Ultrasonic Flow meter

FLOMIC FL3085

Content

1. APPLICATION

Battery-powered ultrasonic flowmeterFLOMIC FL3085isintended fora measurement and archiving of instantaneous flow rate and total volume of liquid passed through a fully flooded piping of large diameters. The measurement method is suitable for any type of liquid including electrically non-conductiveliquids as long as these allow propagation of ultrasonic waves. To ensure high measurement accuracy, the flowmeters are calibrated on a calibration rig. The FLOMIC FL3085 flowmeters do not require external power supply.The built-in battery lifetime is at least 4 years.
The remote version oftransmitterprocesses signals and visualises measured data on instantaneous flow rate and total volume passed through the meter sensor. The transmitter also archives measuredvalueswithina pre-set frequency in a dataloggeror, via electric outputs, in an external master control system.

2. MEASUREMENT METHOD

The meter operation is based on the time the ultrasonic beam needs to travel in the upstream and downstream direction of flow, i.e. the distance between thetwo-meter probes.This arrangement helps to eliminate any asymmetry in the position of the ultrasonic probes.

3. TECHNICAL DESCRIPTION

3.1. Flow meter characteristics

The FLOMIC FL3085 ultrasonic flowmeter is a device used for a measurement and archiving of data of instantaneous flow rate and total volume of liquid passed through the meter sensor located in a fully flooded piping. The meter is produced only in the remote version with the transmitter separated from the sensor – usually mounted on a wall and connected to the sensor by a cable of maximum length 20 metres.

The basic meter version includes a software package for a signal processing and visualisation of instantaneous flow rate and total volume counted from the last reset command. The transmitteris equipped with an opto-coupler enabling the function of a passive pulse output. The pulse length is set at 40 ms; on customer's request, it can be set at 2 ms. The transmitteris also equipped with a RS-232 communication interface.
The optional accessories include a passive current output, data storage memory unit, M-Bus communication interface, GSM module, data-reading via optical interface, bi-directional measurement with indication of flow direction and sensor version for drinking water. The meter probes are also available in the IP68 version.

3.2. Meter design

3.2.1. Sensor dimensions

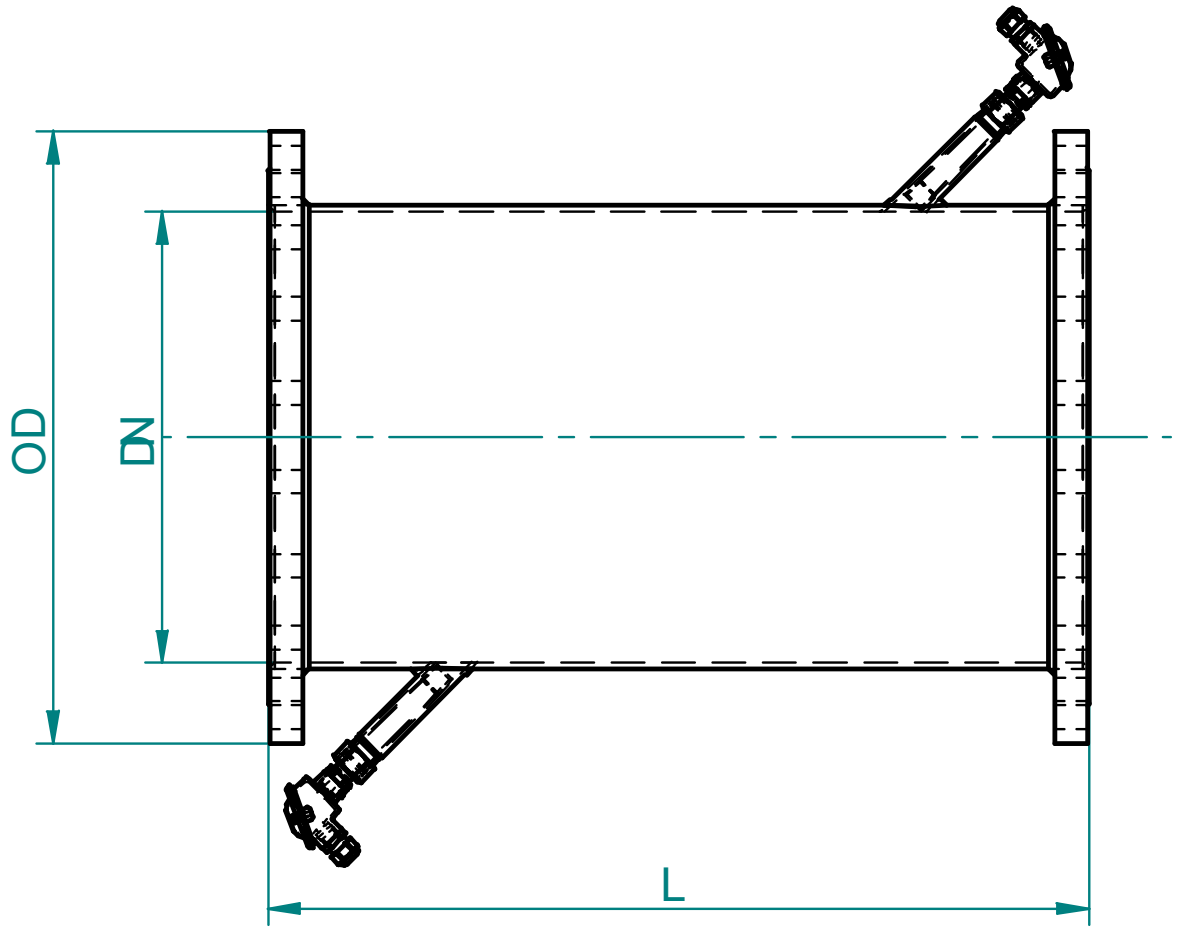


Fig. 1 - Dimensional sketch of meter sensor

DN	200	250	300	350	400	450	500	600	700	800	1000	1200
NPS	8“	10“	12“	14“	16“	18“	20“	24“	28“	32“	40“	48“
L [mm]	600	650	700	750	800	850	900	700	800	850	1000	1150
D [mm]	340	395	445	505	565	615	670	780	895	1015	1230	1455
Weight [kg]	41.5	53.5	68	89	113	136	161	182	292	378	632	978

Table 1 - Sensor dimensions

3.2.2. Transmitterhousing

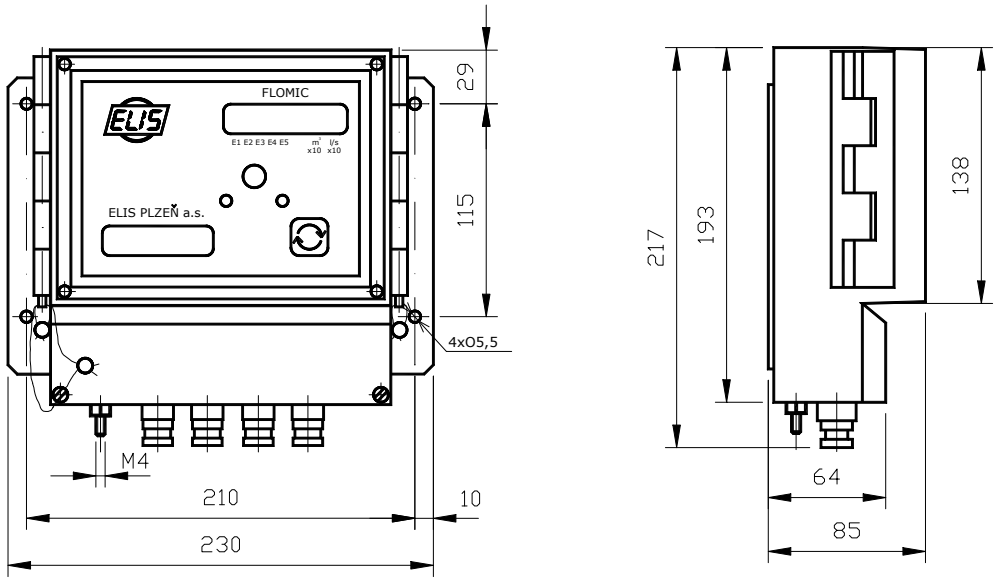


Fig. 2 - Dimensional sketch of transmitterhousing

3.2.3. Ultrasonic sensor

The sensor is a welded structure (sensor body) comprising of flanges, the main pipe and two side pipes serving the purpose of ultrasonic probe holders (see Fig. 3). In the basic design version, the sensor body is made of high-quality steel, the flanges are according to standard EN 1092-1, the pressure rating PN 10. The sensor body is coated with epoxy paint KOMAXIT E 2310, RAL 7035 (light grey).
On customer's request, the sensor body can be made:-of stainless steel;
-with flanges according to standards ANSI or JIS
-for pressures PN 16 or 25 with dimensions DN200 to DN500

The sensor version for application in drinkingwater supply systems, the sensor body is coated with epoxy paint KOMAXIT E 2110, colour tone RAL 5017 (blue).

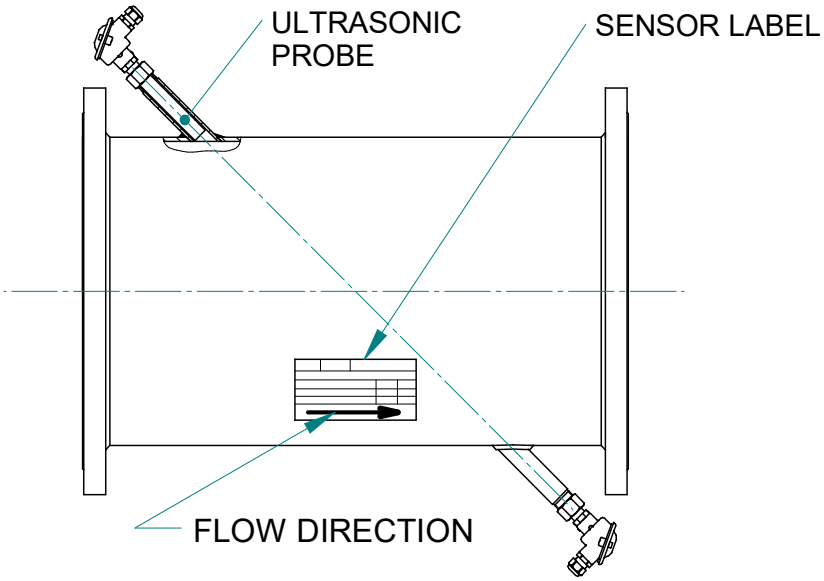


Fig. 3 - Ultrasonic probe assembly

3.2.4. Transmitter

The transmitter (see Fig. 4) has a plastic housing attached to a steel base to be mounted on a wall in vertical position. The housing'sfront panel has a single-line 8-character back-lighted LC display unit, a membrane-typekey button, and information on the meter: its type designation and full name, production series number, name and logo of the manufacturer. At the bottom of the front part of the housing located under a removable cover is a terminal strip provided with another sealed cover. At the bottom of the housing there are four plastic glands (model PG 7) for cables of circular cross-section and agrounding bolt. The PG 7 glands can accommodate and properly seal cables of external diameter 4 to 7 mm.

CAUTION: Prior to setting the meter in operation make sure that all glands are properly tightened, and the unused ones blinded.
CAUTION: When the transmitter is placed in an outdoor environment, it is important to protect it against direct sunshine. The transmitter mustn't be placed into a closed box.

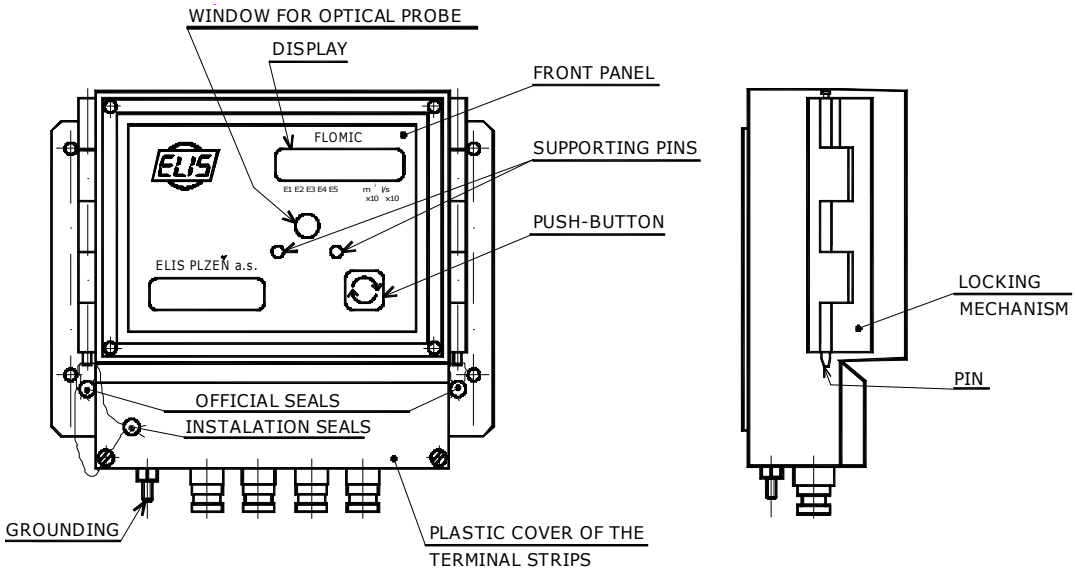


Fig. 4 -Transmitter - description

3.2.5. Meter sensor handling

Arrows indicate the permitted manner of handling the meter sensor assembly. To lift the sensor, use the lifting eyes screwed into the sensor flanges (see Fig. 5).

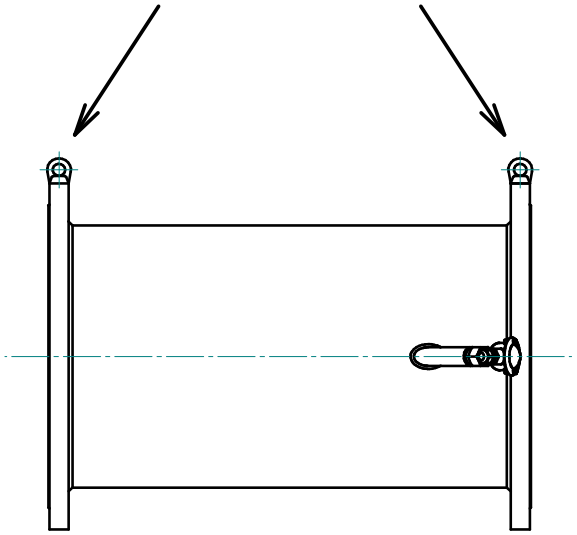


Fig. 5- Sensor handling instruction

4. TECHNICAL SPECIFICATION

Select the correct sensor size in Table 2 considering the desired ranges of the measured data.
Basic parameters of the flow meters are deigned according to standard EN ISO 4064-1 (OIML R 49), The ratio f following flow are shown below:

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

The figures in the table are based on standard EN ISO 4064-1 (OIML R 49).
The flow rate values Q1, Q_2, Q_3 and Q4 related to individual design versions and meter dimensions are shown below

Ratedpiping DN		200	250	300	350	400	450	500	600	700	800	1000	1200
Q_4 overload flowrate	m^3/h	1000	1200	1500	1800	2000	2300	2500	3000	3600	4100	5100	6100
	G/min	4403	5283	6604	7925	8806	10127	11007	13209	15850	18052	22455	26857
Q_3 permanent flowrate	m^3/h	800	960	1200	1440	1600	1840	2000	2400	2880	3280	4080	4880
	G/min	3522	4227	5283	6340	7045	8101	8806	10567	12680	14441	17964	21486
Q_2 transitional flowrate	m^3/h	16	19,2	24	28,8	32	36,8	40	48	57,6	65,6	81,6	97,6
	G/min	70,44	84,53	105,67	126,80	140,89	162,02	176,11	211,34	253,60	288,83	359,27	429,72
Q_1 minimum flowrate	m^3/h	10	12	15	18	20	23	25	30	36	41	51	61
	G/min	44,03	52,83	66,04	79,25	88,06	101,27	110,07	132,09	158,5	180,52	224,55	268,57
Q_{NEC} suppressed flow	m^3/h	2,3	3,6	5,1	7,0	9,1	11,5	14,2	15	18	20,5	25,5	30,5
	G/min	10,1	15,8	22,4	30,8	40,1	50,6	62,5	66,0	79,2	90,2	112,3	134,3
Pulse output constant k_i	l/p	500	500	500	1000	1000	1000	2000	2000	5000	5000	10000	10000
	G/p	100	200	200	200	200	500	500	500	500	1000	1000	1000

Table 2 - Measurement ranges for various piping sizes

where
Q_4 is the overload (maximum) flow rate,
Q_3 is the permanent flow rate,
Q_2 is the minimum flow rate for specified measurement accuracy, and
Q_1 is the minimum flow rate
Q_{NEC} is the sensitivity threshold (flow rate) level of the sensor concerned.

The threshold flow rate value at which the meter starts to detect and generate information about flowingliquid is set at the manufacturer's plant as aQ_{NEC} value corresponding to the flow velocity of 20 mm/s. On customer's request, this value can be set at any level within the range of Q_{NEC} = 0,1 to 25% Q_4.

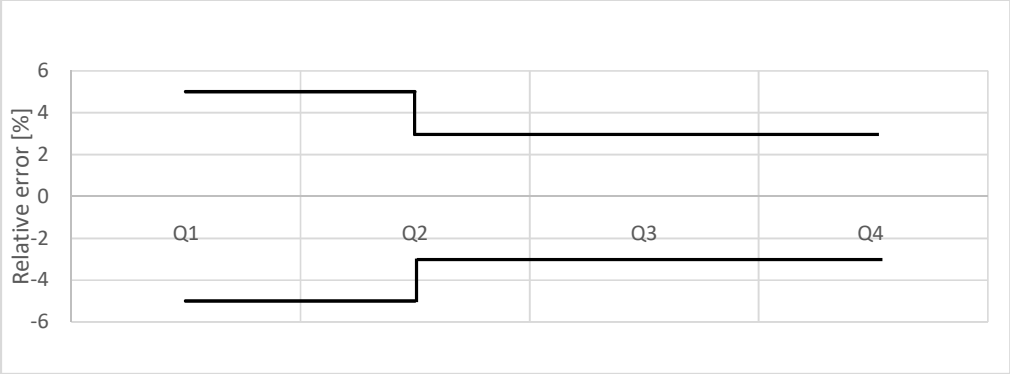
The maximum permissible error in the liquid volume measurements within the flowrate range of Q_1 (including) and Q_2 (excluding) is:

± 5% for any liquid temperature.

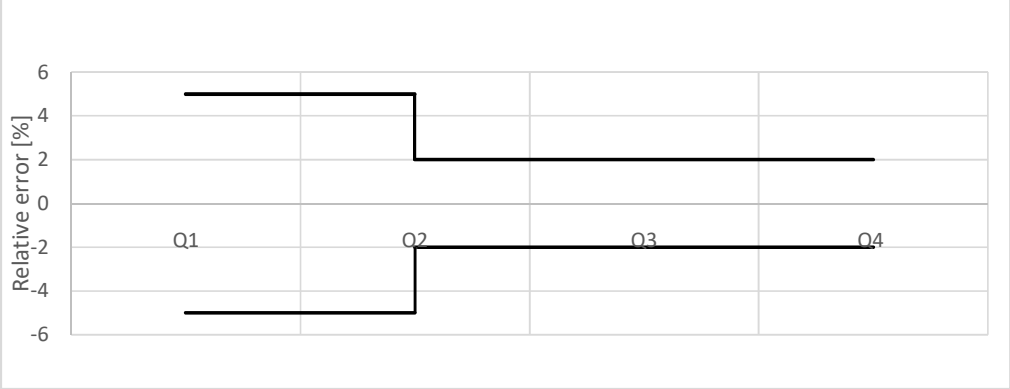
The maximumpermissible error in the liquid volume measurements within the flowrate range of Q_2(including) and Q_4 (including) is:

± 2% for the liquid temperature not exceeding 30 °C, and
± 3% for the liquid temperature exceeding 50 °C.

Flow meter precision rating in accordance with standard EN 14154 (OIML R 49)
for temperature classes T50, T90 and T130



Flow meter precision rating in accordance with standard EN ISO 4064-1 (OIML R 49)
for temperature classes T30



Rated pressure	PN 10, on request PN 16 or PN 25 for DN 200 to DN 500
Measurement accuracyacc to standard EN ISO 4064-1 (OIML R 49)	2 (T30)* 3 (over T50)
Liquid temperature	0 to 150°C
Ambient temperature	0 to 50°C
Storage temperature	-10°C to +70°C (by relative humidity max. 70%)
Display unit	Single-line 8-character LCD
Power supply	Li battery 3.6V/16Ah, type LS 33600, minimum lifetime 4 years
	2 alkaline batteries 9V/550mAh, type MN1604, minimum lifetime 4 years
Transmitter IP	IP 65
Sensor IP - including ultrasonic probes	IP 54 (IP 68/2m)

Outputs	Passive, pulse, U = 5 to 30V, I_{max} = 10mA, pulse length 40ms (2ms)
	Communication interface RS-232
Optional accessories / meter versions	Passive current output 4 to 20mA, U_{max}= 24V
	Volume measured in US gallons
	Storage of measured data
	Reading of stored data by means of GSM module
	Optical interface with optical probe and ArchTerm software
	Sensor protection class IP 68 (2m)
	Sensor design for application in drinking water supply systems
	Flanges according to alternative standards (ANSI, JIS)

Table 3 - Technical specifications of flow meter FL3085

*) in the above standard version, it is possible to supply the flowmeter with higher accuracy in the range and conditions agreed with the manufacturer

Example of above standard parameters:

Measurement accuracy	± 1 % for flow rate Q > Q_2 (see Tab. 2) and temperature up to 50 °C

5. METER INSTALLATION DESIGN

5.1. System design with ultrasonic flowmeters

Designing the system fora placement of flowmeters into the piping must not have a negative effect on meter's accuracy.The required minimum lengths of straight piping sections before and after any FLOMIC flowmeter are 5 x DN and 3 x DN, respectively (see Fig. 6 and 7).

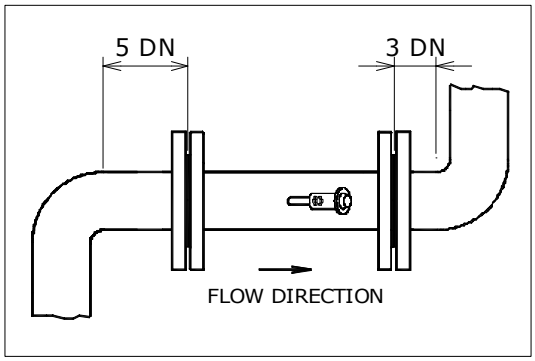


Fig.6 - Minimum straight piping sections before and after flowmeter

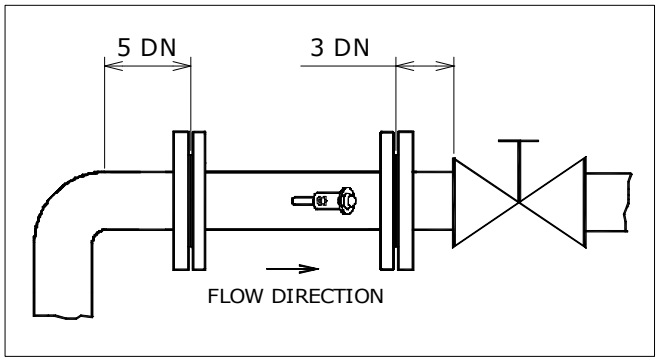


Fig. 7 - Minimum straight piping section before closing valve

If there is a pump in the piping, the flowmeter should be placed at least 20 x DN away at the pump input side (Fig. 8).

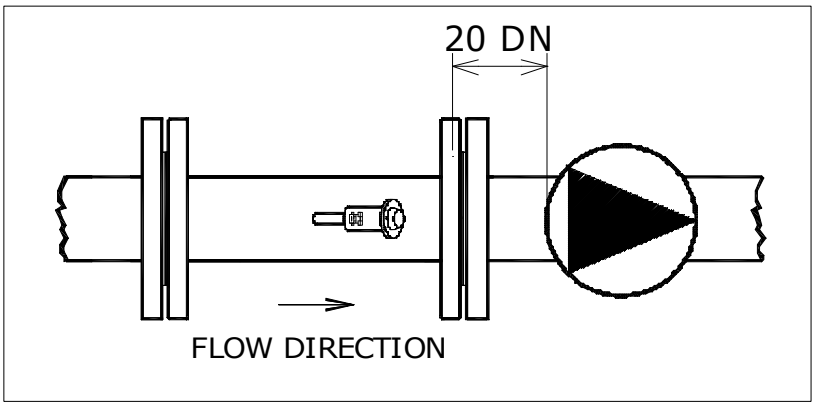


Fig. 8 - Minimum straight piping section at the pump inlet side

If fully flooded piping cannot be ensured, the meter sensor shall be located in piping section where this requirement is always met (see Fig. 9).

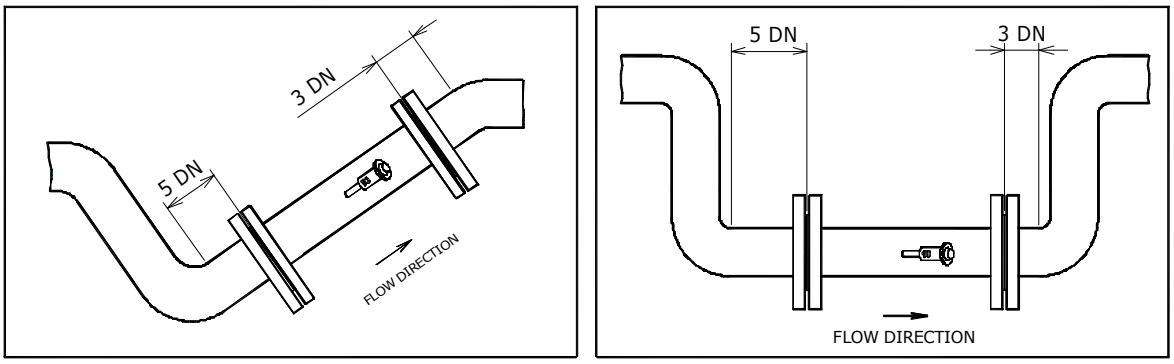


Fig. 9 -Placement proposalsto ensurea fully flooded sensor in the piping

Where the sensor is to be placed in a vertical position, the direction of flowmust be in the upward direction (Fig. 10).

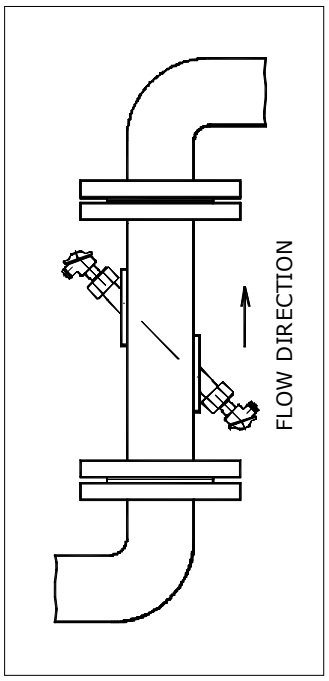


Fig. 10 - Sensor located in vertical piping section

To ensure a correct measurement in all circumstances, the flow cross-section of the sensor mustbe fully filled with the measured liquid. Avoid placing the sensor at the top or in vertical sections of piping with a downward flow direction, in particular where the piping leads directly into open tanks. (see Fig. 11).

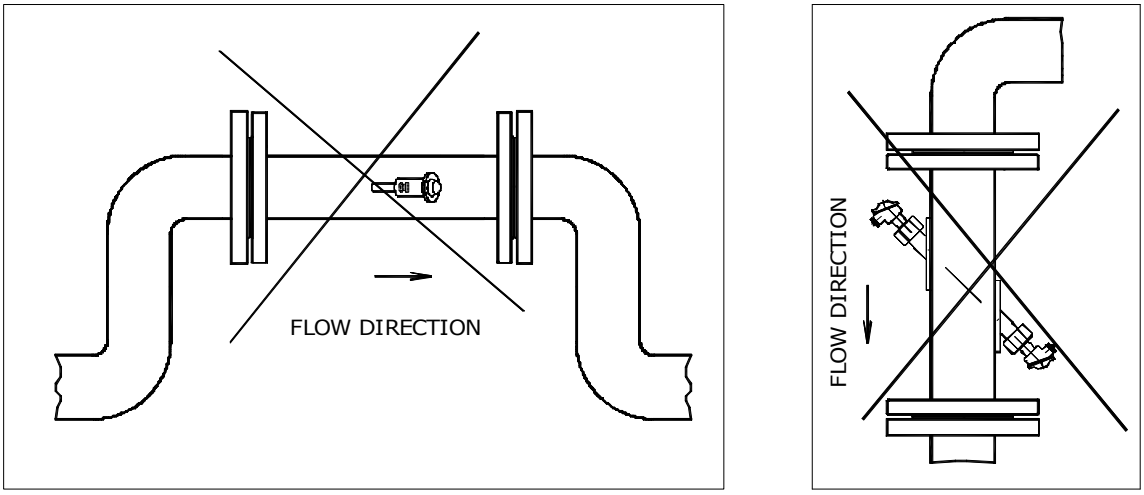


Fig. 11 - Examples of incorrect sensor placement

The correct function of the meter sensor depends, among other things, on its angular position with respect to the longitudinal axis. Occasional air bubbles in the flowing liquid tend to accumulate in any irregularities on the internal piping surface including the hollow ends of the probe holders. This effect will be eliminated if the probes are located in the horizontal plane (see Fig. 12). Should such sensor position be prevented by any obstacles in the vicinity of the piping, make sure that the angle formed by the probe plane and the horizontal plane does not exceed 30°.

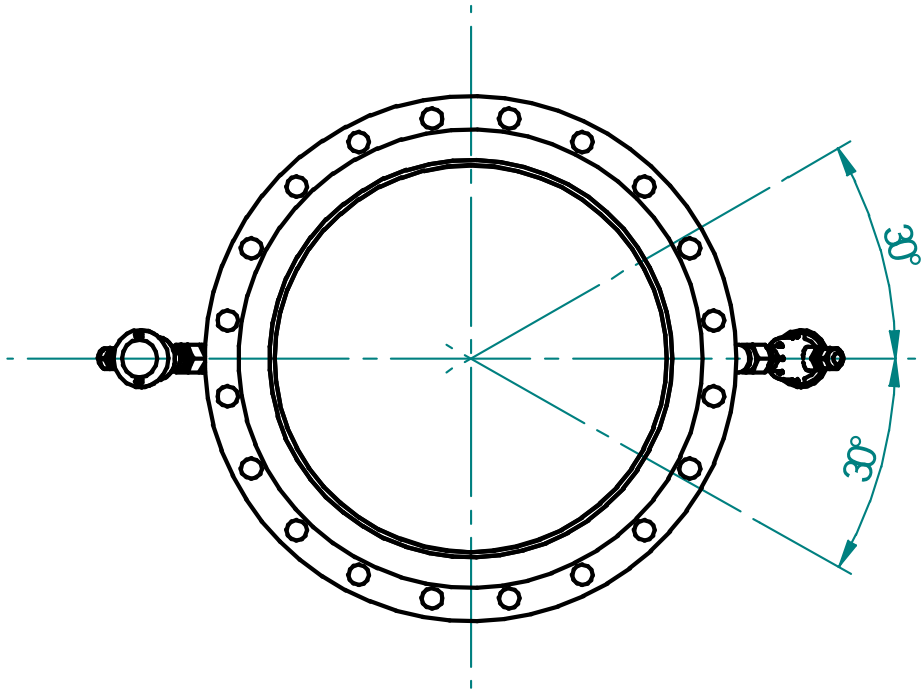


Fig. 12 - Permitted range of angular positions of the sensor with respect to its horizontal axis

5.2. Assembly and installation

5.2.1. General recommendations

The flowmeter installation shall be done in observance of the requirements in EN 14154-2 standard, chapter 5.
To minimise electromagnetic interference, make sure that the meter signal cables are at least 25cm away from the power cables feeding other electric equipment.
The meter sensor and the remote transmitter shall be interconnected by a shielded coaxial cable supplied from the meter manufacturer. All output signals (pulse, current, M-Bus) should also be led by shielded cables with the shielding grounded on the part of master control system. Proper grounded is required for both the meter sensor and the transmitter (see Fig. 13). The interconnection between the grounded bolt on the sensor flange, the piping flange and the grounded point on the transmitter shall be done by a grounding conductor with a minimum cross-section of 4mm^2.

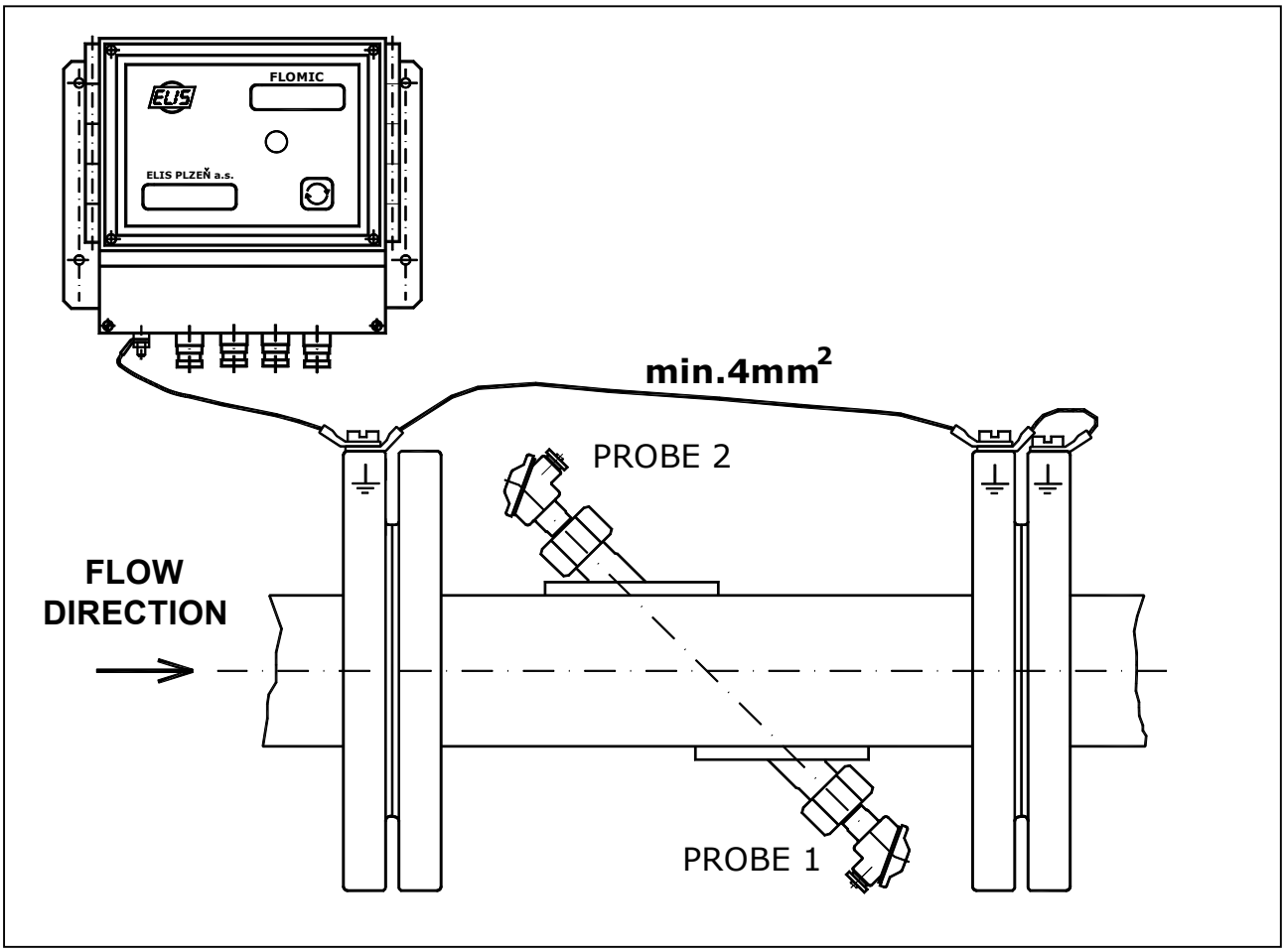


Fig. 13- Grounding connection for the meter sensor and remote transmitter

CAUTION:When the transmitter is placed in an outdoor environment, it is important to protect it against direct sunshine. The transmitter mustn't be placed into a closed box.

5.2.2.Mechanical fitting

The ultrasonic sensors shall be fitted into the piping by means of flanges matching the corresponding counter-flanges on the piping ends. The flange specifications are written on the flange perimeter. In its basic version, the sensor is supplied with flanges according to standard EN 1092-1 (on customer's request, the ANSI or JIS flanges can also be provided.).

5.2.3. Electrical connection

During meter installation, the sensor cables including shielding shall be connected to terminal strip X1 (terminals 1 to 4), and the output signal cables to terminal strip X10, both found in the transmitter (see Fig. 14). The terminal strips can be accessed upon removal of a plastic cover (see Fig. 4).

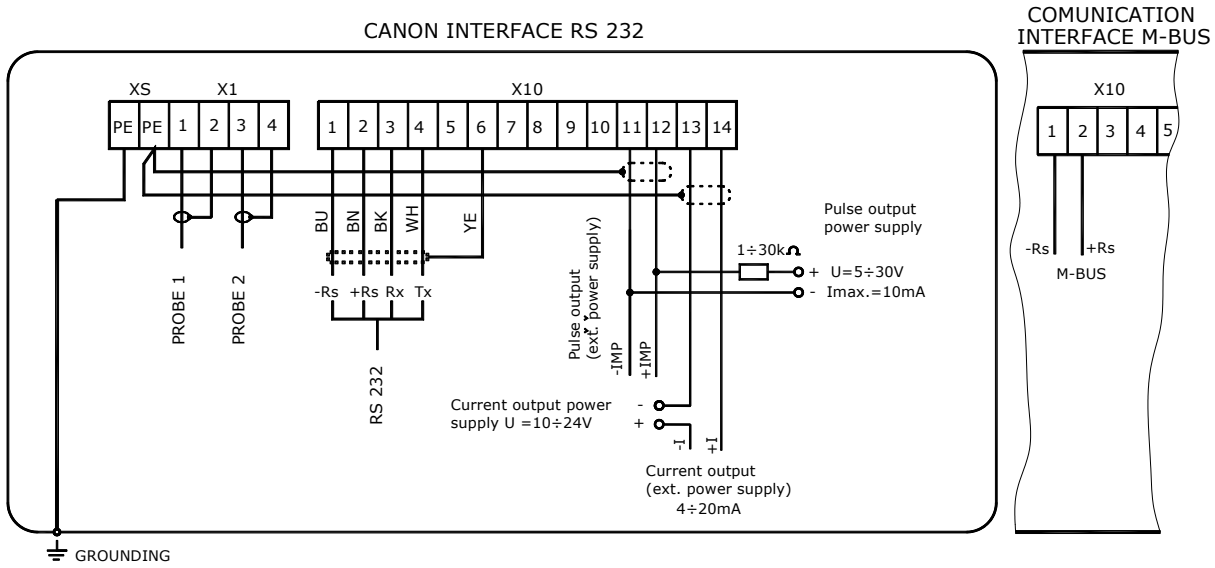


Fig. 14 - Electrical connections

5.2.4. Sealing of operational meters

The FL flow meters are provided with factory (assembly) seals (see Fig. 4). Should the factory seals be removed or damaged, the product warranty will be void.

6. COMMISSIONING

The flowmeter is supplied already calibrated and ready to start operation as soon as the sensor has been fitted into the piping, the piping has been flooded with a liquid and air bubbles removed. The readiness to start operation is signalled by disappearance of the error messages ▼ at the bottom of the display unit. At that stage, check the switching function between the flowrate and liquid volume display modes.

CAUTION!With regard to the powersaving of battery that supplies the transmitter, thebutton for switching the display mode from flowrate to liquid volume can be pressed no faster than once per second.**It is therefore recommended to pressthe button for at least 1 s and release it also for at least 1 s.**

7. OPERATION

7.1.Reading of displayed data

The 8-character display unit (see Fig. 15) displays the values of flow rate in m^3/hour (or in G/min) or the total liquid volume passed through the meter sensor since the last resetting in m^3 (or $Gx10^3$). The displayed value of instantaneous flow rate has certain time delay; it is calculated as the average value of the last six measurements taken every second. Such average values are displayed and brought to all meter outputs.
The average value is calculatedduring an increase as well as a decrease of flow rate. Should an error in the meter function be detected, the corresponding error message is displayed.
The position of the decimal pointon the display is determined based on the total liquid volume passed through the meter and the applicable multiple coefficients (see Table 4 and the following Figure).

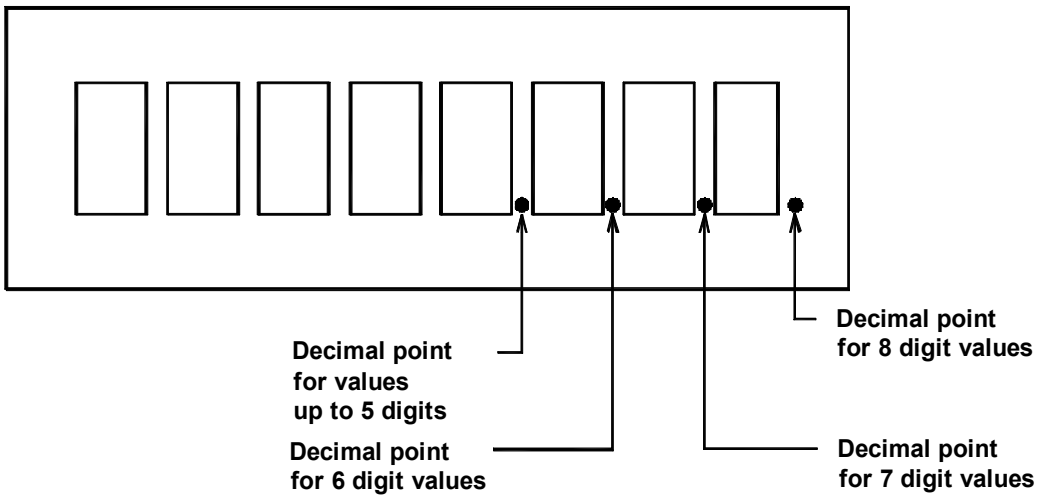


Fig. 15 - Decimal point positions on the display

CAUTION! The displayed values must be multiplied by the coefficients shown in Table 4. The applicable coefficient is displayed next to the value reading.

Piping size DN		200	250	300	350	400	450	500	600	700	800	1000	1200
Coefficient modifying the order of the displayed figure to actual measured value	m^3/h	x10	x10	x10	x10	x10	$x10^2$	$x10^2$	$x10^2$	$x10^2$	$x10^2$	$x10^2$	$x10^2$
	m^3												
	G/min	$x10^4$	$x10^4$	$x10^4$	$x10^4$	$x10^4$	$x10^5$	$x10^5$	$x10^5$	$x10^5$	$x10^5$	$x10^5$	$x10^5$
	G												

Table 4 - Coefficients, for particular piping sizes, modifying the display reading to the actual measured values

7.2. Electrical outputs

7.2.1.Pulse output

The pulse output is included in all meter versions. It consists of an opto coupler component connected to terminals 11 and 12 on terminal strip X10 (see Fig. 14). The maximum current loading of this output is 10mA, the pulse length is 40ms. On customer's request the pulse length can be set at 2ms provided the loading resistance of the communication line is less than 50 kΩ. If voltage pulses are required as the output signals, use an external DC voltage source 5 to 30V connected in series with a limiting resistor so that the maximum loading current would not exceed 10mA. The schematic connection of such external voltage source and limiting resistor is shown in Fig. 14 – Electrical connections.

The pulse length can be reset on site using the J5 jumper on terminal strip X10. To set the pulse length at 2ms, connect terminals 1 and 2, for the pulse length 40ms connect terminals 2 and 3 (see Fig. 16).

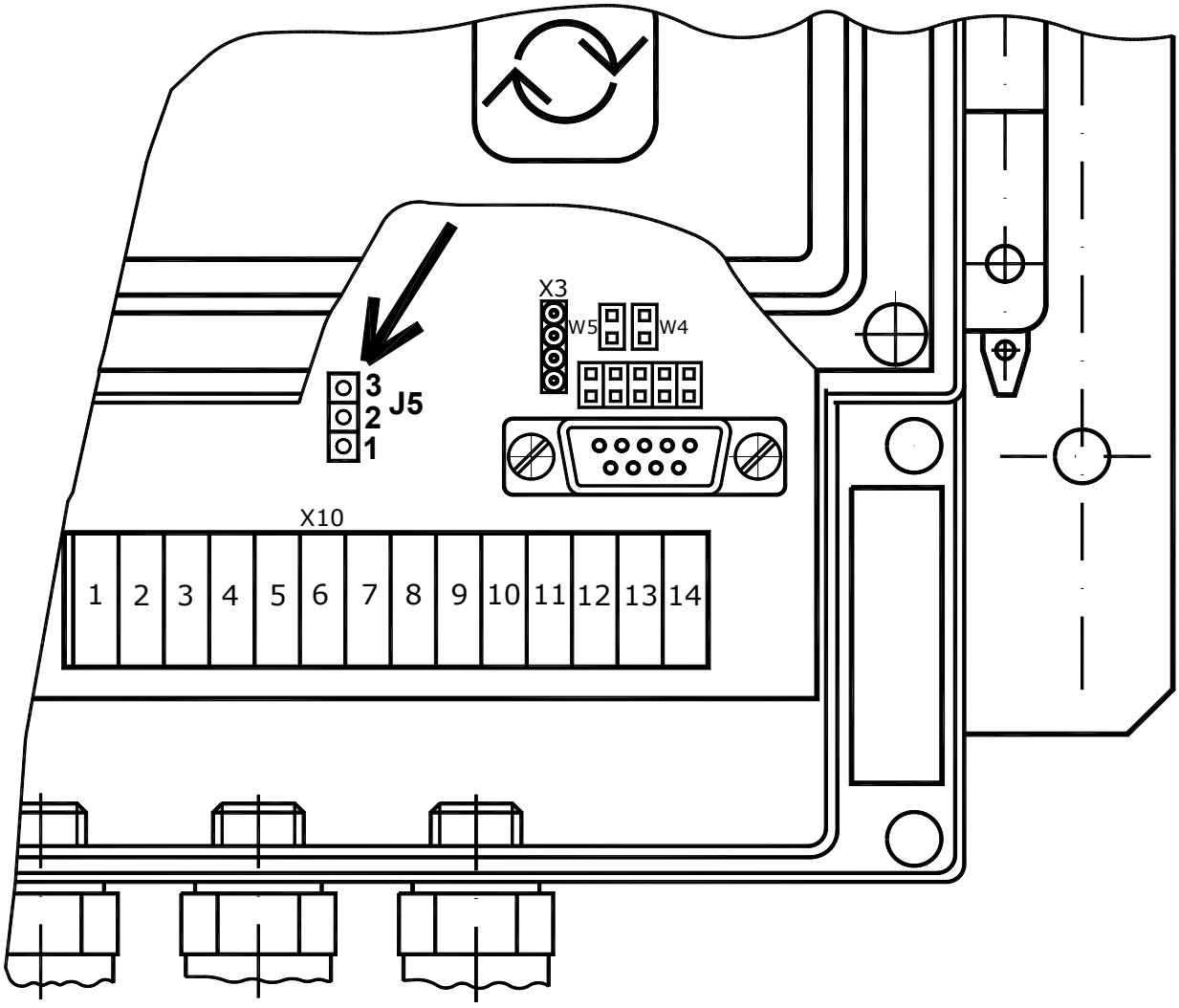


Fig. 16 - Change in the pulse length setting

7.2.2. Current output

The current output 4 to 20mA is connected to terminals 13 and 14 of the output terminal strip X10 (see Fig. 14). Upon reaching the upper limit of the output current (20mA, corresponding to Q_{max}) the output current stops growing and error message E4 will appear on the meter display (see Section 7.5). To use the current output, connect an external DC voltage source 10 to 25V as shown in Fig. 14 in Section 5.2.3. The maximum permitted current loop resistance (ohmic resistance of the line + input resistance of the co-operating device) shall be determined using the following formula:

$$R_s[\Omega] = \frac{U_{source}[V] - 7}{0{,}02}$$

7.3. Communication interface

7.3.1. Communication via optical interface

The optical interface facilitates reading of the real-time measured data (instantaneous flow rate and total liquid volume), reading of the stored data, setting of the data-archiving parameters and reading of error messages.The meter software makes possible storage of data on instantaneous flow rate and total liquid volume measured in specified time intervals, as well as of the maximum and minimum values of instantaneous flow rate over a specified period including the time when such extreme values occurred. Archived are also error messages with their time of occurrence. To take advantage of archiving features,the user has to have a program called ArchTerm and the optical probe with 1.5 mlong connecting cable with the RS-232 connector (see Fig. 17).
The optical probe shall be attached to the reading window on the front panel of transmitter (see Fig. 4) where the correct probe placement is ensured by two positioning pins. The probe is held in place by permanent magnets.

7.3.2. Communication via RS-232

TheRS-232 cable is connected to terminals 1 through to 4 on terminal strip X10 (see Fig. 14). The RS-232 line enables data reading and archiving, reading of error messages and setting of data archiving parameters in the same extent as described in Section 7.3.1. Thearchiving features require the ArchTerm program installed (see Fig. 18). The RS-232 line is compatible with the GSM module. However, the system configuration for the RS-232 line cannot be adopted to accommodate the M-Bus line (different hardware).

7.4. Communication modes

7.4.1. Optical probe + PC/notebook)

The optical probe cable has a RS-232 connector (see Fig. 17). Part of the standard supply package is the RS-232/USB converter.

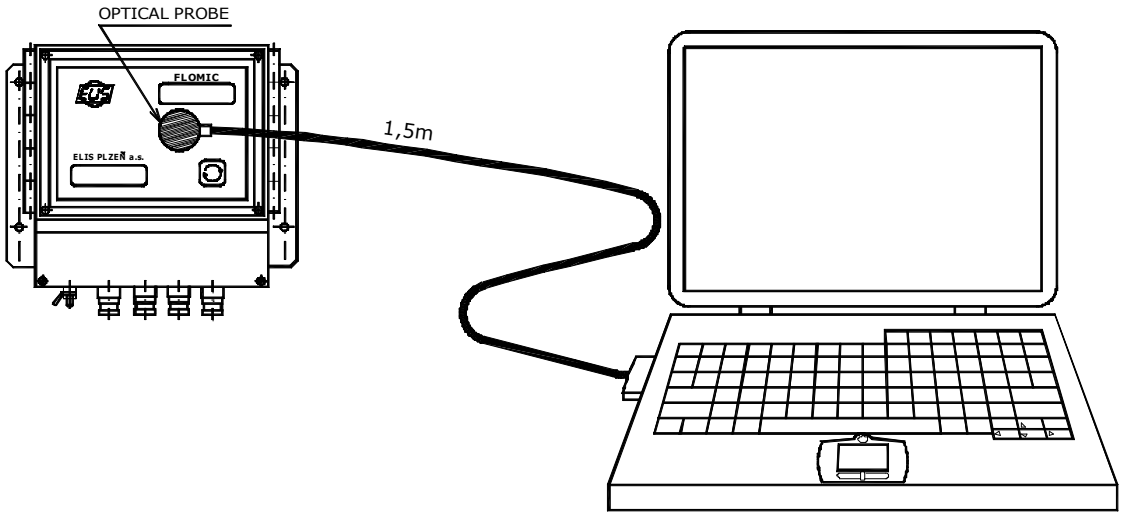


Fig. 17 - Communication via optical cable

7.4.2. RS-232 + PC/notebook

At the one end of the connecting box (see Fig. 18) sealed with a plastic compound is a fixed 5m long cable connected to terminals 1, 2, 3 and 4 on terminal strip X10 of transmitter (see Fig. 14). The fixed cable can be shortened as appropriate. The other end of the connecting box facilitates connection to the PC or notebook. On the PC side, the cable has a RS-232 connector (see Fig. 18).

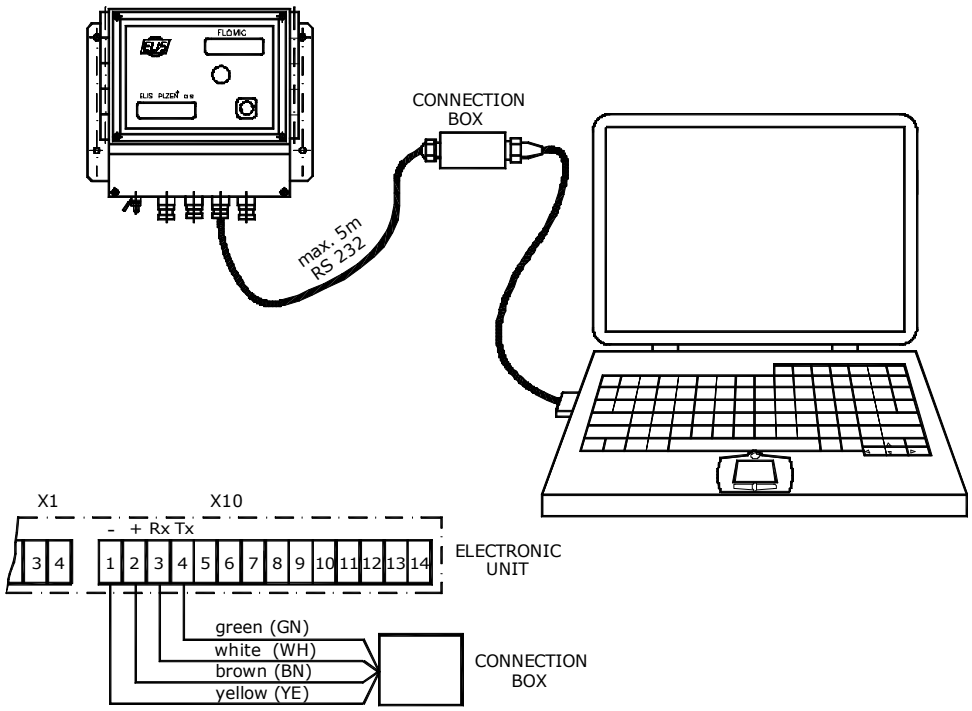


Fig. 18 - Communication via RS-232 line

7.4.3.RS-232 + GSM module

Thetransmitter can be connected to a GSM module via RS-232 line connected to terminals 1 through to 4 on terminal strip X10 of the transmitter (see Fig. 14).

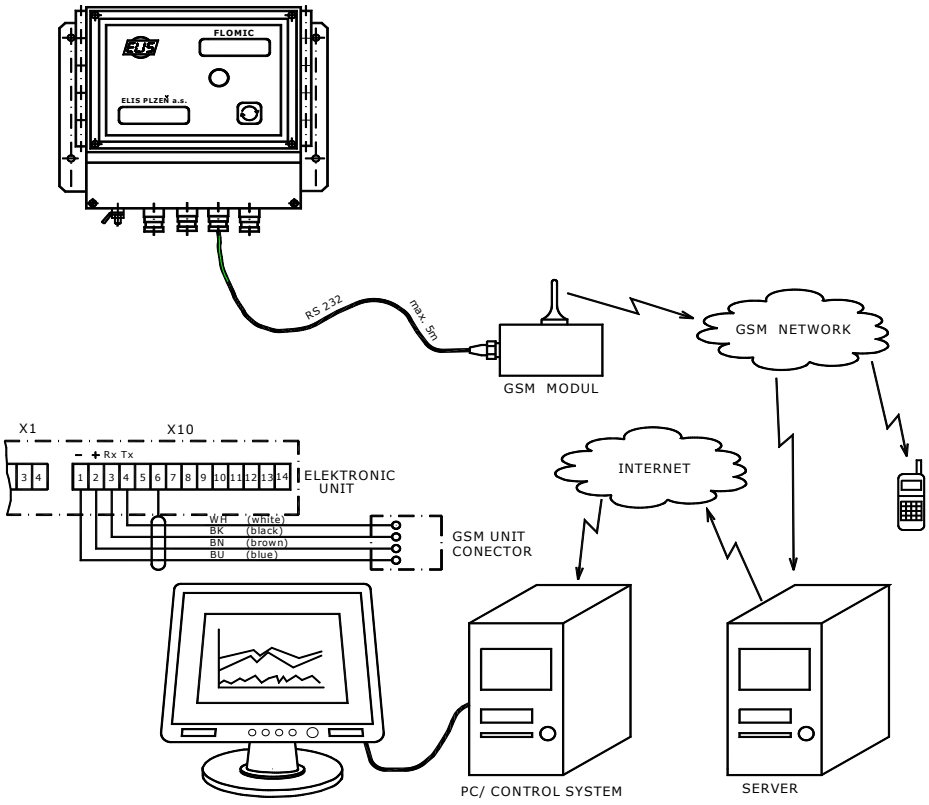


Fig. 19 - Flowmeter data communication via a GSM port

7.5. Error identification

Meter errors E1 through to E5 are indicated at the bottom of the display unit by the▼ symbol.

Types of error:
- E1 - The ultrasonic beamsare blocked, e.g. by airbubbles or mechanical particles
- E2 - Too big differencebetween the travel times of ultrasonic beams in the upstream and downstreamdirection, e.g. due to air bubbles caughtatone probe (may be a temporary occurrencecaused during piping filling with liquid, or byan excessive contamination)
- E3 - A/D converter error, e.g. due to strong electromagnetic interference
- E4 - Flow rate higher than Q_4
- E5 - Discharged battery

Should the display go completely blank, check the battery voltage – it should be higher than 3V. Replace defective or flat battery using the procedure described in section 7.6. Should battery replacement not help, send the meter to the manufacturer for repair.

7.6. Battery lifetime and replacement procedure

The transmitter is supplied with two battery units:
Battery B2 – Li battery LS 33600 STD SAFT 3.6V/ 16.5Ah (1cell)
Batteries B3 and B4 – alkali batteries MN16049V/ 550mAh (2 cells)

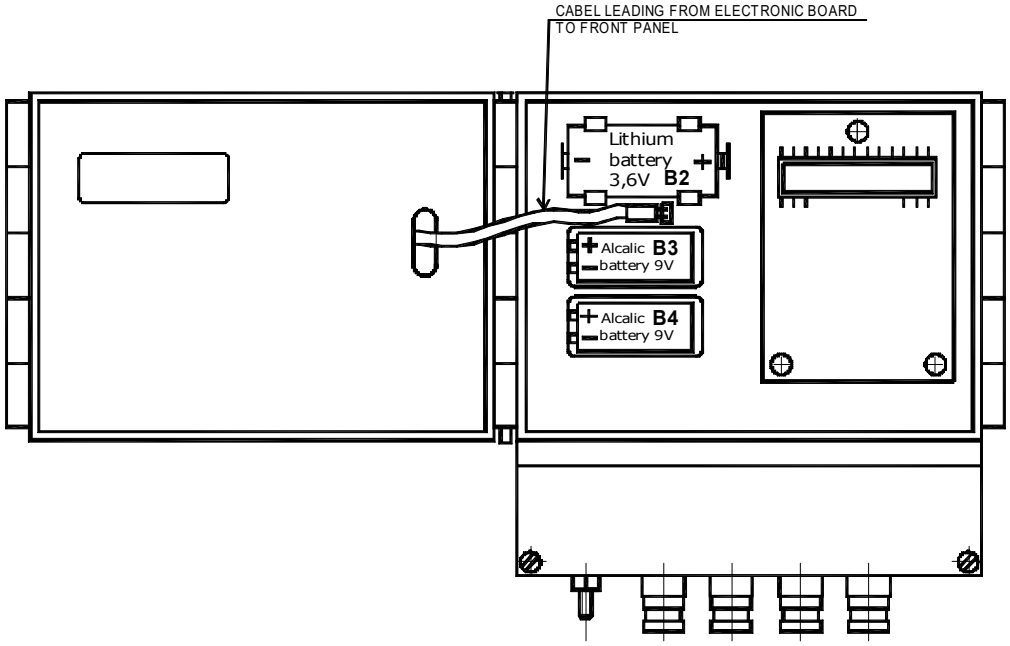


Fig. 20 - Battery replacement

The battery compartment is sealed; first with the manufacturer's seals, and after the first battery replacement by assembly seals. The seals are placed on the plastic housingoftransmitter (see Fig. 4). Battery handling and replacement shall be reserved to staff duly authorised to remove and replace meter seals. The batteries have guaranteed lifetime of 4 years. After their lifetime, all batteries should be replaced at the same time. During the replacement procedure the measurement will be discontinued but all data archived including the total liquid volume passed through the meter sensor will be retained in the meter memory unit.

To replace batteries, use the following procedure (see Fig. 20):
Open the transmitterhousing – pull slowly the pin out of the locking mechanism on the right-hand side of the housing and take off the front panel (see Fig. 4). If necessary, disconnect the flat cable between the PC board and the front panel. Batteries can be seen on the left. Remove battery B2 from its plastic holder. Insert a new battery in the holder so that the battery polarity is as shown on a holder label.
Warning: Incorrect battery polarity may cause damage to the transmitter circuits.

Remove batteries B3 and B4 from their plastic holders. Insert new batteries.

Check the correct placement of batteries in their respective holders and their polarity. The display unit should start showing the measured values and no errors should be indicated. Should error E5 be indicated, check again the correct fitting of all batteries and their voltage. Check the flatcable connection between the PC board and the front panel of the transmitter. The cable connector is on the PC board between battery B2 above and batteries B3 and B4 below. Press the button at the front panel. If the switching function works, replace the front panel and insert the locking pin. Make sure that the housing is properly closed as required by the IP65 specifications.

8. CALIBRATION

Upon delivery, the FLOMIC ultrasonic flowmeters are calibrated according to the manufacturer's test procedures. Calibration is performed using the "flying start" method, where the start and end of test period are defined by output pulses from the flowmeter. If requested, a more precise calibration can be performed considering the customer's specifications and requirements.
The standard calibration process uses pulse outputs. Calibration on the current output may produce additional measurement error of up to 1%. If the customer asks to have the meter calibrated on the current output, then the pulse output may produce additional measurement error of the same magnitude (up to 1%).
Meters already in operation can be re-calibrated by duly authorised organisationswhen using the correct calibration equipment.
Any functional tests, measurement accuracy verification and/or calibration of meters shall be performed using the methods recommended and approved by the meter manufacturer.

Warning:

The standard calibration is done on pulse output. Upon agreement with the manufacturer, water and flow meters can be calibrated nominal by means of current output.
Guaranteed parameters of measurement accuracy always apply only to the electrical output used for the flowmeter calibration. The current output, not used for calibration purposes, is recommended to be used only for measurements with the permissible accuracy that is 1 to 2 % lower than the accuracy achieved when calibrated with the pulse output.
Optionally it is possible under an agreement with the manufacturer to do the calibration of water and flow meters on current output only.

During a checking measurement carried out by the customer is necessary to use the same electrical output that was used for calibration by manufacturer.

9. WARRANTY AND POST-WARRANTY SERVICES

9.1.Warranty service

Warranty service includes product repairs performed free of charge within the agreed warranty period either by the manufacturer at its factory or by a duly authorised partner service centre.
Warranty repair is performed free of charge within the agreed warranty period where the product defect has been identified as caused by defective material, component part or manufacturing procedure.
Should a product be found irreparable due to the above causes, it shall be replaced free of charge.
Warranty service and repair shall be carried out either by the manufacturer (ELIS PLZEŇ a.s.) or a duly authorised service centre or product distributor (provided these have been duly trained to perform such activities and can prove their authorisation by a certificate in writing).

Warranty service/repair is not applicable to:

- products with broken factory seals;
- defects caused by an incorrect product assembly;
- defects caused by a non-standard product application or use;
- damage to the meter transmitter due to the wrong battery polarity;
- the cases of product theft;
- defects caused by a mechanical damage;
- product defects caused by a force majeure or elementary disaster.

Requirements for warranty service shall be communicated to the manufacturer **in writing** (by e-mail, fax or registered mail).
Should the manufacturer not accept the warranty claim, this fact shall be communicated to the customer**in writing** and the respective service/repair costs shall be invoiced to the customer.
In case of invoicing meters, each repair action shall be followed by a metrological verification of the parameters carried out by an authorised metrological centre.

9.2. Post-warranty services

Post-warranty service includes any and all product repairs where the subject defects originated after the agreed warranty period. Such repairs (whether performed at the manufacturer's premises or anywhere else as directed by the customer) shall be invoiced by the manufacturer to the customer.
In case of invoicing meters, each repair shall be followed by a metrological verification of the parameters carried out by an authorised metrological centre.
Requirements for post-warranty service shall be communicated to the manufacturer **in writing** (by e-mail, fax or registered mail).

Manufacturer's address:

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