Goldcard **TANCY**

TCF Coriolis Mass Flowmeter

天信仪表集团有限公司
Tancy Instrument Group Co.,Ltd.

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1. Measurement principle

## 1.1. Product features and application areas

The TCF Coriolis mass flowmeter is a new generation of high-precision flowmeter that uses the Coriolis force principle to directly measure mass flow. The electronic conversion device of the digital signal processor (DSP) integrates the functions of oscillation control, signal processing, calculation and diagnosis. It has the advantages of high measurement accuracy, multi-parameter monitoring, wide range ratio and good reliability. It is widely used in petroleum, chemical, metallurgy, textile, papermaking, pharmaceutical, food and other industries.

Features:

- Directly measure the mass flow, density and temperature of the medium

- The flow measurement is not affected by the physical properties of the fluid, such as density, viscosity, etc.

- Strong flow capacity, high range ratio up to 40:1

- With bidirectional measurement function, it can measure forward and reverse flow

- There are no mechanical moving parts in the measuring tube, which is highly reliable and easy to maintain.

- No straight pipe section required for on-site installation

- High-definition backlit LCD display, red backlight display when alarm is triggered, easy to maintain

- It has self-check and fault self-diagnosis functions, which can detect abnormal operation such as oscillation failure, over-limit alarm, and non- full tube alarm.

- Support analog output, multiple digital outputs and RS485-Modbus, Hart bus communication protocols

1.2. Mass and volume flow measurement

The measuring tube vibrates at the resonance frequency driven by the drive current, generating a sine wave. When there is no flow, the two measuring tubes oscillate in the same phase. When there is a flow, due to the Coriolis force, the measuring tubes oscillate asynchronously, causing a phase shift in the sine waves measured by the inlet and outlet sensors. And the shift is related to the mass flow rate. The volume flow rate can be calculated from the mass flow rate and density measurement .

No flow   Flow through
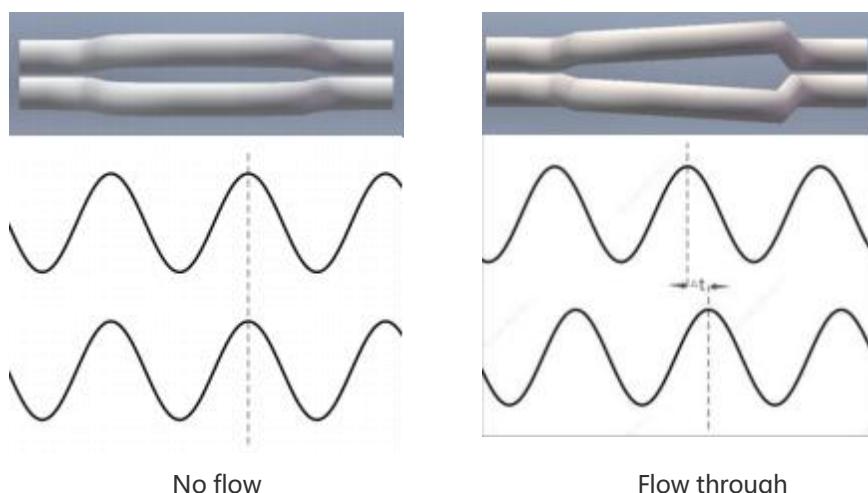
$$Q = K \times \Delta\theta$$

LEGEND:

K: Flow coefficient $\Delta\theta$: Phase difference Q: Mass flow rate

1.3. Density measurement

The measuring tube vibrates at its resonant frequency. When the medium changes, the resonant frequency changes accordingly and the density can be calculated from this.

$$\rho = \frac{K_1}{f^2} + K_0$$

LEGEND:

ρ :density   f : Resonance K_1, K_0: coefficient
                         frequency

1.4. Temperature measurement

The temperature is measured by the temperature sensor and can be used as an output. In addition, the temperature is used to compensate for parameters such as the Young's modules of the measuring tube. Compensate for the effects of temperature changes, Make the measurement more accurate.

2. Performance specifications

2.1. Performance parameter table

performance	parameter
Nominal diameter DN (mm)	25/50/80/100/150
Maximum working pressure	10MPa (at reference temperature)
Nominal pressure	PN16/PN40/PN63/PN100 Class 150/Class 300/Class 600
Medium temperature	-40℃~ 204℃
Accuracy level	Liquid: 0.1, 0.15, 0.2
	Gas: 0.35 grade
Repeatability	0.05%
Density accuracy	±0.001g/ ^{cm3}
Temperature accuracy	±0.1℃ +0.005 |T|, T is Celsius temperature
Measuring tube material	316L
Supply voltage	220V AC
	24V DC
Output method	Standard configuration: 4mA~20mA +Hart+ Pulse/Frequency+RS485 Expand 1 channel Expand 1 channel 4mA~20mA active output based on standard configuration Expand 1 channel 4mA~20mA passive output based on standard configuration
4mA~20mA output accuracy	0.1%FS
Installation type	Integrated/Split
Protection level	IP66 / IP67
Explosion-proof grade	Ex db ib IIC T1...T6 Gb
Ambient temperature	-40℃~ 60℃ (LCD displays normally above -20℃)
Relative humidity	5% ~ 95%

2.2. Liquid measuring range

DN(mm)	25	50	80	100	150
Minimum flow rate (kg/h)	450	2000	4000	12000	20000
Maximum flow rate (kg/h)	18000	80000	200000	480 000	800000

2.3. Gas flow

When selecting a meter for a gas application, the pressure drop and range ratio across the sensor depend on the operating temperature, Pressure and fluid composition. The maximum gas flow rate is recommended as follows:

$$\dot{m}_g = a * \rho_g * c * \frac{\pi}{2} * d^2$$

LEGEND:

$\dot{m}_g$: Gas mass flow rate

a : Typical nominal flow recommended 0.2; maximum recommended 0.3 ρ_g : Gas density

c : Speed of sound in gas

d : Inner diameter of the measuring tube

Note: The maximum gas flow rate can never be greater than the maximum liquid flow rate.

2.4. Zero stability

When the flow value is small and close to the declared minimum flow, the measurement accuracy and repeatability will be affected to a certain extent.

Zero stability should be considered at this time , and the flow meter accuracy will depend on the formula:

Accuracy = (zero stability / flow value) × 100% .

Zero stability:

model	Nominal diameter	Zero stability
	mm	Kg/h
TCF-U025	25	0.45
TCF-U050	50	2
TCF-U080	80	5
TCF-U100	100	12
TCF-U150	150	20

3. Environmental conditions

3.1. Ambient temperature and humidity

Ambient temperature	-40℃ ~ 60℃
Atmospheric pressure	86 kPa ~ 106 kPa
Allowable relative humidity	5% ~ 95%

3.2. Storage environment

- The instrument should be stored in a ventilated room with a temperature of -40℃ ~ 60℃ and a relative humidity of no more than 80%.
- The storage area must be free from corrosive gases and harmful vapors.

3.3. Protection level

IP66 / IP67.

3.4. Electromagnetic compatibility

Meets GB/T 31130-2014 Coriolis mass flowmeter and JJF1591-2016 Coriolis mass flowmeter type evaluation outline.

4. Influence of process conditions

4.1. Effect of process temperature

The flow meter has a temperature compensation function, which can compensate for the measurement deviation caused by the inconsistency between the medium temperature during zero point calibration and the medium temperature during operation.

The temperature influences are as follows:

Model Specifications	Mass flow rate (kg/h/℃)
TCF-U025	±0.03
TCF-U050	±0.12
TCF-U080	±0.24
TCF-U100	±0.72
TCF-U150	±1.20

4.2. Effect of process pressure

The process pressure effect refers to accuracy deviations caused when operational pressures differ from calibration pressures.

TCF process pressure effect:

model	Mass flow rate (% flow)	
	Per psi	Per bar
TCF-U025	-0.00028	-0.0041
TCF-U050	-0.00054	-0.0078
TCF-U080	-0.00052	-0.0076
TCF-U100	-0.00048	-0.0070
TCF-U150	-0.00055	-0.0079

5. Output

5.1. Output signal

- RS485 (Modbus-RTU protocol)
- 4mA~20mA Current output
- Hart
- Pulse/Frequency (maximum frequency 10kHz)
- Can be expanded to 1 channel 4mA~20mA Current output

5.2. Alarm signal

According to the interface type, relevant alarm information is displayed.

HART Output

Device alarm message	HART Output

RS485 output

Equipment alarm information	485 bus message output

4mA~20mA Current output

Equipment alarm information	Maximum current output: 3.59mA/22mA

Frequency/ Pulse Output

Pulse output	
Equipment alarm information	No pulse
Frequency Output	
Equipment alarm information	Frequency output: default 0Hz, configurable
Alarm output	
Equipment alarm information	The alarm level is high by default，configurable

LCD unit

Interface display	Prompt alarms, warnings and status messages
Backlit display	Displays alarm, warning, and status event codes Warning and status information are displayed in normal backlight, and red backlight and alarm code are displayed when alarm occurs

5.3. Communication specification parameters

HART protocol version number	7
Manufacturer ID	0x6195
Device Type ID	0xE627
HART Load	250Ω~700Ω
Modbus Address	Default: 2; Range 0~255
Baud rate	Default: 9600, Range (1200, 2400, 4800, 9600, 19200, 38400, 115200)
Check digit	Default: No parity, Range (No parity, Odd parity, Even parity)
Data bits	8-bit
Function Code	0x03: Read a single register 0x04: Read input register 0x06: Write a single register 0x10: Write multiple registers

5.4. Batch Processing

Interface display	Prompt alarms, warnings and status messages

6. power supply

6.1. Supply voltage

Selection code	Voltage Type	Voltage range	Frequency range
A	220V AC	-10% ~ 10%	50Hz±2.5Hz
D	24V DC	18V ~ 36V	—

6.2. Power consumption

Transmitter: Maximum power 10W (active power).

6.3. Current consumption

Transmitter:

- 220V AC power supply: maximum 200mA
- 24V DC power supply: maximum 400mA

6.4. Electrical Connections

RS-485 communication connection method:
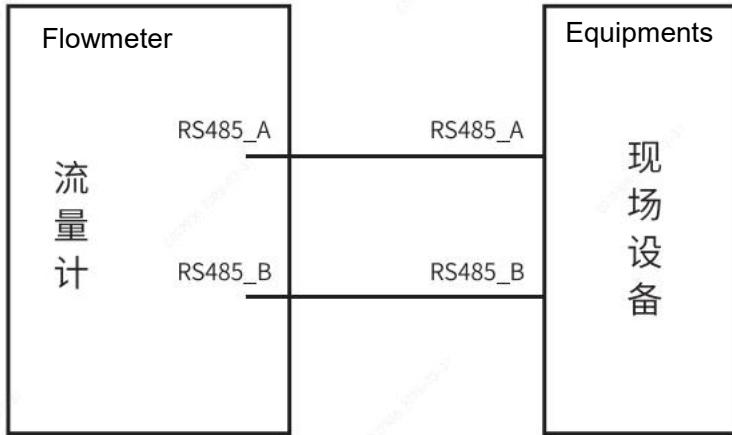
Figure 2 RS-485 communication

RS-485 communication: standard Modbus communication protocol, RTU format, capable of remotely transmitting display data.

Frequency/ Pulse/ Alarm/ Batch Output:

① Frequency signal: The maximum full-scale frequency can be set to 10000Hz, and the set frequency corresponds to the full-scale flow rate.

② Pulse signal: The unit/pulse can be set appropriately according to needs.

③ When used as a passive output, the pull-up resistor R1 The recommended value is 5.1KΩ.
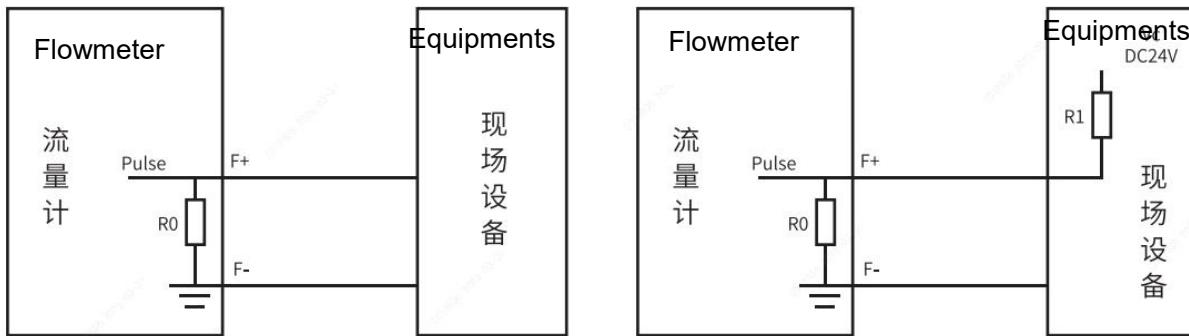
Figure 3 Frequency/Pulse/Alarm/Batch Output (Left is active connection, right is passive connection)

4mA~20mA Current/HART output connection method:
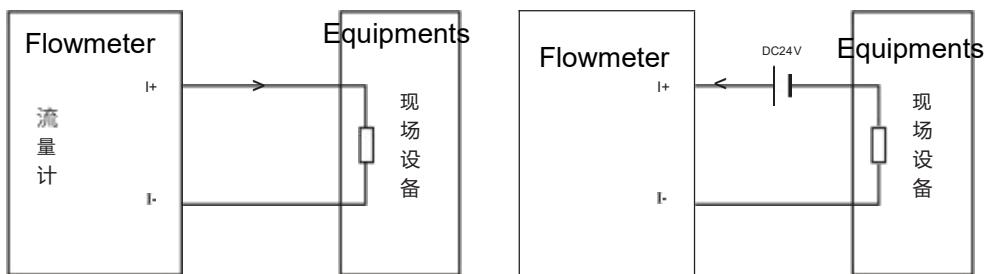
Figure 4 Current output (left is active connection, right is passive connection)

Current output mode:

① The physical value corresponding to 4mA and 20mA is configurable, and the load resistance is 250Ω~700Ω.

② The product is configured as a 4mA~ 20mA output port as standard. Circuit (with Hart), if you need a second 4mA~20mA output, please mark it when ordering and indicate whether it is active or Passive output.

6.5. Wiring

6.5.1 Cable specifications

The wiring of the flow meter is divided into power line, digital (pulse/frequency/alarm/batch) output line, 4mA~20mA/Hart output line and sensor connection line. The parameter is as follows:

Cable Type	Cable specifications	Recommended maximum length
Power cord	$0.8mm^2 \sim 2.5mm^2$	≤ 500 m
Pulse output line	$\geq 0.5mm^2$	≤ 100 m, shielded cable
RS485 line	$\geq 0.5mm^2$	≤ 300 m, shielded twisted pair
4mA~20mA/Hart line	$\geq 0.5mm^2$	≤ 500 m, shielded cable
Sensor cable	dedicated	≤ 25 m, shielded cable

6.5.2 Power supply and output wiring
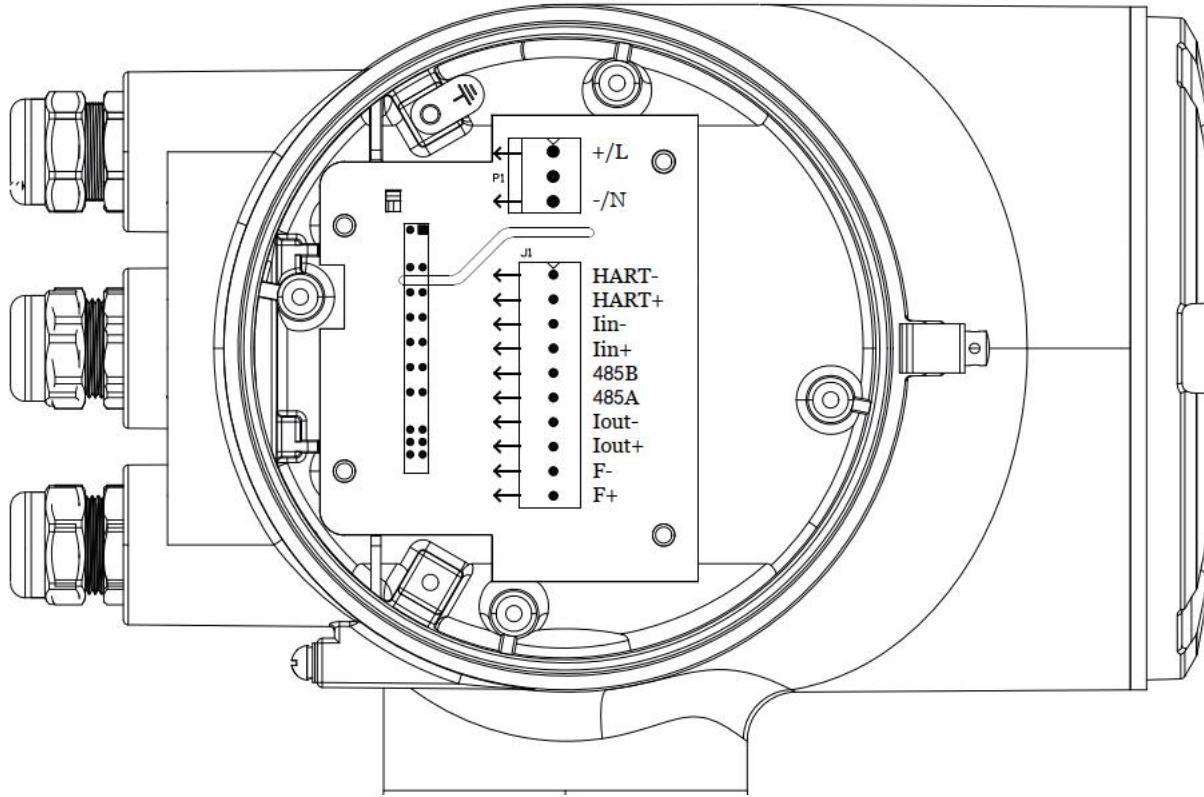
Interface ID	Pin Definition	Remark
L	AC power phase line; DC power +	Power Input
N	AC power neutral line; DC power -	
HART-	Active analog current output - / Passive analog current output +	The first 4mA~20mA output and HART Communication
HART+	Active analog current output +/ Passive analog current output -	
IIN -	Simulate current outflow	4mA~20mA input (reserved, optional)
IIN+	Simulate current inflow	
485-B	RS485 communication-	RS485
485-A	RS485 Communication+	
IOUT -	Active analog current output - / Passive analog current output +	Expand 4mA~20mA output (Optional)
IOUT+	Active analog current output +/ Passive analog current output -	
F-	Output -	Frequency/ Pulse/ Alarm / Batch Processing
F+	Output+	
PE	Grounding	Shell grounding

6.5.3 Split-type dedicated cable wiring

The cable between the split sensor and the converter uses a dedicated cable. The standard cable length is 5 meters, 10 meters, 15 meters, 20 meters and 25 meters. The wiring pin diagram of the dedicated cable is as follows:
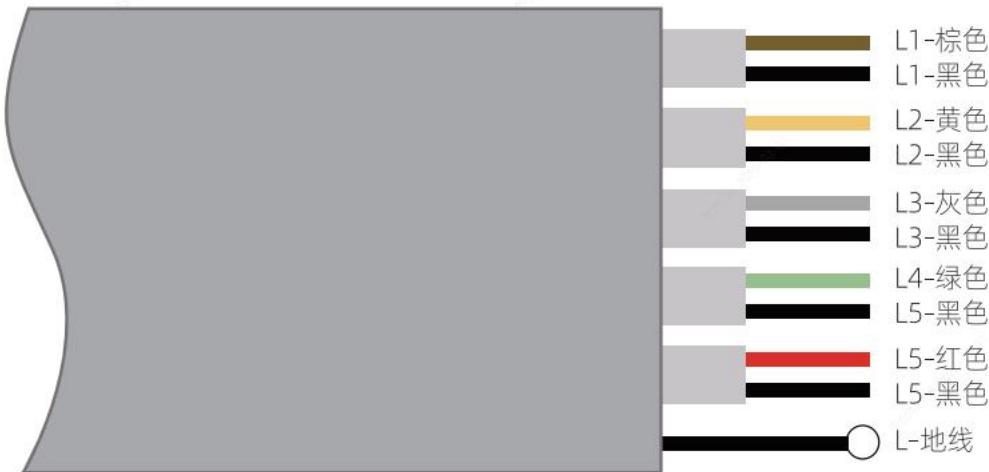
Primary sensor terminal wiring:
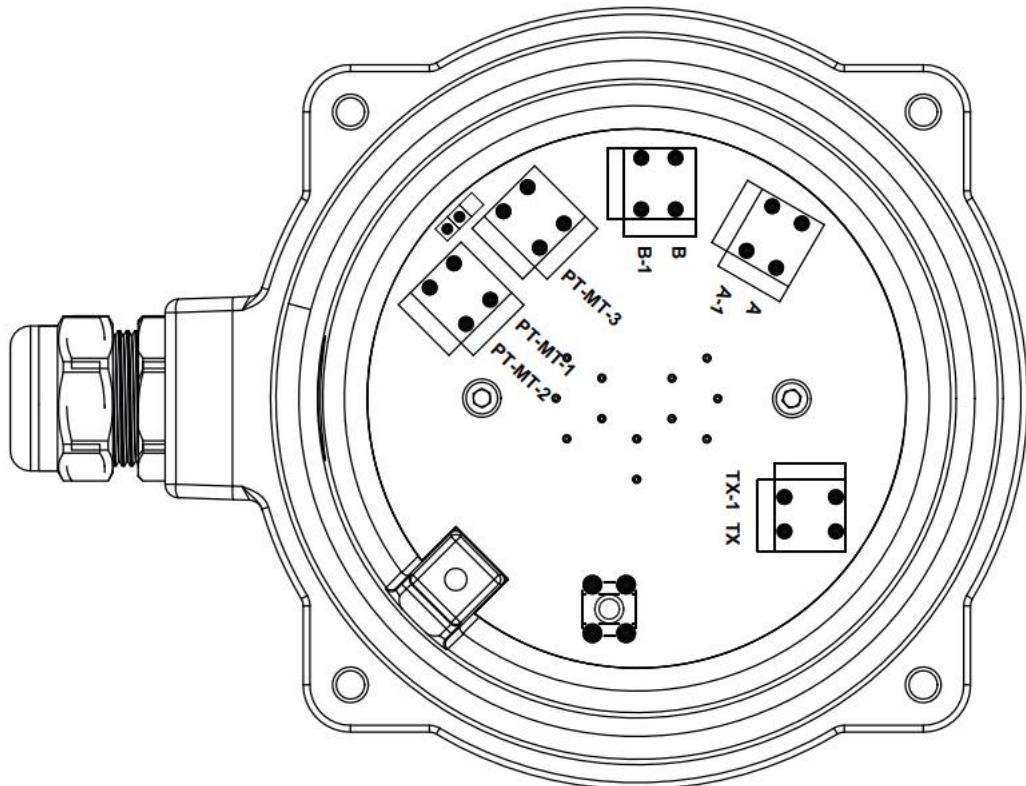
Transmitter terminal wiring:

TX-1
TX

PT-MT-3

PT-MT-2
PT-MT-1

B-1
B

A-1
A
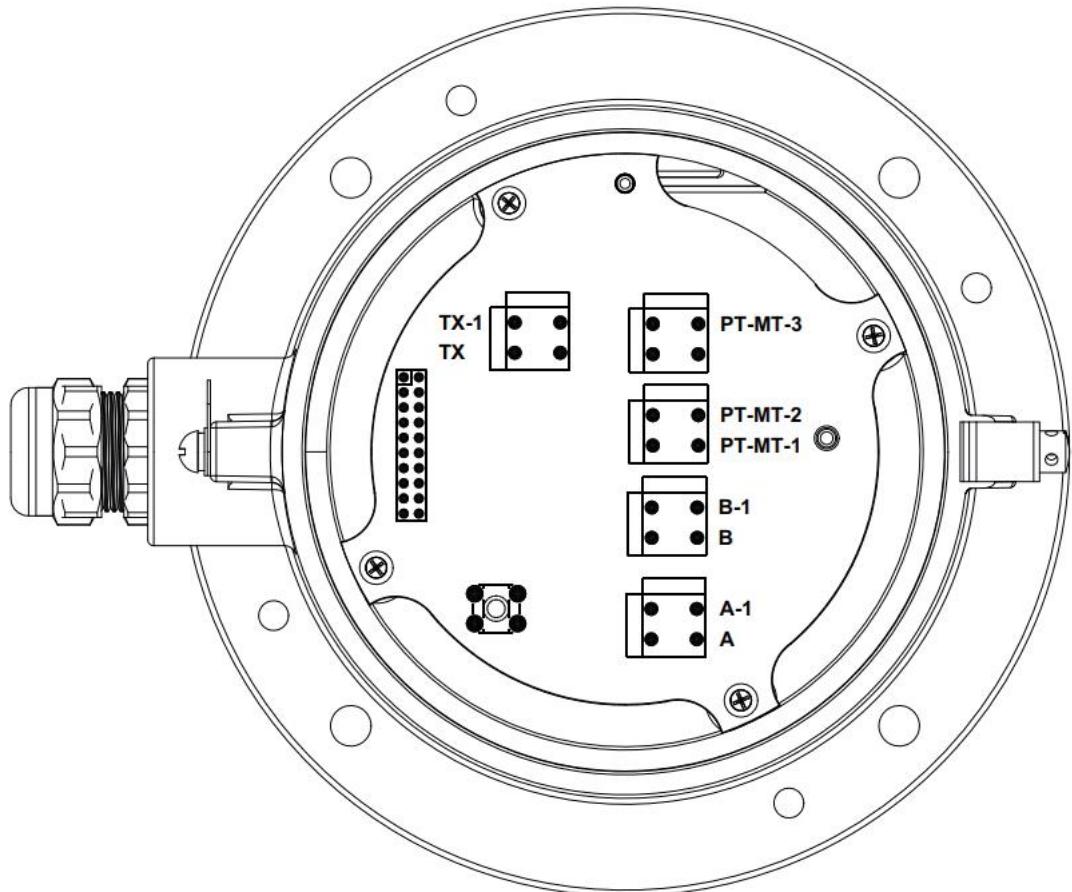
Definition of each terminal

| Interface ID	Pin Definition	Cable
TX	Exciter signal+	L1- Brown
TX-1	Exciter signal -	L1- Black
A	Pickup sensor A signal +	L2- Yellow
A-1	Pickup Sensor A Signal -	L2- Black
B	Pickup sensor B signal +	L3- Grey
B-1	Pickup Sensor B Signal -	L3- Black
PT-MT-1	Temperature sensor signal 1	L4- Green
PT-MT-2	Temperature sensor signal 2	L4- Black
PT-MT-3	Temperature sensor signal 3	L5- Black
U1	Primary sensor ground wire	L- Ground

6.5.4 Grounding method

In order to ensure reliable grounding of the instrument, improve measurement accuracy, and avoid interference from external parasitic potential, the sensor must have a good separate grounding with a grounding resistance less than 10Ω, the cross-sectional area of the grounding wire should be ≥ 4mm² , the grounding wire must not conduct any other interference voltage, and do not connect the grounding wire to other energized electrical equipment.

7. Self-diagnosis function

TCF transmitter has a self-diagnosis function. When an abnormality is detected during operation, the corresponding event code is displayed on the LCD, and is divided into status events, warning events, and alarm events according to the severity level. When an alarm event occurs, the LCD backlight turns red to serve as a reminder. The self-diagnosis information is as follows:

- No vibration of the measuring tube

- Sensor signal asymmetry

- Temperature sensor abnormality

- Partially filled pipe

- Storage exception

- Density anomaly

- Mass flow rate exceeds upper limit

- Pulse output abnormality

When various abnormalities occur, the mass flow, volume flow, density, temperature, cumulative amount and other information are recorded to facilitate on-site maintenance and diagnosis.The system can store up to 200 diagnostic event records.

8. Install

8.1. Installation Location

The flow meter flange must be coaxially aligned and connected with the pipeline flange, and the flow meter housing should be suspended, with no contact with any objects. The flow meter should be installed downstream of the pump and kept at a distance from it. For convenient maintenance, it is recommended to install shut-off valves both upstream and downstream.

8.2. Installation direction

Usually the flow meter is installed in a direction that allows the process medium to fill the measuring tube, thereby achieving accurate measurement. The recommended primary sensor installation direction is as follows:

Serial number	Application Scenario	Primary sensor orientation
1	liquid	
2	gas	
3	Serum	
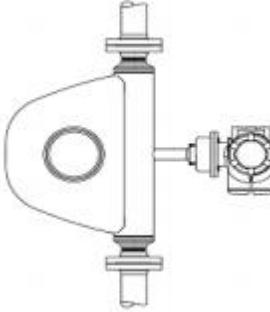
Note:

1) When the fluid is liquid and contains a small amount of solid particles, it is recommended to use installation method 2

2) When the fluid is gas and contains a small amount of liquid, it is recommended to use installation method 1.

3) When installing the primary sensor, ensure that the actual flow direction of the flow is consistent with the flow direction arrow of the primary sensor.

8.3. Upstream and downstream straight pipe runs

No requirements.

9. Mechanical structure

9.1. Structural materials

part	Material
Measuring tube material	S31603/316L stainless steel
Flange material	S31603/316L stainless steel
Sensor housing material	304 Stainless Steel
Transmitter housing material	Aluminum Alloy

9.2. Process connection

Flange code	Flange Type	standard
R1	PN16 RF Face flange	GB/T 9124.1-2019
R3	PN40 RF Face flange	
R4	PN63 RF Face flange	
R5	PN100 RF Face flange	
RA	ANSI Class 150 RF Flange	GB/T 9124.2-2019
RB	ANSI Class 300 RF Flange	
RC	ANSI Class 600 RF Flange	

9.3. Dimensions

All-in-one type:
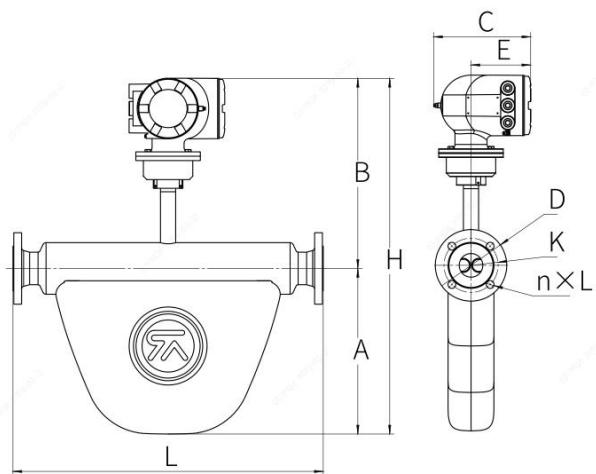
Fig.10 Integrated Dimensions

Table 1 Integrated installation dimensions

Nominal Diameter	Pressure level	L	A	B	C	E	H	D	K	n×L
DN25	PN16	440	228	393	225	138	621	φ115	φ85	4×φ14
	PN40	440	228	393	225	138	621	φ115	φ85	4×φ14
	PN63	470	228	393	225	138	621	φ140	φ100	4×φ18
	PN100	470	228	393	225	138	621	φ140	φ100	4×φ18
	Class150	440	228	393	225	138	621	φ110	φ79.4	4×φ16
	Class300	470	228	393	225	138	621	φ125	φ88.9	4×φ19
	Class600	490	228	393	225	138	621	φ125	φ88.9	4×φ19
DN50	PN16	715	383	419	225	138	802	φ165	φ125	4×φ18
	PN40	715	383	419	225	138	802	φ165	φ125	4×φ18
	PN63	760	383	419	225	138	802	φ180	φ135	4×φ22
	PN100	760	383	419	225	138	802	φ195	φ145	4×φ26
	Class150	715	383	419	225	138	802	φ150	φ120.7	4×φ19
	Class300	760	383	419	225	138	802	φ165	φ127	8×φ19
	Class600	760	383	419	225	138	802	φ165	φ127	8×φ19
DN80	PN16	920	488	442	225	138	930	φ200	φ160	8×φ18
	PN40	920	488	442	225	138	930	φ200	φ160	8×φ18
	PN63	960	488	442	225	138	930	φ215	φ170	8×φ22
	PN100	960	488	442	225	138	930	φ230	φ180	8×φ26
	Class150	920	488	442	225	138	930	φ190	φ152.4	8×φ19
	Class300	960	488	442	225	138	930	φ210	φ168.3	8×φ22
	Class600	960	488	442	225	138	930	φ210	φ168.3	8×φ22
DN100	PN16	1343	673	466	225	138	1139	φ220	φ180	8×φ18
	PN40	1369	673	466	225	138	1139	φ235	φ190	8×φ22
	PN63	1395	673	466	225	138	1139	φ250	φ200	8×φ26
	PN100	1419	673	466	225	138	1139	φ265	φ210	8×φ30
	Class150	1393	673	466	225	138	1139	φ230	φ190.5	8×φ19
	Class300	1411	673	466	225	138	1139	φ255	φ200	8×φ22
	Class600	1457	673	466	225	138	1139	φ275	φ215.9	8×φ26
DN150	PN16	1200	673	466	225	138	1139	φ285	φ240	8×φ22
	PN40	1240	673	466	225	138	1139	φ300	φ250	8×φ26
	PN63	1280	673	466	225	138	1139	φ345	φ280	8×φ33
	PN100	1320	673	466	225	138	1139	φ355	φ290	12×φ33
	Class150	1268	673	466	225	138	1139	φ280	φ241.3	8×φ22
	Class300	1288	673	466	225	138	1139	φ320	φ269.9	12×φ22
	Class600	1338	673	466	225	138	1139	φ355	φ292.1	12×φ29

TCF Coriolis Mass Flowmter
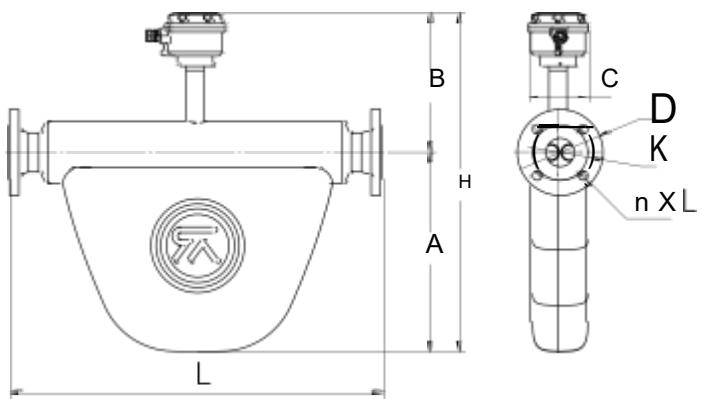
Split type:

Fig.11 Split base table dimensions
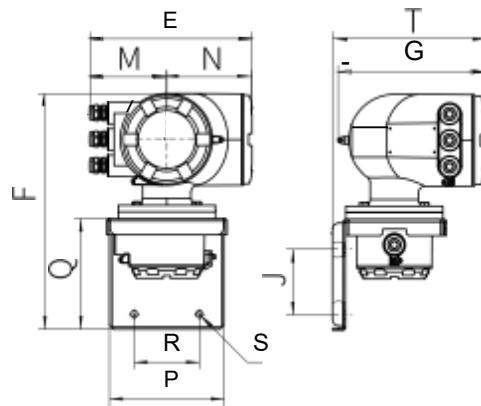
Figure 12 Dimensional drawing of split type transmitter

Table 2 Split base meter installation dimensions

Nominal Diameter	Pressure level	L	A	B	C	H	D	K	n×L
DN25	PN16	440	228	241	116	469	φ115	φ85	4×φ14
	PN40	440	228	241	116	469	φ115	φ85	4×φ14
	PN63	470	228	241	116	469	φ140	φ100	4×φ18
	PN100	470	228	241	116	469	φ140	φ100	4×φ18
	Class150	440	228	241	116	469	φ110	φ79.4	4×φ16
	Class300	470	228	241	116	469	φ125	φ88.9	4×φ19
	Class600	490	228	241	116	469	φ125	φ88.9	4×φ19
DN50	PN16	715	383	267	116	650	φ165	φ125	4×φ18
	PN40	715	383	267	116	650	φ165	φ125	4×φ18
	PN63	760	383	267	116	650	φ180	φ135	4×φ22
	PN100	760	383	267	116	650	φ195	φ145	4×φ26
	Class150	715	383	267	116	650	φ150	φ120.7	4×φ19
	Class300	760	383	267	116	650	φ165	φ127	8×φ19
	Class600	760	383	267	116	650	φ165	φ127	8×φ19
DN80	PN16	920	488	290	116	778	φ200	φ160	8×φ18
	PN40	920	488	290	116	778	φ200	φ160	8×φ18
	PN63	960	488	290	116	778	φ215	φ170	8×φ22
	PN100	960	488	290	116	778	φ230	φ180	8×φ26
	Class150	920	488	290	116	778	φ190	φ152.4	8×φ19
	Class300	960	488	290	116	778	φ210	φ168.3	8×φ22
	Class600	960	488	290	116	778	φ210	φ168.3	8×φ22

DN100	PN16	1343	673	314	116	987	φ220	φ180	8×φ18
	PN40	1369	673	314	116	987	φ235	φ190	8×φ22
	PN63	1395	673	314	116	987	φ250	φ200	8×φ26
	PN100	1419	673	314	116	987	φ265	φ210	8×φ30
	Class150	1393	673	314	116	987	φ230	φ190.5	8×φ19
	Class300	1411	673	314	116	987	φ255	φ200	8×φ22
	Class600	1457	673	314	116	987	φ275	φ215.9	8×φ26
DN150	PN16	1200	673	314	116	987	φ285	φ240	8×φ22
	PN40	1240	673	314	116	987	φ300	φ250	8×φ26
	PN63	1280	673	314	116	987	φ345	φ280	8×φ33
	PN100	1320	673	314	116	987	φ355	φ290	12×φ33
	Class150	1268	673	314	116	987	φ280	φ241.3	8×φ22
	Class300	1288	673	314	116	987	φ320	φ269.9	12×φ22
	Class600	1338	673	314	116	987	φ355	φ292.1	12×φ29

Table 3 Installation dimensions of split type transmitter

E	M	N	F	G	R	J	S	P	Q	T
248	117	131	359	225	100	100	φ10.5	175	169	238

Note: Flanges refer to standards GB/T 9124.1-2019 and GB/T 9124.2-2019. The above are design dimensions.

9.4. Weight

Nominal diameter (mm)	weight (kg)
25	16
50	39
80	81
100	186
150	210

Note: Reference weight for flange integrated type.

10. Order information

10.1. Selection table

TYPE	CODE														INSTRUCTION
TCF															FLOWMETER
PIPE TYPE	U														U TYPE PIPE
SIZE		025													DN25
		050													DN50
		080													DN80
		100													DN100
		150													DN150
MEASURING MEDIUM			L												LIQUID
			G												GAS
ACCURACY CLASS				1											CLASS 0.1
				2											CLASS 0.15
				3											CLASS 0.2
MEDIUM TEMPREATURE					U										-40~204C°
SENSOR MATERIAL															316L STAINLESS STELL
CONNECTION						R1									PN16 RF FLANGE
						R3									PN40 RF FLANGE
						R4									PN63 RF FLANGE
						R5									PN100 RF FLAT FLANGE
						RA									ANSI CLASS150 RF FLANGE
						RB									ANSI CLASS300 RF FLANGE
						BC									ANSI CLASS600 RF FLANGE
Supply voltage							D								24V DC
							A								220V AC
INPUT								0							NULL
OUTPUT									1						4-20mA +Hart+ Pulse+RS485
									2						Expand 1 channel 4-20mA active output
									3						Expand 1 channel 4-20mA passive output
ATEX															Ex db b C T1...T6 Gb P66/ P67
ELECTRICAL INTERFACE										N					ANSI 1/2 NPT
										M					ISO M20*1.5
Transmitter											1				Integrated, aluminum alloy
											2				Split type, made of aluminum alloy
NAMEPLATE												0			According to factory standard nameplate
												1			Custom tag (with tag field on nameplate)
												2			Stainless steel number plate
SIL2													NULL		NULL
													S		YES
PRESSURE Testing														NULL	NULL
														P	YES
Degreasing															NULL — NULL
															D — YES

Material certificate	NULL	NULL
	M	YES
Cable length	L	Split type needs to mark the cable length (unit: METER)05, 10, 15, 20 (special requirements can be Customized

Tancy Instrument Group Co., Ltd.

A: No. 198, Hualian Road, Cangnan County Industrial Park，Wenzhou，Zhejiang
T: 0577-6885 6655
W: www.tancy.com
 E : tancy@tancy.com

The company reserves the right to modify the instructions.