Rev 15k

TFM -- C Series Coriolis Mass Flowmeter

USER MANUAL

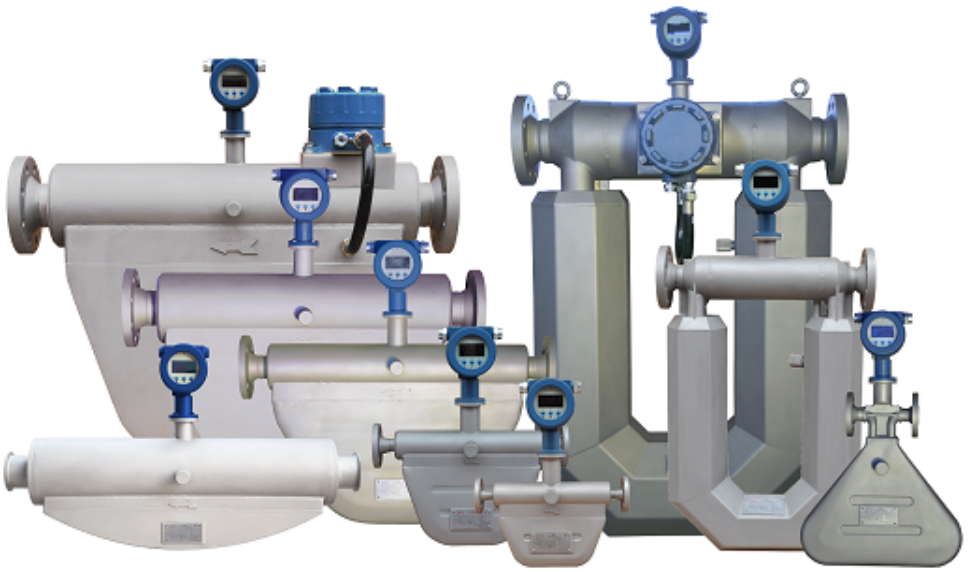
Direct mass flow rate measurement

High accuracy

Digital signal processing

Straight upstream / downstream piping not required

Measure High viscosity liquids



General information	This instrument has been calibrated at the factory before shipment. To ensure correct use of the instrument, please read this manual thoroughly and fully understand how to operate the instrument before operating it. This user manual provides basic technical specifications, instructions for operation, storage and transportation, and other information necessary for the proper operation of the TFM -- C -Series Coriolis Mass Flowmeter (hereinafter - the "flowmeter" or "TFM -- C "). Modbus® is the abbreviation for Modicon Modbus Protocol and it is a registered trademark of Modicon, Inc. ProLink® is a registered trademark of Micro Motion, Inc. Take 5, Inc, dba Tactical Flow Meter((hereinafter called ”TFM” reserves the right to make changes in the design of the flowmeters without prior notice. If you need additional information on the TFM equipment, please contact your local dealer or the factory.
	Before you start operating the flowmeter, please read this manual carefully. Before starting the installation, use or maintenance of the flowmeters, make sure that you have fully read and understand the contents of the manual. This is required to ensure safe operation and proper functioning of the flowmeters. For support, contact your local agent for "TFM", or factory support service below: Tel: (831)--455--0418 Dave@TacticalFlowMeter.com This manual only applies to TFM -- C -Series Coriolis Mass Flowmeters.

Table of contents

1 Product description and technical data

1.1 Applications

The TFM -- C Coriolis mass flowmeter (hereafter called" the flowmeter") is designed to measure the mass and volume flow, density and temperature of flow, and use the gathered information for technological purposes or fiscal transfer.

The flowmeter may be used for the measurement of gasoline, liquefied petroleum gas, kerosene, diesel fuel, oil, oil-water and other liquids in the chemical, petrochemical, oil, food, pharmaceutical and other industries and public municipal facilities.

The flowmeter is used in technological processes, automatic monitoring and control systems in various industries, for stationary technological plants, land mobile refueling and pumping equipment, and in commercial flow measurement systems.

The flowmeter may be provided for use in explosive safe and explosive environments. The flowmeter with the explosion-proof modification will be marked as follows: "TFM TFM -- C -Ex» has a combined type of protection "explosion proof" transmitter: compliant with Underwriters Laboratories Inc. for telemetering equipment for use in Hazardous locations

Class I, Groups C and D; Class II, Groups E, F and G; Class I, Groups A, B, C and D, Division 2.
Intrinsically safe mass flow sensors, for use in Class I, Groups C and D; Class II, Groups E, F and G hazardous locations and also suitable for

Class I, Groups A, B,
C and D, Division 2 hazardous locations

An optional Booster Amplifier is available for use in Class I, Division 1, Groups C and D; Class I, Division 2, Groups A, B, C and D; Class II, Division 1, Groups E, F and G, Hazardous Locations Providing Intrinsically Safe Circuits.

the transmitter , sensor and booster amplifier complies with GOST R 51330.1,and the input and output "intrinsically safe" level «ib» complies with GOST R 51330.10.

The transmitter, sensor and booster amplifier complies with GB3836.1-2010GB3836.2-2010 and GB 3864-2010. It can be used in hazardous locations Zone 1 and Zone 2. The ambient temperature range of the product with this classification is -20 ℃- +40℃. The marking of the equipment is EX d [ib] IIB+H2 T6 Gb

CAUTION!

Note: The flowmeter is not intended for use at nuclear facilities.

1.2 Principle of operation

The flowmeter consists of the following units (as shown in Figure 1.1):

- Flow sensor (1);
- Transmitter (2).

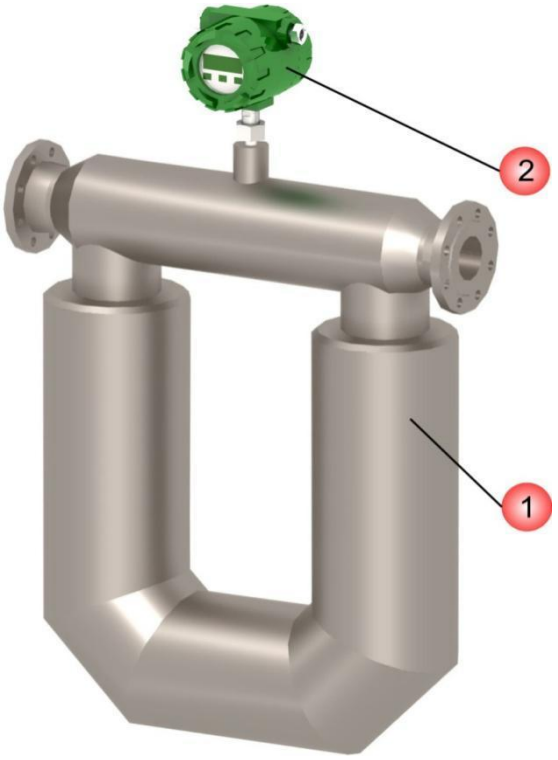


Figure 1.1 –TFM -- C Series flowmeter-U type sensor

The Transmitter may be mounted directly on the flow sensor (integral version, standard) or remotely (remote version, optional).

The sensor consists of a measuring chamber with inlet and outlet flanges for mounting on a pipeline. Inside the measuring chamber there are two parallel U-shaped flow tubes, which vibrate by means of an electromagnetic coil and a magnet.

The principle of operation is based on the Coriolis effect.

Figure 1.2 shows the forces affecting the flow tube through which the measured liquid is flowing, during the half-cycle fluctuations, when the tube moves up.

The liquid flowing into the tube creates a resistance to movement due to inertial forces, or the fluid upward movement and downward pressure on the tube by inertial forces. The vertical momentum is measured by driving the tube bend, the liquid, flowing out of the pipe, (inertial forces) pushes the tube up. This causes the tube to twist. When the tube is moving down in the second half of the oscillation cycle, it twists in the opposite direction. This twisting is called the Coriolis effect.

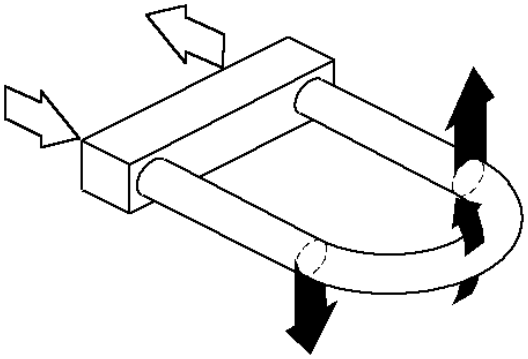


Figure 1.2 – Forces affecting the tube on the upward moving

Twist angle of the sensor tube is directly proportional to the amount of fluid passing through the tube within the specific time. Electromagnetic detectors situated on both inlet (left) and outlet (right) side of the tube, measure the tube oscillation frequency. Mass flow rate is determined by measuring the time delay between the signals of those detectors. This is a phase angle measurement. When there is no flow, the tubes don't twist and there is no time delay between, or phase angle difference, the left and right detector signals. Mass flow rate **Q** is proportional to the time delay **Δt** between the detector signals.

$$Q = K * \Delta t / 3.6 \text{ , kg/h} \qquad (1.0)$$

where K – calibration coefficient, g/s/μs determined using pure water;
Δt – time delay between the detector's signals, μs.

The density of the medium is determined by measuring the period of oscillation of the flow tubes, which is proportional to the density of the medium. The density measuring channel is calibrated for two different fluid mediums with exactly known (measured by standard density meter) density (water and air). For each medium the flowmeter measures the flow tube oscillation period corresponding to the medium density. The measured value of the oscillation period is shown in Menu item 70 (see the display menu). The medium density and the corresponding oscillation period for both water and air are entered in the menu display (Menu items 62 ... 65) or through Modbus. Due to the linear dependency of the oscillation period of the density the actual medium density can be determined by the oscillation period measured by the flowmeter.

Temperature measurement is performed using a platinum, Pt 100, temperature sensor. The measured temperature is used for correction of the flow and density when the medium temperature changes. Temperature correction factors of flow and density are entered in the flowmeter memory at the factory and can be changed through the menu display or Modbus.

Flowmeters require manual correction of flow when the medium pressure changes. When manual correction mode is enabled in the menu, the user will specify the actual pressure value taken from the external pressure sensor (see Menu items 39 ... 41).

The sensor generates the primary electrical signal containing information of the time delay between the signals of the detectors. The primary signal is transmitted to the electronic transmitter located directly on the sensor or remotely from it. The transmitter uses a digital signal processor to processes the primary signal, calculates mass and volume flow values, temperature correction, generates output signals, and displays the information on the flowmeter's display, drives the analog outputs and supplies the data to the ModBus registers or other digital communication protocols, such as HART.
Features of the Coriolis measurement principle:

- direct measurement of mass flow rate in the pipeline;
- long term accuracy and stability;
- ability to measure flow of high viscosity liquids, non-Newtonian fluids, fluids containing solid or gas inclusions;
- reliable operation under mild vibration and misalignment of the pipeline,
- Insensitive to medium temperature and pressure changes;
- no moving parts inside the flowmeter (oscillation amplitude of the tube is very small and we may consider them fixed);
- no obstructions to flow inside the flowmeter;
- ability to measure temperature and density of the liquid;
- no need for straight pipe sections before and after the flowmeter;
- No need for flow conditioning plates, etc.

1.3 General specifications

1.3.1 Technical parameters overview

Performance Specification

Model:

-Integral type TFM -- C -U……COM U shaped 2 tubes

-Integral type TFM -- C -T……COM T shaped 2 tubes

-integral type TFM -- C -M……COM Micro bent shaped 2 tubes

-integral type TFM -- C -S……COM Micro bent shaped 2 tubes

-Remote type TFM -- C -U……REM U shaped 2 tubes

-Remote type TFM -- C -T……REM T shaped 2 tubes

-Remote type TFM -- C -M……REM Micro bent shaped 2 tubes

-Remote type TFM -- C -S……REM Super micro bent shaped 2 tubes

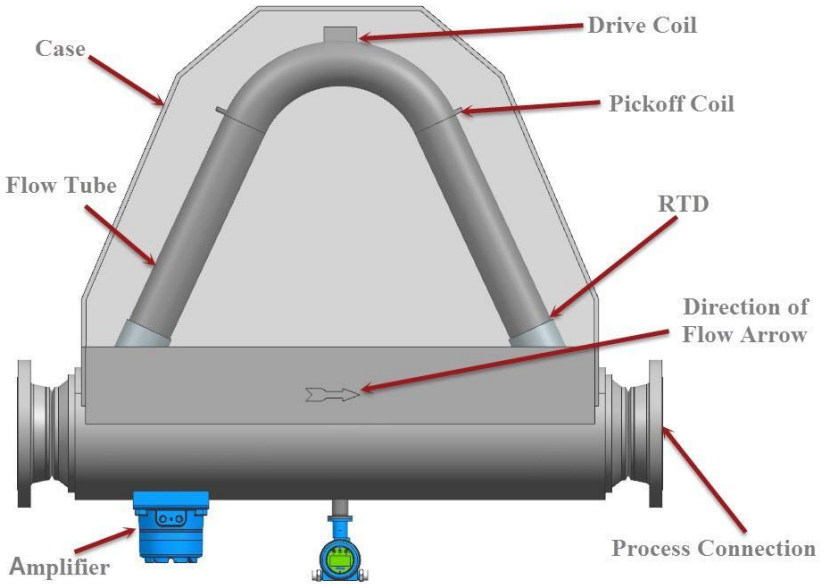
Fluid to be measured: Liquid, Gas or slurries Measurement parameters: Mass flow, density, temperature and water cut %, Brix, concentration, volume flow and net flow.

Transmitter

	**Graphic display** Operation with 'Touch control' Configuration Quick Set up Mass flow, volume flow, density and temperature measurement as well as special function(eg, water-cut off)

Sensor

	**U series** Nominal diameter: 10mm-25mm(3/8''-1'') Material: SS316L for measuring tube; SS304 for housing
	**U series** Nominal diameter:40mm-200mm (1.5''-8'') Material: SS316L for measuring tube; SS304 for housing
	**M (W) Series (Micro-bend shape)** Nominal diameter: 8mm-250mm(1/4''-10'') Material: SS316L for measuring tube; SS304 for housing
	**S Series(Super-bend shape)** Nominal diameter:50mm-150mm(2''-6'') Material: SS316L for measuring tube; SS304 for housing



Mechanical parts are the same for U/W/S series sensors
Amplifier works for the sizes from 100(DN100mm,4'') to 300(DN300,12'')

Brief description of the technical specifications of the flowmeter is presented in Table 1.1.

Table 1.1 – Technical specifications

Parameter	Value
Size	1/8 inch-12 inch
Accuracy	0.05%;±0.1%; ±0.2%; ±0.5%
Process pressure	227 PSI Std (1.5 MPa) Up to 3600 PSIG 25 Mpa`(custom)
Medium temperature	-50…+350 ºC (special order)
Explosion proof grade (modification TFM -- C -Ex)	UL and CSA: Class I, Division 1, Groups B, C and D GOST:1Exd[ib]IICT6X 1ExibIIC(T1-T4)X
Atmospheric pressure	84.0…106.7 kPa
Environment temperature	-40…+55 ºC or -50…+70 ºC (custom)
Relative humidity, %	90 ± 3 % (non-condensing, at 25 ºC)
Resistance to the external magnetic field	Up to 40 A/m, 50 Hz
Enclosure protection	IP65; IP67
Recalibration period	4 years
Temperature sensor	Pt100
Service life	No less than 12 years
Outline dimensions	See ***Appendix*** A
Materials used	Sensor – stainless steel; Transmitter – aluminum alloy.

Notes:

1. Special characteristics can be provided on custom orders.
2. OLED display Temperature range is -40…+70 ºC.

1.3.2 Range of measurement

Flowmeters with accuracy ±0.1%, ±0.2% and ±0.5% are shown in Table 1.2. Normal operation of the flowmeter is guaranteed within the full flow range according to Table 1.2.

Operation of the flowmeter with the flow rate exceeding the upper limit of the full flow range will not be within specification.

The lower limit of the full measuring flow range depends on the parameters of the medium, and must be specified in the order. The turndown is typically 10:1. The lower limit is not zero. See Flow

Ranges in Tables 1.2.1-1.2.8 Coriolis flow meters are not wonderful at very high turndowns compared to thermal flow meters.

Table 1.2.1 – Measuring mass flow range for liquid in kg/h

Model: TFM -- C -T and TFM -- C -U

TFM -- C -T: size 3/8 inch to 1 inch

TFM -- C - U size 1 1/2 inch to 8 inch

Size(inch)	Full flow range, kg/h	Accuracy flow range, kg/h		Zero stability, kg/h
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
3/8	0 – 1 000	70 – 1000	50 – 1000	0.03
1/2	0 – 3,000	200 – 3,000	150 – 3,000	0.07
1	0 – 8,000	600 – 8,000	400 – 8,000	0.15
1 1/2	0– 32,000	2,000 – 32,000	1500 – 32,000	0.90
2	0 – 50,000	2,500 – 50,000	2,000 – 50,000	1.50
3	0– 140,000	7,000 – 140,000	6,000 – 140,000	3.50
4	0– 200 000	12,000 – 200,000	10,000 – 200,000	7.00
6	0 – 500,000	35,000 – 500,000	25,000 – 500,000	17.00
8	0 – 1,200,000	200,000 – 1 200,000	80,000 – 1200,000	45.00
12	0-2,500,000	500,000-2,500,000	200,000-2,500,000	70

Table 1.2.2 – Measuring mass flow range for liquid in lb/m

Model: TFM -- C -T and TFM -- C -U

TFM -- C -T: size 3/8 inch to 1 inch

TFM -- C - U: size 1 1/2inch to 8 inch

Size(inch)	Full flow range, lb/m	Accuracy flow range, lb/m		Zero stability, lb/m
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
3/8	0.37– 37	2.57– 37	1.84– 37	0.00478
1/2	1.1– 110	5.51– 110	3.67– 110	0.01396
1	2.94 – 294	14.70 – 294	11.02 – 294	0.03674
1 1/2	11.76 – 1,176	73.49 – 1,176	55.12 – 1,176	0.14697
2	18.37 – 1,837	128.60 – 1,837	91.86 – 1,837	0.22965
3	51.44 – 5,144	220.46 – 5,144	220.46 – 5,144	0.64301
4	73.49 – 7,349	551.16 – 7,349	367.44 – 7,349	0.91859
6	183.72 – 18,372	1,286.03 – 18,372	918.59 – 18,372	2.29648

8	367.44 –36,744	2,572.06 –36,744	1837.19 –36,744	4.59296

Table 1.2.3 – Measuring volumetric flow range for liquid in Liter/hr

Model: TFM -- C -T and TFM -- C -U

TFM -- C -T: size 3/8 inch to 1inch

TFM -- C - U size 1 1/2inch to 8inch

Size(inch)	Full flow range, Liter/hr	Accuracy flow range, Liter/hr		Zero stability, Liter/hr
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
3/8	10 – 1 000	70 – 1000	50 – 1000	0.13
1/2	30 – 3,000	150 – 3,000	100 – 3,000	0.38
1	80 – 8,000	400 – 8,000	300 – 8,000	1.00
1 1/2	320– 32,000	2,000 – 32,000	1500 – 32,000	4.00
2	500 – 50,000	3,500 – 50,000	2,500 – 50,000	6.25
3	1,400– 140,000	6,000 – 140,000	6,000 – 140,000	17.50
4	2,000– 200 000	15,000 – 200,000	10,000 – 200,000	25.00
6	5,000 – 500,000	35,000 – 500,000	25,000 – 500,000	62.50
8	10,000 – 1,000,000	700,000 – 1 000,000	50,000 – 1000,000	125.00

Table 1.2.4 – Measuring volumetric flow range for liquid in gal/min

Model: TFM -- C -T and TFM -- C -U

TFM -- C -T: size 3/8 inch to 1 inch

TFM -- C - U size 1 1/2inch to 8inch

Size(inch)	Full flow range, gal/min	Accuracy flow range, gal/min		Zero stability, gal/min
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
3/8	0.04 – 4.4	0.31 – 4.4	0.22 – 4.4	0.00057
1/2	0.13 –13	0.66 –13	0.44–13	0.00167
1	0.35 – 35	1.76 – 35	1.32 – 35	0.00440
1 1/2	1.41– 141	8.81– 141	6.60– 141	0.01761
2	2.2 – 220	16.41 – 220	11.01 – 220	0.02752
3	6.16– 616	26.42– 616	26.42– 616	0.07705
4	8.81– 881	66.04– 881	44.03– 881	0.11007
6	22.01 –2,201	154.10 –2,201	110.07 –2,201	0.27518
8	44.03 – 4,403	308.20 – 4,403	220.14 – 4,403	0.55036

Table 1.2.5– Measuring mass flow range for liquid in kg/h

Model: TFM -- C -M and TFM -- C -S(only 2-3 inch available)

TFM -- C -M: size 3/8 inch to 8 inch and TFM -- C -S 2 inch to 3 inch

Size(inch)	Full flow range, kg/h	Accuracy flow range, kg/h		Zero stability, kg/h
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
1/8	0-120	10-120	8-120	0.004
3/8	0 – 1 000	100– 1 000	50 – 1 000	0.045
1/2	0 – 3,000	300 – 3,000	150 – 3,000	0.09
1	0 – 8,000	600– 8,000	300– 8,000	0.25
1 1/2	0– 24,000	2,400– 24,000	1,000– 24,000	1
2	0 – 50,000	5,000 – 50,000	2,000– 50,000	2
3	0– 120,000	10,000– 120,000	6,000– 120,000	3.5
4	0– 500,000	20,000– 200,000	10,000– 200,000	7
6	0 – 500,000	50,000 – 500,000	30,000 – 500,000	23
8	0 – 1,000,000	100,000 – 1,000,000	50,000 – 1,000,000	45
10	0-1,500,000	150,000-1500,000	75,000-1,500,000	70

Table 1.2.6 – Measuring mass flow range for liquid in lb/m

Model: TFM -- C -M and TFM -- C -S(only 2-3 inch available)

TFM -- C -M: size 3/8 inch to 8 inch and TFM -- C -S 2 inch to 3 inch

Size(inch)	Full flow range, lb/m	Accuracy flow range, lb/m		Zero stability, lb/m
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
3/8	0.37– 37.0	3.7– 37.0	2.57– 37.0	0.00478
1/2	1.1– 110.0	7.3– 110.0	5.51– 110.0	0.01396
1	2.94 – 294.0	22.0– 294.0	14.70 – 294.0	0.03674
1 1/2	8.81 – 881.0	88.1 – 881.0	44.09– 881.0	0.14697
2	18.37 – 1,837.0	183.7 – 1,837.0	91.86– 1,837.0	0.22965
3	29.39 – 4.409.0	294 – 4.409.0	202.10– 4.409.0	0.64301
4	73.49 – 7,349.0	551– 7,349.0	367.40– 7,349.0	0.91859
6	183.72 – 18,372.0	1,837 – 18,372.0	918.60 – 18,372.0	2.29648
8	367.44 –36,744.0	3,674.4 –36,744.0	1,937.20 –36,744.0	4.59296

Table 1.2.7 – Measuring volumetric flow range for liquid in Liter/hr

Model: TFM -- C -M and TFM -- C -S(only 2-3 inch available)
TFM -- C -M: size 3/8 inch to 8 inch and TFM -- C -S 2 inch to 3 inch

Size(inch)	Full flow range, Liter/hr	Accuracy flow range, Liter/hr		Zero stability, Liter/hr
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
3/8	10 – 1 000	100– 1 000	70 – 1 000	0.13
1/2	20 – 3,000	200 – 3,000	150 – 3,000	0.38
1	80 – 8,000	600– 8,000	400– 8,000	1.00
1 1/2	240– 24,00	2,400– 24,00	1,200– 24,00	4.00
2	500 – 50,000	5,000 – 50,000	2,500– 50,000	6.25
3	800– 120,000	8,000– 120,000	5.500– 120,000	17.50
4	1,500– 500,000	15,000– 500,000	10,000– 500,000	25.00
6	5,000 – 500,000	50,000 – 500,000	25,000 – 500,000	62.50
8	10,000 – 1,000,000	100,000 – 1,000,000	50,000 – 1,000,000	125.00

Table 1.2.8 – Measuring volumetric flow range for liquid in US gal/min

Model: TFM -- C -M and TFM -- C -S(only 2-3 inch available)
TFM -- C -M: size 3/8 inch to 8 inch and TFM -- C -S 2 inch to 3 inch

Size(inch)	Full flow range, gal/min	Accuracy flow range, gal/min		Zero stability, gal/min
		+/-0.05% and +/-0.1%	+/-0.2% and +/-0.5%	
3/8	0.04 – 4.4	0.44 – 4.4	0.31 – 4.4	0.00057
1/2	0.09 –13.20	0.88–13.20	0.66–13.20	0.00167
1	0.35 – 35.22	2.64– 35.22	1.76– 35.22	0.00440
1 1/2	1.05– 105.67	10.57– 105.67	5.28– 105.67	0.01761
2	2.20 – 220.00	22.01– 220.00	11.01 – 220.00	0.02752
3	3.52– 528.34	35.22– 528.34	24.22– 528.34	0.07705
4	6.60– 881.00	66.04– 881.00	44.03– 881.00	0.11007
6	22.01 –2,201	220.14 –2,201	110.07 –2,201	0.27518
8	44.03 – 4,403	440.29– 4,403	220.14– 4,403	0.55036

		(1) The flow ranges are presented for water at temperature of 20…25 ºC, pressure of 0.1…0.2 MPa and density of 1,000 kg/m^3 under standard conditions. For liquids of different density the volumetric flow range should be calculated by dividing the flow range limits under standard conditions by actual density value. (2) If the measured flow rate is less than low flow cutoff value, the flowmeter will indicate zero flow and accumulation of mass and volume will pause. Low flow cutoff value is set to 1% of the maximum flow rate. Cutoff value can be changed through the menu display or through Modbus. (3) Flowmeter can measure flow over 1% of the upper limit of the full flow range but measurement error in the range of 1% to the lower limit of the full flow range (2%) is not guaranteed to be within specification. Note, this error may be estimated by the formula 1.1. below (4) Medium density measurement range is 200…3000 kg/m^3.
	1.3.3 Accuracy of measurement	Relative basic error of measurement of mass flow (mass) on pulse and digital output signals ($\boldsymbol{\delta_M}$) calculated as $\delta_M = \pm [\delta_0 + (Z / Q_M) *100\%]$, (1.1) where δ_0 – accuracy class, %; Z – zero stability (according to Table 1.2), kg/h; Q_M – measured mass flow rate, kg/h. Note – For the accuracy flow range, corresponding to a given accuracy class (according to Table 1.2), the value of Z is assumed to be 0. Absolute basic error of measurement of medium density ($\boldsymbol{\Delta\rho}$) is ± 1 kg/m^3. Absolute basic error of measurement of medium temperature is ± 1 °C. Additional error of measurement of density, caused by a change of medium temperature is ±0.03 kg/m^3 for every 10 ºC of deviation from the density calibration temperature. Additional error of measurement of density, caused by a change of pressure is ±0.015 kg/m^3 for every 100 kPa of deviation from the density calibration pressure.
		Relative basic error of measurement of volumetric flow (volume) on pulse and digital output signals ($\boldsymbol{\delta_V}$) calculated as $\delta_V = \pm [\delta_0 + (\Delta\rho / \rho) *100\%(\Delta\rho * 100\%/\rho)^2 + (Z / Q_V) *100\%]$, (1.2) where δ_0 – accuracy class, %; $\Delta\rho$ – absolute basic error of measurement of medium density, kg/m^3; ρ – measured medium density, kg/m^3; Z – zero stability (according to Table 1.2), L/h; Q_V – measured volumetric flow rate, L/h. Note – For the accuracy flow range, corresponding to a given accuracy class (according to Table 1.2), the value of Z is assumed to be 0. Relative basic error of measurement of mass flow (mass) on current output signal ($\boldsymbol{\delta_{IM}}$) calculated as $\delta_{IM} = \pm [|\delta_M| + 0.2*I_{max} / (4+16*Q_M / Q_{Mmax})]$, (1.3)

where δ_M – Relative basic error of measurement of mass flow (mass), %;
I_{max} = 20 mA – maximum value of current output signal;
Q_M – measured mass flow rate, kg/h;
$Q_M max$ – upper limit of the full mass flow range, kg/h.

Relative basic error of measurement of volumetric flow (volume) on current output signal ($\boldsymbol{\delta_{IV}}$) calculated as

$$\delta_{IV} = \pm [|\delta_V| + 0.2*I_{max} / (4+16*Q_V / Q_{Vmax})], \quad (1.4)$$

where δ_V – Relative basic error of measurement of volumetric flow (volume), %;
I_{max} = 20 mA – maximum value of current output signal;
Q_V – measured volumetric flow rate, L/h;
$Q_V max$ – upper limit of the full volumetric flow range, L/h.

Additional error of measurement of mass (volumetric) flow rate, caused by a change of medium temperature is ±0.05 % of the maximum flow rate for every 10 ºC of deviation from the zero calibration temperature.

Additional error of measurement of mass (volumetric) flow rate, caused by a change of pressure is ±0.02 % of the maximum flow rate for every 100 kPa of deviation from the zero calibration pressure.

The effect of changes in temperature and pressure can be adjusted by zero calibration under the actual pressure and temperature (see paragraph 2.5.4 Zero point adjustment").

1.3.4 Power supply

Electrical power of the flowmeters, depending on its voltage modification, is provided by an external 24 VDC power supply or 55-265 VAC 50/60 Hz.

Parameters of the power supply are presented in Table 1.3.

Table 1.3 – Power supply parameters

Nominal voltage	Voltage range	Maximum power consumption
24 VDC	18…36 V	15 VA
85-265 VAC 50/60 Hz	85…265 V	15 VA

1.3.5 Output signals

The flowmeter provides the following output signals:

- pulse output;
- current output;
- digital output (RS-485 interface).
- HART communication

The built in display displays the values of the mass flow, volume flow and other measured parameters.

1.3.5.1 Pulse output

Pulse output signal is a periodical pulse signal where the frequency is proportional to the measured value of the mass flow rate using the damping time specified in the menu 49.

The pulse output can be configured to indicate mass flow rate, volumetric flow rate or density of the medium. Pulse output is active.

The total number of pulses generated on the pulse output corresponds to the mass or volume of the fluid passing through the flowmeter since the start of the measurement.

Maximum frequency (fmax) of the pulse output signal calculated as

$$f_{max} = Q_{max} / (3.6*m), \text{ Hz} \quad (1.5)$$

where Qmax – upper limit of the full mass flow range, kg/h;

m – pulse weight, g/pulse.

Pulse output signal frequency range is 0…10000 Hz. Maximum frequency is 12000 Hz.

The amplitude of the pulse output signal is 13 V.

Default pulse weight is presented in Table 1.4.

Table 1.4 – Default pulse weight

Size in inch(mm)	3/8(10)	1/2(15)	1(25)	1 1/2(40)	2(50)	3(80)	4(100)	6(150)	8(200)
Pulse weight, g/pulse	**0.05**	**0.1**	**0.4**	**2**	**4**	**8**	**10**	**20**	**40**

1.3.5.2 Current output

The range of the current in the current output circuit is 4 to 20 mA and is proportional to the measured flow rate(density, Water-cut% , Brix. as an option)

The current value of 4 mA corresponds to zero flow rate. The current value of 20 mA corresponds to the upper limit of the full flow range of the flowmeter (Qmax).

The current output can be configured to indicate mass flow rate, volumetric flow, water cut % or density of the medium.

Current output is active as default.

The current signal parameters are presented in Table 1.5.

Table 1.5 – Current output signal parameters

Current output signal	
Current value	4-20 mA
Load resistance	250 to 600 Ohms

1.3.5.3 Digital output

Digital interface complies with the requirements EIA/TIA-422-B and recommends RTU V.11 and provides for networking and transferring of all measured parameters. The digital interface specifications are presented in Table 1.6.

Table 1.6 – Digital interface specifications

Digital interface	
Standard	EIA RS-485
Data transfer protocol	Modbus RTU
Data transfer BAUD rate	1200, 2400, 4800, and 9600
Maximum distance	300 m
Data format	8 data bits, 1 start bit, no parity bit, 1 stop bits (default).

Data format can be edited in the menus 30, 31.

The following measured parameters can be transmitted through the digital interface: mass (volume) flow rate, mass (volume), density and temperature of the medium.

Digital interface may also be used to calibrate and to configure the flowmeter.

Flowmeter supports two versions of the Modbus register map:

- «TFM» register map version 2.xx is supported by the ModBus RTU and set as default at the factory;
- «ProLink» register map version 3.xx compatible with ProLink II software from Micro Motion is available as well.

Register map and description for «TFM» version 2.xx are presented in the **Appendix** , for «ProLink» version 3.xx – in the **Appendix** .

Register map version can be selected by ModBus RTU or by changing the value of the corresponding Modbus register (see **Appendix**) using third party serial port emulators.

1.3.6 Display

The flowmeter's OLED graphical display features the following measured parameters chat can be displayed:

- Mass flow rate;
- Volumetric flow rate;
- Medium density;
- Medium temperature;
- Total mass;
- Total volume.
- Water cut%(On special order only)
- Brix. (On special order only)

User Interface operation is provided by the means of three optical sensor buttons below the display. Display operation described in the paragraph 2.5.3 Display operating".

Figure 1.3.6 ,Keypad operation

1.4 Pressure drop

The pressure drop for the flowmeter (*ΔP*) at maximum flow rate, pressure and temperature is not more than 0.13 MPa for water.

For the measurement flow of liquids it is important to consider the cavitation effect (liquid boiling), which may occur in certain conditions of the flow. Cavitation may cause the flowmeter to work abnormally. To prevent this, it is important to maintain the pressure at the distance of 5*DN after the flowmeter. That pressure must not be less than the critical pressure (*Pcr*) calculated as

$$Pcr = 2.9\,\Delta P + 1.3\,p_v, \text{ kPa} \qquad (1.6)$$

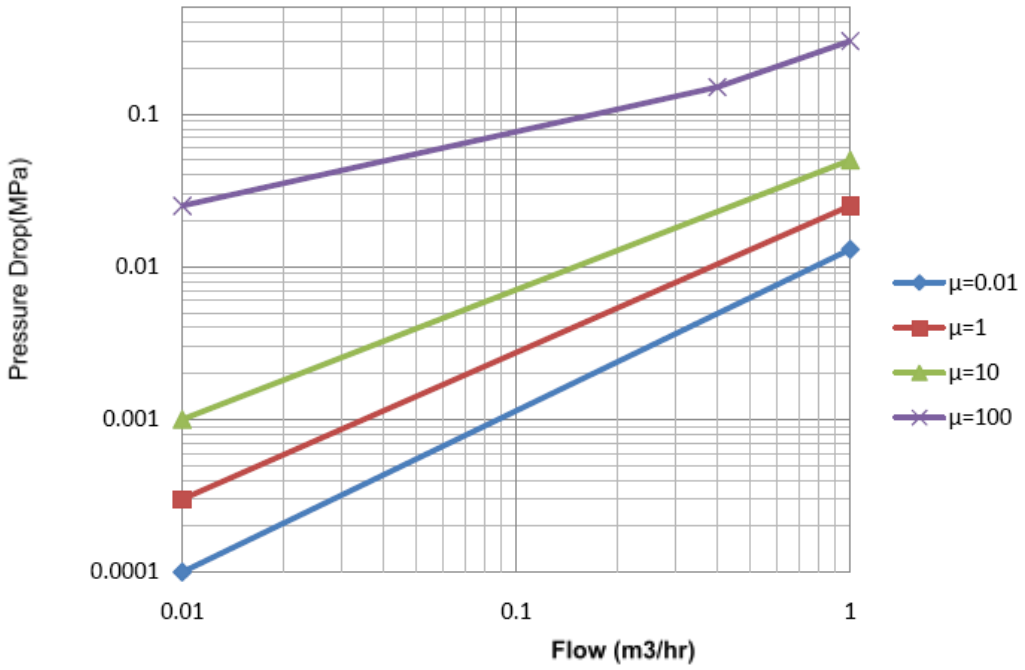
where *ΔP* – pressure drop on the flowmeter, kPa;

p_v – saturated steam pressure at working conditions (background information), kPa.

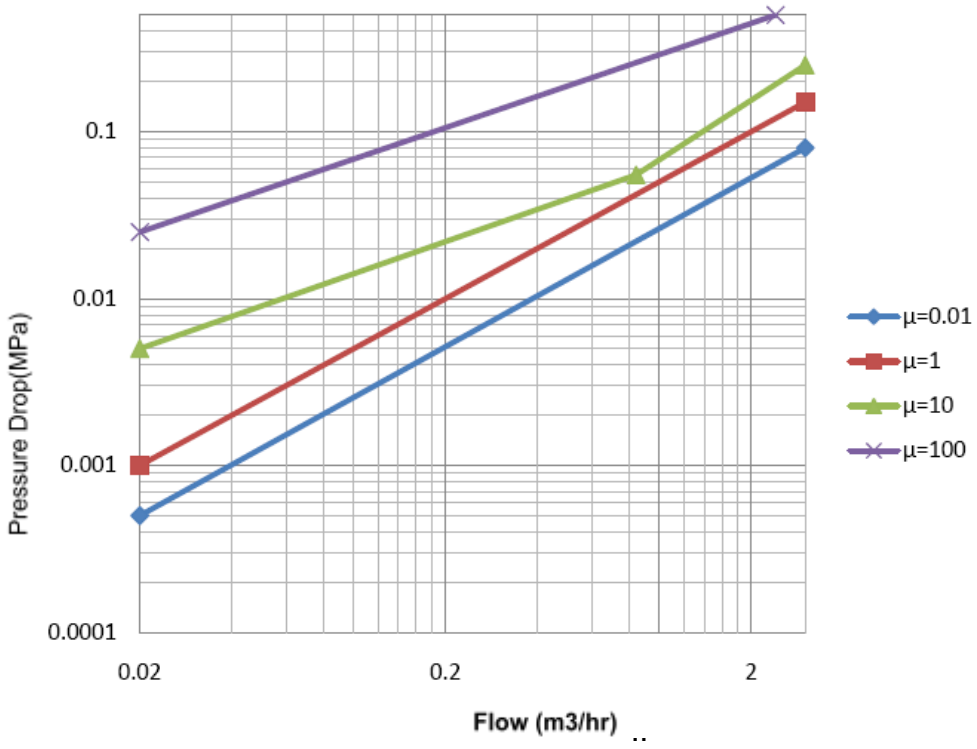
If the pressure calculated by this formula exceeds the actual pressure in the pipeline, a safety valve should be installed to increase the pressure.

Please refer to following pressure drop graphics before engineering design and application Note: μ=cP(Viscosity)

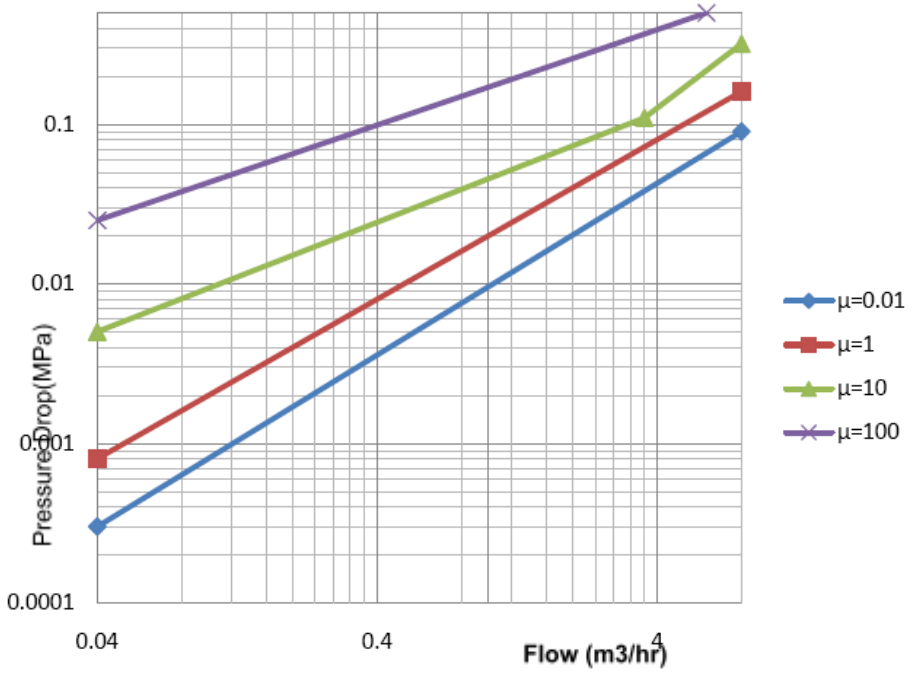
Model: TFM -- C -T Size in 3/8 inch (10mm) µ=cP(Viscosity)



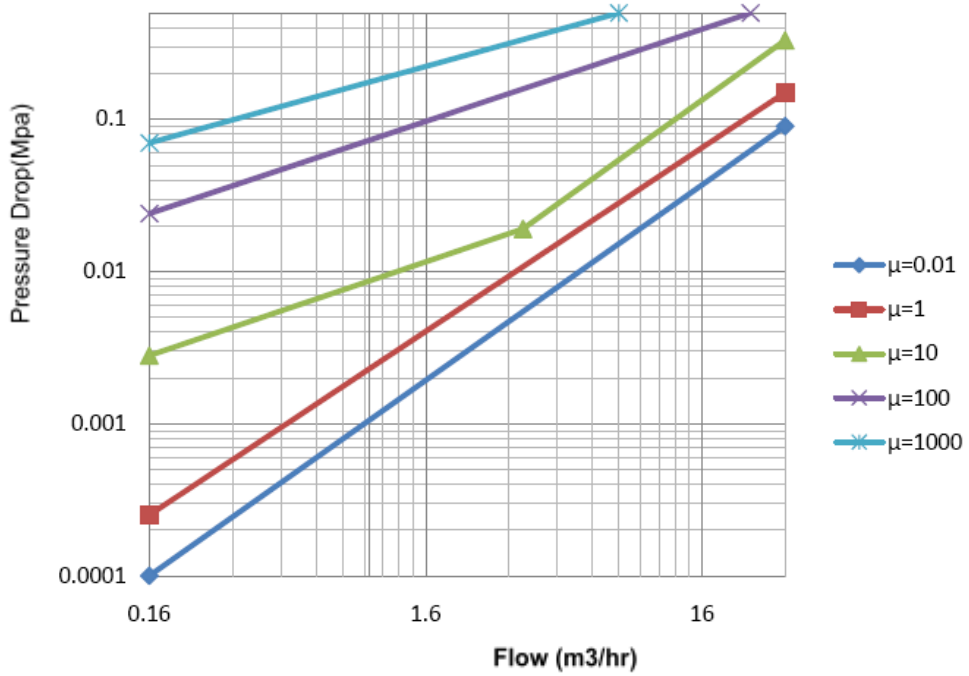
Model: TFM -- C -T Size 1/2 inch (15mm) µ=cP(Viscosity)



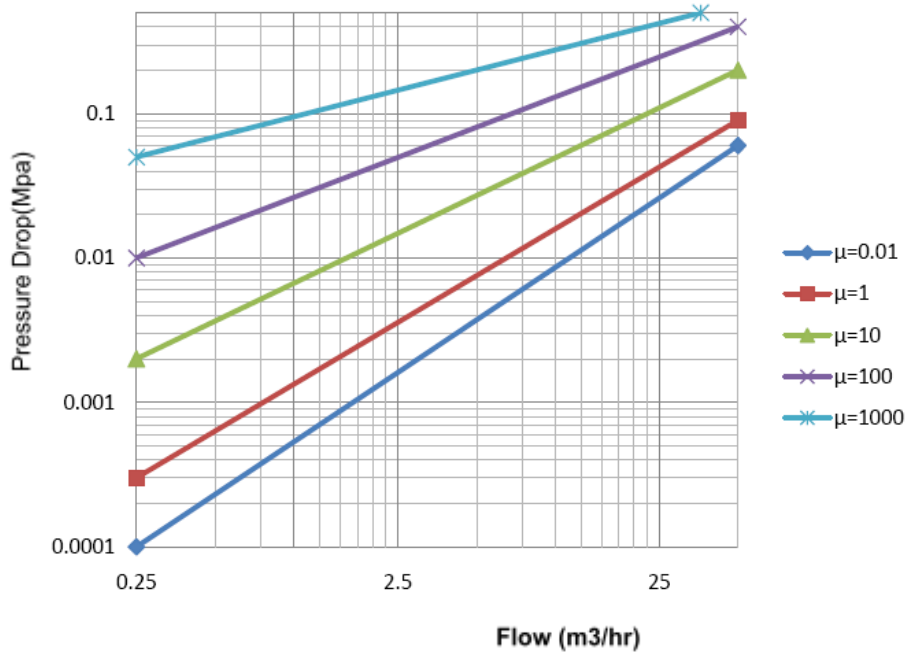
Model: TFM -- C -TSize 1 inch (25mm) µ=cP(Viscosity)



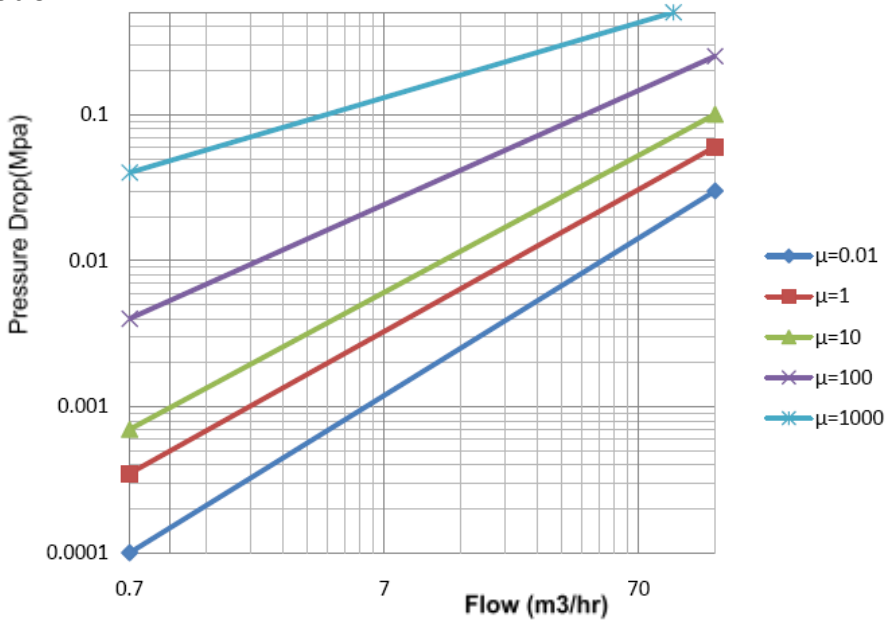
Model: TFM -- C -T Size 1-1/2 inch (40mm) µ=cP(Viscosity)



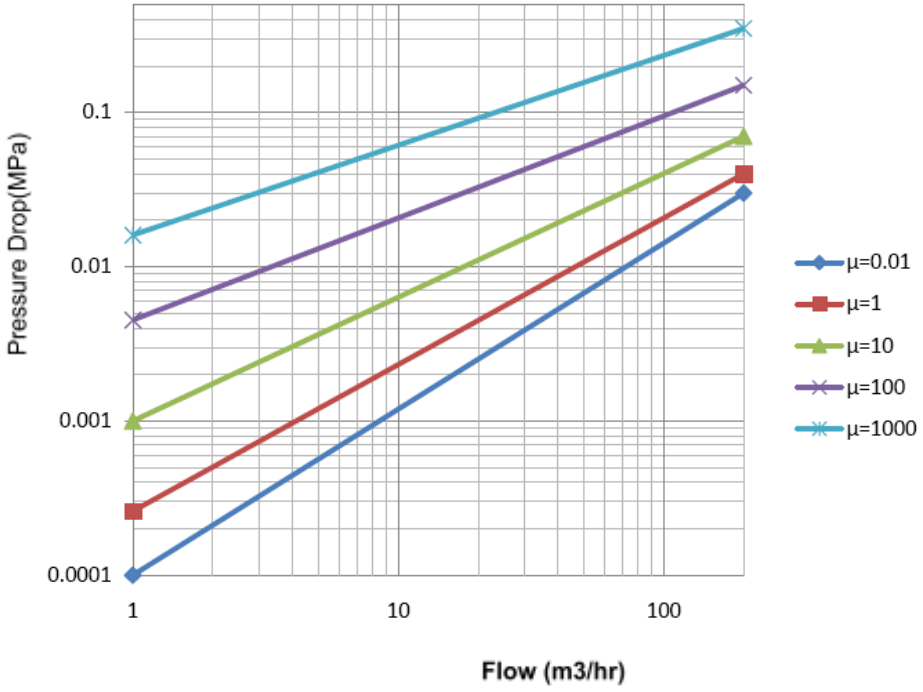
Model: TFM -- C -U Size 2 inch (50mm) μ=cP(Viscosity)



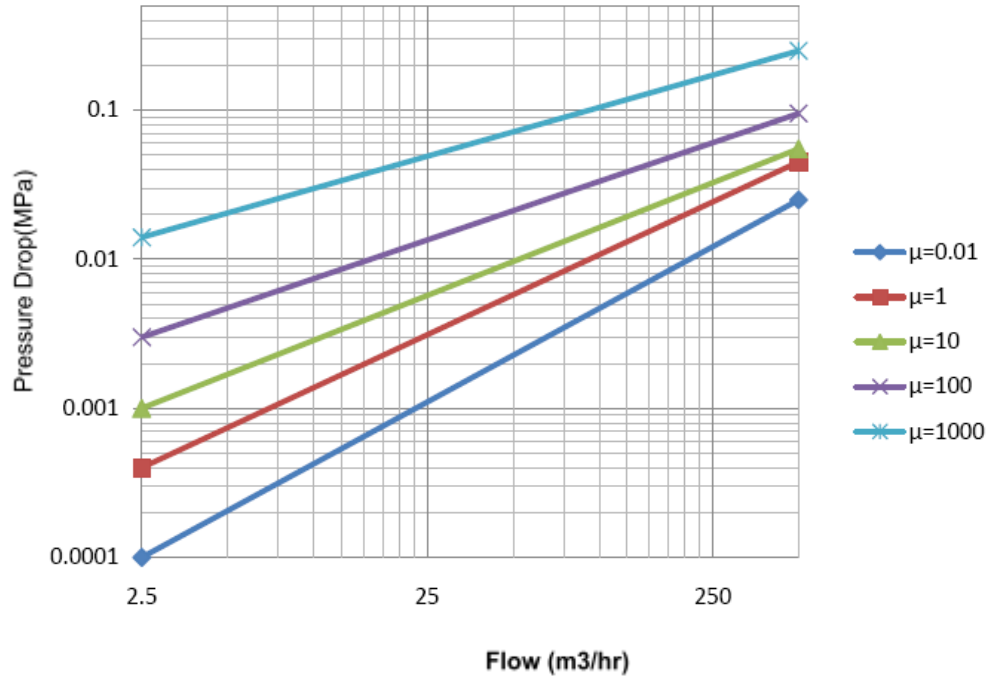
Model: TFM -- C -U Size 3 inch (80mm) μ=cP(Viscosity)



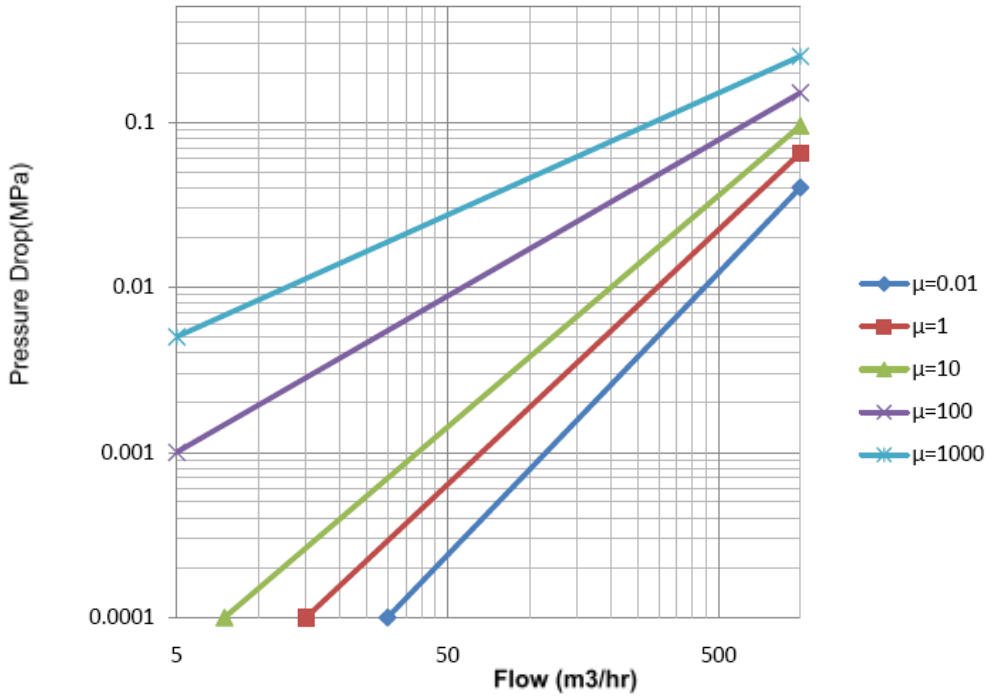
Model: TFM -- C -U Size 4 inch (100mm) µ=cP(Viscosity)



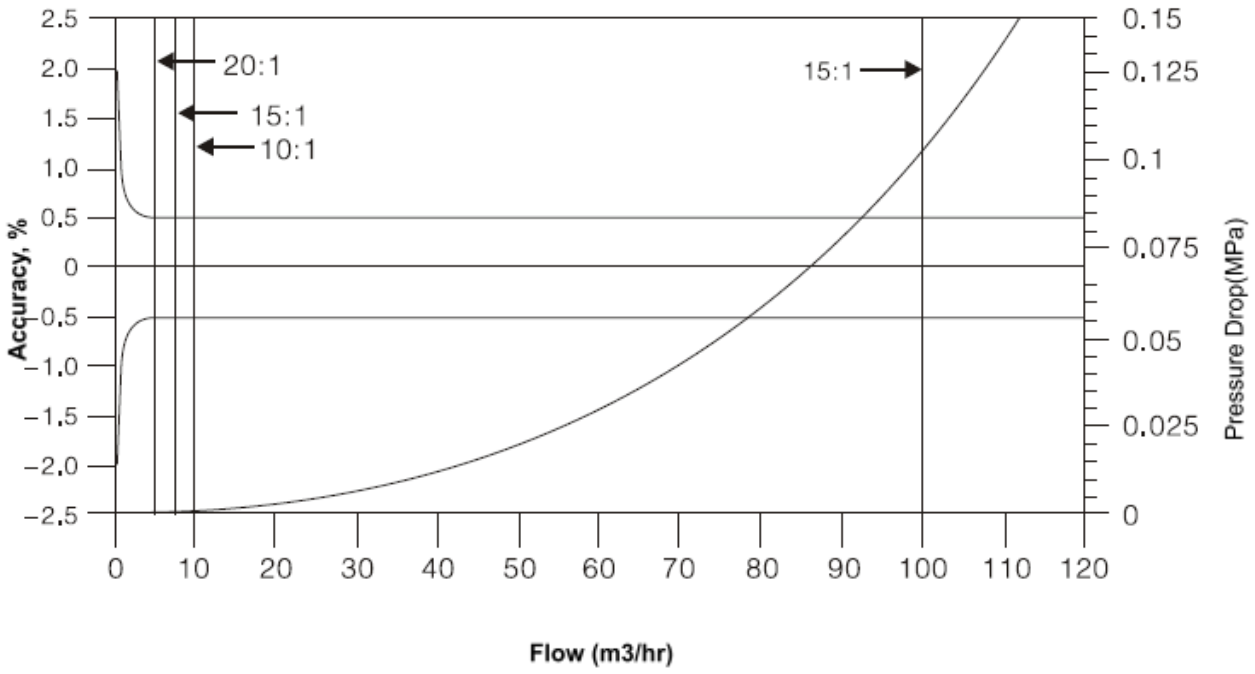
Model: TFM -- C -U Size 6 inch (150mm) µ=cP(Viscosity)



Model: TFM -- C -U Size 8 inch (200mm) μ=cP(Viscosity)



Typical accuracy, turndown, and pressure drop with Model: TFM -- C -M size 2 inch(50mm)



Turndown from Max. flowrate	20:1	15:1	10:1	1.5:1	1:1
Accuracy +/-%	0.2	0.2	0.1/0.05	0.1/0.05	0.1/0.05
Pressure drop	0.001	0.0015	0.002	0.1	0.17

1.5 Approvals

The Flowmeter complies with Underwriters Laboratories Inc. for telemetering equipment for use in Hazardous locations

Class I, Groups C and D; Class II, Groups E, F and G; Class I, Groups A, B, C and D, Division 2.
Intrinsically safe mass flow sensors, for use in Class I, Groups C and D; Class II, Groups E, F and G hazardous locations and also suitable for Class I, Groups A, B,
C and D, Division 2 hazardous locations

Optional Booster Amplifier for use in Class I, Division 1, Groups C and D; Class I, Division 2, Groups A, B, C and D; Class II,
Division 1, Groups E, F and G, Hazardous Locations Providing Intrinsically Safe Circuits

As well, the transmitter , sensor and booster amplifier complied with GOST R 51330.1, and the input and output "intrinsically safe" level «ib» complied with GOST R 51330.10.

The flowmeters with the explosion-proof option "TFM-TFM -- C -Ex» have the integral type of protection "flameproof enclosure" complies with GOST R 51330.1, and the input and output "intrinsically safe" level «ib» complies with GOST R 51330.10. The sensor explosion proof grade is shown below in Table 1.7.

Table 1.7 – Sensor explosion proof grade

Temperature code	Explosion proof grade
“100”	1Ex ibIICT4X
“200”	1Ex ibIICT3X
“350”	1Ex ibIICT1X

Transmitter explosion proof grade is 1ExdibIICT6X.

The explosion proof grade is written on the name plates attached to the body of the sensor of a meter with the explosion-proof modification and to the transmitter.

The name plate must remain affixed, and not altered on the flowmeter ordered.

The "X" letter in the explosion proof grade indicates the following special requirements:

- the measured medium temperature must not exceed the maximum temperature according to the explosion proof grade temperature group;

- explosion protection is provided under pressure not exceeding the maximum allowable pressure for the given modification;

- connection of external circuits to the flowmeter must be implemented through the cable entries compliant with GOST R 51330.1;

- unused cable entries must be closed with the end cap supplied by the flowmeter's manufacturer or other end cap compliant with GOST R 51330.1;

- connection of the external devices to the pulse, current and digital outputs of the flowmeters of "Ex" modification must be implemented in accordance with GOST R 51330.1.

Explosion protection type of "flameproof enclosure" is implemented by putting the electrical parts of the flowmeter into a flameproof enclosure in accordance with GOST R 51330.1, that prevents the explosion from exiting out of the flowmeter into the explosive environment.

Explosion protection of the enclosure is ensured by the following means:

– the housing case can withstand an explosion test at the test pressure of 4 times the pressure of the explosion;

– axial thread length and number of full turns of the thread engagement must comply with GOST R 51330.1 requirements;

– the gaps and lengths of flat and cylindrical flameproof joints must comply with GOST R 51330.1 requirements;

– maximum flowmeter's surface temperature in working conditions must not exceed the temperature range in accordance to GOST R 51330.0 for the temperature groups:

- T4 for the flowmeters with temperature modification code «100»;

- T3 for the flowmeters with temperature modification code «200»;

- T1 for the flowmeters with temperature modification code «350».

Explosion protection type of input and output "intrinsically safe" circuit level «ib» is ensured by the following means:

– external power supply and connection of the external devices to the pulse, current and digital outputs of the flowmeters of "Ex" modification must be implemented in accordance with GOST R 51330.1;

– electric load of anti-spark circuit elements of the flowmeter does not exceed 2/3 of their certified values;

– the values of parameters of the left/right signal coils, drive coil and the temperature sensor circuits do not exceed the limits in accordance with GOST R 51330.10;

– spark safety barrier with Zener diodes must be applied by user;

– electrical clearances and creepage distances comply with GOST R 51330.10. Insulation resistance between the sensor outer shell and electrical circuits elements can withstand a testing voltage of 500 VAC rms;

– internal capacity and inductance of the circuit do not accumulate energy, dangerous for spark ignition gas mixtures of category IIC;

– current-conducting elements and electronic components of the flowmeter circuit are protected from the environment influence with the shell, which provides the protection degree IP 65 according to GOST 14254.

– Block diagram of the flowmeter is shown in Figure 1.3.

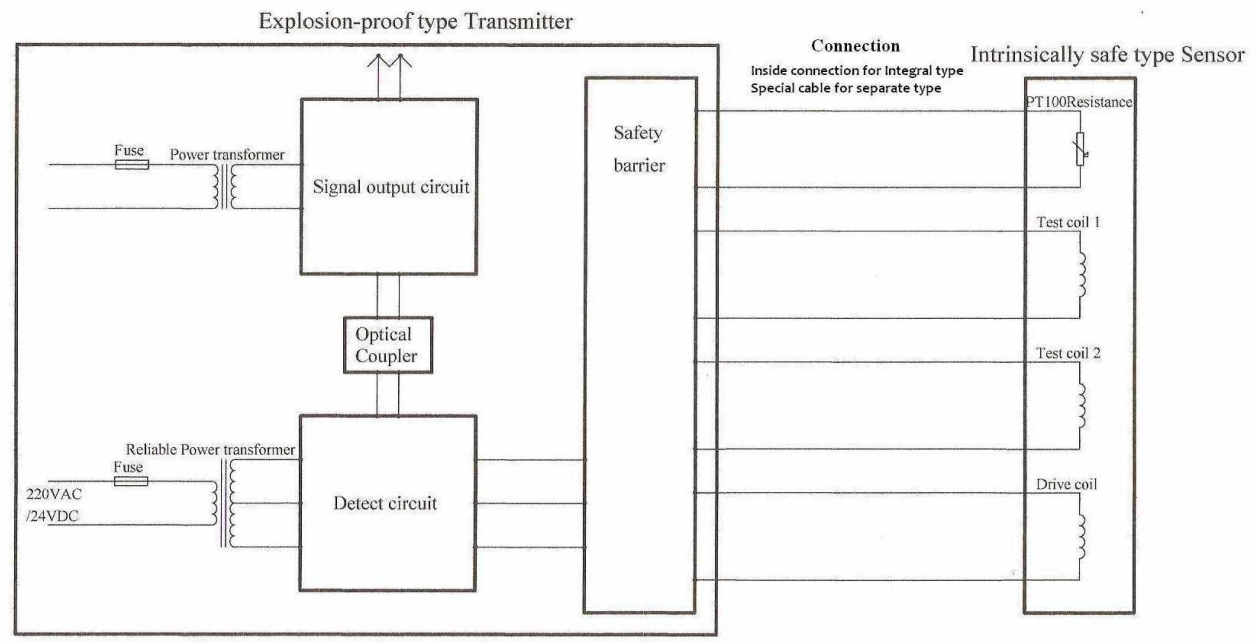


Figure 1.3 – Block diagram of the flowmeter

The transmitter, sensor and booster amplifier complied with GB3836.1-2010GB3836.2-2010 and GB 3864-2010. It can be used in hazardous locations Zone 1 and Zone 2. The range of ambient temperature of the product is -20 ℃- +40℃. The marking of the equipment is EX d [ib] IIB+H2 T6 Gb

Input and output parameters of intrinsically safe circuits are shown in Tables 1.8 and 1.9.

Table 1.8 – Input parameters of intrinsically safe circuits

Parameter name	Parameter value		
	Left / right signal coils	Drive coil	Temperature sensor
Maximum input voltage Ui, V	5.4	10.5	5.4
Maximum input current Ii, mA	72	70	72
Maximum input capacity Ci, pF	50	50	50
Maximum input inductance Li, mH	2.2	3.5	0.010
Maximum input power Pi, W	0.097	0.184	0.097

Table 1.9 - Output parameters of intrinsically safe circuits

Parameter name	Parameter value for the circuit of		
	Left / right coil power	Drive coil power	Temperature sensor power
Maximum output voltage Uo, V	5.4	10.5	5.4
Maximum output current Io, mA	72	70	72
Maximum output capacity Co, μF	10	1	10
Maximum output inductance Lo, mH	5	4.5	5
Maximum output power Po, W	0.097	0.184	0.097

Parameters of the sensor coil windings are shown in Table 1.10.

Table 1.10 – Coil windings parameters

Coil	Wire diameter, mm	Number of turns	Resistance, Ohm
Left / right signal coils	0.13	500	20 ± 0.5
Drive coil (DN10 – DN40)	0.13	300	11 ± 0.5
Drive coil (DN50 – DN200)	0.27	300	8 ± 0.5

Maximum length of the connection cable for the separate type flowmeter is 300 m.

Drive coil power circuits are electrically isolated from other circuits by means of the undamaged transformer according to GOST R 51330.10. Insulation between primary and secondary windings can withstand voltage of at least 1.5 kV.

Ambient temperature for the flowmeters of “Ex” modification must be between -20 and +40 ºC.

1.6 Hazardous area classifications

UL

All models with junction box Ambient temperature: +104 °F (+40 °C) maximum
Class I, Div. 1, Groups C and D
Class I, Div. 2, Groups A, B, C, and D
Class II, Div.1, Groups E, F, and G

Flowmeter's parameters are marked on the name plates attached to the body of the sensor and the top side of the transmitter. Flowmeter has the following name plates:

1. Main name plate with technical parameters on sensor
2. transmitter nameplate

The main name plate is produced according to Figure 1.4 and contains data presented in Table 1.11.

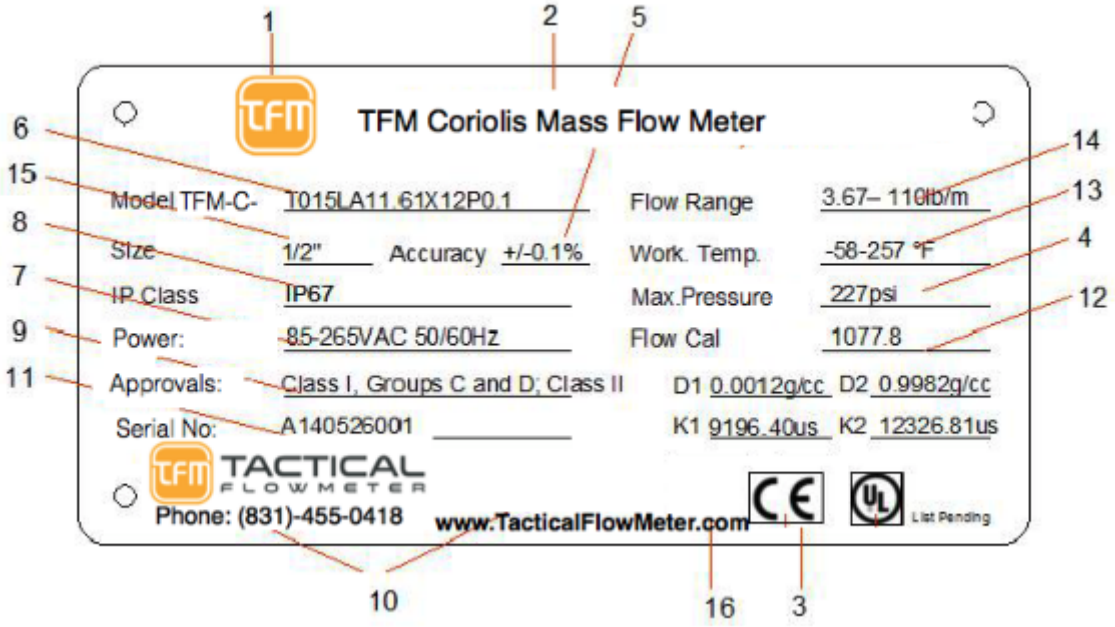


Figure 1.4 – Main name plate

Flowmeter's parameters are marked on the name plates attached to the top side of the transmitter and to the body of the sensor. Flowmeter has the following name plates:

3. Main name plate with technical parameters
4. Sensor name plate with sensor explosion proof information.

The main name plate is produced according to Figure 1.4 and contains data presented in Table 1.11.

Table 1.11 – Main nameplate data

Item #	Description
1	Trademark, TacticalFlowMeter.com badge
2	Flowmeter name
3	approval marks
4	Maximum process pressure (maximum)
5	Accuracy
6	Model
7	Power supply voltage

8	IP protection grade
9	Explosion protection level and Ex-sign
10	Tactical Flow Meter Info
11	Serial number
12	Flow Cal(K factor)
13	Temperature range of the measured medium
14	Full flow range (Q)
15	Meter size
16	CE directive

Before installation of the flowmeter, make sure that the information on the name plates conforms to the specifications in your order.

After the verification procedure the flowmeter is sealed. Sealing is performed using the seal and wire threaded through the holes in the front cover of the transmitter.

It's also allowed to use a sealing tape attached to both the transmitter shell and the front cover of the transmitter.

1.7 Delivery set

The standard flow meter and accessories for the flowmeter are shown in Figures 1.6, 1.7 and in Tables 1.12, 1.13.

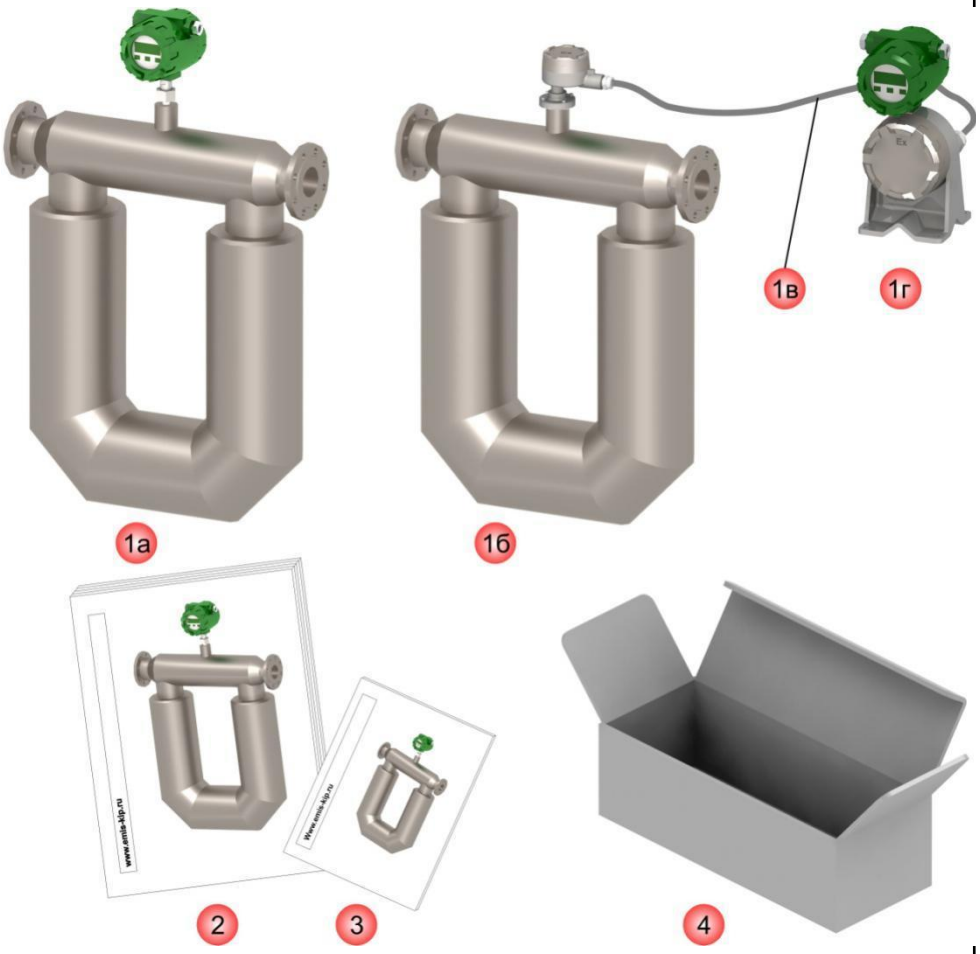


Figure 1.6 – Base delivery set

Table 1.12 – Base delivery set

Item №	Description	Base delivery set	Special order
1a, 16	Coriolis Mass Flowmeter TFM -- C - series		Cable length
2	User manual		
3	Calibration report		
4	Packing box		
5	Inspection report		

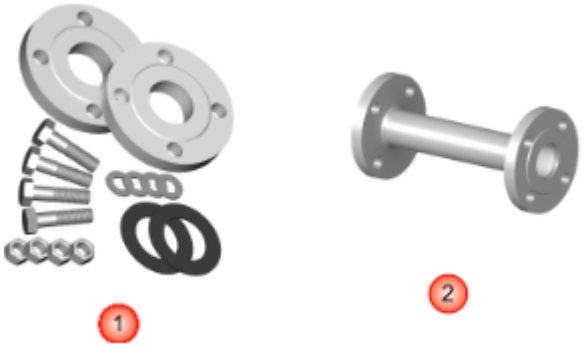


Figure 1.7 Accessories

Table 1.13 - Accessories

Item №	Description
1	Connection kit (flanges, gaskets, stud bolts, nuts, washers)
2	Flowmeter replacement mounting spool

Upon receipt of the flowmeter it is necessary to:

- Check the packaging box for damage;
- Make sure that delivery set is complete;
- Make sure the flowmeter model matches the order data.

If the package is damaged, the delivery set or flowmeter model doesn't match the order and notify the factory immediately.

1.7 Model codes

TFM -- C -series coriolis mass flowmeter's model codes are presented in Table 1.14.

An example of a flowmeter part number is shown below.

	1		2		3		4		5		6		7		8		9		10	
TFM -C-	050		Y		1		W		1		S		1.6		FI		0.5			

Table 1.14 – Flowmeter model codes

Model Selection TFM - C □□□ □ □ □ □ □ □ □ □ □ □

Type		1 DN	2 Medium	3 Structure	4 Sensor	5 Power	6 Digital output	7 Nominal pressure	8 Signal output	9 Accuracy	10 Options	Option Code
TFM	–											Coriolis Mass Flow Meter
		015										15mm, 1/2"
		025										25mm, 1"
		040										40mm, 1 1/2"
		050										50mm, 2"
		080										80mm, 3"
		100										100mm,4"
		150										150mm, 6"
		200										200mm, 8"
		250										250mm, 10"
		300										300mm, 12"
			Y									liquid Flow
			Q									gas Flow
				1								Integral -50 to125 ℃
				2								Remote -50to 200 ℃
				3								High temp. remote -50 to 300℃
				4								Low temp. remote:-200 to125 ℃
					U							U-type sensor
					W							Microbend sensor
					S							Super bend sensor
						1						DC(18to36)V
						2						AC(85to265)V
							S					RS485
							H					Hart
								1.6				1.6 MPa
								2.5				2.5 MPa
								4.0				4.0 MPa
								6.3				6.3 MPa
								10				10 MPa
								16				16 MPa
								26				26 MPa
								150				Class 150 ANSI Flange
								300				Class 300 ANSI Flange
								600				Class 600 ANSI Flange
									F			Pulse output
									I			(4-20mA) current output
										0.1		±0.1% Accuracy
										0.2		±0.2% Accuracy
										0.5		±0.5% Accuracy
											W	TriClover
											B	Jacket
											D	Customized

Example Model No: TFM-C 080Y2U1S2.5I0.2
Coriolis Mass Flow Meter, DN80, to measure liquid, remote type, U-type sensor, DC(18 to 36 VDC) power supply, RS485 Digital 0utput, nominal pressure:2.5MPa, (4 to 20)mA current output, accuracy:±0.2%.

Specification		Approval grade
Remote type	015 to080 size	Exib Ⅱ CT3~T6
	100 to200 size	Exd ib Ⅱ CT3~T6
	TF M transmitter	Exd[ib] Ⅱ CT6
Integral type	015 to 080 size	Exdib Ⅱ CT4~T6
	100 to 200 size	Exdib Ⅱ CT4~T6

Notes: 1) for remote type mass Flowmeter , please specify the cable length when ordering.
2) TFM -- C Model selection software is suggested.

2 Operation and maintenance

2.1 Model selection recommendations

One of the most important conditions for reliable operation of the flowmeter to obtain reliable measurement results is communicating the process parameters. The list of the process parameters required for optimal flowmeter modification selection is presented in Table 2.1.

Table 2.1 – Process parameters for modification selection

Item №	Process parameter
1	Measured medium name:
2	Composition and percentage of liquid components:
3	Composition and percentage of solid impurities in fluid:
4	Composition and percentage of gas inclusions in fluid:
5	Measured medium density:
6	Measured medium viscosity:
7	Flow range:
8	Required accuracy:
9	Process temperature:
10	Process pressure:
11	Allowable pressure drop:
12	Presence of regulators and control components/valves in the system:
13	Process connection size:
14	Pipeline orientation at the installation location:
15	Ambient temperature:
16	Explosion protection grade and requirements:

Do NOT order HART if you simply need it for CONFIGURATION. Every variable is easily modified using the display interface.

Flowmeter size should be selected according to the actual flow rates in the pipeline, which may differ from the calculated (design) values. Flowmeter size should be selected so that the actual flow rate of the medium was in the second third of the flow range. Therefore, the nominal diameter of the flowmeter can be either equal or less than the nominal diameter of the pipeline.

Mismatched pipeline diameters to the nominal diameter of the flowmeter are best addressed with tapered transitions. These can be procured independently, to ensure minimum loss of pressure, the central cone angle must not exceed 30 º.

2.2 Safety precautions

Installation, operation, maintenance of flowmeters should be performed by persons who have studied this manual and fully understand safety instructions for working with electrical devices.

All operations during calibration and use of the flowmeters must comply with the requirements for protection against static electricity.

Installation of the flowmeter in the pipeline and its removal from the pipeline should be performed without pressure in the pipeline and with the power supply switched off. Electrical connections should also be performed only when the power supply is switched off.

During the installation, commissioning and maintenance the following are prohibited:

- replacement of electronic components when the flowmeter is powered on;
- connecting the flowmeter to the power supply with output voltage other than specified in this manual;
- using electrical devices and tools without protective grounding and also in case of their malfunctions.

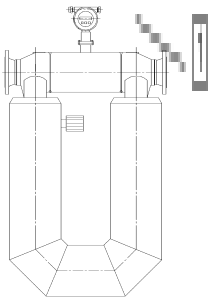
During installation the hazardous factors are:

- power supply voltage of 85 VAC or higher (in case of the external power supply located in close vicinity of the installation);
- excess pressure in the pipeline;
- high temperature of the medium.

Operation and installation of flowmeters with “Ex” option must be performed in accordance with the requirements of Chapter 7.3 of the “Electrical Installations Code " and other regulations regarding the use of electrical equipment in an explosive environment.

Installation and operation of the flowmeter in conditions of pressure or temperature exceeding their maximum allowable values is prohibited.

Do not use the flowmeter with the electronics cover opened, or without the chassis grounding.



To prevent leakage of the gas filling the sensor’s outer shell, do not open the electronics cover 1.

2.3 Installation on pipeline

Determining flowmeter Location

When selecting the installation location follow these rules:

- There should be no strong vibration, high temperatures or strong magnetic fields at the installation. Therefore, do not install the flowmeter close to transformers, power units and other mechanisms that create vibration and electromagnetic interference.
- The flowmeter should not be installed in any strained sections of the pipeline and should not be used as a pillar for the pipeline.
- It is recommended to provide moisture protection for the flowmeter.
- Flowmeter should be installed in easily accessible locations. Free space around the flowmeter should be provided for easy installation and maintenance.
- Display of the flowmeter should be installed where it is convenient for the operator to read the displayed data.
- The installation location of the flowmeter should be selected to ensure a minimum temperature of the transmitter's surface. In direct sunlight the surface temperature may rise by up to 30 degrees compared to the ambient temperature, so if installation in the shade is not possible, it is recommended to use a sunshade.

2.3.1 Installation location

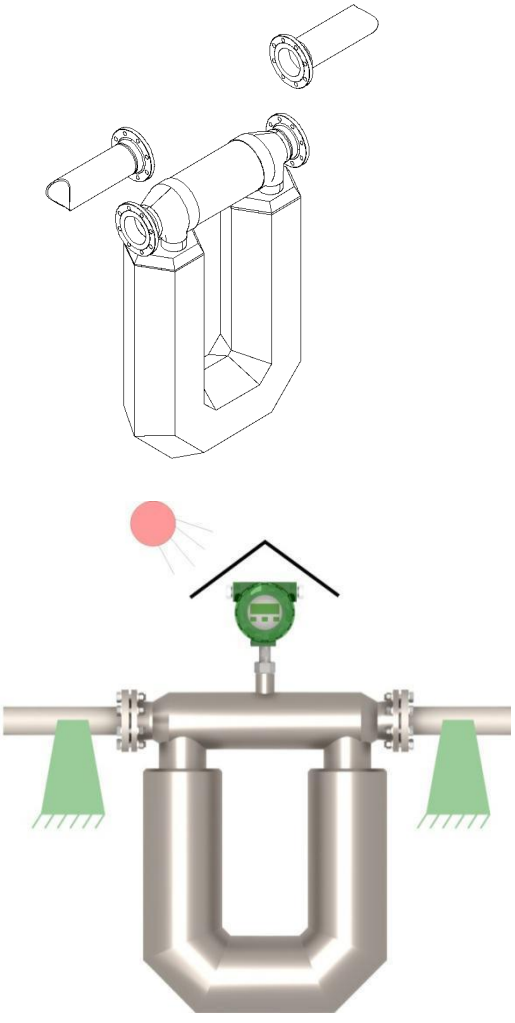


Figure. 2.1 Basic requirements for the installation location

If there is strong vibration or the pipeline is strained at the installation location, you must provide external support for the pipeline before and after the flowmeter. The support base must be firmly attached to a rigid structure.

2.3.2 Orientation

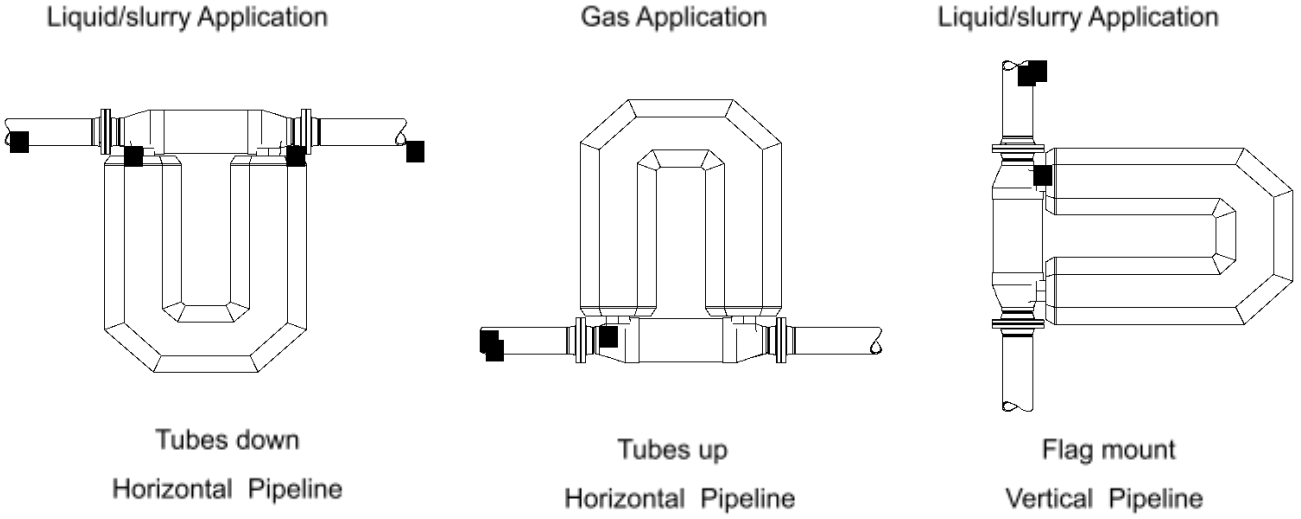
The flowmeter can be installed in horizontal, vertical or inclined sections of the pipeline. It is optimal to install the flowmeter in the horizontal section.

The flowmeter should be installed so that its measuring tubes are always filled with fluid and the arrow on the sensor body coincides with the flow direction. In these conditions, the flowmeter will operate properly in any orientation.

The Flowmeter does not require collateral straight pipeline sections before and after the flowmeter, or installation of additional equipment to condition the flow profile (flow conditioning plates, etc.). However, if two or more flowmeters are installed in the same section of the pipeline, the distance between them should be at least 80" (2 m.)

Installation recommendations are presented in Figure 2.2.

Figure 2.2 Recommendations for installation



Flow direction arrow

The sensor has a flow direction arrow (on the sensor) to locate the transmitter for proper flow direction. Install the sensor so that the flow direction arrow matches the process flow.

Vertical pipeline

If the sensor is installed in a vertical pipeline, liquids and slurries should flow upward through the sensor. Gasses may flow upward or downward.

Pic #	Recommendations
1	We recommended installing the flowmeter tubes downward to allow filling with fluid and to prevent accumulation of gas.
2	For vertical or inclined pipeline orientation it is recommended to install the flowmeter in a pipeline section with the upward flow direction to improve filling the meter with fluid.

Table 2.2 – Notes for Figure 2.2

For bent pipes you must install the flowmeter in the lower section of the pipeline.

Do not install the flowmeter on a horizontal plane because the flowmeter's tubes will not be filled with liquid.

2.3.3 Pipeline preparation

To prepare for the installation of the flowmeter, it is necessary:

- Check all mounting parts to the flowmeter's specifications;
- Cut the pipeline section of length Linst

$$Linst = Lm + 2*Lg + 2*Lf, \quad (2.1)$$

where Lm – flowmeter length (see **Appendix**);

Lg – gasket thickness;

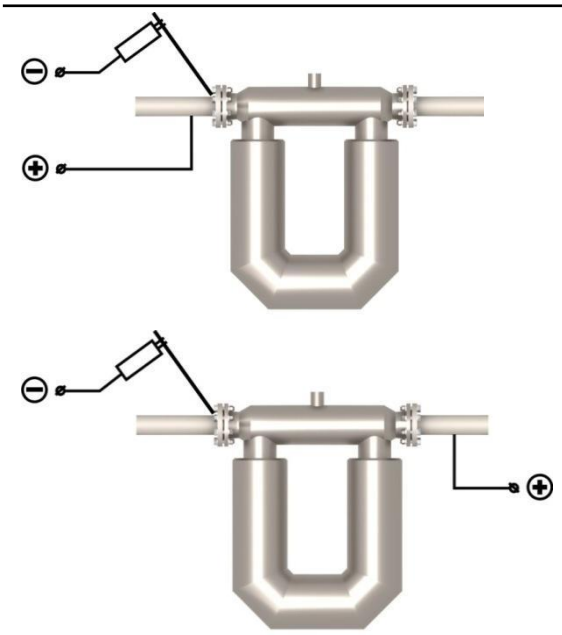
Lf – connection kit flange thickness minus thickness of flanges on the pipeline;

- Install connection kit flanges on the pipeline;
- Using the flowmeter's replacement mounting part, fix and center flanges and weld them to the pipeline.

In the process of installation the flowmeter may be used instead of the replacement mounting part only in the following cases:

- installation is carried out using gas welding;

- When installed using arc welding,the power source must be connected in a way that prevents the welding current from running through the flowmeter - see Figure 2.3.



Right Wrong

Figure 2.3 Connecting the power source for arc welding using the flowmeter

As a result, the installation location must be as shown in Figure 2.4, where the length L is the sum of the length of the flowmeter and thickness of the two gaskets.

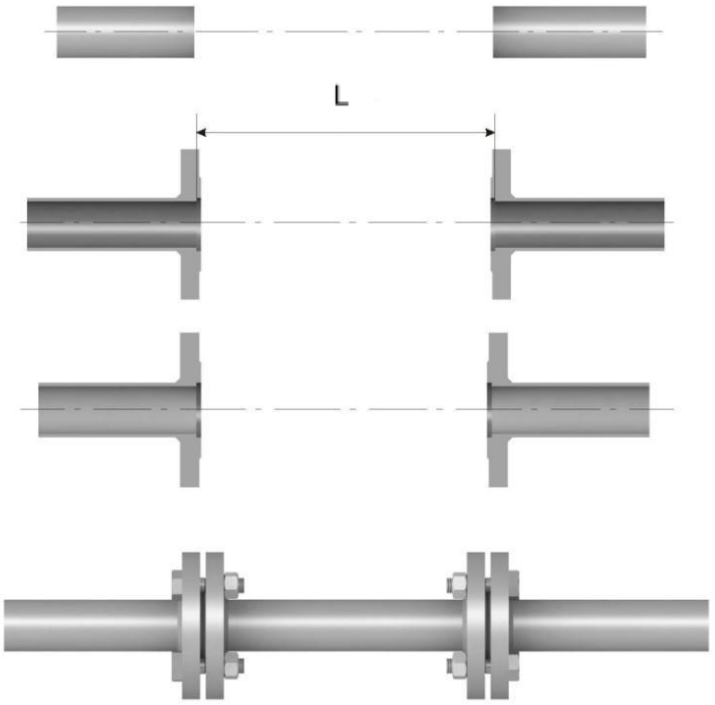


Figure 2.4 Pipeline preparation for installation of the flowmeter

When using filters or gas separators, the length L should be sufficient for their installation.

2.3.4 Installation

Prior to installation, it is necessary:

- Thoroughly clean the pipeline of dirt, sand, and other solid particulates;
- Inspect the flanges and the measuring tubes of the flowmeter and remove solid debris and other particulates from them;
- Remove the preservative grease from the flowmeter, by flushing with kerosene, gasoline or diesel fuel.

To install the flowmeter in the pipeline do the following steps (see Figure 2.5):

- Arrange the flowmeter so that the arrow on the sensor's body corresponds to the process flow direction;
- Slide the bolts through the holes of one of the pipeline flanges and flowmeter's flange, put washers and nuts. Nuts should not be finally tightened at this point;
- Put the gasket between the pipeline flange and flowmeter's flange and align it. It is recommended to avoid protrusion of the gasket into the pipeline opening;
- Install the gasket between the other pair of flanges; slide the bolts through the holes of the flanges, put washers and nuts. Nuts should not be finally tightened at this point;
- Tighten the nuts in the sequence shown in Figure 2.6.

When installing the flowmeter any bending or torsional load on the joints should be avoided. Mating flange misalignment should be avoided.

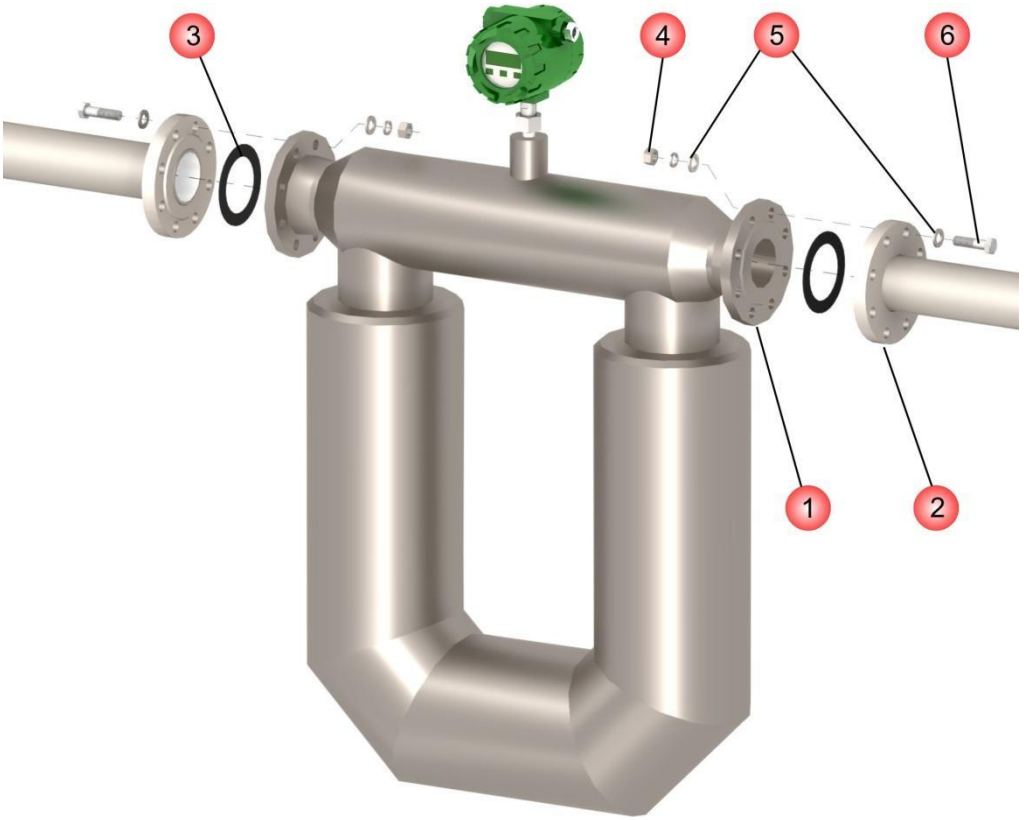


Figure 2.5 Installation of the flowmeter in the pipeline

Table 2.3 – Notes for Figure 2.5

Item №	Mounting part
1	flanges
2	Connection kit flanges
3	Gaskets
4	Nuts
5	Washers
6	Bolts (or stud bolts)

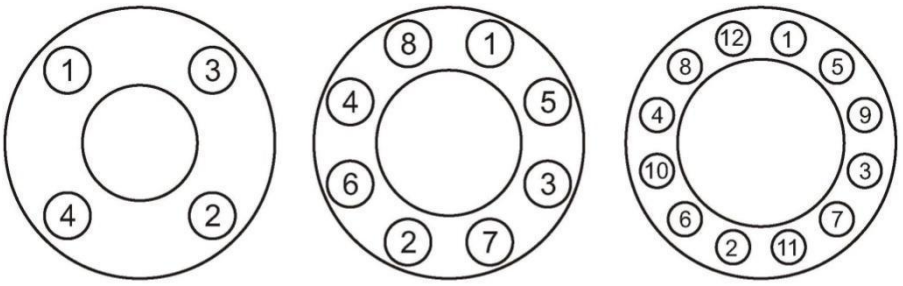


Figure 2.6 - The sequence of tightening the flange bolts

Transmitter of the separate type of the flowmeter can be mounted as shown in Figure 2.7. Transmitter can be mounted with brackets or clamps to the rack, pipe or wall.

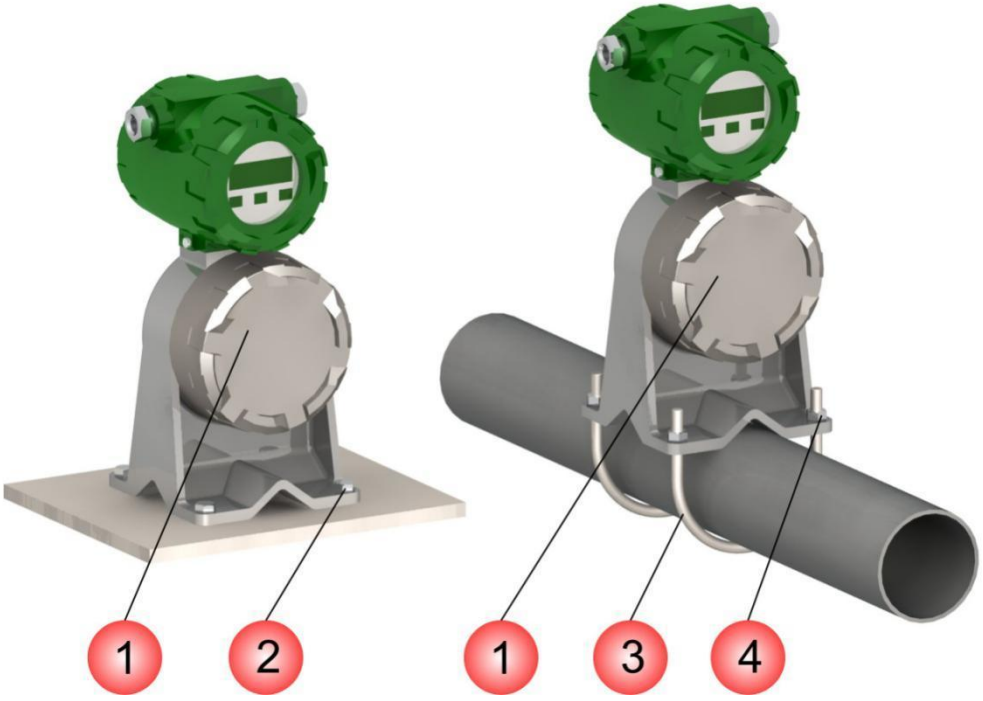


Figure 2.7 – Installation of remote transmitter type illustration

Table 2.4 – Notes for Figure 2.7

Item #	Mounting part
1	Transmitter base
2	Bolts
3	Clamp
4	Nuts

Do not install the transmitter with the cable entry oriented vertically upwards to prevent water ingress. Provide a Drip Loop.

2.3.5 Thermal insulation

If thermal insulation of the pipeline and the flowmeter is necessary, see the recommendations shown in Figure 2.8.

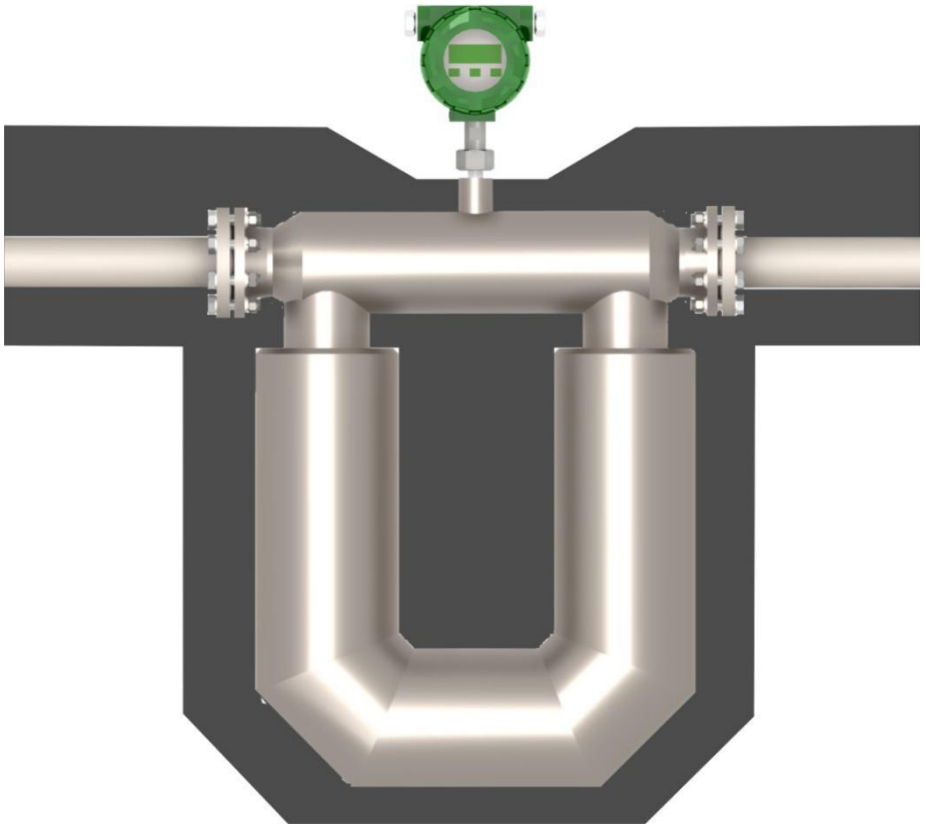
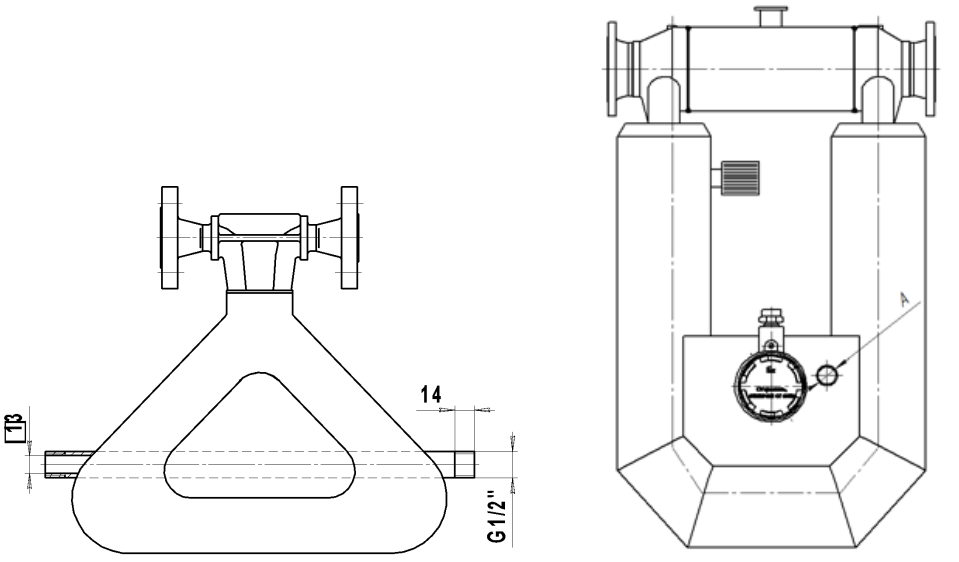


Figure 2.8 – Recommendation for thermal insulation of the flowmeter

2.3.6 Cooling

For high temperature operation of the flowmeter (with medium temperature above +200 °C) external forced convection cooling may be provided (see Figure 2.9).



DN15-25 DN40-200

Figure 2.9 – External cooling supply

2.3.7 Transmitter rotation

If the front side of the transmitter display is not visible you may rotate the transmitter at an angle of 90° or 180°, so that the display is facing the user. To do this, unscrew the four bolts (1) (see Figure 2.10). Then turn the transmitter (2) by 90° or 180° in the desired direction and tighten those 4 bolts to ensure sealing. Be very careful with the wiring during the process. Do not turn more than 180 Degrees.

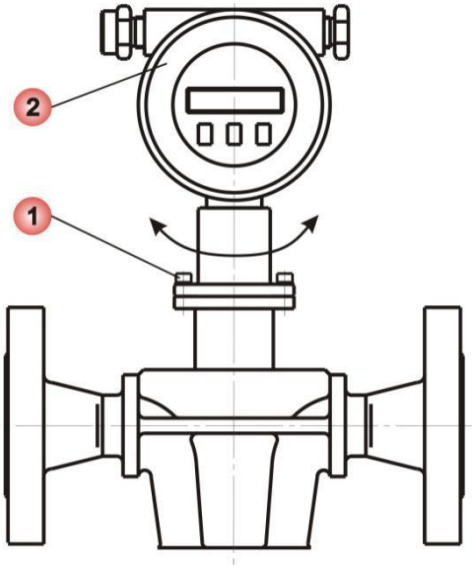


Figure 2.10 – Rotation of the transmitter

To avoid excessive twisting of wires inside the flowmeter do not turn the transmitter at an angle over 180° from its initial position.

2.4 Wiring

2.4.1 Basic guidelines

Electrical connections should be performed in the following sequence (see Figure 2.11):

- Remove the back cover (1) of the transmitter;
- Lead signal cables (2) and power cable (7) through the cable entries (3)
- Loosen the terminal block screws (4);
- Connect wires according to the wiring diagram shown in Appendix ;
- Tighten the terminal block screws;
- Tighten the clamp for the cable entry;
- If necessary, install the blind plug (5) instead of the unused cable entry;
- Connect the ground cable to the ground terminal (6);
- Tighten the cover of the transmitter.

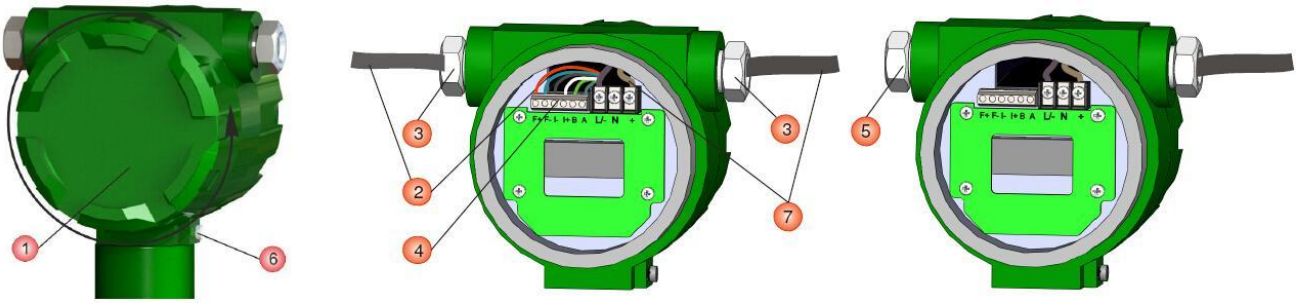


Figure 2.11 - Electrical connections

Table 2.5 – Notes for Figure 2.11

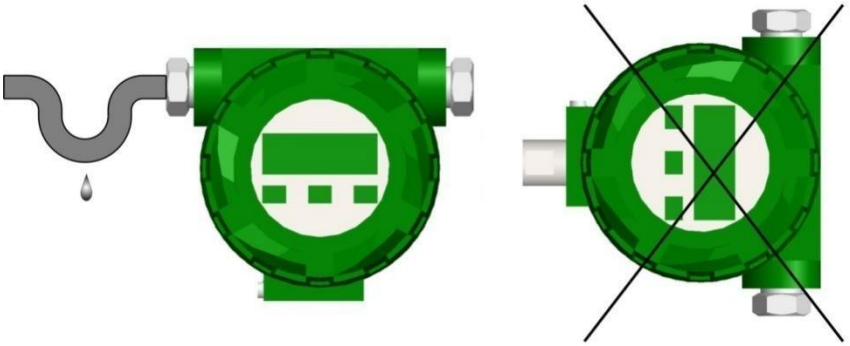
Item №.	Description
1	Back cover of the transmitter
2	Signal cable
3	Cable entries
4	Wiring Terminal block
5	Blind plug
6	Ground terminal
7	Power cable

Maximum length of the power cable is 1000 ft (300 m) with minimum wire section 0.8 mm^2 (AWG18).

The current and pulse outputs should use a twisted pair wire with a maximum length of 150 m and minimal wire section 0.5 mm^2 (AWG20).

Remote transmitters are connected through a special 9-conductor shielded cable with a maximum length of 1000 ft (300 m.) The connection diagram is shown in Figure C.1 of Appendix .After mounting and electrical connection the zero point adjustment should be performed (see paragraph 2.5.4 “Zero point adjustment”).

	When using the flowmeter in hazardous areas, apply the requirements for explosion protection provided in paragraph 2.4.2 "Installation with explosion protection"
2.4.2 Installation with explosion protection	Installation of flowmeters in explosive environment must be performed in accordance with requirements of: – This manual; – Section 3.4 of “Operational Code for Electrical Installations”; – Section 7.3 of “Electrical Installations Code”; – GOST R 51330.0; – GOST R 51330.1; – GOST R 51330.10; – Instruction BCH332-74/MMCC (“Instructions for installation of electrical equipment, power and lighting lines in hazardous areas”); – Other regulations in force within the enterprise. During installation you must pay attention to the specific operating conditions mentioned in Section 1.5 "Explosion protection". Before installation the flowmeter should be inspected. You must pay special attention to explosion proof grade labels, warning labels, and make sure that there is no damage to the flameproof shell and flow sensor. Also make sure that the grounding terminal and the seals for cables and covers are available and in good condition, also check the connecting cables condition. Upon completion of the electrical installation the electrical resistance of the ground line should be checked. This value must not exceed 1 Ohm. A copper wire with a section of at least 2.5 mm2 (AWG13) should be used for grounding. Unused cable entry must be closed with the end cap supplied by the flowmeter’s manufacturer or other end cap complied with GOST R 51330.1; During installation, check the explosion-proof surfaces of mounting parts involved in providing explosion protection. Scratches, dents, chips on the explosion-proof surfaces of those parts (which are in the explosion path), are not permitted. After the completion of the electrical connections it is necessary to close the transmitter covers firmly and engage the screw latch lock on the covers.

2.4.3 Wiring recommendations	During electrical connection of the flowmeter you must follow the following requirements: ● Wire connections must be cleaned and fixed on terminals to prevent a short circuit between each other and the body of the flowmeter (ground); ● It is recommended to use separate power supplies or a multichannel power supply with isolated channels to power the flowmeter and each of its outputs; ● If it is necessary to calculate the load resistor value, the total load impedance should be calculated as the sum of the cable resistance, external load resistance, resistance of safety barriers, load resistance of the secondary equipment; ● To minimize interference when transmitting of analog output signal 4-20 mA and digital signal it is recommended to use a shielded twisted pair cable. Grounding of the cable should be provided only on one side of the cable (near the power supply); ● It is not recommended to lay the signal cables in the same conduit with power wires, and also near sources of strong electromagnetic fields. If necessary, grounding of signal wiring can be done at any point in the signal circuit. For example, it is possible to ground the negative terminal of the power supply. The electronics housing is grounded to the sensor housing.
2.4.4 Waterproofing	The flowmeter meets all the requirements for moisture protection grade specified in the "Technical Specifications" section. In order to ensure the required protection grade, after the installation or maintenance of the flowmeter, the following requirements should be fulfilled (see Figure 2.12):
	● Seals in the transmitter should not have dirt or damage. If necessary, clean or replace the seals. It is recommended to use the original sealing elements from the manufacturer. ● Electrical cables should fit the cable entry and must not be damaged. ● Covers and the cable entries must be tightened firmly. ● Unused cable entries must be plugged. ● Just before the cable entry the cable should have U-shaped drip loop to prevent any liquid from going into the transmitter when the liquid flows down the cable. Do not install the transmitter with the cable entry directed vertically upwards.  ***Figure 2.12 Recommendations for orientation of cables and cable entries***

2.4.5 Grounding

Transient electrical signals induced by lightning, welding, large power-consuming equipment or switches may lead to distortion of the flowmeter's measuring or damage it. For protection from transient processes one must provide a connection of the ground terminals located on the transmitter body (see Figure 2.13), with the ground through a wire, designed for operation under high currents.

For grounding, it is required to use copper wire of at least 2.5 mm^2 (AWG13) section. Ground wires should be as short as possible and have a resistance of less than 1 Ohm.

Transmitter must be grounded through the pipeline, unless the pipeline provides a proper NEC compliant ground. Note many pipelines are "hot" so check the voltage levels to a known earth ground.

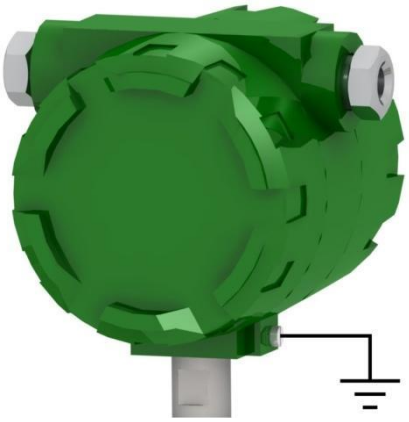


Figure 2.13 Grounding

There should be no potential applied or induced on the ground wire.

Do not use the same wire for grounding of two or more devices.

5 Operation and maintenance

2.5.1 Basic recommendations

To ensure reliable operation of the flowmeter and maintain accuracy it is necessary to satisfy the following requirements:

- To prevent damage to the measuring tubes of the flowmeter caused from water hammer, hydroblow, opening / closing valves on the inlet pipe should be done gradually;
- Operation at flow rates close to the upper limit of the full flow should last no more than 2 hours per day;

2.5.2 Power-Up

Right after power-up the flowmeter performs a self-test, and if it passes all tests, the flowmeter begins to measure flow, to generate output signals and display the measured values.

2.5.3 Display operating

The User Interface for the flowmeter is via the flowmeter's display and is performed via three optical buttons below the display. User interaction doesn't require opening the front cover of the transmitter, which is important in an explosive environment, in conditions of high humidity or precipitation, and other conditions with a high probability of contamination of the internal structural elements of transmitter or ingress of moisture, liquids, foreign objects, etc.

To "push" the optical button one should briefly put a finger or other opaque object close to the display glass in the area of the button. At that time the OLED next to the display lights for a moment. The Flowmeter will display the measured parameters shown in Table 2.6. To change the display page (next page of parameters), press the ↓ button. Display sequence corresponds to Table 2.6.

Table 2.6 – Displayed parameters order

Displayed parameter	*Display format*
Mass flow rate Mass total	Flow XXX.XXX Mass XXX.XXX
Volume flow rate Volume total	Flow XXX.XXX Volm XXX.XXX
Density Temperature	Den XXX.XXX Temp XX.X
Brix	Brix x.xxx ° Bx
Volume	Volm XXX.XXX

If the displayed value is more than 999.999, the units will automatically switch to the appropriate units to be able to display the proper value.

If no button is pressed within two minutes, flowmeter automatically switches to display mass or volume flow rate (Menu items 1 or 2), depending on the state of the menu item 47 "First Menu".

The flowmeter can be configured via the display interface. The structure of the menu is shown in Figure 2.14, description of the menu items presented in Table 2.7.

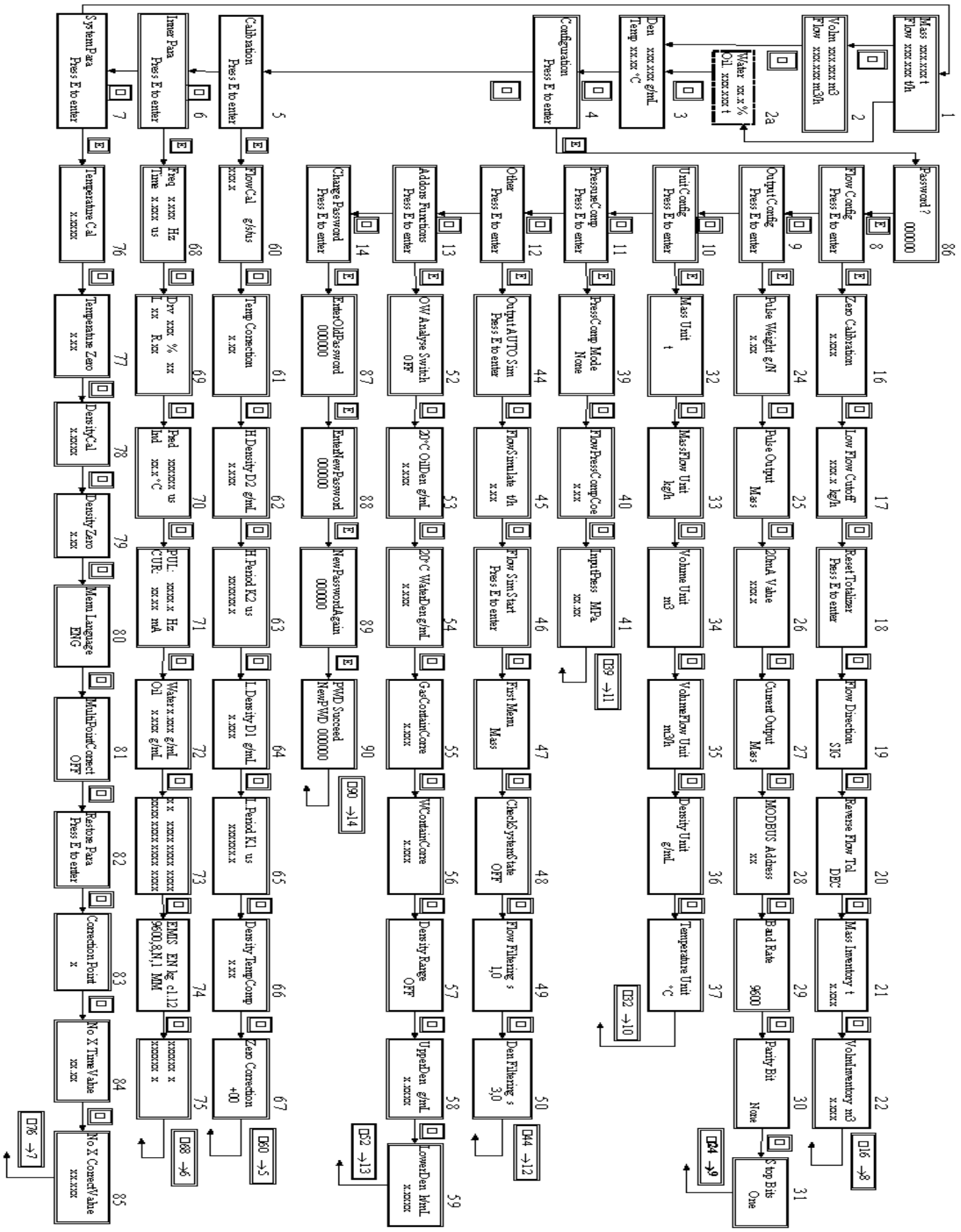
In the editable menu items press «E» button to switch to edit mode.

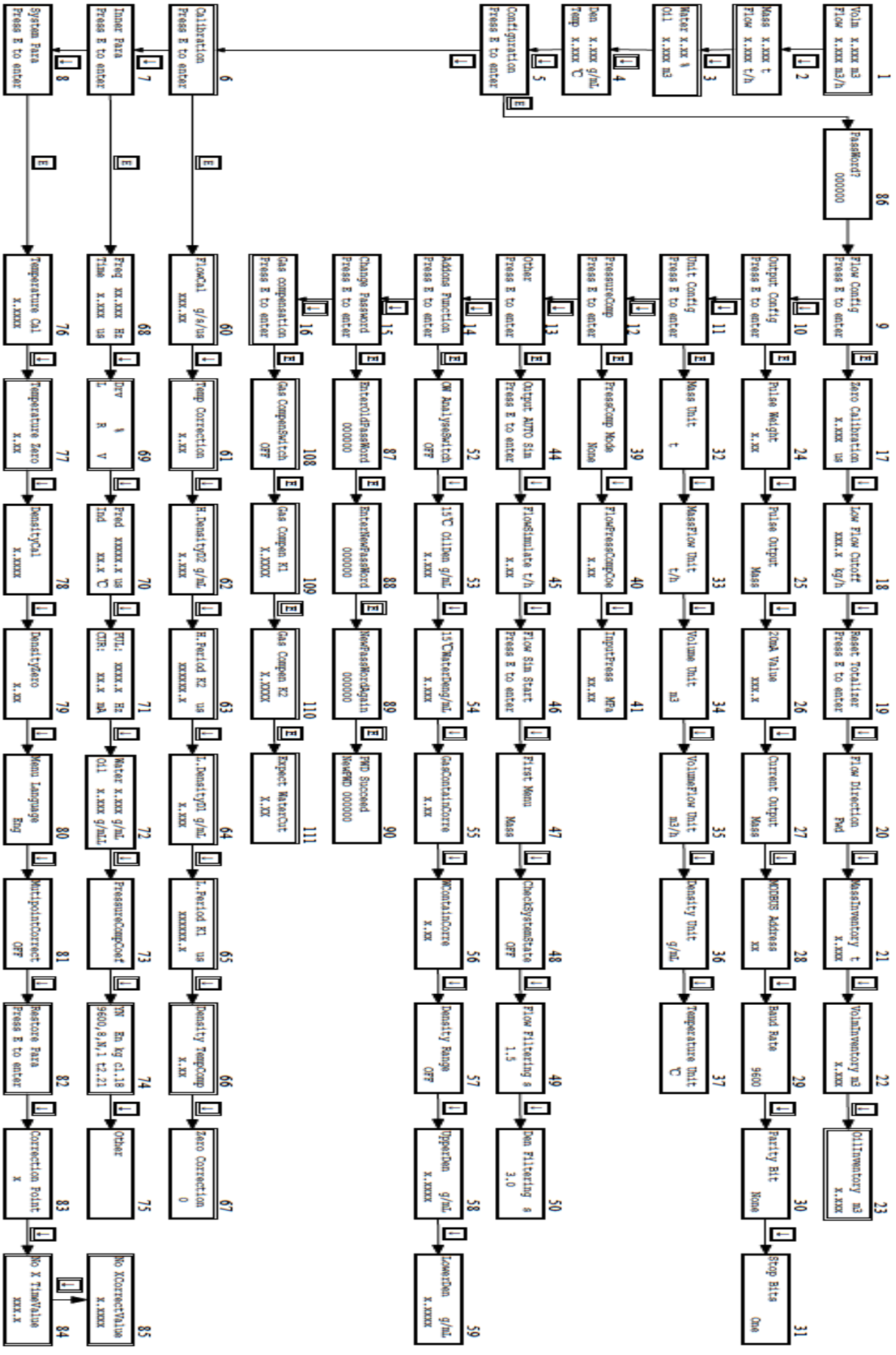
- If the menu item has several predefined options press «↓» or «→» to move between those options. The currently selected option flashes or is highlighted. To accept the selection press «E». The message «Saved? Y N» about saving changes will appear. Press «↓» or «→» to move between «Y» (yes) and «N» (no) options. Select «Y» to accept changes or «N» to cancel, then press «E» to quit edit mode.

- If the menu item requires a numeric value the entry is performed by changing the digits one by one and moving to the next digit on the right. The

digit in the currently selected position is flashing. Press «↓» to increment the digit in the current position from 0 to 9. To move to the next digit press «→». Press «E» to finish editing, then select «Yes» to accept changes or «No» to cancel, then press «E» to quit edit mode.

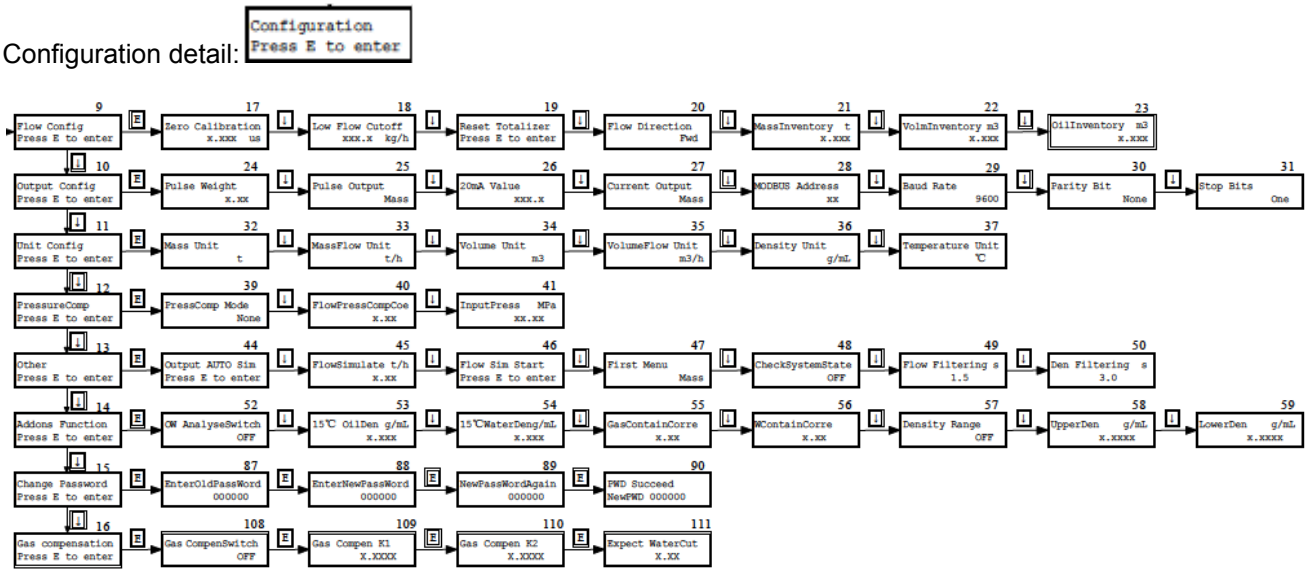
USER INTERFACE ROOT MENU



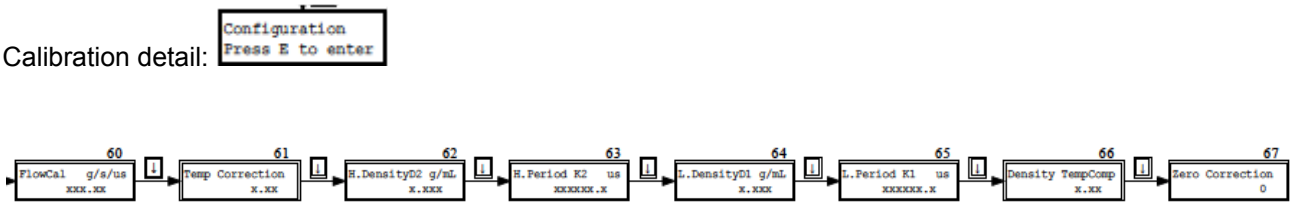


Link to view image on website (expand on your screen for easier reading)

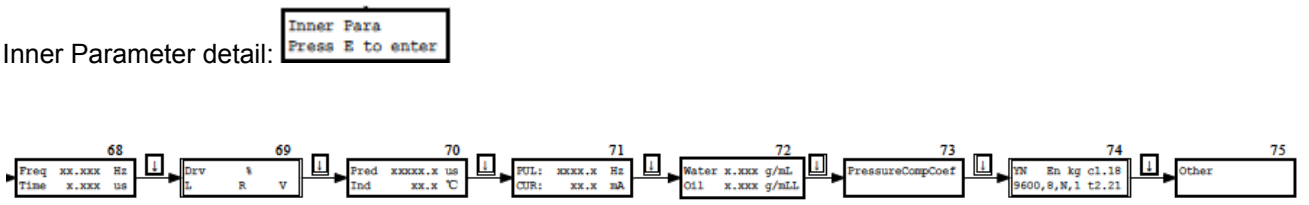
Configuration detail:



Calibration detail:



Inner Parameter detail:



System Parameter detail:

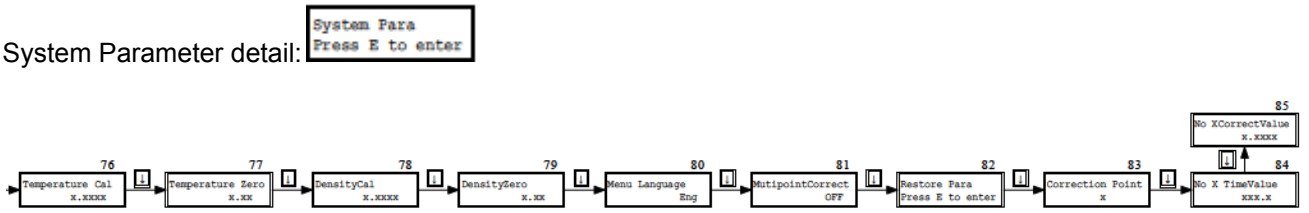


Table 2.7 – Displayed parameters

Menu item	Indication format	Button actions	Description
Measured parameters display			
0	TFM Ver.2.23 and later. 2012.03	→1	Version and data of electronics. Press"→" at first screen and it's showed on flowmeter's power-up.
1	Flow XXX.X Mass XXX.XXXX	↓2, →0	Total mass and mass flow rate. Mass flow units: Kg lb Ton(Metric ton,default setting) Mass flow rate units: t/d t/h(default setting) Kg/h Kg/m lb/h lb/m

2	Flow XXX.X Volm XXX.XXXX	↓3, →1	API tables (Special function , need to be marked on order) supported by the petroleum measurement application The API tables listed here are supported by the petroleum measurement application. API MPMS Chapter 11 provides Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils for 3 different sets of base conditions: 60 ° F and 0 psig 15 ° C and 0 kPa 20 ° C and 0 kPa » 60° F is used as the base temperature within the United States and by producing countries that deal with the United States » The 15 ° C temperature is popular in Latin America and Europe. » The 20 ° C temperature is popular in Asia. » Middle-East counties such as Saudi Arabia or the U.A.E. may use 60 ° F when trading with U.S. companies and then use 15 or 20° C when trading elsewhere. » Literally any country or user may decide that they need to use any one of the 3 base temperatures for any reason at any time. Total volume and instant volumetric flow rate. Volumetric flow units: GL(US Gallon) BBL m^3 Total volume units: m^3/d BL/d(BBL/day) GL/h (US gallon/hr) m^3 /h GL/m(US Gallon/min) m^3 /m(cubic meter/min) This menu item is not displayed when Menu item 52 "OW Analyze Switch" if set to On.

2a	Oil XXX.XXX Water XXX %	↓4, →1	Mass or volume flow rate of net oil and water cut %. This menu item is displayed only if Menu item 52 "OW Analyze Switch" if set to On. API MPMS Chapter 11 provides Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils for 3 different sets of base conditions: 60 ° F and 0 psig 15 ° C and 0 kPa 20 ° C and 0 kPa » 60° F is used as the base temperature within the United States and by producing countries that deal with the United States » The 15 ° C temperature is popular in Latin America and Europe. » The 20 ° C temperature is popular in Asia. » Middle-East counties such as Saudi Arabia or the U.A.E. may use 60 ° F when trading with U.S. companies and then use 15 or 20° C when trading elsewhere. » Literally any country or user may decide that they need to use any one of the 3 base temperatures for any reason at any time.
3	Den X.XXX Temp XX.XX	↓4, →1	Density and temperature of the measured medium. Denisty flow units: g/mL kg/L b/gl(lbs/ US gallon) kg/m (Kg/m3) g/cc Tempetaure unit: ℃ ℉
4	Brix measurement		Brix x.xxx ° Bx (Speical order only) Volm XXX.XXX m3
5	**Configuration** Press «E» to enter	↓5, →1, E86	Press «E» button to enter the submenus for configuring the flowmeter.

Submenus of the "Configuration" menu				
86	Password?	000000	E8	The following submenus can be accessed only after entering the 6-digit password. If the entered password is invalid a message "Wrong password" will be displayed. To return to the Menu item 4 "Configuration" press «→». To enter the password again press «↓».
8	**Flow Config** Press «E» to enter		↓9, →4, E16	Allows user to specify low flow cutoff, flow direction and the way of its counting.
16	Zero Calibration	X.XXX us	↓17, →6	Zero point adjustment. The value displayed is the time delay between the signals coils, taken as zero point. Press «E» to start zeroing procedure described in paragraph 2.5.4.
17	Low Flow Cutoff	X.XXX kg/h	↓18, →6, E – edit	If the current mass flow rate is less than specified Low Flow Cutoff value then the flow rate is assumed as zero and totalizers will pause. Cutoff default values Cutoff type: Mass flow Recommended setting: 1.0% of the sensor's rated maximum flow rate
18	Reset Totalizer Press «E» to enter		↓19, →6, E – reset	Press «E» to reset mass and volume totalizers (resettable totalizer).
19	Flow Direction	Fwd Rvr Bid Abs NFwd NBid	↓20, →6, E – edit	Option of flow direction, Forward «Rwd» or Reverse «Rvr» or Bidirectional«Bid» or Absolute Value «Abs» or Negate Forward«NFwd» or Negate Birirectional «Nbid» If «Rwd» is chosen then only direct flow will be accumulated (direction corresponding to the arrow on the sensor body). Please see following chapter configuring the flow direction parameter for more detailes

Configuring the flow direction parameter

The flow direction parameter controls how the transmitter reports flow rate and how flow is added to or subtracted from the totalizers, under conditions of forward flow, reverse flow, or zero flow.

- Forward (positive) flow moves in the direction of the arrow on the sensor.
- Reverse (negative) flow moves in the direction opposite of the arrow on the sensor.

Options for flow direction include:

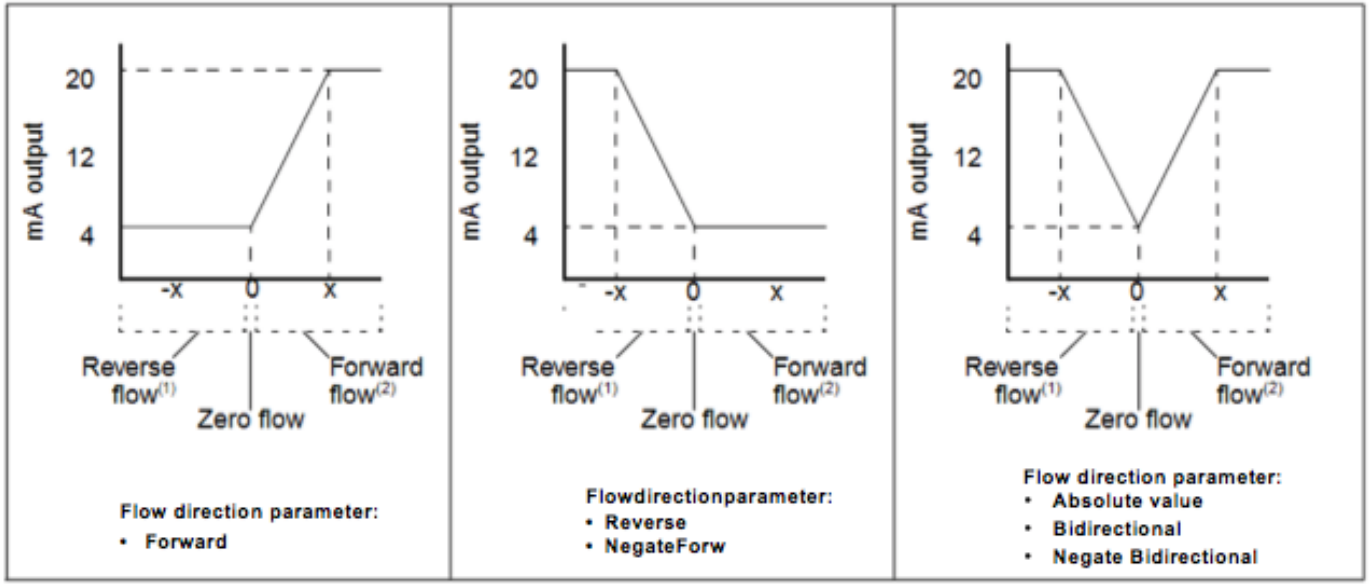
- Forward(Rwd)
- Reverse(Rvr)
- Bidirectional(Bid)
- Absolute Value(Abs)
- Negate Forward(NFwd)
- Negate Bidirectional(Nbid)

For the effect of flow direction on mA outputs: See Figure 2.15 if the 4 mA value of the mA output is set to 0.

mA output configuration:

- 20 mA value = x
- 4 mA value = 0

(1) Process fluid flowing in opposite direction from flow direction arrow on sensor.
(2) Process fluid flowing in same direction as flow direction arrow on sensor.



For Example

Configuration:

- Flow direction = Forward
- mA output: 4 mA = 0kg/hr; 20 mA = 2000kg/hr

(See the first graph in Figure 2.15.)

As a result:

- Under conditions of reverse flow or zero flow, the mA output level is 4 mA.
- Under conditions of forward flow, up to a flow rate of 2000kg/hr, the mA output level varies between 4 mA and 20 mA in proportion to (the absolute value of) the flow rate.
- Under conditions of forward flow, if (the absolute value of) the flow rate equals or exceeds 2000kg/hr, the mA output will still at 20mA

Effect of flow direction on frequency output, totalizers, and digital communications(see table 2.7.1)

Forward flow(1)

Flow direction value	Frequency output	Flow totals	Flow values via digital comm.
Forward	Increase	Increase	Positive
Reverse	0 Hz	No change	Positive
Bidirectional	Increase	Increase	Positive
Absolute value	Increase	Increase	Positive(3)
Negate Forward	Zero(3)	No change	Negative
Negate Bidirectional	Increase	Decrease	Negative

Zero flow

Flow direction value	Frequency output	Flow totals	Flow values via digital comm.
All	0 Hz	No change	0

Reverse flow(4)

Flow direction value	Frequency output	Flow totals	Flow values via digital comm.

Forv
Rev
Bidi
Abs
Neg
Neg
(1) Process fluid
(2) Refer to the
(3) Process fluid
20 MassInv
21 VolmInv
9 Output Press «
24 Pulse W
25 Pulse O
26 20mA V
27 Current

Forward	0 Hz	No change	Negative
Reverse	Increase	Increase	Negative
Bidirectional	Increase	Decrease	Negative
Absolute value	Increase	Increase	Positive(3)
Negate Forward	Increase	Increase	Positive
Negate Bidirectional	Increase	Increase	Positive

(1) Process fluid flowing in same direction as flow direction arrow on sensor.
(2) Refer to the digital communications status bits for an indication of whether flow is positive or negative.
(3) Process fluid flowing in opposite direction from flow direction arrow on sensor

20	MassInventory	X.XXX	↓21, →6	Accumulated total mass. This value is also displayed in Menu item 1 "Flow Mass".
21	VolmInventory	XXXX.XX	↓16, →6	Accumulated total volume. This value is also displayed in Menu item 2 "Flow Volm".
9	**Output Config** Press «E» to enter		↓10, →4, E24	Configuration of the outputs of the flowmeter.
24	Pulse Weight	XXX. XX g/N	↓25, →9, E – edit	Input mass flow rate, volume flow rate or density corresponding to one pulse on the pulse output. Frequency output scale methods: Units per pulse A pulse represents a user-specified number of flow For example Pulse output: Mass Pulse Weight: 50.0 g/N, which means a pulse represents 50g.
25	Pulse Output	Mass Volm Dens	↓26, →9, E – edit	The pulse output can be configured to denote mass flow rate ("Mass"), volumetric flow rate ("Volm") or density ("Dens") of the medium.
26	20mA Value	XXX.X	↓27, →9, E – edit	Input mass flow rate, volume flow rate or density corresponding to 20mA on the current output.
27	Current Output	Mass Volm Dens Water cut% Brix.	↓28, →9, E – edit	The current output can be configured to denote mass flow rate ("Mass"), volumetric flow rate ("Volm") , density ("Dens") of the medium and water cut %. And Brix °

28	MODBUS Address	XXX	↓29, →9, E – edit	Address of the flowmeter in Modbus network.
29	Baud Rate	9600 4800 2400 1200	↓30, →9, E – edit	Data transfer baud rate in Modbus network.
30	Parity Bit	No Even Odd	↓31, →9, E – edit	Parity control in data transfer protocol. Select «NO» for no parity; «Even» for 1 even parity bit; «Odd» for 1 odd parity bit.
31	Stop Bits	One Two	↓24, →9, E – edit	Select one or two stop bits in data transfer protocol in Modbus network.
10	**Unit Config** Press «E» to enter		↓11, →4, E32	Select units for parameters displayed in the menu items 1, 2, 3.
32	Mass Unit	Kg, lb, Ton(metric)	↓33, →10, E – edit	Select units for mass totalizer.
33	MassFlow Unit	t/d t/h(default setting) Kg/h Kg/m lb/h lb/m	↓34, →10, E – edit	Select units for mass flow rate.
34	Volume Unit	GL(US Gallon) BBL m^3	↓35, →10, E – edit	Select units for volume totalizer.
35	VolumeFlow Unit	m^3/d BL/d(BBL/day) GL/h (US gallon/hr) m^3 /h GL/m	↓36, →10, E – edit	Select units for volumetric flow rate.

				(US Gallon/min) m³/m (cubic meter/min)		
36	Density	36	Density Unit	g/mL kg/L lbs/gal kg/m3 g/cc	↓37, →10, E – edit	Select units for density.
37	Temper	37	Temperature Unit	℃ ℉	↓32, →10, E – edit	Select units for temperature.
38	Brix° u	38	Brix° unit	Bx °	39, →10, E – edit	Select units for Brix° .
11	**Pressu** Press «	11	**PressureComp** Press «E» to enter		↓12, →4, E39	Switching On/Off and changing parameters of pressure compensation for flow.
39	PressC	39	PressComp Mode	None Manu Auto	↓40, →11, E – edit	Pressure compensation modes: Select «None» to disable pressure compensation; select «Manu» for manual compensation, when the actual pressure value is entered manually in the Menu item 41; select «Auto» for automatic pressure compensation, when actual pressure is measured by an external pressure sensor, connected to the flowmeter's corresponding terminals. It's for special order requirement for standard specification, no Pressure Compenstaion mode.
40	FlowPre CompC	40	FlowPress CompCoe	X. XX	↓41, →11, E – edit	Coefficient of pressure compensation for flow as percentage of calibration coefficient correction for pressure deviation of 1MPa. Default value is 0.01 %/MPa.
41	InputPr	41	InputPress MPa	XX. XX	↓39, →11, E – edit	Actual pressure value for manual compensation mode.
12	**Other** Press «	12	**Other** Press «E» to enter		↓13, →4, E44	Miscellaneous functions such as flow simulation, etc.
44	Output Press «	44	Output AUTO Sim Press «E» to enter		↓45, →12, E – edit	Press «E» to start automatic flow simulation procedure. The sequence of frequency and current test signals appears on the flowmeter's outputs. Signal on the current output changes from 4 to 20 mA in steps of 0.5mA; frequency on the pulse output changes from 0 to 12000 Hz in steps of 375 Hz. Values change every 5 seconds.
45	FlowSin	45	FlowSimulate t/h	X. XX	↓46, →12, E – edit	Input mass flow rate used in flow simulation. Signals on pulse and current outputs will correspond to that flow rate.
46	Flow Si	46	Flow Sim Start		↓47, →12,	Flow simulation mode starts by pressing «E». Simulated flow rate is specified in the Menu item

	Press «E» to enter		E – edit	45. Simulation stops after pressing «↓» или «→».
47	First Menu	Hold Mass Volm	↓48, →12, E – edit	Select the menu item, which will be displayed if no button is pressed within 2 minutes. Select "Mass" to move to Menu item 1, "Volm" to move to Menu item 2. If "Hold" option is selected moving to other menu items will not occur.
48	CheckSystem State	OFF ON	↓49, →12, E – edit	Enable/disable system check function.
49	Flow Filtering s	X.XXX	↓50, →12, E – edit	Flow rate averaging time from 0.5 to 10 s in steps of 0.5 s.
50	Den Filtering s	X.X	↓44, →12, E – edit	Density averaging time from 0.5 to 30 s in steps of 0.5 s.
13	**Addons Function** Press «E» to enter		↓14, →4, E52	Entering parameters for measurement of two-component media.
52	OW Analyse Switch	OFF ON	↓53, →13, E – edit	Enable/disable oil-water analyze function.
53	20ºC OilDen or API 15C oilDen or 60 ° F OilDen	X.XXX g/mL	↓54, →13, E – edit	Density of pure oil under standard conditions.
54	20ºC WaterDen or API 15CWaterDen Or 60 ° F WaterDen	X.XXX g/mL	↓55, →13, E – edit	Density of pure water under standard conditions.
55	GasContainCorre	X.XXX	↓56, →13, E – edit	Flow compensation by percentage of gas in the oil-water. It works only if oil-water analyze function is enabled in the Menu item 52.
56	WContainCorre	X.XXX	↓57, →13, E – edit	Flow compensation by percentage of pure water in the oil-water (not realized in current versions of flowmeters).
57	Density Range	OFF ON	↓58, →13, E – edit	Enable/disable density range check. When enabled and If density of the medium is out of range specified in menu items 58 and 59 then the volumetric flow will not be calculated.

58	UpperDen	X.XXXX	↓59, →13, E – edit	The upper limit of density range (see Menu item 57).	
59	LowerDen	X.XXXX	↓52, →13, E – edit	The lower limit of density range (see Menu item 57).	
14	**Change Password** Press «E» to enter		↓8, →4, E87	Password changing is used for protection against unauthorized access to the settings of the flowmeter.	
87	EnterOld PassWord	000000	↓→ edit, E88	Input current password	**If the entered password is invalid a message "Wrong password" will be displayed. To return to the Menu item 14 "Change Password" press «→». To enter the password again press «↓».**
88	EnterNew PassWord	000000	↓→ edit, E89	Input new password	
89	NewPassWord Again	000000	↓→ edit, E90	Confirm new password	
90	PWD Succeed	NewPWD 000000	↓14, →14, E14	New password is displayed	
5	**Calibration** Press «E» to enter		↓6, →1, E60	Setting of calibration parameters provided for measuring flow, density, temperature.	
60	FlowCal	X.XXX g/s/us	↓61, →5, E – edit	Calibration coefficient **K**.	
61	Temp Correction	X.XX%	↓62, →5, E – edit	Temperature correction coefficient for flow rate as percentage of calibration coefficient correction for temperature deviation of 100°C.	
62	H.Density D2	X.XXX g/mL	↓63, →5, E – edit	High density value corresponding to the medium of high density (water). Used for calibration for density measuring.	
63	H.Period K2	XXXXXX.X us	↓64, →5, E – edit	Measuring tubes oscillation frequency for the medium of high density (water). Used for calibration for density measuring.	
64	L.Density D1	X.XXX g/mL	↓65, →5, E – edit	Low density value corresponding to the medium of low density (air). Used for calibration for density measuring.	
65	L.Period K1	XXXXXX.X us	↓66, →5, E – edit	Measuring tubes oscillation frequency for the medium of low density (air). Used for calibration for density measuring.	
66	Density TempComp	X.XX %	↓67, →5, E – edit	Temperature correction coefficient for density as percentage of measured density correction for temperature deviation of 100°C.	

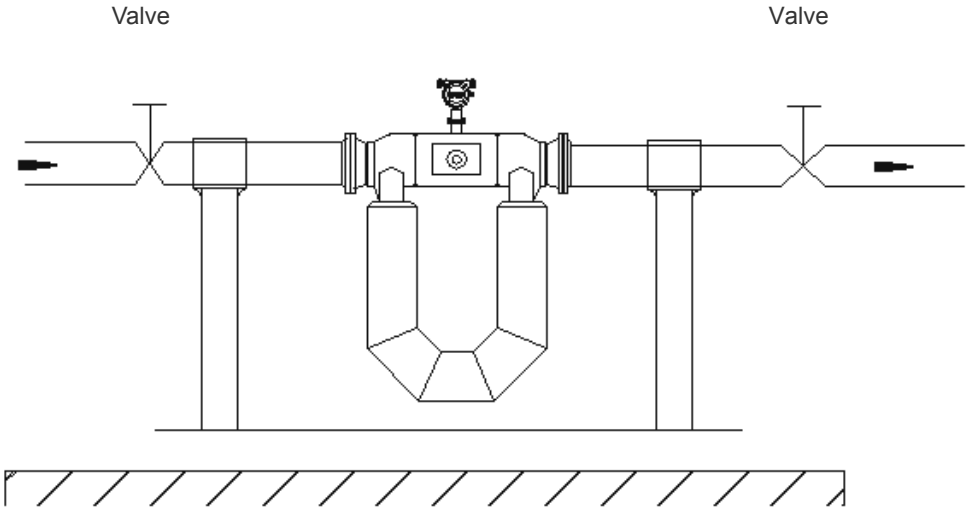
67	Zero Correction +00	↓60, →5, E – edit	Correction of the zero flow point in the range of -19 to +19.
6	**Inner Para** Press «E» to enter	↓7, →1, E68	Inner parameters of the flowmeter used for diagnostic purposes.
68	Freq XX.XX Hz Time XX.XX us	↓69, →6	Measuring tubes oscillation frequency. Current time delay between left and right signal coils
69	Drv XXX %, YY L XX mV R XX mV	↓70, →6	Drive coil load as percentage (XXX) and its standard deviation within 8 seconds as percentage (YY). Voltage on the left (L) and right (R) signal coils.
70	Pred XXXXX.XX us Ind XX.X °C	↓71, →6	Measuring tubes oscillation period. Internal temperature of the flowmeter.
71	PUL: XXXX.X Hz CUR: XX.XX mA	↓72, →6	Frequency of the signal on the pulse output. Current value on the current output.
72	Water X.XXX g/mL Oil X.XXX g/mL	↓73, →6	Density of water in oil-water under working conditions. Density of oil in oil-water under working conditions.
73	X X XXXX XXXX XXXX XXXX XXXX XXXX XXXX	↓74, →6	Internal parameters for pressure compensation mode.
74	GPE EN kg cX.XX 9600, 8, N, 1 tY.YY	↓75, →6	Menu language (EN), version of the display menu (X.XX), Modbus data format, register map version (Y.YY)
75	XXXXXX 1 XXXXXX 0	↓68, →6	Display low volume flow cutoff (L/h), totalizer mode (0 – disabled, 1 – enabled), low density cutoff (g/mL), bytes order for float point values (default value is 0).
7	**System Para** Press «E» to enter	↓1, →1, E76	System parameters of the flowmeter. **Intended to use for the representatives of the manufacturer only.**
76	Temperature Cal X.XXXX	↓77, →7, E – edit	Correction coefficient of the temperature Tk for simulation mode (in the range of 0.9 – 1.1). T= Tk ×Tdev +T0. (Tdev is temperature deviation).
77	Temperature Zero X.XX	↓78, →7, E – edit	Zero temperature T0 for simulation mode (in the range of -20C° to +20C°).
78	DensityCal X.XXXX	↓79, →7, E – edit	Correction coefficient of the density ρk for simulation mode (in the range of 0.9 – 1.1). ρ= ρk× ρdev + ρ0. (ρdev is density deviation).
79	DensityZero X.XX	↓80, →7, E – edit	Zero density ρ0 for simulation mode (in the range of -0.1 g/cm^3 to +0.1 g/cm^3).

80	Menu Language	RUS ENG	↓81, →7, E – edit	Select display menu language. Switching from English language to Russia
81	MultipointCorrect	OFF ON	↓82, →7, E – edit	Enable/disable multipoint correction function used for correction of the calibration coefficient in several points of flow rate (time delay).
82	Restore Para Press «E» to enter		↓83, →7, E – edit	Restore of all coefficients and settings of the flowmeter, except for calibration parameters in the menu items 60-67, to factory defaults.
83	Correction Point	X	↓84, →7, E – edit	Number of correction coefficient (0 – 7), which values are specified in the menu items 84 and 85.
84	No X TimeValue	YY.YYY	↓85, →7, E – edit	The value of time delay between left and right signal coils (YY.YYY µs) for the correction coefficient number X.
85	No XCorrectValue	XX.XXX	↓76, →7, E – edit	Correction coefficient (in the range of 0.9 to 1.1) applied to the calibration coefficient **K** for time delay point specified in the menu item 84.

2.5.4 Zero point adjustment

After installation and all wiring, a zero point adjustment (zero calibration) procedure should be performed. This procedure sets the base point corresponding to zero flow. Without actual flow there is a time delay between signal coils, this delay assumed as zero point. To perform this procedure, follow these steps:

- Apply power to the flowmeter and let it warm up for at least 30 minutes;
- Let the measuring medium flow through the flowmeter, as long enough for thermal equilibrium
- Close the valve located after the flowmeter;
- Make sure that the flowmeter's tubes are completely filled with fluid;
- Close the valve located before the flowmeter(see Fig. 2.16);
- Make sure that the fluid in the flowmeter is completely still;



Common base
Figure.2.16 installation for zero adjustment

CAUTION!

Place pipe supports as close to the process connection as possible
• Make sure pipe supports are securely clamped or attached to the process line
• **If multiple meters are installed in series or in parallel, piping to each meter must have separate supports. The flowmeter should not share the same pipe supports**
• Do not install a flowmeter in the highest part of the system. The lowest part of the system is required to keep the tubes full.

- Using the root menu (see Figure 2.14) press ↓ button several times to move to the Menu item "Configuration Press E to enter". Press the E button and enter the password (default password is 000000). To enter the password press ↓ to increment the currently selected digit, to move to the next digit press → button. After the correct password entry the screen will say Flow Config Press E to enter. Press E. Next the screen will say Zero Calibration with the zero uS below. Press E to start. The Zeroing message will appear with a blinking N. Use the → to make the Y blink. Press E to start zero calibration procedure. A message "Zeroing?" will appear. Press E to confirm that. Zero calibration procedure lasts for 30 seconds, the countdown time is displayed.

ZeroPoint Flow calibration procedure should also be performed if the flowmeter indicates any flow when there is no actual flow at the moment.

2.5.5 Protection switch

The flowmeter has a protection switch block (see Figure 2.17), which protects the flowmeter's calibration coefficients from unauthorized access. The protection switch block is located at the front side of the display board to the right from the display. The protection switch block contains 8 switches.

To access the protection switch block it is necessary to remove the sealing wire or the sticker from the front cover of the transmitter, then open the front cover(see Figure.2.17)

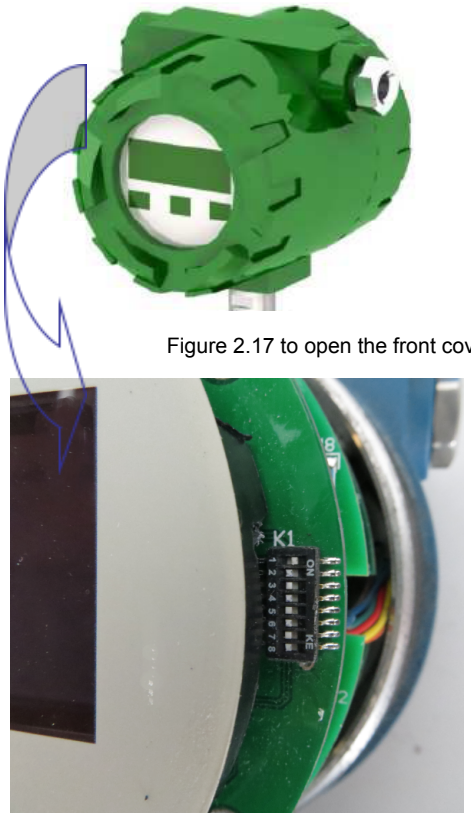


Figure 2.17 to open the front cover

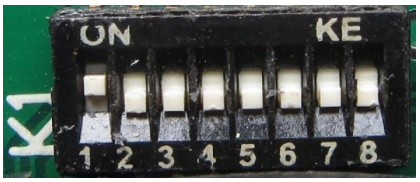


Figure 2.17 switch block No. 1 (at "ON " position)

At the factory switch 1 is set to ON (see Figure 2.17). In this position, the calibration parameters of the flowmeter cannot be changed, entering the menu section 5 "Calibration" and section 7 "System Para" is not available. Such a state of the switches is necessary to change some Modbus registers through a digital interface, such as the Modbus register map version or display language (see ***Appendices D and E***).

If any of switches 1-8 is set to ON, the access to the "Calibration" and "System Para" sections will also be impossible. But you still can view the values.

To enter the "Calibration" and "System Para" sections and change or just see the calibration coefficients, it is necessary to set all the switches to OFF positions (see Figure 2.18).

It is critical that you not change any of the calibration coefficients that match the flow meter to the calibration process.

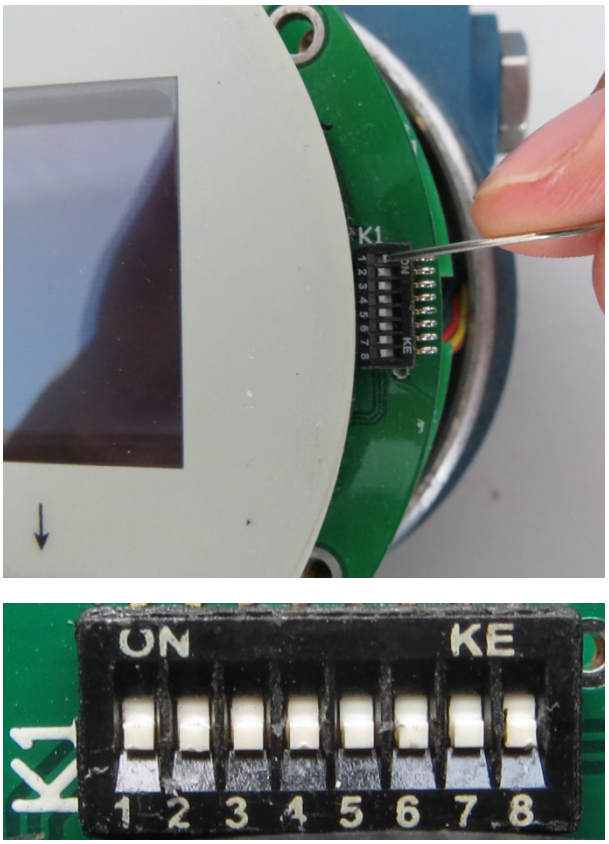


Figure 2.18 set No. 1 switch block to OFF position

2.5.6 Maintenance

Flowmeters do not require special maintenance other than periodic inspection to verify the following:

- Compliance with the working conditions;
- Whether the voltage and the other parameters of the power supply conform to the requirements in parameter 1.3.4 “Power supply”;
- Visibility of the information on the nameplates and other labels;
- Cleanness of the exterior surfaces of the flowmeter;
- Tightness of connections of the flowmeter to the pipeline;
- No damage to any flowmeters parts are visible.

Examination period for the flowmeter depends on operation conditions and is defined by the maintenance organization in agreement with the operating organization.

In case of the flowmeter’s failure it is necessary to follow the instructions of paragraph 2.5.7 “Troubleshooting”.

CAUTION!

Working in inappropriate operating conditions may lead to failure of the flowmeter or increase the measurement error.

2.5.7 Troubleshooting

Possible faults, their probable cause and solutions are presented in Table 2.8.

Table 2.8 - Troubleshooting

Fault	*Probable cause*	*Solution*
1 When the flowmeter is powered there is no indication on display nor any signal on the flowmeter’s outputs	Incorrect connection of the power wires to the flowmeter.	Check the power cable connection according to the wiring diagram in ***Appendix*** .
	Power wires broken or loose..	Check the power wires and replace them if needed.
	Power supply voltage does not meet the requirements .	Check the power supply voltage and set its value in accordance with the requirements of this manual.

2 When the flowmeter is powered the measured parameters are displayed correctly but there are no signals on the flowmeter's outputs	Wrong connection of the output wires to the flowmeter or secondary devices.	Check the output wires connection according to the wiring diagrams in ***Appendix*** . Check the computer's port used to connect the flowmeter to the computer through the digital interface. Make sure that the same port number is set in the "TFM-Integrator" settings.
3 When there is a known flow the flowmeter shows zero flow rate on the outputs	The actual flow rate is less than the lower limit of the measuring range for this size of the flowmeter. The actual flow rate is less than the low flow cutoff value set in the menu.	Fully open the valves to set the flow rate within the measuring flow range. Decrease the low flow cutoff value to be less than the actual flow rate.

Fault	*Probable reason*	*Repairing way*
4 When there is no flow the flowmeter indicates a certain flow	Deviation of the zero point caused by temperature and pressure deviation from temperature and pressure values on previous zero point calibration.	Perform zero calibration in accordance with the paragraph 2.5.4 "Zero point adjustment".
5 In the menu it we can not enter the "Calibration" and "System Para" sections	At least one of the switches of the protection switch block is set to the ON position.	Set all the switches to OFF positions (see Figure 2.15) only for the time needed to perform changes in those sections. Put it back in the protection mode when done.

A special LED indicator is provided for indication of some faults of the flowmeter. The LED is located above the display and its color and blink period indicates the flowmeter's fault shown in Table 2.9.

Table 2.9 – LED diagnostics

Lighting period	*Fault*
Lights continuously right after power-up	Self-diagnostics test failed
Lights continuously some time later after power-up	Incorrect zero calibration
Flashing. The color is red	Malfunction of the flowmeter
Flashing. Lights within 3/4 of the period, dark within 1/4 of the period	Flow rate is less than the lower limit of the flow range for this size of the flowmeter

To determine a fault in the sensor part of the flowmeter it is necessary to check the resistance of the coils first. Resistance value should be in the ranges specified in Table 2.10.

Table 2.10 – Coils diagnostics

Circuit element	*Wire color*	*Contact number*	*Resistance, Ohms*
Left coil	Brown, red	1, 2	60 – 75
Right coil	Orange, yellow	3, 4	60 – 75
Drive coil	Blue, green	5, 6	6 – 30
Temperature sensor	Gray, white	7, 8	75 – 175
Temperature sensor	Gray, black	7, 9	75 – 175

3 TRANSPORTATION AND STORAGE

3.1 Transportation

For Transportation of the flowmeter it is important to follow these recommendations:

- The flowmeter should be transported in a high quality wooden container, which should protect the flowmeter from mechanical damage;
- It is recommended to use waterproof packing materials in the transport container;
- Transportation should be accomplished with ambient temperatures from -40 to +70 °C, with relative humidity up to 100% non-condensing at 35 °C;
- Protection against precipitation/rain must be provided;
- Flowmeters can be transported by any oofed transport, including air transport in heated hermetic compartments in accordance with the rules in force for this type of transport;
- The requirements in the package handling marks should be fulfilled;
- Stacking the container on the transport vehicle must be provided to prevent their movement;
- The container must not receive sharp blows while loading / unloading;
- The flow meter must not be in the shipping container for more than 3 months;
- After transportation at temperatures below 0 °C, the flowmeter should be unpacked at least 12 hours after its storage in a 70 degree F or 21 degree C environment.

When the flowmeter is transported out of the package it is necessary to follow recommendations shown in Figure 3.1. NEVER lift the flowmeter by the electronics transducer.

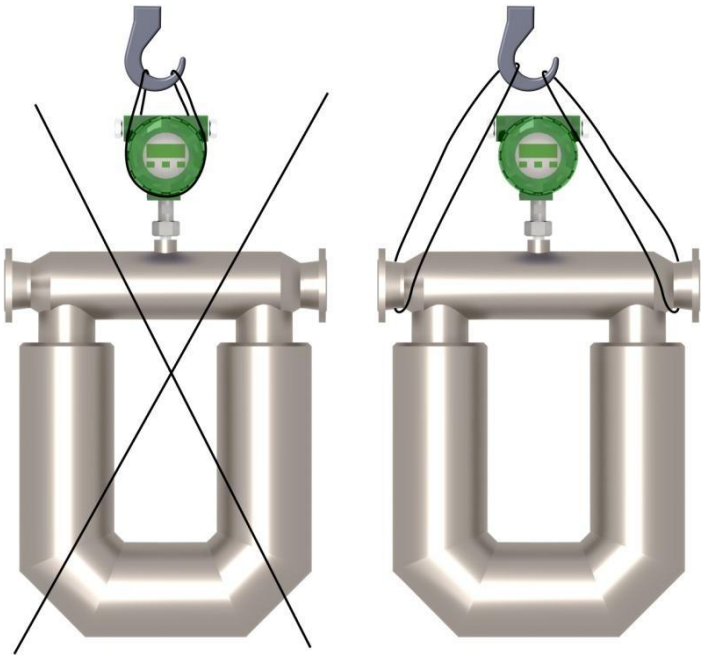


Figure 3.1 Flowmeter Transport and lifting requirements.

3.2 Storage

Flowmeters can be stored in unheated rooms with air temperature of -20 to +70 °C and relative humidity up to 95% (non-condensing at 25 °C).

Flowmeters can be stored in transport boxes stacking up to 3 boxes in height. For long-term storage it is recommended to use the manufacturer's package.

3.3 Recycling

Flowmeters are free of harmful substances and components that are hazardous to human health and the environment during and after the life of the flowmeter.

Recycling of the flowmeter can be performed separately for groups of materials: plastic parts, metal and fastening parts.

Appendix A

Outline dimensions and weight

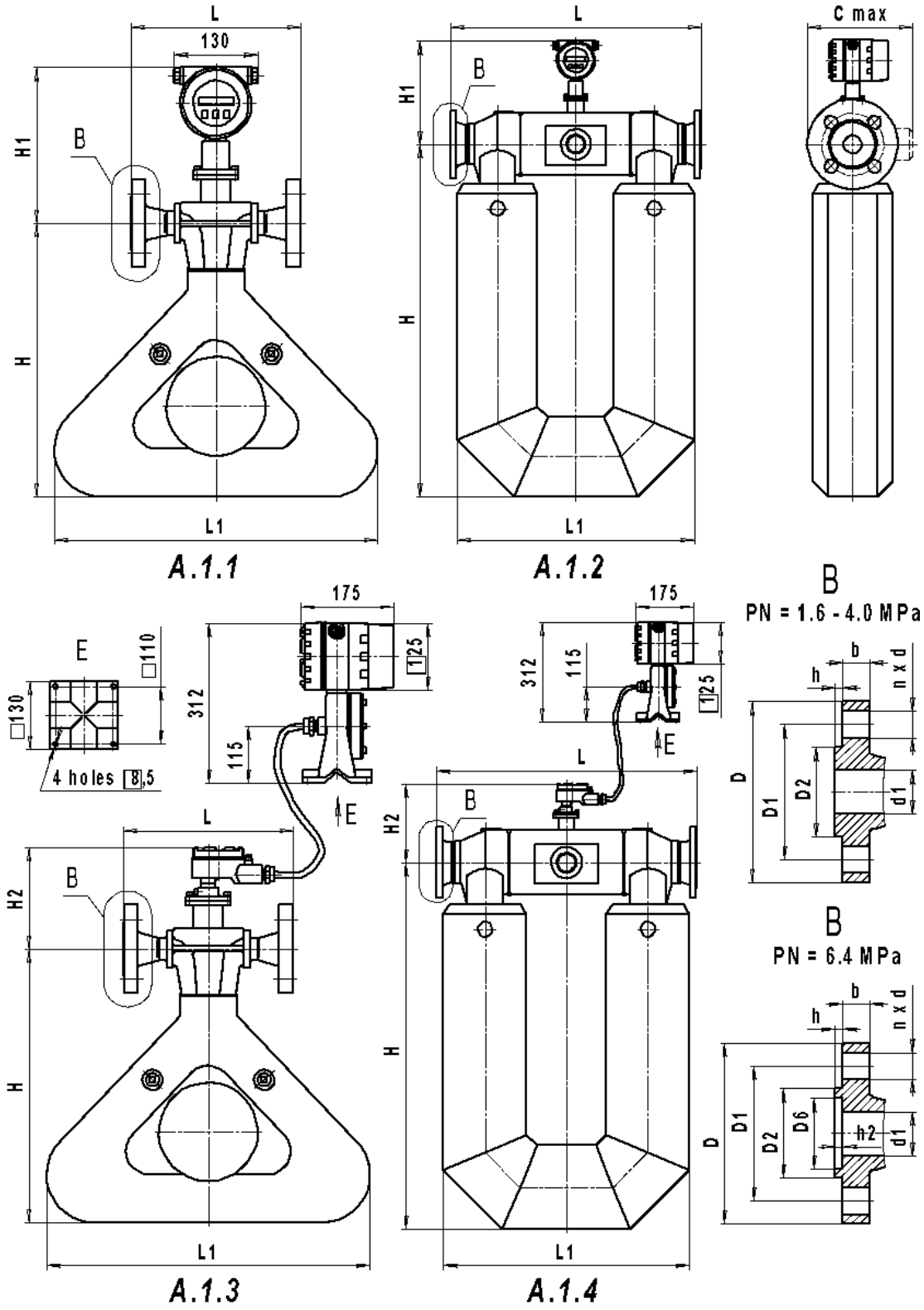


Figure A.1 **Outline dimensions(T and U type sensor)**

Integral type – Figure A.1.1., A.1.2
Remote type – Figure A.1.3, A.1.4

Table A.1 – Outline dimensions and weight

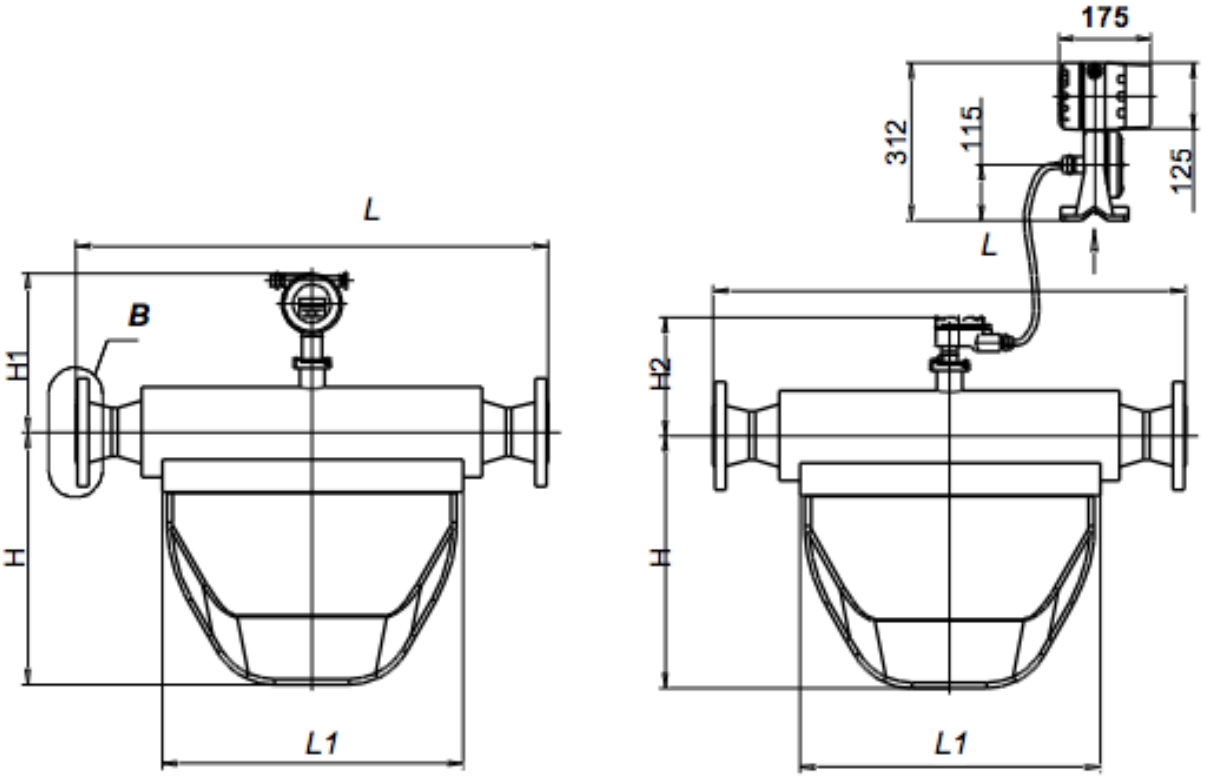
Process connection size	Figure	L, mm	L, in	L, mm	L, in	L1, mm	L1,in	H,mm	H, in	H1, mm	H1, in	H2, mm	H2, in	C max, mm *	C max, in *	Weight Kg	Weight lb	Weight Kg	Weight lb
		1.6-4.0 MPa		6.4 MPa												A.1.1, A.1.2		A.1. 3, A.1.4	
3/8 inch	A.1.1; A.1.3	150	5.91	170	6.69	350	13.78	290	11.42	260	10.24	190	7.48	95	3.74	11	24.3	14	30.9
1/2 inch	A.1.1; A.1.3	180	7.09	194	7.64	350	13.78	300	11.81	260	10.24	190	7.48	95	3.74	11	24.3	14	30.9
1 inch	A.1.1; A.1.3	200	7.87	248	9.76	450	17.72	420	16.54	280	11.02	210	8.27	115	4.53	15	33.1	18	39.7
1 1/2 inch	A.1.2; A.1.4	520	20.47	547	21.54	470	18.50	660	25.98	280	11.02	210	8.27	150	5.91	30	66.2	33	72.8
2 inch	A.1.2; A.1.4	558	21.97	588	23.15	550	21.65	730	28.74	290	11.42	220	8.66	165	6.50	35	77.2	38	83.8
3 inch	A.1.2; A.1.4	780	30.71	808	31.81	710	27.95	1040	40.94	320	12.60	250	9.84	205	8.07	80	176.4	83	183.0
4 inch	A.1.2; A.1.4	920	36.22	948	37.32	860	33.86	1140	44.88	350	13.78	280	11.02	416	16.38	185	407.9	188	414.5
6 inch	A.1.2; A.1.4	1100	43.31	1140	44.88	1050	41.34	1520	59.84	380	14.96	310	12.20	440	17.32	320	705.6	323	712.2
8 inch	A.1.2; A.1.4	1364	53.70	1410	55.51	1160	45.67	1655	65.16	420	16.54	350	13.78	535	21.06	625	1378.1	628	1384.7

* *CmaxOverall width of the body, excluding transmitter Spreadsheet link*

Table A.2 – Flowmeter flange dimensions

Process connection size	PN,MPa	d1		D6		D2		D1		D		b		h		h2		n	d	
		mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in		mm	in
3/8 inch, DN10	1.6; 2.5; 4	10.0	0.39	NA		40.0	1.57	60.0	2.36	90	3.54	12.0	0.47	2.0	0.08	NA		4.00	14.0	0.55
	6.4	8.0	0.31	35	1.38	41.0	1.61	70.0	2.76	100	3.94	16.0	0.63	4.0	0.16	3.0	0.12	4.00	14.0	0.55
1/2 inch, DN 15	1.6; 2.5; 4	15.0	0.59	NA		46.0	1.81	65.0	2.56	95	3.74	12.0	0.47	2.0	0.08	NA		4.00	14.0	0.55
	6.4	11.6	0.46	40	1.57	46.0	1.81	75.0	2.95	105	4.13	16.0	0.63	4.0	0.16	3.0	0.12	4.00	14.0	0.55
1 inch, DN 25	1.6; 2.5; 4	27.3	1.07	NA		65.0	2.56	85.0	3.35	115	4.53	13.0	0.51	3.0	0.12	NA		4.00	14.0	0.55
	6.4	24.8	0.98	58	2.28	65.0	2.56	100.0	3.94	140	5.51	20.0	0.79	4.0	0.16	3.0	0.12	4.00	18.0	0.71
1 1/2 inch, DN40	1.6; 2.5; 4	41.1	1.62	NA		85.0	3.35	110.0	4.33	150	5.91	15.0	0.59	3.0	0.12	NA		4.00	18.0	0.71
	6.4	37.0	1.46	76	2.99	84.0	3.31	125.0	4.92	170	6.69	22.0	0.87	4.0	0.16	3.0	0.12	4.00	22.0	0.87
2 inch, DN 50	1.6; 2.5; 4	52.3	2.06	NA		99.0	3.90	125.0	4.92	165	6.50	18.0	0.71	2.0	0.08	NA		4.00	18.0	0.71
	6.4	47.0	1.85	88	3.46	99.0	3.90	135.0	5.31	180	7.09	22.0	0.87	4.0	0.16	3.0	0.12	4.00	22.0	0.87
3 inch, DN80	1.6; 2.5; 4	79.5	3.13	NA		132.0	5.20	160.0	6.30	200	7.87	20.0	0.79	2.0	0.08	NA		8.00	18.0	0.71
	6.4	77.0	3.03	121	4.76	132.0	5.20	170.0	6.69	215	8.46	24.0	0.94	4.0	0.16	3.0	0.12	8.00	22.0	0.87
4 inch, DN100	1.6; 2.5; 4	101.7	4.00	NA		156.0	6.14	190.0	7.48	235	9.25	21.0	0.83	3.0	0.12	NA		8.00	22.0	0.87
	6.4	94.0	3.70	150	5.91	156.0	6.14	200.0	7.87	250	9.84	25.5	1.00	4.5	0.18	3.5	0.14	8.00	26.0	1.02
6 inch, DN150	1.6; 2.5; 4	154.0	6.06	NA		211.0	8.31	250.0	9.84	300	11.81	26.0	1.02	2.0	0.08	NA		8.00	26.0	1.02
	6.4	142.0	5.59	204	8.03	211.0	8.31	280.0	11.02	345	13.58	31.5	1.24	4.5	0.18	3.5	0.14	8.00	33.0	1.30
8 inch, DN200	1.6; 2.5; 4	200.0	7.87	NA		285.0	11.22	320.0	12.60	375	14.76	35.0	1.38	3.0	0.12	NA		12.00	30.0	1.18
	6.4	198.0	7.80	260	10.24	284.0	11.18	345.0	13.58	415	16.34	37.5	1.48	4.5	0.18	3.5	0.14	12.00	36.0	1.42

* *CmaxOverall width of the body, excluding transmitter*



A.2.1 **A.2.2**

Figure A.2 Outline dimensions(M type sensor)

Integral type – Figure A.2.1
Remote type – Figure A.2.2

Table A.3 – *Outline dimensions and weight*

Process connection size	*Figure*	L for 1.6-4.0MPa		L for 6.4MPa		*L1*		*H*		*H1*		*H2*		*Cmax,**		*Weight, kg*	
		mm	*in*	*mm*	*in*	*mm*	*in*	*mm*	*in*	*mm*	*in*	*mm*	*in*	*mm*	*in*	*A.2.1*	*A.2.2*
DN10,3/8 inch	*A.2*	*360*	*14.17*	*374*	*14.72*	*240*	*9.45*	*180*	*7.09*	*290*	*11.42*	*220*	*8.66*	*95*	*3.74*	*11*	*14*
DN15,1/2 inch	*A.2*	*400*	*15.75*	*414*	*16.30*	*280*	*11.02*	*184*	*7.24*	*290*	*11.42*	*220*	*8.66*	*115*	*4.53*	*15*	*18*
DN25,1 inch	*A.2*	*500*	*19.69*	*536*	*21.10*	*360*	*14.17*	*250*	*9.84*	*300*	*11.81*	*230*	*9.06*	*150*	*5.91*	*30*	*33*
DN40,1 1/2 inch	*A.2*	*600*	*23.62*	*634*	*24.96*	*460*	*18.11*	*300*	*11.81*	*310*	*12.20*	*240*	*9.45*	*165*	*6.50*	*35*	*38*
DN50,2 inch	*A.2*	*800*	*31.50*	*828*	*32.60*	*640*	*25.20*	*410*	*16.14*	*320*	*12.60*	*250*	*9.84*	*205*	*8.07*	*80*	*83*
DN80,3 inch	*A.2*	*900*	*35.43*	*928*	*36.54*	*700*	*27.56*	*490*	*19.29*	*350*	*13.78*	*280*	*11.02*	*416*	*16.38*	*185*	*188*
DN100,4 inch	*A.2*	*1130*	*44.49*	*1156*	*45.51*	*860*	*33.86*	*660*	*25.98*	*370*	*14.57*	*290*	*11.42*	*440*	*17.32*	*320*	*323*
DN150,6 inch	*A.2*	*1410*	*55.51*	*1450*	*57.09*	*1200*	*47.24*	*900*	*35.43*	*400*	*15.75*	*330*	*12.99*	*535*	*21.06*	*625*	*628*
DN200,8 inch	*A2*	*1800*	*70.87*	*1844*	*72.60*	*1450*	*57.09*	*1170*	*46.06*	*420*	*16.54*	*350*	*13.78*	*580*	*22.83*	*820*	*823*

* *CmaxOverall width of the body, excluding transmitter*

Flange connection

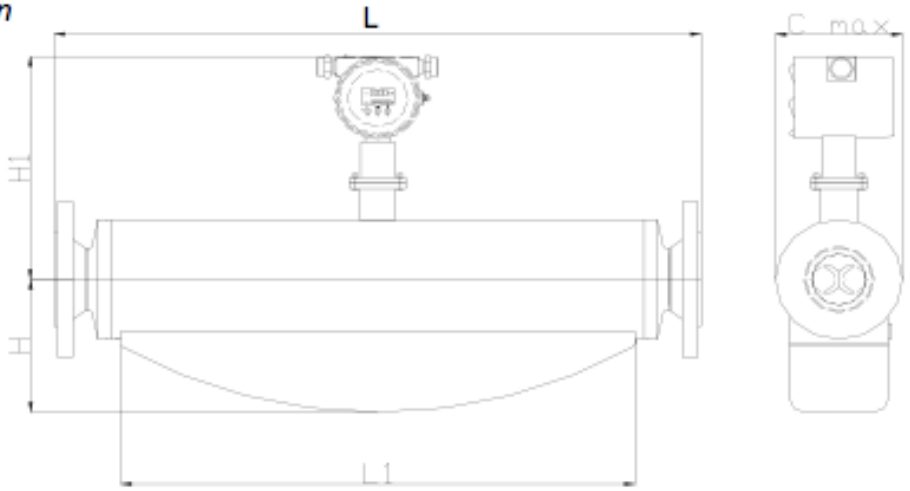


Figure A.3 Outline dimensions (S type sensor)

Process connection size	Figure	1.6-4.0MPa		6.4MPa		L1,mm		H,mm		H1,mm		Cmax *		Weight, kg	
		L, mm	l, in	L, mm	L, in	mm	in	mm	in	mm	in	mm	in	Kg	Lb
2 inch DN50	A.3	800	31.50	834	32.83	620	24.41	200	7.87	320	12.60	205	8.07	30	13.6
3 inch, DN80	A.3	935	36.81	973	38.31	730	28.74	200	7.87	350	13.78	416	16.38	60	27.2
4inch, DN 100	A.3	1130	44.49	1182	46.54	870	34.25	275	10.83	370	14.57	550	21.65	90	40.8

* *CmaxOverall width of the body, excluding transmitter*

Tri-Clamp Connection

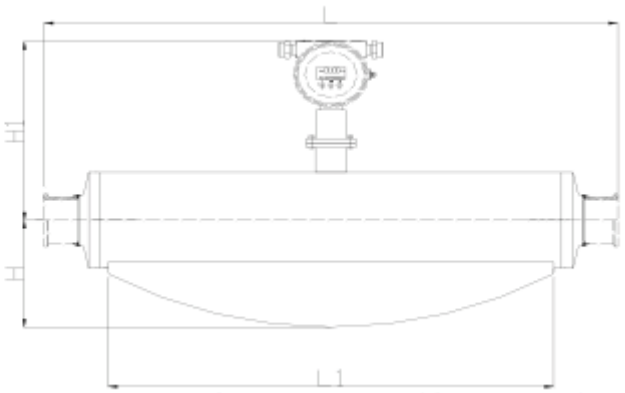


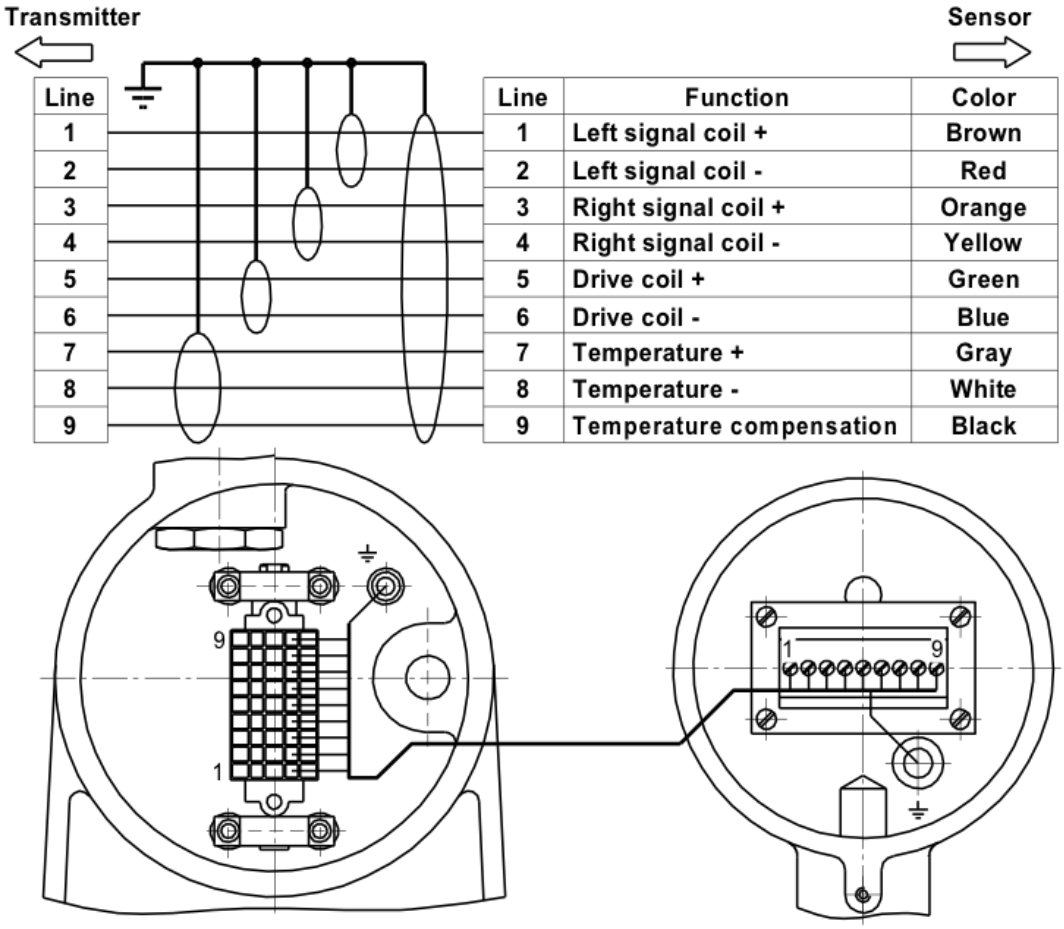
Figure A.4 Outline dimensions(S type sensor)

Process connection size	Figure	1.6-4.0MPa		6.4MPa		L1,mm		H,mm		H1,mm		Cmax *		Weight, kg	
		L, mm	l, in	L, mm	L, in	mm	in	mm	in	mm	in	mm	in	Kg	Lb
2 inch DN50	A.4	800	31.50	834	32.83	620	24.41	200	7.87	320	12.60	205	8.07	30	13.6
3 inch, DN80	A.4	935	36.81	973	38.31	730	28.74	200	7.87	350	13.78	416	16.38	60	27.2
4inch, DN 100	A.4	1130	44.49	1182	46.54	870	34.25	275	10.83	370	14.57	550	21.65	90	40.8

* *CmaxOverall width of the body, excluding transmitter*

Appendix B

Wiring diagrams



Line	Function	Color
1	Left signal coil +	Brown
2	Left signal coil -	Red
3	Right signal coil +	Orange
4	Right signal coil -	Yellow
5	Drive coil +	Green
6	Drive coil -	Blue
7	Temperature +	Gray
8	Temperature -	White
9	Temperature compensation	Black

Figure C.1 – Separate type transmitter wiring box connection

Table B1 wiring color demonstration

Line	Function	Color
1	Left signal coil +	Brown
2	Left signal coil -	Red
3	Right signal coil +	Orange
4	Right signal coil -	Yellow
5	Drive coil +	Green
6	Drive coil -	Blue
7	Temperature +	Gray

8	Temperature -	White
9	Temperature compensation	Black

Wiring Side.

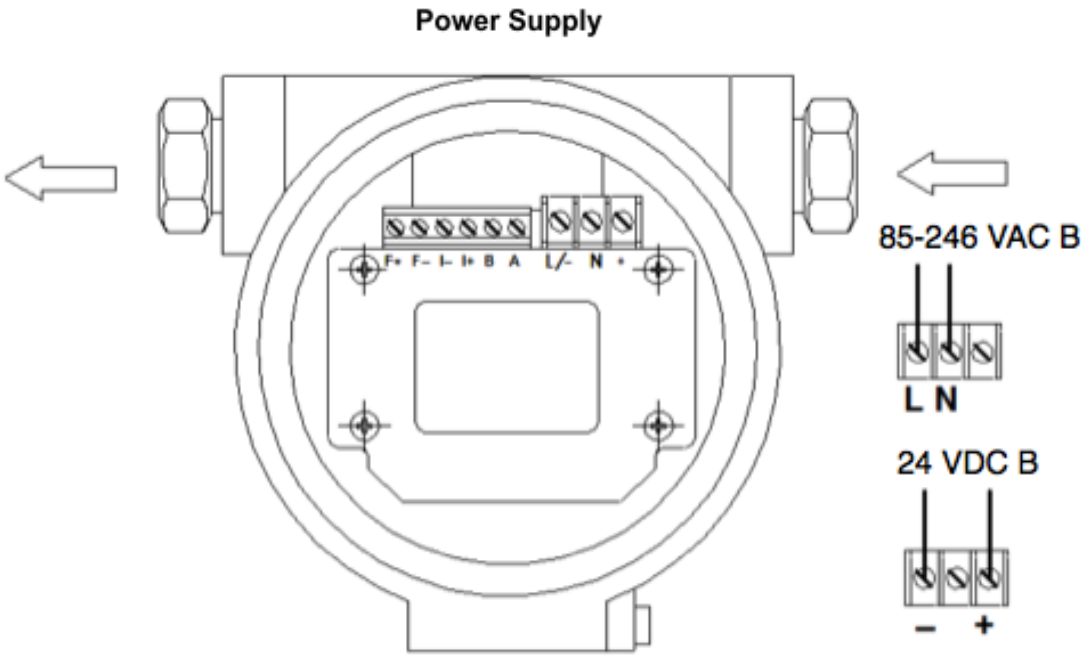


Figure C.2 – Power supply connection

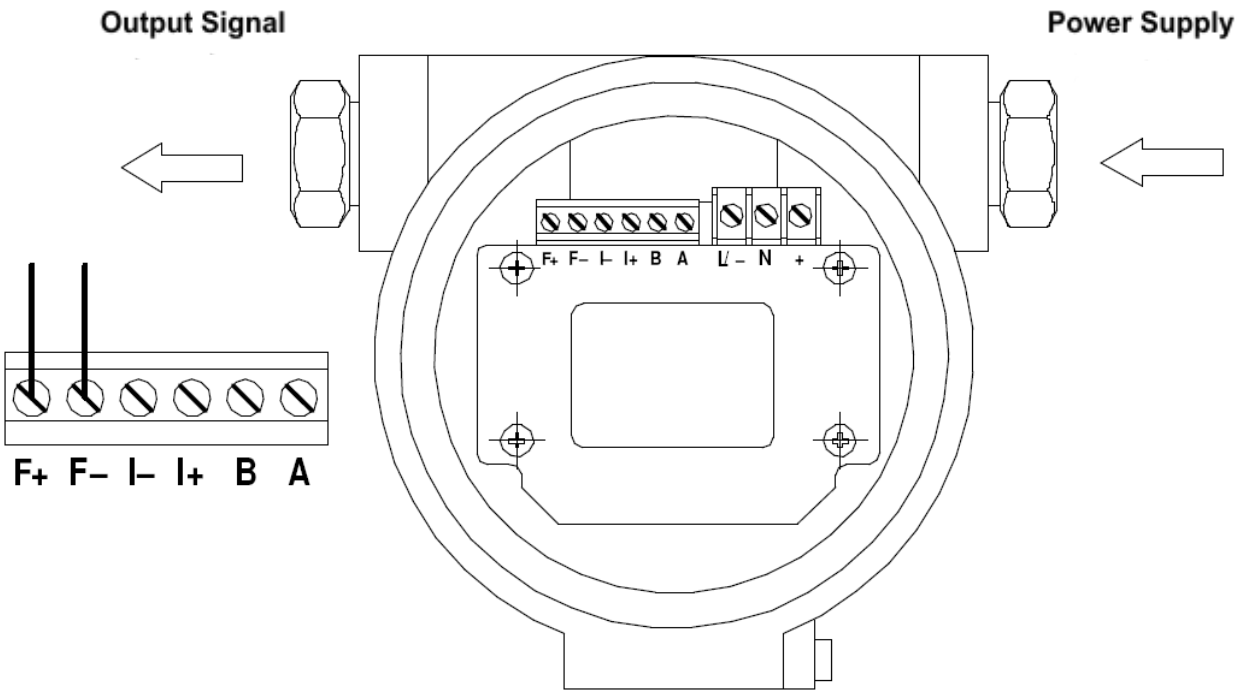


Figure C.3 – Pulse output connection

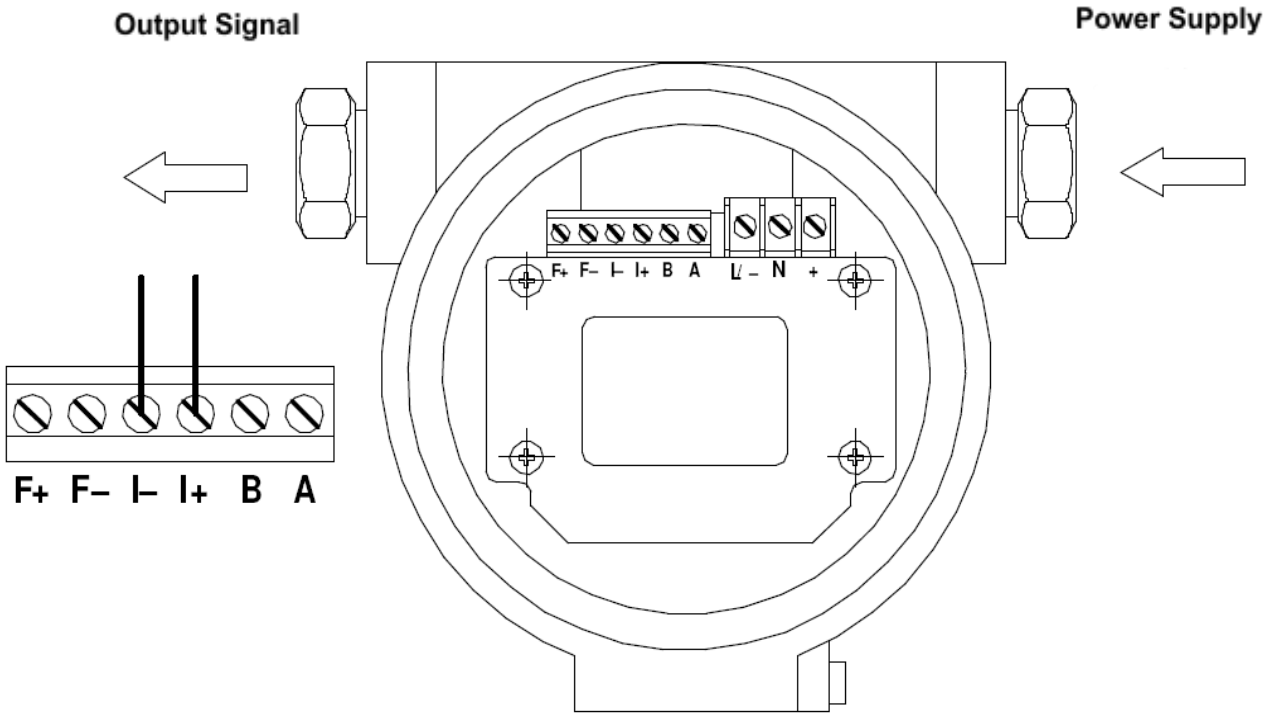


Figure C.4 – 4-20mA and HART communication output connection. The 4-20 is ACTIVE

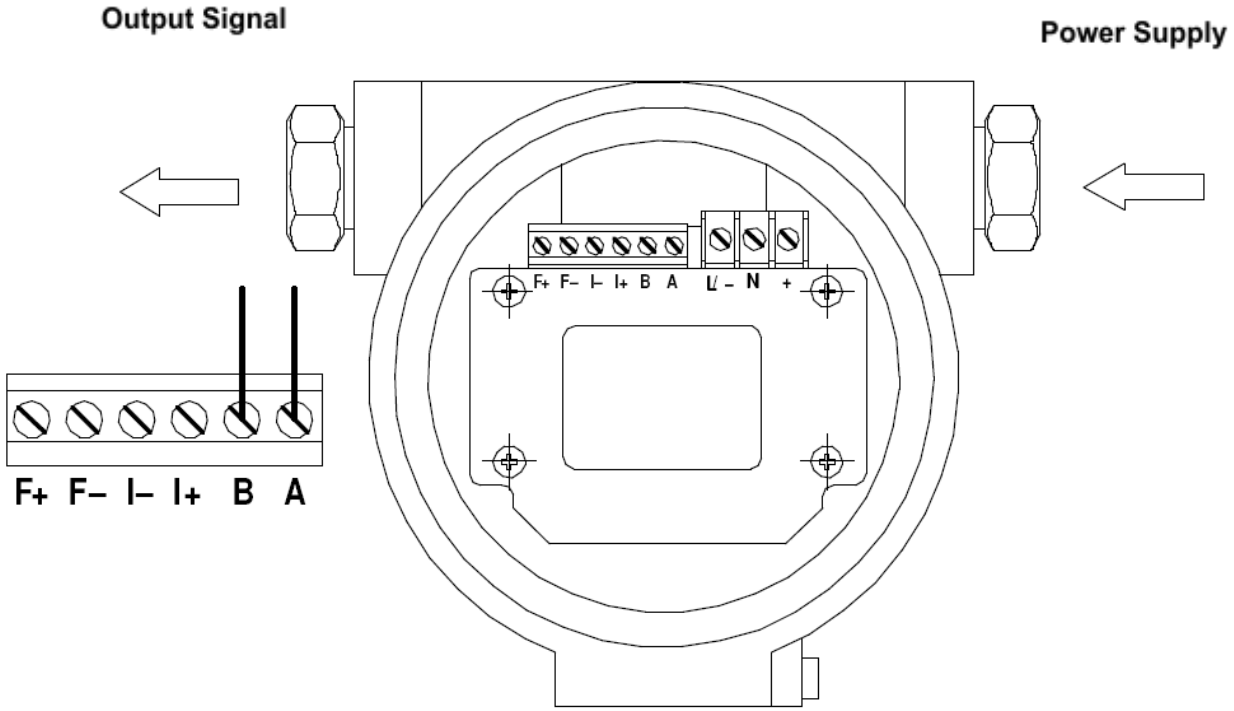


Figure C.5 – Digital output connection

5. Power Supply and Signal output Wiring

5.1. Power wiring

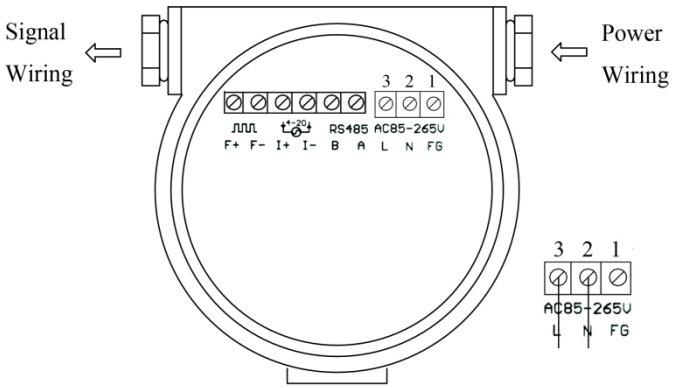
5.1.1 The basic requirement:

The transmitter can be connected either 85-265 VAC or to 24 VDC power. Be sure to check the label for your power requirement. Assume the power is 24 VDC for safety.

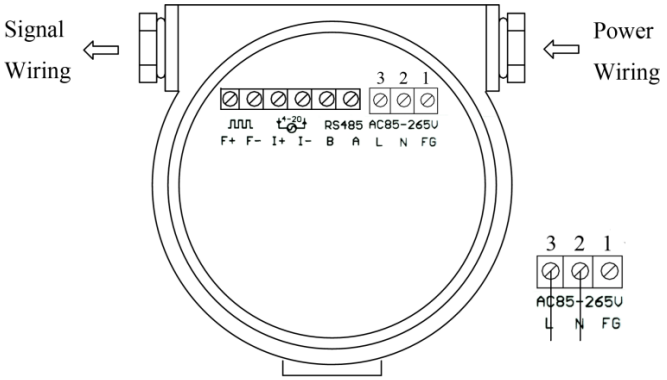
AC (85 to 265) VAC	Power: Normal 10 W, MAX 15W
DC (18 to 30) VDC	Power: Normal 10 W, MAX 15W

5.1.2 Power Cable

The power cable should use 2 conductor cables and the area of each conductor must be > 20 Ga or 0.8 square millimeter. For 85-265VAC, the length of the power cable should be ≤ 1000 ft, 300m, for DC24V, the length of the power cable must be ≤ 300 ft, 100m.



AC Power Wiring for DSP transmitter



DC Power Wiring for DSP transmitter

5.2 4-20mA output wiring

5.2.1 4~20mA output can be configured to mass flow or volume flow.

5.2.2 The cable should be 2 conductor cable and the area of each conductor should be > 24 Ga or 0.5 square millimeter.

Current Output default is an ACTIVE (Sourced or 4 wire) 4-20mA output!

Do NOT apply 24 VDC to the I+ or I- terminals

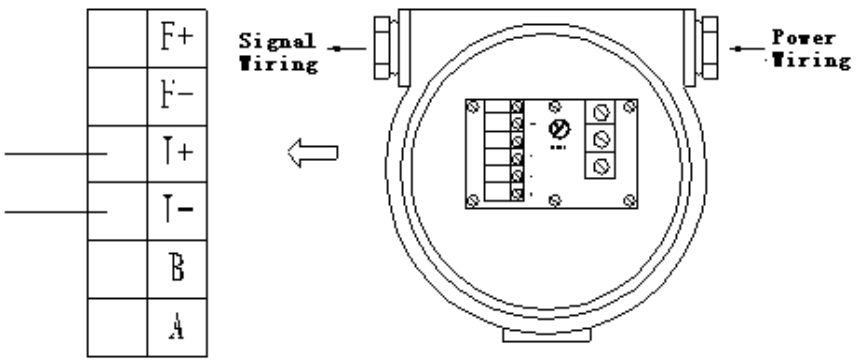


Figure 5.2

5.2.3 4~20mA current output terminal block.

I+ is the current input of the Mass Flowmeter;
I- is the current output of the Mass Flowmeter;

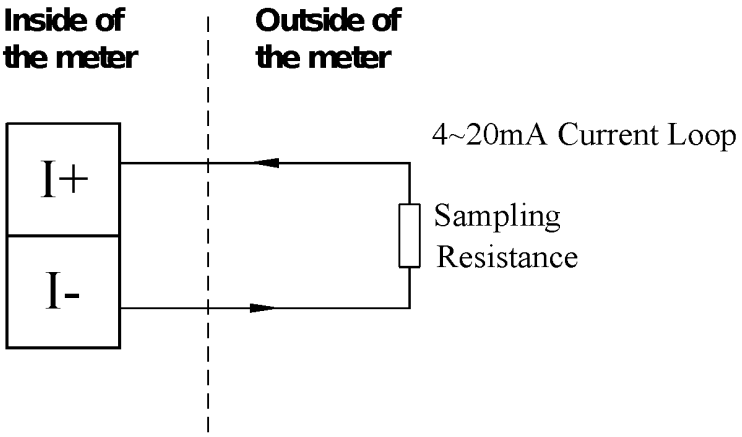
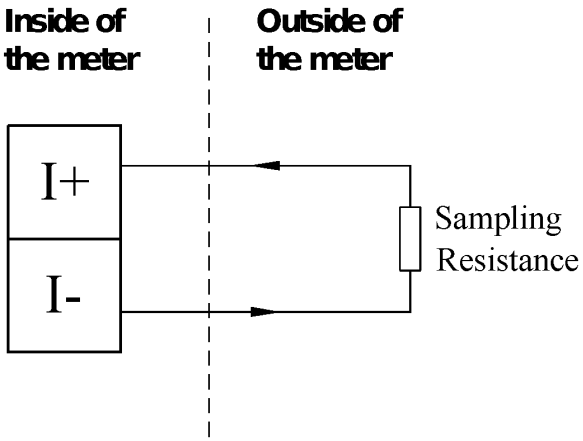


Figure 5.3

5.2.4 Active Output (DEFAULT) and Passive Output

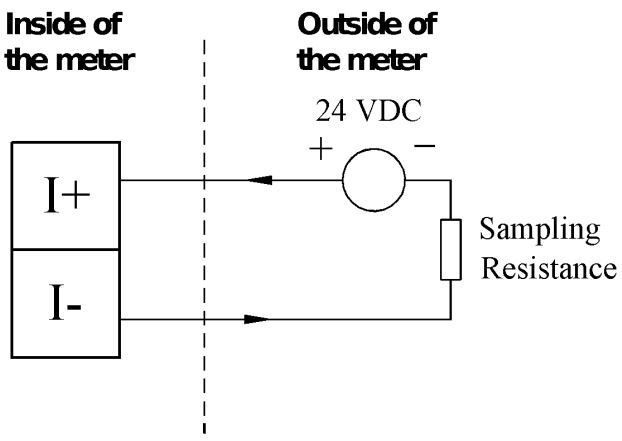
Active Output is that the current output is powered by the Mass Flowmeter. Only the sampling resistance is needed while measuring the current output signal, such as that of the internal resistor of a Fluke DMM in the Current Measuring mode.



This mode is where you can attach a Fluke Meter in the DC mA mode with the red wire on the current side and the meter provides the power to drive the current output. The Sampling resistance, in one example could be 250 Ohms and a DVM could be placed across the resistor to read 1-5 VDC for 4-20 mA signal generated by the meter.This means do NOT apply 24 VDC to either terminal. Doing so will void the warranty.

Figure 5.4

OPTIONALLY, Passive 4-20 mA output is available where the PLC supplies the 24VDC to get the current output from the mass flowmeter. The illustration is shown in Figure 5.5



This mode is very common in PLC's and the power is provided by YOUR system, the PLC and the PLC has an internal resistance to "pick off" the current either by directly measuring the current or dropping it across a resistor, such as a 250 Ohm resistor and converts the 4-20 mA to a 1-5 VDC signal. THIS IS NOT THE DEFAULT MODE.. DO NOT USE THIS WIRING UNLESS section 5.2.5 is used

Figure 5.5

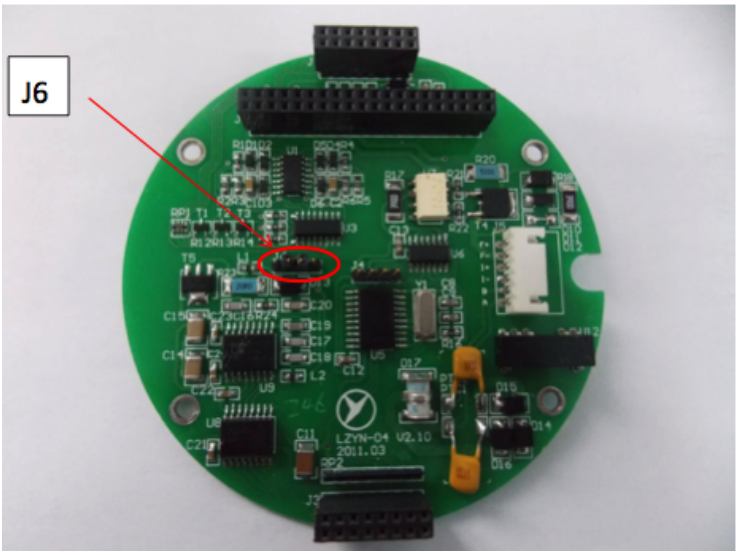
5.2.5 The Switch between Passive Output and Active Output (Default is Active)

The switch between passive current output and active current output is accomplished by configuring the 4 jumpers on J6 on the output board, see Figure 5.6, under the display board.

If PASSIVE mode is required, note that switching to this mode is ZERO fun and can harm the electronics if not done in a proper environment by a skilled individual.

The board detailed below is under the Display board and requires dismantling of the electronics. The Display has 4 phillips head screws that can be removed to allow pulling the two 16 pin connectors at J-1 and J-3 to expose the board shown below. Simply move the jumpers to the desired position to attain the mode you seek. Below we show the **DEFAULT** Active mode, where the meter provides the 24 VDC power for the 4-20 output. Be extremely careful to seat both J-1 and J-3 of the display board to the output board properly so all 16 pins are properly aligned.

The Default ACTIVE mode is shown below:



Extreme caution must be used if you wish to change the 4-20 mA output mode. Use proper static handling procedures to ensure the circuitry is protected and the power must be disconnected. Incorrect circuit handling procedures may lead to a failure and is not covered under warranty. The meter is supplied from the factory with an active output configuration (Shown in this photo) where a Fluke meter can be used to measure the current directly.

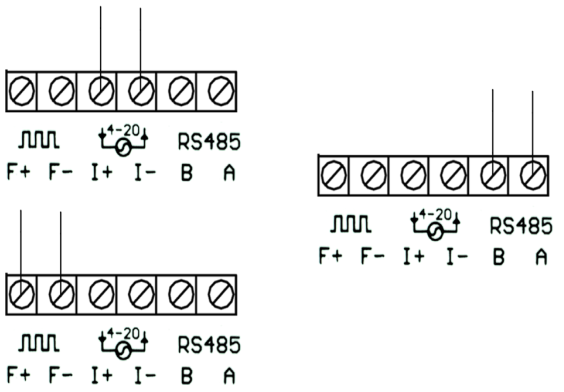
Figure 5.6

active current output:  That is to set J6 as 	The **DEFAULT** Active current output is where a 4-20mA signal is directly output from the positive and negative terminal blocks, forming a signal circuit with the signal collecting device. The 4-20 mA output in this mode can be measured with a Fluke Meter on the mA DC mode with the red wire in the current connection. The flow meter provides the power to drive the 4-20 mA output. This can be called a 4 wire, Active or Sourced 4-20 **DO NOT APPLY 24 VDC to the terminals.**
passive current output:  That is to set J6 as 	**OPTIONALLY,** you may use the Passive current output mode, where you provide the power supply circuit and is typical of many PLC's. This is also called a 2 Wire, but because the meter takes more than 4 mA to run it is actually a 4-wire and is also called Source. Only 1 jumper is required for this mode. Secure the second jumper on just one of the pins for future use, or discard.

5.3 Pulse output wiring

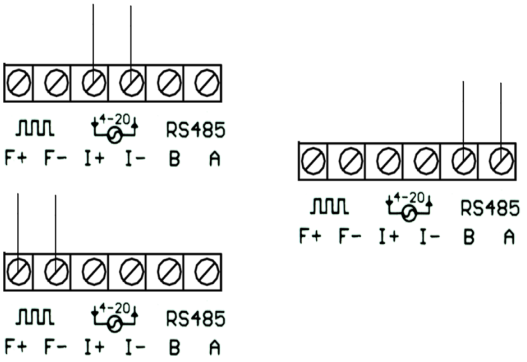
5.3.1 Active pulse output can be configured to mass flow or volume flow or density. The output cable should be 2-conductor cable and the area of each conductor is > 24 Ga of 0.5 square millimeter.

5.3.2 The length of the output line should be ≤ 500 ft or 150 meters.



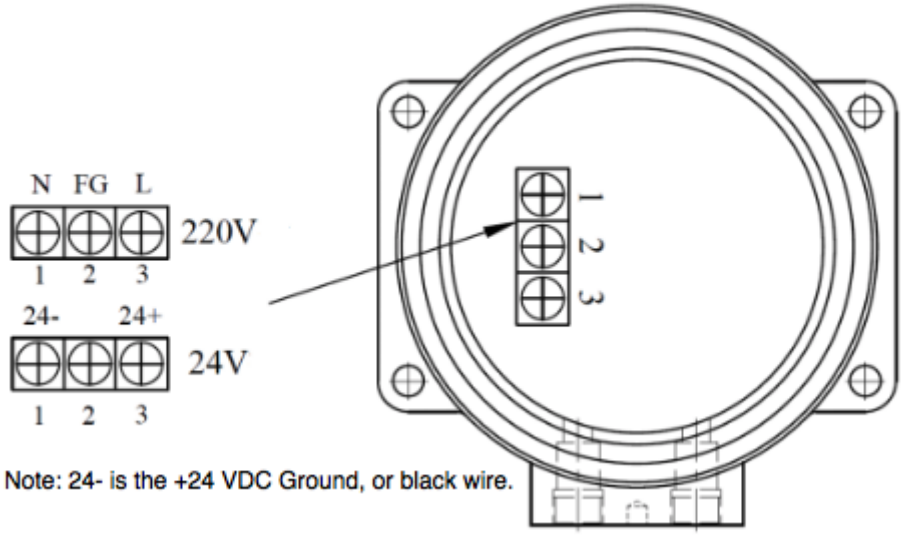
5.4 RS485 output wiring

RS485 output supports the MODBUS RTU protocol. The length of the output line should be ≤ 1000 ft or 300 meters. There are two protocols. One is our factory protocol and another is a ProLink III Compatible register set that will allow the use of the flow meter on the MicroMotion ProLink III software program. ProLink III and Micromotion are copyrighted names owned by Micromotion.



5.5 Amplifier wiring

For flow meter sizes over 100mm (4’’), an additional power supply is required for the amplifier, which is the same power type as the sensor. The power may be (85-260)VAC or (18-36 VDC). Double check the power type in the nameplate on the sensor. For 85-260 VAC, the length of the power cable should be ≤ 1000 ft, 300m, for 24VDC meters, the length of the power cable should be ≤ 300 ft,100m, and use 2-conductor cable where the area of each core > 20 Ga or 0.8 square millimeter.



APPENDIX C

ModBus Coriolis V 2.25

Communication Mode: Modbus-RTU.

Communication Interface:

Interface Mode : RS485, asynchronization, half-duplex

Data format : 1 start bit, 8 data bits, no parity bit & 1 or 2 stop bits (or 1 Odd Parity or Even Parity , 1 stop bit)

Default : 9600, 8, N, 1

Baud rate : 9600bps(Default), 4800bps, 2400bps and 1200bps for option.

Max. length of data frame: 1 byte address+253 byte data+2byte CRC=256 Bytes

FC 01 Frame structure

Function code 01: Read coils

Request

Address	Function Code	Start address		Quantity of coils		CRC	
	01H						

Response

Address	Function Code	Byte count	Coil status	CRC	
	01H				

Error

Address	Function Code	Error code	CRC	
	81H			

Example

Request (Read coil Reverse Flow Direction Total Mode)

Address	Function Code	Start address		Quantity of coils		CRC	
01H	01H	00H	08H	00H	01H	7CH	08H

Response

Address	Function Code	Byte count	Coil status	CRC	
01H	01H	01H	00H	51H	88H

Error

Address	Function Code	Error code	CRC	
01H	81H	01H	81H	90H

Exception Code:

01H : Function code is not supported
02H : IIncorrect Starting Address or Starting Address Number of Registers
03H : Number of Outputs is not between 1-2000
04H : Failed to read discrete outputs

FC 05 Frame structure

Function code 05: Write single coil

Request

Address	Function Code	Output address		Output value		CRC	
	05H						

Response

Address	Function Code	Output address		Output value		CRC	
	05H						

Error

Address	Function Code	Error code	CRC	
	85H			

Example

Request (Reset totalizer)

Address	Function Code	Output address		Output value		CRC	
01H	05H	00H	02H	FFH	00H	2DH	FAH

Response

Address	Function Code	Output address		Output value		CRC	
01H	05H	00H	02H	FFH	00H	2DH	FAH

Error

Address	Function Code	Error code	CRC	
01H	85H	01H	83H	50H

Exception Code:

01H : Function code is not supported
02H : Output Address is not supported
03H : Output values are not 0x0000 or 0xFF00
04H : Fail to write single output

FC 04 Frame structure

Function code 04: Read register

Request

Address	Function Code	Starting address		Quantity of Registers		CRC	
	04H						

Response

Address	Function Code	Byte count	Input Register		CRC	
	04H					

Error

Address	Function Code	Error code	CRC	
	84H			

Example

Request (Read mass flowrate, 0.1234567 kg/s)

Address	Function Code	Start address		Quantity of Registers		CRC	
01H	04H	00H	A7H	00H	02H	C0H	28H

Response

Address	Function Code	Byte count	Input Register				CRC	
01H	04H	04H	3DH	FCH	D6H	DEH	E8H	20H

Error

Address	Function Code	Error code	CRC	
01H	84H	01H	82H	C0H

Exception Code:

01H : Function code is not supported
02H : Incorrect Starting Address or Starting Address Number of Registers
03H : Number of outputs is not between 0-125.
04H : Failed to read input registers

FC 06 Frame structure

Function code 06: Write single register

Request

Address	Function Code	Register address		Register Value		CRC	
	06H						

Response

Address	Function Code	Register address		Register Value		CRC	
	06H						

Error

Address	Function Code	Error code	CRC	
	86H			

Example

Request (Write mass unit, kg)

Address	Function Code	Register address		New register content		CRC	
01H	06H	00H	15H	00H	01H	59H	CEH

Response

Address	Function Code	Register address		New register content		CRC	
01H	06H	00H	15H	00H	01H	59H	CEH

Error

Address	Function Code	Error code	CRC	
01H	86H	01H	83H	A0H

Exception Code:

01H : Function code not supported
02H : Illegal Register Address
03H : Register value is not between 0-65535.
04H : Failed to write single register

FC 08 Frame structure

Function code 8: Diagnostics, only support sub-function code 00

Request

Address	Function Code	Sub-function code		Data		CRC	
	08H	00H	00H	xxH	xxH		

Response

Address	Function Code	Sub-function code		Data		CRC	
	08H	00H	00H	xxH	xxH		

Error

Address	Function Code	Error code	CRC	
	88H			

Example

Request

Address	Function Code	Sub-function code		Data		CRC	
01H	08H	00H	00H	A5H	37H	DAH	8DH

Response

Address	Function Code	Sub-function code		Data		CRC	
01H	08H	00H	00H	A5H	37H	DAH	8DH

Error

Address	Function Code	Error code	CRC	
01H	88H	01H	87H	C0H

Exception Code:

01H : Function code or sub-function is not supported
03H : Wrong Data Value.
04H : Failed to execute.

FC 16 Frame structure

Function code 16: Write Multiple Register

Request

Address	Function Code	Starting address		Quantity of Registers		Byte count	Register value				CRC	
	10H			00H	02H	04H						

Response

Address	Function Code	Starting address		Quantity of Registers		CRC	
	10H			00H	02H		

Error

Address	Function Code	Error code	CRC	
	90H			

Example

Request (Write flow calibration factor, 1100.0 g/s/us)

Address	Function Code	Start register address		Quantity of Registers		Data byte count	New register content				CRC	
01H	10H	00H	63H	00H	02H	04H	44H	89H	80H	00H	11H	48H

Response

Address	Function Code	Start register address		Quantity of Registers		CRC	
01H	10H	00H	63H	00H	02H	B1H	D6H

Error

Address	Function Code	Error code	CRC	
01H	90H	01H	8DH	C0H

Exception Code:

01H : Function code is not supported
02H : Incorrect Starting Address or Starting Address Number of Registers
03H : Illegal Data Value:
Registers not between 1-123 or Bytes ≠Number of registers *2.
04H : Failed to write multiple registers

FC 17 Frame structure

Function code 17: Report Slave ID

Request

Address	Function Code	CRC	
	11H		

Response

Address	Function Code	Byte count	Slave ID	Run Indicator Status	Software Version				CRC	
	11H	06H	A0H	FFH						

Error

Address	Function Code	Error code	CRC	
	91H			

Example

Request (Read SlaveID, software version 1.45)

Address	Function Code	CRC	
01H	11H	C0H	2CH

Response

Address	Function Code	Byte count	Slave ID	Run Indicator Status	Software Version				CRC	
01H	11H	06H	A0H	FFH	00H	01H	04H	05H	3EH	17H

Error

Address	Function Code	Error code	CRC	
01H	91H	01H	8CH	50H

Exception Code:

01H : Function code or sub-function is not supported

04H : Failed to report Slave ID

Data Format

Address: 1 byte, from 0x01H to 0xFDH, max 253

Note: Use Address 0x00H (0 Decimal) to broadcast.

Function code: 1 byte, only the following codes are legal:

Function code 01: Read coil
Function code 04: Read register
Function code 05: Write single coil
Function code 06: Write single register
Function code 08: Diagnostics, only supports sub-function code 00
Function code 16: Write multiple registers
Function code 17: Report Slave ID

Register address: 2 bytes, 16 bit integer with high bytes first

The addresses of MODBUS mapping are decimal with starting address 1. Note and address 127 is 0x007EH (126 decimal)

Coil: Read, 1 = ON, 0 = OFF

Write, 0xFF00 = ON and 0x0000 = OFF

16-bit Integer register: 2 bytes, 16 bits integer with high bytes first

Floating point registers: 4 bytes, single precision IEEE754 floating-point and high bytes first. For example, floating-point of -1.5(0xBF 0xC0 0x00 0x00) will report as 0xBF 0xC0 0x00 0x00

from low address to high address for memory.

CRC：2 bytes, from the start address to the end of data, low bytes first. In RTU mode, messages start with a silent interval of at least 3.5 character intervals.
Frame start: the first received byte after transmission time of 3.5 time intervals is the address.
Errors: Function code 0x80H + 0x01H
Exception code, 01 or 02 or 03 or 04.

MODBUS RTU mapping

Coil		Function：Read 01；Write 05	
0001	WO	Output emulation	
		1	Output emulation
0003	WO	Reset totalizer	
		1	Reset totalizer
0005	WO	Initiate zero calibration	
		1	Zero calibration
0009	RW	Reserved	
		Read	Return 0
		Write	Return Error Code 4
0011	RW	Oil-Water Analysis Switch (Water Cut modes)	
		0	OFF
		1	ON
0013	RW	Mass flowrate Multipoint Correction	
		0	OFF
		1	ON
0027	RW	Oil-Water Gas Compensation Switch	
		0	OFF
		1	ON
16-bit Integer register		Function：Read 04；Write 06	
0012	RW	Current output variable code	
		0	Mass flowrate
		1	Volume flowrate
		2	Density
0013	RW	MODBUS Baud rate code	
		0	9600bps
		1	4800bps
		2	2400bps
		3	1200bps
0014	RW	Pulse output variable code	
		0	Mass flowrate
		1	Volume flowrate
		2	Density
0015	RW	Zero correction	
0016	RW	Reserve Register	
0017	RW	Flow direction code	

		0	Forward flow only
		1	Reverse flow only
		2	Bidirectional flow
		3	Absolute forward/reverse
		4	Negate – forward only
		5	Negate – bidirectional
0018	RW	Mass flowrate unit code	
		0	lb/m
		1	lb/h
		2	kg/m
		3	t/D
		4	kg/h
		5	t/h
0019	RW	Density unit code	
		0	g/ml
		1	Kg/L
		2	Kg/ m^3
0020	RW	Temperature unit code	
		0	℃
		1	F
0021	RW	Volume flowrate unit code	
		0	GPM
		1	GPH
		2	BPD
		3	m^3/D
		4	BPH
		5	m^3/h
0022	RW	Mass Total unit code	
		0	lb
		1	kg
		2	t
0023	RW	Volume Total unit code	
		0	gal
		1	bbl
		2	m^3
0024	RW	MODBUS slave address or Slave ID	
Floating point registers		Function: Read 04; Write 16	
0100 0101	RW	flow cal	
0102 0103	RW	flow temp. Compensation factor	
0104 0105	RW	High Density D2 (g/cm3)	
0106 0107	RW	High Period K2 (us)	
0108 0109	RW	Low Density D1(g/cm3)	
0110 0111	RW	Low Period K1 (us)	
0112 0113	RW	Density temp.compensation factor	
0114 0115	RW	Pulse equivalent weight	
0116 0117	RW	20mA value	

0118 0119	RW	Mass flow low cutoff (kg/h)
0120 0121	RO	Zero Value (us) (Read Only value)
0122 0123	RW	20℃net oil density (g/cm3)
0124 0125	RW	20℃ net water density (g/cm3)
0168 0169	RO	Mass flowrate (kg/s)
0170 0171	RO	Density (g/cm3)
0172 0173	RO	Temperature (℃)
0174 0175	RO	Volume flowrate (L/s)
0176 0177	RO	Mass Total (kg)
0178 0179	RO	Volume Total (L)
0204 0205	RO	Water Ratio(%) Water Cut
0212 0213	RO	NET oil mass Total (kg) Water Cut

APPENDIX D

Modbus register map version 3.xx (ProLink)

Modbus register map version V3.02

General information

The addresses in the tables below are decimal; the starting address is 1.

For example, address 127 corresponds to hexadecimal address 0x007EH (126 decimal).

Read/Write mode: WO – write only; RO – read only; RW – read and write

Coils

Functions: Read – 01, Write – 05

Read: 0 – Off ; 1 – On

Write: 0x0000 – Off , 0xFF00 – On

Address	Mode	Description	Menu item *
0002	RW	Start / Stop totalizers 0 – Stop totalizers 1 – Start totalizers	–
0003	RW	Reset totalizers (resettable) 0 – Abort 1 – Reset totalizers	18
0004	RW	Reset totalizers (inventory) ** 0 – Abort 1 – Reset totalizers	–
0005	RW	Zero calibration 0 – Abort 1 – Start zero calibration	16
0056	RW	Reset mass totalizer (resettable) 0 – Abort 1 – Reset mass totalizer	–
0057	RW	Reset volume totalizer (resettable) 0 – Abort 1 – Reset volume totalizer	–
0082	RW	Pressure compensation 0 – Off (default) 1 – On	39

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

** To write in registers the switches 2-4-6-8 must be in ON position.

16-bit registers – integer values

2 bytes, high byte first

Functions: Read – 04, Write – 06

Address	Mode	Description	Menu item *

0003	WO	Register map version ** 1 – TFM (default) 2 – ProLink	74
0016	RO	Transmitter software version - Format XXX.X	–
0039	RW	Mass flow rate unit 70 – g/s 73 – kg/s 74 – kg/min 77 – t/day 75 – kg/h (default) 78 – t/h	33
Address	**Mode**	**Description**	**Menu item ***
0040	RW	Density unit 91 – g/cm^3 (default) 96 – kg/L 92 – kg/m^3	36
0041	RW	Temperature unit 32 – °C (default) 33 – F	37
0042	RW	Volumetric flow rate unit 0 – mL/s 24 – L/s 17 – L/min 29 – m^3/day 138 – L/h (default) 19 – m^3/h	35
0044	RO	Pressure unit 0 – MPa 7 – Bar (default) 12 – kPa	–
0045	RW	Mass total unit 60 – g 61 – kg (default) 62 – t	32
0046	RW	Volume total unit 0 – mL 41 – L (default) 43 – m^3	34
0120	RO	Device type code 40 – Core Processor 21/41/42 – RFT9739/1700A/2700A	–
0125	RO	Alarms code	–
0126	RO	Alarms code	–
0136	RO	Zero calibration time (s)	–
0313	RW	Modbus slave address	28
0419	RO	Alarms code	–
0420	RO	Alarms code	–
0421	RO	Alarms code	–
0422	RO	Alarms code	–
0423	RO	Alarms code	–
0424	RO	Alarms code	–
0521	RW	Bytes sequence in floating point 32-bit registers 0 – 0-1-2-3 (default) 1 – 2-3-0-1 2 – 1-0-3-2 3 – 3-2-1-0	75
1138	RO	Output signals 0 – None 1 – Current + Pulse + RS485 (default) 2 – Fieldbus (H1) or Profibus-PA	–
1166	RO	Output channel A type 0 – Current (primary) (default) 1 – Pulse 2 – Digital 3 – Current (secondary) 4 – Discrete output 5 – Discrete input	–
Address	**Mode**	**Description**	**Menu item ***
1167	RO	Output channel B type 0 – Current (primary) (default)	–

		1 – Pulse 2 – Digital 3 – Current (secondary) 4 – Discrete output 5 – Discrete input	
1168	RO	Output channel C type 0 – Current (primary) (default) 1 – Pulse 2 – Digital 3 – Current (secondary) 4 – Discrete output 5 – Discrete input	–

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

** To write in registers the switches 2-4-6-8 must be in ON position.

32-bit registers – single precision floating point values complied with IEEE 754 format

4 bytes, high bytes first

Functions: Read – 04, Write – 16

For example, value "-1.5" corresponds to "0xBF 0xC0 0x00 0x00" in the order from low to high address in memory.

Address	Mode	Description	Menu item *
0149 0150	RW	Low density cutoff (g/cm^3)	–
0155 0156	RW	Low density for density calibration (g/cm^3)	64
0157 0158	RW	High density for density calibration (g/cm^3)	62
0159 0160	RW	Period for low density (µs)	65
0161 0162	RW	Period for high density (µs)	63
0163 0164	RW	Temperature correction coefficient for density (% / 100ºC)	66
0189 0190	RW	Flow rate averaging time from 0.5 to 10 s in steps of 0.05 s	49
0191 0192	RW	Temperature averaging time (s) ***	–
0193 0194	RW	Density averaging time from 0.5 to 30 s in steps of 0.05 s	50
0195 0196	RW	Low mass flow cutoff (kg/h)	17
0197 0198	RW	Low volume flow cutoff (L/h)	75
0199 0200	RW	Upper limit of density range (g/cm^3)	58
0201 0203	RW	Lower limit of density range (g/cm^3)	59
0231 0232	RO	Zero point standard deviation (µs)	–
0233 0234	RO	Zero point (µs)	16
0247 0248	RO	Mass flow rate	1
0249 0250	RO	Density	3
0251 0252	RO	Temperature	3
0253 0254	RO	Volumetric flow rate	2
0257 0258	RO	Calculated pressure from external pressure sensor (kgf/cm^2) ***	73
Address	**Mode**	**Description**	**Menu item ***
0259 0260	RO	Mass totalizer (resettable)	1
0261 0262	RO	Volume totalizer (resettable)	2
0263 0264	RO	Mass totalizer (inventory)	21
0265 0266	RO	Volume totalizer (inventory)	22
0267 0268	RW	Coefficient of pressure compensation for flow (% / PSI)	40
0269 0270	RW	Coefficient of pressure compensation for density (% / PSI) ***	–
0271 0272	RW	Flow calibration pressure (kgf/cm^2)	73
0273 0274	RW	Pressure relating to 4 mA (kgf/cm^2) ***	42

0275 0276	RW	Pressure relating to 20 mA (kgf/cm^2) ***	43
0285 0286	RO	Measuring tubes oscillation frequency (Hz)	68
0287 0288	RO	Left coil voltage (mV)	69
0289 0290	RO	Right coil voltage (mV)	69
0291 0292	RO	Drive coil load (%)	69
0293 0294	RO	Live mass flow rate (zero point not counted) (kg/h)	–
0451 0452	RW	Input external pressure (kgf/cm^2)	41
		ASCII registers	
0072, 0073, 0074	RW	Calibration coefficient (g/s/µs) Format: XXXXXX Example: “23.350” , K=23.35 g/s/µs	40
0075, 0076	RW	Temperature correction coefficient for flow Kt (%/100ºC) Format: XXXX Example: “5.00” , Kt=5.0 %/100ºC	61

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

*** Reserved for future modifications.