PIEZUS

ELECTROMAGNETIC FLOWMETERS

NovaMAG Pro

Operation manual

38978553.407111.010

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This Operation Manual applies to **NovaMAG Pro Electromagnetic Flowmeters** (hereinafter referred to as Flowmeter, Instrument, Item) and includes technical specifications, operation description and information about the main operating instructions of flowmeters to be studied by maintenance personnel.

Flowmeters are manufactured as per 38978553.407111.010 TU Technical Specifications in general purpose design or explosion-proof design, for various pipeline dimension types, in compact, remote, and combined design that differs in body design and other parameters. Explosion-proof flowmeters have combined explosion-proof type: intrinsically safe electric circuits of "ia" level as per GOST 31610.11 and d flameproof enclosures as per GOST IEC 60079-1.

The design includes flow part (sensor based on electromagnetic transducer), and transmitter that processes the received information. Overall and installation dimensions are given in Appendix B.

Based on classification as per GOST R 52931, flowmeters are subdivided as follows:
– by the type of energy used, they belong to electrical devices;
– intended for information communication with other devices;
– by resistance to atmospheric pressure, they comply with Group P1;
– by resistance to vibration, they belong to Group N2.

Further in the text, the following abbreviations are used:

APCS – automated process control system.
ADC – analog-to-digital converter.
URL – upper range limit.
Dn – nominal diameter of a pipeline channel with an installed sensitive element – a sensor.
MR – flowmeter measurement range.
PC – personal computer (IBM-compatible).
SW – software.
PFT – primary flow transducer.
EM – electronic module (converts signals from the sensor and processes them according to a program settings)
AC – alternating current.
DC – direct current.
Q – volumetric flow rate measured value.
Q_t – $Q_t=3 \cdot Q_{min}$ – transition flow.
Q_{nom} – nominal value of volumetric flow rate.
Q_{max} – maximum measurement value of volumetric flow rate as per passport.
Q_{min} – minimum measurement value of volumetric flow rate.
V – the volume of liquid passed through the pipeline cross-section.

1 Use and Field of Application

1.1 The flow meter is designed for technical and commercial metering of the average volumetric flow rate (Q) and volume (V) of liquid passing through the sensor in the forward and/or reverse direction by providing the following:

– display of measurement results on the LCD indicator;
– transmission of the measured value in the form of standardized output electrical signals: pulse, frequency (0.1…3000 Hz), current (4…20 mA);
– keeping measurement log in non-volatile memory;
– transmission of measured values and archived data via RS-485 or Ethernet interfaces to external APCS systems;
– transmission of data via standard digital interfaces or a radio channel.

1.2 The flowmeter complies with the requirements of GOST R 52931, TR CU 004/2011 On Safety of Low-Voltage Equipment, TR CU 020/2011 Electromagnetic Compatibility, TR CU 032/2013 On Safety of Equipment Operating under Gauge Pressure, GOST 28723, GOST R IEC 61326-1.

1.3 Explosion-proof flow meters additionally comply with the requirements of TR CU 012/2011 On Safety of Equipment Intended for Use in Explosive Atmospheres.

1.4 Application - at installations and facilities of the heat and power industry, in housing and utilities infrastructure, water treatment, water supply, metallurgy, pulp and paper, chemical and other industries.

2 Specifications

2.1 Basic features

2.1.1 The permissible nominal diameter (DN) of the measuring section of the sensor pipeline depends on the connection type:

– flange connection from 2 to 1600 mm;
– connection without flanges (sandwich) from 2 to 200 mm;
– taper socket with grooved union nut DIN11851 (sanitary version), Tri-Clamp DIN 32676 from 15 to 150 mm;
– threaded connection from 2 to 8 mm (and others on request);
– herringbone-type hose adapter from 2 to 8 mm (and others on request).

2.1.2 The dynamic range of liquid flow measurements and measurement errors depend on the design version accuracy class (A, A1, B, B1, C, C1, D, D1). Basic performance parameters of the flowmeters are given in Table 2.1.

2.1.3 The flow meter data outputs have the parameters specified in Table 2.2.

Table 2.1 Performance parameters

Parameter Name	Value for accuracy class			
	A (A1)	**B (B1)**	**C (C1)**	**D (D1)**
Nominal diameter (Dn), mm	from 5 to 1600	from 2 to 1600	from 2 to 1000	from 2 to 1000
Dynamic range, minimum	1:250 (1:200)	1:125 (1:100)	1:62.5 (1:50)	1:30 (1:25)
Limits of permissible reduced to transition flow rate measurement error of volumetric flow rate in flow rate ranges, %: $Q_{min} \le Q < Q_t$ 1)	±1	±0.5	±0.25	±0.2
$Q_{min} \le Q < Q_t$ for flowmeters with Dn from 2 to 8 mm	±1	±0.5	±0.3	±0.25
$Q_{min} \le Q < Q_t$ during simulated calibration 2) with Potok-T simulation bench	±1	±0.6	±0.5	±0.5
$Q_{min} \le Q < Q_t$ during simulated calibration with Artcheck simulation device	±1	±0.75	±0.75	±0.75
Limits of permissible relative error in measuring volumetric flow rate and volume, flow rate ranges, %: $Q_t \le Q \le Q_{max}$ 3)	±1	±0.5	±0.25	±0.2
$Q_t \le Q \le Q_{max}$ for flowmeters with Dn from 2 to 8 mm	±1	±0.5	±0.3	±0.25
$Q_t \le Q \le Q_{max}$ during simulated calibration with Potok-T simulation bench	±1	±0.6	±0.5	±0.5
$Q_t \le Q \le Q_{max}$ during simulated calibration with Artcheck simulation device	±1	±0.75	±0.75	±0.75
Volumetric flow measurement range, m^3/hr	from 0.0011 to 90477.9			
Operating range of frequency output, Hz	from 0.1 to 3000			
Limits of permissible relative error in reproducing the volumetric flow rate value by frequency output, %	±0.05			
Output current signal, mA	from 4 to 20			
Limits of permissible reduced to the range of current output error of conversion of volumetric flow rate into current output signal, %	±0.5 ±0.05 (option)			

Notes: 1) Q_t – transition flow rate, $Q_t = 3 \cdot Q_{min}$;
2) Simulated calibration can be applied to flowmeters with Dn 20 mm and bigger;
3) Q_{max} is maximum flow rate value, specified in the operation manual and the flowmeter passport.

Table 2.2 Parameters of data outputs

Pulse output (Digital Out):	
Passive transistor key with permissible load, max	25 V / 50 mA
Maximum pulse repetition frequency	Max 50 pulse/s
Pulse duration	from 20 to 500 ms
Pulse weight	up to 2500 l
Communication cable length, max	1200 m
Galvanic isolation	available (500 V)

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Isolation resistance, min	40 MOhm

Table 2.2 continued

Frequency output (Digital Out):	
Passive transistor key with permissible load, max	25 V / 50 mA
Signal frequency in the range	0.1…3000 Hz
Communication cable length, max	1200 m
Galvanic isolation	available (500 V)
Isolation resistance, min	40 MOhm
Analog current output (Analog Out):	
Signal range (linearly increases with flow rate increase)	4…20 mA (2-wire)
Type of output operation (selected on order)	active or passive
External supply voltage of the current loop for passive output	12 to 30 V (DC)
Load resistance*	up to 250 Ohm
Communication cable length, max	3000 m
Galvanic isolation	available (500 V)
Isolation resistance, min	40 MOhm
HART interface (option for analog current output):	
External supply voltage of the current loop for passive output	24 to 36 V (DC)
Data transfer protocol	HART version 7 and higher
Data transfer rate	1200 bps
Communication cable length, max	1500 m
RS-485 Interface:	
Data transfer protocol	ModBus RTU
Data transfer rate	9600, 19,200, 38,400 bps
Communication cable length, max	1200 m
Galvanic isolation	available (500 V)
Isolation resistance, min	40 MOhm
Ethernet 100Base-T Interface (option):	
Data transfer protocol	ModBus TCP
Data transfer rate	100 Mbps
Communication cable length, max	100 m
Galvanic isolation	available (500 V)

Isolation resistance, min	40 MOhm

* If HART interface is available, the load resistance in the circuit is minimum 250 Ohm.

Note – The insulation resistance value is specified under normal conditions:
ambient air temperature (20 ±5) °C, relative humidity maximum 80%.

2.2 Additional options

2.2.1 The front panel of the electronic unit has an indicator and five control buttons – the purpose of all elements is specified in Section 6 (in the compact **(Option K) and remote (Option PA)** version, the front panel inside the housing can rotate 360°, while no force must be applied to prevent the connecting wires break due to twisting). **In the compact version (Options KM, KS) and remote version (Options PAM, X, XS, XSS), the front panel does not rotate.**

2.2.2 The flow meter is powered, depending on the version, as follows:
– from direct current with a voltage of 18-36 V (nominal 24 V) (12-48 V (nominal 24 V) on request, optionally);
– from alternating current circuit with a frequency of 50 Hz with a voltage of 110 to 250 V (nominal 220 V).

2.2.3 Power consumption, maximum 9 VA (9 W - for direct current).

2.2.4 The design parameters of the flow meter are specified in Table 2.3.

Table 2.3 Basic design parameters

Name	Value (properties)
Design version: – compact	sensor and EM are combined in one housing
– remote	sensor and electronic module (EM) are connected by a cable up to 50 m long
– combined	sensor and the EM are connected by a cable up to 1200 m
Mechanical connection of sensor to pipeline (Appendix B)	flanged
	without flanges (sandwich type)
	taper socket with grooved union nut
	threaded connection
	herringbone-type hose adapter
Electrical connections	Cable glands
Parts in contact with medium	Sensor lining and electrodes
Sensor lining material (selected on request)	hard rubber (-20…+80 °C)
	(PTFE -40…+150 °C)
	PPS (-20…+220 °C)
	PFA (-40…+180 °C)
	PU (-60…+80 °C)
	FEP (F46) (-40…+120 °C)
Sensor electrodes material	stainless steel 03X17H14M3 (or analog AISI 316)
	titanium

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Table 2.3 continued

Name	Value (properties)
Sensor electrodes material (Other materials are optional)	tantalum
	platinum
	hastelloy
	tungsten carbide
Protection grade of components as per GOST 14254-2015	for compact version: IP65; IP67
	for remote and combined versions: a) electronic module: IP65; IP67; IP68 b) sensor: IP65; IP67; IP68
	for sanitary version: IP65; IP67; IP68
Explosion protection of Ex-version	a) primary transducer (in remote version): 1Ex db ia IIC T6…T4 Gb X b) digital transducer (in remote version): 1Ex db [ia] IIC T6 Gb X c) compact version flowmeter: 1Ex db IIC T6…T4 Gb X
Overall dimensions	in Appendix B
Weight of components	a) sensor: 2 to 1200 kg (depends on Dn); b) EM: maximum 3.5 kg (compact version 1); maximum 2 kg (compact version 2)

2.2.5 The flowmeter functional specifications are specified in Table 2.5.

Table 2.5 Functional specifications

Name	Value (properties)
Straight sections of pipeline for connection of the flowmeter sensor (form the middle of PFT), minimum	minimum 5×Dn to the center, 3×Dn after the flowmeter sensor
Operation Mode	continuous
Switching on time	5 s
Operating mode establishment time after switching on	max 15 min
Indication of measurement information and messages*	2 lines of 16 characters
Reading interval on the indicator	up to 15 s
Vibration resistance as per GOST R 52931	Group N2**
Vibration resistance in transport packaging as per GOST R 52931	Group F3

* Displays the values of volumetric flow rate, accumulated volume in both directions and the flow rate balance value, diagnostic messages in the form of an error code (Appendix E) and the setup menu (Appendix F).
** Vibration in the range from 10 to 55 Hz with an amplitude of up to 0.35 mm.

2.3 Operation conditions

Measured medium:

– conductive liquids with a minimum conductivity of 5 μS/cm (20 μS/cm for demineralized water): drinking, industrial and heating water, waste water, various aqueous solutions, food products, pulps and similar mixtures;
– solid particle content of more than 5% is allowed upon agreement with the manufacturer, must be specified when placing an order. Recommended solid particle content by weight shall be maximum 5% (without crystallizing impurities) for normal operation of the flow meter;
– range of operating flow rates from 0.05 to 12.5 m/s;
– operating pressure maximum 10 MPa;
– depending on the sensor lining material, the working fluid temperature shall be from -60 to +180 °C;
– for explosion-proof design, the temperature range according to the explosion protection level specified in Table 2.5.

Table 2.5 Temperature range of the measured medium depending on the explosion protection level of the compact flowmeter

Ex marking	T4	T5	T6
Compact version flowmeter			
1Ex db IIC T6…T4 Gb X	-60…+125 °C	-60…+90 °C	-60…+75 °C

Operating conditions:

– explosion-proof and explosion-hazardous areas without aggressive vapors and gases;
– atmospheric pressure from 84 to 106.7 kPa (from 630 to 800 mm Hg), which corresponds to an altitude of maximum 1000 m above sea level;
– relative air humidity at +35 °C, max: 98%, without moisture condensation;
– ambient temperature from -60 to +70 °C
– for explosion-proof flowmeter, ambient air temperatures for integral and remote versions are specified in Table 2.6.

Table 2.6 Temperature range depending on explosion protection level

Ex marking	T4	T5	T6
1Ex db ia IIC T6…T4 Gb X (primary transducer / remote ver.)	-40…+80 °C	-40…+80 °C	-40…+75 °C

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Table 2.6 continued

Ex marking	T4	T5	T6
1Ex db [ia] IIC T6 Gb X (electronic transducer / remote version)	–	–	-40…+75 °C
1Ex db IIC T6…T4 Gb X (compact version)	-40…+80 °C	-40…+80 °C	-40…+75 °C

Explosion-proof version flow meters can be installed in B-I and B-II explosion-hazardous areas and outdoor installations of T4…T6 temperature classes in accordance with general regulatory documents governing the use of electrical equipment in explosive conditions.

Normal conditions:

– ambient air temperature +(20 ± 5) °C;
– permissible media temperatures +(20 ±5) °C;
– relative air humidity from 45 to 80%, without moisture condensation;
– atmospheric pressure from 84 to 106.4 kPa (630 to 800 mm Hg).

2.4 Resistance to interferences and electromagnetic emission

In terms of resistance to industrial radio interference, the flow meter complies with the performance criterion A as per GOST R IEC 61326-1.

In terms of radio interference emission, the flow meter complies with the standards established for class B equipment as per GOST R 51318.22.

The flow meter is resistant to alternating magnetic fields with a frequency of (50 ±1) Hz and a strength of up to 400 A/m.

3 Features of the device and operation features

3.1 Mechanical specifications

3.1.1 The flowmeter design consists of two components: a sensor (mounted directly in the pipeline) and an electronic module (EM), which processes the measurement signal.

3.1.2 The flowmeter is available with the following versions of parts: compact, remote or combined. In the compact design, the EM is fixed with help of a tubular bracket on the sensor pipeline (monoblock design). In the remote design the sensor and EM are connected by a special shielded cable up to 200 m long. In the combined design, the electronics are partially located in the sensor termination box and are connected to EM by an electric cable with a length up to 1200 m.

3.1.3 For the remote design, the EM housing is made of plastic in a moisture-proof design, with a transparent cover through which it is possible to see indicator that displays the results of measurement. The housing can be fixed on a DIN rail (35 mm) or on a wall. A remote design of the components is preferable if access to the installation location in the pipeline is difficult, as well as when installing the sensor outdoors, at high temperatures of the measured medium or when pipeline vibrations may occur.

3.2 Measurement principle

3.2.1 The flowmeter's sensitive element is the flow part of the pipe made of a non-magnetic material coated inside with dielectric insulation (lining), placed between the electromagnet poles.

3.2.2 The flowmeter sensor operation is based on Faraday's law of electromagnetic induction, according to which electromotive force is induced in a conductor moving in a magnetic field. The role of the moving conductor in the flow part of the sensor is played by an electrically conductive liquid, the magnetic field is created by coils, and the electromotive force is taken from the measuring electrodes. The measured electromotive force is proportional to the average velocity (v) of the flow in the pipeline, and if cross-section is known, then to the volumetric flow rate, Figure 3.1.

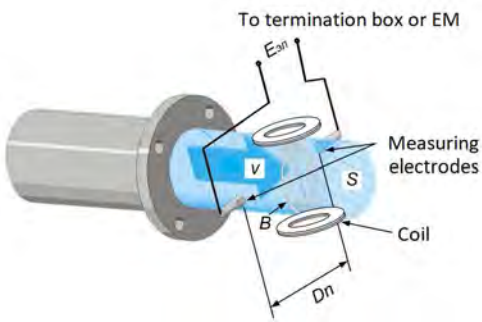

Figure 3.1 Explanation of the electromagnetic sensor operation (distance between the ends of the measuring electrodes is compliant with the internal diameter of the pipe Dn); *B* is magnetic induction (magnetic field)

The voltage induced on the measuring electrodes ($E_{эл}$) is determined by the formula

$$E_{el} = \varepsilon \cdot v \cdot B \cdot Dn \qquad (1)$$

where ε is a constant; *v* is the speed of the fluid, m/s;

B is magnetic induction (magnetic field strength), T;

Dn is nominal diameter of the pipeline channel, m.

The value of the fluid flow rate is determined, with a known cross-section of the flow part channel (*S*), using formula

$$Q = K \cdot S \cdot E_{\boldsymbol{EL}} = K \cdot \pi \cdot \frac{D_n^2}{4} \cdot \varepsilon \cdot v \cdot B \cdot D_{\mathrm{y}}\,, \qquad (2)$$

where Q is the instant flow rate, m^3/s;

K is the calibration constant;

S is the cross-sectional area of the pipeline flow part, m^2;

E_{EL} is voltage on the measuring electrodes.

3.3 Device operation

3.3.1 Signal from the main sensor electrodes enters the EM, where it gets amplified and processed (converted into digital), output signals with flow rate information are generated. Information on the volume of liquid that has passed through the flowmeter is stored in the internal non-volatile memory and saved for a long time during power failures. In the event of a reading error from the non-volatile memory, when the flowmeter is turned on, a corresponding code is generated, which is recorded in the hardware log.

Note: Additional sensor electrodes are used to determine an empty pipe and improve measurement accuracy.

3.3.2 Measurement results are displayed on the front panel indicator and can be transmitted to other automation devices via digital interfaces (RS-485, HART), as well as electrical signals: current 4...20 mA, pulse frequency or their number.

3.3.3 When remotely polling measurement results, data is transmitted from the flowmeter on a personal computer (PC) via lines of interface RS-485. A two-wire cable and an interface adapter, supplied separately, are required for connection. The P-Master program can be used to display measured values or change settings.

3.3.4 Flow rate of the passed liquid is determined by the output signals as per formulas:

a) based on pulse output signals

$$\boldsymbol{V = N \cdot m}\,, \qquad (3)$$

where ***V*** is the value of the measured volume, m^3;

N is the number of pulses counted by the external counter;

m is the pulse "weight", i.e. the volume of liquid passing through the flowmeter necessary for generation of one pulse at the output, m^3.

b) frequency-based output signals (0.1…3000 Hz)

$$Q_M = \frac{f_{out} \cdot Q_{URL}}{f_{max}} , \quad (4)$$

where Q_M is the measured volumetric flow rate of the liquid medium, m^3/s;
Q_{URL} is the upper range limit of flow measurement, m^3/s;
f_{max} is the value of the frequency of binding the signal at the output, Hz;
f_{out} is the measured signal frequency value at the flowmeter output, Hz.

c) for current output (4…20 mA)

$$Q_M = \frac{(I_{out} - I_{min}) \cdot QURL}{I_{max} - I_{min}} , \quad (5)$$

where Q_M is the measured volumetric flow rate of liquid, m3/s (or other units);
Q_{URL} is the upper range limit of flow rate measurements by the current output;
I_{min}= 4 mA is the minimum value of the current output signal;
I_{max}= 20 mA is the maximum value of the current output signal;
I_{out} is the value of the current at the flowmeter output, mA.

4 Safety measures

4.1 In terms of the method of protecting people from electric shock, the flowmeter complies with class 0I as per GOST 12.2.007.0.

4.2 The following are sources of danger during installation and operation:

– power supply circuit voltage of 220 V AC with a frequency of 50 Hz: the flowmeter electrical circuits must be connected only when the power supply is disconnected;
– gauge pressure in the pipeline: the sensor must be connected and disconnected from the main lines supplying the measured medium after closing the valve on the line before the Item. Disconnect the flowmeter only after the supply pressure has been released down to atmospheric pressure;
– high temperature of the measured medium.

4.3 Before carrying out works on the pipeline, make sure that there is no life-threatening direct or alternating current voltage.

4.4 Installation (dismantling), connection, adjustment and maintenance of the flowmeter must be performed only by qualified specialists who have studied this operation manual and have

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been briefed in general safety rules that take into account the features of a specific type of works.

4.5 During operation, maintenance and calibration, it is necessary to observe the requirements of GOST 12.3.019, Operational Code for Electrical Installations and Rules for Labor Protection During the Operation of Electric Consumers.

4.6 Installation and operation of explosion-proof flowmeters must be carried out as per requirements of GOST R IEC 60079-0, GOST R IEC 60079-14 and other regulatory documents governing the use of electrical equipment in explosive conditions.

5 Installation and connection instructions

5.1 Installation requirements

5.1.1 Upon receipt of the flowmeter, check its package contents in accordance with the passport. In case of damage or discrepancies, a report shall be drafted.

5.1.2 Only persons who have studied this operation manual and have received appropriate safety training must be allowed to install the flowmeter.

5.1.3 Protective plugs on the flanges of the flowmeter sensor should be removed only before installation in the pipeline. This is especially important for flowmeters with a lining made of polymer coatings. Save the removed plugs, since when dismantling the sensor for maintenance (calibration or repair), they must be immediately installed in their place.

5.1.4 Select the installation location in such a way that the sensor is always filled with the working medium.

5.1.5 In order to increase the reliability and service life of the flow meter, it is preferable to use remote design in the following cases:

– when strong pipeline vibrations may occur (if this cannot be eliminated, the pipeline in the area of the counter flanges must be reinforced or installed on props);
– at a high temperature of the working medium or an external uncontrolled heat source;
– if access to the installation site in the pipeline is difficult.

5.1.6 Flowmeter components should be protected against uncontrolled surface heating due to direct sunlight.

5.1.7 When installing the counter flanges, a spacer (mounting insert) of similar installation length should be used instead of the flow meter sensor. Welding works are forbidden when the sensor is installed.

5.1.8 It is recommended to take special measures to prevent interference from power equipment, i.e. separate laying of signal power cables in cable ducts.

5.1.9 Installation of flowmeters in explosive environments must be carried out as per requirements of the documents:

–Electrical Installation Code, Chapter 7.3 Electrical Installations in Explosive Areas;

–Operational Code for Consumer Electrical Installations,

Chapter 3.4 "Electrical Installations in Explosive Areas";

– GOST 30852.0, GOST 30852.1, GOST 30852.10;

– GOST 31610.0 (IEC 60079-0:2011) Explosive Atmospheres. Part 0. Equipment. General Requirements, GOST 31610.11;

– GOST IEC 60079-1;

– GOST R IEC 60079-0, GOST R IEC 60079-11;

– VSN332-74 Installation Instructions for electrical equipment, power and lighting circuits of hazardous areas.

5.1.10 Before installing the items, pay attention to the explosion protection marking, warning labels, absence of damage of the explosion-proof enclosure, sealing for cables and covers, condition of the connected cable. Cable glands which are not used when connecting the flowmeter, must be closed with plugs supplied by the manufacturer.

5.2 Selecting the front panel position

The flow meter in a compact design has the following two options for changing position of the display module with controls:

– **around an axis perpendicular to the display plane**, with a discreetness of 90° (to do this, unscrew the cover, unscrew two screws, turn the display module in the desired direction and fix it back);

– **around vertical axis of the sensor:**

a) <u>for sensors with Dn≥10</u>, it is allowed to rotate the EM housing around the axis of the stand that connects sensor and EM. In order to rotate the housing, unscrew the four screws connecting the flanges of the sensor and EM, turn the EM in the desired direction and fix it back. Carry out the operation carefully not to damage the seal between flanges and not to damage the multi-core cable running inside the stand;

b) for sensors with Dn≤10, in the compact version EM design No. 2, the EM and sensor are connected by thread with fixation in any position relative to the sensor with the help of a side pin, Figure 5.1. A 2 mm hex key is used for fixation. The EM should be rotated carefully not to damage the connecting cable from sensor inside housing.

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The flow meter in remote design allows to place EM in the most convenient place, ensuring access to the control buttons and indicator for taking the readings or configuring the operation.

Figure 5.1 EM body rotation around the axis along the thread (1) with fixation with a pin (2)

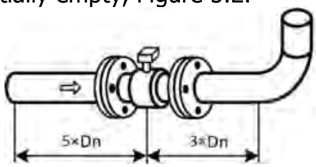
5.3 Straight sections length requirements

In order to ensure guaranteed measurement error, when installing the flowmeter sensor, the recommended lengths of straight sections of the pipelines at the inlet (at least 5×Dn) and outlet (at least 3×Dn) should be observed. Straight sections shall be measured from the middle of PFT.

The flowmeter sensor may be mounted in the flow part of a horizontal, vertical or inclined pipeline.

Horizontal installation: it is recommended to install the sensor so that it remains filled even if the pipeline is completely or partially empty, Figure 5.2.

a)



b)

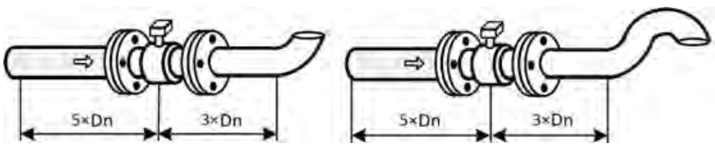


Figure 5.2 Horizontal installation of the sensor with mandatory straight sections at the inlet and outlet: a) in a conventional pressure pipeline; b) an open-ended elbow when the pipe is operating on outflow (the sensor will always be filled with liquid in the absence of pressure)

The sensor housing shall be positioned so that the EM (or termination box) is located at the top or bottom (avoid mounting with a 90° rotation along the longitudinal axis),

The use of narrowing or widening at the inlet and outlet is allowed if the pipeline diameter does not correspond to the sensor internal diameter (DN). The taper of the transition should not exceed 8° (Figure 5.3).

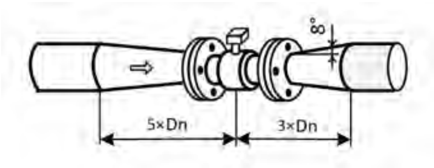
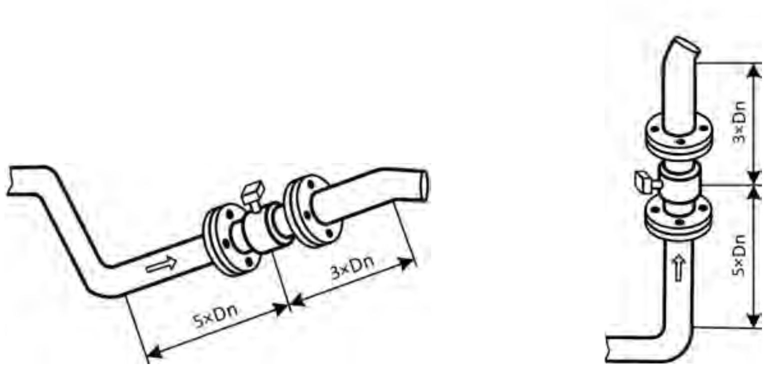


Figure 5.3 Examples of using narrowing/widening

Inclined and vertical installation of the sensor: used in pressure pipelines, Figure 5.4. It is preferable to mount the sensor on the ascending section (flow from bottom to top), otherwise there is a risk of air penetration into the pipeline, which will lead to additional measurement errors (the orientation of the indicator around the longitudinal axis is not important).



a) b)

Figure 5.4 Examples of sensor installation: a) inclined; b) vertical

5.4 Installation of the electromagnetic sensor on site

Orientation of the sensor electrodes

The electromagnetic sensor is installed correctly if the two measuring electrodes are located within 45° relative to the horizontal, as shown on the left in Figure 5.5

(avoid installation orientation in which the sensor electrodes are located as shown on the right in the figure).

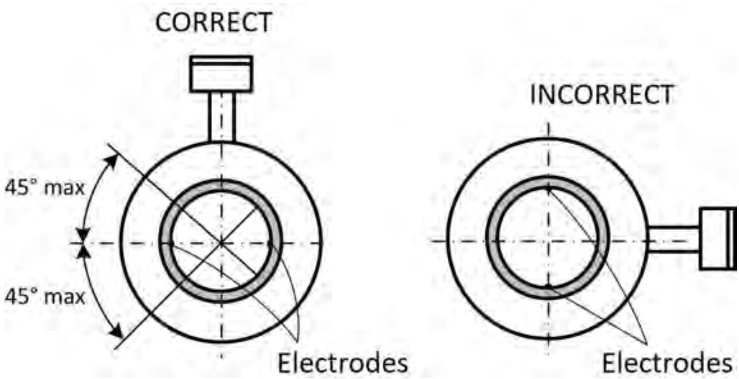


Figure 5.5 Examples of the sensor electrodes position

If the flow meter has an empty pipe detection function, the electrodes should be placed as close to the horizontal plane as possible.

Installation of the sensor near pumps and valves: avoid installing the flow meter on the pump suction side due to the risk of vacuum in the pipeline (vacuum can cause the lining to peel off and the sensor to be broken), Figure 5.6.

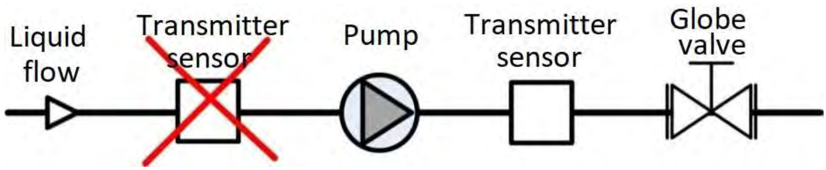


Figure 5.6 Selection of the flowmeter sensor installation location

If there are control or shut-off valves (globe valves) in the pipeline, the flowmeter should be installed downstream due to the risk of vacuum and severe distortion of the flow rate profile.

Dismantling the sensor for maintenance: If the flow meter requires periodic calibration or maintenance (cleaning), it is recommended to install a bypass pipeline on the pipeline where the flowmeter measuring sensor is planned to be installed, which will allow the process not to be stopped during maintenance work, Figure 5.7.

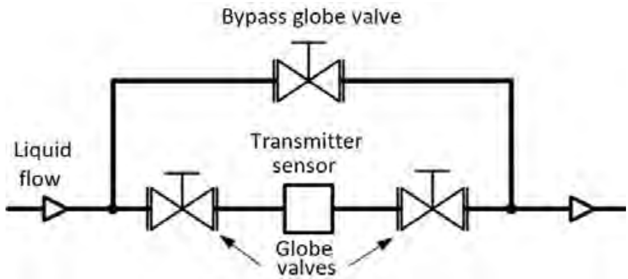


Figure 5.7 Installation of the sensor as per a typical bypass scheme

Flanged connections installation

When installing the sensor on the pipeline, it is required to use sealing gaskets. The sealing gaskets material must be selected to be resistant to the operating conditions.

When installing the sensor in non-metallic or lined pipelines, electrically conductive rings should be used (contact the manufacturer or regional dealer for instructions). For a fluoroplastic lining of the sensor, dielectric sealing gaskets and electrically conductive rings are installed on both sides (at the flow inlet and outlet), on both sides of the ring, Figure 5.8.

Note - If the flowmeter sensor has a rubber lining, then a dielectric gasket on this side between the electrically conductive ring is not required.

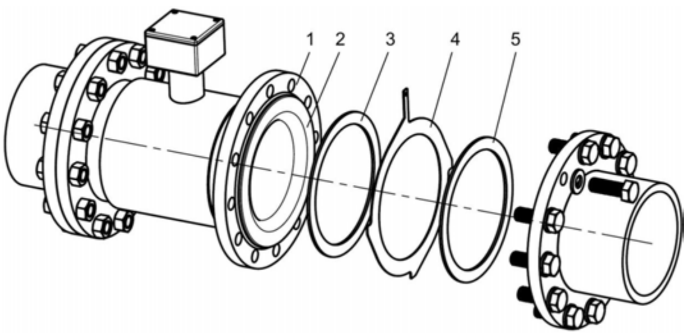
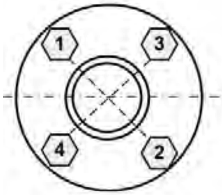
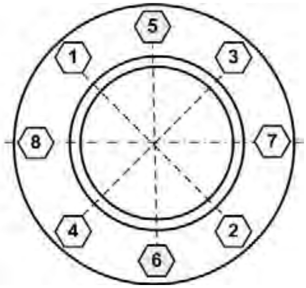


Figure 5.8 Installation of a metal ring and gaskets for a flange connection of the sensor, where: 1 - flange; 2 - lining; 3 and 5 - sealing gaskets; 4 - electrically conductive ring

Tightening of the flange bolts must be performed in the diagonal alternation sequence indicated by the numbers in Figure 5.9 (during dismantling, loosening of the bolts shall be performed in the reverse order).





4 bolts 8 bolts

Figure 5.9 The sequence of tightening or loosening flange fastening bolts

When tightening bolts in the sequence shown in Figure 5.9, it is recommended to gradually increase the tightening force in the following steps:

- Step 1: manually without force;
- Step 2: by 50% of the maximum tightening torque;
- Step 3: by 80% of the maximum tightening torque;
- Step 4: by 100% of the maximum tightening torque; regarding Tables 5.1 and 5.2: the values indicated therein are approximate, since the tightening torque depends on various parameters (temperature, bolt material, sealing gasket material).

Table 5.1 Recommended tightening torque of flange bolts for Dn diameters from 15 to 150 mm

Nominal diameter Dn, mm	Nominal pressure	Bolt nominal size	Recommended tightening torque, Nm	
			min.	max. (100%)
15	PN 40	4×M12	15	40
25	PN 40	4×M12	25	40
40	PN 40	4×M16	35	100
50	PN 40	4×M16	35	100
65	PN 40	4×M16	35	100
80	PN 40	8×M16	35	100
100	PN 16	8×M16	50…100	100…150
125	PN 16	8×M16	50…100	100…175
150	PN 16	8×M20	90…100	100…200

Table 5.2 Recommended tightening torque of flange bolts for Dn diameters from 200 to 600 mm

Nominal diameter Dn, mm	Recommended maximum tightening torque (100%), Nm (for PN nominal pressure, PTFE lining)			
	PN 10	PN 16	PN 25	PN 40
200	130	90	130	170
250	100	130	190	250
300	120	170	190	270
350	160	220	320	410
400	220	280	410	610
450	190	340	330	420
500	230	380	440	520
600	290	570	590	850

5.5 Electrical connections

5.5.1 Before connecting the flowmeter circuits, the flanges of its sensor must be securely connected to the flowing medium. The flowmeter flanges shall be connected with help of conductive jumpers with counter flanges of the pipeline, as shown in Figure 5.10.

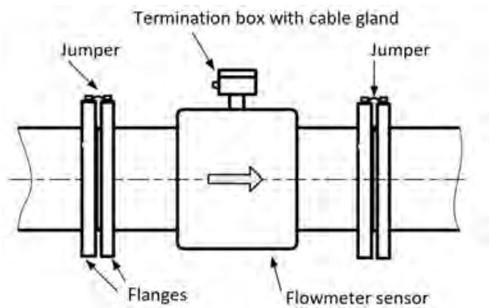


Figure 5.10 Flowmeter sensor flange connection diagram (fasteners on the flanges are not shown)

A copper wire with a cross-section of at least 4 mm^2 must be used for electrical connection.

ATTENTION!
If there is a current in the pipeline, for example, in the case of using cathodic protection against corrosion, it is necessary to install electrical jumpers, see Figure 5.11.

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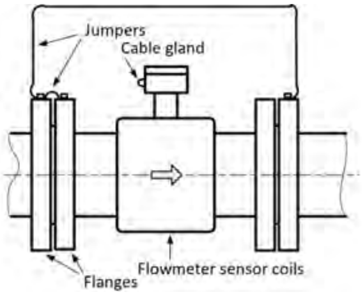
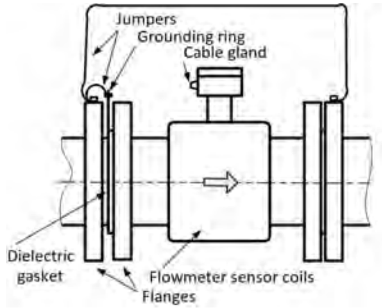


a)



b)

Figure 5.11 Diagram of flange connections when cathodic protection is used (fasteners on the flanges are not shown):
a) without metal rings; b) with one electrically conductive ring and dielectric gaskets

5.5.2 When EM is installed at a distance, use a special connecting cable from the supply package. The connection diagram is given in Appendix D (the cable shield is grounded only on the EM side).

5.5.3 For electrical installation, in order to ensure effective sealing of the cable gland, it is recommended to use a round cross-section cable with an external diameter of 7...10 mm. Sealing of the cable gland using standard sealing rings and gaskets is MANDATORY.

Note: Do not allow moisture inside EM. After installation is complete, the protective cover must be screwed to ensure a reliable sealing. The unused cable gland shall be closed with a plug.

5.5.4 Electrical connections of the Item components are made according to the selected application diagram (Appendix D).

It is possible to combine several flowmeters for operation in an RS-485 network. In addition to flowmeters, other devices operating on a similar protocol can be connected to the information network, Figure D.8 (Appendix D). In order to ensure conflict-free operation of the devices, the following conditions shall be observed:
– each device in the RS-485 network shall be assigned a unique number from 0 to 246;
– all devices in the network and computer SW must operate at the same data exchange rate.

The operating parameters of the RS-485 interface are specified in Appendix H.

5.5.5 It is recommended to use a copper shielded cable with an insulating sheath – it must have a common shield that is connected to ground on one side. The power cables must have a conductor cross-section of at least 0.32 mm^2 (22 AWG), and the RS-485 interface wires (for 9600 bit/s) and signal wires must have a cross-section of 0.2…0.32 mm^2 (24–22 AWG) with a maximum length of 1200 m.

5.5.6 Do not lay signal wires through a pipeline or open cable tray together with a power cable, or near powerful electrical equipment (transformers and electric motors).

5.5.7 It is recommended to connect the flowmeter to a power supply circuit no other power equipment is connected to. If this is not possible, then the connection should be made through a network voltage stabilizer or a UPS.

Note: If frequent power outages are typical at the installation location of the flowmeter, it is recommended to connect it through a UPS.

6 Operating controls and displays

6.1 Front panel buttons

Five buttons are located on the flowmeter display module for controlling the display mode and operation programming (Figures 6.1).

The buttons with arrows <Left>, <Right>, <Up>, <Down> are used to navigate the programming menu and change the parameter values. The <ENTER> button is used to confirm the entry of values or select menu items.

The transition from the main operating mode to the setup menu is done by holding down the <ENTER> button for at least 3 s.

Note: Return from the setup mode to the operating mode occurs automatically if the buttons on the front panel have not been pressed for 5 minutes.

A numeric access code (password) and physical access restriction (sealing the front panel) can be used to protect against unauthorized entry into the programming mode. All flowmeter setup operations must be completed before the start of measurements.

6.2 LED indicator

The green indicator located on the front panel (pos. 1 in Figure 6.1) performs two functions:

- constantly lights up when the mains power is supplied;
- blinks during data transmission via the digital communication interface.

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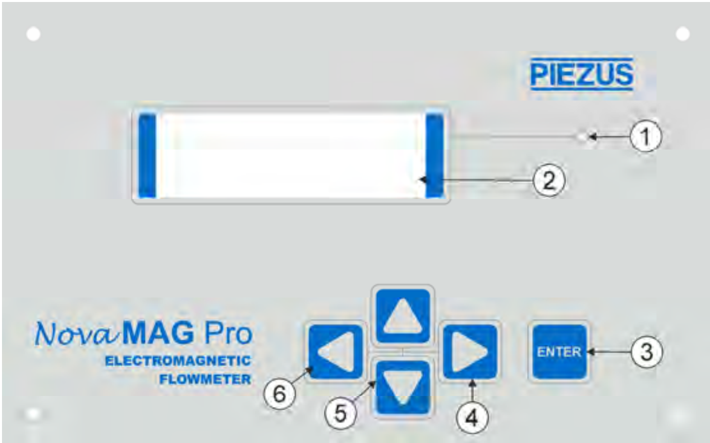
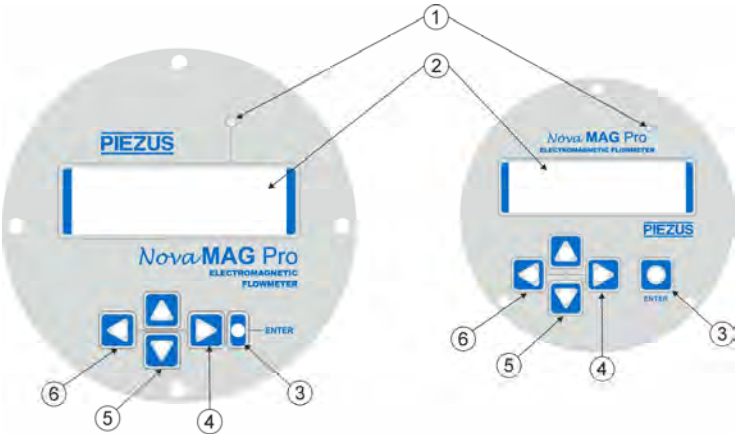


a) remote and combined version



b) compact version for design options 1 and 2, explosion-proof version, remote version (Option PA)

Figure 6.1 Flowmeter front panel elements:
1 - LED indicator of the supply voltage (green);
2 - 2-line symbol LCD indicator; 3 - <ENTER> button for confirming the command selection; 4 - button for moving the cursor to the right; 5 - buttons for moving the cursor up/down; 6 - button for moving the cursor to the left

6.3 Character display LCD

The indicator on the front panel displays the values selected during setup in two lines. The user can set the parameters to be displayed on the indicator continuously, which implies continuous display of one of the following values: flow rate, accumulated volume in the forward and reverse directions, volume balance +/-, temperature on channels 1 and 2, switch-on time, operating time, current date and time, pressure, error codes (Figure 6.2).

000000.000 m^3/h
0.000 m^3

Figure 6.2 Example of the indicator appearance in the operating two-line mode in the absence of flow rate: line 1 is volumetric flow rate (Q), line 2 is accumulated volume in the forward direction (V)

In the two-line mode, two selected parameters can be displayed simultaneously, which are set in the subsections of the menu "Display | Line 1" and "Display | Line 2" (see the setup menu in Appendix F). Changing the value selection shall be adjusted using the <Down> and <Up> arrow buttons.

7 Preparing for work on site

7.1 Flowmeter test switching on

After the sensor correct installation and the pipeline filling with liquid, the power supply voltage shall be applied. This initializes the built-in SW and diagnoses the units (a message with the product name and the running software version number will briefly appear); after that the device is ready for operation. The flow meter will automatically start measurements using the parameters configured by the user last time (during initial configuration by the manufacturer or installation setup) - the measurement results will be displayed.

In the operating mode, the indicator displays two lines with information about the current flow rate and the accumulated volume of the passed liquid.

Note: The accumulated value of the passed volume begins to change 15 seconds after the device is turned on. This time is required for the flowmeter to reach a steady-state operating mode.

If there is no flow rate, the indicator will show a zero value of 000000.000, while:

- there are no pulses at the frequency output;
- a 4 mA signal is set at the current output;
- a zero value of the actual flow rate is transmitted via the digital interface and the volume/balance counters do not increase.

In case of malfunctions, a corresponding error message will appear in the form of two characters of a special code (Appendix E).

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Note: The manufacturer and authorized service centers provide services for setting up the flow meter and putting it into operation.

7.2 Factory settings of parameters

Programmable settings are stored in the EM non-volatile memory and comply with the order. The main ones of them are also indicated in the passport:

- nominal diameter, Dn, of the sensor flow part;
- identification number of the firmware version;
- calibration factors obtained during setup;
- serial number of the flowmeter, month and year of manufacture.

A number of parameters have factory settings that can be changed from the front panel or remotely from a PC using the P-Control program.

Additional default settings:

– analog output smoothing (damping) time value is 0 s;

– RS-485 interface: speed is 38400 baud; Modbus RTU protocol, exchange format: 1 start bit + 8 data digits + 1 stop bit, no parity check; default network address is 247;

– HART interface (option): speed is 1200 baud; default network address is 1;

– for entering the setup menu, factory default password is 12.

After making final changes, it is recommended to set a new unique password to enter the parameter setup menu – this is done by selecting the following menu items: "Settings | Access code".

7.3 Operation Mode and Configuration Menu

The operating mode is set when the power is turned on and enables reading of measurement data by service personnel, as well as viewing of the list of main parameters from the front panel.

The setup mode (programming) is used during preparation for operation, as well as before starting the flowmeter at the site of operation:

● correction of instrument time and calendar data;
● entering service information into memory: address and speed in the RS-485 network, address in the HART network, as well as other parameters that do not affect metrology;
● zeroing out information in the archives of non-volatile memory.

The flowmeter operating mode is selected via buttons on the front panel using menu. In order to switch from the main operating mode to the setup menu, hold down the <ENTER> button for at least 3 seconds, until the first line of the menu is on the LCD indicator.

If a password has been set to restrict access, a prompt will pop up to enter it; in case of an incorrect entry, the flowmeter returns to the operating mode.

The menu main sections are: **Measurement, Display, Output signals, Interface, Settings, Parameters, About the device**; they are described in detail in Appendix F.

The arrow buttons <Up/Down> switch sections, and transition to the selected one is performed by pressing the <ENTER> button.

7.4 Parameters remote control

For remote configuration and receiving measurement data via the RS-485, the P-Control program for PC is used. The SW is available do download from the manufacturer's website.

The program allows the following:

– search for connected devices in the network;
– read the flowmeter information;
– read current value of measurement results;
– change flowmeter operating parameters;
– read measurement results log, set up logging period.

Computer requirements:

– IBM-PC compatible;
– MS Windows 7/8/10 operating system (32-bit or 64-bit);
– at least 30 MB hard disk free space(for the program itself and storage of measurement archives);
– availability of USB and Ethernet ports;
– availability of RS-485/USB interface converter;
– keyboard and mouse.

Note: In order to connect the controlled device to the PC via the USB port, any interface converter (RS-485/USB) with the appropriate driver is suitable. In this case, galvanic isolation between the RS-485/USB interface lines is desirable.

Program launch

The P-Control program does not require installation. For operation, PC must have .NET Framework 4.8 or higher pre-installed (if this application is unavailable, a request for installation thereof is generated automatically when the P-Control software is launched).

Using the program

Before launching the P-Control program, the flowmeter must be connected to the port of PC via an RS-485/USB interface adapter and plugged into the circuit.
When working with the program, please refer to the user manual supplied.

7.5 Identification of SW built into the flowmeter and SW protection

The SW of the flowmeters is built-in and is installed in the non-volatile flash memory of the microcontroller during manufacture and ensures the processing of measurement information, display on the LCD, exchange of data with external devices via digital interfaces, as well as conversion of them into standardized current and frequency-pulse output signals.

The name of the flowmeter, the identification designation and the version number of its software are written into this flash memory together with the software during the manufacture of the microcontroller board.

In accordance with P50.2.077-2014, the level of SW protection against unintentional and intentional changes is High.

7.5.1 The embedded SW is identified by designation and version number. Identification data must have the values specified in Table 7.1.

Table 7.1 Identification data

Parameters	Values
SW identification name	NMAGPro
Version number (identification number) of SW, not lower than	4.23.0

There are two methods to check the flowmeter software parameters compliance:

1) when turning on the device power, monitor the display on the LCD indicator since information about the name of the flow meter and the software version will briefly display during loading.

2) when flowmeter is running, use the front panel buttons, enter the service menu, in the "Parameters | About the device" section do as follows:

– select the "Software version" item

– on the second line of the screen, the first 6 positions display the version number

– select the "Identifier" item and the program identification name will be displayed on the second line of the screen.

The SW identification data does not depend on the identification method and is sufficient for SW identification.

7.5.2 The microcontroller board is protected against unintentional and intentional mechanical impacts via front panel with a mastic seal installed in a sealing cup with a screw for fastening the front panel to the housing, or a self-destructing sticker with the manufacturer's symbols adhered over the screw for fastening the front panel to the housing. Protection is implemented as per measuring instrument type.

ATTENTION!
It is not recommended to break the protective seal on the front panel of the flowmeter, since this will void the manufacturer's warranty for the Item.

Modification, reboot, deletion or other intentional changes to SW are possible only by reprogramming the microcontroller.

The following measures have been taken to protect the microcontroller and the built-in SW:

– there are no user-accessible connectors the microcontroller can be reprogrammed through;

– the SW is a confidential information of the manufacturer. It is a subject to appropriate division of access of the manufacturer's employees. And it is under the principle of non-disclosure;

– access (except for the development team) to the SW source codes is not provided;

– reading the SW from the memory of the firmware upgraded microcontroller is protected by a special Security Bit and is not a trivial process;

– microcontroller replacement on the flowmeter board is impossible outside the manufacturer’s plant due to the presence of the microcontroller’s own unique identifier, the SW and the flowmeter serial number are tied to during the first programming at the manufacturer, and such replacement makes the flowmeter inoperative.

7.5.3 Measuring information after primary processing by the microcontroller is stored in non-volatile memory (FRAM), implemented as a separate memory chip.

The measurement information archive and a specially allocated memory area for storing information recorded by the Artcheck device after the flowmeter calibration are located in another non-volatile memory (EEPROM), also implemented as a separate memory chip.

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Both memory microchips and the information recorded therein are protected against unintentional and intentional mechanical impacts with help of the front panel, as is the entire microcontroller board they are mounted on.

The software and measurement information are saved when the flowmeter is powered off.

7.5.4 The flow meter provides for keeping an electronic event log, i.e. registration and recording in non-volatile memory (EEPROM) of facts of making any changes to the calibration coefficients and measurement information.

The flowmeter has a function of informing the user about errors. Storage of error information in EEPROM is implemented. The error log reset (zeroing) function is password-protected and access rights are restricted. Flow meter operation error codes are listed in Appendix E.

7.5.5 Metrologically significant flowmeter parameters and coefficients are recorded in the FRAM memory of microcontroller both during manufacture (e.g. Dn based on the order sheet) and based on the results of the initial calibration (calibration K and L coefficients).

Calibration mode (writing to the FRAM memory of microcontroller) and any changes to the flowmeter's calibration coefficients are not available from the user menu. Unauthorized and authorized attempts to change metrologically significant flow meter parameters and coefficients in FRAM are recorded in the electronic event log.

Calibration mode is protected by an encryption key and access rights are divided. Access to metrologically significant parameters and coefficients stored in FRAM is possible through an encryption key generated by the manufacturer and unique for each flowmeter. Rewriting to the FRAM memory of microcontroller can be done at the manufacturer.

The key can be transferred to persons accredited for calibration (State regional metrology centers, metrology institutes) and the manufacturer's service centers for repair and periodic calibration.

ATTENTION!

Unauthorized attempts to change the flowmeter metrologically significant parameters and coefficients recorded in the electronic event log can be regarded as attempts to falsify metering.

8 Operation of flowmeter

8.1 General information

8.1.1 The flow meter passport should indicate the date of commissioning, the report number and date of approval by the management of the consumer. It is also recommended to make notes in the passport regarding operation: the composition of the measured medium, installation location, data on verification and maintenance, malfunctions that occurred and possible causes.

8.1.2 The commissioned flowmeter operates continuously in automatic mode.

8.1.3 When switched on, the flow meter performs self-diagnostics. When condition is good, the signal values corresponding to the measured parameter are set at the outputs. If an emergency error is detected (during startup or during operation), additional information is generated in code messages on the LCD indicator (saved in non-volatile memory). Error codes and their decoding are given in Appendix E.

8.1.4 When the flowmeter power is off, the measurement and accumulation of the volume of liquid passed through the sensor stops. The period of time the power was disconnected, can be estimated by the missing of periodic records in the archive (see the programming menu) or by resetting the switch-on time value to zero.

ATTENTION!
It is prohibited to operate the flowmeter in inappropriate climatic conditions, as well as at a temperature of the measured medium below or above the permissible limits.

8.2 Maintenance and verification

Maintenance shall be carried out at least once every six months. The removing dust and dirt, as well as preventive inspections should be done, during which the following is checked for:
- integrity of housings, absence of dents and visible mechanical damage;
- reliability of fastening of screw connections and the Item itself in the working position;
- no signs of loss of tightness in the pressure supply lines;
- no damage to the insulation in the connecting electrical cables;
- the grounding (the grounding bolts must be rust-free and tightened; clean and tighten if necessary);
- make sure that the electrical contacts of the termination box are in good condition (tighten the screw connections of the termination box if necessary);
- make sure that the sealing of the supply cables is reliable.

It is PROHIBITED to operate the flowmeter with visible mechanical damage.

Periodic calibration of the flow meter as per document
MP 208-055-2023. The interval between calibrations shall be 5 years.

8.3 Troubleshooting Methods

8.3.1 During operation of the flowmeter, malfunctions may occur that require a response from service personnel. Reference information on possible problems and methods for eliminating them is provided in Table 8.1.

Table 8.1 List of possible faults and troubleshooting methods

Status, external signs	Troubleshooting
1. Power is switched on, the indicator is off	Check for power supply voltage at the terminals and, if absent, provide power supply
	Check the set address of the flow meter in the network

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2. Unable to establish communication with flowmeter via RS-485 interface	Check for compliance with the communication speed set for operation
	Check the serviceability of the equipment for communication with the PC (interface converter)
3. Output current is greater than 20 mA or less than 4 mA	The flowmeter current output is damaged, repairs are required at the Manufacturer
4. Measurements are unstable, the measurement error exceeds permissible	Check the measured medium line for tightness and sensor for cleanliness
	Prepare a set of documentation for the installation site, send it to the manufacturer along with photo/video evidence. After receiving the Manufacturer's response about the readiness to accept the device, send it for repair

8.3.2 In case of malfunctions not listed in Table 8.1, contact the manufacturer.

8.3.3 Before sending the flowmeter for repair, the operating company must draw up a report indicating the date and circumstances of the failure. The components of the Item must be cleaned of working medium and other contaminants on the internal and external surfaces.

8.3.4 The flowmeter can be repaired by the manufacturer or an organization authorized to do so.

Note: If it is impossible to restore the flowmeter, the manufacturer can replace the entire product or its components with similar ones.

8.3.5 Claims will not be accepted in cases the flowmeter manufacturer seals are damaged and there are defects caused by violation of rules of operation, transportation and storage.

The manufacturer also reserves the right to refuse repair if there are obvious signs of unqualified interference in the product.

9 Package contents

Depending on the order terms, the flowmeter may have a different set of supply package (Table 9.1).

Table 9.1 Supply package

Name	Quantity
NovaMAG Pro Electromagnetic Flowmeter	1 pc
Connecting cable between sensor and EM (only for remote or combined design, upon request of ordered length)	1 pc
Data Sheet 38978553.407111.010 ПС	1 copy
Operation manual 38978553.407111.010 (this document)	*

Verification method. MP 208-055-2023	*
Installation kit (defined by supply contract)	Optional
* Soft copy is available on the manufacturer's website.	

The installation kit may optionally include:
1) a set of counter flanges with fasteners and gaskets;
2) grounding disks (rings) for relevant flanges;
3) concentric reducers;
4) thermowells for heating the electronic module.

10 Marking, sealing and packaging

10.1 The Item marking is on the label on the housings and contains the following information (Figure 10.1):

– name of the manufacturer or trade mark;
– bar code (QR code);
– designation of the Item version (order code);
– rated power supply voltage, its type and power consumption;
– factory serial number (S/N:), month and year of manufacture;
– degree of protection against water and dust as per GOST 14254 (IP code);
– operating temperature range for the Item;
– measuring instrument type approval mark;
– mark of product circulation on the market of the Customs Union states;
– inscription Made in the Russian Federation.

Additionally, for explosion-proof design, the following shall be indicated:
– explosion protection mark and Ex-certification agency;
– ambient temperature during operation;
– Ex-marking of explosion protection according to Table 10.1.

Table 10.1 Marking of explosion protection level for temperature range

Temperature range of measured medium, °C	Marking of sensor	Marking of electronic module
-60 to +125	1Ex db ia IIC T4 Gb X	1Ex db [ia] IIC T6 Gb X
-60 to +90	1Ex db ia IIC T5 Gb X	1Ex db [ia] IIC T6 Gb X
-60 to +75	1Ex db ia IIC T6 Gb X	1Ex db [ia] IIC T6 Gb X

10.2 The sensor shows an arrow indicating the flow direction during calibration. The movement of the medium inside the pipe in this direction results in an increase in the counter of the volume that passed in the positive direction.

There is a grounding sign on the housing of the flow meter sensor, next to the holes for attaching the grounding wire.

Compact design

Remote design

Figure 10.2 Locations of the sensor housing seal

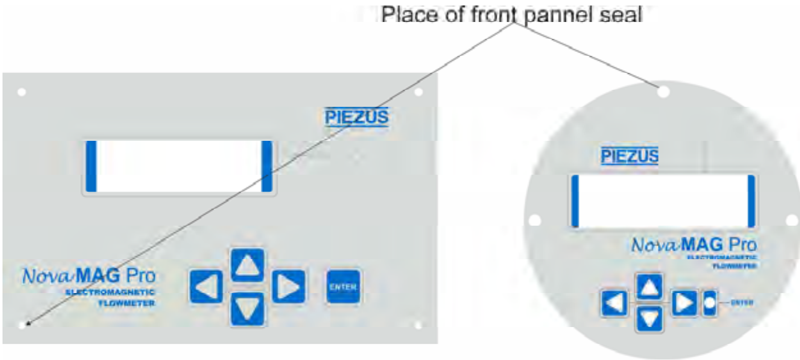

Figure 10.3 Locations of the electronic module seal

10.3 Stamp sealing shall be done in places shown in Figures 10.2 and 10.3 to confirm the initial or periodic calibration, as well as to exclude unauthorized interference with the settings. This is done by installing a Verification Officer mastic seal or a QCD seal on the housing screws of the structure, or a hanging seal on the lockwire of the bolts that secure the EM to the sensor.

10.4 The flowmeter is packaged in a special container of the manufacturer, made in accordance with the requirements of GOST 23170. At the same time, it is allowed to pack the installation elements of the flowmeter in a separate box.

11 Transportation and Storage

11.1 The flowmeter can be transported in closed transport of any type and over any distance in the Manufacturer's standard container. Transportation can be carried out at an ambient temperature from -60 to +70 °C, subject to protection measures against impacts and vibrations.

11.2 Flowmeters in transport container withstand the effects of vibration for Group F3 as per GOST R 52931.

11.3 Protective rings or disks are installed on the flanges of the flowmeter sensor on flow meters with PTFE lining material. They prevent deformation of the PTFE lining and they should be removed only before installation in the pipeline (when dismantling the sensor, the protective rings or disks must be installed back on the flanges).

ATTENTION!
It is prohibited to lift and carry the flowmeter by holding the EM housing (in the compact version) or termination box (in the remote version). Do not carry the sensor using a crowbar (stick) threaded inside - this can damage the lining and electrodes. For large diameters, only lifting mechanisms and hoists should be used with help of securing to the standard brackets on the flow meter flanges. Do not use manual or self-propelled stackers.

11.4 Flowmeters must be stored in the shipping container. PTFE lined flowmeters must be stored with protective rings or disks installed. Ventilated areas should be selected where condensation on the surface is excluded. The air in the room should not contain dust, acid and alkali vapors, or gases that cause corrosion. The storage temperature is from -60 to +70 °C.

12 Manufacturer Warranty

The manufacturer's warranty obligations are valid for 18 months from the date of installation of the Item recorded in the passport, but not more than 24 months from the date of sale.

In case of failure of the Item during the warranty period, provided that the consumer complies with the rules of transportation, storage, installation and operation, the manufacturer undertakes to repair or replace it. For repairs/replacements, contact the address specified in the Item passport.

The warranty shall be void in the following cases:

– mechanical damage to the equipment;

– performance of pre-installation, installation, repair and maintenance works by unqualified personnel;

– improper installation of equipment;

– inappropriate use of the flowmeter, e.g. dosing;

– failure to comply with the operation manual.

ATTENTION!
The manufacturer is not responsible for the incorrect Dn selection, length of the sensor connection cable, flowmeter design and/or mismatch of the lining material and electrodes with the parameters of the working medium.

13 Service life and lifetime

Operating mode is continuous.

Average time between failures is 150,000 hrs.

Average service life is 15 years (this reliability indicator is set for normal operating conditions: non-aggressive environment, temperature +(20 ±5) °C, no vibration or shaking).

14 Disposal Information

The Item is environmentally safe and does not contain toxic substances and chemical materials, does not pose a danger to human health and the environment.

After the flowmeter specified service life runs out, the procedure for disposal shall be determined by the company operating the Item.

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APPENDIX A Materials selection recommendations

Lining and electrodes materials selection

The sensor lining, depending on the measured liquid parameters, shall be made of the following materials:

- **Technical-grade hard rubber** is used for medium-aggressive liquids with an operating temperature of up to +80 ºC. Used for drinking or warm water for industrial and household needs, etc. If the operating temperature of the measured liquid can exceed +100 ºC, then a lining made of PTFE must be used.
- **PTFE** is used for aggressive liquids with an operating temperature in the range from -40 to +150 ºC. The most universal lining and is widely used in the chemical and food industries.
- **Teflon PFA** is resistant to acids (hydrochloric, sulfuric, nitric), as well as almost all chemicals and solvents with operating temperature ranging from -40 to +180 ºC. Typically used in critical or highly corrosive processes in the chemical and food industries.
- **FEP (F46)** is resistant to acids (hydrochloric, sulfuric, nitric), as well as almost all chemicals and solvents with operating temperature ranging from –40 to +120 ºC. Used in the chemical and food industries.
- **PPS** is high resistance to almost all solvents, many acids and alkalis, has exceptional heat resistance and an operating range from –20 to +220 °C.
- **PU** has high mechanical strength and wear resistance, resistant to solutions of salts, alkalis, oils and many solvents (damaged by nitric acid and chlorine-containing acids, dissolved by acetone). Application is limited by the permissible operating temperature in the range from –60 to +80 ºC.

The sensor electrodes, depending on the measured liquid parameters, shall be selected among the following materials:

- **Stainless steel 03X17H14M3 (or equivalent AISI 316)** is used for all common water-based liquids and other environments with low concentrations of acids and alkalis: dairy products, mineralized, sea and waste water.
- **Hastelloy (nickel alloy XH65MB)** meets the increased requirements of most industrial systems for resistance to acidic and alkaline environments.
- **Titanium** is corrosion-resistant to most environments, used for some acids, alkalis and liquid agricultural waste.
- **Platinum** is chemically very stable and used for highly aggressive liquids, such as concentrated acids and alkalis.
- **Tungsten carbide** is very wear-resistant to abrasive environments that cause wear and chipping of surfaces. Resistant to acids at normal temperatures.

Note: For recommendations on material selection for lining and electrodes, depending on the specific conditions of their use, you can contact the manufacturer.

APPENDIX B The Overall and Mounting Dimensions

B.1 Design of flowmeter in a general industrial version

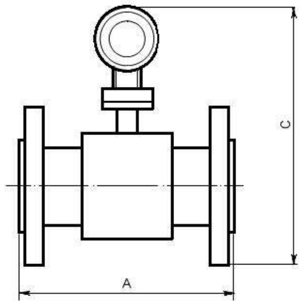


Figure B.1 Flanged version overall dimensions

Dn, mm	Dimension A**, mm	Tolerance for dimension A, mm	Dimension C, mm (maximum), with standard EM*	Weight, kg
10	200	+0/-3	330	4.3
15	200	+0/-3	355	7.0
20	200	+0/-3	365	7.0
25	200	+0/-3	370	7.0
32	200	+0/-3	385	9.5
40	200	+0/-3	395	10.5
50	200	+0/-3	405	11.5
65	200	+0/-3	425	13.5
80	200	+0/-3	445	15.5
100	250	+0/-3	465	19.5
125	250	+0/-3	495	24.5
150	300	+0/-3	530	31.5
200	350	+0/-3	580	38.5
250	450	+0/-5	665	46.0
300	500	+0/-5	720	58.5
350	550	+0/-5	770	68.5
400	600	+0/-5	825	97.5
450	600	+0/-5	880	111.5
500	600	+0/-5	935	125.5
600	600	+0/-5	1055	161.5
700	600	+0/-5	1175	233.5

Appendix B continued

Table continued

Dn, mm	Dimension A**, mm	Tolerance for dimension A, mm	Dimension C, mm (maximum), with standard EM*	Weight, kg
800	800	+0/-5	1285	328.5
900	900	+0/-5	1375	423.5
1000	1000	+0/-5	1475	513.5

* Reference Dimensions
** Optionally, other sensor lengths are available

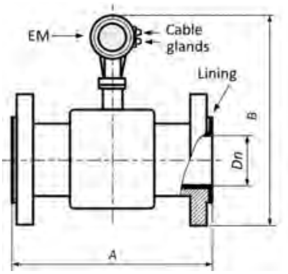
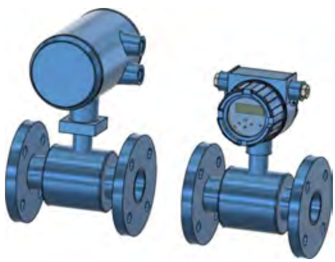


Figure B.2 View of the sensor design with a standard EM installed

Counter flanges for flowmeter installation are manufactured as per GOST 33259-2015, EN 1092-1 or ASME B16.5-2017. Standard, material and working pressure are specified when ordering.

The electronic module housing for the compact design of the flowmeter can have two design options, shown in Figure B.3.



a) b)

Figure B.3 View of the compact design options for the aluminum EM housing, EM dimensions, Fig.: a) Version 1 (standard EM); b) Version 2 (small-sized EM)

Appendix B continued

B.2 Non-explosion-proof flowmeters of remote version of sensor and electronic module

Remote version of Electromagnetic Sensor with termination box

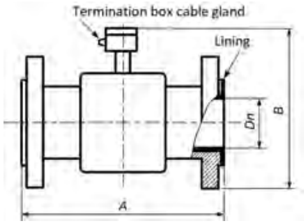


Figure B.4 Design of the sensor remote flanged version with electric junction box

Dn, mm	Dimension *A***, mm	Tolerance for dimension *A*, mm	Dimensions *B*, mm (maximum)*	Weight, kg
10	200	+0/-3	195	3.7
15	200	+0/-3	210	3.7
20	200	+0/-3	220	3.7
25	200	+0/-3	225	3.7
32	200	+0/-3	240	6.2
40	200	+0/-3	250	7.2
50	200	+0/-3	260	8.2
65	200	+0/-3	280	10.2
80	200	+0/-3	300	12.2
100	250	+0/-3	320	16.2
125	250	+0/-3	350	21.2
150	300	+0/-3	385	28.2
200	350	+0/-3	435	35.2
250	450	+0/-5	520	42.7
300	500	+0/-5	575	55.2
350	550	+0/-5	625	65.2
400	600	+0/-5	680	94.2
500	600	+0/-5	790	123.0
600	600	+0/-5	910	159.0
700	600	+0/-5	1030	231.0
800	800	+0/-5	1140	326.0

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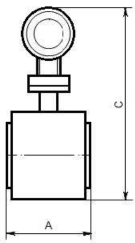
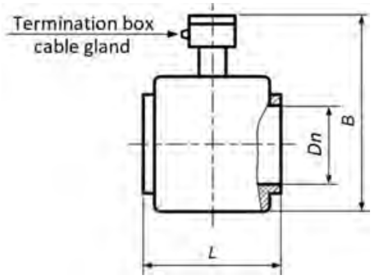
Appendix B continued

Table continued

Dn, mm	Dimension *A***, mm	Tolerance for dimension *A*, mm	Dimensions *B*, mm (maximum)*	Weight, kg
900	900	+0/-5	1230	421.0
1000	1000	+0/-5	1330	511.0

* Reference Dimensions
** Optionally, other sensor lengths are available





Compact design   Remote design of sensor

Figure B.5 Design of sensor without flanges (sandwich)

Dn Diameter		Dimension *L*, mm (maximum)**	Dimensions *B*, mm (maximum)*	Dimension C, mm (maximum), with standard EM	Weight, kg (max.)***
mm	inch				
≤10	Dimensions are subject for confirmation when placing an order.				
10	3/8	100	185	330	1.96
15	1/2	100	210	355	2.0
20	3/4	100	220	365	2.1
25	1	100	225	370	2.2
32	1 1/4	100	240	385	2.3
40	1 1/2	100	250	395	2.5
50	2	100	260	405	2.8
65	2 ¼	100	280	425	3.2
80	3	100	300	445	3.5
100	4	100	320	465	4.0
125	5	130	350	495	6.0

Appendix B continued

Table continued

Dn Diameter		Dimension *L*, mm (maximum)**	Dimensions *B*, mm (maximum)*	Dimension C, mm (maximum), with standard EM	Weight, kg (max.)***
150	6	130	385	530	8.0
200	8	220	435	580	12

* Reference Dimensions.
** Optionally, other sensor length is available.
*** Depends on the lining material; for the compact version + 3 kg to the weight.

Plastic EM for remote flowmeter design

The plastic housing is fixed on the wall or on a DIN rail (35 mm) in a place that provides easy access for reading the LCD indicator and configuring the operation from the front panel, Figure B.6.

* Reference dimensions

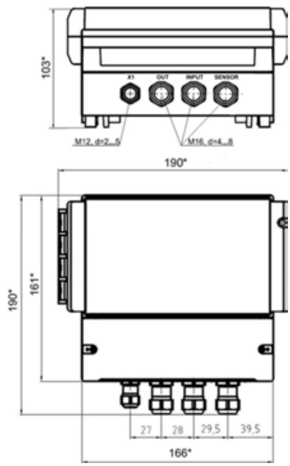


Figure B.6 View and overall dimensions of the electronic module (cable glands, if necessary, can be installed of larger length or replaced with plugs)

All cable glands are waterproof, used types are MG16A-06G (made of plastic, mounting hole Ø16.5 mm, incoming cable diameter 4–7 mm) or similar metal ones. Optionally, a version with M20x1.5 cable entry thread is available.

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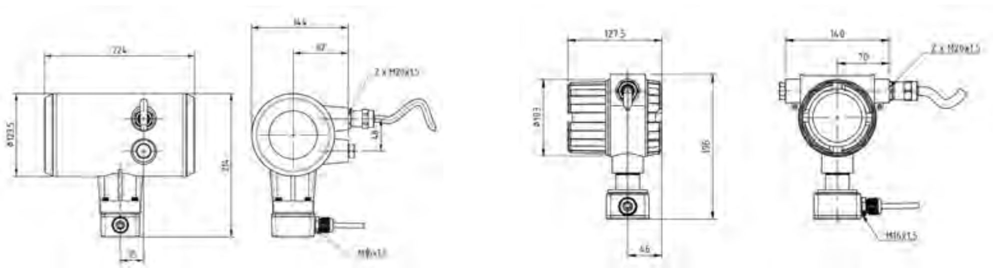
Aluminum EM for remote flowmeter design

The aluminum housing is fixed to a wall, panel or pipe with a diameter of 50 mm (2”) with the help of a bracket (included in supply package, see Appendix O), Figure B.7.

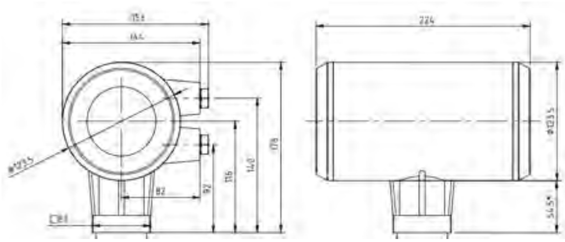
Appendix B continued



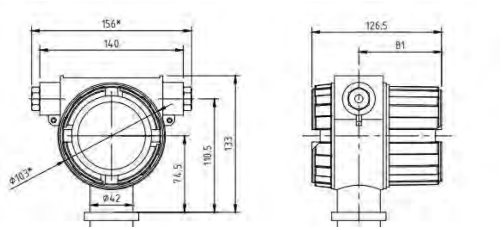
Version 1 (standard EM) Version 2 (small-sized EM)

Figure B.7 Appearance and overall dimensions of the electronic module (cable glands, if necessary, can be installed of larger length or replaced with plugs)

The flowmeter EM compact design

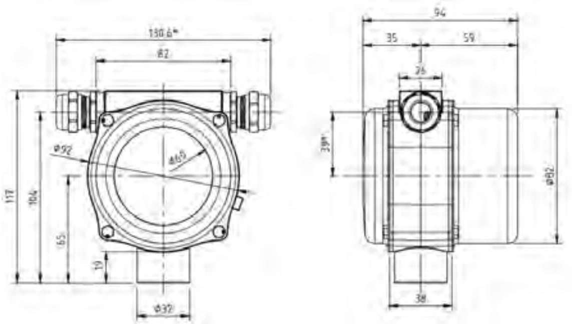


Version 1 (standard EM)



Version 2 (small-sized EM)

Appendix B continued



Version 3 (Stainless steel EM)

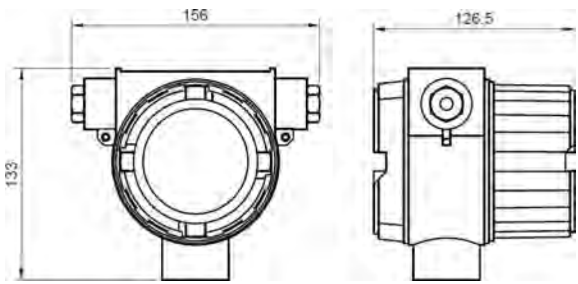


Figure B.8 External view and overall dimensions of the electronic module housing

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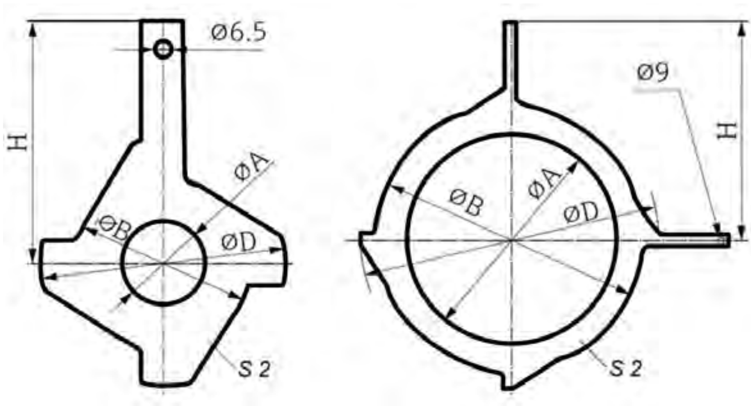
Appendix B continued

Accessories: grounding discs for Dn below 600 mm

Grounding disks (rings) for flanged connections can be used for Dn=25–600 mm with flanges of any standard and nominal pressure the flow meter can be equipped with, Figure B.9.



a) Dn ≤300 mm b) Dn 300…600 mm

Figure B.9 Overall dimensions of grounding disks (rings) for flanged connections with Dn up to 600 mm

Dn Diameter		Dimension *A*, mm	Dimension *B*, mm	Dimension *D*, mm	Dimension *H*, mm	Figure
mm	inch					
25	1	26	62	77.5	87.5	B.9a
32	1 1/4	35	80	87.5	94.5	B.9a
40	1 1/2	41	82	101	103	B.9a
50	2	52	101	115.5	108	B.9a
65	2 1/4	68	121	131.5	118	B.9a
80	3	80	131	154.5	135	B.9a
100	4	104	156	186.5	153	B.9a
125	5	130	187	206.5	160	B.9a
150	6	158	217	256	184	B.9a
200	8	206	267	288	205	B.9a
250	10	260	328	359	240	B.9a
300	12	312	375	413	273	B.9b
350	14	343	420	479	265	B.9b
375	15	393	461	523	395	B.9b

Appendix B continued

Table continued

Dn Diameter		Dimension *A*, mm	Dimension *B*, mm	Dimension *D*, mm	Dimension *H*, mm	Figure
mm	inch					
400	16	393	470	542	395	B.9b
450	18	439	525	583	417	B.9b
500	20	493	575	650	460	B.9b
600	24	593	676	766	522	B.9b

Accessories: grounding discs for Dn above 700 mm

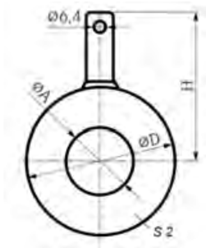


Figure B.10 Overall dimensions of grounding disks (rings) for flanged connections with Dn from 700 mm (A, D, H dimensions are for reference)

The inner diameter of the metal ring is slightly larger than the inner diameter of the sensor. The ring has an outer bar for connecting the grounding cable.

Note: Information about all disk dimensions can be clarified with the managers of the manufacturer.

Sensor of the flow meter design for small diameters

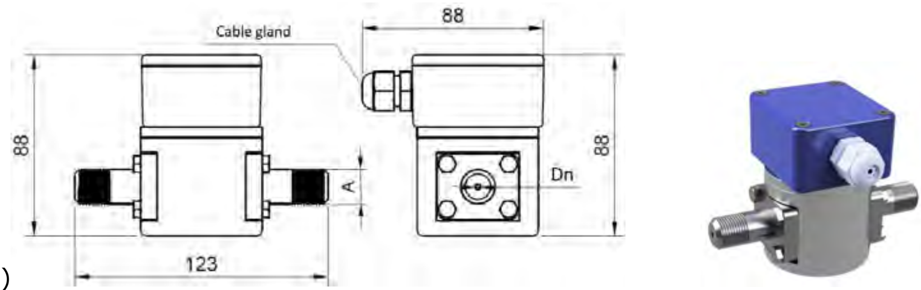
Dn Diameter, mm	A (thread)	Housing design version	Maximum weight, kg	Figure
2	*	remote	1.2 (1.1**)	B.11a
	*	compact	2.8	B.11b
2.5	*	remote	1.2 (1.1**)	B.11a
	*	compact	2.8	B.11b
4	*	remote	1.2 (1.1**)	B.11a
	*	compact	2.8	B.11b
5	*	remote	1.2 (1.1**)	B.11a
	*	compact	2.8	B.11b
6	*	remote	1.2 (1.1**)	B.11a
	*	compact	2.8	B.11b

Appendix B continued

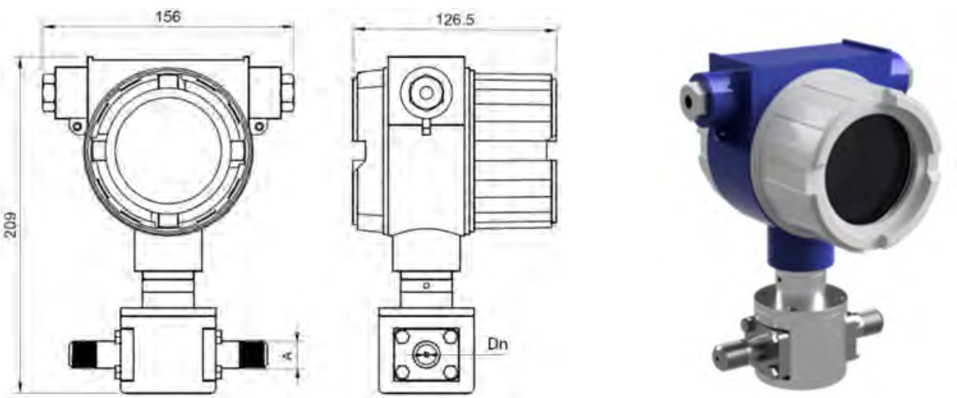
Table continued

Dn Diameter, mm	A (thread)	Housing design version	Maximum weight, kg	Figure
8	*	remote	1.2 (1.1**)	B.11a
	*	compact	2.8	B.11b

* The connection thread is optionally available from the following list:
NPT 3/8"; 3/8" – 16 UNC; M12x1.5 and others, according to the list of the ordering code.
** Sensor without a termination box (with a packing or connector for circuit connections).



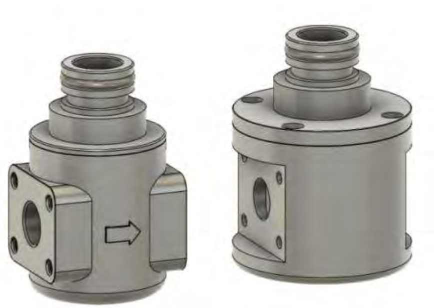
a)



b)

Figure B.11 Sensor design for small Dn diameters:
a) remote design (with junction box); b) compact design with small-sized EM

Appendix B continued


a)


b)


c)

Figure B.12 Sensor design for small Dn diameters:
a) remote design with connector; b) compact design with small-sized EM;
c) remote compact design (with junction box)

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Appendix B continued

B.3 Compact design explosion-proof flowmeters

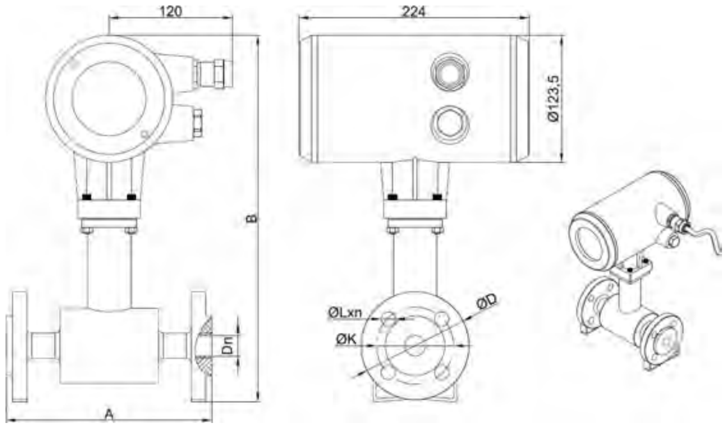

Figure B.13 Overall dimensions of explosion-proof flowmeter (housing 1)

Dn	PN	A, mm	Tolerance for A, mm	B, mm	ØD, mm	ØK, mm	ØLxn, mm x pcs.	Weight, kg
15	40	200	+0/-3	355	95	65	14 x 4	7.0
20	40	200	+0/-3	365	105	75	14 x 4	7.0
25	40	200	+0/-3	370	115	85	14 x 4	7.0
32	40	200	+0/-3	385	140	100	14 x 4	9.5
40	40	200	+0/-3	395	150	110	18 x 4	10.5
50	40	200	+0/-3	405	165	125	18 x 4	11.5
65	40	200	+0/-3	425	185	145	18 x 4	13.5
80	40	200	+0/-3	445	200	160	18 x 8	15.5
100	16	250	+0/-3	465	220	180	18 x 8	19.5
125	16	250	+0/-3	495	250	210	18 x 8	24.5
150	16	300	+0/-3	530	285	240	22 x 8	31.5
200	10	350	+0/-3	580	340	295	22 x 8	38.5
250	10	450	+0/-5	665	395	350	22 x 12	46.0
300	10	500	+0/-5	720	445	400	22 x 12	58.5
350	10	550	+0/-5	770	505	460	22 x 16	68.5
400	10	600	+0/-5	825	565	515	26 x 16	97.5
500	10	600	+0/-5	935	670	620	26 x 20	125.5
600	10	600	+0/-5	1055	780	725	30 x 20	161.5

Appendix B continued

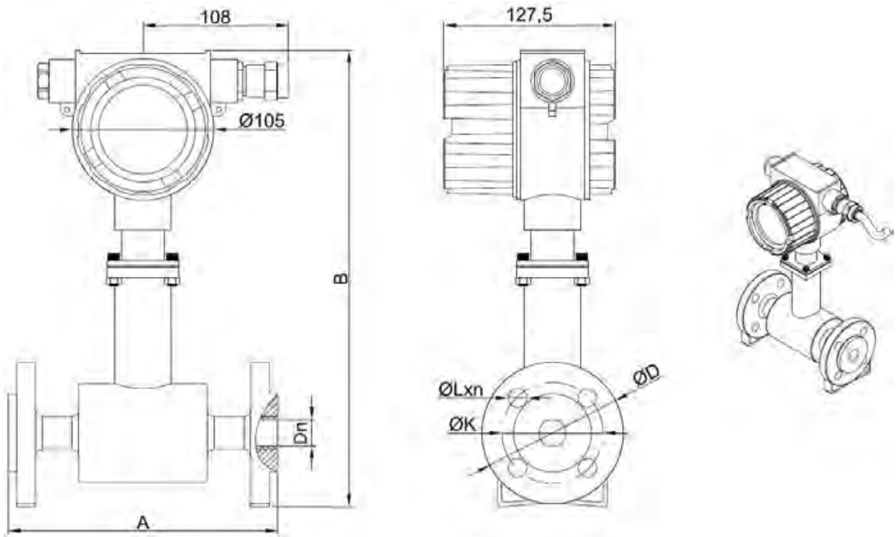

Figure B.14 Overall dimensions of explosion-proof flowmeter (housing 2)

Dn	PN	A, mm	Tolerance for A, mm	B, mm	ØD, mm	ØK, mm	ØLxn, mm x pcs.	Weight, kg
15	40	200	+0/-3	335	95	65	14 x 4	5.5
20	40	200	+0/-3	345	105	75	14 x 4	5.5
25	40	200	+0/-3	350	115	85	14 x 4	5.5
32	40	200	+0/-3	365	140	100	14 x 4	8.0
40	40	200	+0/-3	375	150	110	18 x 4	9.0
50	40	200	+0/-3	385	165	125	18 x 4	10.0
65	40	200	+0/-3	405	185	145	18 x 4	12.0
80	40	200	+0/-3	425	200	160	18 x 8	14.0
100	16	250	+0/-3	445	220	180	18 x 8	18.0
125	16	250	+0/-3	475	250	210	18 x 8	23.0
150	16	300	+0/-3	510	285	240	22 x 8	30.0
200	10	350	+0/-3	560	340	295	22 x 8	37.0
250	10	450	+0/-5	645	395	350	22 x 12	45.5
300	10	500	+0/-5	700	445	400	22 x 12	57.0
350	10	550	+0/-5	750	505	460	22 x 16	67.0
400	10	600	+0/-5	805	565	515	26 x 16	96.0
500	10	600	+0/-5	915	670	620	26 x 20	124.0
600	10	600	+0/-5	1035	780	725	30 x 20	160.0

Appendix B continued

B.4 Explosion-proof flowmeters with remote design

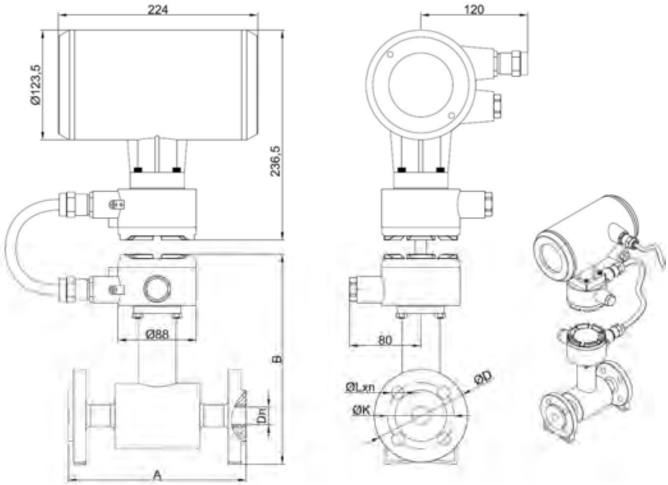

Figure B.15 Overall dimensions of explosion-proof flowmeter (housing 1)

Dn	PN	A, mm	Tolerance for A, mm	B, mm	ØD, mm	ØK, mm	ØLxn, mm x pcs.	Weight, kg
15	40	200	+0/-3	235	95	65	14 x 4	8.0
20	40	200	+0/-3	245	105	75	14 x 4	8.0
25	40	200	+0/-3	250	115	85	14 x 4	8.0
32	40	200	+0/-3	265	140	100	14 x 4	10.5
40	40	200	+0/-3	275	150	110	18 x 4	11.5
50	40	200	+0/-3	285	165	125	18 x 4	12.5
65	40	200	+0/-3	305	185	145	18 x 4	14.5
80	40	200	+0/-3	325	200	160	18 x 8	16.5
100	16	250	+0/-3	345	220	180	18 x 8	20.5
125	16	250	+0/-3	375	250	210	18 x 8	25.5
150	16	300	+0/-3	410	285	240	22 x 8	32.5
200	10	350	+0/-3	460	340	295	22 x 8	39.5
250	10	450	+0/-5	545	395	350	22 x 12	47.0
300	10	500	+0/-5	600	445	400	22 x 12	59.5
350	10	550	+0/-5	650	505	460	22 x 16	69.5
400	10	600	+0/-5	705	565	515	26 x 16	98.5
500	10	600	+0/-5	815	670	620	26 x 20	126.5
600	10	600	+0/-5	935	780	725	30 x 20	162.5

Appendix B continued

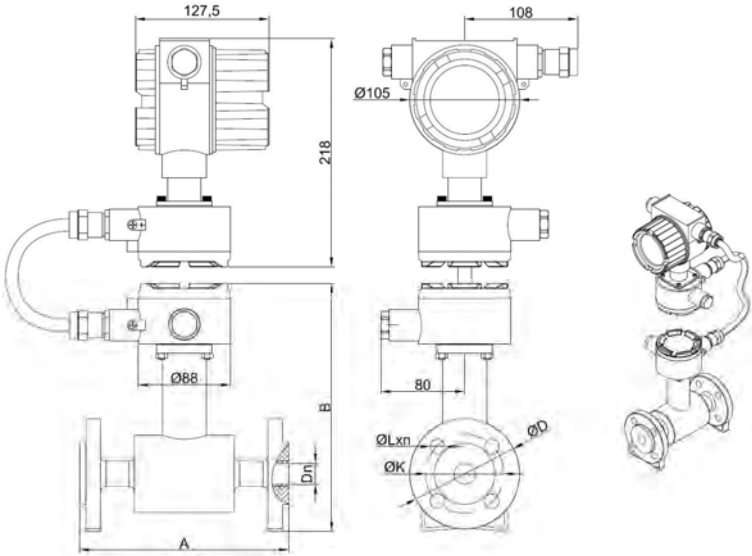

Figure B.16 Overall dimensions of explosion-proof flowmeter (housing 2)

Dn	PN	A, mm	Tolerance for A, mm	B, mm	ØD, mm	ØK, mm	ØLxn, mm x pcs.	Weight, kg
15	40	200	+0/-3	235	95	65	14 x 4	6.5
20	40	200	+0/-3	245	105	75	14 x 4	6.5
25	40	200	+0/-3	250	115	85	14 x 4	6.5
32	40	200	+0/-3	265	140	100	14 x 4	9.0
40	40	200	+0/-3	275	150	110	18 x 4	10.0
50	40	200	+0/-3	285	165	125	18 x 4	11.0
65	40	200	+0/-3	305	185	145	18 x 4	13.0
80	40	200	+0/-3	325	200	160	18 x 8	15.0
100	16	250	+0/-3	345	220	180	18 x 8	19.0
125	16	250	+0/-3	375	250	210	18 x 8	24.0
150	16	300	+0/-3	410	285	240	22 x 8	31.0
200	10	350	+0/-3	460	340	295	22 x 8	38.0
250	10	450	+0/-5	545	395	350	22 x 12	46.5
300	10	500	+0/-5	600	445	400	22 x 12	58.0
350	10	550	+0/-5	650	505	460	22 x 16	68.0
400	10	600	+0/-5	705	565	515	26 x 16	97.0
500	10	600	+0/-5	815	670	620	26 x 20	125.0
600	10	600	+0/-5	935	780	725	30 x 20	161.0

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APPENDIX C Volumetric flow rate measurement ranges

General performance parameters are given in Section 2, Table 2.1.

For standard nominal diameters (Dn) of the sensor, the measurement ranges of volumetric flow rate (Q) - depending on the accuracy class of the device - are given in Tables B.1–B.8. Designations in the tables:

Q_{min} is minimum flow rate; Q_t is transition flow rate;
Q_{nom} is nominal flow rate; Q_{max} – overload flow rate.

Table B.1 Measurement ranges for standard Dn flowmeters of Class A

Dn, mm	Q_{min}, m^3/hr	Q_t, m^3/hr	Q_{nom}, m^3/hr	Q_{max}, m^3/hr
5	0.00353	0.01060	0.70686	0.88357
6	0.00509	0.01527	1.01788	1.27235
8	0.00905	0.02714	1.80956	2.26195
10	0.01414	0.04241	2.82743	3.53429
15	0.03181	0.09543	6.36173	7.95216
20	0.05655	0.16965	11.3097	14.1372
25	0.08836	0.26507	17.6715	22.0893
32	0.14476	0.43429	28.9529	36.1911
40	0.22619	0.67858	45.2389	56.5487
50	0.35343	1.06029	70.6858	88.3573
65	0.59730	1.79189	119.459	149.324
70	0.69272	2.07816	138.544	173.180
80	0.90478	2.71434	180.956	226.195
100	1.41372	4.24115	282.743	353.429
125	2.20893	6.62680	441.786	552.233
150	3.18086	9.54259	636.173	795.216
200	5.65487	16.9646	1130.97	1413.72
250	8.83573	26.5072	1767.15	2208.93
300	12.7234	38.1703	2544.69	3180.86
350	17.3180	51.9541	3463.61	4329.51
400	22.6195	67.8584	4523.89	5654.87
450	28.6278	85.8833	5725.55	7156.94
500	35.3429	106.029	7068.58	8835.73
600	50.8938	152.681	10178.8	12723.5
700	69.2721	207.816	13854.4	17318.0
800	90.4779	271.434	18095.6	22619.5
900	114.511	343.533	22902.2	28627.8
1000	141.372	424.115	28274.3	35342.9
1200	203.575	610.726	40715.0	50893.8
1400	279.680	839.040	56110.0	69920.0
1600	361.912	1085.73	72382.3	90477.9

Appendix C continued

Table B.2 Measurement ranges for standard Dn flowmeters of Class A1

Dn, mm	Q_{min}, m^3/hr	Q_t, m^3/hr	Q_{nom}, m^3/hr	Q_{max}, m^3/hr
5	0.00442	0.01325	0.70686	0.88357
6	0.00636	0.01909	1.01788	1.27235
8	0.01131	0.03393	1.80956	2.26195
10	0.01767	0.05301	2.82743	3.53429
15	0.03976	0.11928	6.36173	7.95216
20	0.07069	0.21206	11.3097	14.1372
25	0.11045	0.33134	17.6715	22.0893
32	0.18096	0.54287	28.9529	36.1911
40	0.28274	0.84823	45.2389	56.5487
50	0.44179	1.32536	70.6858	88.3573
65	0.74662	2.23986	119.459	149.324
70	0.86590	2.59770	138.544	173.180
80	1.13097	3.39292	180.956	226.195
100	1.76715	5.30144	282.743	353.429
125	2.76117	8.28350	441.786	552.233
150	3.97608	11.9282	636.173	795.216
200	7.06859	21.2058	1130.97	1413.72
250	11.0447	33.1340	1767.15	2208.93
300	15.9043	47.7129	2544.69	3180.86
350	21.6476	64.9427	3463.61	4329.51
400	28.2744	84.8231	4523.89	5654.87
450	35.7847	107.354	5725.55	7156.94
500	44.1787	132.536	7068.58	8835.73
600	63.6173	190.852	10178.8	12723.5
700	86.5902	259.770	13854.4	17318.0
800	113.097	339.292	18095.6	22619.5
900	143.139	429.417	22902.2	28627.8
1000	176.715	530.144	28274.3	35342.9
1200	254.469	763.407	40715.0	50893.8
1400	349.600	1048.80	56110.0	69920.0
1600	452.390	1357.17	72382.3	90477.9

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Appendix C continued

Table B.3 Measurement ranges for standard Dn flowmeters of Class B

Dn, mm	Q_{min}, m^3/hr	Q_t, m^3/hr	Q_{nom}, m^3/hr	Q_{max}, m^3/hr
2	0.00113	0.00339	0.11310	0.14137
2.5	0.00177	0.00530	0.17670	0.22089
4	0.00452	0.01357	0.45239	0.56549
5	0.00707	0.02121	0.70686	0.88357
6	0.01018	0.03054	1.01788	1.27235
8	0.01810	0.05429	1.80956	2.26195
10	0.02827	0.08482	2.82743	3.53429
15	0.06362	0.19085	6.36173	7.95216
20	0.11310	0.33929	11.3097	14.1372
25	0.17671	0.53014	17.6715	22.0893
32	0.28953	0.86859	28.9529	36.1911
40	0.45239	1.35717	45.2389	56.5487
50	0.70686	2.12058	70.6858	88.3573
65	1.19459	3.58378	119.459	149.324
70	1.38544	4.15632	138.544	173.180
80	1.80956	5.42868	180.956	226.195
100	2.82743	8.48230	282.743	353.429
125	4.41786	13.2536	441.786	552.233
150	6.36173	19.0852	636.173	795.216
200	11.3098	33.9293	1130.97	1413.72
250	17.6714	53.0143	1767.15	2208.93
300	25.4469	76.3406	2544.69	3180.86
350	34.6361	103.908	3463.61	4329.51
400	45.2390	135.717	4523.89	5654.87
450	57.2555	171.767	5725.55	7156.94
500	70.6858	212.058	7068.58	8835.73
600	101.788	305.364	10178.8	12723.5
700	138.544	415.632	13854.4	17318.0
800	180.956	542.868	18095.6	22619.5
900	229.022	687.067	22902.2	28627.8
1000	282.743	848.230	28274.3	35342.9
1200	407.150	1221.45	40715.0	50893.8
1400	559.360	1678.08	56110.0	69920.0
1600	723.823	2171.47	72382.3	90477.9

Appendix C continued

Table B.4 Measurement ranges for standard Dn flowmeters of Class B1

Dn, mm	Q_{min}, m^3/hr	Q_t, m^3/hr	Q_{nom}, m^3/hr	Q_{max}, m^3/hr
2	0.00141	0.00424	0.11310	0.14137
2.5	0.00221	0.00663	0.17670	0.22089
4	0.00565	0.01696	0.45239	0.56549
5	0.00884	0.02651	0.70686	0.88357
6	0.01272	0.03817	1.01788	1.27235
8	0.02262	0.06786	1.80956	2.26195
10	0.03534	0.10603	2.82743	3.53429
15	0.07952	0.23856	6.36173	7.95216
20	0.14137	0.42412	11.3097	14.1372
25	0.22089	0.66268	17.6715	22.0893
32	0.36191	1.08573	28.9529	36.1911
40	0.56549	1.69646	45.2389	56.5487
50	0.88357	2.65072	70.6858	88.3573
65	1.49324	4.47971	119.459	149.324
70	1.73180	5.19541	138.544	173.180
80	2.26195	6.78584	180.956	226.195
100	3.53429	10.6029	282.743	353.429
125	5.52233	16.5670	441.786	552.233
150	7.95216	23.8565	636.173	795.216
200	14.1372	42.4115	1130.97	1413.72
250	22.0893	66.2680	1767.15	2208.93
300	31.8086	95.4258	2544.69	3180.86
350	43.2951	129.885	3463.61	4329.51
400	56.5487	169.646	4523.89	5654.87
450	71.5694	214.708	5725.55	7156.94
500	88.3573	265.072	7068.58	8835.73
600	127.235	381.704	10178.8	12723.5
700	173.180	519.541	13854.4	17318.0
800	226.195	678.584	18095.6	22619.5
900	286.278	858.833	22902.2	28627.8
1000	353.429	1060.29	28274.3	35342.9
1200	508.938	1526.81	40715.0	50893.8
1400	699.200	2097.60	56110.0	69920.0
1600	904.779	2714.34	72382.3	90477.9

Appendix C continued

Table B.5 Measurement ranges for standard Dn flowmeters of Class C

Dn, mm	Q_{min}, m^3/hr	Q_t, m^3/hr	Q_{nom}, m^3/hr	Q_{max}, m^3/hr
2	0.00226	0.00679	0.11310	0.14137
2.5	0.00353	0.01060	0.17670	0.22089
4	0.00905	0.02714	0.45239	0.56549
5	0.01425	0.04275	0.70686	0.88357
6	0.02052	0.06157	1.01788	1.27235
8	0.03619	0.10857	1.80956	2.26195
10	0.05700	0.17101	2.82743	3.53429
15	0.12826	0.38478	6.36173	7.95216
20	0.22802	0.68406	11.3097	14.1372
25	0.35628	1.06884	17.6715	22.0893
32	0.5837	1.7512	28.9529	36.1911
40	0.9121	2.7362	45.2389	56.5487
50	1.4251	4.2754	70.6858	88.3573
65	2.4084	7.2253	119.459	149.324
70	2.7932	8.3797	138.544	173.180
80	3.6483	10.945	180.956	226.195
100	5.7000	17.101	282.743	353.429
125	8.9070	26.721	441.786	552.233
150	12.826	38.478	636.173	795.216
200	22.802	68.406	1130.97	1413.72
250	35.628	106.88	1767.15	2208.93
300	51.300	153.91	2544.69	3180.86
350	69.830	209.49	3463.61	4329.51
400	91.210	273.62	4523.89	5654.87
450	115.43	346.30	5725.55	7156.94
500	142.51	427.54	7068.58	8835.73
600	205.22	615.65	10178.8	12723.5
700	279.32	837.97	13854.4	17318.0
800	364.83	1094.5	18095.6	22619.5
900	461.74	1385.2	22902.2	28627.8
1000	570.00	1710.1	28274.3	35342.9

Appendix C continued

Table B.6 Measurement ranges for standard Dn flowmeters of Class C1

Dn, mm	Q_{min}, m^3/hr	Q_t, m^3/hr	Q_{nom}, m^3/hr	Q_{max}, m^3/hr
2	0.00283	0.00848	0.11310	0.14137
2.5	0.00442	0.01325	0.17670	0.22089
4	0.01131	0.03393	0.45239	0.56549
5	0.01767	0.05301	0.70686	0.88357
6	0.02545	0.07634	1.01788	1.27235
8	0.04524	0.13572	1.80956	2.26195
10	0.07069	0.21206	2.82743	3.53429
15	0.15904	0.47713	6.36173	7.95216
20	0.28274	0.84823	11.3097	14.1372
25	0.44179	1.32536	17.6715	22.0893
32	0.72382	2.17147	28.9529	36.1911
40	1.13097	3.39292	45.2389	56.5487
50	1.76715	5.30144	70.6858	88.3573
65	2.98648	8.95943	119.459	149.324
70	3.46361	10.3908	138.544	173.180
80	4.52389	13.5717	180.956	226.195
100	7.06858	21.2057	282.743	353.429
125	11.0447	33.1340	441.786	552.233
150	15.9043	47.7130	636.173	795.216
200	28.2743	84.8230	1130.97	1413.72
250	44.1786	132.536	1767.15	2208.93
300	63.6172	190.852	2544.69	3180.86
350	86.5902	259.771	3463.61	4329.51
400	113.097	339.292	4523.89	5654.87
450	143.139	429.416	5725.55	7156.94
500	176.715	530.144	7068.58	8835.73
600	254.469	763.407	10178.8	12723.5
700	346.361	1039.08	13854.4	17318.0
800	452.389	1357.17	18095.6	22619.5
900	572.555	1717.67	22902.2	28627.8
1000	706.858	2120.57	28274.3	35342.9

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Appendix C continued

Table B.7 Measurement ranges for standard Dn flowmeters of Class D.

Dn, mm	Q_{min}, m³/hr	Q_t, m³/hr	Q_{nom}, m³/hr	Q_{max}, m³/hr
2	0.00471	0.01414	0.11310	0.14137
2.5	0.00736	0.02209	0.17670	0.22089
4	0.01885	0.05655	0.45239	0.56549
5	0.02945	0.08836	0.70686	0.88357
6	0.04241	0.12723	1.01788	1.27235
8	0.07540	0.22619	1.80956	2.26195
10	0.11781	0.35343	2.82743	3.53429
15	0.26507	0.79522	6.36173	7.95216
20	0.47124	1.41372	11.3097	14.1372
25	0.73631	2.20893	17.6715	22.0893
32	1.20637	3.61911	28.9529	36.1911
40	1.88496	5.65487	45.2389	56.5487
50	2.94524	8.83573	70.6858	88.3573
65	4.97746	14.9324	119.459	149.324
70	5.77268	17.3180	138.544	173.180
80	7.53982	22.6195	180.956	226.195
100	11.7810	35.3429	282.743	353.429
125	18.4078	55.2233	441.786	552.233
150	26.5072	79.5216	636.173	795.216
200	47.1239	141.372	1130.97	1413.72
250	73.6311	220.893	1767.15	2208.93
300	106.029	318.086	2544.69	3180.86
350	144.317	432.951	3463.61	4329.51
400	188.496	565.487	4523.89	5654.87
450	238.565	715.694	5725.55	7156.94
500	294.524	883.573	7068.58	8835.73
600	424.115	1272.35	10178.8	12723.5
700	577.268	1731.80	13854.4	17318.0
800	753.982	2261.95	18095.6	22619.5
900	954.259	2862.78	22902.2	28627.8
1000	1178.10	3534.29	28274.3	35342.9

Appendix C continued

Table B.8 Measurement ranges for standard Dn flowmeters of Class D1

Dn, mm	Q_{min}, m^3/hr	Q_t, m^3/hr	Q_{nom}, m^3/hr	Q_{max}, m^3/hr
2	0.00565	0.01696	0.11310	0.14137
2.5	0.00884	0.02651	0.17670	0.22089
4	0.02262	0.06786	0.45239	0.56549
5	0.03534	0.10603	0.70686	0.88357
6	0.05089	0.15268	1.01788	1.27235
8	0.09048	0.27143	1.80956	2.26195
10	0.14137	0.42411	2.82743	3.53429
15	0.31809	0.95426	6.36173	7.95216
20	0.56549	1.69646	11.3097	14.1372
25	0.88357	2.65072	17.6715	22.0893
32	1.44764	4.34293	28.9529	36.1911
40	2.26195	6.78584	45.2389	56.5487
50	3.53429	10.6029	70.6858	88.3573
65	5.97295	17.9189	119.459	149.324
70	6.92721	20.7816	138.544	173.180
80	9.04779	27.1434	180.956	226.195
100	14.1372	42.4115	282.743	353.429
125	22.0893	66.2680	441.786	552.233
150	31.8086	95.4259	636.173	795.216
200	56.5487	169.646	1130.97	1413.72
250	88.3573	265.072	1767.15	2208.93
300	127.234	381.703	2544.69	3180.86
350	173.180	519.541	3463.61	4329.51
400	226.195	678.584	4523.89	5654.87
450	286.278	858.833	5725.55	7156.94
500	353.429	1060.29	7068.58	8835.73
600	508.938	1526.81	10178.8	12723.5
700	692.721	2078.16	13854.4	17318.0
800	904.779	2714.34	18095.6	22619.5
900	1145.11	3435.33	22902.2	28627.8
1000	1413.72	4241.15	28274.3	35342.9

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APPENDIX D Electrical circuits connections

A special termination panel is provided for electrical connections in the EM. In the remote version, the panel is located in the lower section of the housing (Figure D.1), in the compact version it is located in the rear part of the housing under the screw cover (Figures D.2 and D.3).

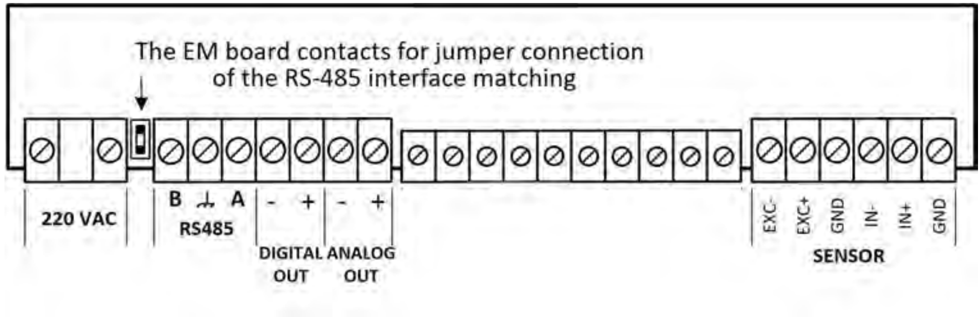


Figure D.1 Contacts layout on the termination box of EM (remote version, jumper for the matching resistor is not installed)

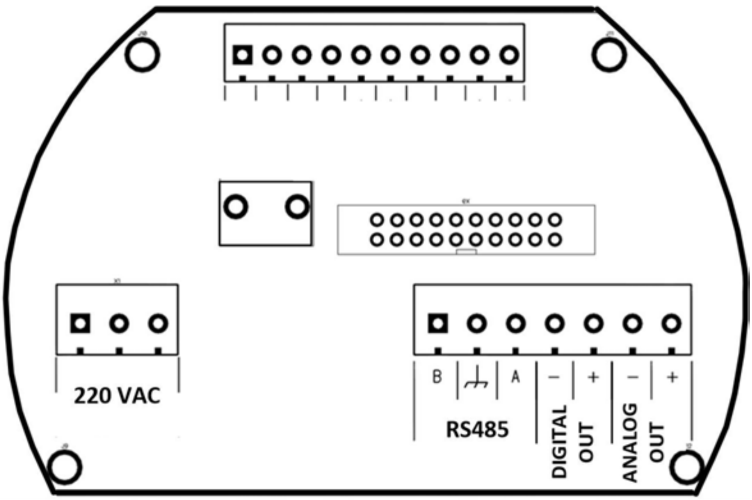
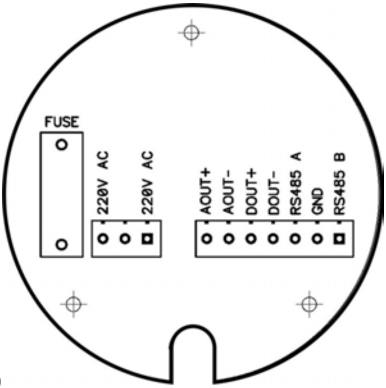


Figure D.2 Layout of contacts on the termination box of the EM board in compact version, option 1

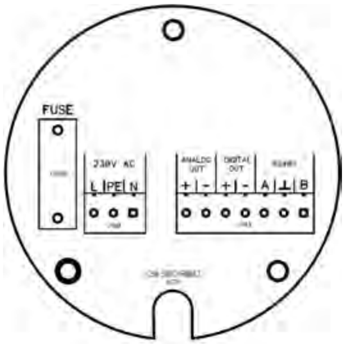
Frequency and pulse outputs are on the terminals DIGITAL OUT. The operating mode of the discrete output is selected from the flowmeter setup menu.

Appendix D continued

Circuit power supply of the flowmeter is distributed to the 220 V AC (or 24 V) terminations. In order to ensure normal operation, it is recommended to use a circuit with no power equipment, which can generate a high level of interference. When using the power supply circuit of power equipment, the flowmeter must be connected via a line voltage stabilizer or a UPS.

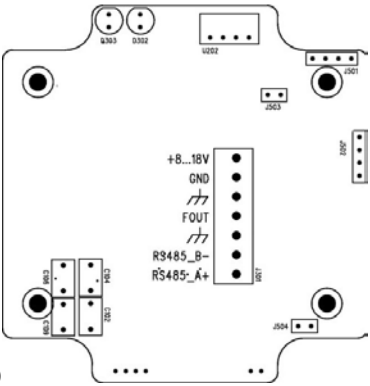


a)

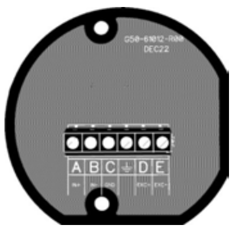


b)

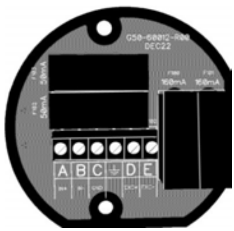
Figure D.3 Layout of contacts on termination box of the EM board, option 2 designs: a) compact; b) super-compact



a)



b)



c)

Figure D.4 Layout of contacts on the termination box of the board:
a) for a combined version of the flowmeter;
b) for a general purpose design sensor; c) for a sensor of explosion-proof design (with installed fuses)

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Appendix D continued

Sensor and electronic module connection

For a remote design of the flowmeter, a special multi-core cable connecting the sensor to the electronic module is included in the supply package.
The cable is connected as per diagram shown in Figure D.5.

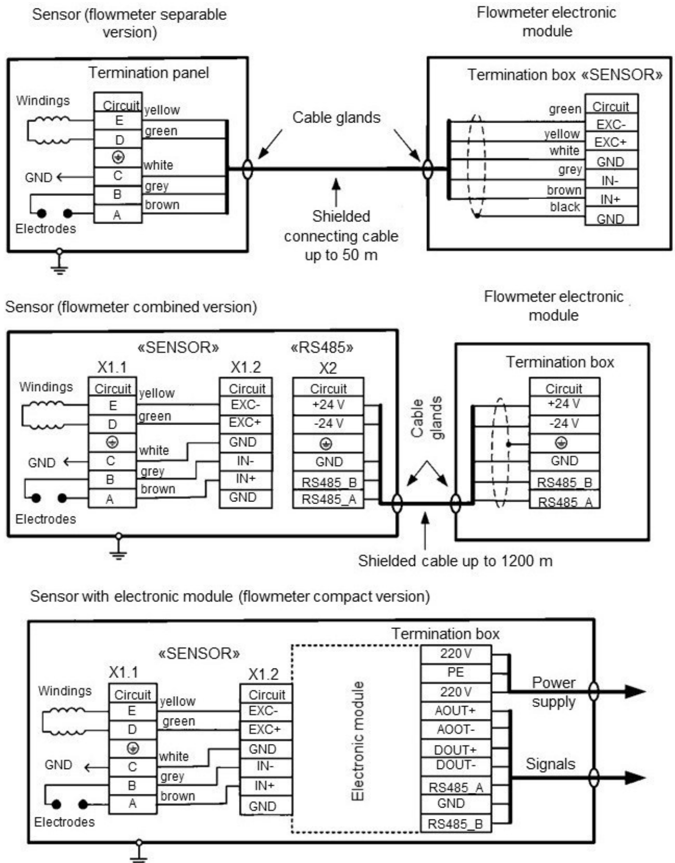


Figure D.5 Connection of sensor to EM for different flowmeter designs

For a remote design, when connecting EM to sensor, the SROS 5-22HGR (manufactured by TEKABEN) cable type is used, its length shall be specified when ordering the Item (the cable should not be replaced with another or shortened at the installation site, as this affects the performance).

Appendix D continued

Connection of discrete outputs: pulse and frequency

The operating mode of the discrete output is selected in software (see the programming menu, Appendix F). The output is passive, galvanically isolated. The external supply voltage must not exceed 25 V, Figure D.6.

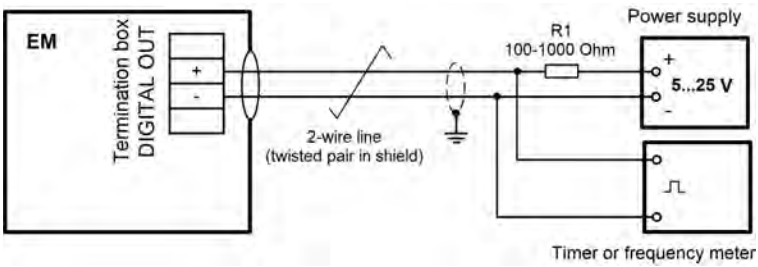


Figure D.6 Electrical diagram for connecting the discrete output

Connection to the information network via RS-485 interface

The signal in the RS-485 standard is transmitted via current loop separately from the transducer power lines; the connection is shown in Figures D.7, D.8.

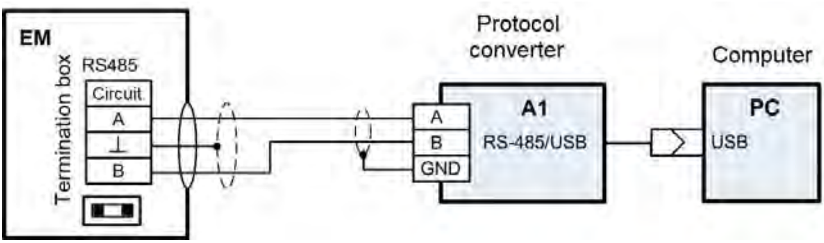
a) 

Figure D.7 Flowmeter - PC connection diagram

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Appendix D continued

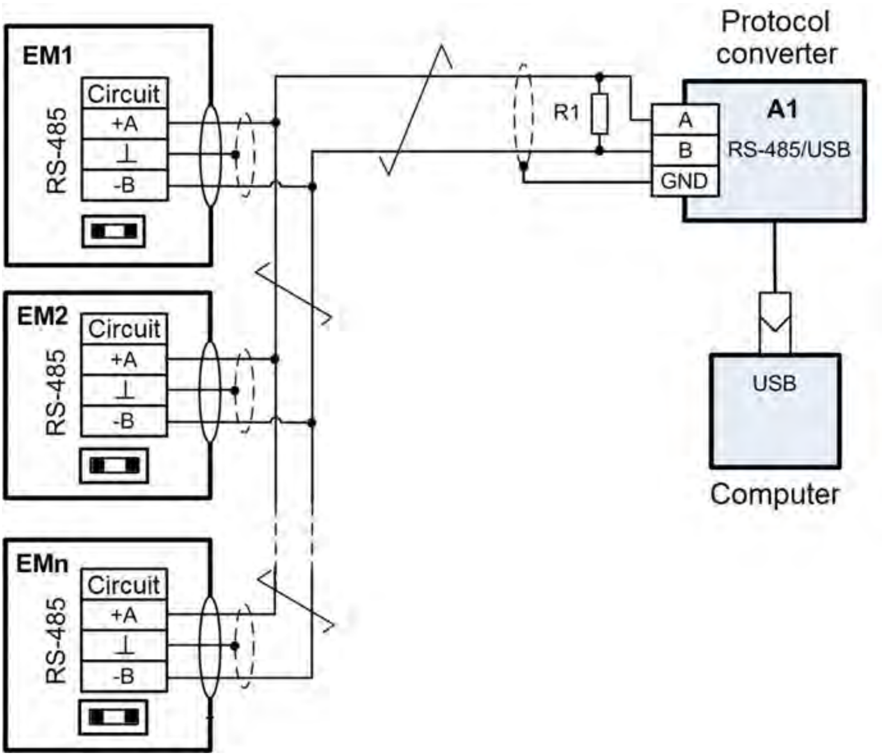


Figure D.8 Connecting several flowmeters (or compatible devices) in a local network via RS-485 interface to a computer (or APCS system)

Connection via Ethernet interface

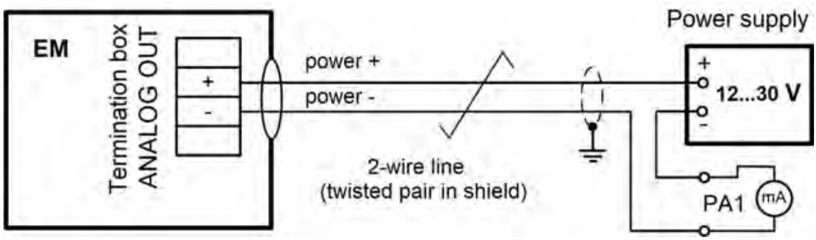
Figure D.9 Flowmeter - PC connection diagram

Appendix D continued

Connection of the analog current output 4…20 mA

Depending on the type selected when ordering, the galvanically isolated output is connected as per diagram in Figure D.10.

a)



b)

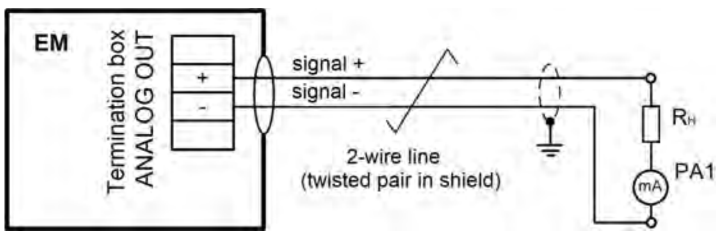


Figure D.10 The current output connection electrical diagrams:
a) passive type; b) active type

Connection via HART interface (optional)

A HART communicator can be connected to configure the flowmeter as per Figure D.11.

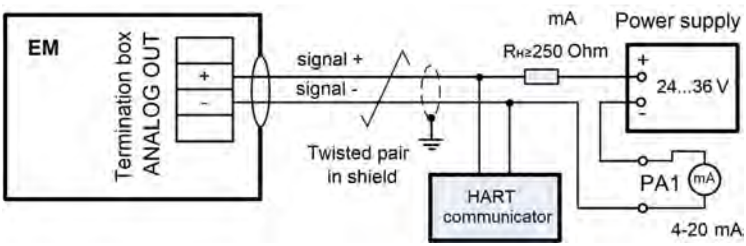


Figure D.11 HART communicator connection option

Appendix D continued

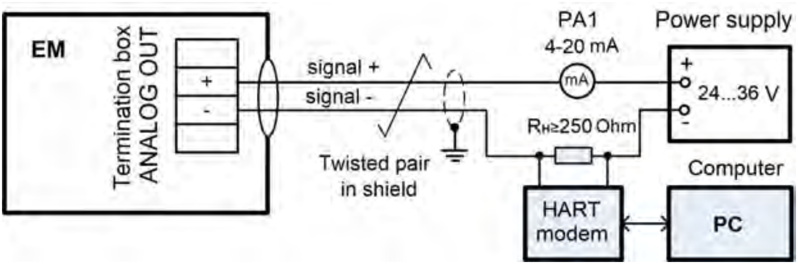


Figure D.12 HART communicator connection option

Connection of multiple flowmeters: up to 15 instruments can be connected in one circuit. For multichannel mode, each device must have an individual communication address – a numeric value from 1 to 15 (the initial address during manufacture is 1). The address is changed in software via the HART protocol, using a stand-alone HART communicator or a HART modem with a PC.

When the multichannel communication mode is activated, the device's analog output signal is disabled, its value is fixed at 4 mA. The measured values are transmitted to the computer, and all instruments are sequentially polled.

APPENDIX E Flowmeter operation error codes

Code*	Name	Status	Description
0	ERR_NO_ERRORS	I	No error
1	ERR_FLOW_TOO_HIGH	W	Flow rate above Q_{max}
2	ERR_ADC_OVERLOAD_POS	W	ADC overload in measurement positive half-wave
3	ERR_ADC_OVERLOAD_NEG	W	ADC overload in measurement negative half-wave
4	ERR_NOT_CALIBRATED	E	Flowmeter not calibrated
5	ERR_ECC_FLOW_LOW	E	Liquid flow rate too small to enable electrode cleaning
55	ERR_DIGITAL_OUTPUT_OVERLOAD	E	Pulse output overload, need to increase pulse weight
56	ERR_FREQUENCY_OUTPUT_OVER-LOAD	E	Frequency output overload, need to increase the binding flow rate value
58	ERR_ANALOG_OUTPUT_OVERLOAD	E	Analog output overload, need to increase the binding flow rate value
59	ERR_WATCHDOG_RESET	E	Reset from watchdog timer
5A	ERR_BROWNOUT_FAIL	W	Reset due to short-term power interruption
5B	ERR_EXTERNAL_RESET	W	Error due to external reset
5C	ERR_POWER_ FAIL	I	Reset due to power outage
5D	ERR_MULT_RST_SOURCES	W	Reset source group error
5E	ERR_AUTH_FAILED	I	Login error
A9	ERR_CONFIGURATION_INVALID	E	Flowmeter configuration checksum is invalid
AA	ERR_STATE_LOAD_FAIL	E	Flowmeter status area checksum is invalid

* Error code values are displayed on the LCD indicator in hexadecimal form.

Status: **E** – major error; **W** – warning; **I** – information.

Notes:
1. It is possible to record up to 9 different errors simultaneously.
2. The first 5 errors are displayed on the flow meter front panel indicator.
3. All errors are possible to be read via RS-485 interface.

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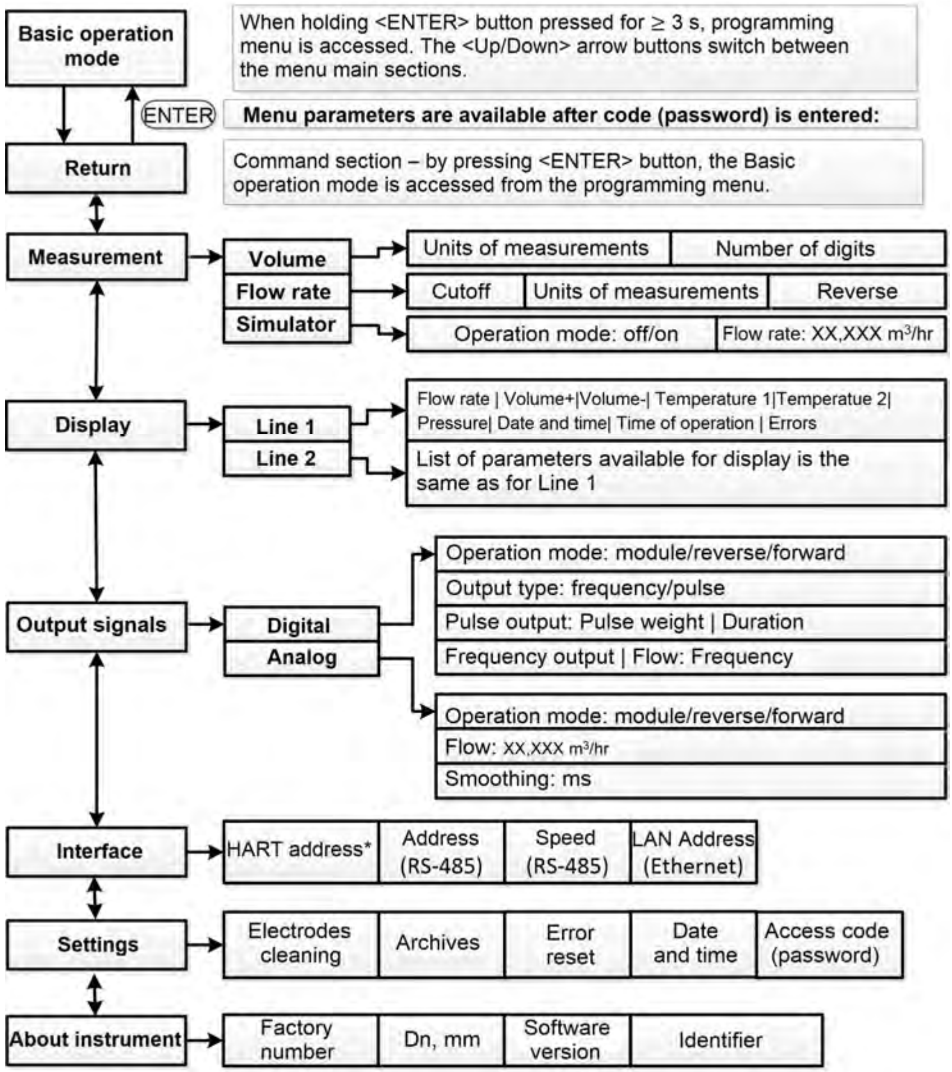
APPENDIX F Flowmeter configuration menu



* The menu item is available only for the HART interface flowmeter version (the interface speed is always fixed at 1200 baud).

Appendix F continued

When activated by the <ENTER> button, in all menu sections the (Return) line is a command to go to the previous level.

The programming menu consists of the following elements:

Commands are menu items for confirming execution of any actions. The command is activated by pressing the <ENTER> button;

Sections are main menu items containing other items (subsections) of lower level. Transition to the lower level is done by pressing the <ENTER> button;

Fields are places that require the entry of a numeric or symbolic value, or display some information. The end of value entry is made by pressing the <ENTER> button. Exit from the field intended for viewing is done by holding the <ENTER> button for more than 3 s;

Lists are fields where one parameter value from the available list needs to be selected. The value from the list is selected using the vertical navigation buttons, confirmed by the <ENTER> button.

Pressing the <ENTER> button in the upper-level section leads to the transition to the next hierarchically lower level (subsection). The Exit command each current level has is to go to a higher menu level.

The menu main sections are: Measurement, Display, Outputs, Interface, Settings, Parameters. They are intended for:

- **Measurement** includes the Volume, Flow Rate and Simulator subsections:

- **Volume** allows to set the parameters of the meters of the volume of liquid that has passed through the flow meter. There are two independent meters that sum up the volume in the forward and reverse directions. The parameters set in this section apply to both meters, both in forward and reverse directions.

Information on the volume of liquid that has passed through the flowmeter is stored in the internal non-volatile memory and is preserved for a long time during power failures. In the event of an error of reading from the non-volatile memory, when the device is turned on, a corresponding code is generated, which is recorded in the hardware log, and an error state is generated.

Units of measurement are the accumulated volume units of measurement selected from the list. The flowmeter can measure the volume of liquid in cubic meters or liters.

Number of digits means that the field sets the number of digits after the decimal point to display the accumulated volume. The user sets the number of digits after the decimal point using the arrows and confirms selection with the <ENTER> button.

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Appendix F continued

The accumulated volume will be displayed with a selected number of digits after the decimal point.
- **Flow rate** - contains the flow rate measurement settings (instant flow). **Cutoff** - the flow rate threshold below which it is considered that there is no flow in the pipeline. The specified cutoff is applied to both positive and negative flow directions. **Units of measurement** – the required units of liquid flow rate, that the user Selects from the list: liters/hour; liters/min.; liters/second; m^3/hour; m^3/min.; m^3/s (the selection is confirmed by pressing the <ENTER> button). Instant flow rate is measured in two directions: positive and negative (flow in the negative direction is displayed with a minus sign on the indicator). **Reverse flow** – prohibition/permission to record negative (directed in the opposite direction) liquid flow rate.
– **Simulator** – this section sets the parameters of the simulator work, which serves to configure the flow rate measurement channel in APCS and allows simulation of signals at the flowmeter outputs proportional to the values specified in the "Flow rate" field. At the same time, the actual flow rate in the pipeline does not matter. **Operation mode** – this item can be used to enable/disable the simulator. When enabled, the simulator affects the frequency and current outputs. **Flow** – a field for entering the value of the simulated flow. The value cannot exceed the maximum flow rate for a given sensor diameter.

· **Display** – the section contains two lists that can be used to configure the display of information on the indicator:
– **Line 1/Line 2** – the catalogs of lists for selection contain specifications that will be displayed in the first and second lines of the indicator in two-line mode.

· **Output signals** – a section for configuring the flowmeter output signals:

– **Digital output** – this section sets the output operating parameters. **Output type** – this subsection is for selection of the output operating mode: Frequency/Pulse. **Pulse output** allows to set the pulse output parameters for displaying measurement results in the form of pulses where the number thereof is proportional to the volume of liquid passed through. **Pulse weight** – this field specifies the volume of liquid, that passes through the flowmeter and triggers one pulse generation at the pulse output. **(Pulse) Duration** – in the field, value is selected regarding the response time of the device the pulse output is connected to. When specifying

Appendix F continued

duration, consider the maximum flow rate in the pipeline and the specified pulse weight. Pulses are always issued with a pulse ration of 2. If the pulse duration and weight are programmed so that the instrument does not have time to issue them, the unissued pulses are added to the buffer. If this happens for a long time, the buffer overruns and an overrun error is generated. The permissible pulse duration is between 10 ms and 1 sec. Therefore, the maximum number of pulses issued per second is 50 (with a minimum duration of 10 ms).

Frequency output - in this subsection, settings are programmed for outputting flow rate measurement results in the form of a frequency that is proportional to the measured flow rate.

Operating mode is a list of one of the values selections: Forward, Backward, Module. In the Forward mode, the frequency will be proportional to the flow rate in positive direction. In the Backward mode, the frequency will be proportional to the flow rate in negative direction. In the Module mode, the frequency will be proportional to the flow rate regardless of flow direction.

Flow - in this field, the flow rate value is entered that corresponds to the maximum frequency value. The value must not exceed the maximum flow rate for a given sensor diameter.

Frequency - in this field, frequency value is entered that corresponds to the flow rate set in the Flow field. The maximum frequency is f_{max} = 2000 Hz.

- **Analog output** - in this subsection for the output current 4...20 mA, the parameters for normalizing the output of flow rate measurement results are programmed. A 4 mA current always corresponds to zero flow, and a value of 20 mA to the flow rate specified in the Flow field.

Operating mode is a list of one of the values selections: Forward, Backward, Module. In the Forward mode, the current will be proportional to the flow rate in positive direction. In the Backward mode, the current will be proportional to the flow rate in negative direction. In the Module mode, the current will be proportional to the flow rate regardless of flow direction.

Flow - in this field, the flow rate value is entered that corresponds to the value of current 20 mA. The value must not exceed the maximum flow rate for a given sensor diameter.

Smoothing – in this field, the damping time of the output signal 4...20 mA in milliseconds is entered.

· **Interface** is for configuration of the relevant operating communication parameters:

– **HART address** – in this field, the flow meter address for data exchange is set (permissible values are from 1 to 15).

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Appendix F continued

– **Address (for RS-485 port)** – in this field, the flow meter address on the data exchange bus is set (permissible values are from 1 to 249).
– **Speed (for RS-485 port)** – select one of the serial interface speed values from the list: 9600, 19200 and 38400 bit/s.
– **Ethernet address** – in this field, the flow meter address for data exchange is set (the default value is 10.0.0.1).

· **Settings** – this section allows to change additional parameters:

– **Electrode cleaning** – in this field, the time period can be set (in minutes) after which the ECC (Electrodes Clearing Circuit) will be activated and automatic cleaning will be performed. During the electrode cleaning (approximately 60 s), no measurements are performed, the last measured flow rate value is recorded at the flow meter outputs. In this case, the accumulated volume meters operate using the last flow rate measurement. After the electrode cleaning is complete, measurements continue in the normal mode. If the value is set to 0, periodic electrode cleaning is not performed. **Note**: It is not recommended to use the electrode cleaning function with tantalum or hastelloy electrodes.
– **Archiving** – in this subsection, the time period can be set (in minutes) after which a record will be made to the archive (the information is saved in non-volatile memory). Data on the accumulated flow rate values in both directions (positive and negative), date, time, operating time and error codes are stored. The archive size is up to 1 MB (contains 4096 blocks with 11 records in each block) and it is circular.
– **Error reset** – this subsection allows to delete current records of all errors that have occurred since the start of work or the last reset of the error memory. In the archive, various error codes can be seen, and when there were no errors, all codes will be zero. If the same error is repeated, it is recorded only once.
– **Date/Time** – a subsection for setting the current date and time. Using horizontal arrows, the user sets the pointer to the digit that needs to be changed. Using vertical arrows, the desired digit can be found. The correctness of the set date and time is confirmed by pressing the <ENTER> button.
– **Access code** – this field allows user to set a digital password code for access to the main setup menu. When entering this field, the pointer blinks on the first character of the password. The password has up to 9 digits. Using the horizontal and vertical arrows located on the front panel, the user writes down the password and confirms it by pressing the <ENTER> button. Once the password is written, it will be requested with each attempt to enter the programming menu. If the password is entered incorrectly, it returns to the main operating

Appendix F continued

mode. In order to cancel password-based access, set the value to 0.

ATTENTION! If password is set, its loss will result in loss of access to the menu of the instrument.

· **About instrument** - this section is for viewing only and contains information about the flowmeter supply package. Since the fields indicate information that affects performance, the user cannot make changes to the following:

– **Factory number**, a factory number common for the flowmeter components.
– **Dn**, the nominal diameter of the sensor pipe in mm.
– **SW version**, microcontroller software version number.
– **Identifier**, the flowmeter SW checksum calculated when the power is turned on.

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APPENDIX G Monitoring and changing settings

G.1 Use a special program on a PC to check the flowmeter settings conformity with the actual specifications indicated in the passport. In order to do this, connect EM to computer via an RS-485/USB interface converter, as shown in Appendix D, and use P-Control program.

Compare the flowmeter settings (including internal diameter of the sensor pipe and operating range) with the passport data.

G.2 **Changes of the instrument date and time** can be done by using buttons on the flowmeter EM front panel or from P-Control program.

Changes using the flowmeter setup menu:

– select commands «Settings | Date and time»;
– use the <Left> button to move the cursor sequentially to the "day", "month", "year", "hours", "minutes" position;
– in each position, use the <Up> or <Down> buttons to change the value of the selected parameter.
The set value is saved by pressing the <ENTER> button.

Changes with the help of P-Control software:

1) unzip the program file and open P-Control folder, select the executable P-Control.exe file therein, run P-Control on PC;

2) select the COM Settings command and specify the communication parameters: number of the COM port used, communication speed (38400/19200/9600 bit/s), the polling timeout (values from 100 to 2000 ms are allowed). When making changes to the parameters, first click the «Save» button, and then the «Next» button;

3) select the «Device Search» command, specify the range of addresses to poll in the network. By default, all addresses from 1 to 247 are polled sequentially.

When making changes to the parameters, first click the «Save» button, and then the «Next» button; an automatic search will start for connections to the network of
RS-485 instruments and a list of those available will appear in the «Device List» sector;

4) in the Device List select the device with the mouse cursor and, on the corresponding tabs of the information field, check the operating parameters;

5) open the «Status» tab, thereon, select the « Set date» command to correct the values;

6) end the communication session by pressing the button .

APPENDIX H RS-485 Interface operation parameters

In order to integrate the flowmeter into automated energy resource control and metering systems, the user may need to develop proprietary software to read the data.

- Modbus RTU protocol is used.
- 255 (0xff) address is reserved to work with one flowmeter on the bus.
- For identification on the bus, the flowmeter supports command 17 (report slave id). The flowmeter-specific information has the following form:

```
typedef struct
{
  uint32_t
    id,
    serial;
  char
    tag[ 11 ];
} deviceSpecificSlaveID __attribute__ ( ( packed ) );
```

The device tag string (tag) is terminated by '\0'.

The flow meter identifier contains the built-in SW compilation timestamp (id) and its factory number (serial). The numbers are transmitted in little endian format (the least significant byte is transmitted first).

- To receive data from the flowmeter, use the read command 4 (read input registers).

The flowmeter response uses IEEE754-2008 single-precision floating-point numbers (single precision, 32 bit) in big endian format (reverse float, the most significant byte is transmitted first). The two flowmeter registers form a register pair in the format of a single-precision floating-point number.

- The input registers of the flow meter contain the following values:

Pair No.	Instrument variable
0	Accumulated volume "+", m^3
1	Accumulated volume "-", m^3
2	Instant value of volumetric flow rate, m^3/s

Note: If the flowmeter does not have a corresponding volumetric meter, the 0 m^3 value is transmitted.

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APPENDIX I HART Interface operation parameters

I1 The following instrument variables can be obtained via the HART protocol:

Identifier (decimal number)	Instrument variable
0	OFF (no) – not assigned
1	Instant value of volumetric flow rate, m^3/s
250	Accumulated volume "+", m^3
251	Accumulated volume "-", m^3
252	Balance

The following device parameters are assigned in the factory setting:

Primary process variable (PV) → Volumetric flow rate value;
Second process variable (SV) → Accumulated volume "+";
Third process variable (TV) → Accumulated volume "–";
Fourth process variable (FV) → not assigned.

Note: The instrument variables to process variables can be assigned or changed with the help of command 51.

I2 Universal and common HART commands

I2 .1 Reading the unique instrument identifier (0, read unique identifier)

- Access type is reading
- Command data none
- Response data is 17 bytes

Offset	Description	Value
0	Fixed value	254
1	Manufacturer identifier	224
2	Instrument type	13
3	Number of preambles	5
4	Protocol version	6
5	Instrument version	0x30
6	SW version	0x12
7	Hardware version	0x0A
8	Transfer medium	0
9/10/11	Unique identifier	XXXX
12	Number of preambles	5
13	Number of variables	4
14/15	Reconfiguration counter	XXXX
16	No extended status	0

Appendix I continued

I2.2 Reading the primary process variable (1, read primary variable)

- Access type is reading
- Command data none
- Response data is 5 bytes

Offset	Description
0	Unit of measurement identifier
1–4	Value of primary process variable

I2.3 Reading the primary process variable as current and percentage value of the measurement range (2, read loop current and percent of range)

- Access type is reading
- Command data none
- Response data is 8 bytes

Offset	Description
0–3	Current actual value
4–7	Percentage value of MR

I2.4 Reading the primary process variable as current and four process dynamic variables (3, read dynamic variables and loop current)

- Access type is reading
- Command data none
- Response data is 24 bytes

Offset	Description
0–3	Current of primary process variable
4	PV unit of measurement identifier
5–8	Primary process variable
9	SV unit of measurement identifier
10–13	Second process variable
14	TV unit of measurement identifier
15–18	Third process variable
19	FV unit of measurement identifier
20–23	Fourth process variable

I2.5 Setting of a HART short address (6, write polling address)

- Access type is write
- Command data is a byte of information with the required address (0 ... 63)
- Response data is a byte of information with the current active address

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Appendix I continued

Note: If the multi-address mode is used (address value >0), then for the current output of the primary variable, the value of current is set to 4 mA, the so-called parking mode.

I2.6 Reading a user message (12, read message)

- Access type is reading
- Command data none
- Response data is 25 bytes of user message

Note: A user message can be set with help of command 17.

I2.7 Reading the instrument name, descriptor and date (13, read tag, descriptor and date)

- Access type is reading
- Command data none
- Response data is 21 bytes

Offset	Description
0–5	Instrument tag
6–17	Instrument descriptor (description)
18–20	Date

I2.8 Reading the sensor information on primary process variable (14, read primary variable transducer information)

- Access type is reading
- Command data none
- Response data is 16 bytes

Offset	Description
0–2	Sensor factory No.
3	PV units of measurement identifier
4–7	Sensor URL
8–11	Sensor LRL
12–15	Measurement range

Note: The sensor URL implies maximum permissible liquid flow rate in the measuring cross-section at a speed of 12.5 m/s, and LRL implies the maximum value of the EMR cutoff value and the minimum flow rate of 38 mm/s. The measurement range is determined as a difference between these numbers.

I2.9 Reading the output information of primary process variable (15, read primary variable)

- Access type is reading

Appendix I continued

- Command data none
- Response data is 18 bytes

Offset	Description
0	Emergency signal identifier
1	Transfer function type
2	Flow rate units of measurement identifier
3–6	Flow rate matching the 20 mA current
7–10	Flow rate matching the 4 mA current
11–14	Smoothing constant
15	Write protection tag
16	Reserved
17	ADC channel identifier

I2.10 Reading the instrument manufacturer code (16, read final assembly number)

- Access type is writing
- Command data none
- Response data is 3 bytes of manufacturer code

I2.6 Write a user message (17, write message)

- Access type is writing
- Command data is 24 bytes of user message
- Response data is 24 bytes. Same, from command body

I2.12 Write the instrument name, descriptor and date (18, write tag, descriptor and date)

- Access type is writing
- Command data is 21 bytes
- Response data is 21 bytes. Same, from command body

Offset	Description
0–5	Instrument tag
6–17	Flow rate units of measurement identifier
18–20	Date

I2.13 Write the primary process variable smoothing coefficient (34, write primary variable damping value)

- Access type is writing
- Command data is 4 bytes. EMR flow rate smoothing coefficient value
- Response data is 4 bytes. Same, from command body

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Appendix I continued

Note: The value shows the number of counts involved in smoothing at the analog output.

I2.14 Write the primary process variable MR (35, write primary variable ranges)

- Access type is writing
- Command data is 9 bytes
- Response data is 9 bytes. Same, from command body

Offset	Description
0	Flow rate units of measurement identifier
1–4	Flow rate upper value for the 20 mA current
5–8	Ignored

I2.15 Write the primary process variable measurement units (flow rate) (44, write primary variable units)

- Access type is writing
- Command data is 1 byte measurement units code
- Response data is 1 byte. Same, from command body

I2.16 Reading the assignment of the instrument variables to four process variables (50, read dynamic variable assignments)

- Access type is reading
- Command data none
- Response data is 4 bytes

Offset	Description
0	Code of instrument primary variable (flow rate)
1	Code of instrument second variable (SV)
2	Code of instrument third variable (TV)
3	Code of instrument fourth variable (FV)

I2.17 Write the assignment of instrument variables to four variables of process (51, write dynamic variable assignments)

- Access type is reading
- Command data is 4 bytes
- Response data is 4 bytes. Same, from command body

Note: The data format of the write command is similar to the read command. (#50). Only the flow rate value can be used as the primary process variable.

Appendix I continued

I2.18 Reading the instrument write archive

- Access type is reading
- Command data is 1 byte of archive write number
- Response data is 58 bytes

Information about the contents of the response data is provided upon request.

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APPENDIX J Ensuring explosion protection

The flowmeters belong to group II explosion-proof equipment as per GOST 31610.0 (GOST IEC 60079-0:2017) and are intended for use in explosion hazardous areas in accordance with explosion protection marking, requirements of TR CU 012/2011 and other prescriptive documents.

The compact flowmeters explosion protection type is explosion-proof enclosure d as per GOST IEC 60079-1 with the marking 1Ex db IIC T6...T4 Gb X. Remote flowmeters have a combined explosion protection type: intrinsically safe electrical circuits of ia level as per GOST IEC 60079-11:2011 and explosion-proof enclosures d as per GOST IEC 60079-1 with the primary transducer marking 1Ex db ia IIC T6...T4 Gb X and the electronic transducer marking 1Ex db [ia] IIC T6 Gb X.

The housing design and parts of the flowmeter enclosure is made regarding general requirements of GOST IEC 60079-0:2017. The electrical components are enclosed in an explosion-proof enclosure that can withstand explosion pressure and can prevent combustion from being transmitted to the surrounding explosive environment. The explosion stability and explosion-resistance of the enclosure comply with the requirements for electrical equipment of IIC subgroup as per GOST IEC 60079-1. The parameters of explosion-resistance connections (the thread axial length, number of full undamaged turns of the threaded connections) comply with the requirements of GOST IEC 60079-1 for electrical equipment of subgroup IIC. The inspection window is hermetically installed in the cover and forms a single design. The flow part is powered from the associated equipment - the electronic transducer. In remote version, the current and voltage of the circuits connecting the primary and electronic transducers are limited with the help of zener diodes and resistors. The electrical load of the limiting elements does not exceed 2/3 of their nominal values.

The X sign in the explosion protection marking indicates special operating conditions:

– the housing of the electronic transducer may only be opened when the power supply voltage is disconnected;

– the cable glands used must have valid certificates of conformity with the requirements of TR CU 012/2011;

– the temperature of the measured medium must not exceed the values specified in clause 2.3;

– the unused opening for the cable gland must be closed with a plug supplied by the manufacturer;

– the gauge pressure of the measured medium must not exceed the maximum value permissible for the corresponding version of the flow meter.

Appendix J continued

Parameters of the electrical circuit of the linked equipment

Power supply circuit of the primary transducer:

Maximum voltage of spark-hazardous circuits of the linked equipment, Um	110…250 V AC, 50 Hz 18…36 V DC
Maximum output voltage, U_0	5 V
Maximum output current, I_0	114 mA
Maximum output power, P_0	143 mW
Maximum external capacitance, C_0	1.59 µF
Maximum external inductance, L_0	1500 mH

Measurement electrode circuit:

Maximum voltage of spark-hazardous circuits of the linked, Um	110…250 V AC, 50 Hz 18…36 V DC
Maximum output voltage, U_0	5 V
Maximum output current, I_0	50 mA
Maximum output power, P_0	95 mW
Maximum external capacitance, C_0	1.59 µF
Maximum external inductance, L_0	1 mH

Intrinsically safe equipment electric circuit parameters

Power supply circuit of the primary transducer:

Maximum input voltage, U_i	7.5 V
Maximum input current, I_i	630 mA
Maximum input power, P_i	1.3 W
Maximum internal capacitance, C_i	0 µF
Maximum internal inductance, L_i	1200 mH

Measurement electrode circuit:

Maximum input voltage, U_i	5 V
Maximum input current, I_i	250 mA
Maximum input power, P_i	1.25 W
Maximum internal capacitance, C_i	0 µF
Maximum internal inductance, L_i	0 mH

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APPENDIX M Drawings of explosion protection means

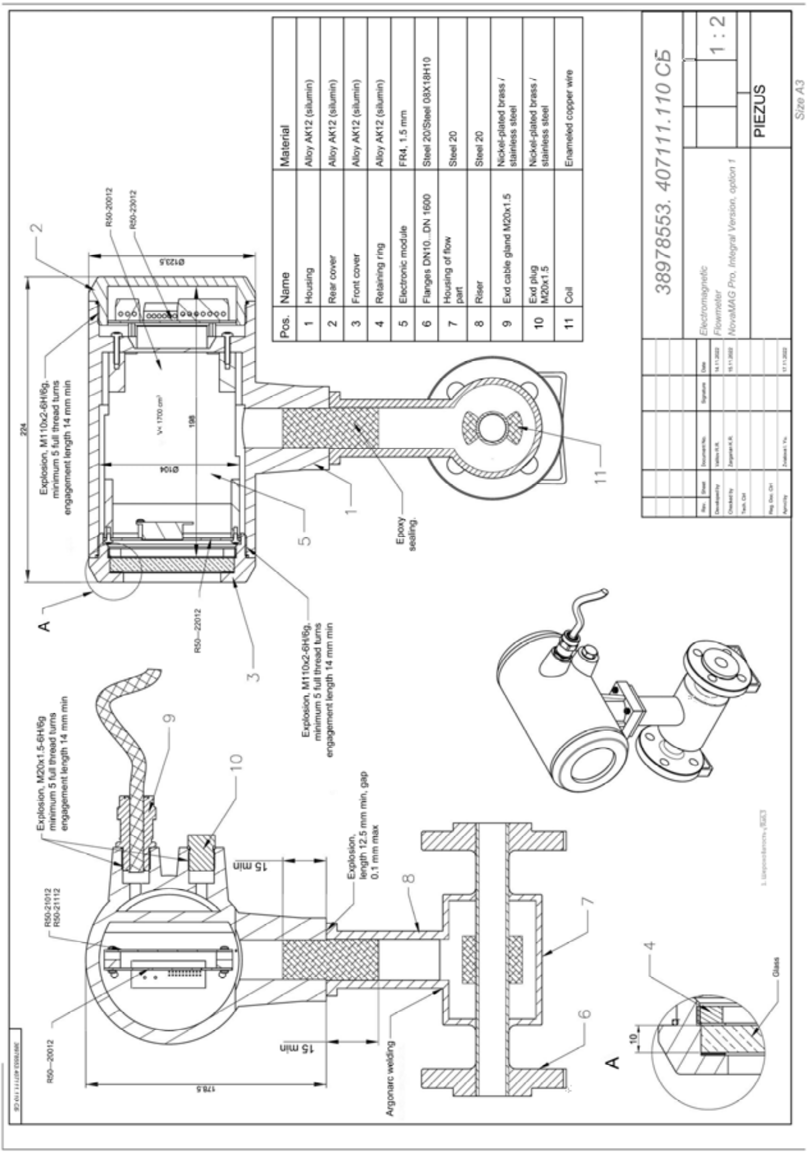


Figure M.1 Design features of explosion-proof

compact flowmeter version (housing 1)

Appendix M continued

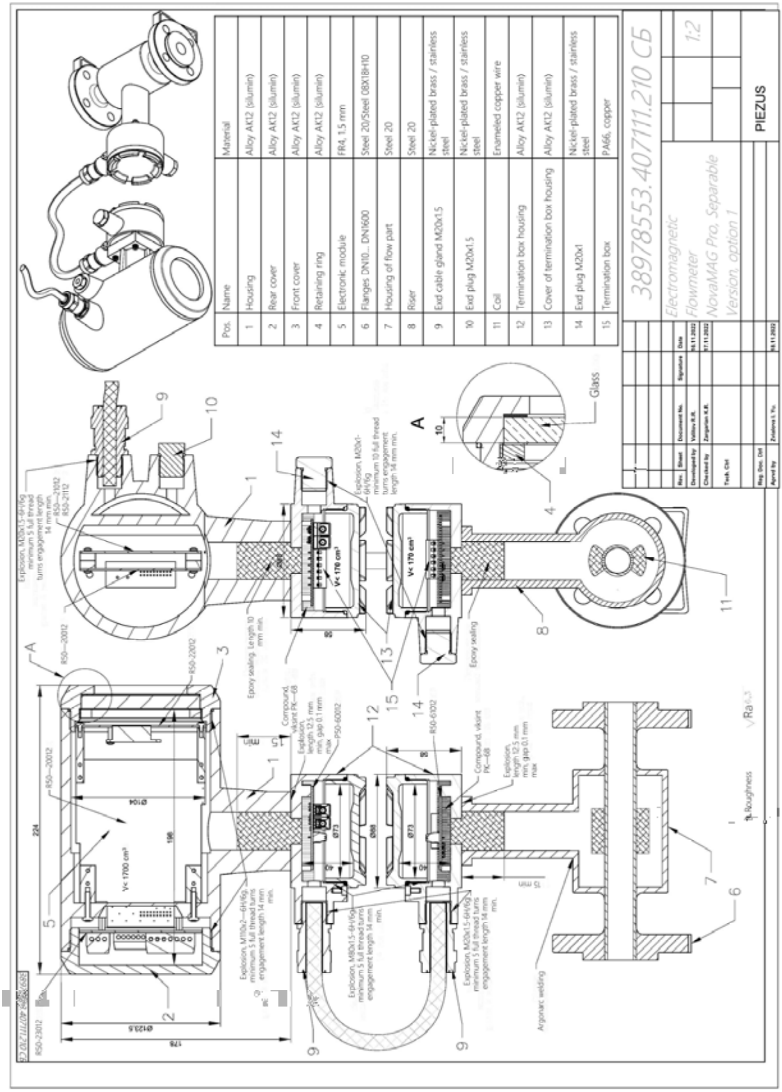


Figure M.2 Design features of explosion-proof remote version of the flow meter (housing 1)

Appendix M continued

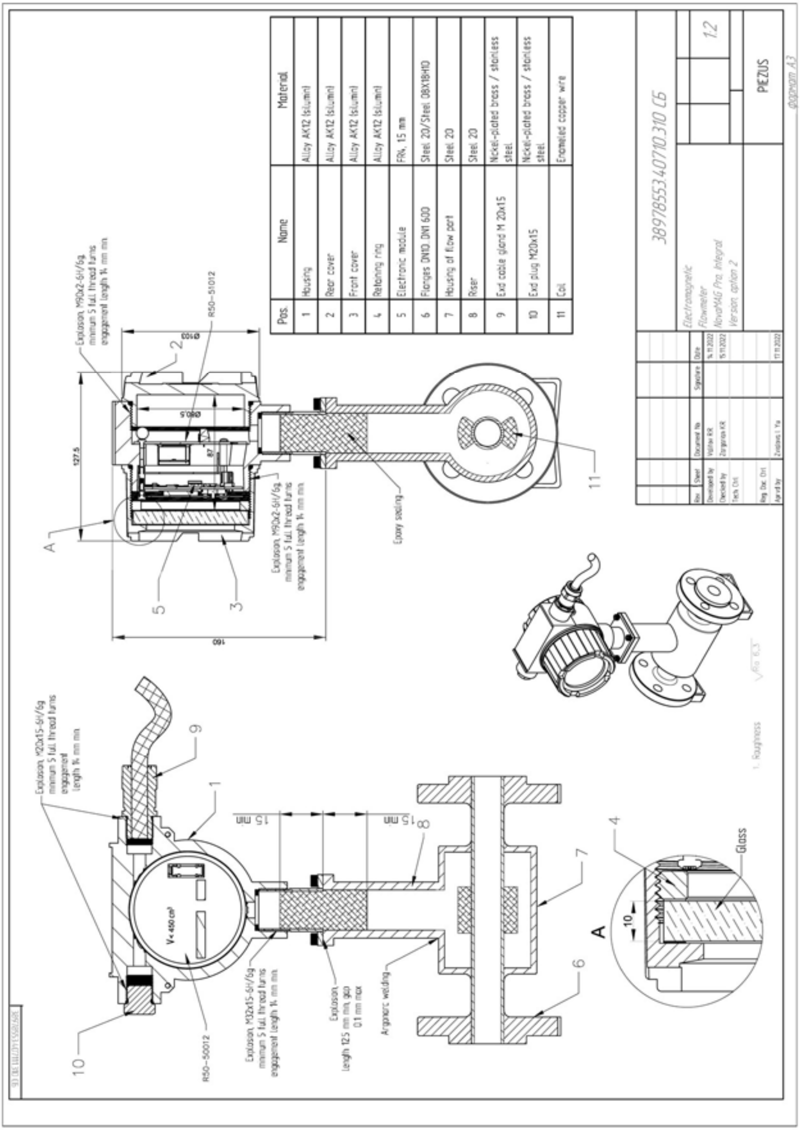


Figure M.3 – Design features of explosion-proof compact flowmeter version (housing 2, small-sized)

Appendix M continued

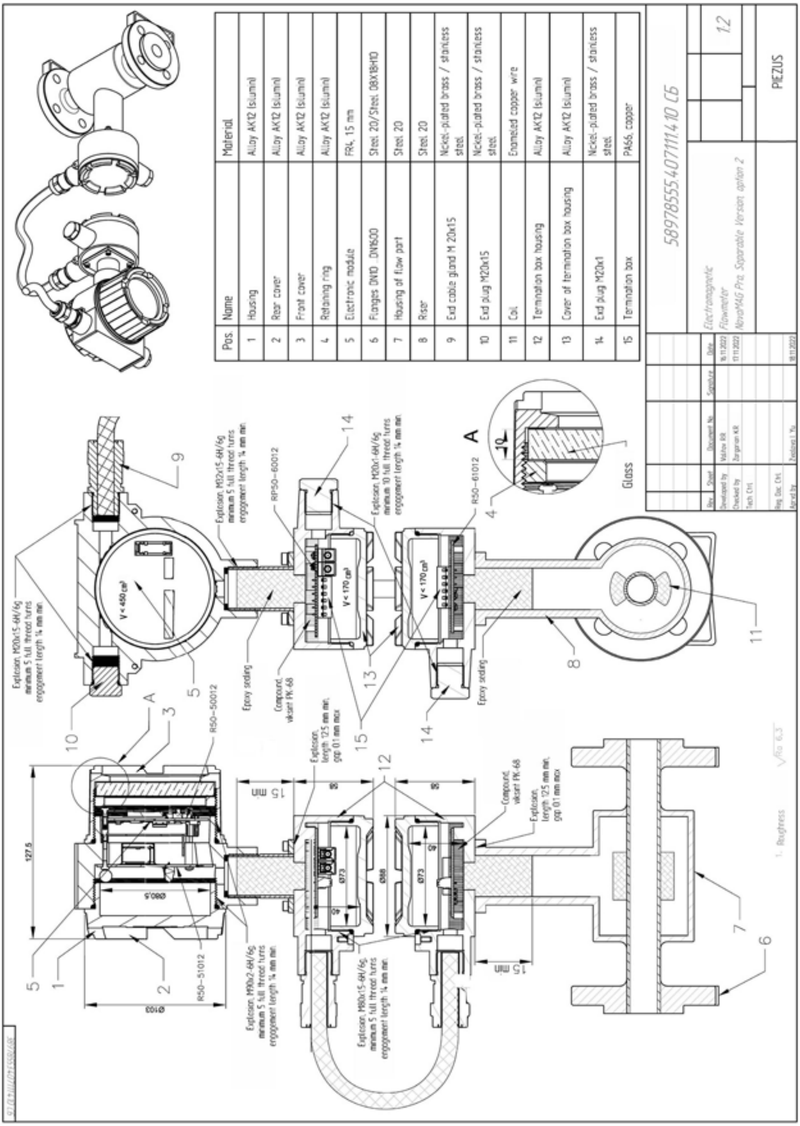


Figure M.4 Design features of explosion-proof remote flowmeter version (housing 2, small-sized)

Appendix M continued

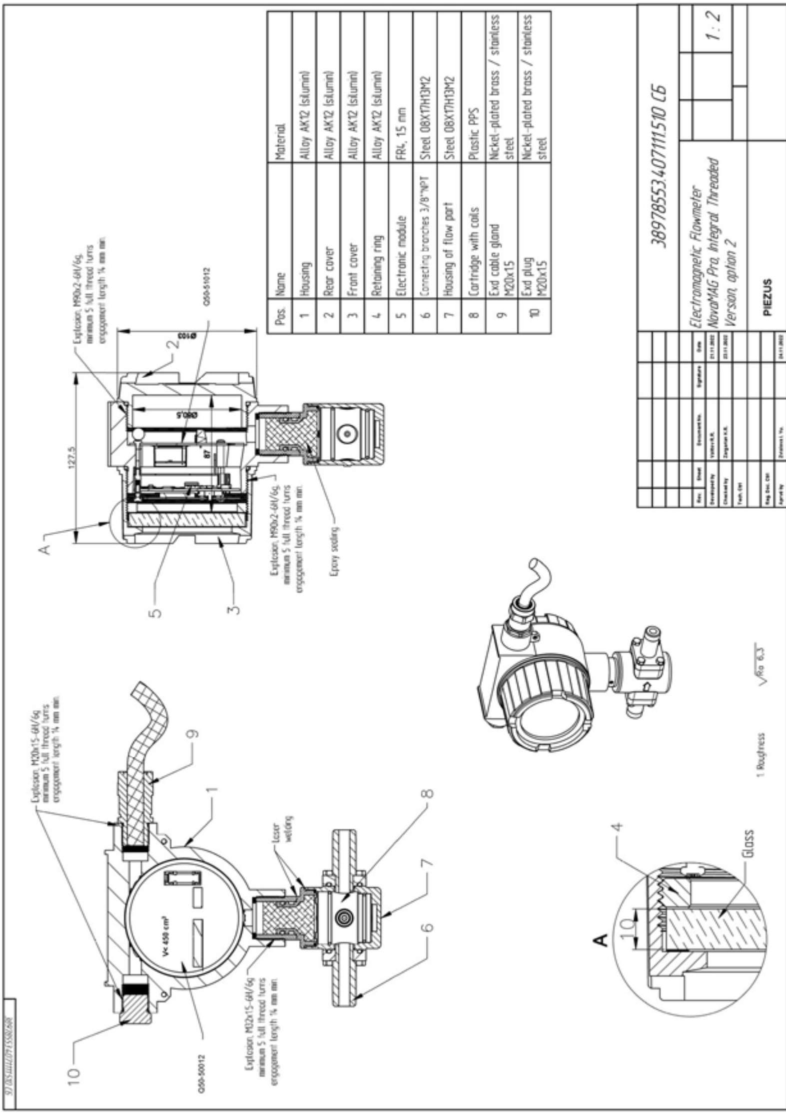


Figure M.5 Design features of explosion-proof compact flowmeter version (For Dn 2-8 m flowmeters, housing 2, small-sized)

Appendix M continued

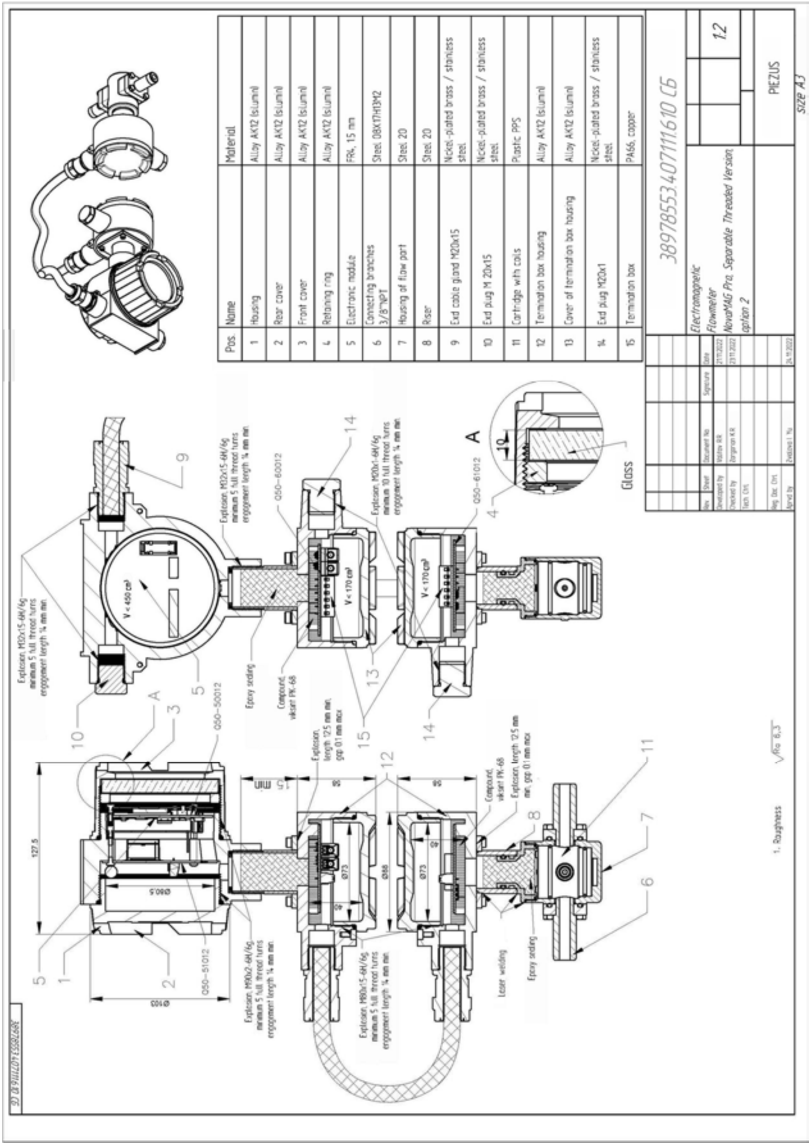
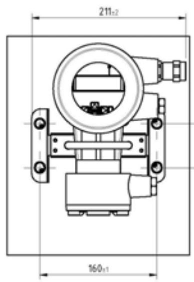
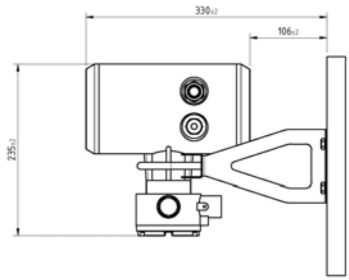


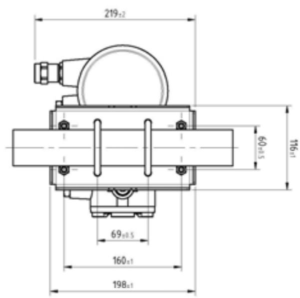
Figure M.6 Design features of explosion-proof

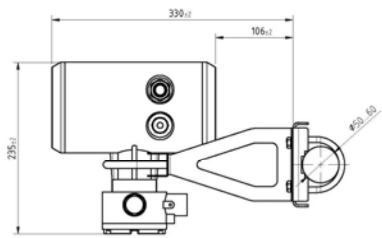
remote flowmeter version (For Dn 2-8 mm flowmeters, housing 2, small-sized)

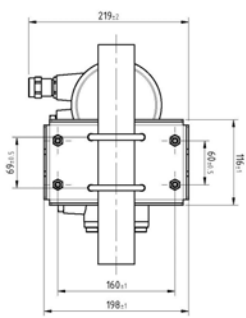
APPENDIX O Bracket for fixing the EM of remote version, explosion proof version and the EM IP67 version

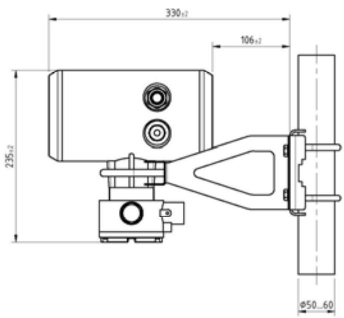












For notes

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