Electromagnetic flowmeter for application in explosive atmospheres

FLONEX FXx11x

Contents

1. BASIC INFORMATION

1.1 Application

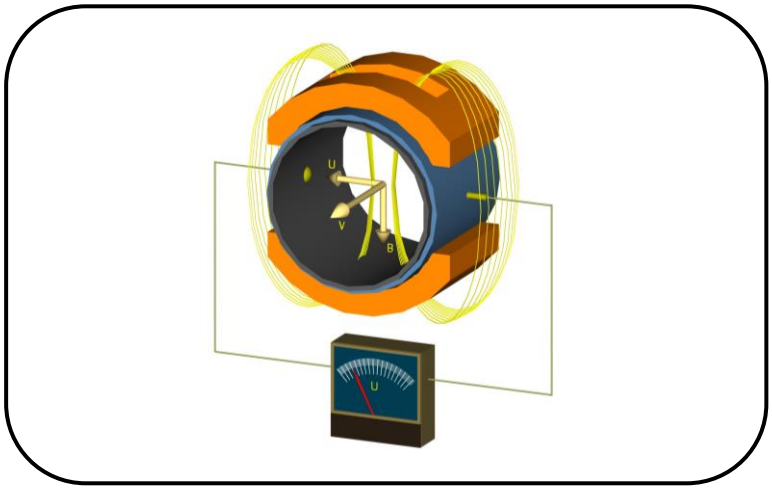
FLONEX FXx11x is an electromagnetic flowmeter intended for measurement of volume flow rate of electrically conductive liquids in fully-flooded piping in operating environments involving explosion risk. The meter facilitates high-precision bi-directional flow rate measurements at flow velocities ranging from 0.025 to 10 m/s. The minimum required conductivity of the measured fluid is 10 µS/cm, for de-mineralised water 20 µS/cm.

1.2. Measurement principle

The function of electromagnetic flowmeter is based on the Faraday induction law. The meter sensor consists of a non-magnetic electrically non-conductive tube and two inbuilt electrodes that pick up the induced voltage in a plane perpendicular to the direction of the magnetic power lines. The magnetic field is generated by electric current flowing through two coils wound on the tube. The flow of the conductive liquid through the tube gives rise to induced voltage **U** proportional to the magnetic flux density **B**, flow velocity **v** and the length of the virtual conductor **l**:

$$U = B \times l \times v$$

U induced voltage
B flux density
l distance between the measuring electrodes
v flow velocity of the measured liquid



For the given sensor size, the values of flux density and distance between electrodes are constant. Therefore, the voltage induced on the electrodes is proportional to the velocity of the liquid flowing through the sensor tube. The volume flow rate is then the product of the liquid flow velocity and the tube cross-section: $Q = v \times S$.

1.3 Meter properties and functions

The functions of the meter transmitter include visualisation of the measured values and, using the associated control push-buttons, setting of the operational meter parameters.

Main flowmeter functions:

- Bi-directional measurements of:
  - volume flow rate;
  - aggregate fluid volume passed through the meter sensor;
- Archiving of the measured data and information on specific operational events;
- Checking on sensor flooding condition.

Flowmeter interface facilities:

- two multifunction outputs and one current output including HART® communication interface;
- communication interface RS-485 MODBUS RTU.

1.4 Important user information

Electromagnetic flowmeters of the production series FXx11x are manufactured and tested in accordance with the applicable international regulations and standards. To ensure successful meter commissioning and meeting the specified metrological parameters, the user shall duly observe all directions and recommendations given in the product manual.

1.4.1 Safety instructions

- Prior to any meter handling, the user and/or the meter installation staff shall get acquainted with the meter documentation.
- When connecting the flowmeter to the power supply, due attention shall be paid to the applicable national regulations and standards with special regard to the issues of labour safety and health protection.
- The meter installation, electrical connection and commissioning work shall be performed by suitably qualified operators.
- It is essential, especially in cases of the meter application in explosive environments, to observe all conditions and instructions given in the product manual regarding the meter installation and electrical connection, and to pay due attention to all warning labels.
- When installing the meter in environments implying explosion risk, the provisions/requirements of standards ČSN EN 600 79-0 and ČSN EN 60079-14 shall be duly observed.
- Should the product show signs of incorrect function, the user shall not attempt to dismantle the meter. Any repair work is reserved to the meter manufacturer. When sending a meter for repair, make sure to attach representation on decontamination as of Chapter 17 (ANNEX) hereof.
- The key meter parts are protected against dismantling by company seals. Should any such seal be broken, the customer will forfeit their right to claim free warranty services.

1.4.2 Liability

ELIS PLZEŇ a.s., the manufacturer of flowmeters for liquids, delivers its products in the highest possible quality. All products developed by ELIS PLZEŇ are part of intellectual property of the company and are a subject of copyrights. The same rights also apply to the documents delivered together with the product.
It is forbidden to supplement, amend or otherwise alter documents without prior consent of ELIS PLZEŇ a.s. Any infringement of the aforementioned intellectual property is punishable.

The documents delivered with the product are meant for familiarizing with the product itself and with the conditions of its use and installation. All flowmeter users are obliged to get familiar in detail with these documents and follow manufacturer's instructions as described therein. Following the abovementioned instructions will prevent the loss of warranty for reasons of incorrect installation and misapplication.

Installation of this flowmeter shall be performed only by a company trained for this purpose by ELIS PLZEŇ a.s. Such a company, after receiving the training, shall be fully responsible for the correct installation and commissioning. ELIS PLZEŇ a.s. bears no responsibility for defects in the product caused by an incorrect installation, its wrong application or incompetent configuration or programming.

These products, that ELIS PLZEŇ a. s. makes available on the market, are certified according to applicable standards. The accompanying documentation consists of *Project design, installation and service manual* and *Declaration of Conformity*. The products have a warranty as stated in the *Confirmation of Purchase Order* or in the *Purchase Contract*.
All product manuals are regularly updated and the current version is delivered together with the product and also available on the Internet under www.elis.cz/en.
ELIS PLZEŇ a. s. shall have the sole right to update technical documentation for its products.

When ordering a flowmeter, the buyer shall provide all required parameters. ELIS PLZEŇ a.s., as the purchaser, shall confirm the received Purchase Order and send it back together with manufacturer's General Terms and Conditions.
Deliveries of flowmeters shall be governed by the Czech Civil Code. The product is delivered pursuant to the confirmed Purchase Order or Purchase Contract. ELIS PLZEŇ a. s. is not responsible for differences in flowmeter parameters that were not confirmed in writing.

In the *Project design, installation and service manual* the following icons are used:

Warning: incorrect operation or erroneous flowmeter configuration may cause damage to product or injury to persons.

Information about another flowmeter features or types of documents delivered together with the product.

1.5 Product warranty

The flowmeter manufacturer provides product warranty in accordance with their valid commercial conditions.
Additional information regarding warranty is included in Chapter 14 hereof.

1.6 Representations and certificates

Applicable to electromagnetic flowmeters of the product series FLONEX FXx11x are the following representations and certificates (see Annexes in Section 17 below):

- **Representation on CE compliance**
- **ATEX certificate**
- **IECCEx certificate**

  - **Electromagnetic flowmeter FLONEX FXx114 - compact version**
    no intrinsically safe outputs

ATEX

II 2G Ex db eb ib [ib] IIB T6…T5 Gb
II 2D Ex tb IIIC T80°C…T95°C Db

IECEx
Ex db eb ib [ib] IIB T6…T5 Gb
Ex tb IIIC T80°C…T95°C Db

- **Electromagnetic flowmeter FLONEX FXx116 - remote version no intrinsically safe outputs**

ATEX

Transmitter
II 2G Ex db eb ib [ib] IIB T6…T5 Gb
II 2D Ex tb IIIC T80°C…T95°C Db

Sensor
II 2G Ex eb ib IIB T6…T3 Gb
II 2D Ex tb IIIC T155°C Db

IECEx

Transmitter
Ex db eb ib [ib] IIB T6…T5 Gb
Ex tb IIIC T80°C…T95°C Db

Sensor
Ex eb ib IIB T6…T3 Gb
Ex tb IIIC T155°C Db

2. METER IDENTIFICATION

2.1. FLONEX FXx11x flowmeter type designation

FLONEX FXx11x electromagnetic flowmeter versions:

FLONEX FXx11x

- **4** – Compact version including transmitter C12.10/C13.10
- **6** – Remote version including transmitter C12.30/C13.30 and terminal box plus two cables

- **1** – Flow sensor including flanges

- **1** – Explosive environment

- **1** – Transmitter ELIS C12.x0 (24 V ± 20% DC)
- **2** – Transmitter ELIS C13.x0 (95–250 V AC)

Induction sensor ISx.1xxEx

- **0** – Measuring electrodes
- **1** – Measuring electrodes plus one grounding electrode

- **2** – Soft rubber
- **3** – Hard rubber for drinking water
- **4** – PTFE
- **7** – E-CTFE

- **1** – Connecting column and round flange

- **1** – Flanges EN1092-1
- **2** – Flanges ASME B16.5

2.2. Scope of deliveries

2.2.1 Compact meter version FLONEX FXx114

- Flowmeter FLONEX FXx114, interfaces RS-485 MODBUS RTU and HART®
- Product manual – Electromagnetic flowmeter for explosive environments, FLONEX FXx11x
- Product manual – Meter control manual for products of the type series FLONEX FX and FLONET FH
- Product manual – Electromagnetic flowmeters FLONEX FX and FLONET FH with communication interface RS-485 MODBUS RTU
- Product manual – Electromagnetic flowmeters FLONEX FX and FLONET FH with communication interface HART®

2.2.2 Remote meter version FLONEX FXx116

- Transmitter for FLONEX FXx116 including connection box and RS-485 MODBUS RTU and HART® interfaces
- Meter sensor and connection box
- Product manual – Electromagnetic flowmeter for explosive atmospheres, FLONEX FXx11x
- Product manual – Meter control manual for products of the type series FLONEX FX and FLONET FH

- Pruct manual – Electromagnetic flowmeters FLONEX FX and FLONET FH with communication interface RS-485 MODBUS RTU
- Product manual – Electromagnetic flowmeters FLONEX FX and FLONET FH with communication interface HART®
- Transmitter holder

2.3. Associated documents

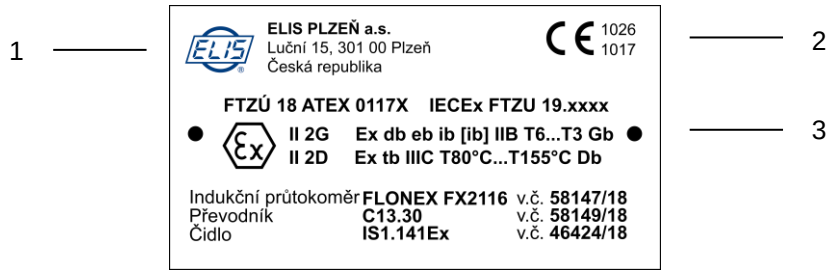
- Representation on CE compliance
- ATEX certificate
- IECEx certificate
- Calibration report - optional

2.4. Flowmeter rating plates

2.4.1. Main meter rating plate

The main meter plate is located on top of the transmitter housing.

Both compact and remote meter versions



Example of the main meter plate

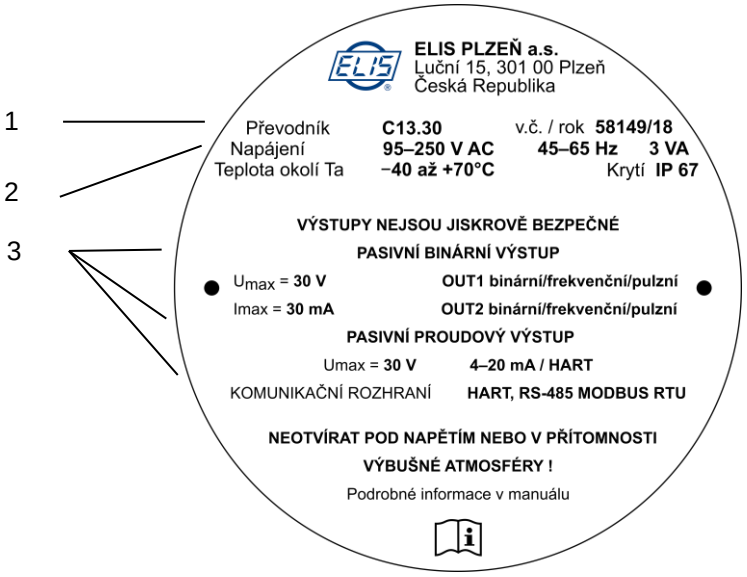
Comments

1 Manufacturer's name and address
2 CE mark and identification numbers of relevant authorities
3 Equipment protection level marking for operation in explosive atmospheres

2.4.2 Transmitter rating plate

The transmitter plate is attached to the rear cover of the transmitter terminal box.

Both compact and remote meter versions



Example of the transmitter plate

Comments

1 Transmitter for compact meter version, AC power supply
2 Power supply 95−250VAC, 45−65 Hz, 10VA max. or 19.2–28.8 VDC, 10W max.
3 Output functions (binary, frequency, impulse or current outputs, communication interface) are pre-set in production as required in the product order documentation, but the user may subsequently change the setting.

The initial output parameter setting is described in the flowmeter delivery note.

2.4.3. Sensor rating plate

The rating plate attached to the sensor housing includes the operational parameters of the sensor.

Compact or remote version

Example of the sensor plate

Comments

1 *Sensor pressure parameters in reference to the PED directive*
2 *Ambient temperature*
3 *Temperature of the measured fluid*

3. DESIGN AND MATERIAL METER VERSIONS

3.1 Compact and remote meter versions

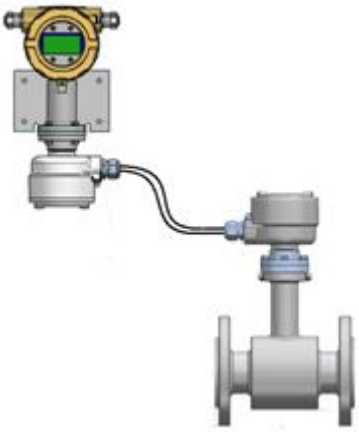
In the cases of compact flowmeter version, the meter sensor and transmitter are connected internally. In remote flowmeter version, the connection between the meter sensor and transmitter is facilitated by two signal cables up to 150m long.
To eliminate the risk of electromagnetic interference, the transmitter should be as close as possible to the meter sensor.

The remote flowmeter version is preferable in the following cases:

- the ambient and/or measured fluid temperatures more than 70°C;
- space limitations not permitting application of the compact meter version;
- where the meter installation spot is difficult to reach.

Compact meter version

Remote meter version



3.2 Operating pressure of the measured fluid

As electromagnetic flowmeters are intended for the **maximum permitted operating pressure PS in excess of 0.5 bar**, they are, in reference to the **Directive of the European Parliament and Council No 97/23/ES** considered pressure equipment and as such assigned to pressure equipment categories **0** (SEP*), **I, II or III.**

Comment: ***** Sound Established Procedure

To select the correct rated pressure of the sensor flanges, the following parameters should be considered:

- Maximum operating pressure of the measured fluid, PS;
- Rated inner diameter (DN) of the piping at the sensor output;
- Maximum temperature of the measured fluid, TS.

Standard sensor design

Operating pressure of flanged sensors according to standard ČSN EN 1092-1; material: carbon steel

Rated sensor size DN	Rated pressure PN	**Maximum permitted pressure PS (bar)** for maximum permitted temperature TS_{max}*			
		TS_{max} = 80°C (lining material MG, NG)	TS_{max} = 110°C (lining PTFE, E-CTFE)	TS_{max} = 120°C (lining E-CTFE)**	TS_{max} = 139°C (lining PTFE)**
DN15–DN50	PN40	38.3	36.7	36.3	35.2
DN65–DN200	PN16	15.3	14.6	14.5	14
DN250–DN300	PN10	9.5	9.1	9.0	8.8

Comments: * applicable to flanges made of material group 3E0 according to ČSN EN1092-1, such as steel P245GH, P265GH
** available on special request only

Operating pressure of flanged sensors according to standard ASME B16.5; material: carbon steel

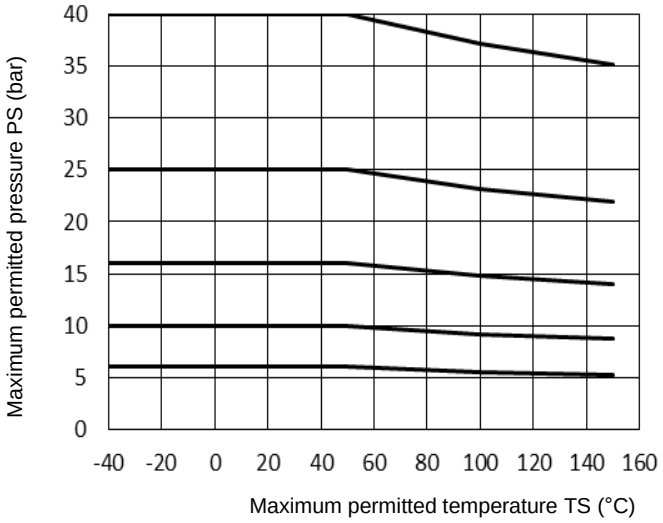
Rated sensor size NPS	Rated pressure Class 150	**Maximum permitted pressure PS (bar)** for maximum permitted temperature (TS_{max})*			
		TS_{max} = 80°C (lining material MG, NG)	TS_{max} = 110°C (lining PTFE, E-CTFE)	TS_{max} = 120°C (lining E-CTFE)**	TS_{max} = 139°C (lining PTFE)**
NPS ½“–12“	Class 150	15.9	15.9	15.9	15.8

Comments: * applicable to flanges made of material group 3E0 according to ČSN EN1092-1, such as steel P245GH, P265GH
** available on special request only

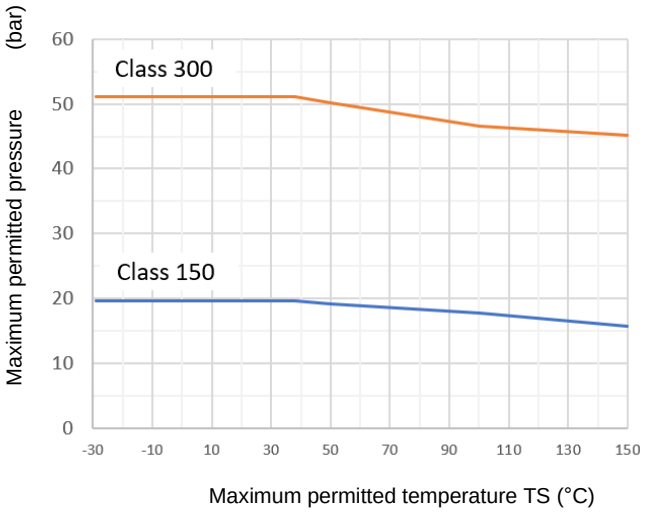
The values of PS (maximum permitted pressure) and TS (maximum permitted temperature), related to a specific sensor, are shown on the flowmeter sensor plate. Specified on the sensor plate also is the PED category.

Upon consultation with the manufacturer and in consideration of the pressure and temperature characteristics of other flange materials as specified in standards ČSN EN 1092-1 and ASME B16.5, meter sensors can be provided with flanges of other PS and TS parameters.

Pressure vs. temperature classes of flanges according to standard ČSN EN1092-1



Pressure vs. temperature classes of flanges according to standard ASME B16.5



3.3 Sensor dimensions

Electromagnetic flowmeter FXx11x is intended for flow-rate measurements with the fluid flow velocity within the range of 0.025 – 10 m/s. In practical situations, it is recommended to limit the fluid flow velocity values to the range of 0.5 – 5 m/s. At low fluid flow velocities, the relative measurement error tends to increase, while at high velocities flow turbulences may occur.

If the inner sensor diameter is the same as those of the connecting piping, the pressure loss at the meter sensor is negligible.

If the operating fluid flow velocity is too low and the measurement error too high, it is possible to increase the fluid velocity by using a meter sensor of a smaller size with the corresponding reduction of the inner diameters of the connecting pining. The disadvantage of this solution consists of a pressure loss at the pipe reduction area. Therefore, in practical situations, to reduce the pressure loss to a reasonable value, the pipe size reduction is limited to a single degree.

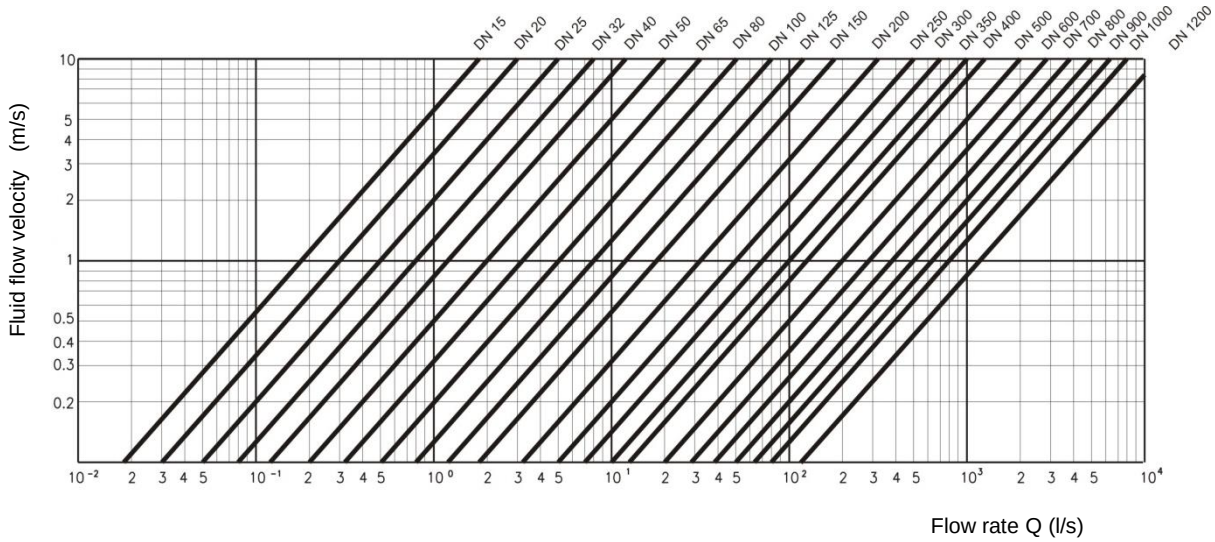
Fluid flow velocity in a piping can be calculated using the formula:

$$v = \frac{0.0003536 \times Q}{DN^2} \qquad \text{(m/s, m}^3\text{/h, m)}$$

Flow rates for various sensor dimensions

DN	NPS	l/s		m3/h	
		Q_1 v = 0.025 m/s	Q_4 v = 10 m/s	Q_1 v = 0.025 m/s	Q_4 v = 10 m/s
15	½“	0.0036	1.8	0.013	6.5
20	¾“	0.0067	3.33	0.024	12
25	1“	0.0100	5	0.036	18
32	1 ¼“	0.0167	8.33	0.060	30
40	1 ½“	0.0250	12.5	0.090	45
50	2“	0.0400	20	0.144	72
65	2 ½“	0.0667	33.33	0.240	120
80	3“	0.1000	50	0.360	180
100	4“	0.1556	77.77	0.560	280
125	5	0.2389	119.44	0.860	430
150	6“	0.3611	180.55	1.300	650
200	8“	0.6389	319.44	2.300	1 150
250	10“	1.0000	500	3.600	1 800
300	12“	1.4000	700	5.040	2 520

Relationship between fluid flow velocity and flow rate for various sensor sizes



3.4 Sensor lining

The sensor lining material shall be chosen with respect to the type and properties of the measured fluid. In cases of the meter application in chemical or food-processing industries, the user should consult the choice of the best suitable lining with the meter manufacturer.
The sensors of flowmeters FLONEX FXx11x can be supplied lined with one of the following materials:

- Soft rubber
- Hard rubber for drinking water
- PTFE
- E-CTFE

General properties

Soft rubber (MG)
Soft rubber is a material with high resistance to abrasion. It is recommended for less chemically aggressive environments containing abrasive particles. This material is also noted for good resistance to dilatations and rapid temperature changes in the range of −20°C to +64°C (on request, −35°C to +64°C).

Hard rubber for drinking water (NG)
Hard rubber is suitable for most applications in water management and water supply systems. Hard rubber is certified for safe contact with drinking water. It is also recommended for medium-aggressive liquids with operating temperatures within the range of +5°C to +64°C.

PTFE
PTFE lining is suitable for applications in chemical and food-processing industries. It can also be used with aggressive liquids at operating temperature range of −20ºC to +110ºC (on request, −35ºC to +139ºC).

E-CTFE
Chemical resistance of this type of lining is similar to that of PTFE. It is suitable for applications in chemical industry where the temperatures of the operational fluid range from −20ºC to +110ºC (on request, −35ºC to +114ºC). Applicable only to sensor size DN300.

Flowmeters intended for application in explosive atmospheres: temperature classes and maximum surface temperatures for various types of lining materials and fluid temperatures

Ambient temperature −35°C to +60°C

Sensor sizes DN15 – DN25

Type of lining	*Max. temperature of measured fluid*	*Temperature class for 2G*	*Surface temperature for 2D*
MG	−35°C to +48°C	T6	80°C
NG	+5°C to +48°C	T6	80°C
PTFE	−35°C to +48°C	T6	80°C
PTFE	−35°C to +63°C	T5	95°C
PTFE	−35°C to +98°C	T4	130°C
PTFE	−35°C to +123°C	T3	155°C

Sensor sizes DN32 – DN300

Type of lining	*Max. temperature of measured fluid*	*Temperature class for 2G*	*Surface temperature for 2D*
MG	−35°C to +64°C	T6	80°C
NG	+5°C to +64°C	T6	80°C
E-CTFE, PTFE	−35°C to +64°C	T6	80°C
E-CTFE, PTFE	−35°C to +79°C	T5	95°C
E-CTFE, PTFE	−35°C to +114°C	T4	130°C
PTFE	−35°C to +139°C	T3	155°C

Comments: MG … soft rubber
NG … hard rubber for drinking water
E-CTFE … applicable only to sensor size DN300

3.5 Electrode materials

Standard materials for the measuring and grounding electrodes:

- Stainless steel 1.4571 (in combination with lining materials MG or NG)
- Hastelloy C276 (in combination with lining materials PTFE or E-CTFE)

Optional materials:

- Hastelloy C276
- Titanium
- Tantalum
- Platinum and Rhodium

3.6 *Sensors for flowmeters of the type series FLONEX FXx11x: review of design and material versions*

EN 1092-1					ASME B16.5		IP	Material										Grounding electrode			
	PN							Linear				Elektrodes									
DN	6	10	16	40	NPS	class 150	67	SR	SPR	PTFE	E-CTFE	1.4571	Hastelloy	Hastelloy	Ti	Ta	Pt-Rh	PTFE	E-CTFE	SR, HR	NG
15					1/2"		standard					standard for SR,SPR	standard for PTFE, E-CTFE		on request						
20					3/4"																
25					1"																
32					1 1/4"																
40					1 1/2"																
50					2																
65					2 1/2"																
80					3"																
100					4"																
125					5"																
150					6"																
200					8"																
250					10"																
300					12"																

Medium temperature (°C)			
-20 to +80 (on request -35 to +80)	+5 to +80	-20 to +110 (on request -35 to +150)	-20 to +110 (on request -35 to +120)

4. INSTALLATION

4.1 Taking over

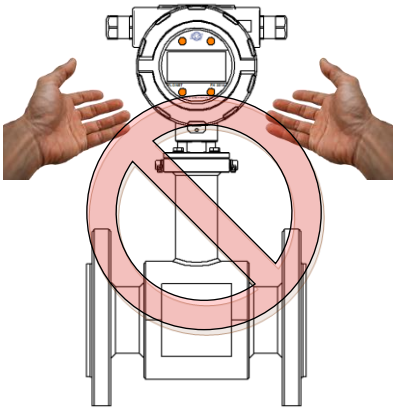
When taking over a delivered product, a visual inspection shall be carried out to confirm the integrity of both the product and its packaging.
The correct scope of delivery shall be checked in reference to the product order, delivery note and product rating plates.

4.2 Meter handling

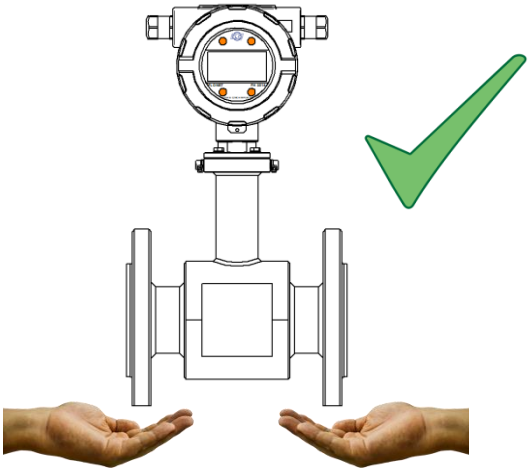
Avoid lifting the meter by holding on to any transmitter part or connection box; use for this purpose the meter flanges or lifting eyes only.

In transport, to avoid irreversible damage to the meter lining, do not place any auxiliary equipment into the meter piping.

Forbidden gripping



Recommended gripping



When using lifting equipment, apply suitable textile slings; application of metal chains or cables might result in damage to the meter.
It is recommended to transport the meter to the installation site in transport packaging.

4.3 Storage

For a flowmeter in storage, it is essential to:

- Observe the specified storage conditions regarding temperature and humidity;
- Avoid long-term meter exposure to direct sunshine (risk of display damage).

It is recommended to store the meter in complete transport packaging and remove the covers and packaging materials only immediately before installation.

4.4 Installation conditions

4.4.1 General principles

Applicable to mechanical installation of the flowmeter are the following rules:

- The protection covers and packaging shall only be removed immediately before the meter installation;
- The arrow on the sensor housing shall point at positive fluid flow direction;
- In cases of sensor installation into vertical piping the fluid flow direction shall be upwards;
- The piping flanges shall be parallel to one another;
- The inner piping and seal diameters shall correspond to the inner sensor diameter;
- The seals and grounding rings shall be correctly fitted between the flanges and not extend in the flow profile;
- The piping supports before and after the flowmeter location shall minimise the mechanical stresses acting on the sensor (vibration, tension, bend and others);
- No piping support shall be located under the meter sensor;
- The transmitter shall be protected from direct sunshine;
- The meter installation location shall be selected so as to ensure easy access for the operator to the transmitter and all meter rating plates;
- The meter sensor shall always be fully flooded by the measured fluid to avoid aeration;
- In cases of electrically non-conductive piping the measured fluid shall be grounded by means of grounding rings.

The sensor shall be inserted between the piping flanges by a shifting movement. With larger sensor sizes it is recommended to use installation inserts. It is also advisable, during the sensor insertion in the piping, to protect the sealing surfaces on the lining by a metal sheet or similar material.

Following the meter installation, no subsequent electric-arc welding operations shall be carried out on the piping at the sensor location. In particular, avoid welding on the piping flanges connected to the meter sensor.

4.4.2 Straight piping sections

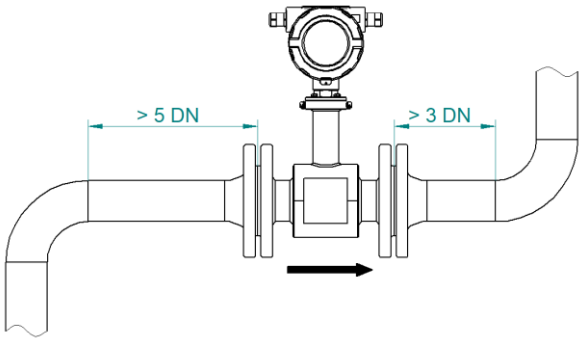
To ensure correct functioning of an electromagnetic flowmeter, conditions shall be provided for the measured fluid flow and flow profile stability in the meter sensor.
Before and after the meter sensor there shall be straight piping sections the required length of which are specified as multiples of the inner piping diameter. In cases of bi-directional measurements, the same requirements concern straight piping sections before and after the sensor. If there are flow-disturbing elements (such as bend or fitting) in the piping near the sensor location, the required length of straight piping section shall be increased – multiplied by the number of such elements.

At the contact plane between the sensor and the attached piping there shall not be any protruding edges causing the flow turbulence. The inner diameter of the piping shall not be smaller or greater by more than 3% than that of the sensor.

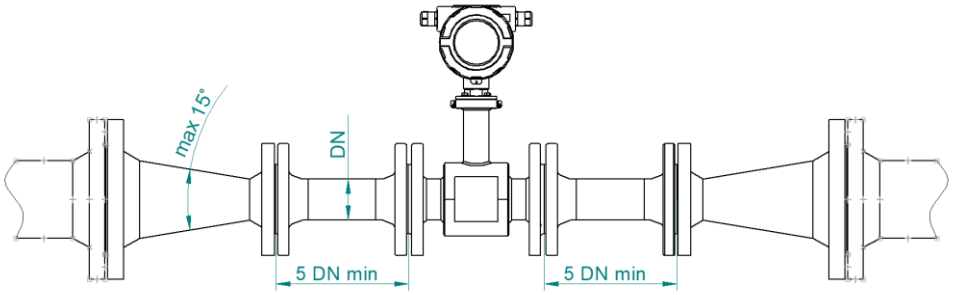
Avoid sensor placement at locations where at the sensor input are chemicals (especially chloride compounds) injected or dosed in the measured fluid. Imperfect blending of the fluid components may cause errors in the flow rate measurements or, in extreme cases, reduction of the measured flow rate to nil.

Preferable are flowmeter sensor installations before any piping elements affecting the smooth flow of the measured fluid.

In cases of bi-directional flow measurement, the basic required length of straight piping sections before and after the sensor is 5D.

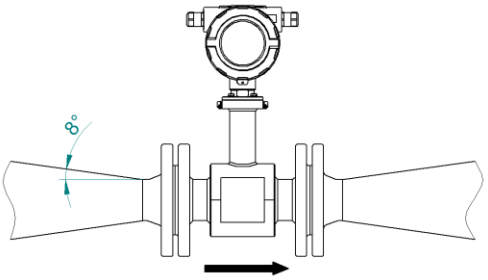


Installation of a flowmeter of a smaller size than that the attached piping requires the use of cone-shaped reduction pieces with the angle of inclination not exceeding 15°.



In cases of sensor installation in horizontal piping, to prevent generation of air bubbles, it is recommended to use eccentric reduction pieces (see standard ČSN EN 6817).

Reduction pieces with angle of inclination up to 8º can be included in the straight piping length.

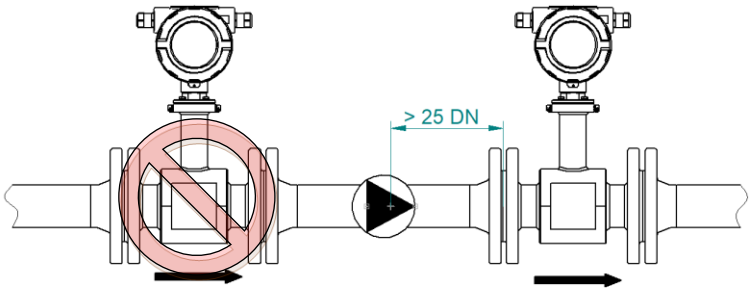


4.4.3 Suppression of the pump effects

To prevent creation of a low-pressure zone in the sensor and possible damage to the sensor lining, a pump shall always be placed before (at the input side of) the sensor. The length of the straight piping section between the pump and the sensor shall be at least 25 DN.

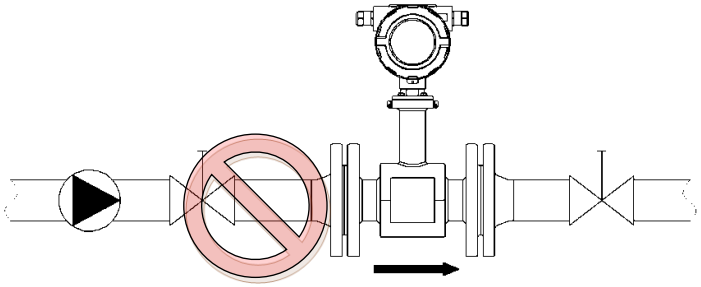
Placing the pump before the meter sensor reduces the cavitation effect and release of gases from the measured fluid. Increased pressure in the piping system will keep the fluid above the saturated vapour pressure and prevent cavitation effects.

The movement of the fluid in piping should be continuous and stable. If a pump generates fluid pressure pulses (e.g. pneumatic pump), a suitable pulse damping device should be included in the piping.



4.4.4 Suppression of the effects of closing valves

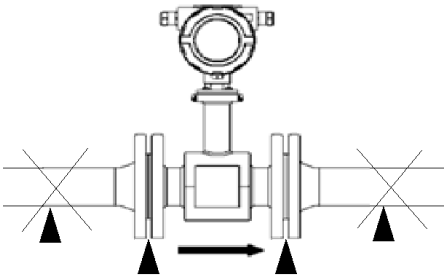
To eliminate the disturbing effects on the fluid flow velocity profile in the sensor and prevent the action of the cavitation phenomenon, the closing and throttling valves shall always be located after (at the output side of) the sensor.



Correct valve placement

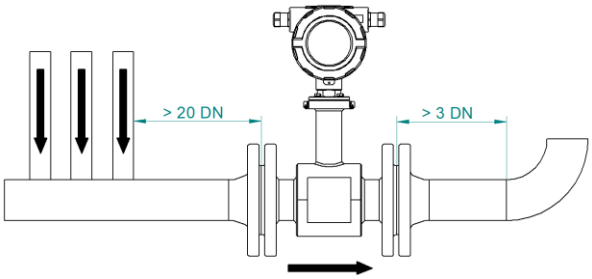
4.4.5 Suppression of vibration effects

Mechanical stresses and vibrations acting on the meter sensor might be detrimental to its function or integrity. It is therefore necessary to fix the position (support) the attached piping as close to the sensor housing as possible. It is assumed that the number of events involving particularly large stresses on the piping, such as filling or draining the piping system, or major fluid pressure changes) does not exceed 1,000 over the meter lifetime.



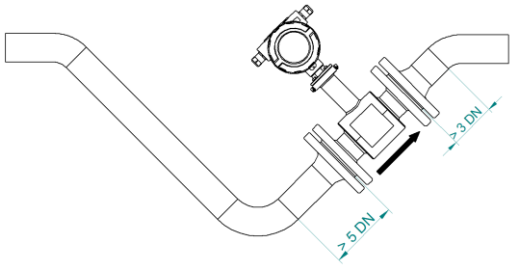
4.4.6 Piping stacks

The nearest stack on the piping system on the sensor input side should be at the distance of at least 20DN from the sensor.



4.4.7 Sensor flooding

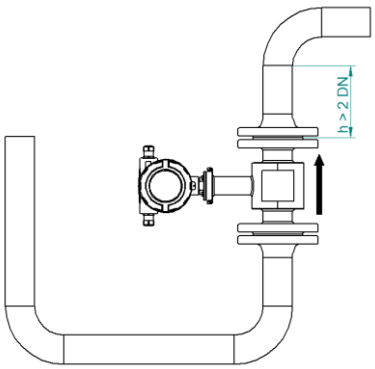
The meter sensor shall be completely filled with the measured fluid at all times. In cases where complete flooding of the whole cross-section of the connecting piping cannot be ensured, the meter sensor shall be located at such spot where this condition is always met.



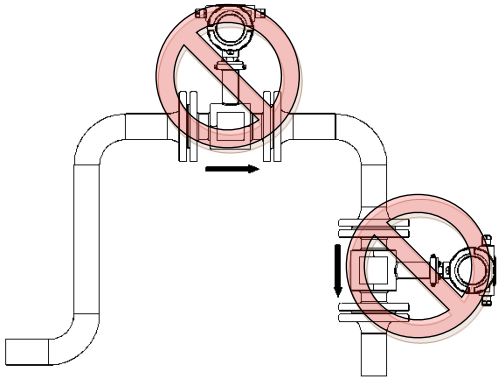
Permanent sensor flooding

4.4.8 Free discharge points

The sensor shall not be located at the highest piping section or in a vertical piping section with the flow direction downwards, especially in cases where a free discharge point is close by. Observation of this rule will prevent measuring errors due to a higher air bubble concentration within the sensor.



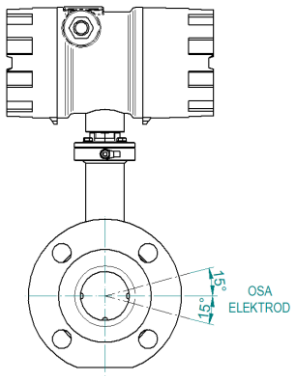
Free discharge



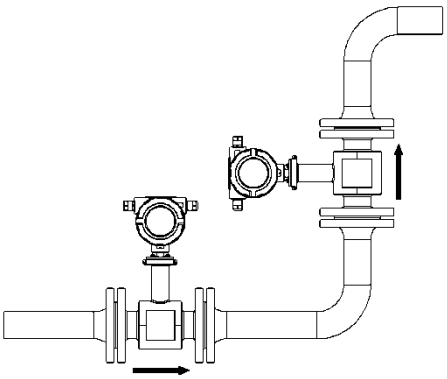
Risk of fluid aeration

The sensor will work equally well in both horizontal and vertical positions. However, care shall be taken that the measuring electrode axis in the sensor be to the extent possible in a horizontal plane and the fluid flow direction be upwards.

The permitted deviation of the electrode axis from the horizontal plane is 15° in both fluid flow directions. The free discharge point shall be higher by 2DN than the sensor output end.



Electrode axis



Vertical sensor position

4.5 Tightening torque

Electromagnetic flowmeters of the type series FXx11x are supplied without bolts, nuts and other fasteners or sealing elements.
The entity contracted to perform the meter installation work shall provide the necessary fasteners and seals and carry out the installation work in observance of the applicable standards, paying due attention to the given operational requirements and conditions.

Electromagnetic flowmeters with PTFE lining do not require any additional sealing. The sealing function is facilitated by the flared sensor lining. However, it is necessary for the sealing planes on the piping flanges to be free of any sharp edges. Due attention shall also be paid to observance of the recommended tightening torque.
Rubber and E-CTFE-lined sensors require the use of special sealing elements.

In cases where the meter sensor is to be attached to flanges made glass, ceramics, enamel or other smooth-surface materials, it is recommended to use additional sealing rings at the contact planes. The tightening torque shall be determined with respect to the specific material properties of the connecting flanges.

The sealing material shall not contain any electrically-conductive components that might get loose during the sensor operation, collect on the sensor lining and deteriorate its insulation properties.

Bolt tightening:

- Tighten the flange bolts using a suitable torque wrench, never an impact wrench.
- The connecting bolts shall be undamaged, preferable new, slightly greased.
- Stop tightening the bolts as soon as the required tightness has been achieved.
- Tighten the bolts along the flange perimeter in a crosswise manner, each in three steps: 50, 80 an 100% of the specified torque. Do not use torque in excess of the recommended/specified value.

Recommended bolt-tightening torque for sensor with PTFE lining

Flanges according to ČSN EN 1092-1

PN	DN	Number of bolts	Thread	Specified torque (Nm)
PN40	15	4	M12	16
	20	4	M12	27
	25	4	M12	37
	32	4	M16	61
	40	4	M16	78
	50	4	M16	100
PN16	65	8	M16	62
	80	8	M16	76
	100	8	M16	84
	125	8	M16	112
	150	8	M20	161
	200	12	M20	147
PN10	250	12	M20	163
	300	12	M20	195

Flanges according to ASME B16.5

Class	NPS	Number of bolts	Thread	Specified torque (Nm)
150	½“	4	½“, M12	12
	¾“	4	½“, M12	18
	1“	4	½“, M12	23
	1 ¼“	4	½“, M12	35
	1 ½“	4	½“, M12	48
	2“	4	5/8“, M16	94
	2 ½“	4	5/8“, M16	110
	3“	4	5/8“, M16	161
	4“	8	5/8“, M16	114
	5	8	¾“, M20	160
	6“	8	¾“, M20	200
	8“	8	¾“, M20	272
	10“	12	7/8“, M22	255
	12“	12	7/8“, M22	340

The flange tightening torque for rubber or E-CTFE-lined sensors depends on the seal material and the sensor design version. Consult this issue with the seal supplier.

4.6 Thermal insulation

When installed in thermally insulated piping, to prevent unnecessary heat loss, the meter sensor is usually provided with thermal insulation too.
In such cases, the following rules need be observed:

- Insulation shall be applied onto the meter sensor only;
- Maximum surface temperature of the sensor, whether thermally insulated or not, shall not exceed the values given in Section 3.4.

The maximum surface temperature of a thermally insulated sensor was determined on the basis of thermal tests according to standard ČSN EN 60079-0 with the sensor insulated by laminated curled strip of stone wool with perpendicular fibre orientation, 40mm thick, on an aluminium foil reinforced by a glass grid.

Thermal conductivity coefficient λ_D according to standard EN ISO 13787			
°C	50	100	150
$Wm^{-1}K^{-1}$	0.046	0.056	0.070

- In the cases of compact flowmeter version, the part connecting the sensor and transmitter shall remain bare.
- The transmitter shall be protected from additional thermal radiation sources (sunshine, heat emanating from other equipment).

4.7 Flowmeter heating

In measuring fluids with sub-zero operational temperatures, or at ambient temperatures close to the specified minimum fluid temperatures, it is permitted to provide the meter sensor with thermal insulation and auxiliary heating system.

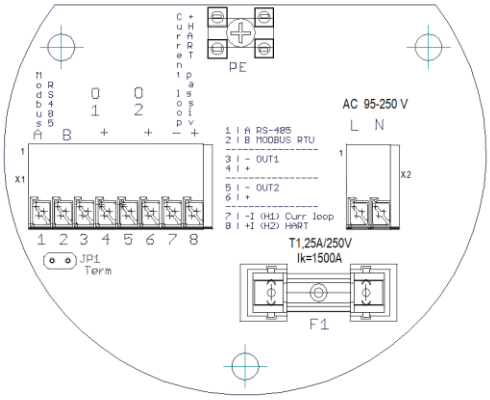
- The sensor heating can be facilitated by electricity or a suitable heat-carrying medium supplied through a special piping system.
- In cases of electric heating, it is recommended to use a regulated AC power source with current switching at zero.

In explosive atmospheres, the electric heating system design, installation and operation shall meet the requirements of standard ČSN EN 60079-14: Annex F – Installation of auxiliary electric heating systems. In any case, upon application of any thermal insulation and/or auxiliary heating system, the maximum permitted surface temperature of the meter (corresponding to the given temperature class) shall not be exceeded.

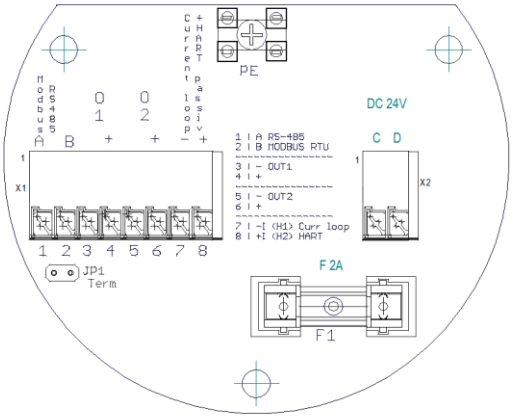
5. ELECTRICAL CONNECTIONS

5.1 Transmitter

5.1.1 Terminal box – compact and remote meter versions



Terminal	AC power source
L	95 – 250VAC, 45 – 65Hz
N	
PE	



Terminal	DC power source
+	24V ± 20% (19.2 – 28.8VDC)
–	
PE	

Output signals			
Terminals			Function
1	A		RS-485 MODBUS RTU
2	B		
3	–	OUT1	Binary output
4	+		
5	–	OUT2	
6	+		
7	–I (H1)		Current output (HART)®
8	+I (H2)		

The output and communication signals shall be connected to target devices via shielded cables. The cable shielding shall be connected to the PE terminal at one end only; preferably on the flowmeter side.

5.1.2 Electrode circuit – intrinsically safe output Ex ib IIB

Uo	Io	Po	Ci	Li
(V)	(mA)	(mW)	(nF)	(mH)
30	0.66	4.95	negligible	negligible

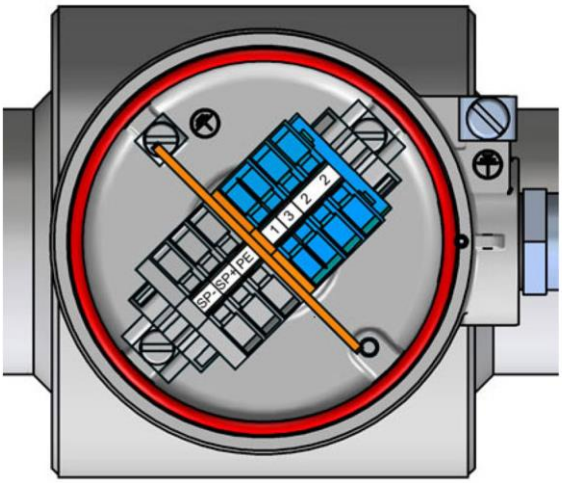
Linear characteristic

5.1.3 Excitation circuit

Excitation current: I = 200mA
Maximum voltage: Umax = 15V

5.1.4 Connection box - transmitter

In cases of remote meter version, the transmitter unit includes a connection box certified as Ex “e”. Connection between the meter sensor and transmitter is facilitated by two signal cables up to 150m long.



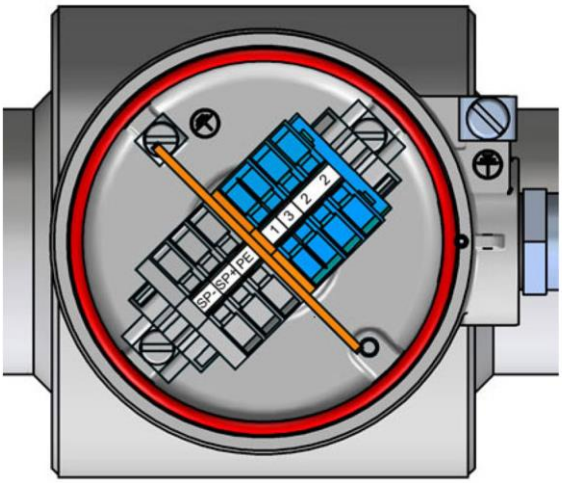
Terminal strip in the connection box of the transmitter

Transmitter cable connection table (two cables up to 150m long)

Terminal	Description	Cable 1	Cable 2
		Electrode circuit	Excitation circuit
SP−	Excitation winding		•
SP+	Excitation winding		•
PE	Cable shielding (terminals SP+, SP−)		•
2	Shielding of signal cables connected to terminals 1 and 3	•	
1	Electrode E1	•	
3	Electrode E2	•	

Cable 1 for intrinsically safe circuits shall have a light-blue cover.

5.2 Connection box - sensor



Sensor connection box

Sensor cable connection table (two signal cables up to 150m long)

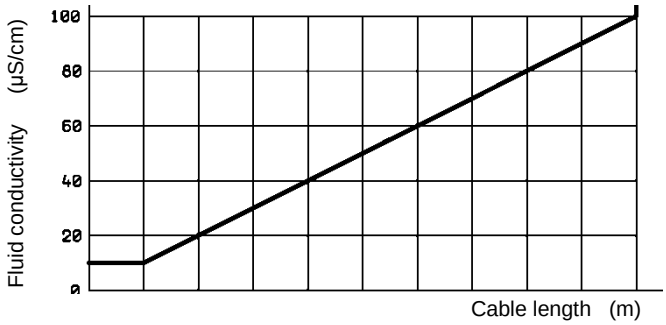
Terminal	Description	Cable 1	Cable 2
		Electrode circuit	Excitation circuit
SP−	Excitation winding		•
SP+	Excitation winding		•
PE	Cable shielding (terminals SP+, SP−)		•
2	Shielding of signal cables connected to terminals 1 and 3	•	
1	Electrode E1	•	
3	Electrode E2	•	

Cable 1 for intrinsically safe circuits shall have a light-blue cover.

5.3 Signal cables

The maximum length of the connecting cables depends on the measured fluid conductivity and electric parameters of the cables themselves (L, C, R).
To eliminate risk of electromagnetic interference via the connecting cables, the transmitter shall be located as close as possible to the meter sensor.

The relationship between the measured fluid conductivity and the maximum length of the cables connecting the meter transmitter and sensor is shown in the following graph:



The above graph applies to sensor sizes up to DN80. For sizes in excess of DN80, the maximum cable length shown in the graph shall be derated as follows:

$$L_{DNXX} = \frac{L_{DN80} \times DN80}{DNXX} \quad \text{(m)}$$

where L_{DN80} is maximum cable length determined from the graph for sensor sizes up to DN80
L_{DNXX} is maximum cable length for the given sensor size (in excess of DN80)
$DNXX$ sensor size in excess of DN80

Signal cable specifications

Cable 1: Measuring electrode circuit
Parameters: L = 0.65 mH/km
C cable core/shielding = 160nF (loop 2 x 160 nF/km)
R = 26 Ω/km (loop 2 x 26 Ω/km)
Cover colour: light blue
Maximum length: 150m

Cable 2: Excitation coil circuit
R = 26 Ω/km (loop 2 x 26 Ω/km)
Maximum length: 150m

The supplied cables of length up to 150m meet the requirements regarding the acceptable values of Lc, Cc and Lc/Rc for an intrinsically safe measuring electrode circuit of the protection level Ex “ib”.

The signal cables are included in the product delivery scope. In their order, the customer shall specify the cable length.

The flowmeter is calibrated with the connecting signal cable in place. The customer shall not modify or exchange the cable; such action shall be reserved to the authorised service staff or the meter manufacturer.
The connecting cable shall be fixed in position. Should it be left free, changes in the cable capacity due to its movement might adversely affect the measurement precision, especially at low fluid flow velocities.
Cable extension or shortening is not permitted. Replacement of a damaged cable shall be arranged with the meter manufacturer.

5.4 Power and information cables

In an explosive atmosphere, the cables shall meet the requirements related to installation in zones 1 and 2 (Gb) and in zones 21 and 22 (Db) according to standard ČSN EN 60079-14.
For each output signal, it is recommended to use a twisted pair of conductors with independent shielding.

Shielding is to be grounded at one end only, preferably on the PE terminal on the meter side. It is recommended to use twisted pairs of conductors with finely stranded cores and braided wire shielding, multi-core type-A cables according to standard ČSN EN 60079-14.

The flowmeter does not include a line voltage contactor. Unless the meter be provided with a power cord and plug, part of the meter installation set shall be a line power switch or circuit breaker (see section 6.11.3.1 of standard ČSN EN 61010-1).

5.5 Cable placement

To minimise the effect of electromagnetic interference, the connecting cables to the meter transmitter shall be laid at least 25cm away from the power cables of other electric equipment.

If used in explosive atmospheres, the flowmeter electrical installation shall meet the requirements and conditions specified in standard:
ČSN EN 60079-14 Explosive atmospheres – Electrical installations design, selection and erection,
and the requirements of other relevant national regulations and standards concerning:

- Connecting cable types and parameters;
- Mechanical protection of cables;
- Grounding of the conductive shielding;
- Protective interconnection and grounding.

In selecting cable routes, attention shall be paid to the risk of thermal degradation of the cable insulation due to nearby technological heat sources. All cables shall be laid outside the thermal insulation layers on piping.
The cable bushings shall be properly sealed and tightened with suitable tooling. To prevent cables from being pulled out of the bushings, their position shall be mechanically fixed no further than 0.3m away from each bushing.
Outside the bushing, the cable shall be bent to form a “dripping loop” (the straight length of about 30mm of the cable is led horizontally from the bushing and then bent down to form a loop).

5.6 Power supply specifications

The electrical circuits of the transmitter associated with the FLONEX FXx11x flowmeter are designed as floating, insulated from the ground potential.
The FXx11x electromagnetic flowmeter can be delivered with either AC or DC power supply.

AC power supply
- 95 - 250VAC, 45 - 65Hz, 3VA max.
- Internal fuse T 1.25A/250V, 5 x 20mm, breaking capacity 1,500A/250V

DC power supply
- 24V ± 20% (19.2 - 28.8VDC), 3W max.
- Internal fuse T 2A/250V, 5 x 20mm

If a product is used in zones 1 or 2, its electronic circuits shall meet the requirements of overvoltage categories I/II according to standard ČSN EN 60664-1.

Special attention shall be paid to the power supply arrangement in cases of an electromagnetic flowmeter installed in a piping system provided with cathodic protection.
Here the provisions of section 6.8 of standard ČSN EN 60079-14 shall be observed, as well as the relevant national standards.

In locations with strong electromagnetic interference (e.g. in the vicinity of frequency converters), it is recommended to include a filter in the power supply lines. The filter shall be installed as close as possible to the meter transmitter.

Filter parameters:

Rated voltage:	250V/50Hz
Rated current:	0.5A or higher
Attenuation characteristic:	10kHz 10−20dB
	10MHz 40dB

5.7 Sensor specifications

The flowmeter sensor includes no independent power supply.

The measuring electrode circuit is certified as intrinsically safe of protection class Ex “ia” and, as such, can only be connected to other intrinsically safe circuits with output parameters compatible with the sensor input parameters:
Ui ≤ 30V Ii ≤ 100mA Li, Ci negligible

The electromagnetic coils are certified as increased-safety components of the Ex “e” design.

5.8 Output connections

Outputs from flowmeters of the production type series FLONEX FXx11x are not designed as intrinsically safe.

5.8.1 Multifunction outputs OUT1, OUT2

Functions and parameters

- Passive outputs: electrically insulated from the ground and other inputs and outputs
- Open collector: Umax = 30V, Imax = 30mA
- Status in cases of power cut: open
- Output operational modes:
  - Frequency: Frequency range 0−10kHz, duty cycle 1:1
  - Impulse: Maximum frequency 100Hz
    Selectable impulse number
    Impulse length setting 1−999ms
  - Binary: Exceedance of set limit values of measured quantities
    Permanently closed
    No-error condition

Multifunction outputs – selectable functions

- Impulses/frequency for Q+
- Impulses/frequency for Q–
- Impulses/frequency for IQI
- Q > Qmax
- |Q| > Qmax

- Output negation

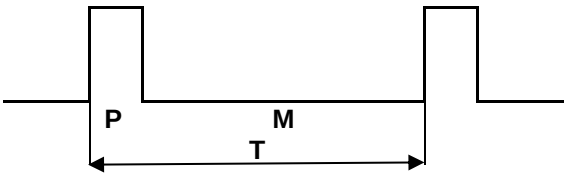
Impulse number determination for the impulse output

Restrictive conditions in setting the impulse output parameters:

- Maximum output frequency: f_{max} = 100Hz
- The idle period between impulses ***M*** shall be equal to or longer than the impulse width ***P***. Breaching this condition will result in an error message.

It holds:

$$M \geq P$$



$$P + M = T \qquad f = \frac{1}{T}$$

In selecting the impulse number, the following requirement shall be met:

$$Q_{max} \leq 3.6 \times V \times f_{max} \qquad (m^3/h,\ l/imp,\ imp/s)$$

where: ***Q*** … fluid flow rate (m³/h)
V … volume per one impulse (l)
P … impulse length (s)
f … impulse output frequency (Hz)
T … cycle length (s)

The flowmeter functions permit setting the ***V*** values per impulse in steps shown in the table below:

V (litres)							
0.001	0.01	0.1	1	10	100	1,000	10,000

The impulse length in cases of electronic determination of the fluid volume passed through the sensor is recommended to be set at P_{min}= 5ms, which meets the condition for f_{max} at the impulse output equal to 100Hz. In cases of electro-mechanical counters, P_{min} is usually set at 50ms, corresponding to the maximum frequency at the impulse output of 10Hz.

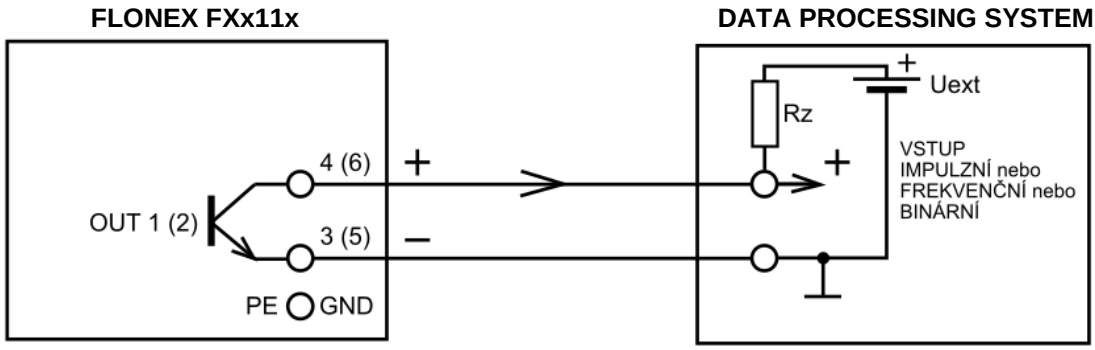
Example:
Assume that a user specified for their flowmeter of DN100 the maximum operating flow rate:
Q_{max} = 150 m³/h (Q_{max} = 41.66 l/s … v = 5.3 m/s)

For the fluid volume corresponding to one impulse (of length 5ms, f_{max} 100Hz) it holds:

$$V \geq \frac{Q_{max}}{3.6 \times f_{max}} = 0.416\ l$$

By selecting the next higher impulse number from the above table (1 litre per impulse) the user will make sure that the impulse output frequency will not exceed (for the specified Q_{max} of 150 m³/hour) the value of 100Hz and verify the selection of the impulse length (5ms). The user may chose the ***V*** values other than those from the basic selection in the above table, e.g. 0.5 litres/impulse.

Passive output



Imax = 30mA

Uextmax = 30V

Output terminals		
Output	Terminals	
OUT1	3	–
	4	+
OUT2	5	–
	6	+

The signal cable shielding should be connected to the PE terminal on the meter transmitter (the preferred solution).

5.8.2 Current output 4–20mA/HART®

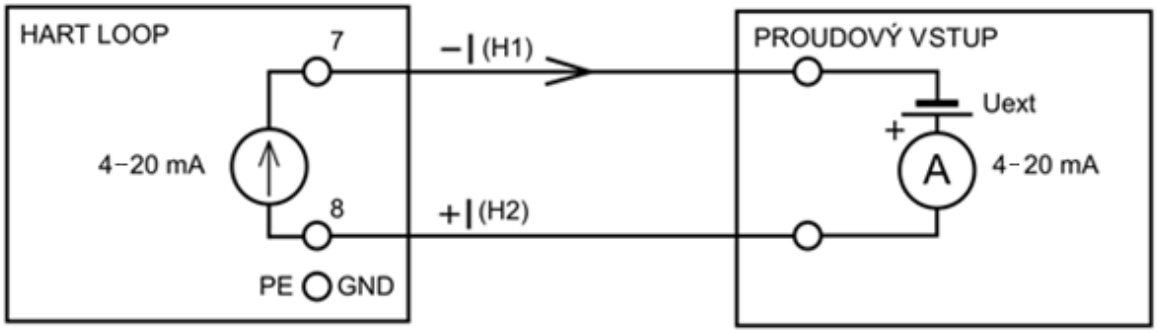
Functions and parameters

- Passive current output electrically insulated from the ground and other inputs and outputs
- Umax = 30V
- HART® communication, Rzmin = 250Ω
- Programmable function:
  - Volume flow rate
- Fixed current setting in the range of 4 – 20mA

In cases of power cut, the current output will preserve the last value prior to the power failure.

Passive output

FLONEX FXx11x **DATA PROCESSING SYSTEM**



Imax = 20mA
Imin = 4mA

Uextmax = 30V

Current loop resistance:

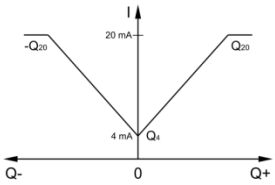
$$Rz = \frac{Uext - 8}{0{,}02} \quad (\Omega, V, A)$$

Rzmin = 250Ω for the HART® communication
Rzmax = 800Ω

Selectable functions of the current output

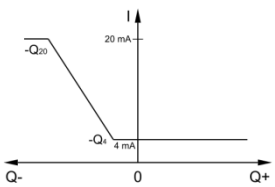
- Output –Q … +Q
- Output 0 … |Q|
- Fixed current 4 ... 20mA

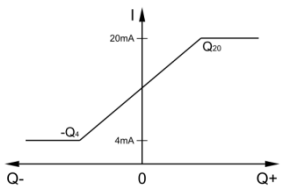
Current corresponding to |Q|

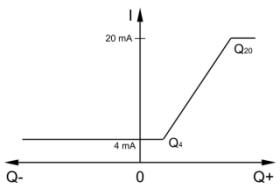


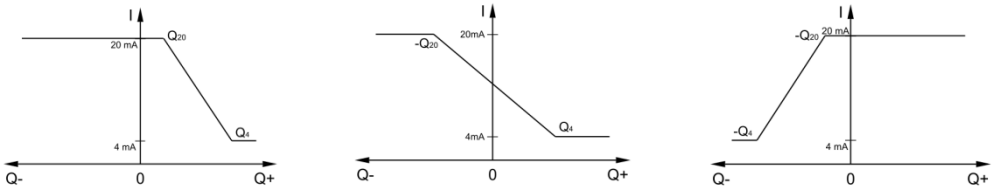
Current corresponding to –Q ... +Q

The flow rates corresponding to 4 or 20mA can be either positive or negative, and their mutual relationships can be either “greater than” or “lower than”. Therefore, the user may select any one of six possible functions of I_{out} vs. flow rate Q.



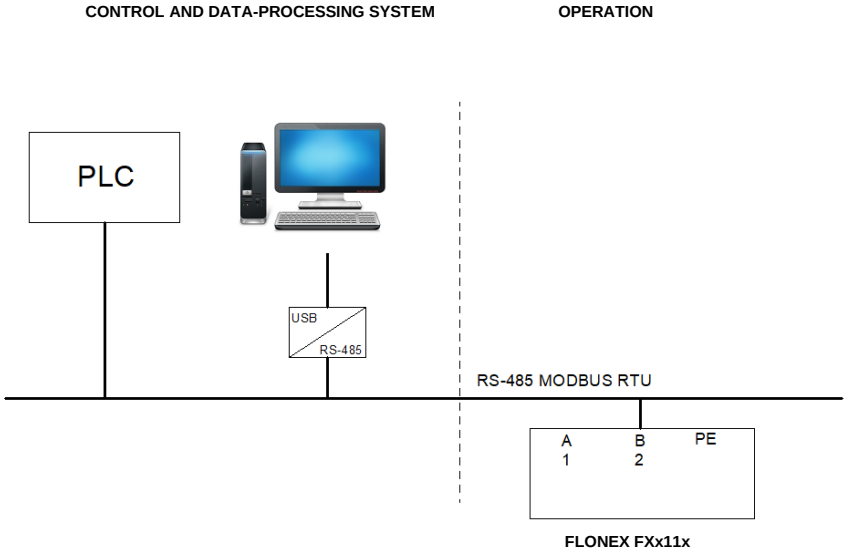






5.8.3 Communication interfaces

5.8.3.1 *Communication interface RS-485 MODBUS RTU*



Communication interface: RS-485 MODBUS RTU according to standard ČSN EN 61158, electrically insulated

PC requirements: Windows XP or higher OS upgrade (Linux, iOS) with JAVA 8u40, the FLOSET 4.0 software installed

Connecting cable: Type A according to ČSN EN 61158-2 (a twisted pair of conductors, 90% shielding)

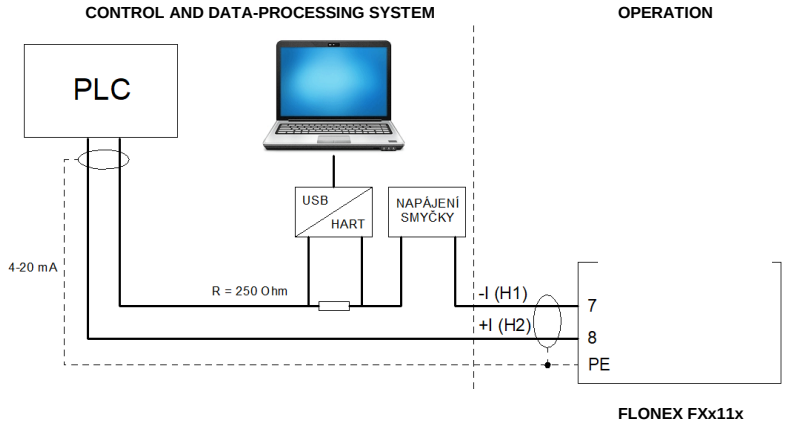
Interconnection:

FXx11x	Bus conductor
1	A
2	B
PE	Shielding

Detailed instructions regarding application of the RS-485 MODBUS RTU communication interface is included in the manual:

Es 90664K **Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH – communication interface RS-485 MODBUS RTU**

5.8.3.2 Communication interface HART®



Data communication: HART®, electrically insulated
Connection cable: A twisted pair of conductors, 90% shielding

Interconnection:

FXx11x	Current loop
7	–
8	+
PE	Shielding

Current output: Passive, 4 − 20mA, Rzmin = 250Ω

Detailed instructions regarding application of the HART® data communication is included in the manual:
Es 90665K Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH – communication interface HART®

5.9 Grounding and potential equalising

To guarantee correct operation of the FXx11x electromagnetic flowmeter, it is necessary to ensure that the potential of the measured fluid before and after the flowmeter, the reference meter potential and the PE protection conductor be equalised with the ground potential at the meter installation site. For the equipment grounding and potential equalising, use Cu conductor of cross-section 4mm^2.

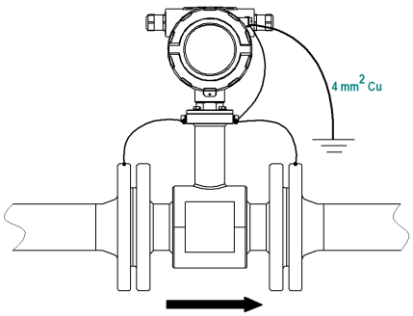
The external PE terminal on the transmitter box is internally connected to the reference meter potential.

In explosive atmospheres, the potential equalising arrangement shall meet the conditions specified in standard:
ČSN EN 60079-14 Explosive atmospheres – Electrical installation design, selection and erection and other applicable national regulations and standards. The potential equalising conductor shall have the cross-section of at least 4 mm^2 Cu. The grounding lines shall be as short as possible and of a low inductance.

Electrically conductive piping
Flanges on the conductive piping shall be connected to the PE terminals on the sensor and transmitter housings and to the ground potential.

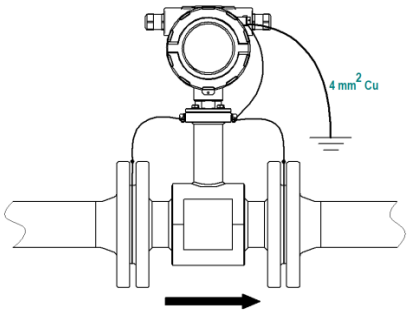
The bolted connections between the piping and sensor flanges cannot be taken for a reliable and satisfactory conductive connection. It is recommended to provide threaded holes on the flanges for a reliable bolted connection of the grounding/equalising conductor.

It is not recommended to place the grounding or equalising conductors under the heads of the main flange bolts; such connection may be subject to corrosion and adversely affect the measurement precision.



Piping made of insulating materials or piping with insulating lining
In such cases, the requirement for the fluid potential equalisation shall be met by two grounding rings installed before and after the flowmeter. Each grounding ring shall be inserted between two sealing rings.

The grounding rings are not included among the standard meter accessories, but they can be ordered with the product. Regarding chemical stability and resistance with respect to the measured fluid, the grounding rings shall meet the same criteria as the measuring electrodes.



In the cases of remote meter version, the PE terminal on the meter sensor and the transmitter box shall be interconnected by a Cu conductor of cross-section 4mm^2.

This connection shall not serve the purpose of potential equalisation with any other equipment or devices.

6. METER COMMISSIONING

6.1 Check on electrical connections

Prior to meter energising, check and make sure that:

- The power network voltage complies with the specifications on the meter rating plate;
- The power network is properly protected;
- All terminals and electrical connections are properly tightened;
- The installation cables are:
  - intact,
  - connected at their ends to the correct terminals in the flowmeter and the co-operating equipment,
  - secured against incidental excessive stress (pulling out of the respective bushings), and
- The meter grounding and potential equalising has been carried out as specified in the product manual.

6.2 Check on meter housing tightness

To attain the parameters of the equipment protection class referred to in Chapter 8 (METER SPECIFICATIONS), the flowmeter installation shall be carried out in observance of the following directions:

- Use only cables of external diameters corresponding to the sizes of the cable bushings installed;
- Form dripping loops on the cables;
- Avoid meter installation position where the cable bushings lead upwards;
- Tighten properly all covers and lids on the meter housings:
  - recommended tightening torque on the transmitter lids: 8Nm,
  - recommended tightening torque on the connection boxes: 8Nm.

Following every service action:

- Check the condition (integrity and intactness) of all sealing elements and surfaces;
- Using suitable tooling, tighten all cable bushings and meter housing covers.

6.3 Check on the installed meter

The flowmeters are supplied calibrated with verified functions and parameters set according to the customer specifications.
Prior to the meter commissioning, inspect the meter installation site in reference to the requirements of Section 4.4 above, and possible adverse effects from the nearby technological equipment such as:

- Undesirable meter warming by external heat sources;
- Excessive temperature stress on cable insulation;
- Vibrations and shocks in the piping, and others.

6.4 Check on the meter operation conditions

Prior to filling the piping and the installed meter sensor with the fluid to be measured, make sure that the fluid parameters (temperature and pressure) are within the limits specified on the meter plate, and that any risk to life or health of personnel is excluded.

7. OPERATION

7.1 Meter energising

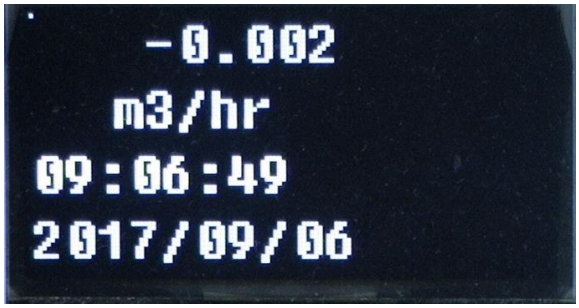
7.1.1 Display status

Upon turning the power on, all meter modules will undergo the initiation procedure. Following the display test, the basic screen format with the following data will be shown:

- Current volume flow rate;
- Aggregate fluid volume passed through the meter sensor in the positive direction;
- Aggregate fluid volume passed through the meter sensor in the negative direction.

The bar chart at the top of the display shows the current flow rate related to the specified maximum flow rate.

Basic screen format



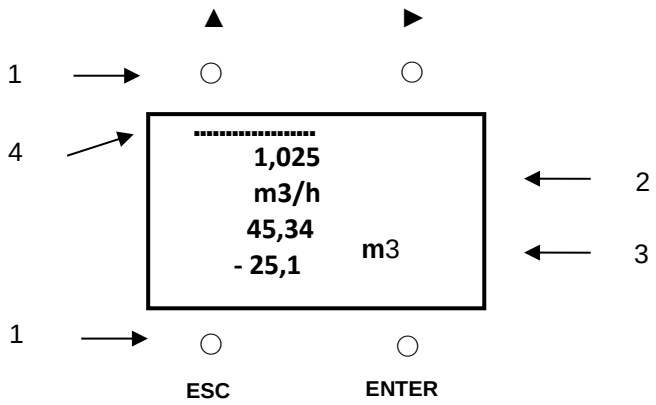
7.2 Front panel and control buttons

7.2.1 Display

The meter is provided with a colour OLED display of 128 x 64 pixels where all the measured quantities, flowmeter parameters and important user information will be visualised. The display control is facilitated by means of four optical buttons (optical reflex sensors).

7.2.2 Control button functions

Button locations with respect to the display



Comments:
1 Optical buttons (optical reflex sensors)
2 Instantaneous flow rate
3 Item selected from MENU – DISPLAY, or error messages
4 Instantaneous flow rate in the form of bar chart

Control button functions
Buttons ▲, ►, **ENTER** are actuated by a short touch with a finger on the button.
Button **ESC** is actuated by either a short (0.3s) or long (> 2s) touch with a finger.

▲ Moving in a menu to the next item above
Cyclic functions: Setting a numeric value 0–9 (increasing)
Change in sign +/-

► Moving in a menu to the next item below
Moving the position mark (cursor) in setting numeric values

ENTER Confirmation of selected action

ESC Departure from current operation to the previous menu item without any parameter change

ESC 2 s Finger touch > 2s: return to the basic screen format

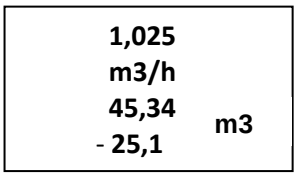
Actuated can be just one button at a time; the other buttons shall remain uncovered.

7.3 Flowmeter control

7.3.1 Manual control

Manual meter control and selection of menu items using optical buttons do not require any special skills; these functions are intuitive and user friendly.

7.3.1.1 Basic screen



The basic screen always shows information on instantaneous flow rate (lines 1 and 2).
The remaining two lines are reserved for supplementary data the user may select from the menu **Display**.
The meter is supplied with these two lines pre-set to show the aggregate flow volume passed through the sensor in the positive and negative directions.

Should any extraordinary event occur that might adversely affect the measurement precision or prevent flow rate measurement, lines 3 and 4 on the display will show the respective error or diagnostic messages generated by the meter diagnostic functions.

Error and diagnostic messages

No error
ADC converter error
Fast flow-rate changes
EEPROM error
WATCHDOG, timer
Calibration error
Disconnected excitation
Short-circuited excitation
Calibration in progress
Empty piping
OUT1 overflow
OUT2 overflow
Current output
Date / time error
Overflow > 110%
Communication error

As long as you move in the control or parameter-setting menus, the display remains in the active mode (back-lighted).
The backlighting time can be set in the menu item **Backlighting time**. Deactivated display will automatically be activated upon touching any control button.

User password

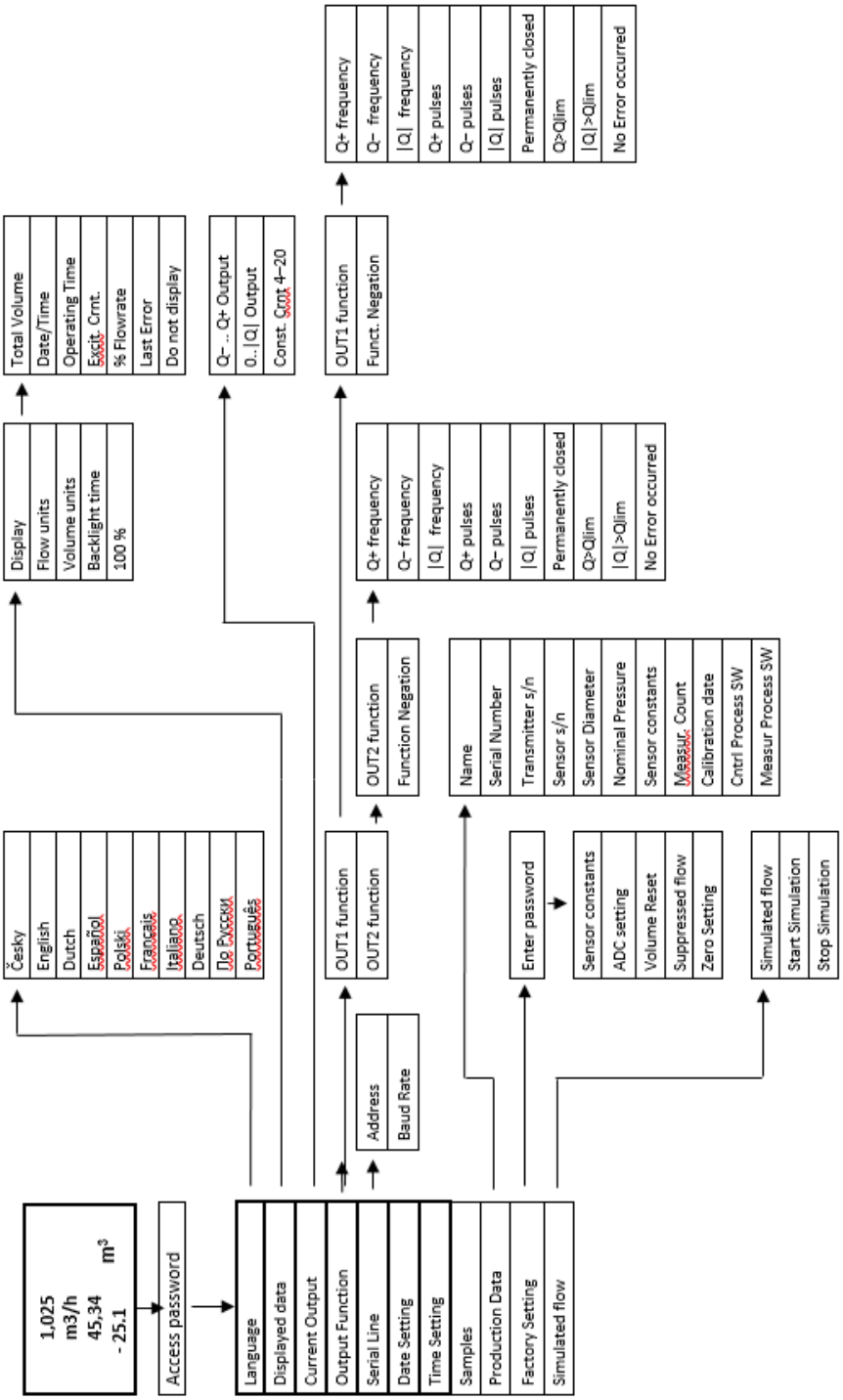
To enter the Main menu from the Basic screen, actuate the **ESC 2 s** button and specify your user password.

The initial user password pre-set in production is 0000.

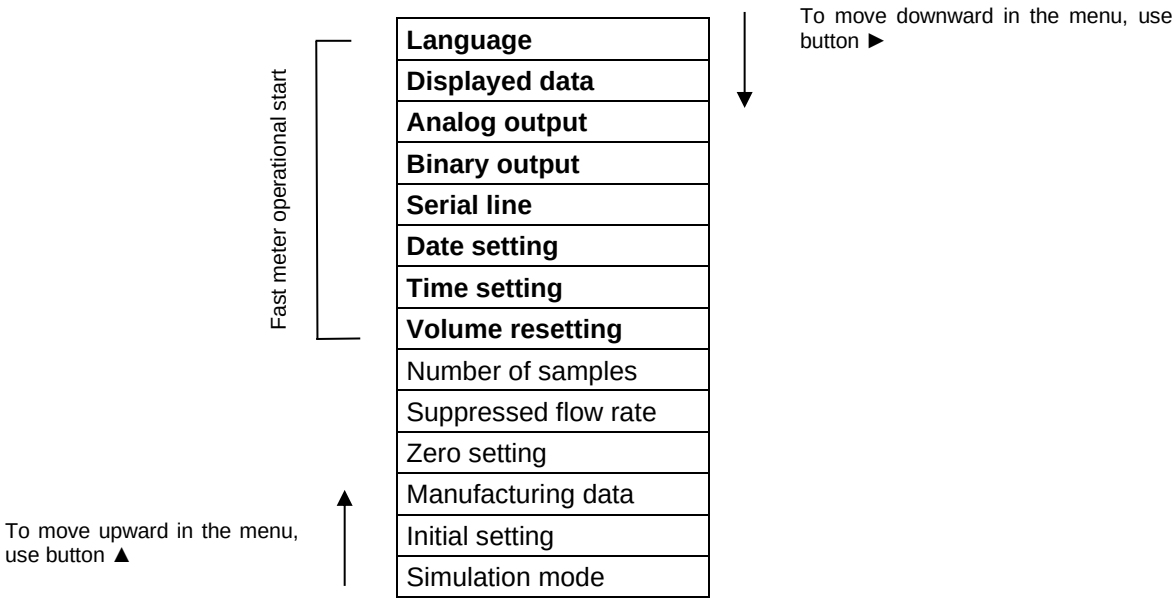
To return to the Basic screen format actuate the **ESC 2 s** button.

Should no control button (▲, ►, **ESC, ENTER**) be actuated during the recent three minutes, or should the specified backlighting time elapse before that, the display will return automatically to the Basic screen format.

7.3.1.2 Control menu structure



7.3.1.3 Main menu



The selected item will be shown in a highlighted window where it can be opened by actuating the ENTER control button. When scrolling up or down in the menu, always four neighbouring items will be shown.

The manufacturer supplies the flowmeter verified as to its functions, calibrated and with parameters set according to the customer's order. If installed in the user's technology in observance of the requirements specified in the product manual, the flowmeter will be ready for immediate operational start.
In cases where the user requires an accelerated procedure for the meter commissioning and setting of the meter parameters with respect to the given operational conditions and the co-operating higher-level control system, it suffices to set the parameters shown in bold print in the above list of the main menu items.

Detailed description of the meter control procedures is given in the manual:
Es 90666K Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH: meter control procedures

7.3.2 Remote meter control using the FLOSET 4.0 program

Flowmeters of the type series FLONEX FXx11x are provided with the RS-485 MODBUS RTU and HART® communication interfaces.

Across such interfaces the meter can be connected as subordinated equipment to a computer (a personal, notebook or tablet computer) with Windows XP or higher OS upgrade (Linux, iOS) and JAVA 8u40 installed.

Program FLOSET 4.0 makes it possible to:
- read the measured quantities (volume flow rate, flow volumes passed through the meter sensor in both directions);
- set the parameters of the measured quantities to be displayed (units and number of decimal positions);
- set the multifunction output parameters (in the binary impulse or frequency operational modes), and the current output parameters;
- select the meter communication language and set the date and time;
- set the digital interface parameters;

- set the data archiving parameters and read the archived data;
- monitor extraordinary operational events and read the archived data on such occurrences.

7.3.2.1 Communication interface RS-485 MODBUS RTU

This interface consists of a serial line RS-485 of the following parameters:
- Speed 300, 600,1200, 2400, 4800, 9600, 19200, 38400, 57600 Bd
- 8 data bits, 1 stop bit
- No parity

Detailed description of communication via interface RS485 MODBUS RTU is given in the manual:
Es 90664K Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH – communication interface RS-485 MODBUS RTU

7.3.2.2 Communication interface HART®

Digital interface HART® facilitates transfer of the meter data via the current output. Using the HART® interface and HART®/USB converter or similar device, the flowmeter can be connected as subordinated equipment to a computer.

Detailed description of communication via interface HART® is given in the manual:
Es 90665K Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH – communication interface HART®

8. TECHNICAL DATA

<table>
<tr><th colspan="6">Basic information and parameters</th></tr>
<tr><td colspan="2">Measurement principle</td><td colspan="4">The Faraday induction law</td></tr>
<tr><td colspan="2">Minimum fluid conductivity</td><td colspan="4">10 µS/cm, 20 µS/cm for demineralised water</td></tr>
<tr><td colspan="2">Measured flow velocity range</td><td colspan="4">0.025 – 10 m/s</td></tr>
<tr><td colspan="2">Rated inner diameter of piping</td><td colspan="4">DN15 – DN300,
NPS ½“−12“</td></tr>
<tr><td colspan="2">Measured flow rate range</td><td colspan="4">6.5 – 2,520 m³/h (for v = 10 m/s)</td></tr>
<tr><td colspan="2">Flowmeter design versions</td><td colspan="4">Compact
Remote</td></tr>
<tr><td colspan="2">Sensor design</td><td colspan="4">Flanged, DN15 – DN300</td></tr>
<tr><td colspan="2">Measuring and grounding electrode materials</td><td colspan="4">Standard:
• Stainless steel 1.4571 (MG, NG)
• Hastelloy C276 (PTFE, E-CTFE)
Optional:
• Hastelloy C276
• Titanium
• Tantalum
• Platinum and rhodium</td></tr>
<tr><td rowspan="13">Measured fluid temperature / sensor lining material</td><td rowspan="13">Relationship between the fluid temperature and product temperature class Ex: see Sect. 3.4</td><td>Flanges</td><td>Lining</td><td colspan="2">Maximum fluid temperature (°C)</td></tr>
<tr><td rowspan="5">Carbon steel (standard)</td><td></td><td>DN25</td><td>DN32 – DN300</td></tr>
<tr><td>MG</td><td>-20 to +48</td><td>-20 to +64</td></tr>
<tr><td>NG (from DN40)</td><td></td><td>+5 to +64</td></tr>
<tr><td></td><td>DN15 – DN25</td><td>DN32 – DN300</td></tr>
<tr><td>PTFE</td><td>-20 to +123</td><td>-20 to +139</td></tr>
<tr><td colspan="2">E-CTFE (DN300 only)</td><td>-20 to +114</td></tr>
<tr><td rowspan="5">Stainless steel (optional)</td><td></td><td>DN25</td><td>DN32 – DN300</td></tr>
<tr><td>MG</td><td>-35 to +48</td><td>-35 to +64</td></tr>
<tr><td>NG (from DN40)</td><td></td><td>5 to +64</td></tr>
<tr><td></td><td>DN15–DN25</td><td>DN32–DN300</td></tr>
<tr><td>PTFE</td><td>-35 to +123</td><td>-35 to +139</td></tr>
<tr><td colspan="2">E-CTFE (DN300 only)</td><td>-35 to +114</td></tr>
<tr><td colspan="2">Manufacturing materials</td><td colspan="4">Transmitter casing: pressure casting, Al alloy
Sensor connection box: pressure casting, Al alloy
Sensor: measuring tube – stainless steel 1.4301
Flanges and sensor casing: carbon steel (standard)
stainless steel (optional), and others</td></tr>
<tr><td colspan="2">Surface finish</td><td colspan="4">Transmitter casing: powder paint
Sensor connection box: powder paint
Flanges and sensor casing: polyurethane paint (standard)
All-stainless-steel sensor: shot blasting</td></tr>
<tr><td colspan="2">Grounding</td><td colspan="4">On flanges
With grounding rings
Grounding electrode (DN25 – DN300 for MG, PTFE)
(DN300 for E-CTFE)
(DN40 – DN300 for NG)</td></tr>
</table>

AC power supply	95 – 250VAC, 45 – 65Hz, 3VA max. Internal fuse: T 1.25A/250V, 5 x 20 mm, Breaking capacity 1,500A/250V
DC power supply	24V ± 20% (19.2 to 28.8V), 3W max. Internal fuse: T 2A/250V, 5 x 20 mm
Magnetic field	Impulse unidirectional field Excitation current: 200mA max Selectable frequency: 1.56Hz; 3.125Hz; 6.25Hz; 12.5Hz
Back-up battery	CR2032
Operating environment	Explosive and dusty atmosphere
Protection class	Transmitter: IP 67 Sensor: IP 67
Pressure loss	Negligible in cases where the sensor and connected piping are of the same inner diameter
Starting time	30 min.

Functions and properties	
Meter display	Graphic backlighted OLED display, 128 x 64 pixels
Control elements	Optical reflex sensors actuated by touch across the front viewing window in the transmitter
Communication language	Czech, English, Dutch, Spanish, Polish, French, German, Russian and Portuguese
Physical units of displayed quantities	Metric US Imperial
Functions	Bidirectional measurements of: • Volume flow rate • Aggregate fluid volume passed through the meter sensor Communication with external equipment Archiving of measured data and extraordinary operational events Sensor flooding check
Zero insensitivity	Selectable
Condition following power cut	Summary counters: No change Meter configuration and setting: No change Diagnostic and error messages: Stored Multifunction outputs: Open Current output: The last value prior to the power cut retained

Process parameters	
Fluid temperature	Compact meter version −35°C to +70°C Remote meter version −35°C to +139°C
Pressure class	PN 40 (4.0MPa) for DN15 – DN50 PN 16 (1.6MPa) for DN65 – DN200 PN 10 (1.0MPa) for DN250 – DN300 Class 150 ASME B16.5 for NPS ½"–12"
Solid particle content	≤ 2%
Gas content	≤ 5%

Environment	
Ambient temperature	Compact meter version: −35°C to +60°C, no condensation Remote meter version: • Transmitter: −40°C to +70°C, no condensation • Sensor: –35°C to +60°C, no condensation
Storage temperature	−10°C to +70°C, no condensation (for MG, PTFE and E-CTFE) +5°C to +70°C, no condensation (for NG)

Measurement precision	
Reference conditions	See Chapter 9 (CALIBRATION)
Measurement precision at reference conditions	Standard: Class 2 acc. to ČSN EN ISO 4064-1 $Q_3/Q_1 = 400$ On request, for example: ±0.5% of the measured value for flow rate 5 – 100% Q_4 ±0.2 % of the measured value for flow rate 10 – 100% Q_4

Outputs	
1 × Current output 4 - 20mA	Passive: electrically insulated from the ground and other outputs; Uextmax = 3 V, Uextmin = 8V, Rzmax = 800Ω HART® communication, Rzmin = 250Ω
2 × Multifunctional output	Passive: electrically insulated from the ground and other outputs; Uextmax = 30V, Imax = 30mA Open collector Operational modes: • Frequency • Impulse • Binary Frequency: frequency range 0 – 10kHz, duty cycle 1:1 Impulse: Maximum frequency 100Hz Impulse length 1 – 999ms Selectable impulse number Output negation Binary: Exceeding limit values of measured quantities Error messages Output negation
Communication interface	Interface RS-485 MODBUS RTU electrically insulated from the ground and all outputs; Umax = 30V Interface HART®

Cables	
Data and power cables	Common cables for measurement and regulation systems Data cables: twisted pair of conductors, 90% shielding
Signal cables (remote meter version)	Supplied with the product: two cables up to 150m long
Communication cable	Twisted pair of conductors with common shielding; bus-bar cable, type A according to standard ČSN EN 61158-2
Cable bushings	Compact meter version: • Transmitter: two blinds Ex “d“, thread M20x1.5 Remote meter version: • Transmitter: two blinds Ex “d“, thread M20x1.5 • Transmitter connection box: one bushing Ex “e“, thread M20x1.5, including sealing insert for two cables • Sensor connection box: one bushing Ex “e“, thread M20x1.5, including sealing insert for two cables

9. CALIBRATION

9.1 General

The flowmeter is supplied verified as to its functions, calibrated and with parameters set according to the customer’s requirements.
The measuring precision of the flowmeter in its fundamental form is guaranteed to meet the provisions of the international standard EN ISO 4064-1**: Water meters for cold drinking water and hot water**.

Unless agreed otherwise with the customer, the flowmeters are calibrated using the frequency output 0 – 10kHz.
Upon special requirement and agreement with the flowmeter manufacturer, the meter calibration may be carried out using alternative, i.e. impulse or current outputs.
The guaranteed measurement precision parameters shall always be related to the type of output which was used for the meter calibration. The remaining two types of output are recommended to be used for measurements with precision lower by 1 – 2% compared to that of the calibrated output.
For inspection or comparison measurements at the customer’s premises, or metrological verification of the meter parameters, the same type of electric output as that used for the initial calibration at the manufacturing plant shall be selected. Such measurements shall be performed under specified reference conditions.

At such measurements it is important to connect the hydraulic meter section (the sensor) into the hydraulic circuit on the test stand using connection elements (flanges, threaded fittings, fittings used in food-processing lines or others) of the same type, size and design as found on the meter sensor, to prevent occurrence of hydraulic disturbances that might significantly affect the meter measurement precision.

9.2 Reference conditions

Measured fluid: water, temperature 22°C ± 4K
Ambient temperature: 22°C ± 2K
Electrical conductivity of the measured fluid: > 300µS
Straight piping sections: ≥ 10DN before and 5DN after the flowmeter
Minimum medium pressure at the meter output: 1 bar
Sensor to be centred, grounded and supplied with power as required by the product manual
Time for the meter temperature stabilisation: > 30min
The meter shall be set for zero flow rate.

9.3 Measurement precision

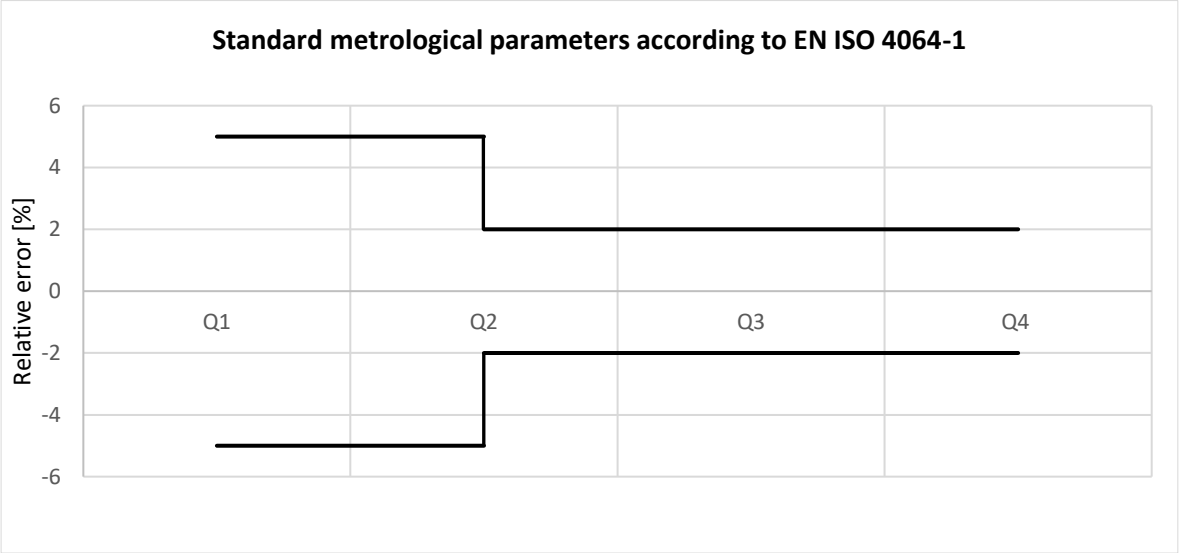
9.3.1 Electromagnetic flowmeter FLONEX FXx11x – standard precision

The meter precision shall meet the requirements of standard EN ISO 4064-1 (Water meters for cold drinking water and hot water).

Definition according to EN ISO 4064-1:

$$\frac{Q_4}{Q_3} = 1.25 \qquad \frac{Q_2}{Q_1} = 1.6$$

Q_4 flow rate for fluid flow velocity at the meter sensor of 10 m/s.
Q_1 flow rate for fluid flow velocity at the meter sensor of 0.025 m/s.



Flow rate values Q1, Q2, Q3 and Q4 for various meter sizes

Rated inn. diameter DN		Overloading flow rate Q_4 (m^3/h)	Continuous flow rate Q_3 (m^3/h)	Transient flow rate Q_2 (m^3/h)	Minimum flow rate Q_1 (m^3/h)	Measurement range Q_3/Q_1
15		7,9	6,30	0,0252	0,0157	400
20		12	10	0,0384	0,0240	
25		20	16	0,0640	0,0400	
32		31,25	25	0,1000	0,0625	
40		50	40	0,1600	0,1000	
50		79	63	0,2528	0,1580	
65		125	100	0,4000	0,2500	
80		200	160	0,6400	0,4000	
100		313	250	1,00	0,625	
125		500	400	1,60	1,00	
150		788	630	2,52	1,6	
200		1 250	1 000	4,00	2,5	
250		2 000	1 600	6,40	4,0	
300		3 125	2 500	10,00	6,25	

Flow values of the billing meter FLONEX FXx114 in a compact version

Rated inner diameter	Overloading flow rate Q_4	Continuous flow rate Q_3	Transient flow rate Q_2	Minimum flow rate Q_1	Measurement range Q_3/Q_1
15	7,9	6,30	0,0252	0,0157	
20	12	10	0,0384	0,0240	
25	20	16	0,0640	0,0400	
32	31,25	25	0,1000	0,0625	
40	50	40	0,1600	0,1000	
50	79	63	0,2528	0,1580	
65	125	100	0,4000	0,2500	400
80	200	160	0,6400	0,4000	
100	313	250	1,00	0,625	
125	500	400	1,60	1,00	
150	788	630	2,52	1,6	
200	1 250	1 000	4,00	2,5	
250	2 000	1 600	6,40	4,0	
300	2 000	1 600	10,24	6,40	250

Flow values of the billing meter FLONEX FXx116 in a remote version

Rated inner diameter	Overloading flow rate Q_4	Continuous flow rate Q_3	Transient flow rate Q_2	Minimum flow rate Q_1	Measurement range Q_3/Q_1
15	7,9	6,30	0,0504	0,031	
20	12	10	0,0768	0,048	
25	20	16	0,1280	0,080	
32	31,25	25	0,2000	0,125	
40	50	40	0,3200	0,200	
50	79	63	0,5056	0,316	
65	125	100	0,8000	0,500	200
80	200	160	1,2800	0,800	
100	313	250	2,00	1,250	
125	500	400	3,20	2,000	
150	788	630	5,04	3,152	
200	1 250	1 000	8,00	5,000	
250	2 000	1 600	12,80	8,000	
300	2 000	1 600	20,48	12,800	125

9.3.2 Increased precision

For zero flow rate setting and reference conditions:

Relative error		Flow rate range
±0.5%	of the measured value	5–100% Q_4
±0.2%	of the measured value	10–100% Q_4

Upon agreement with the manufacturer, flowmeters may be supplied with other (optional) precision parameters.

10. METER DESIGN DETAILS

10.1 Transmitter

Transmitter C12.x0/C13.x0 is accommodated in a box made of aluminium alloy with removable front and rear covers. The box is coated with powder paint and it is certified for operation in explosive atmospheres. Its design meets the requirements of protection class Ex "d".
Behind the window in the front cover there is a backlighted OLED display of 128x64 pixels. The flowmeter control is facilitated by optical buttons (optical reflex sensors) actuated by touching the respective spots on the front window.
The transmitter terminals can be accessed upon removal of the rear box lid. When closed, the lid position is secured by means of an Allen bolt.
External cables can be brought into the terminal compartment via two threaded holes M20 x 1.5.

Located at the top of the transmitter box is a grounding bolt and a flat area reserved for the flowmeter rating plate with information and data required by standard IEC/EN 60079-0.
The transmitter housing is certified as flameproof enclosure meeting the requirements of protection classes Ex "d" and Ex "tb".
The transmitter rating plate is located on the rear cover of the transmitter box.
Attached to both the front and rear covers of the transmitter box are plates with a warning label reading:

DO NOT OPEN WITH THE POWER ON OR IN EXPLOSIVE ENVIRONMENTS.

In the case of remote meter version (with two connecting cables), the transmitter assembly includes a separate connection box. The box is made of aluminium alloy and it is certified for compliance with protection class Ex "e" ("tb IIIC"). The connection box accommodates a certified WAGO terminal strip for connecting the intrinsically safe measuring electrode circuit (of protection class Ex "ib") and the excitation circuit (protection class Ex "e").
The terminals are certified for meeting the requirements of protection classes and operating environments Ex "ia" (the measuring electrode circuit) and Ex "e" (the excitation circuit).
An external cable can be brought into the terminal compartment through one threaded hole M20 x 1.5.

10.2 Sensor

The induction sensor consists of a measuring tube made of non-magnetic steel with insulation lining, two measuring electrodes and, in some cases, one grounding electrode. Located outside the measuring tube is a winding the function of which is to generate electromagnetic field perpendicular to the measuring electrode axis. The excitation winding and measuring electrodes are protected by a hermetically tight housing made of carbon or stainless steel. In its standard design version, the sensor is provided with flanges according to EN 1092-1 or ANSI B16.5. Upon agreement with the manufacturer, other types of flanges can be provided.
The carbon steel sensor parts are coated with a polyurethane paint.
The sensor can also be supplied in all-stainless-steel design.

Sensor for compact meter version
In compact meter version, the transmitter is attached to the meter sensor by means of a steel column with a stainless-steel flange. This flange is provided with two threaded holes to facilitate connections for potential equalising conductors.

Sensor for remote meter version
In this case, attached to the sensor housing is a connection box including terminals for connections to the excitation circuit and measuring electrodes.
The connection box is an aluminium alloy casting certified for class Ex "e" (Ex "tb IIIC") protection. The WAGO terminal strip installed inside the box serves the purpose of connecting the intrinsically safe circuit of the measuring electrodes of the Ex "ib" class and the excitation circuit of the Ex "e" protection class. The WAGO terminals themselves meet the certification requirements for the Ex "ia" and Ex "e" environments for the measuring electrodes and excitation circuits, respectively.
On the sensor connection box is a warning label reading
DO NOT OPEN WITH THE POWER ON OR IN EXPLOSIVE ENVIRONMENTS.
Attached to the sensor housing is a sensor rating plate and an arrow indicating the positive fluid flow direction. There is also a PE terminal to facilitate the potential equalising interconnection.
The connections to the sensor terminal box are described in Chapter 5 (ELECTRICAL CONNECTIONS).

Electromagnetic sensors IS x.1xxEx used with flowmeter of the FLONEX FXx11x type series are certified for application in explosive atmospheres.

Sensor for compact meter version
ES certificate on sensor type verification No FTZÚ 12 ATEX 0139U – electromagnetic sensor of type designation ISX.1XXEx

Sensor for remote meter version
Certificate on sensor type verification No FTZÚ 12 ATEX 0160X – electromagnetic sensor of type designation ISX.1XXEx including a terminal strip

The measuring electrode circuit is certified as intrinsically safe of the Ex "ia" protection class, and as such it may only be connected to other intrinsically safe circuits of output parameters compatible with the sensor input parameters:
Ui ≤ 30V Ii ≤ 100mA Li, Ci negligible
The electromagnetic coils are certified as Ex "e" safe design devices.

10.3 Cable bushing sizes

Terminal compartment of the transmitter unit – both compact and remote meter versions

Cable bushings facilitating access to the terminal compartment of the meter transmitter are not included among the accessories of the flowmeter in the Ex-design version.
The flowmeter is supplied with threaded plugs of the Ex "d" class. The cable bushings and their installation shall meet the requirements of standards related to the Ex-type protection classes:

Ex db IIB Gb and **Ex tb IIIC Db**.

Remote meter version – transmitter and sensor

Cable bushings facilitating access for signal cables to the connection box and sensor are not included among the accessories of the flowmeter in the Ex-design version.
The complete flowmeter in the remote design version (including signal cables) is supplied with cable bushings including sealing inserts with two openings meeting the protection class requirements of:

Ex eb IIB Gb and **Ex tb IIIC Db**.

10.4 Company seals

Electromagnetic flowmeters of the type series FLONEX FXx11x are supplied calibrated, verified as to their functions and with parameters set according to the customer's order specifications. Upon completion of all fabrication and testing procedures, the meters are provided with the manufacturer's (company) seals.

Company seal

- Upon closing the meter transmitter housing, the front lid including a viewing window is secured against opening or removal by a self-adhesive company seal.
- In the cases of compact meter version, a self-adhesive company seal is applied onto the flanges connecting the meter transmitter and sensor.

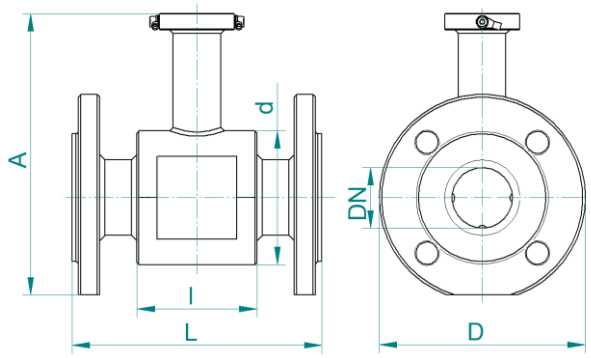
If a company seal is broken, the user will forfeit their right to warranty services, i.e. free-of-charge meter repair during the agreed product warranty period.

Assembly seal

Following electrical connection of the meter and closing the connection compartment on the meter transmitter, the organisation responsible for the meter installation will secure the lid position by a self-adhesive seal.

10.5 Dimensions and weight

10.5.1 Sensor



10.5.1.1 Flanges according to EN 1092-1

Rated pressure	DN	D	d	A	L	l	Weight * (kg)
PN40	15	95	62	164	200	66	2.5
	20	105	62	170	200	66	3
	25	115	72	180	200	96	4.2
	32	140	82	197	200	96	6.2
	40	150	92	207	200	96	6.5
	50	165	107	225	200	96	8.6
PN16	65	185	127	245	200	96	10.4
	80	200	142	260	200	96	12.1
	100	220	162	280	250	96	15.5
	125	250	192	310	250	126	20.4
	150	285	218	344	300	126	25
	200	340	274	399	350	211	35
PN10	250	395	370	475	450	211	54
	300	445	420	525	500	320	65

Comment: * The weight data are of informative nature only.

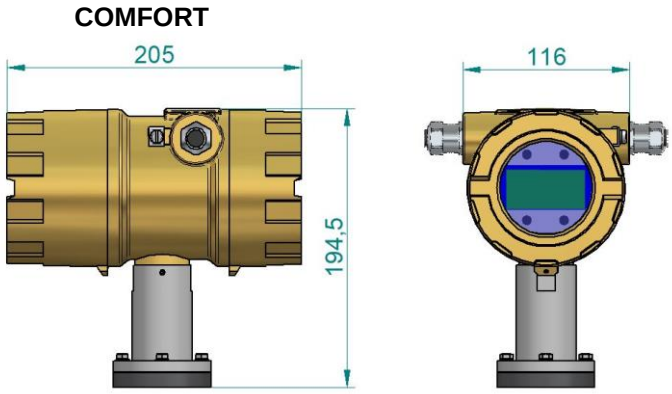
10.5.1.2 Flanges according to ASME B16.5

Rated pressure	NPS	D	d	A	L	l	Weight* (kg)
Class 150	½“	88.9	62	172	200	66	3
	¾“	98.6	62	177	200	66	3
	1“	108	72	187	200	96	3
	1 ¼“	117.3	82	197	200	96	4
	1 ½“	127	92	207	200	96	4
	2“	152.4	107	227	200	96	6
	2 ½“	177.8	127	249	200	96	9
	3“	190.5	142	263	200	96	14
	4“	228.6	162	292	250	96	16
	5	254	192	320	250	126	19
	6“	279.4	218	346	300	126	25
	8“	342.9	274	405	350	211	41
	10“	406.4	370	485	450	211	54
	12“	482.6	420	548	500	320	77

Comment: * The weight data are of informative nature only

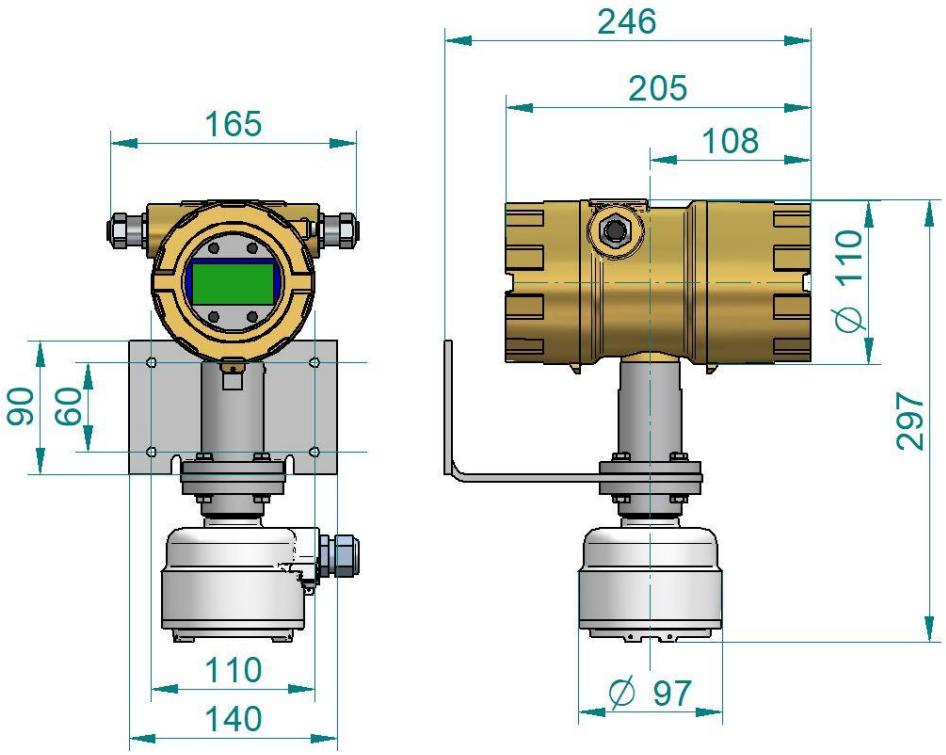
10.5.2 Transmitter

10.5.2.1 Transmitter for compact meter version



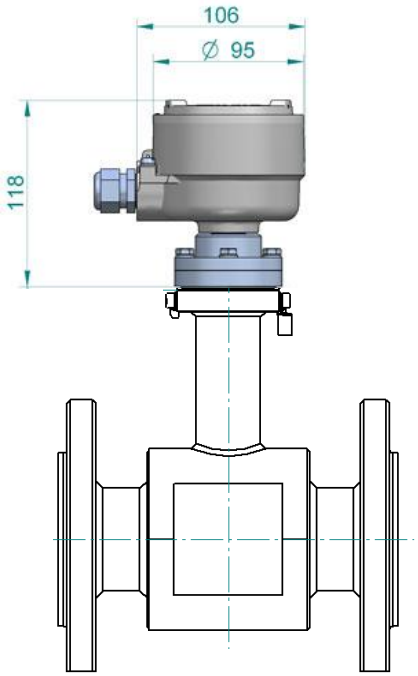
Transmitter weight: approx. 3kg

10.5.2.2 Transmitter for remote meter version



Transmitter and holder, aggregate weight: approx. 4kg

10.5.3 Sensor connection box



Connection box weight: 0.4kg

11. FLOWMETER FAULTS

11.1 General rules

Prior to any flowmeter handling, it is necessary for the staff (of the user of servicing organisation) concerned to study carefully the product documentation.

The staff authorised to correct/repair flowmeter defects shall:

- Be duly qualified to perform repair of electronic equipment and measuring devices, and be certified for work on electrical equipment with rated voltage up to 1,000V according to Czech Regulation 50/1978 Coll. or a corresponding national standard in other countries;
- Be properly trained for repair of flowmeters of the type series FLONEX FX under the authority of the meter manufacturer;
- Observe the relevant national regulations and standards applicable to work on electrical equipment with special regard to labour safety and health protection.

The meter manufacturer shall not be liable for any damage due to unprofessional conduct on the side of the user or their service organisation.
Some service actions require that the flowmeter or a part thereof be energised. Such actions shall be performed with due care to prevent the risk of electric shock.

11.2 Software and simulation devices

To check the functions and identify defects or faults in the FLONEX flowmeters, the user will need:

- FLONEX FXx11x project design, installation and service manual;
- FLOSET 4.0 computer program;
- Computer with Windows 7 or a higher OS upgrade (Linux, iOS) including JAVA 8u40;
- Communication cable USB 2.0 (with USB type-A connector at one and RS-485 at the other end).

11.3 Fault identification

Flowmeters FXx11x are intended for application in explosive atmospheres.

The user shall in no case try to repair the defective flowmeter. Repair work is reserved to the meter manufacturer.
Service operators may only perform operations related to replacement of fuse F1 on the PC board in the terminal compartment.

Make sure to deenergise the meter prior to starting operations related to fault identification and repair, such as opening the transmitter housing, check on the power cable connections or disconnecting the meter sensor.
A fully functional flowmeter can be subject to tests and its parameters can be set using the FLOSET 4.0 program and communication via the RS-485 MODBUS RTU serial line.

The flowmeter software includes instructions for internal meter checks and utilisation of diagnostic algorithms providing user information on specific meter malfunctions or extraordinary occurrences in the form of error codes appearing on the meter display.

Error code	Error description	Likely error cause and error removal procedure
E00	AD range overflow	Excessive flow rate (a short-term step change in flow rate from 0 to Q_4). If the error condition continues, the fault will be in the measuring PC board.
E01	Flow-rate step change	See error code E00
E02	Memory read/write error	If RTC time error is too big, replace back-up battery on the processor board. Should this not help, replace electronic unit (the processor, output and/or measuring PC boards).
E03	Other types of electronic unit error	Should the error condition continue, replace electronic unit (the processor, output and/or measuring PC board).
E04	Error message in cases where it is not possible to calibrate zero flow rate	Wait for a few seconds and repeat zero flow rate calibration. Should the error condition continue, replace electronic unit (the processor, output and/or measuring PC board).
E05	Low excitation current	Disconnected excitation circuit – defective sensor or broken connection between the transmitter and sensor. Defective measuring PC board. Should the error condition continue, replace electronic unit (the processor, output and/or measuring PC board).
E06	Shorted coil circuit	Short in excitation circuit – defective sensor or a short circuit in the connection between the transmitter and sensor. Check the conditions of signal cables.
E07	Information – zero setting in progress, measurement discontinued	Flow measurement discontinued for one minute. Upon completion of the zero-setting procedure, this information message disappears from the display and measurement can continue.
E08	High resistance of measured fluid	Indication of a not fully-flooded piping condition.
E09	OUT1 output error	Output frequency in excess of 10kHz. Impulse output frequency in excess of 100Hz. Time period between impulses is shorter than impulse length.
E10	OUT2 output error	Apply comments to error E09 to the OUT2 output.
E11	Information on excessive current	Incorrect configuration of the current output. Current beyond the range of 4 – 20mA The output current does not correspond to the flow rate range.
E12	Incorrect time setting	Incorrect time setting following back-up battery replacement. Should the error condition continue, replace electronic unit (the processor, output and/or measuring PC board).
E13	Exceeding the value of the overload flow rate Q4	Check the setting of Q 100%. Should the error condition continue, replace electronic unit (the processor, output and/or measuring PC board).

Extraordinary operational conditions of the flowmeter

At the time of the flowmeter commissioning, when the setting of the meter parameters with respect to the co-operating technology and/or the higher-level computer control system may still have to be optimised, it can happen that the meter behaviour is irregular.

Description	Likely cause	Corrective action
Unintelligible text on the display	Display or processor board fault	Switch off and on the meter power; if it does not help, send the meter to the manufacturer for repair
Meter including display is functioning well, the meter menu control does not work	Incorrect procedure in working with the optical reflex sensors.	See the manual: touch just one optical sensor at a time.
The measured values of instantaneous flow rates fluctuate excessively including drops to zero flow rate	Imperfect transmitter or fluid grounding. In cases of remote meter version, signal interference. Loose signal cable. Power line interference. Excessive content of air bubbles or solid particles in measured fluid.	In reference to the manual, check potential equalisation connections and sensor and fluid grounding. Connect a line voltage filter. Eliminate the action of external interference sources. Check the correct sensor installation in the co-operating technology. Prevent aeration of the fluid in piping.
Meter is apparently fully functional but it does not perform measurements	Fluid conductivity too low.	Check the fluid conductivity, consult the problem with the product manufacturer.

11.4 Meter repair procedures

If the flowmeter is not functioning as it should, where:

- No data appear on the display;
- Connection via the RS-485 communication line cannot be made; and/or
- Meter outputs (current, frequency and impulse outputs) are not activated,

check the meter power source and power supply connections.

The power supply terminals and connections can be accessed upon removal of the rear cover on the transmitter housing.

The following operations can only be performed in environments free of explosion risks

Procedure

1. Switch off the meter power source
2. Release the Allen bolt securing the closed position of the rear cover on the transmitter housing
3. Remove the rear cover on the transmitter housing
4. Check the tightness of the power supply cable conductor connections in the respective terminals
5. Switch on the meter power source

Warning: risk of electric shock

6. Check the live condition of the transmitter terminals and the value of the power supply voltage
7. If the line voltage is within the required range (consult the product manual) and the error condition still exists, check the condition of fuse F1 5x20mm on the terminal plate
   Fuse specifications according to the manual
   - AC power source: T 1.25A/250V, breaking capacity 1500A/250V
   - DC power source: T 2A/250 V

   When checking the fuse condition, observe the standard rules applicable to repair of electronic equipment and measuring devices – remove the fuse from its holder only after switching off the meter power supply.
8. If fuse F1 is in order or if upon its replacement the error condition still exists, the meter needs be sent to the manufacturer for repair.

When replacing the transmitter or sensor covers, tighten the securing bolts using the torque of 8Nm.

Should you fail to repair the meter error using the above procedure, contact the authorised service centre or directly the meter manufacturer.

12. MAINTENANCE

The FLONEX FXx11x flowmeter does not require any special maintenance. During regular product inspections, apart from visual check on the mechanical integrity and absence of signs of damage to the external meter parts, it is recommended to check the tightness of cable bushings and grounding terminals.

Transmitter
The transmitter housing exterior is coated with a layer of powder paint. For cleaning, use standard procedures applicable to maintenance of measuring devices.

To clean the viewing window and rubber seal, avoid application of abrasive cleaning agents.

Sensor
To clean the sensor surface, use standard procedures applicable to maintenance of measuring devices. The PIGS method (mechanical cleaning) is not permitted for maintenance of the inner parts of the sensor as it implies a risk of damage to the sensor lining and measuring electrodes. The inner surfaces of a dismantled sensor should be cleaned using a piece of cloth or brush and a cleaning agent with degreasing and mild abrasive effects (for example a liquid cleaning cream).

13. SERVICES

General principle
Prior to leaving the meter for service with the meter manufacturer or an authorised service centre, the product shall be thoroughly decontaminated.

Representation on product decontamination
In observance of the applicable environment conservation, labour safety and health protection regulations, attached to any requirement for meter repair shall be a **representation in writing on the meter decontamination**.
Any costs of the meter decontamination needed to be performed at the manufacturer's laboratories shall be invoiced to the customer concerned.
A form to be used for representation on product decontamination is included in this manual (see Chapter 17).

A meter that cannot be decontaminated shall not be sent away for any service action.

14. WARRANTY

14.1 Warranty services

Warranty services consist of product maintenance or repair actions carried out free of charge within the agreed warranty period by the product manufacturer or a duly authorised manufacturer's partner organisation.

A warranty repair action is product repair carried out free of charge within the agreed warranty period where the product fault concerned has been caused by defective material, component part or workmanship.
Should the product fault as of the preceding paragraph be found irreparable, the product will be replaced at no cost to the customer.
Warranty services may only be performed by the product manufacturer, their duly authorised service centre or an authorised distributer who may prove their qualifications by a licence in writing received after thorough training at the manufacturer's plant.

Excluded from warranty services shall be:

- Products with broken company seals;
- Products with defects caused by incorrect installation or electric connection;
- Transmitters damaged due to incorrect electric connection;
- Products with defects caused by non-standard product application;
- Defects due to mechanical damage;
- Defects caused by force majeure or natural disaster;
- Alienated products.

Any warranty service or repair claims shall be communicated to the manufacturer **in writing** (by E-mail, fax or registered post).
Should the manufacturer reject a warranty claim, such position shall be made known to the customer **in writing** whereby the repair costs will be invoiced to the customer.
In cases of invoicing meters, following any service action the meter shall be sent to an Accredited Metrological Laboratory for verification.

14.2 Post-warranty services

Post-warranty services consist of any product maintenance or repair actions related to conditions and/or defects occurring upon expiry of the agreed warranty period. Any such action irrespective of the location where it is to be carried out and whether performed by the manufacturer or their duly authorised partner organisation, shall be invoiced to and paid for by the customer.
In cases of invoicing meters, following any service action the meter shall be sent to an Accredited Metrological Laboratory for verification.
Post-warranty product service or repair requirements shall be communicated to the manufacturer **in writing** (by E-mail, fax or registered post).

15. ORDER NUMBER

- In specifying the product order number refer to the information in Section 3.6 (Sensors for flowmeter FLONEX FXx11x: review of design and material versions).
- In cases of meter application in explosive atmospheres, the fluid temperature shall correspond to the sensor temperature class or maximum surface temperature referred to in Section 3.4.
- The Q value used in meter output parameter setting is equal to Q_3 as specified in standard EN ISO 4064-1.

Ordinal numbers of the order number digits			1	2	3	4	5	6	-	7	8	9	10	11
ORDER NUMBER			**F**	**X**	**x**	**1**	**x**	**x**						
METER TYPE DESIGNATION														
Sensor type	with flanges						1							
							x							
Design version	compact COMFORT							4						
	remote COMFORT							6						
TECHNICAL PARAMETERS														
Sensor size	EN	ASME												
	DN15	NPS 1/2"								0	1			
	DN20	NPS 3/4"								0	2			
	DN25	NPS 1"								0	3			
	DN32	NPS 1 1/4"								0	4			
	DN40	NPS 1 1/2"								0	5			
	DN50	NPS 2"								0	6			
	DN65	NPS 2 1/2"								0	7			
	DN80	NPS 3"								0	8			
	DN100	NPS 4"								0	9			
	DN125	NPS 5"								1	0			
	DN150	NPS 6"								1	1			
	DN200	NPS 8"								1	2			
	DN250	NPS 10"								1	3			
	DN300	NPS 12"								1	4			
	Non-standard										x			
Sensor flanges	EN ISO 1092-1											1		
	ASME B16.5											2		
	Non-standard											*		
Sensor material and surface finish	Housing and flanges made of carbon steel, polyurethane coating												1	
	All-stainless-steel 1.4301												2	
	Non-standard												x	
Electrode and grounding ring material	Stainless steel 1.4571													1
	Hastelloy C-276													2
	Titanium													3
	Tantalum													4
	Platinum and rhodium													5
	Non-standard													x

Ordinal numbers of the order number digits		12	13	14	15	16	17	18	19	-	20
ORDER NUMBER											
Sensor lining	Soft rubber MG, DN25 – DN300	1									
	Hard rubber for drinking water NG, DN40 – DN300	2									
	PTFE DN15 – DN300	3									
	E-CTFE DN300	4									
	Non-standard	x									
Sensor protection class	IP 67		1								
Fluid grounding	Grounding electrode			1							
	Grounding on piping			2							
	Grounding rings			x							
Rated pressure	EN ASME										
	PN 10				1						
	PN 16				2						
	PN 40				3						
	Class 150				4						
Maximum temperature of measured fluid (°C)	For relationship between fluid temperature and equipment temperature class Ex see Section 3.4 hereof: 50					1					
	80					2					
	110					3					
	120					4					
	139					5					
	Non-standard					x					
Connecting cable length (m) for remote meter version	3						1				
	6						2				
	10						3				
	15						4				
	25						5				
	Non-standard						x				
Power source	95 –250VAC, 45 – 65Hz							1			
	24V ± 20% (19.2 – 28.8VDC)							2			
MEASURED FLUID											
Type of fluid	Water										1
	Non-standard										x

Ordinal numbers of the order number digits		-	21	22	23	24	25
ORDER NUMBER							
FLOWMETER SETTING							
Impulse number (litre/imp)	0.001		1				
	0.01		2				
	0.1		3				
	1		4				
	10		5				
	100		6				
	1,000		7				
	10,000		8				
	Non-standard		x				
Fluid volume units	l			0	1		
	m3			0	2		
	gal			0	3		
	imp gal			0	4		
	bbl			0	5		
	bush			0	6		
	yd3			0	7		
	ft3			0	8		
	in3			0	9		
	bblLiq			1	0		
	hl			1	1		
Flow rate units	l/sec					0	1
	l/min					0	2
	l/h					0	3
	MilL/den					0	4
	m3/s					0	5
	m3/min					0	6
	m3/h					0	7
	m3/den					0	8
	ft3/s					0	9
	ft3/min					1	0
	ft3/h					1	1
	ft3/den					1	2
	gal/s					1	3
	gal/min					1	4
	gal/h					1	5
	gal/den					1	6
	MilGal/den					1	7
	bbl/s					1	8
	bbl/min					1	9
	bbl/h					2	0
	bbl/den					2	1
	ImpGal/s					2	2
	ImpGal/min					2	3
	ImpGal/h					2	4
	ImpGal/den					2	5

Ordinal numbers of the order number digits		26	27	28	29	30	31	32
ORDER NUMBER								
Number of samples to be averaged	25	1						
	50	2						
	100	3						
	150	4						
	200	5						
	250	6						
	Non-standard	x						
Measurement insensitivity	Standard ±0.5% Q_3		1					
	Non-standard		x					
Language	Česky			0	1			
	English			0	2			
	Dutch			0	3			
	Español			0	4			
	Polski			0	5			
	Français			0	6			
	Deutsch			0	7			
	По Русски			0	8			
	Português			0	9			
Data on display	Aggregate volume					1		
	Time/date					2		
	Operating time					3		
	Flow rate in per cent					4		
	Last error condition					5		
Flow rate 100% (l/s)	Flow rate for Q_3 (Q_3 = Q for v = 8 m/s)						1	
	Order-specified flow rate						x	
Analog output	Not requested							1
	-Q … +Q ($Q = Q_3$, Q_3 = Q for v = 8 m/s)							2
	-Q … +Q according to order							3
	0 ... |Q| ($Q = Q_3$, Q_3 = Q for v = 8 m/s)							4
	0 ... |Q| according to order							5
	Fixed current 4–20 mA (0 to Q_3, Q_3 = Q for v = 8 m/s)							6
	Fixed current 4–20 mA according to order							7

Ordinal numbers of the order number digits			33	34	35	36	37	38
ORDER NUMBER								
Output OUT1	Not requested		0	1				
	Q_3 = Q for v = 8 m/s	Frequency Q+	0–10 kHz … 0–Q_3	0	2				
		Frequency Q–	0–10 kHz … 0–Q_3	0	3				
		Frequency IQI	0–10 kHz …0–Q_3	0	4				
		Non-standard:	Q ≠ Q_3x	0	5				
		Imp. for Q+	Impulse length 5ms,	0	6				
		Imp. for Q–	Minimum gap length 5ms,	0	7				
		Imp. for |Q|	Imp. number: see Section 5.8.1	0	8				
		Non-standard impulses, impulse number		0	9				
		Q > Q lim	Q lim = Q_3, OUT1 = on	1	0				
		|Q| > Q lim	Q lim = Q_3, OUT1 = on	1	1				
	No-error condition		OUT1 = on	1	2				
	Permanently closed		OUT1 = on	1	3				
OUT1 function	Positive					1			
	Negative					2			
Output OUT2	Not requested					0	1	
	Q_3 = Q for v = 8 m/s	Frequency Q+	0–10 kHz … 0–Q_3			0	2	
		Frequency Q–	0–10 kHz … 0–Q_3			0	3	
		Frequency IQI	0–10 kHz …0–Q_3			0	4	
		Non-standard:	Q ≠ Q_3			0	5	
		Imp. for Q+	Impulse length 5ms,			0	6	
		Imp. for Q–	Minimum gap length 5ms,			0	7	
		Imp. for |Q|	Imp. number: see Section 5.8.1			0	8	
		Non-standard impulses, impulse number				0	9	
		Q > Q lim	Q lim = Q_3, OUT2 = on			1	0	
		|Q| > Q lim	Q lim = Q_3, OUT2 = on			1	1	
	No-error condition		OUT2 = on			1	2	
	Permanently closed		OUT2 = on			1	3	
OUT2 function	Positive							1
	Negative							2

Ordinal numbers of the order number digits		39	40	41	42	43	-	44	-	45	46	47	-	48
ORDER NUMBER														
COMMUNICATION														
RS-485 MODBUS RTU														
Address	1	0	0	1										
	2	0	0	2										
	3	0	0	3										
	.	.	.	.										
	.	.	.	.										
	247	2	4	7										
Speed	300				1									
	600				2									
	1200				3									
	2400				4									
	4800				5									
	9600				6									
	19200				7									
	38400				8									
	56800				9									
HART®	Not requested					1								
	Yes					2								
CALIBRATION														
	No calibration							1						
	Standard precision according to EN ISO 4064-1, class 2							2						
	Higher precision: ±0.5%/±0.2%, see Section 9.3.2 No calibration report issued							3						
	Higher precision: ±0.5%/±0.2%, see Section 9.3.2 Including calibration report							4						
	Non-standard calibration							5						
COMMERCIAL TERMS AND CONDITIONS														
Packaging	No packaging									1				
	Standard									2				
	For export									3				
	Non-standard									x				
Delivery	Personal collection										1			
	Forwarding company at supplier's costs										2			
	Forwarding company at customer's costs										3			
	Non-standard										x			
Warranty	6 months											1		
	12 months											2		
	18 months											3		
	24 months											4		
	36 months											5		
	Non-standard											x		
DOCUMENT IDENTIFICATION														
File No.	Es90674K Flowmeter manual													1

16. ASSOCIATED DOCUMENTS AND STANDARDS

Standards

ČSN EN 6817	Flow rate measurement of conductive liquids in closed profiles – Measuring method using electromagnetic flowmeters
ČSN EN 29104	Flow rate measurement of liquids in closed profiles
EN ISO 4064-1	Water meters for cold drinking water and hot water
ČSN EN 1092-1	Flanges and flanged connections
ASME B16.5	Pipe flanges and flanged fittings
ČSN EN 13480	Metal pipes for industrial application
ČSN EN 61010-1	Electrical measuring, control and laboratory equipment; safety requirements
ČSN EN 60664-1	Low voltage equipment insulation co-ordination

ČSN EN IEC 60079-0: 2018	Explosive atmospheres – Equipment – General requirements
ČSN EN 60079-1: 2014	Explosive atmospheres – Eq. protection by flame-proof enclosures Ex “d“
ČSN EN 60079-7: 2015	Explosive atmospheres – Equipment protection by increased safety Ex “e“
ČSN EN 60079-11:2012	Explosive atmospheres – Equipment protection by intrinsic safety Ex “i“
ČSN EN 60079-14:2014	Explosive atmospheres – Electrical installation design, selection and erection
ČSN EN 60079-25:2010	Explosive atmospheres – Intrinsically safe electrical systems
ČSN EN 60079-31:2014	Explosive atmospheres – Equip. dust ignition protection by enclosure Ex “t“
ČSN EN 60664-1:	Low voltage equipment insulation co-ordination

Manuals

Es 90664K	**Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH – communication interface RS-485 MODBUS RTU**
Es 90665K	**Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH – communication interface HART®**
Es 90666K	**Electromagnetic flowmeters of the type series FLONEX FX and FLONET FH – meter control procedures**

17. ANNEXES

17.1 ATEX certificate

EU certificate on type verification tests

FTZÚ 18 ATEX 0117X: **Electromagnetic flowmeter FLONEX**

17.2 IECEx certificate

IECEx certificate on type verification tests

IECEx FTZU 20.0010X: **Electromagnetic flowmeter FLONEX**

17.3 Representation on meter decontamination

Representation on decontamination

CUSTOMER	**ADDRESS**	
	Name	Telephone
FLOWMETER TYPE	Delivery date	Delivery note

Production serial number

MEASURED FLUID

FLUID PROPERTIES AND ASSOCIATED RISKS

Toxic		Implying biological hazard	
Corrosive		Caustic agent	
Flammable		Detrimental to environment	

Other types of risk

The sensor cavities have been emptied and cleaned		
Meter surface is free of fluid traces		
Residual contamination	Yes	
	No	

METER HANDLING SAFETY PRECAUTIONS

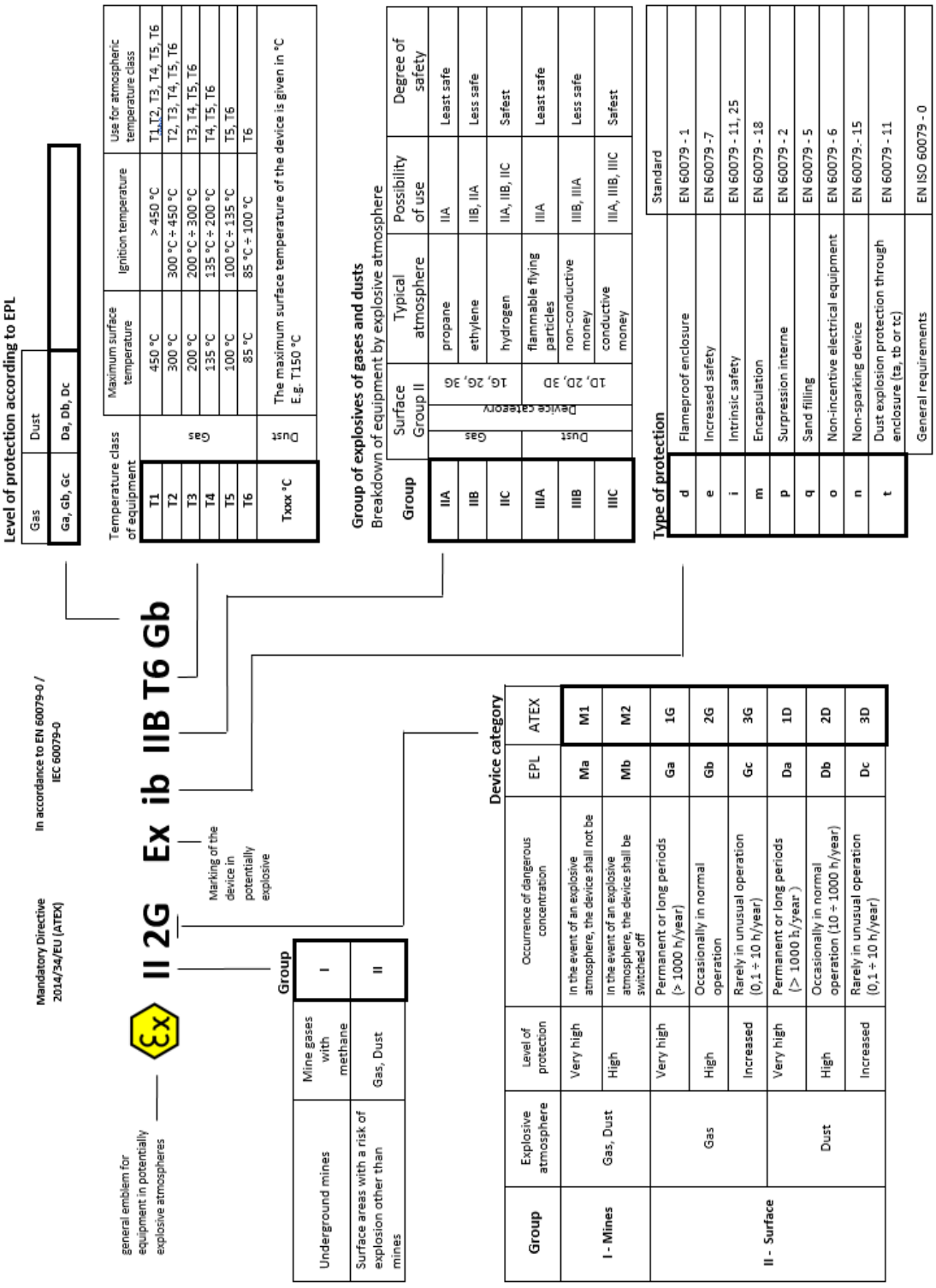
Protection gloves	
Protection glasses	
Protection face shield	
Respirator	
Protection clothing	
Fume chamber	

Other precautions

We confirm that the flowmeter has been properly decontaminated.
Provided the above safety precautions are observed, the flowmeter handling will not constitute any risk to health or environment.

Date	Place	Signature

17.4 Marking of equipment intended for explosive atmospheres



Manufacturer's address:

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