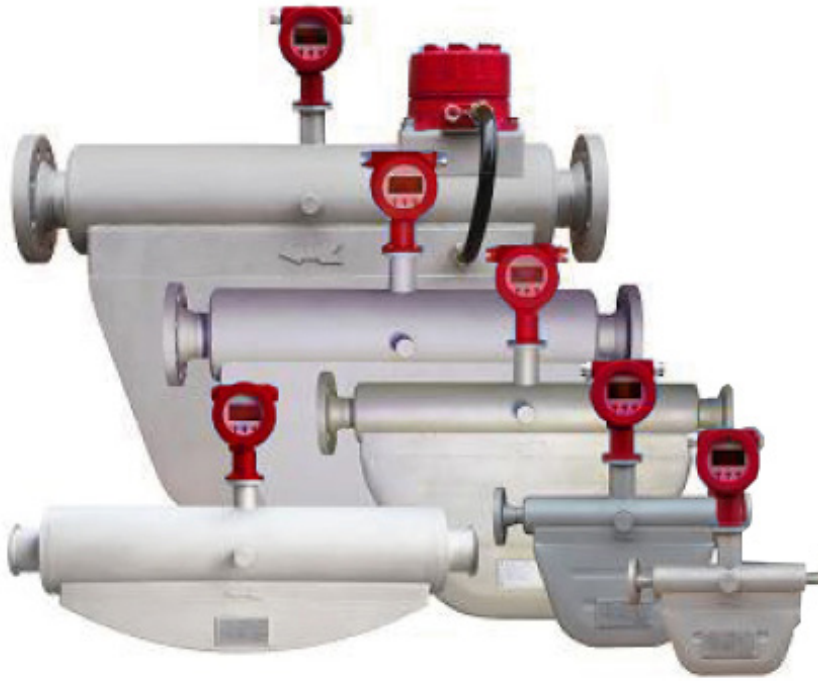
DANIEL®
SERIES CORIOLIS MASS FLOW METER
USER MANUAL



Decades Proven. Field Chosen.™

NOVEMBER 2025

GENERAL INFORMATION

This instrument has been calibrated at the factory before shipment. To ensure proper operation, please read this manual thoroughly and familiarize yourself with the instrument before use.

This user manual provides technical specifications, instructions for operation, storage, transportation, and other essential information for the proper operation of the Daniel® Coriolis Mass Flowmeter (hereinafter referred to as "the flowmeter".

Modbus®is the abbreviation for Modicon Modbus Protocol and is a registered trademark of Modicon, Inc

ProLink® is a registered trademark of Micro Motion, Inc.

Daniel® Measurement and Control (hereinafter referred to as "Daniel® ") reserves the right to modify the design of the flowmeters without prior notice, provided such changes do not negatively impact their performance. For additional information, please contact your local dealer or the head office.

⚠ CAUTION

Before installing, using, or maintaining the flowmeter, ensure you have fully read and understood this manual to guarantee safe operation and proper functionality.

For assistance, contact your local Daniel® representative or visit:

www.daniel.com

⚠ CAUTION

This manual applies only to the Series Coriolis Mass Flowmeters and does not cover other Daniel® products or those of other manufacturers.

CONTENTS

1 PRODUCT DESCRIPTION AND TECHNICAL DATA

1.1 APPLICATIONS

The Daniel® Coriolis Mass Flowmeter (hereinafter referred to as 'the flowmeter') is designed to measure mass and volume flow, density, and temperature of the flow. The gathered data is used for technological monitoring and transfer purposes.

The flowmeter is used to measure gasoline, liquefied petroleum gas, kerosene, diesel fuel, oil, oil-water mixtures, and other liquids in the chemical, petrochemical, and oil industries.

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

The flowmeter is designed for safe use in both non-explosive and explosive environments. The flowmeter of explosion-proof modification has a combined type of protection "explosion proof" transmiter".

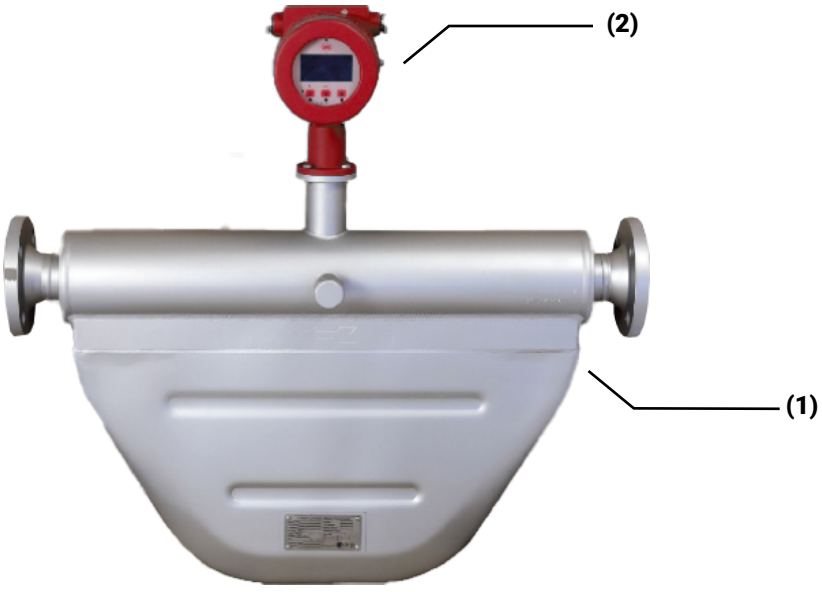
⚠ CAUTION
The flowmeter is not intended for use at nuclear facilities.

1.2 PRINCIPLE AND SENSOR SERIES

1.2.1 PRINCIPLE

FIGURE 1.1 –DANIEL® SERIES FFLOWMETER M-TYPE CORIOLIS

The flowmeter consists of the following units (as shown in Figure 1.1):
- Flow sensor (1);
- Transmitter (2).



Transmitter can be mounted right on the flow sensor (integral type) or separate from it (separate type).

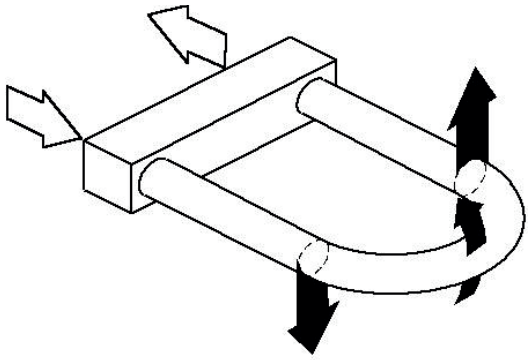
The sensor consists of a measuring chamber with inlet and outlet flanges for pipeline installation. Inside the measuring chamber there are two parallel U-shaped flow tubes, which vibrate by means of an electromagnetic coil and a magnet.

The operating principle 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.

At this time the liquid flowing into the tube creates resistance to its upward movement and downward pressure on the tube. Absorbing vertical momentum by driving around the tube's bend, the liquid, flowing out of the pipe, pushes the tube up. This makes the tube 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 Coriolis effect.

FIGURE 1.2 – FORCES AFFECTING THE TUBE ON THE UPWARD MOVING



The twist angle of the sensor tube is directly proportional to the volume of fluid passing through it over a given period. Electromagnetic speed detectors situated on both inlet (left) and outlet (right) side of the tube, measure the tubes oscillations frequency. Mass flow rate is determined by measuring the time delay between the signals of those detectors. When there is no flow, the tubes don't twist and there is no time delay between left and right detectors signals. Mass flow rate **Q** is proportional to the time delay **Δt** between the detectors signals.

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

where K – calibration coefficient, g/s/μs;

Δt – time delay between the detectors 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 kind of medium with exactly known (measured by standard density meter) density (water and air). For each medium the flowmeters shows the flow tubes 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 the built-in platinum temperature sensor Pt100. The measured temperature is used for automatic 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 have the manual correction of flow when the medium pressure changes. When manual correction mode is enabled in the menu, the user should 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 about the time delay between the signals of the detectors. The primary signal is transmitted to the electronic transmitter placed directly on the sensor or separate from it. The transmitter with digital signal processor processes the primary signal, calculates mass and volume flow values, temperature correction, generates output signals, and displays the information on the flowmeter's display.

Features of this measurement principle:

- Direct measurement of mass flow rate in the pipeline without additional errors;
- Maintaining high accuracy and stability over long time;
- Ability to measure the flow of high viscosity liquids, non-Newtonian fluids, fluids containing solid or gas inclusions;
- Reliable operation under conditions of vibration and misalignment of the pipeline, of the medium temperature and pressure changing;
- No moving parts inside the flowmeter (oscillation amplitude of the tubes is very small and they can be considered fixed) and parts subject to wear, which extends the life time of the flowmeter;
- No obstructions to the flow inside the flowmeter;
- Ability to measure temperature and density of the liquid;
- No need for straight pipe sections before and after the flowmeter, as well as flow conditioning plates, etc.

1.2.2 MODELS

Series Coriolis Mass Flowmeters are available in the following two configurations:

1.2.2.1 M-TYPE CORIOLIS

These flowmeters are comprised of two V-shaped tubes in a casing with a considerably smaller radius than the conventional V-Shaped Coriolis flowmeters. The smaller radius ensures a more compact instrument with significantly lower pressure differential values compared to other flowmeters.

M-TYPE CORIOLIS SIZE (1/8" - 10")

1.2.2.2 S-TYPE CORIOLIS

These flowmeters are the most compact in our range of Coriolis Mass Flowmeters, designed specifically to provide optimum performance in lowflow applications. It comprises a single flow tube which is considerably smaller in size than the conventional M-Shaped flowmeters.

S-TYPE CORIOLIS (SIZE 1" – 4")

1.3 GENERAL SPECIFICATIONS

1.3.1 TECHNICAL PARAMETERS OVERVIEW

Performance Specification

Model:

- Integral type - M……COM S shaped 2 tubes
- Integral type - S……COM S shaped 2 tubes
- Remote type - M……REM M shaped 2 tubes
- Remote type - S……REM S shaped 2 tubes

Fluid to be measured: Liquid, Gas or slurries Measurement items: Mass flow, density, temperature and water cut %,concentration, volume flow and net flow 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-10inch (DN3-DN250mm)
Accuracy	±0.1%; ±0.2%; ±0.5%
Accuracy	± 0.05% (for 0.1% accuracy), ± 0.1% (for 0.2% accuracy) or ±0.25% (for 0.5% accuracy)
Process pressure	Up to 3625Psi (PN 25MPa)`
Density mesuring range	2 to 30 lb/gal (0.2 to 3 g/cm3)
Density measuring accuracy	±0.001 g/cm3
Density basic error	±0.02 lb/gal (±0.002 g/cm3)
Density Repeatability	±0.01 lb/gal (± 0.001 g/cm3)
Medium temperature	Direct mount: -58 °F to 257 °F (-50 °C to 125 °C) Remote mount: -58 °F to 392 °F (-50 °C to 200 °C)

TABLE 1.1 – TECHNICAL SPECIFICATIONS (CONTINUED)

Parameter	Value
Atmospheric pressure	84.0...106.7 kPa
Environment temperature	-40...+55 ºC or -50...+70 ºC (special order)
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 for options
Verification period	4 years
Temperature sensor	Pt100
Service life	not less than 12 years
Outline dimensions	See **Appendix** A
Materials used	Sensor – stainless steel; Transmitter – aluminum alloy.

NOTES

1. It is possible to produce flowmeters with special characteristics according to the order.
2. Temperature range for OLED display is -40...+70 ºC.

1.3.2 RANGE OF MEASUREMENT

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

Operation of the flowmeter with the flow rate exceeding the upper limit of the full flow range is not allowed.

The lower limit of the full measuring flow range depends on the parameters of the medium, and should be specified in the order.

TABLE 1.2.1– MEASURING MASS FLOW RANGE FOR LIQUID(METRIC UNIT)

Size(inch)	Full flow range, kg/h	Accuracy flow range, kg/h		Zero stability, kg/h
		+/-0.1%	+/-0.2% and +/-0.5%	
1/8”	1.2 – 120	10 – 120	6 – 120	0.035
3/8”	10 – 1,000	100 – 1,000	70 – 1,000	0.045
1/2”	20 – 3,000	200 – 3,000	150 – 3,000	0.09
1”	80 – 8,000	600 – 8,000	400 – 8,000	0.25
1 ½”	240 – 24,00	2,400 – 3,200	1,200 – 3,200	1
2”	500 – 50,000	5,000 – 50,000	2,500 – 50,000	2
3”	800 – 140,000	10,000 – 140,000	6,000 – 140,000	3.5
4”	1,500 – 500,000	20,000 – 500,000	10,000 – 500,000	7
6”	5,000 – 500,000	50,000 – 500,000	30,000 – 500,000	23
8”	10,000 – 1,000,000	100,000 – 1,000,000	50,000 – 1,000,000	45
10”	15,000 – 1,500,000	150,000 – 1,500,0000	75,000 – 1,500,000	70

Model: Daniel® M-Type Coriolis

Size: from 1/8 to 10 inches

TABLE 1.2.2 – MEASURING MASS FLOW RANGE FOR LIQUID(US UNIT)

Size(inch)	Full flow range, lb/hr	Accuracy flow range, lb/hr		Zero stability, lb/hr
		+/-0.1%	+/-0.2% and +/-0.5%	
1/8”	2 – 265	22 – 265	13 – 265	0.0088
3/8”	22 – 2,204	220.40 – 2,204	110 – 2,204	0.099
1/2”	44 – 6,613	661.30 – 6,613	330 – 6,613	0.2
1”	176 – 17,636	1322 – 17,636	661 – 17,636	0.55
1 ½”	529 – 52,910	5,291 – 52,910	2,204 – 52,910	2.2
2”	1,102 – 110,231	11,023 – 110,231	4,409 – 110,231	4.41
3”	1,767 – 264,555	22,046 – 264,555	13,227 – 264,555	7.72
4”	3,306 – 440,925	44,092 – 440,925	22,046 – 440,925	15.43
6”	11,023 – 1,102,311	110,231 – 1,102,311	66,138 – 1,102,311	50.71
8”	22,046 – 2,204,622	220,462 – 2,204,622	110,231 – 2,204,622	99.21
10”	33,069 – 3,307,000	330,693 – 3,307,000	165,346 – 3,307,00	154.32

Model: Daniel® M-Type Coriolis
Size: from 1/8 to 10 inches

TABLE 1.2.3 – MEASURING VOLUMETRIC FLOW RANGE FOR LIQUID(METRIC UNIT)

Size(inch)	Full flow range, liter/hr	Accuracy flow range, liter/hr		Zero stability, liter/hr
		+/-0.1%	+/-0.2% and +/-0.5%	
1/8”	1,2 – 120	10 – 120	6 – 120	0.035
3/8”	10 – 1,000	100 – 1,000	70 – 1,000	0.045
1/2”	20 – 3,000	200 – 3,000	150 – 3,000	0.09
1”	80 – 8,000	600 – 8,000	400 – 8,000	0.25
1 ½”	240 – 24,00	2,400 – 24,00	1,200 – 24,00	1
2”	500 – 50,000	5,000 – 50,000	2,500 – 50,000	2
3”	800 – 120,000	8,000 – 120,000	5.500 – 120,000	3.5
4”	1,500 – 500,000	15,000 – 500,000	10,000 – 500,000	7
6”	5,000 – 500,000	50,000 – 500,000	25,000 – 500,000	23
8”	10,000 – 1,000,000	100,000 – 1,000,000	50,000 – 1,000,000	45
10”	15,000 – 1,500,000	150,000 – 1,500,000	75,000 – 1,500,000	70

Model: Daniel® M-Type Coriolis
Size: from 1/8 to 10 inches

TABLE 1.2.4 – MEASURING VOLUMETRIC FLOW RANGE FOR LIQUID(US UNIT)

Size(inch)	Full flow range, gal/min	Accuracy flow range, gal/min		Zero stability, gal/min
		+/-0.1%	+/-0.2% and +/-0.5%	
3/8”	0,04 – 4,4	0,44 – 4,4	0,31 – 4,4	0.000132
1/2”	0,09 – 13,20	0,88 – 13,20	0,66 – 13,20	0.000308
1”	0.35 – 35.22	2.64 – 35.22	1.76 – 35.22	0.00066
1 ½”	1.05 – 105.67	10.57 – 105.67	5.28 – 105.67	0.00396
2”	2.20 – 220.00	22.01– 220.00	11.01 – 220.00	0.00660
3”	3.52 – 528.34	35.22 – 528.34	24.22 – 528.34	0.01541
4”	6.60 – 881.00	66.04 – 881.00	44.03 – 881.00	0.03082
6”	22.01 – 2,201	220.14 – 2,201	110.07 – 2,201	0.074848
8”	44.03 – 4,403	440.29 – 4,403	220.14 – 4,403	0.198129

Model: Daniel® M-Type Coriolis
Size: from 1/8 to 10 inches

TABLE 1.2.5 – MEASURING MASS FLOW RANGE FOR LIQUID (METRIC UNIT)

Size(inch)	Full flow range, kg/h	Accuracy flow range, kg/h		Zero stability, kg/h
		+/-0.1%	+/-0.2% and +/-0.5%	
1”	80 - 10000	600 – 10000	300 – 10000	0.25
1 ½”	240 - 24000	2400 – 24000	1000 – 24000	1
2”	500 - 50000	5000 – 50000	2000 – 50000	2
3”	800 - 150000	10000 – 150000	6000 – 150000	3.5
4”	1500 - 200000	20000 – 200000	10000 – 200000	7

Model: Daniel® S-Type Coriolis
Size: from 1 to 4 inches

TABLE 1.2.6 – MEASURING MASS FLOW RANGE FOR LIQUID(US UNIT)

Size(inch)	Full flow range, lb/h	Accuracy flow range, lb/h		Zero stability, lb/h
		+/-0.1%	+/-0.2% and +/-0.5%	
1”	176 - 22046	1323 - 22046	661 - 22046	0.55
1 ½”	529 - 52911	5291 - 52911	2205 - 52911	2.2
2”	1102 - 110231	11023 - 110231	4409 - 110231	4.41
3”	1764 - 330693	22046 - 330693	13228 - 330693	7.72
4”	3307 - 440925	44092 - 440925	22046 - 440925	15.43

Model: Daniel® S-Type Coriolis
Size: from 1 to 4 inches

TABLE 1.2.7 – MEASURING VOLUMETRIC FLOW RANGE FOR LIQUID (METRIC UNIT)

Size(inch)	Full flow range, liter/h	Accuracy flow range, liter/h		Zero stability, liter/h
		+/-0.1%	+/-0.2% and +/-0.5%	
1”	176 - 22046	1323 - 22046	661 - 22046	0.25
1 ½”	529 - 52911	5291 - 52911	2205 - 52911	1
2”	1102 - 110231	11023 - 110231	4409 - 110231	2
3”	1764 - 330693	22046 - 330693	13228 - 330693	3.5
4”	3307 - 440925	44092 - 440925	22046 - 440925	7

Model: Daniel® S-Type Coriolis
Size: from 1 to 4 inches

TABLE 1.2.8 – MEASURING VOLUMETRIC FLOW RANGE FOR LIQUID (US UNIT)

Size(inch)	Full flow range, gal/min	Accuracy flow range, gal/min		Zero stability, gal/min
		+/-0.1%	+/-0.2% and +/-0.5%	
1”	077 - 91.13	5.83 - 97.13	2.91 - 97.13	0.00066
1 ½”	2.33 - 232.96	23.29 - 232.96	9.71 - 232.96	0.00396
2”	4.85 - 485.21	48.55 - 485.21	19.43 - 485.21	0.0066
3”	7.76 - 1,454.07	97.13 - 1,454.07	58.21 - 1,454.07	0.01541
4”	14.55 - 1,940.09	194.03 - 1,940.09	97.13 - 1,940.09	0.03082

Model: Daniel® S-Type Coriolis
Size: from 1 to 4 inches

(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/m3 under standard conditions. For liquids of different density the volumetric flow range should be calculated by dividing these 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) The flowmeter can measure flow rates exceeding 1% of the upper limit of the full range; however, the measurement error in this range (from 1% to 2% of the lower limit) is not standardized. However, this error can be estimated by the formula 1.1.

(4) Medium density measurement range is 200…3000 kg/m3.

Relative basic error of measurement of mass flow (mass) on pulse and digital output signals (δ_M) calculated as

$$(\delta_M) = \pm [\delta 0 + (Z / QM) * 100\%], \qquad (1.1)$$

where δ0 – accuracy class, %;

Z – zero stability (according to Table 1.2), kg/h;

QM – 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.

1.3.3 ACCURACY OF MEASUREMENT

Absolute basic error of measurement of medium density (Δρ) is ± 1 kg/m3.

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/m3 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/m3 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 (δV) calculated as

$$\delta v = \pm [\delta 0 + (\Delta\rho / \rho) *100\% + (Z / QV) *100\%], \quad (1.2)$$

where δ0 – accuracy class, %;

Δρ – absolute basic error of measurement of medium density, kg/m3;

ρ – measured medium density, kg/m3;

Z – zero stability (according to Table 1.2), L/h;

QV – 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 (δIM) calculated as

$$\delta IM = \pm [|\delta M| + 0.2*Imax / (4+16*QM / QMmax)], \quad (1.3)$$

where δ0 – Relative basic error of measurement of mass flow (mass), %;

Imax = 20 mA – maximum value of current output signal;

QM – measured mass flow rate, kg/h;

QMmax – upper limit of the full mass flow range, kg/h.

Relative basic error of measurement of volumetric flow (volume) on current output signal (δIV) calculated as

$$\delta IV = \pm [|\delta V| + 0.2*Imax / (4+16*QV / QVmax)], \quad (1.4)$$

where δ0 – Relative basic error of measurement of volumetric flow (volume), %;

Imax = 20 mA – maximum value of current output signal;

QV – measured volumetric flow rate, L/h;

QVmax – 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 DC 24V power supply or AC 220 V with frequency (50 ± 1) 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
DC 24 V	18...36 V	15W
AC 220 V	85...265 V	15W

1.3.5 OUTPUT SIGNALS

The flowmeter has the following output signals:

- pulse output;
- current output;
- Digital output (RS-485 interface).
- Hart communication

To display the values of the mass flow, volume flow and other measured parameters the flowmeter's transmitter has built-in display.

1.3.5.1 PULSE OUTPUT

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

The pulse output can be configured to denote 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 measurement start.

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

$$fmax = Qmax / (3.6*m), Hz \qquad (1.5)$$

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 can be increased up to 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	0.1	0.1	0.4	2	4	8	10	20	40

1.3.5.2 ANALOG OUTPUT

The value of the current in the current output circuit ranges from 4 to 20 mA and is proportional to the measured flow rate(density, Water-cut% , Brix. For 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 report mass flow rate, volumetric flow, water cut % or density of the medium.

CURRENT OUTPUT IS PASSIVE.

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...600 Ohm

1.3.5.3 DIGITAL OUTPUT

Digital interface complies with the requirements EIA/TIA-422-B and recommendations RTU V.11 and provides the opportunity of 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	RS-485
Data transfer protocol	Modbus RTU
Data transfer baud rate	1200, 2400, 4800, 9600 bit/s
Maximum distance	1200 m
Data format	8 data bits, 1 start bit, no parity bit, 2 stop bits (default).

Data format can be changed 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 can also be used to calibrate and to configure the flowmeter.

Flowmeter supports two versions of the Modbus register map:

- «Daniel® » register map version 2.xx is supported by the «Daniel Integrator» software and set as default at factory;
- «ProLink» register map version 3.xx compatible with ProLink II software from Micro motion.

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

Register map version switching can be performed by the «Daniel® Integrator» or changing the value of the corresponding Modbus register (see Appendix) using third party serial port tools.

1.3.6 DISPLAY

The flowmeter's OLED graphic display contains 4 lines with 16 symbols per line. The following measured parameters can be displayed:

- Mass flow rate;
- Volumetric flow rate;
- Medium density;
- Medium temperature;
- Total mass;
- Total volume.
- Water cut%(Requested on water cut measurement programing)
- Brix. (Requested on Brix measurement with density compensationprograming)

Display 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.

No.	Notes
1	E key: enter
2	→ key: move curse or reture
3	↓ key : page down
5	OLED screen
6	OLED light for working status

⚠ CAUTION

- Operation point of the photoelectric key is located right behind the glass panel.
- It is better to operate the photoelectric key in verticaldirection, rather than horizontal direction.

TABLE 1.5

Key	Measurement State	Menu State	Function State	Data State
E	Show the Measurement Results and State on Page1/2/3. Page Down to Menu State.	Next Menu.	Select Function.	Change Number. Change Unit. Change Character.
→	Return to the Previous Screen	Return to the Upper-Level Menu. Press this Key to Return to the Measurement. State.	Select Function.	Move the Cursor to the Right.
↓		Enter the Menu.	Confirm and Save the Function.	Save the Input, then Go Back to. The Function Menu.

1.4 PRESSURE DROP

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

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

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

where ΔP – pressure drop on the flowmeter, kPa;

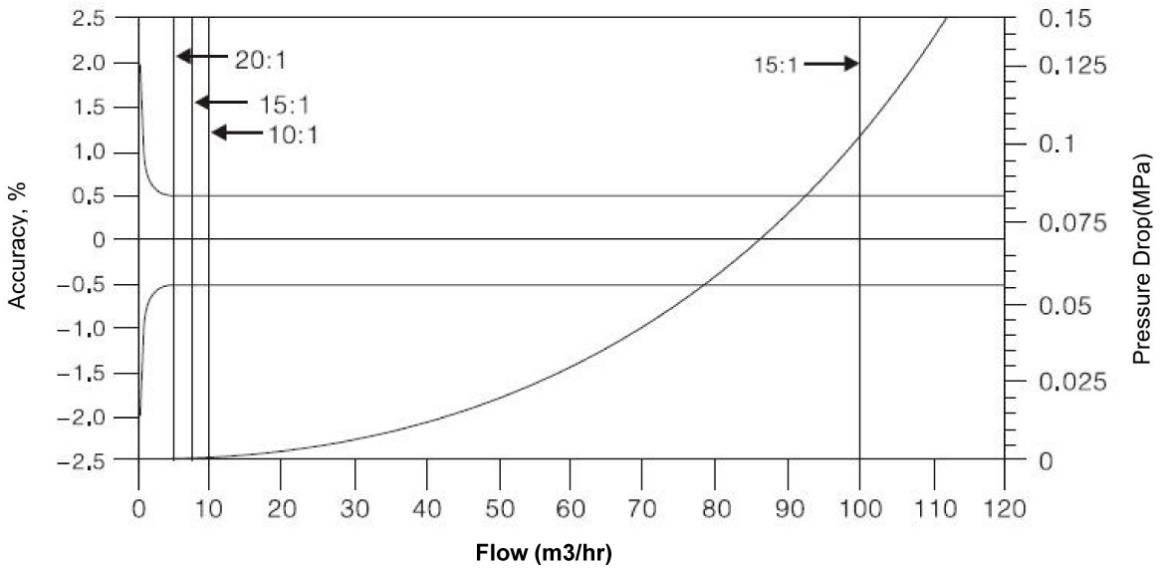
p_v – saturated steam pressure at working conditions (background information), kPa.

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 graph before engineering design and application

Note: μ=cP(Viscosity)

TYPICAL ACCURACY, TURNDOWN, AND PRESSURE DROP WITH MODEL: 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	0.1	0.1
Pressure drop	0.001	0.0015	0.002	0.1	0.17

1.5 EXPLOSION PROTECTION

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.

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.

The sensor explosion proof grade is showed in Table 1.7.

TABLE 1.7 – SENSOR EXPLOSION PROOF GRADE

Temperature code	Explosion proof grade
"100"	ibIICT4X
"200"	ibIICT3X
"350"	ibIICT1X

Explosion proof grade is written on the name plates attached to the body of the sensor of explosion-proof modification and to the transmitter.

The name plates' appearance is showed on flowmeter ordered.

The "X" letter in the explosion proof grade means the 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 complied with GOST R 51330.1;
- 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;

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

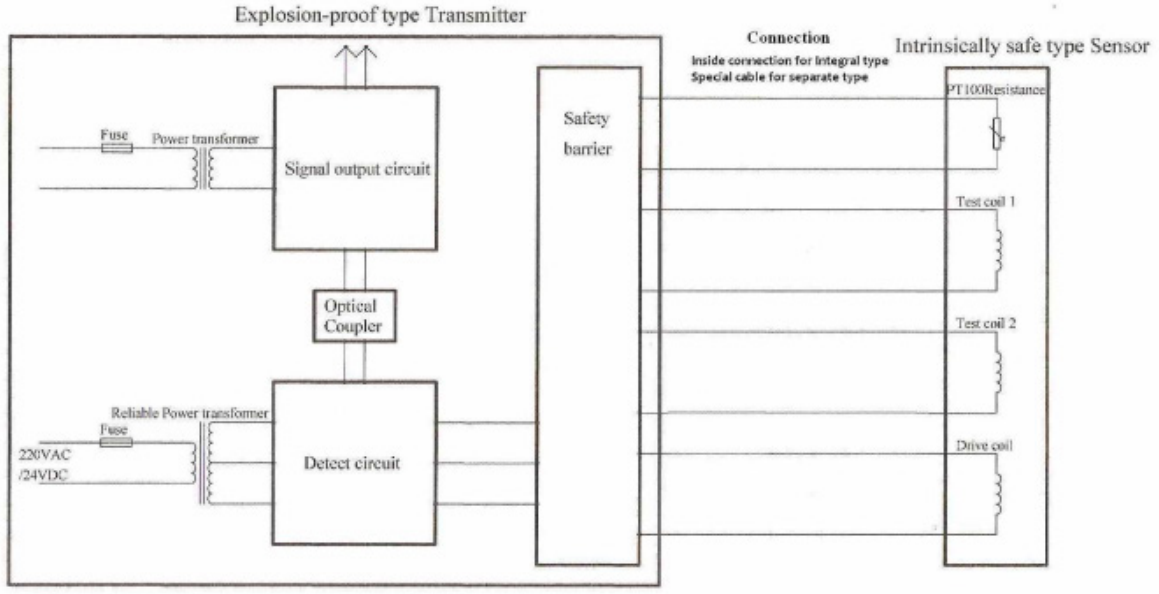
The enclosure's explosion protection is ensured through the following measures:

- the housing case withstands the explosion test at the test pressure of 4 times the pressure of the explosion;
- axial thread length and number of full turns of thread engagement comply with GOST R 51330.1 requirements;
- the gaps and lengths of flat and cylindrical flameproof joints 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:

- 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 is applied;
- electrical clearances and creepage distances comply with GOST R 51330.10. Insulation resistance between the sensor outer shell and electrical circuits elements can withstand the testing voltage of 500 V AC 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 transmitterl, sensor and booster amplifier complied with GB3836.1-2010GB3836.2-2010 and GB 3864-2010. it can be used in hazardous location Zone 1 and Zone 2. The range of ambient temperature of the product is -20°C - +40°C.

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.

1.6 HAZARDOUS AREA CLASSIFICATIONS

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 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(FACTORY MAY CHANGE THE FORMAT OF THE NAMA PLATE WITHOUT THE NOTIFICATION TO THTE END-USER)

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 NAME PLATE DATA

Item №	Description
1	Trademark of the manufacturer
2	Flowmeter name
3	approval marks
4	Maximum process pressure (max)
5	Accuracy class
6	Model sierie
7	Power supply voltage
8	IP protection grade
9	Explosion protection grade
10	Information about manufacturer
11	Serial number
12	Flow Cal(K factor)
13	Temperature range of the measured medium (Twork)
14	Full flow range (Q)
15	Meter size
16	CE directive

⚠ CAUTION
Before installation of the flowmeter, make sure that the information on the name plates conforms to the data in the order.

After 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 base delivery set and the 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
1	Coriolis Mass Flowmeter Daniel ® -series	+	Cable length
2	User manual	CD	
3	Calibration report	CD	
4	Packing box	+	
5	Inspection report	CD	

FIGURE 1.7 ACCESSORIES

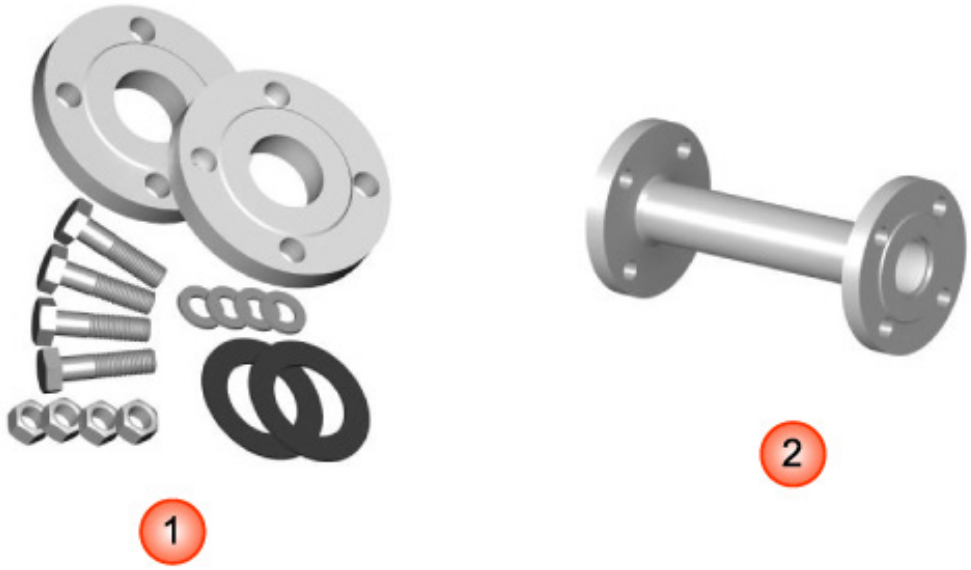


TABLE 1.13 - ACCESSORIES

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

⚠ CAUTION
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, delivery set or flowmeter model doesn't match the order you should draw up a statement.

1.8 MODEL CODES

Series coriolis mass flowmeter's model codes are presented in Table 1.14.

The example of the flowmeter's modification for the order is showed below.

	1		2		3		4		5		6		7		8		9		10		11		12
COR	02	-	M	-	L	-	A15	-	COM	-	CS	-	1	-	R	-	1	-	U	-	304	-	0

TABLE 1.14 – FLOWMETER MODEL CODES

Item №	Description
1	**Sensor Size**
1/8”	18
3/8”	38
1/2”	05
1”	01
1 1/2”	15
2”	02
3”	03
4”	04
6”	06
8”	08
10”	10
2	**Sensor Type**
M	Size from 1/8” to 10”
S	Size from 1” to 4”
3	**Medium**
L	Liquid
G	Gas
4	**Flange Rating / Maximum Working Pressure**
D16	DIN PN16 16 BAR MWP
D25	DIN PN25 25 BAR MWP
D40	DIN PN40 40 BAR MWP
D63	DIN PN63 63 BAR MWP
D10	DIN PN100 100 BAR MWP
D60	DIN PN160 160 BAR MWP
D50	DIN PN250 250 BAR MWP
A15	ANSI 150#RF 285 PSI MWP
A30	ANSI 300#RF 740 PSI MWP
A60	ANSI 600#RF 1,480 PSI MWP
A90	ANSI 900#RF 2,220 PSI MWP
A50	ANSI 1500#RF 3,705 PSI MWP
10K	JIS 10K
30K	JIS 30K
SFC	Sanitary fitting connection
CSC	Customized connection
5	**Structures**
COM	Compact version -58°F to +257°F (-50°C to +125°C)
REM	Remote version -58°F to +392°F (-50°C to +200°C)
RXM	Remote version -58°F to +572°F (-50°C to +300°C)

TABLE 1.14 – FLOWMETER MODEL CODES (CONTINUE)

Item №	Description
6	**Explosion Proof**
NX	Not for hazadous application
UL	UL approved for class I, Div.1 Groups B, C and D
AX	ATEX and IECEX approved for II 2G Exdb ib IIA/IIB/IIC T*Gb
7	**Power Supply**
1	DC18 to 36V
2	AC85 to 265V
8	**Signal Output**
R	Modbus RTU(RS485) + one active 4-20mA + one active pulse/frequency, standard
H	HART + one active 4-20mA + one active pulse/frequency
S	2* active 4-20mA + active pulse
D	Modbus RTU(RS485) + 2* active 4-20mA + one active pulse/frequency
9	**Accuracy**
1	+/- 0.1% of RD
2	+/- 0.2% of RD
5	+/- 0.5% of RD
10	**Software Version**
M	Metric unit programming
U	US unit programming
11	**MATERIAL**
314	Tubes 316SS and 304 SS Housing case (Non-Wetted Parts)
316	All 316 SS (Tubes + Housing case)
HAS	Hastelloy C
12	**PROCESS CONNECTION SIZE**
0	Same as Sensor
1	One size Up from Sensor

NOTES

1) for separate type mass Flowmeter , please confirm the special cable length when ordering.

2) Daniel® Model selection guider software is recommend to use.

1.9 AGENCY CERTIFICATIONS FOR CORIOLIS MASS FLOW METER

TABLE 1-15: AGENCY CERTIFICATIONS

Certification type		Description	Certificate
Electrical	UL and CUL	Class 1 Division 1 Groups B, C, and D	E360841 vol. 1
Metrology		NTEP	25-067

2 OPERATION AND MAINTENANCE

2.1 MODEL SELECTION RECOMMENDATIONS

One of the most important conditions for reliable operation of the flowmeter and to obtain reliable measurement results is correspondence of the flowmeter's modification to 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 regulation and control components in the system:
13	Process connection size:
14	Pipeline orientation at the installation place:
15	Ambient temperature:
16	Explosion protection grade and requirements:

⚠ CAUTION

To avoid erroneous self-dependent selection of the modification of the flowmeter please send the completed questionnaire to the nearest Daniel® company representative.

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 chosen so that the actual flow rate of the medium was in the second third of the flow range. Therefore, nominal diameter (DN) of the flowmeter can be either equal or less than the nominal diameter of the pipeline.

When mismatch pipeline diameter and the nominal diameter of the flowmeter tapered transitions can be used. They can be made independently, at that to ensure minimum loss of pressure, the central cone angle must not exceed 30 °C.

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

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

Installing or removing the flowmeter from the pipeline must be done with the pipeline depressurized and the power supply turned off. Electrical connection should also be performed only when the power supply is switched off.

During the installation, commissioning and maintenance shall be 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 220V AC or higher (in case of the external power supply located in close vicinity of the installation place);
- excess pressure in the pipeline;
- high temperature of the medium.

⚠ CAUTION
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 cover opened, and also without the chassis grounding.

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

2.2 INSTALLATION ON PIPELINE

2.2.1 INSTALLATION LOCATION

Determining a Location

When selecting the installation place you should follow these rules:

- There should be no strong vibration, high temperatures or strong magnetic fields at the installation place. 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 the strained section 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 places. Free space around the flowmeter should be provided for easy installation and maintenance.
- Display of the flowmeter should be installed at a place which is convenient for the operator to read displayed data.

- The installation place 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.

FIGURE. 2.1 BASIC REQUIREMENTS FOR THE INSTALLATION PLACE

⚠ CAUTION

If there is a strong vibration or pipeline strained at the installation place, it is necessary to provide external support for the pipeline before and after the flowmeter. The support base must be firm.

In this case installation of the flowmeter in such places, including mobile units is permitted.

2.2.2 ORIENTATION

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

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

Flowmeter does not require collateral straight pipeline sections before and after the flowmeter, nor installation of additional equipment to level the flow profile (flow conditioning plates, etc.). But if two or more flowmeter are installed in the same section of the pipeline, the distance between them should be at least 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 help you configure the transmitter for flow direction. If possible, install the sensor so that the flow direction arrow matches actual process flow.

Vertical pipeline

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

TABLE 2.2 – NOTES FOR FIGURE 2.2

Pic №	Recommendations
1	It is recommended to install the flowmeter tubes downward to improve their filling with fluid and to prevent accumulation of gas in them.
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 of the pipe with fluid.

In the event of bending pipe it is recommended to install the flowmeter in the lower section of the pipeline.

Do not install the flowmeter on a horizontal pipe before the drainage section with free flow, because in this case filling the flowmeter's tubes wit fluid is not guaranteed.

2.2.3 PIPELINE PREPARATION

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

- Check the completeness of the connection kit and conformity of all mounting parts to the flowmeter's modification;
- 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 depth of landing 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.

⚠ CAUTION

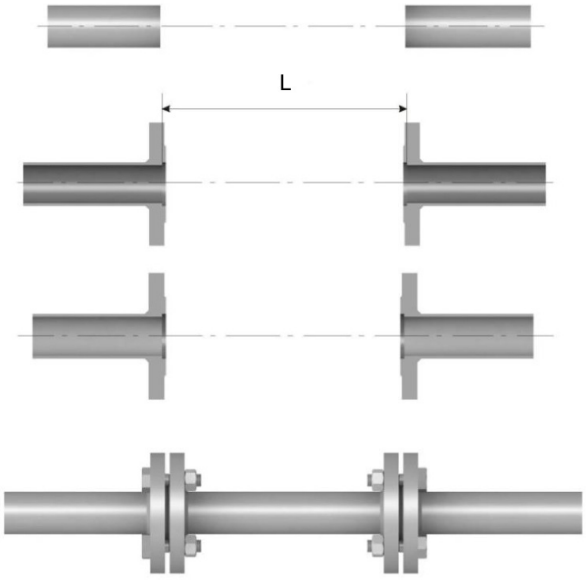
In the process of installation the flowmeter may be used instead of the replacement mounting part only in the following cases:

- installation is carried out using a gas welding;
- when installing using an electric arc welding,the power source is connected in a way that prevents the welding current to run through the flowmeter - see Figure 2.3.

FIGURE 2.3 CONNECTING THE POWER SOURCE FOR ARC WELDING USING THE FLOWMETER

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

FIGURE 2.4 PIPELINE PREPARATION FOR INSTALLATION OF THE FLOWMETER



⚠ CAUTION

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

2.2.4 INSTALLATION

Prior to installation, it is necessary:

- Thoroughly clean the pipeline of cinder, sands, and other solid particles;
- Inspect the flanges and the measuring tubes of the flowmeter and remove solid mechanical and other particles from them;
- Remove the preservative grease from the flowmeter, by passing through it 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 direction of flow;
- 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 yet;
- 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 yet;
- Tighten the nuts in the sequence shown in Figure 2.6.

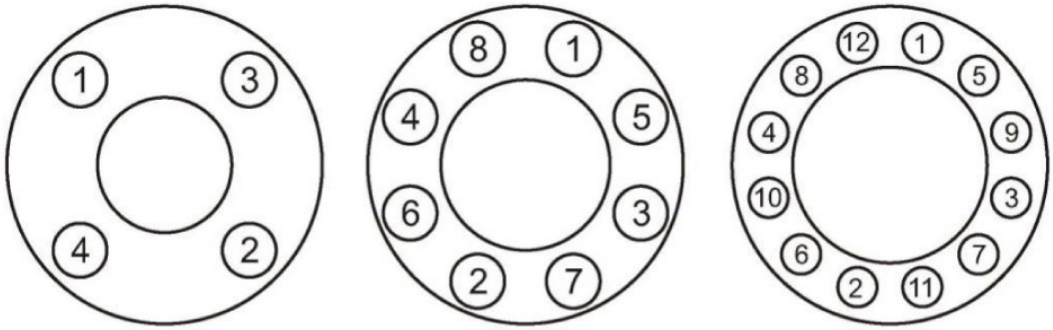
When installing the flowmeter bending and torsional load on the joints, and also mated flanges misalignment should be minimized.

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 TRANSMITTER OF SEPARATE TYPE ILLUSTRATION

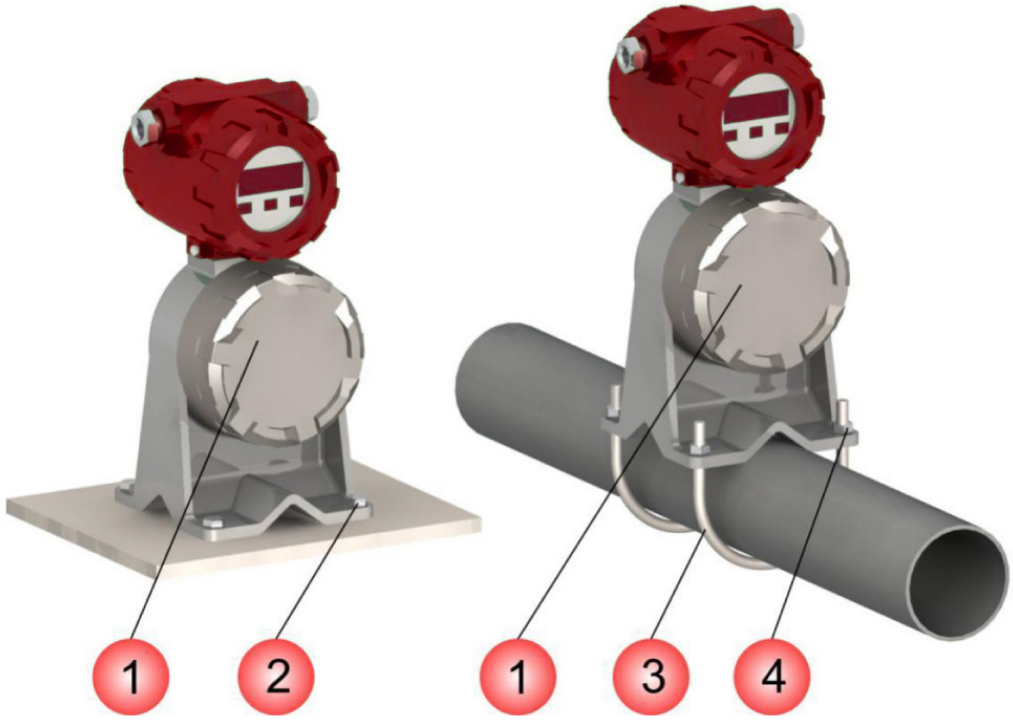


TABLE 2.4 – NOTES FOR FIGURE 2.7

Item №	Mounting part
1	Transmitter base
2	Bolts
3	Clamp
4	Nuts

⚠ CAUTION

Do not install the transmitter with the cable entry directed vertically upwards.

2.2.5 THERMAL INSULATION

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

FIGURE 2.8 – RECOMMENDATION FOR THERMAL INSULATION OF THE FLOWMETER

2.2.6 COOLING

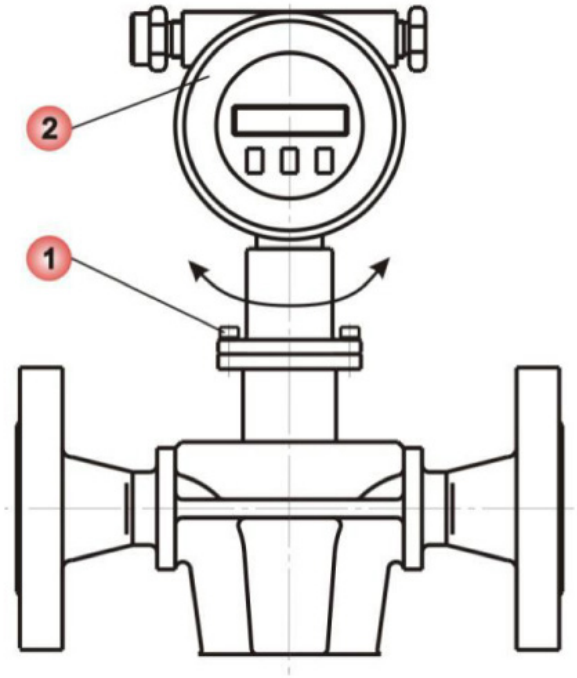
For high temperature modification of the flowmeter (with medium temperature above +200 °C) possibility of external cooling is provided (see Figure 2.9).

FIGURE 2.9 – EXTERNAL COOLING SUPPLY

2.2.7 TRANSMITTER ROTATION

If in the process of installation the front side of the transmitter appeared to be not in front of the user and display is not visible, it is possible to 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.

FIGURE 2.10 – ROTATION OF THE TRANSMITTER



⚠ CAUTION

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

2.3 WIRING

2.3.1 BASIC OPERATIONS

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)
- Loose the terminal block screws (4);
- Connect wires according to the wiring diagram shown in Appendix;
- Tighten the terminal block screws;
- Tighten the clamp of 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 CONNECTION OF THE FLOWMETER

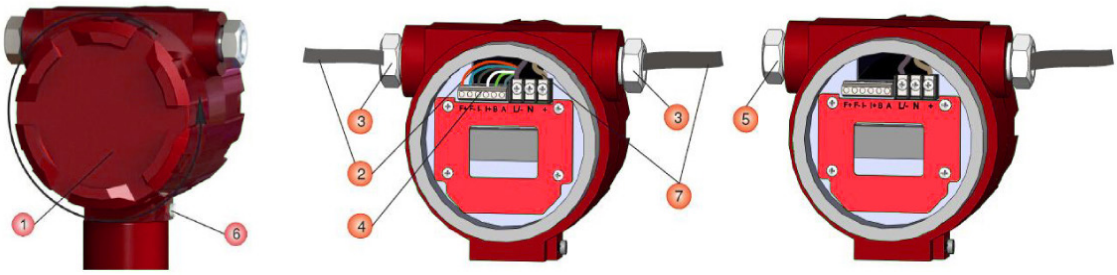


TABLE 2.5 – NOTES FOR FIGURE 2.11

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 300 m with minimum wire section 0.8 mm2 (AWG18).

Connecting to the current and pulse outputs should be performed with a twisted pair wire with the maximum length of 150 m and minimal wire section 0.5 mm2 (AWG20).

Sensor and transmitter of the flowmeter of separate type are connected through a special 9-core shielded cable with maximum length of 300 m. 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”).

⚠ CAUTION

When using the flowmeter in hazardous areas, apply the requirements for explosion protction provided in paragraph 2.4.2 “Installation with explosion protection”

2.3.2 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 should pay attention to the specific operating conditions mentioned in Section 1.5 “Explosion protection”.

Before installation the flowmeter should be inspected. You should pay special attention to explosion proof grade labels, warning labels, make sure that there is no damage to the flameproof shell and flow sensor. Also make sure that 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. It must not exceed 1 Ohm. A copper wire with 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 put the latch lock on the covers.

2.3.3 WIRING RECOMMENDATIONS

During electrical connection of the flowmeter you should follow these recommendations:

- Wire cores 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.

2.3.4 WATERPROOFING

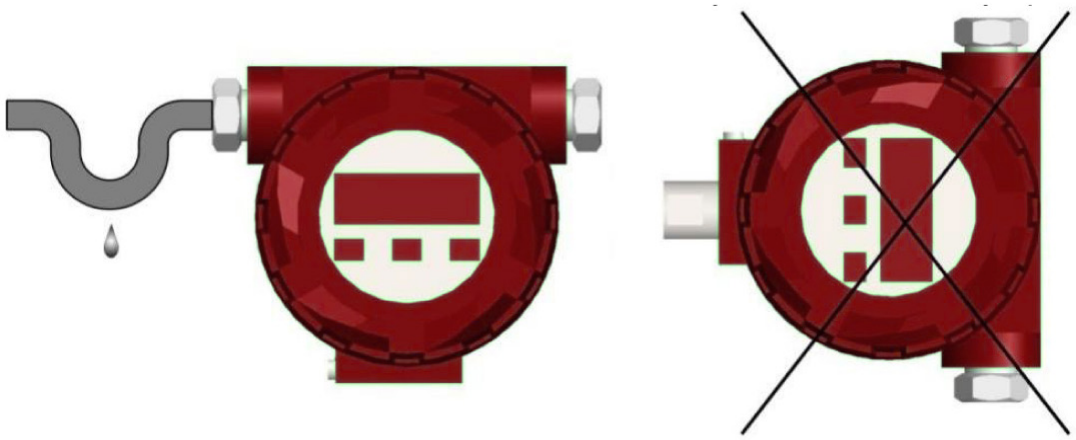
The flowmeter meets all the requirements for moisture protection grade specified in the “Technical Specifications” section.

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 loop to prevent any liquid from going into 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



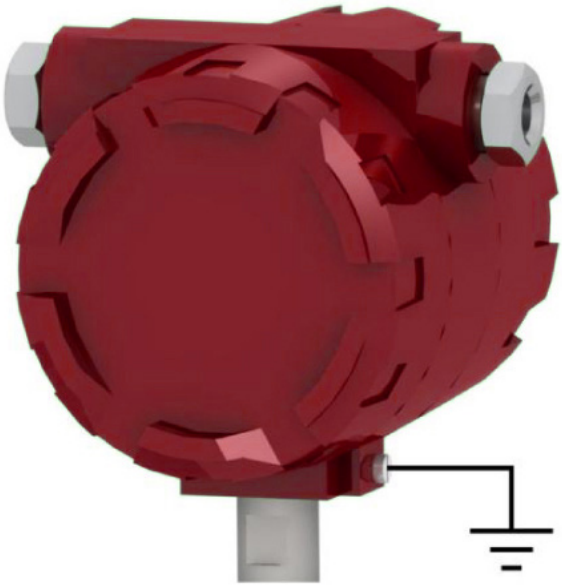
2.3.5 GROUNDING

Transient processes induced by lightning, welding, big power-consuming equipment or switches may lead to distortion of the flowmeter's measuring or damage it. For protection from transient processes one should 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 recommended to use copper wire of at least 2.5 mm2 (AWG13) section. Ground wires should be as short as possible and have a resistance of less than 1 Ohm.

Transmitter can be grounded through the pipeline, if the pipeline provides the ground.

FIGURE 2.13 GROUNDING



⚠ CAUTION

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 because of 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 succeeds, the flowmeter begins to measure flow, to generate output signals and display the measured values.

2.5.3 DISPLAY OPERATING

Controlling of the flowmeter's display is performed via three buttons of optical type, below the display. Thus, display operating doesn't require opening the front cover of the transmitter, which is important in explosive environment, in conditions of high humidity or precipitations, 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. Flowmeter can 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 SEQUENCE

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 Volume	Brix x.xxx °Bx (Only for Brix measurement software verson) Volm XXX.XXX

If the displayed value becomes more than 999.999, the units are automatically switched to bigger ones to be able to display that value.

If no button is pressed within two minutes, flowmeter is automatically switched 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 display menu. 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 is flashing. To accept 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 has numeric value its editing is performed by changing the digits one by one and moving to the next digit on the right. The digit in currently selected position is flashing. Press «↓» to increment the digit in 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.

TABLE 2.7 – DISPLAYED PARAMETERS

Root menu

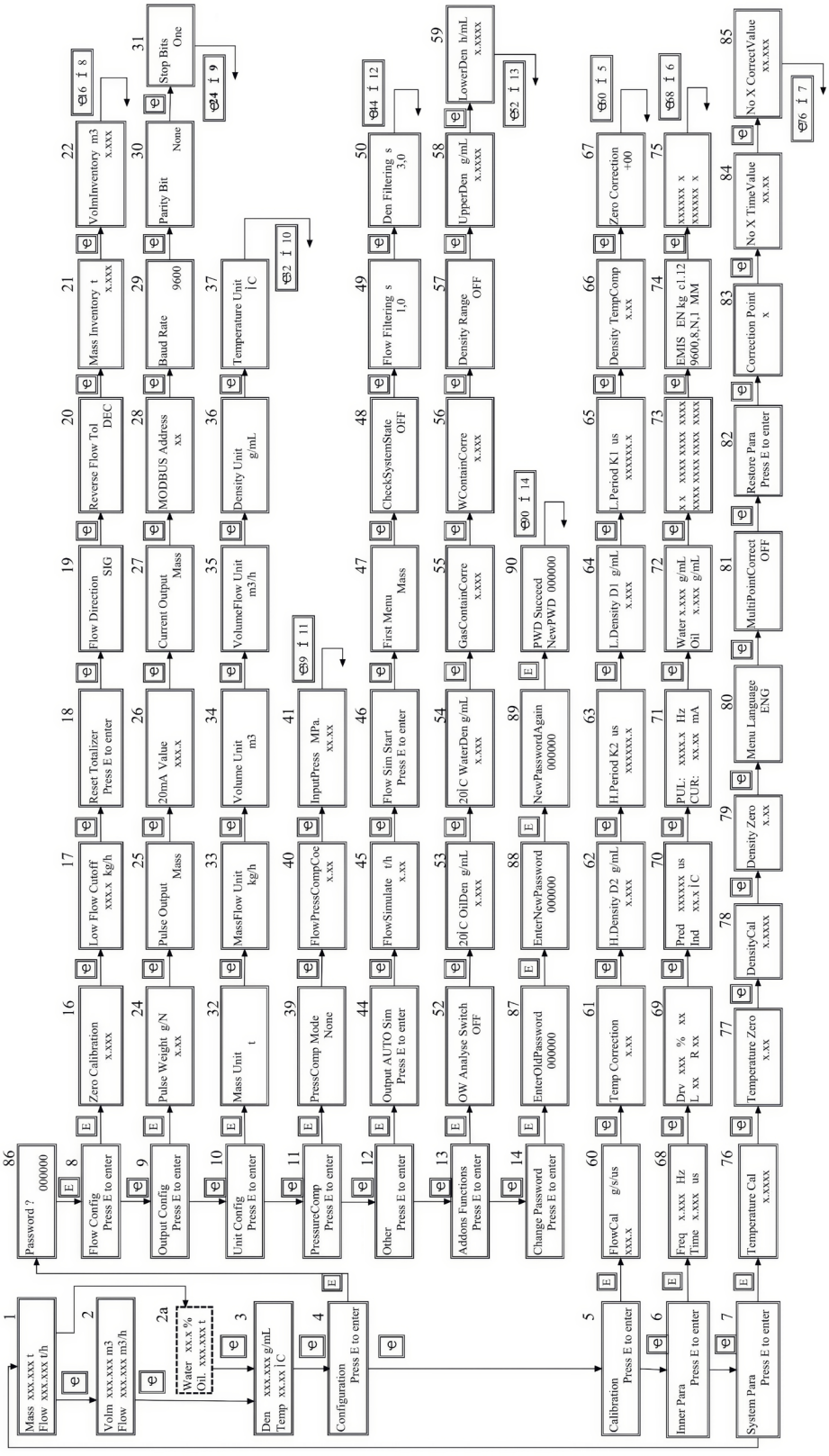


FIGURE 2.14 DISPLAY MENU STRUCTURE(REFER TO OUR LATEST VERSION PER P.O)

Menu item	Indication format	Button actions	Description
0	Daniel® Ver.2.62 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:** gk g ton(Metric ton,default setting) **Mass flow rate units:** g/s kg/s kg/m t/D kg/h t/h
2	Flow XXX.X Mass XXX.XXXX	↓3,→1	Total volume and instant volumetric flow rate. **Volumetric flow units:** ml L m3 **Volume flow units:** mL/s L/s L/m m3/D L/h m³/h(cubic meter/h)
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 (Not supported at standard version software, Consult factory for detailes) 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.

Menu item	Indication format		Button actions	Description
3	Den Temp	XXX.X XXX.XXXX	↓4, →1	Density and temperature of the measured medium. **Denisty flow units:** g/mL Kg/L kg/m (Kg/m3) **Tempetaure unit:** °C °F
4	Brix measurement			Brix x.xxx °Bx Volm XXX.XXX m3 (this is not supported for standard version software, consult factory for more detailes.
5	**Configuration** Press «E» to enter		↓5, →1 E86	Press «E» button to enter the submenus for configuring the flowmeter.
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	Reset Totalizer Press «E» to enter	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:

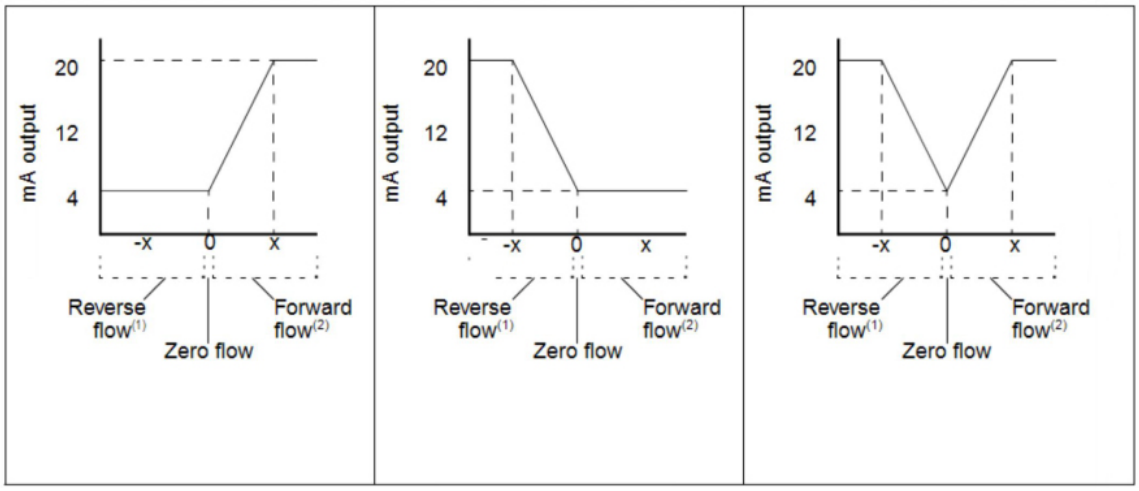
- Forward(Rwd)
- Reverse(Rvr)
- Bidirectional(Bid)
- Absolute Value(Abs)

- 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.



Flow direction parameter:

- Forward

Flowdirectionparameter:

- Reverse
- NegateForw

Flow direction parameter:

- Absolute value
- Bidirectional
- Negate Bidirectional

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.**
Flow direction value	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
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

Menu item	Indication format		Button actions	Description
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	Select in Menu 25 for pulse output type; The pulse output can be configured to denote mass flow rate (“Mass”), volumetric flow rate (“Volm”) of the medium. Input mass flow rate, volume flow rate 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 : If Pulse output=Mass(g/N) Mass Pulse Weight: 50.0 g/N, which means a pulse represents 50g. If pulse ouptut=Volume (ml/N) Volume pulse Weight: 50.0 ml/N, which means a pulse represents 50ml.
25	Pulse Output	Mass Volm	↓26, →9 E – edit	The pulse output can be configured to denote mass flow rate (“Mass”), volumetric flow rate (“Volm”) of the medium.

Menu item	Indication format		Button actions	Description
26	20mA Value	XXX.X	↓27, →9 E – edit	Select in Menu 26 for 4-20mA output type; The 20mA output can be configured to denote mass flow rate ("Mass"), volumetric flow rate ("Volm") of the medium, density and Water cut. Input mass flow rate, volume flow rate, density or water cut% corresponding to 20mA on the current output. For example : **1.** If 20mA output selected to to be mass 20mA=20.000 t/hr which means 20mA represents 20t/hr. **2.** If 20mA output selected to to be volume 20mA=20.000 m3/hr which means 20mA represents 20m3/hr.
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 ° **NOTES** Brix ° for sugar degree measurement requested on special programing.
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	↓33, →10 E – edit	Select units for mass totalizer.
33	Mass Flow Unit	lb/m lb/h kg/m mt/D kg/h t/h	↓34, →10 E – edit	Select units for mass flow rate.
34	Volume Unit	gal(US Gallon) bbl m3 L	↓35, →10 E – edit	Select units for volume totalizer.
35	VolumeFlow Unit	GPM GPH BPD m^3/D BPH m^3/h	↓36, →10 E – edit	Select units for volumetric flow rate.
36	Density Unit	g/mL kg/L lbs/gal kg/m3 g/cm	↓37, →10 E – edit	Select units for density.

Menu item	Indication format		Button actions	Description
37	Temperature Unit	° C ° F	↓32, →10 E – edit	Select units for temperature.
38	Brix° unit	Bx °	↓39, →10 E – edit	Select units for Brix°.
11	**PressureComp** Press «E» to enter		↓12, →4 E39	Switching On/Off and changing parameters of pressure compensation for flow.
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	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	InputPress MPa	XX. XX	↓39, →11 E – edit	Actual pressure value for manual compensation mode.
12	**Other** Press «E» to enter		↓13, →4 E44	Miscellaneous functions such as flow simulation, etc.
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	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 Sim Start Press «E» to enter		↓47, →12 E – edit	Flow simulation mode starts by pressing «E». Simulated flow rate is specified in the Menu item 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.

Menu item	Indication format		Button actions	Description	
53	20°C 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	20°C WaterDen or API 15CWaterDen Or 60 °F WaterDen	X.XXX g/mL	↓55, →13 E – edit	Density of pure water under standard conditions.	
55	Gas Contain Corre	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.	

Menu item	Indication format		Button actions	Description
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 Time	XX.XX Hz XX.XX us	↓69, → 6	Measuring tubes oscillation frequency. Current time delay between left and right signal coils.
69	Drv L XX mV	XXX %, YY 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 Ind	XXXXX.XX us XX.X °C	↓71, → 6	Measuring tubes oscillation period. Internal temperature of the flowmeter.
71	PUL: CUR:	XXXX.X Hz XX.XX mA	↓72, → 6	Frequency of the signal on the pulse output. Current value on the current output.
72	Water Oil	X.XXX g/mL 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	Daniel® EN kg 9600, 8, N, 1	cX.XX 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/cm3 to +0.1 g/cm3).
80	Menu Language	RUS ENG	↓81, → 7 E – edit	Select display menu language. Switching from English language to Russia.
81	Multipoint Correct	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.

Menu item	Indication format	Button actions	Description
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 Power 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 certain time delay between signal coils anyway, that 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 as the thermal balance is established;
- 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;

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. CMF should not share the same pipe supports.
- Do not install a CMF in the highest part of the system. The lowest part of the system ispreferred.

Staying in the root menu (see Figure 2.14) press ↓ button several times to move to the Menu item “Configure”. Press **E** button and enter the password (default password is 000000). To enter the password press ↓ to plus the currently selected digit, to move to the next digit press → button. After successful password entering a message “Zero calibration” will appear. 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 remaining time is displayed.

⚠ CAUTION
Zero calibration should also be performed if the flowmeter indicates some 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 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 PRONT CONVER

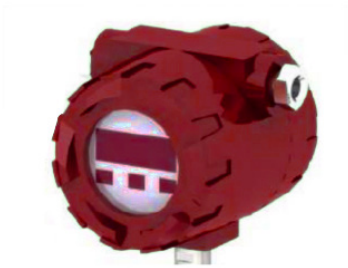
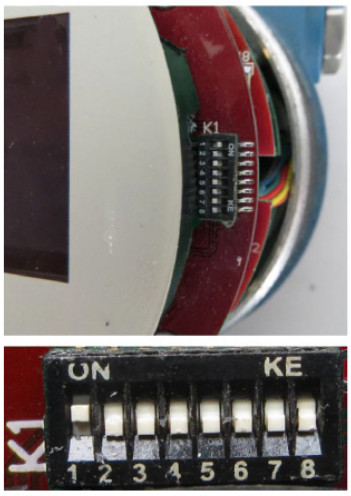


FIGURE 2.17 SWITCH BLOCK NO. 1 (AT “ON ” POSITIO)

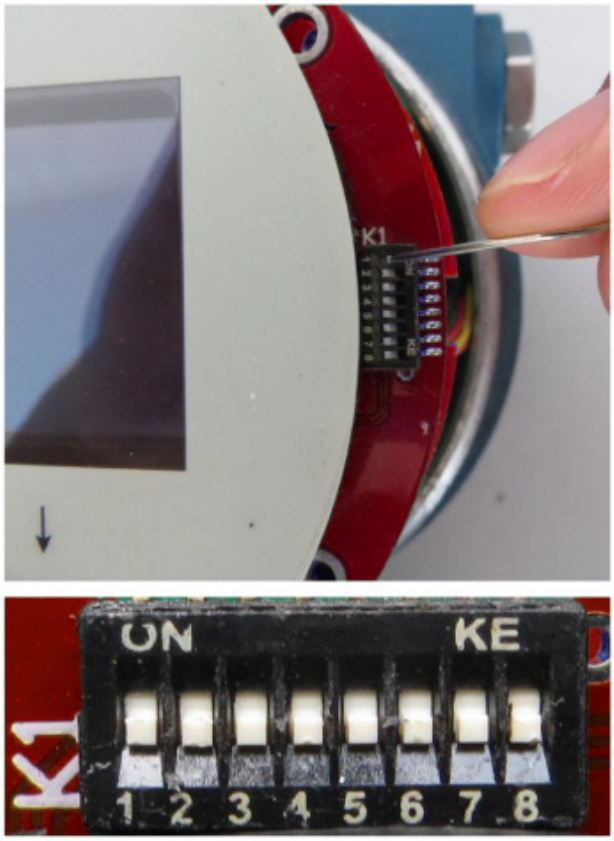


At factory switches 1 is set to ON (see Figure 2.17). In this position, the calibration parameters of the flowmeter cannot be changed, entering the menu section 5 “Calibration” and section 7 “System Para” is not available. Such a state of the switches is necessary to change of some Modbus registers through 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 entrance 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).

FIGURE 2.18 SET NO. 1 SWITCHE BLOCK TO OFF POSITION



2.5.6 MAINTENANCE

The flowmeter put into operation does 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 of 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 the flowmeters parts is visible.

Examination period for the flowmeter depends on operation conditions and 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 the paragraph 2.5.7 "Troubleshooting".

⚠ CAUTION

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

2.5.7 TROUBLESHOOTING

Possible faults, their probable reasons and repairing ways are presented in Table 2.8.

TABLE 2.8 - TROUBLESHOOTING

Fault	Probable reason	Repairing way
1. When the flowmeter is powered there is no indication on display nor any signal on the flowmeter's outputs.	Wrong connection of the power wires to the flowmeter. Power wires break. Power supply voltage does not meet the requirements of this manual.	Check the power cable connection according to the wiring diagram in **Appendix.** Check the power wires and replace them if needed. 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 286918919 \h * MERGEFORMAT Appendix 286918919 \h * MERGEFORMAT Appendix.** Check the computer's port used to connect the flowmeter to the computer through digital interface. Make sure that the same port number is set in the "Daniel®-Integrator" settings.
3. When there is a certain actual 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.
4. When there is no actual flow the flowmeter indicates a certain flow.	Deviation of the zero point because of temperature and pressure deviation from temperature and pressure values on previous zero calibration.	Perform zero calibration in accordance with the paragraph 2.5.4 "Zero point adjustment".
5. In the menu it is not possible to enter the "Calibration" and	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) for the time needed to perform changes in those sections.

A special LED indicator is provided for indication in case of some faults of the flowmeter. LED is located over the display and its color and lighting period depends on the kind of the flowmeter's fault according to 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	Wrong 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 range, Ohm
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

Reclamation act appearance and procedure of returning the faulty flowmeter and its warranty repair are descripted in the passport of the flowmeter.

3 TRANSPORTATION AND STORAGE

3.1 TRANSPORTATION

While transportation of the flowmeter it is recommended to follow these recommendations:

- The flowmeter should be transported in a transport container, which should protect the flowmeter from mechanical damage;
- It is recommended to lay a waterproof paper inside the transport container;
- Transportation should be performed at ambient temperatures from -40 to +70 °C, with relative humidity up to 100% non-condensing at 35 °C;
- Protection against atmospheric precipitation must be provided;
- Flowmeters can be transported by all kinds of roofed 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;
- Method of stacking the boxes on the transport vehicle must prevent their movement;
- The boxes must not be the object to sharp blows while loading / unloading;
- Period of stay in the transportation conditions must be not more than 3 months;
- After transportation at a temperature below 0 °C container with the flowmeter should be unpacked at least 12 hours after its storage in a warm room.

When the flowmeter is transported out of package it is necessary to follow recommendations given in Figure 3.1.

FIGURE 3.1 OUT OF PACKAGE TRANSPORTATION RULES

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 a transport boxes stacking of up to 3 boxes in height and also without package. For the long-term storage it is recommended to use the manufacturer's package.

3.3 UTILIZATION

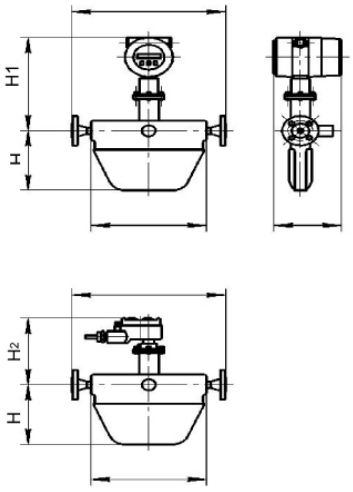
Flowmeters are free of harmful substances and components that are hazardous to human health and the environment during and after the life of the flowmeter and after utilization.

Utilization of the flowmeter is performed separately for groups of materials: plastic parts, metal parts and fastening parts.

4 VERIFICATION

Verification of the flowmeters is performed in accordance with the document "Instructions GSI. Daniel® Series Coriolis Mass Flowmeter. Verification procedure."

FIGURE A.4 OUTLINE DIMENSIONS AND CONNECTION OF FLOWMETER SENSOR M SIZE 1/2", 1", 1 1/2", 2" AND 3".



(1) Integral type- fig.A.4.1; Remote type- fig.A.4.2

(2) Flange connection sizes of the flowmeter are shown on the p. 76.

(3) Electronic transmitter dimensions of remote type flowmetrer are shown on the p. 74.

(4) Max pressure for flowmeters of ½"(Dn15mm) is up to 25Mpa;1"(Dn 025mm) is up to 16Mpa; 1 1/2"(Dn 040mm), 2" (Dn50mm) and 3"(Dn80mm) is up to 16MPa

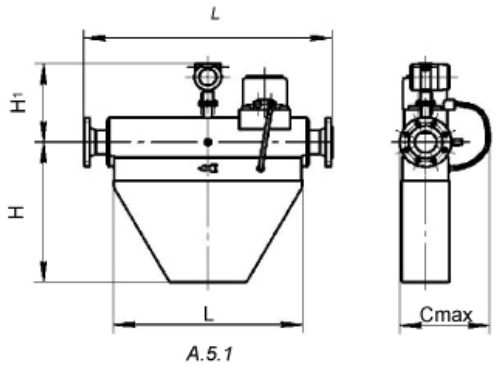
TABLE A.4 (METRIC UNITS)

Size	L, mm		D4*1, mm	H, mm	D4*1, mm	D4*2, mm	Cmax, мм	Weight, kg	
	≤300# (4 MPa)	≥600# (6.3 MPa)						A.4.1	A.4.2
1"(Dn25mm)	500	536	360	258	302	218	180	19	22
1 ½" (Dn40mm)	600	634	460	306	315	200	180	29	32
2"(Dn50mm)	800	828	640	410	325	200	180	42	45
3"(Dn80mm)	900	928	700	495	350	250	180	82	85

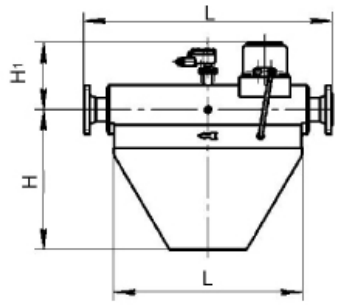
TABLE A.4 (US UNITS)

Size	L		L1	H	Display	
	≤300# (4 MPa)	≥600# (6.3 MPa)			H1	H2
1" (0.08 ft)	19.68" (1.64 ft)	21.10" (1.75 ft)	14.17" (1.18 ft)	9.84" (0.82 ft)	11.81" (0.98 ft)	9.05" (0.75 ft)
1 ½" (0.13 ft)	23.62" (1.96 ft)	24.96" (2.08 ft)	18.11" (1.50 ft)	11.81" (0.98 ft)	12.20" (1.01 ft)	9.44" ((0.78 ft)
2" (0.16 ft)	31.49" (2.62 ft)	32.59" (2.71 ft)	25.19" (2.09 ft)	16.14" (1.34 ft)	12.59" (1.04 ft)	9.84" (0.82 ft)
3" (0.26 ft)	35.43" (2.95 ft)	36.53" (3.04 ft)	27.55" (2.29 ft)	19.29" (1.60 ft)	13.77" (1.14 ft)	11.02" (0.91 ft)

FIG.A.5 - DIMENSIONS AND CONNECTION SIZES OF FLOWMETER SENSOR M (4”, 6” AND 8”,DN 100MM, 150MM AND 200MM)



A.5.1



A5.2

(1) Integral type- fig.A.5.1; Remote type- fig.A.5.2

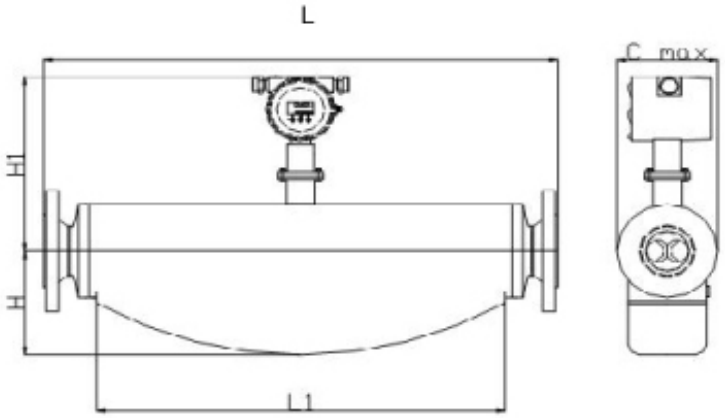
(2) Flange connection sizes of the flowmeter are shown on the p. 76. Electronic transmitter dimensions of remote type flowmetrer are shown on the p. 74.

TABLE A.5

Size	L, mm		D4*1, mm	H, mm	D4*1, mm	D4*2, mm	Cmax, мм	Weight, kg	
	≤300# (4 MPa)	≥600# (6.3 MPa)						A.5.1	A.5.2
4”(Dn100mm)	1130	1156	860	663	370	285	470	139	142
6”(Dn150mm)	1450	1490	1200	902	400	316	520	269	272
8”(Dn200mm)	1800	1844	1450	1170	426	342	570	434	437

Size	L		L1	H	Display	
	≤300# (4 MPa)	≥600# (6.3 MPa)			H1	H2
4” (0.32 ft)	44.48” (3.70 ft)	45.51” (3.79 ft)	33.85” (2.82 ft)	25.98” (2.16 ft)	14.56” (1.21 ft)	11.41” (0.95 ft)
6” (0.49 ft)	55.51” (4.62 ft)	57.08” (4.75 ft)	47.24” (3.93 ft)	35.43” (2.95 ft)	15.74” (1.31 ft)	12.99” (1.08 ft)
8” (0.65 ft)	70.86” (5.90 ft)	72.59” (6.04 ft)	57.08” (4.75 ft)	46.06” (3.83 ft)	16.53” (1.37 ft)	13.77” (1.14 ft)

FIG.A.6 - DIMENSIONS AND CONNECTION SIZES OF FLOWMETER (2", 3" AND 4") SENSOR S TYPE.



1) Integral type- fig.A.6.1; Remote type- fig.A.6.2

2) Flange connection sizes of the flowmeter are shown on the p. 76.

Electronic transmitter dimensions of remote type flowmetrer are shown on the p.74.

TABLE A.6

Size	L - in - mm			L1 in mm	H in mm	S in mm	H1	
	DIN 2501 (Mpa) OR ANSI B16.5 ≤4.0 or 300LB	DIN 2501 (Mpa) OR ANSI B16.5 ≥6.3 or 600LB	△L (mm) ±△L				Compact in mm	Remote in mm
1" (Dn25mm)	17.32 440	18.5 470	±4	11.42 290	5.71 145	2.76 70	12.44 316	8.58 218
1-1/2" (Dn40mm)	21.65 550	23.62 600		15.35 390	6.06 154	3.07 78	12.95 329	9.13 232
2 inch (Dn50mm)	31.5 800	32.83 834		23.15 588	7.87 200	4.02 102	13.58 345	9.84 250
3 inch (Dn80mm)	36.81 935	38.31 973		28.74 730	7.87 200	5.51 140	14.57 370	10.63 270
4 inch (Dn100mm)	44.49 1130	46.54 1182	±5	34.25 870	10.83 275	9.61 244	15.16 385	11.42 290

NOTES
ANSI B16.5 flanges • 150lb - 300lb dimensions complied with DIN PN16; PN25' and PN40, 600lb dimensions complied with DIN PN63

FIGURE A.11 OVERALL DIMENSIONS AND CONNECTION SIZE OF ELECTRONIC UNIT OF REMOTE TYPE.

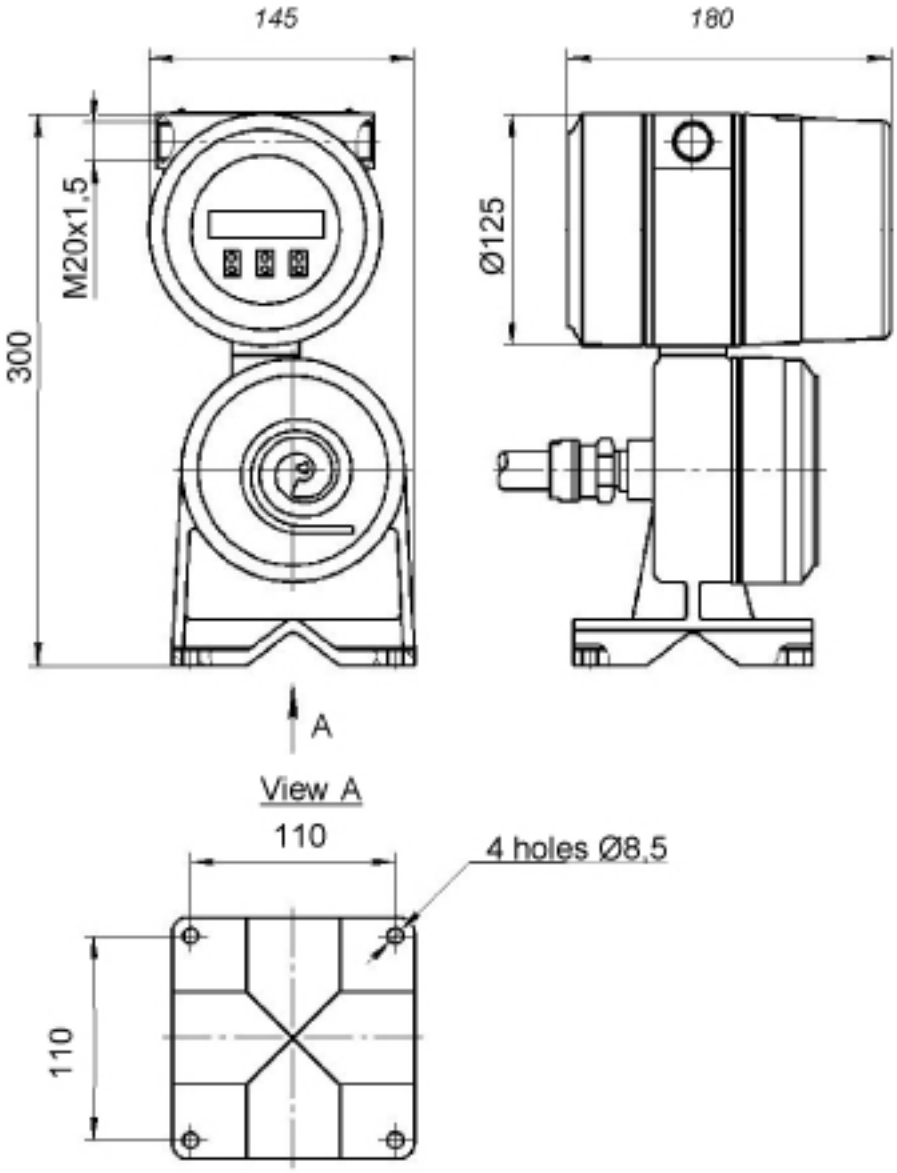


FIGURE A.12 BRACKET FOR FIXING REMOTE TYPE ELECTRONIC UNIT ON THE ASSEMBLY STAND

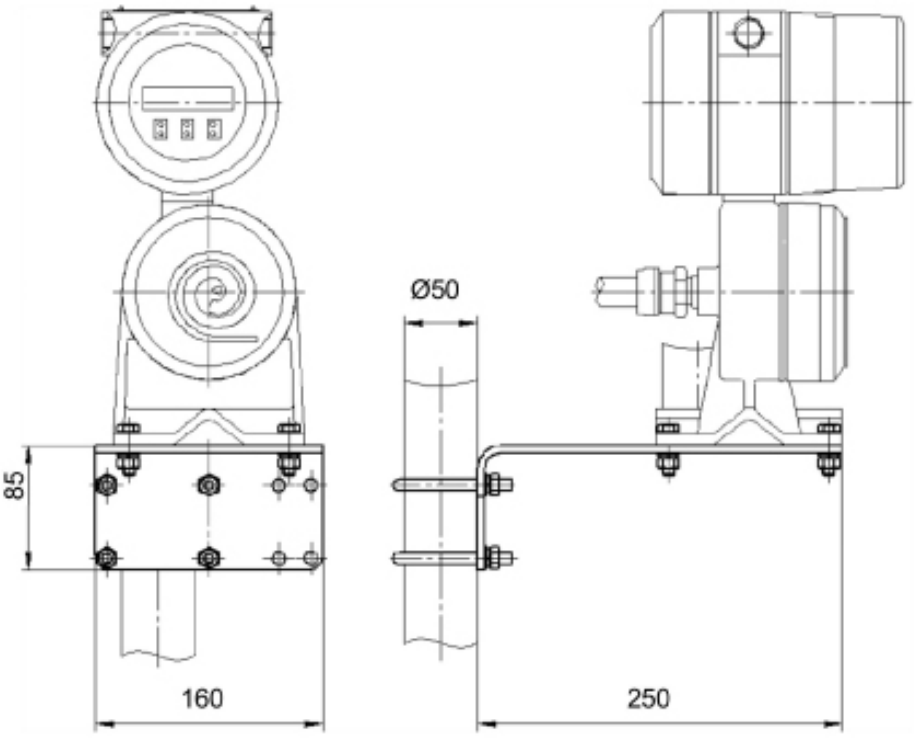


TABLE A.12 – SCOPE OF MOUNTING KIT FOR ELECTRONIC UNIT OF REMOTE TYPE

Parts	Quantity	Note
Bracket	1 pcs	
Clamp 50	2 pcs	For fixing on the assembly stand of Ø60 mm
Clamp 100	2 pcs	For fixing on the assembly stand of Ø110 mm
Bolt M8x30	4 pcs	For fixing electronic unit on the bracket
Nut M8	12 pcs	
Spring washer 8	12 pcs	
Washer 8	12 pcs	

Installation kit for remote type electronic unit is supplied by special order and addional cost.

FIGURE A.2 OUTLINE DIMENSIONS OF CONNECTION KIT FLANGES

Class 150 lb Weld Neck Flanges - ANSI B16.5

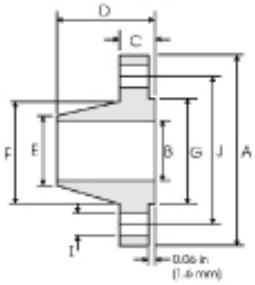


TABLE A.6 – CONNECTION KIT FLANGE DIMENSIONS AND WEIGHT

Pipe		Flange Data				Hub Data		Raised Face	Drilling Data		
Nominal Pipe Size		A	B	C	D	E	F	G	H	I	J
	Outside Diameter	Overall Diameter	Inside Diameter	Flange Thickness min	Overall Length	Diameter at Weld Bevel	Hub Diameter	Face Diameter	Number of Holes	Bolt Hole Diameter	Diameter of Circle of Holes
	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm		in mm	in mm
½"	0.840 21.30	3.500 88.90	0.620 15.70	0.440 11.20	1.880 47.80	0.840 21.30	1.190 30.20	1.380 35.00	4	0.620 15.70	2.380 60.45
1	1.315 33.40	4.250 108.0	1.050 26.70	0.560 14.20	2.190 55.60	1.320 33.50	1.940 49.30	2.000 50.80	4	0.620 15.70	3.120 79.25
1 ½"	1.900 48.30	5.000 127.0	1.610 40.90	0.690 17.50	2.440 62.00	1.900 48.30	2.560 65.00	2.880 73.15	4	0.620 15.70	3.880 98.60
2	2.375 60.30	6.000 152.4	2.070 52.60	0.750 19.10	2.500 63.50	2.380 60.45	3.060 77.70	3.620 91.90	4	0.750 19.10	4.750 120.7
3	3.500 88.90	7.500 190.5	3.070 78.00	0.940 23.90	2.750 69.85	3.500 88.90	4.250 108.0	5.000 127.0	4	0.750 19.10	6.000 152.4
4	4.500 114.3	9.000 228.6	4.030 102.4	0.940 23.90	3.000 76.20	4.500 114.3	5.310 134.9	6.190 157.2	8	0.750 19.10	7.500 190.5
6	6.625 168.3	11.00 279.4	6.070 154.2	1.000 25.40	3.500 88.90	6.630 168.4	7.560 192.0	8.500 215.9	8	0.880 22.40	9.500 241.3
8	8.625 219.1	13.50 342.9	7.980 202.7	1.120 28.40	4.000 101.6	8.630 219.2	9.690 246.1	10.62 269.7	8	0.880 22.40	11.75 298.5

FIGURE A.3 OUTLINE DIMENSIONS OF CONNECTION KIT FLANGES

Class 300 lb Weld Neck Flanges - ANSI B16.5

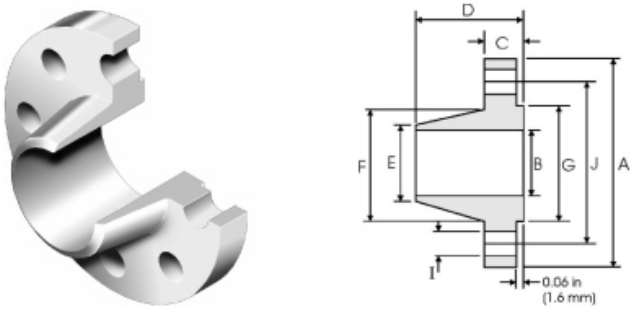


TABLE A.7 – CONNECTION KIT FLANGE DIMENSIONS AND WEIGHT

Pipe		Flange Data				Hub Data		Raised Face	Drilling Data		
Nominal Pipe Size		A	B	C	D	E	F	G	H	I	J
	Outside Diameter	Overall Diameter	Inside Diameter	Flange Thickness min	Overall Length	Diameter at Weld Bevel	Hub Diameter	Face Diameter	Number of Holes	Bolt Hole Diameter	Diameter of Circle of Holes
	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm		in mm	in mm
½"	0.840 21.30	3.750 95.20	0.620 15.70	0.560 14.20	2.060 52.30	0.840 21.30	1.500 38.10	1.380 35.00	4	0.620 15.70	2.620 66.55
1	1.315 33.40	4.880 123.9	1.050 26.70	0.690 17.50	2.440 62.00	1.320 33.50	2.120 53.80	2.000 50.80	4	0.750 19.00	3.500 88.90
1 ½"	1.900 48.30	6.120 155.4	1.610 40.90	0.810 20.60	2.690 68.30	1.900 48.30	2.750 69.85	2.880 73.15	4	0.880 22.30	4.500 114.3
2	2.375 60.30	6.500 165.1	2.070 52.60	0.880 22.30	2.750 69.85	2.380 60.45	3.310 84.00	3.620 91.90	8	0.750 19.00	5.000 127.0
3	3.500 88.90	8.250 209.5	3.070 78.00	1.120 28.40	3.120 79.25	3.500 88.90	4.620 117.3	5.000 127.0	8	0.880 22.30	6.620 168.1
4	4.500 114.3	10.00 254.0	4.030 102.4	1.250 31.70	3.380 85.80	4.500 114.3	5.750 146.0	6.190 157.2	8	0.880 22.30	7.880 200.1
6	6.625 168.3	12.50 317.5	6.070 154.2	1.440 36.50	3.880 98.50	6.630 168.4	8.120 206.2	8.500 215.9	12	0.880 22.30	10.62 269.7
8	8.625 219.1	15.00 381.0	7.980 202.7	1.620 41.10	4.380 111.2	8.630 219.2	10.25 260.3	10.62 269.7	12	1.000 25.40	13.00 330.2

FIGURE A.4 OUTLINE DIMENSIONS OF CONNECTION KIT FLANGES

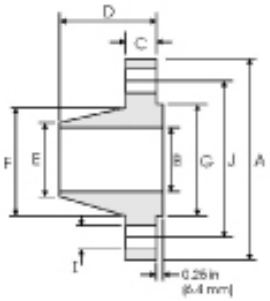


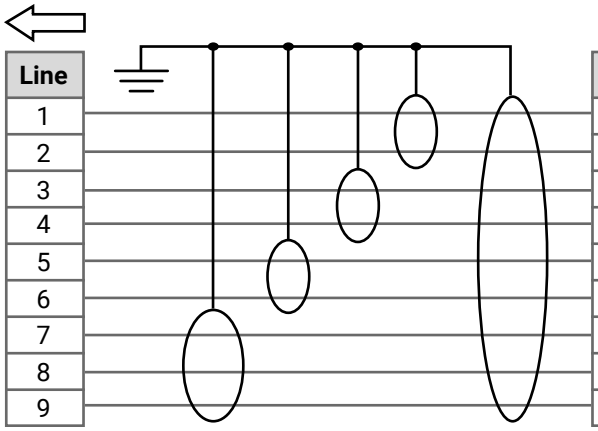
TABLE A.8 – CONNECTION KIT FLANGE DIMENSIONS AND WEIGHT

Pipe		Flange Data				Hub Data		Raised Face	Drilling Data			Weight
Nominal Pipe Size		A	B	C	D	E	F	G	H	I	I	
	Outside Diameter	Overall Diameter	Inside Diameter	Flange Thickness min	Overall Length	Diameter at Weld Bevel	Hub Diameter	Face Diameter	Number of Holes	Bolt Hole Diameter	Diameter of Circle of Holes	kg/ piece
	in mm	in mm	in mm	in mm	in mm	in mm	in mm	in mm		in mm	in mm	
½"	0.840 21.30	3.750 95.30	To be specified by Purchaser	0.560 14.20	2.060 52.30	0.840 21.30	1.500 38.10	1.380 35.00	4	0.620 15.70	2.620 66.55	0.87
1	1.315 33.40	4.880 124.0		0.690 17.50	2.440 62.00	1.320 33.50	2.120 53.80	2.000 50.80	4	0.750 19.10	3.500 88.90	1.76
1 ½"	1.900 48.30	6.120 155.4		0.880 22.40	2.750 69.85	1.900 48.30	2.750 69.85	2.880 73.15	4	0.880 22.40	4.500 114.3	3.49
2	2.375 60.30	6.500 165.1		1.000 25.40	2.880 73.15	2.380 60.45	3.310 84.10	3.620 91.90	8	0.750 19.10	5.000 127.0	4.36
3	3.500 88.90	8.250 209.6		1.250 31.75	3.250 82.60	3.500 88.90	4.620 117.3	5.000 127.0	8	0.880 22.40	6.620 168.1	8.53
4	4.500 114.3	10.75 273.1		1.500 38.10	4.000 101.6	4.500 114.3	6.000 152.4	6.190 157.2	8	1.000 25.40	8.500 215.9	17.4
6	6.625 168.3	14.00 355.6		1.880 47.80	4.620 117.3	6.630 168.4	8.750 222.3	8.500 215.9	12	1.120 28.40	11.50 292.1	34.9
8	8.625 219.1	16.50 419.1		2.190 55.60	5.250 133.4	8.630 219.2	10.75 273.1	10.62 269.7	12	1.250 31.75	13.75 349.3	53.9

APPENDIX B

B.1 WIRING DIAGRAMS

TRANSMITTER **SENSOR**



Line	Function	Line
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

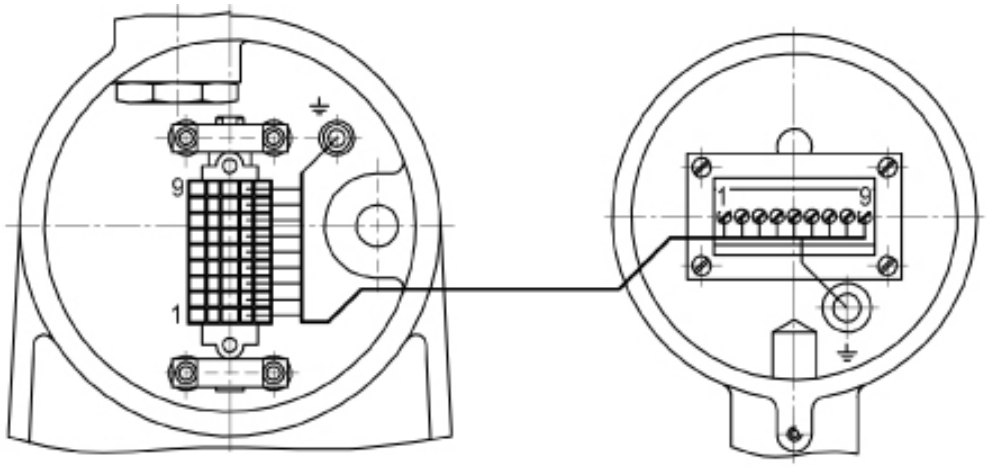


TABLE B1 WIRING COLOR DEMONSTRATION

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

B.2 WIRING

FIGURE C.2 – POWER SUPPLY CONNECTION

OUTPUT SIGNAL **POWER SUPPLY**

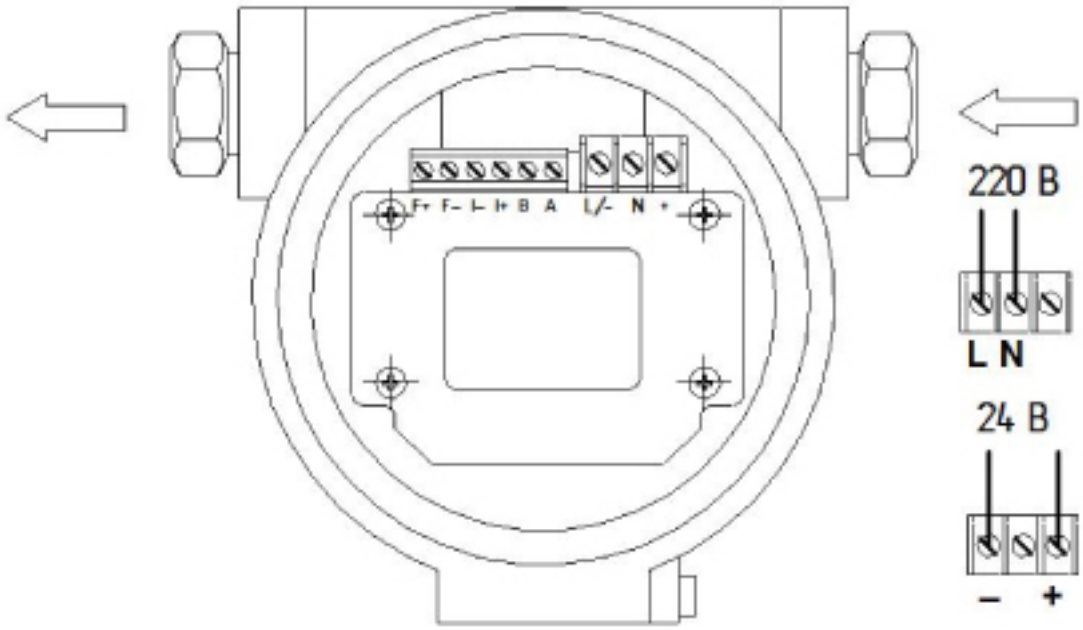
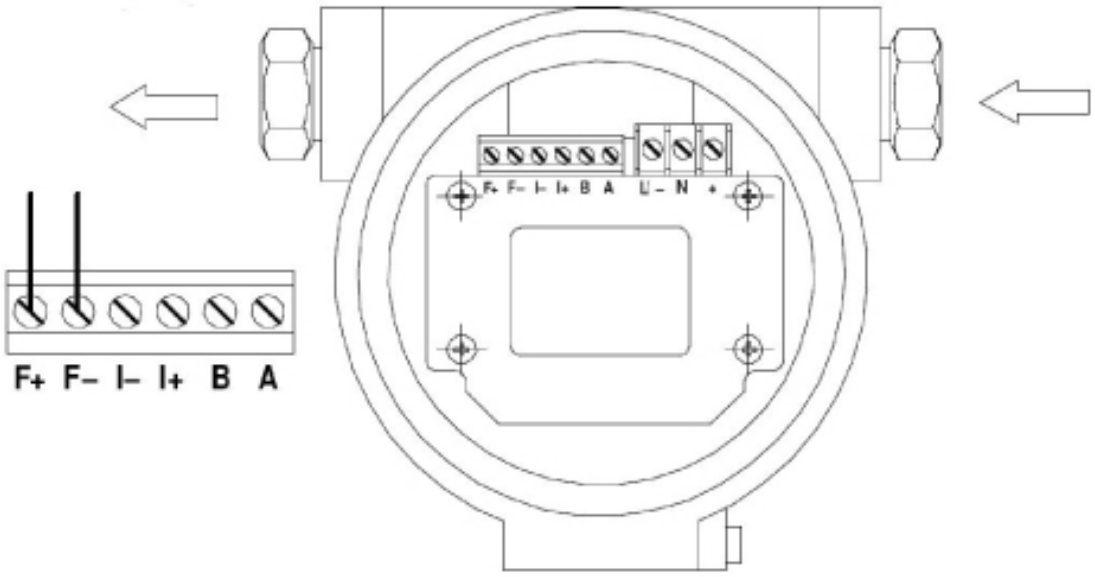


FIGURE C.3 – PULSE OUTPUT CONNECTION

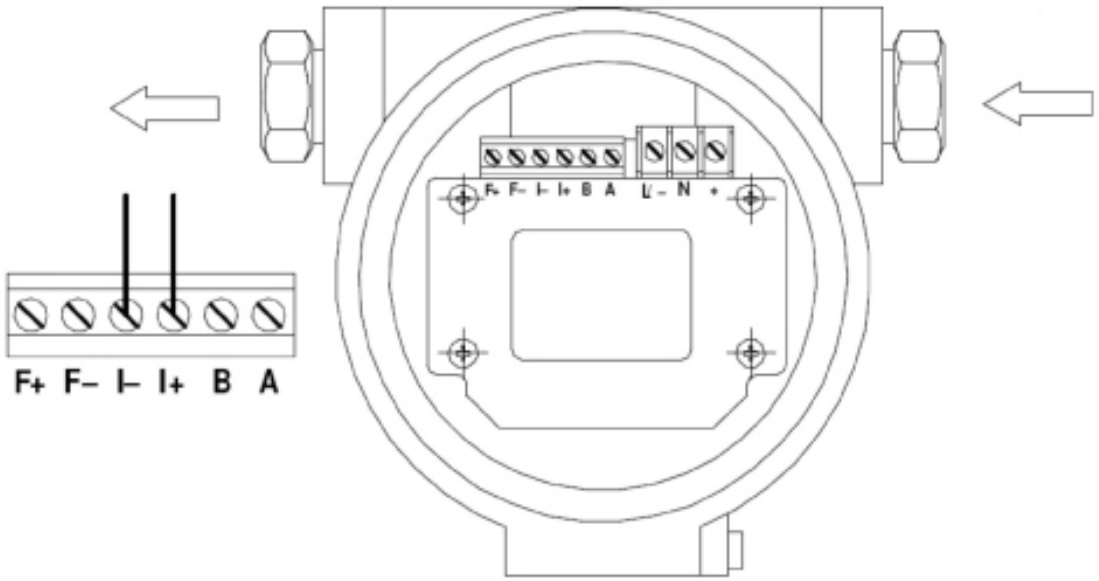
OUTPUT SIGNAL **POWER SUPPLY**



- Active pulse output can be configured to mass flow, volume flow, density or water ratio.
- The cable should be two-core cable and 24-gauge minimum. The maximum length of output line is 492 ft. (150 m).

FIGURE C.4 – CURRENT AND HART COMMUNICATION OUTPUT CONNECTION

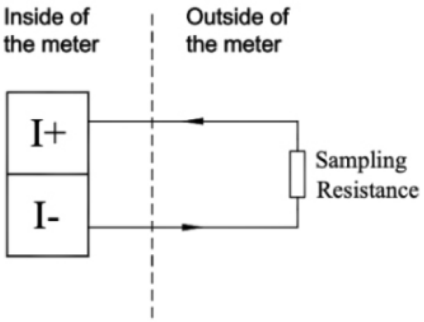
OUTPUT SIGNAL **POWER SUPPLY**



4-20 mA output can be configured to display mass flow, volume flow, density or water cut% or Brix° for special program.

- The cable should be two-core cable and 24-gauge minimum.
- **The factory default analog (4-20mA) output is Active current output.**

CURRENT OUTPUT WIRING C.4.1

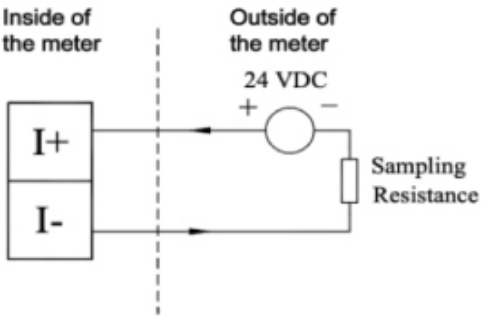


⚠ CAUTION

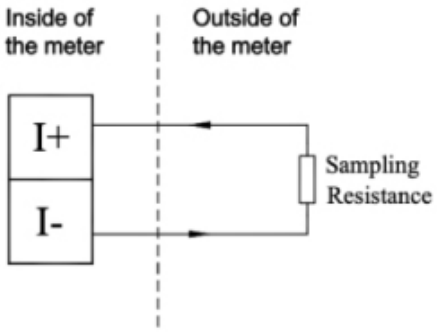
1. The 4-20 mA is configured as SOURCE, meaning that the meter provides the power to run the 4- 20mA. You can validate the meter by connecting a DVM in the Current measuring mode and reading 4 mA, or so, with nothing connected to the meter unless you switch it to PASSIVE.
2. See page B3 and B4 OR page 81-83 of the manual to make the meter SINK or passive, where you provide the voltage to the 4-20 mA signal.
3. Again, make sure you do NOT put 24 VDC into the terminals from the PLC or any device as it will void warranty.

B.3 PASSIVE OUTPUT AND ACTIVE OUTPUT

Passive output is that besides the sampling resistance, the outer power supply of 24VDC must be added so as to get the current output from the mass flowmeter the outer wiring of passive current output is as the figure show below C.4.2:



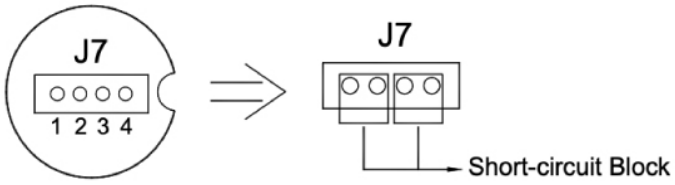
Active Output is that the current output is powered by the Mass Flowmeter itself. Only the sampling resistance is needed while collecting the current output signal as the figure show below C.4.3:



B.4 THE SWITCH BETWEEN PASSIVE OUTPUT AND ACTIVE OUTPUT

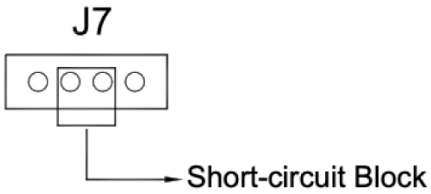
The switch between passive current output and active current output is realized by setting the jumpers of J7 on the output board(including 070401,04V1.00,04V1.01,04V1.02,04V1.03). If active current output is required, we need to short-circuit jumper 1 and 2, then jumper 3 and 4 as well. The illustration is in C4.4 :

FIGURE C4.4



If passive current output is required, we need to short-circuit jumper 2 and 3. The illustration is in Figure C4.5:

FIGURE C4.5



B.5 ACTIVE AND PASSIVE CURRENT OUTPUT

- Active current output is that the devices such as transmitters and signal generators have already been supported by power supply circuit of their own, so the 4~20mA signal could be directly output from the positive and negative terminal blocks, forming a signal circuit with the signal collecting device, which could measure the signal directly in this way.
- Passive current output is that the devices like the transmitters and signal generators have no supporting power supply circuit of themselves. Only when the signal collecting device could provide additional power supply to them, the 4~20mA signal could be output to be measured by the signal collecting device

FIGURE C.5 – DIGITAL OUTPUT CONNECTION

OUTPUT SIGNAL **POWER SUPPLY**

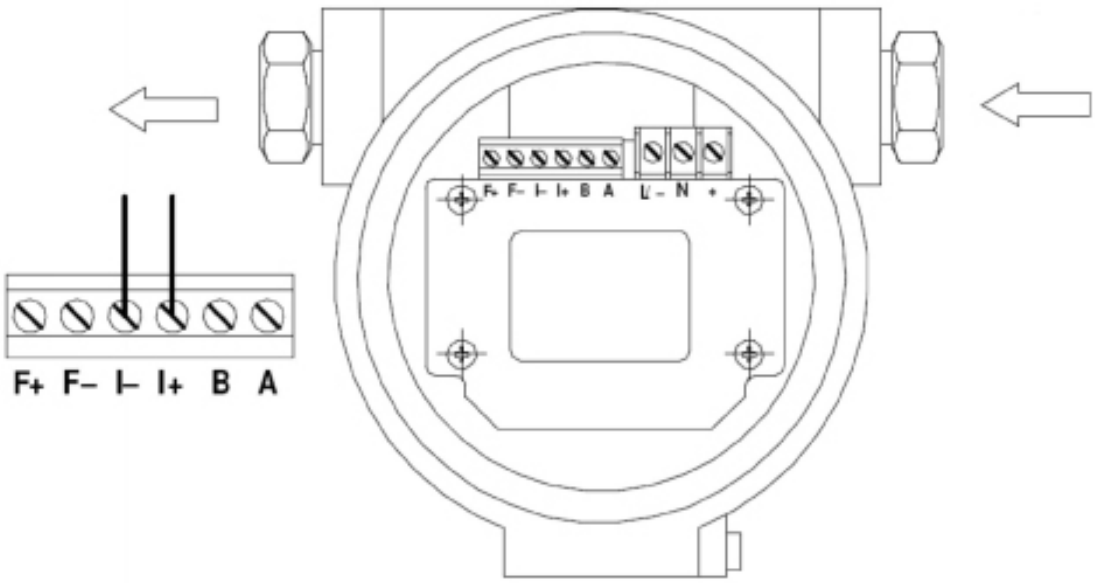
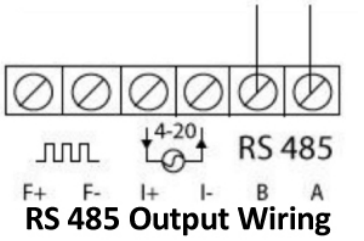


FIGURE C.6 – AMPLIFIER BOARD (FOR FLOWMETERS DN≥100).

RS 485 output is compatible to RTU mode of MODBUS protocol. The maximum length of output line is 985 ft. (300 m).



RS 485 Output Wiring

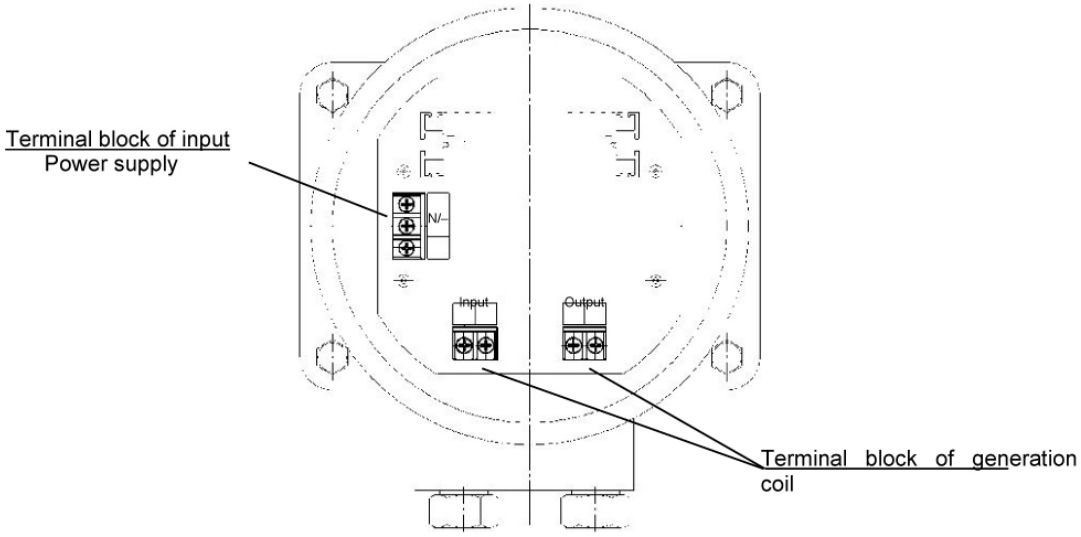
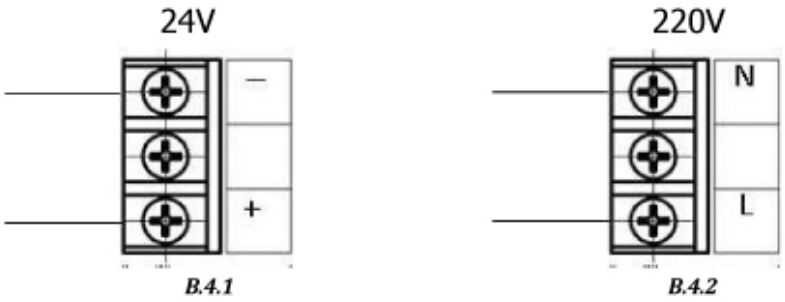


FIGURE C.7 – CONNECTION OF WIRINGS TO TERMINAL BLOCK OF AMPLIFIER (FOR FLOWMETERS DN≥100).

(1) «Input» and «Output» terminal blocks are used to connect generation coil.



B.4.1 *B.4.2*

(1) B.4.1 – for version with 24V DC power supply;

B.4.2 – for version with 220V AC power supply;

(2) Voltage of amplifier is the same as voltage of electronic display.

(3) L – phase wire; N – null wire.

APPENDIX C

MODBUS REGISTER MAP VERSION 2.XX

MODBUS REGISTER MAP VERSION V2.17(DANIEL® OWN VERSION)	
Interface mode	RS-485, asynchronous, half-duplex
Baud rate	1200, 2400, 4800, 9600 bit/s
Data format	1 start bit, 8 data bits, No parity bit and 1 or 2 stop bits (or 1 Odd Parity or Even Parity, and 1 stop bit). Can be set in the Menu items 30, 31. Default data format is 9600-8-N-1
Maximum length of data frame	1 byte address + 253 byte data + 2byte CRC = 256 Byt

FRAME STRUCTURE:

FUNCTION 01: READ COIL STATUS

QUERY:

Slave address	Function	Starting address		Coils quantity		CRC	
	01H	00H	08H	00H	08H		

RESPONSE:

Slave address	Function	Byte count	Coil status	CRC	
	01H	01H			

ERROR:

Slave address	Function	Error code	CRC	
	81H	01H		

Exception code:

01H: Function is not supported.

02H: Incorrect Starting address or Coils quantity.

03H: Coils quantity is out of range of 1 – 200.

04H: Failed to read coil.

FUNCTION 04: READ INPUT REGISTERS

QUERY:

Slave address	Function	Starting address		Registers quantity		CRC	
	04H						

RESPONSE:

Slave address	Function	Byte count	Data value		CRC	
	04H					

ERROR:			
Slave address	**Function**	**Error code**	**CRC**
	84H	01H	

Exception code:

01H: Function is not supported.

02H: Incorrect Starting address or Registers quantity.

03H: Registers quantity is out of range of 0 – 125.

04H: Failed to read registers.

FUNCTION 05: WRITE SINGLE COIL

QUERY:				
Slave address	**Function**	**Coil address**	**Data value**	**CRC**
	05H			

RESPONSE:				
Slave address	**Function**	**Coil address**	**Data value**	**CRC**
	05H			

ERROR:			
Slave address	**Function**	**Error code**	**CRC**
	85H	01H	

Exception code:

01H: Function is not supported.

02H: Incorrect Coil address.

03H: Data value is out of range of 0x0000 – 0xFF00.

04H: Failed to write single coil.

FUNCTION 06: WRITE SINGLE REGISTER

QUERY:				
Slave address	**Function**	**Register address**	**Data value**	**CRC**
	06H			

RESPONSE:				
Slave address	**Function**	**Register address**	**Data value**	**CRC**
	06H			

ERROR:

Slave address	Function	Error code	CRC	
	86H	01H		

Exception code:

01H: Function is not supported.

02H: Incorrect Register address.

03H: Data value is out of range of 0 – 65535.

04H: Failed to write single register.

FUNCTION 08: DIAGNOSTICS (SUPPORTS ONLY SUBFUNCTION CODE 00)

QUERY:

Slave address	Function	Subfunction		Data value		CRC	
	08H	00H	00H	xxH	xxH		

RESPONSE:

Slave address	Function	Subfunction		Data value		CRC	
	08H	00H	00H	xxH	xxH		

ERROR:

Slave address	Function	Error code	CRC	
	88H	01H		

Exception code:

01H: Function or subfunction is not supported.

03H: Incorrect Data value.

04H: Failed to diagnose.

FUNCTION 16: WRITE MULTIPLE REGISTERSCODE 00)

QUERY:

Slave address	Function	Starting address		Registers quantity		Byte count	Data value				CRC	
	10H			00H	02H	04H						

RESPONSE:

Slave address	Function	Starting address		Registers quantity		CRC	
	10H			00H	02H		

ERROR:			
Slave address	**Function**	**Error code**	**CRC**
	90H	01H	

Exception code:

01H: Function is not supported.

02H: Incorrect Starting address or Registers quantity.

03H: Registers quantity (N) is out of range of 1 – 123 or Byte count is not equal to N * 2.

04H: Failed to write multiple registers.

FUNCTION 17: REPORT SLAVE ID

QUERY:		
Slave address	**Function**	**CRC**
	11H	

RESPONSE:						
Slave address	**Function**	**Byte count**	**Slave ID**	**Run indicator status**	**Software version**	**CRC**
	11H	06H	AOH	FFH		

ERROR:			
Slave address	**Function**	**Error code**	**CRC**
	91H	01H	

Exception code:

01H: Function or subfunction is not supported.

04H: Failed to fetch Slave ID.

Minimal query period is 32 μs. Recommended period is 125 μs.

EXAMPLE OF QUERIES:

Read Reverse flow total count mode

QUERY:							
Slave address	**Function**	**Starting address**		**Coils quantity**		**CRC**	
41H	01H	00H	08H	00H	08H	B2H	CEH

RESPONSE:				
Slave address	**Function**	**Byte count**	**Coil status**	**CRC**
41H	01H	01H	00H	44H 48H

ERROR:				
Slave address	**Function**	**Error code**	**CRC**	
41H	81H	01H	80H	44H

Result: Reverse flow is subtracted from the totalizer values

RESET TOTALIZER (RESETTABLE)

QUERY:							
Slave address	**Function**	**Coil address**		**Data value**		**CRC**	
41H	05H	00H	02H	FFH	00H	23H	3AH

RESPONSE:							
Slave address	**Function**	**Coil address**		**Data value**		**CRC**	
41H	05H	00H	02H	FFH	00H	23H	3AH

ERROR:				
Slave address	**Function**	**Error code**	**CRC**	
41H	85H	01H	82H	84H

PERFORM ZERO CALIBRATION

QUERY:							
Slave address	**Function**	**Coil address**		**Data value**		**CRC**	
41H	05H	00H	04H	FFH	00H	C3H	3BH

RESPONSE:							
Slave address	**Function**	**Coil address**		**Data value**		**CRC**	
41H	05H	00H	04H	FFH	00H	C3H	3BH

ERROR:				
Slave address	**Function**	**Error code**	**CRC**	
41H	85H	01H	82H	84H

READ MASS FLOW RATE

QUERY:							
Slave address	**Function**	**Starting address**		**Registers quantity**		**CRC**	
41H	04H	00H	A7H	00H	02H	CEH	E8H

RESPONSE:

Slave address	Function	Byte count	Data value		CRC	
41H	04H	04H	43H	B4H	74H	D0H

ERROR:

Slave address	Function	Error code	CRC	
41H	84H	01H	83H	14H

Result: mass flow rate is 360.9126 kg/s

WRITE MASS UNIT OF KG

QUERY:

Slave address	Function	Register address		Data value		CRC	
41H	06H	00H	15H	00H	01H	57H	0EH

RESPONSE:

Slave address	Function	Register address		Data value		CRC	
41H	06H	00H	15H	00H	01H	57H	0EH

ERROR:

Slave address	Function	Error code	CRC	
41H	86H	01H	82H	74H

WRITE CALIBRATION COEFFICIENT K = 1100 G/S/MS

QUERY:

Slave address	Function	Starting address		Registers quantity		Byte count	Data value				CRC	
41H	10H	00H	63H	00H	02H	04H	44H	89H	80H	00H	44H	89H

RESPONSE:

Slave address	Function	Starting address		Registers quantity		CRC	
41H	10H	00H	63H	00H	02H	BFH	16H

ERROR:

Slave address	Function	Error code	CRC	
41H	90H	01H	8CH	14H

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 *
0001	WO	Output emulation 1 – Start output emulation	12
0003	WO	Reset totalizer (resettable) 1 – Reset totalizer	18
0004	WO	Reset totalizer (inventory) ** 1 – Reset totalizer	-
0005	WO	Zero calibration 1 – Start zero calibration	16
0009	RW	Reverse flow total count mode 0 – Subtract from the totalizer (default) 1 – Add to the totalizer	20
0011	RW	Oil-water analyze (pure oil counting) 0 – Off (default) 1 – On	52
0013	RW	Multipoint correction 0 – Off 1 – On	81
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 *
0002	RW	Menu language ** 1 – English (default) 2 – Russian	80
0003	RW	Register map version ** 1 – Daniel® (default) 2 – ProLink	-
0012	RW	Current output 0 – Mass flow rate (default) 1 – Volumetric flow rate 2 – Density	27
0013	RW	Modbus Baud rate 0 – 9600 bit/s (default) 1 – 4800 bit/s 2 – 2400 bit/s 3 – 1200 bit/s	29
0014	RW	Pulse output 0 – Mass flow rate (default) 1 – Volumetric flow rate 2 – Density	25
0015	RW	Zero correction	67
0016	RW	Reserved ***	
0017	RW	Flow direction 0 – Single direction (default) 1 – Bidirectional	19
0018	RW	Mass flow rate unit 0 – g/s 1 – kg/s 2 – kg/min 3 – t/day 4 – kg/h (default) 5 – t/h	33
0019	RW	Density unit 0 – g/cm^3 (default) 1 – kg/L 2 – kg/m^3	36
0020	RW	Temperature unit 0 – °C (default) 0 – F	37
0021	RW	Volumetric flow rate unit 0 – mL/s 1 – L/s 2 – L/min 3 – m^3/day 4 – L/h 5 – m^3/h (default)	35
0022	RW	Mass total unit 0 – g 1 – kg 2 – t (default)	32

Address	Mode	Description	Menu item *
0023	RW	Volume total unit 0 – mL 1 – L 2 – m^3(default)	34
0023	RW	Modbus slave address	28
0257	RO	Calculated pressure from external pressure sensor (Bar)	-
0267	RW	Coefficient of pressure compensation for flow (% / PSI)	40
0269	RW	Coefficient of pressure compensation for density (% / PSI) ***	-
0271	RW	Flow calibration pressure (Bar)	-
0273	RW	Pressure relating to 4 mA (Bar) ***	-
0275	RW	Pressure relating to 20 mA (Bar) ***	-
0451	RW	Input external pressure (Bar)	41
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

* 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.

*** Reserved for future modifications.

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 *
0100 0101	RW	Calibration coefficient (g/s/μs)	60
0102 0103	RW	Temperature correction coefficient for flow (% / 100°C)	61
0104 0105	RW	High density for density calibration (g/cm^3)	62
0106 0107	RW	Period for high density (μs)	63
0108 0109	RW	Low density for density calibration (g/cm^3)	64
0110 0111	RW	Period for low density (μs)	65
0112 0113	RW	Temperature correction coefficient for density (% / 100°C)	66
0114 0115	RW	Pulse weight	24
0116 0117	RW	Value relating to 20 mA	26
0118 0119	RW	Low flow cutoff (kg/h)	17
0120 0121	RW	Zero point (μs)	16
0122 0123	RW	Density of pure oil under standard conditions (g/cm^3)	53
0124 0125	RW	Density of pure water under standard conditions (g/cm^3)	54
0126 0127	RW	Flow compensation by percentage of gas in the oil-water	55
0128 0129	RW	Flow compensation by percentage of pure water in the oil-water	56 ***
0130 0131	RW	Correction coefficient of the temperature (for simulation mode)	76
0132 0133	RW	Zero temperature (for simulation mode)	77
0134 0135	RW	Correction coefficient of the density (for simulation mode)	78
0136 0137	RW	Zero density (for simulation mode)	79
0138 0139	RW	Time delay for point 0, D0 (μs)	84
0140 0141	RW	Time delay for point 1, D1 (μs)	
0142 0143	RW	Time delay for point 2, D2 (μs)	
0144 0145	RW	Time delay for point 3, D3 (μs)	
0146 0147	RW	Time delay for point 4, D4 (μs)	
0148 0149	RW	Time delay for point 5, D5 (μs)	
0150 0151	RW	Time delay for point 6, D6 (μs)	
0152 0153	RW	Time delay for point 7, D7 (μs)	
0154 0155	RW	Correction coefficient for point 0, K0	85
0156 0157	RW	Correction coefficient for point 1, K1	
0158 0159	RW	Correction coefficient for point 2, K2	
0160 0161	RW	Correction coefficient for point 3, K3	
0162 0163	RW	Correction coefficient for point 4, K4	
0164 0165	RW	Correction coefficient for point 5, K5	
0166 0167	RW	Correction coefficient for point 6, K6	
0168 0169	RO	Mass flow rate (kg/h)	1
0170 0171	RO	Density (g/cm^3)	3
0172 0173	RO	Temperature (°C)	3
0174 0175	RO	Volumetric flow rate (L/s)	2
0176 0177	RO	Mass total (kg)	1
0178 0179	RO	Volume total (L)	2
0180 0181	RO	Current value on the current output (mA)	71

Address	Mode	Description	Menu item *
0182 0183	RO	Frequency of the signal on the pulse output (Hz)	71
0184 0185	RO	Measuring tubes oscillation frequency (Hz)	68
0186 0187	RO	Left coil voltage (mV)	69
0188 0189	RO	Right coil voltage (mV)	69
0190 0191	RO	Drive coil load (%)	69
0202 0203	RO	Internal temperature	70

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

*** Reserved for future modifications.

With over 90 years of experience, Daniel is the only manufacturer that has the knowledge and experience to engineer and offer superior products that are trusted to provide the most reliable and accurate measurements in the global oil and gas industry.

Contact Us
Email: sales@Daniel.com
Phone: +1 (346) 509-3700

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