h	220000 l/h		65.0	60.0
	F250.1	250000 l/h			75.0	
	F250.2	300000 l/h			75.0	

Note: special orders for user

7.2 Scale conversion

7.2.1 Liquids conversion

◆ Volumetric flow of measured liquids Q_t (1/h)

In accordance with density and maximum flow of measured liquid, the flow of water is obtained by substituting them into Formula 1, then, look up the corresponding Nominal size and float number in flow table, thus flow value measured is obtained by substituting flow value of water corresponding standard float No. finally, the scale range of liquid measured is obtained by rounding number.

$$Q_s = \sqrt{\frac{(\rho_f - \rho_s)\rho_t}{(\rho_f - \rho_t)\rho_s}} \times Q_t \quad \dots\dots\dots(1)$$

Note:

Q_t = Max. Volumetric flow of measured liquid (1/h)

Q_m = Max. Mass flow of measured liquid (kg/h)

Q_s = Flow of water-standard medium (1/h)

ρ_f = Density of float (kg/m³)

ρ_t = Density of measured liquid (kg/m³)

ρ_s = Density of water (kg/m³)

◆ Mass flow of measured liquids Q_m (kg/h)

According to Formula 2, the method is same as above.

$$Q_s = \sqrt{\frac{(\rho_f - \rho_s)}{(\rho_f - \rho_t)\rho_s}} \times Q_m \times 1000 \quad \dots\dots\dots(2)$$

Float densities of various materials see table 7-1

7.2.2 Gases conversion

Because gas is easily affected by temperature and pressure other than liquid at the time of calculating flow, not only the density is regarded, but also it is regarded for the influences from temperature and pressure. so it is extremely important to provide exact temperature and pressure value of measured gas under operating condition.

◆ Standard flow of measured gases Q_N (Nm³/h)

$$Q_s = \sqrt{\frac{\rho_{st} \times P_s \times T_t}{\rho_s \times P_t \times T_s}} \times Q_N \quad \dots\dots\dots(3)$$

Note:

Q_N = Max. Volumetric flow (Nm³/h) of gases in calibrating condition

Q_t = Max. Volumetric flow of gases in operating condition (m³/h)

Q_m = Max. Mass flow of gas in operating condition (kg/h)

Q_s = Flow of air-standard medium (m³/h)

ρ_s = Density of air in calibrating condition (kg/m³)

ρ_{st} = Density of gas in calibrating condition (kg/m³)

ρ_t = Density of air in operating condition (kg/m³)

P_s = Absolute pressure of air in calibrating condition (0.1MPa)

P_t = Absolute pressure of gas in operating condition (MPa)

T_s = Absolute Temp. of air in calibrating condition (293.15K)

T_t = Absolute Temp. of gas in operating condition (K)

◆ Operating flow of measured gases: Q_t (m³/h)

$$Q_s = \sqrt{\frac{\rho_{st} \times P_t \times T_s}{\rho_s \times P_s \times T_t}} \times Q_t \quad \dots\dots\dots(4)$$

◆ Mass flow of gases to be measured Q_m (kg/h)

$$Q_s = \sqrt{\frac{1}{\rho_t \times \rho_s}} \times Q_m \quad \dots\dots\dots(5)$$

7.3 Accuracy class

See table 7-2 :

Table 7-1

Float densities of various materials	
Materials	Densities (g/m ³)
CrNi Steel	7.85
PTFE	3.40
PVDF	3.80
PV	1.38 ~ 1.43
PP	0.90 ~ 0.91
Nickel-base alloy	8.89
Ti	4.50
Al	2.70
Cu	8.90

Table 7-2

Standard		VDI / VDE 3513			
Accuracy	1.0	1.5	2.0	2.5	
Error %	Relative to full	Relative to full	Relative to full	Relative to full	Relative to full
Flow %	scale	scale	scale	scale	scale
100	1.000	1.500	2.000	2.500	
90	0.925	1.387	1.850	2.312	
80	0.850	1.275	1.700	2.125	
70	0.775	1.162	1.550	1.937	
60	0.700	1.050	1.400	1.750	
50	0.625	0.937	1.250	1.562	
40	0.550	0.825	1.100	1.375	
30	0.475	0.712	0.950	1.187	
20	0.400	0.600	0.800	1.000	
10	0.325	0.487	0.650	0.812	

8 Indicator

8.1 P8 type

- ◆ Mechanical indicator with stainless steel housing;
- ◆ Lightly and beautiful appearance;
- ◆ May connect to hygienic type.



P8 type

8.2 P10 type

(1) P10 / Exi type

(2) P10 / Exd type

- ◆ Mechanical indicator;
- ◆ LCD display (flow rate and flow total);
- ◆ 2-wire (4-20) mA current output with hart communication;
- ◆ Key setting, the hand operator or PC remote configuration;
- ◆ Exi / Exd;
- ◆ One or two limit switches selectable;
- ① Limit switch KG22 (K1, K2); ② Limit switch KG24 (KE1, KE2).



P10/Exi: intrinsically safe type

P10/Exd: explosion-proof type

8.3 P10I type

- ◆ Mechanical indicator with explosion protection housing;
- ◆ One or two limit switches selectable.
- ① KG22 limit switch (K1, K2); ② KG23 limit switch (KR1, KR2).



P10I type

8.4 P10B type

- ◆ Mechanical indicator;
- ◆ LCD display (flow rate and flow total);
- ◆ Powered supply by 3.6V Lithium battery (service life: 1 year).



P10B Type

9 Electrical data and connection

9.1 Limit switches

9.1.1 KG22

KG22 consists of two parts. One is inductance approach switch SJ3.5N and cutting discs on rotation axis (fig.9-1.Technical parameters) see table 9-1), another is external isolated switching amplifier (WE77/Ex , it is selected by user see fig.9-2.Technical parameters see table 9-2).

Default set:

K1 : Low limit

K2 : High limit

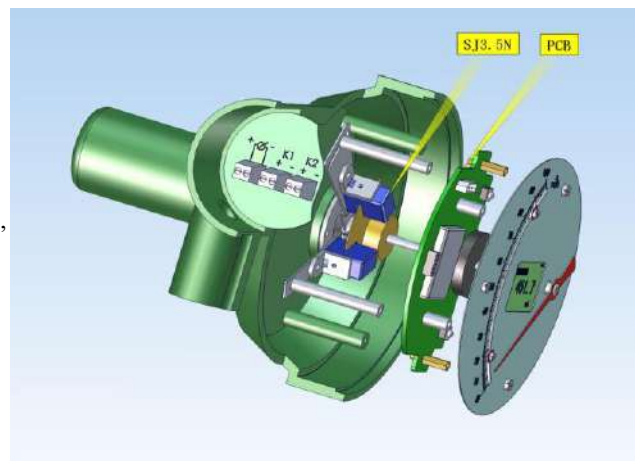


Fig.9-1

Table 9-1

Rated voltage	8 V DC	
Current loss	Active area open	Active area close
	≥3 mA	≤1 mA
Self-inductance	160μH relate to dangerous place	
Self capacitance	20μF relate to dangerous place	
Ambient temperature	-25℃~+100℃	
Degree of protection	IP65	



Table 9-2

Technical data	AC TYPE	DC TYPE
	WE77 / Ex-1	WE77 / Ex-1-G
	WE77 / Ex-2	WE77 / Ex-2-G
Power Supply	220V AC/45-65Hz	-
Standard	24 ,42 ,110 ,127V AC	-
Special type	About 3.5VA	15-70V DC
Power Consumption		Max 6.3W
Input intrinsically safety	DIN19243 or NAMUR	DIN19243 or NAMUR
Explosion-proof type	[EExia]IIC or [EExib]IIC	[EExia]IIC or [EExib]IIC
Explosion-proof certificate number	Ex-79/2043 X	Ex-81/2146 X
Open-circuit voltage	8 V DC(13.5 V DC)	8 V DC(12.7 V DC)
Short-circuit current	8 mA (31 mA)	8 mA (21 mA)
Safe distributed inductance /Capacitance		
[EExia]IIC	3 mH/230ηF	2 mH/230ηF
[EExib]IIC	31 mH/609ηF	70 mH/800ηF
Output non-intrinsically safety		
Model of switch	WE77/Ex-1: 1 transition terminal	WE77/Ex-1:1 transition terminal
	WE77/Ex-2: 2 transition terminal	WE77/Ex-2:2 transition terminal
Contact capacity	AC:4A/250V/500A/cos=0.7	DC: 220V/0.1A:60V/0.6A:24V/4A
Display “relay operating”	LED	LED

KG22 and WE77 / Ex electrical connection see fig. 9-3:

fig. 9-4 Electrical connection of one transition terminal,

fig. 9-5 Electrical connection of two transition terminal.

Symbols used on the figure:

- 1: SJ3.5N sensor
- 2: Isolated switching amplifier
- 3: LED on while relay works
- 4: Relay output
- 5: Power supply 220V AC

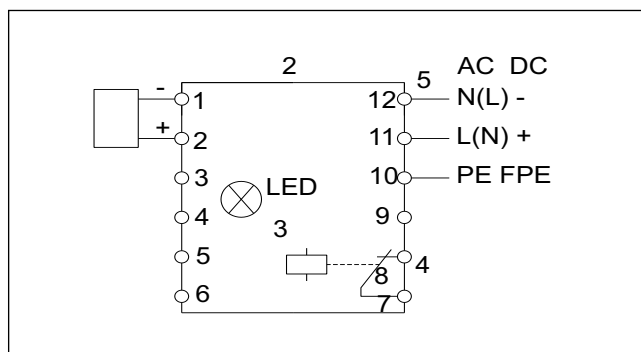


Fig. 9-4

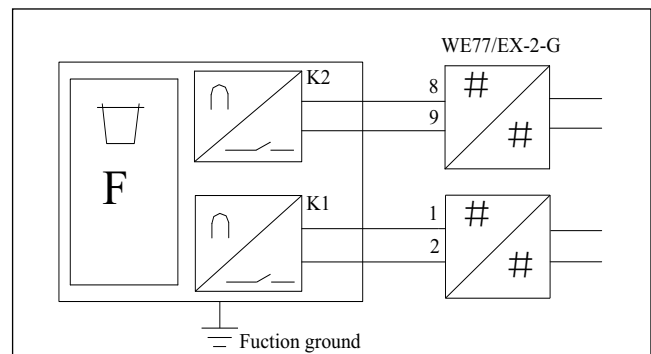


Fig. 9-3

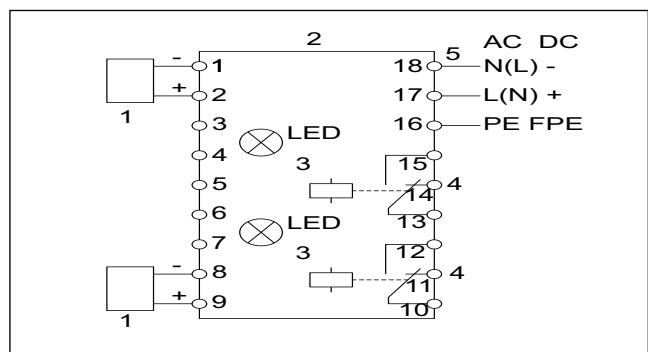


Fig. 9-5

9.1.2 KG23

Fig.9-6KG23 is reed switch,

- ◆ Compact and lightweight;
- ◆ Fast speed on-off time is $1 \sim 3\text{ms}$;
- ◆ Connection point vermeidbar oxidation, Carbonization, Corrosion.

Table 9-3 KG23 Technical parameters,

Fig. 9-7 KG23 Electrical connection .

Default set:

KR1: Low limit

KR2: High limit

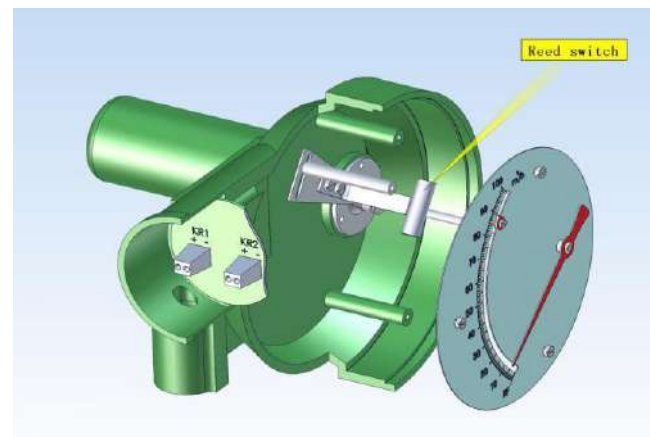


Fig. 9-6

Table 9-3

Contact form	SPST
Power rating	10W
Switching current (Max.)	1.0A
Load current (Max.)	1.5A
Switching voltage (Max.)	100V
Min. breakdown voltage	200V
Contact impedance	200 milliohms
Insulation impedance (min.)	10^{12} ohms
Contact capacity (max.)	0.2pf

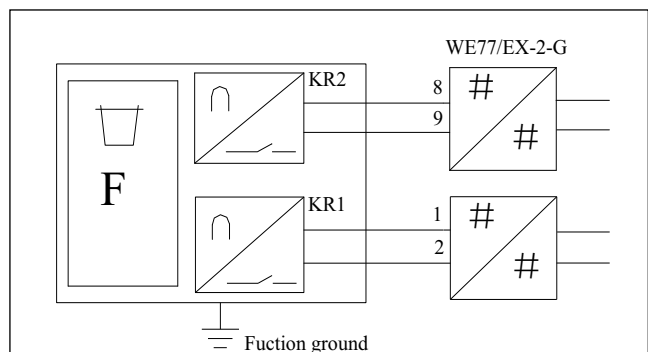


Fig. 9-7

9.1.3 KG24

KG24 is optical coupling switch which photoelectric relay is integrated on flow board card and set digital value. See fig. 9-8:

- ◆ Limit signal of output is better reliable, safe and precise;
- ◆ Limit setting is better convenient.

Photoelectric relay technical parameters see table 9-4:

Default set:

KE1: Low limit

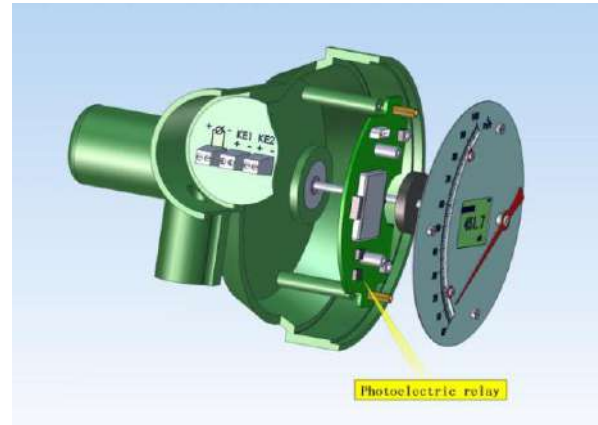
KE2: High limit

If Continuous load current is greater than absolute maximum ratings, KG24 needs directly connect to WE77/E, also connect to other isolated switching amplifier which is offered or recommended by manufactory.

KG24 electrical connect see fig. 9-9.

Table 9-4

Item		Absolute maximum ratings
Turn off	Load voltage (peak AC)	350V
	Off state leakage current	1μA
Turn on	On resistance (Max.)	25Ω
	Continuous load current	0.12A
Power dissipation		300mW
I/O isolation voltage		1500V AC
Turn on time (Max.)		5ms
Turn off time* (Max.)		2ms



ig.9

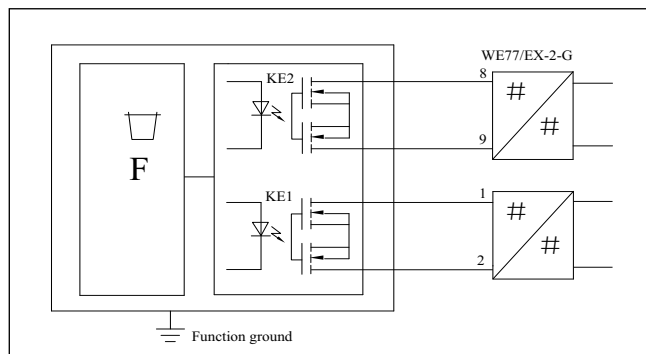


Fig. 9-9

9.2 (4-20)mA / HART communication protocol electronic signal output

See fig. 9-10:

9.2.1 Electrical data:

Power supply: (12 ~ 36)VDC;

Rated voltage: 24VDC.

9.2.2 Electrical connection:

Terminal wiring see fig. 9-11:

Fig. 9-12 electrical connection of Explosion-proof

R: recommended 250Ω.

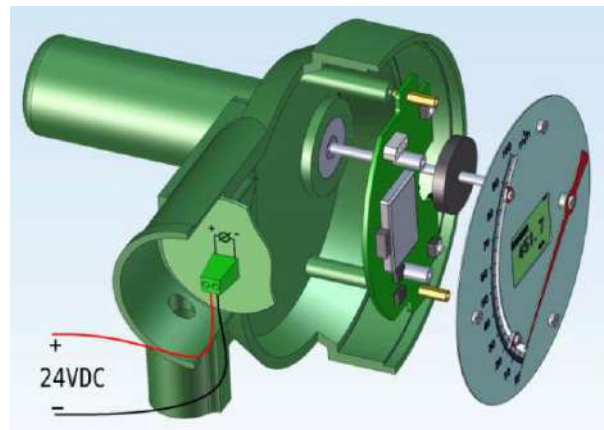


Fig. 9-10

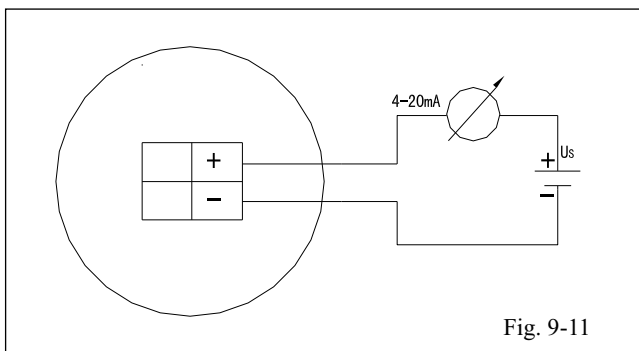


Fig. 9-11

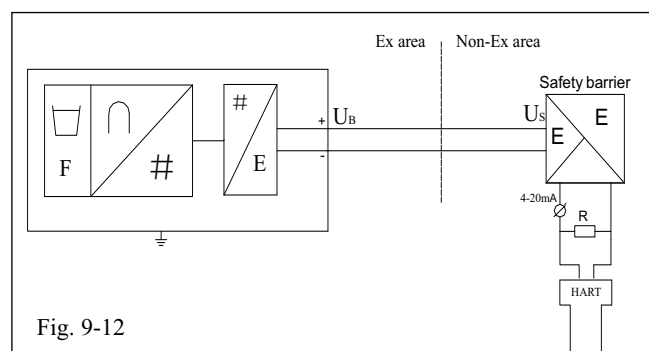


Fig. 9-12

10 MDVB-S order code

MDVB-S			
2.Installation form			
PI	Vertical (if select Vertical mounting ,this column is ignored)		
HI	Horizontal		
BO	Bottom-in side-out		
SO	Side-in side-out		
UP	Up-in down-out		
3.Process connection			
F	Flange connection		
W	Screw thread connection		
H	Clamp connection / Hygienic		
C	Cutting sleeve connection		
4.Materials (other ones is optional also)			
S4	304/304SS		
S6	316/316SS		
S4L , S6L	304L/304LSS, 316L/316LSS		
S7, S7L	317/317SS, 317L/317LSS		
C276,B2,B1,N6	Hastelloy alloy C276, Hastelloy alloy B2, Hastelloy alloy B1, N6		
PV	PV (Vertical, Max: DN100, normal atmospheric temperature)		
PP	PP (Vertical, Max: DN100)		
C4,B2,B1,N6	Hastelloy alloy C4, Hastelloy alloy B2, Hastelloy alloy B1, N6		
Ti	Titanium alloy		
Zr	Zirconium alloy		
Al	Aluminium alloy		
Cu	Copper alloy		
SP	1Cr18Ni9Ti with PTFE liner		
5.Indicators			
P8	Mechanical indicator with stainless steel housing		
P10	A	Mechanical indicator with two-wire signal output (4-20)mA.(K22 or K24)	
	H	Mechanical indicator with two-wire signal output (4-20)mA/HART,(K22 or K24)	
	I	Mechanical indicator,(K22 or K23)	
	B	Mechanical indicator with LCD display powered supply by lithium-ion battery	
6.Explosion protection type			
Exi	Intrinsic safety type		
Exd	Explosion-proof type		
7.Measuring medium			
L	Liquid		
G	Gas		
8.Jacket-type			
T	With Heating / cooling jacket		
9.Limit switches			
KG22	K1	Low limit	
	K2	High limit	
KG23	KR1	Low limit	
	KR2	High limit	
KG24	KE1	Low limit	
	KE2	High limit	
10.High temperature			
H1	Medium temperature : 120℃ ~ 160℃		
H2	Medium temperature : 160℃ ~ 250℃		
H3	Medium temperature : 250℃ ~ 400℃		