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Ultrasonic Flow Meter

SONOELIS SE4011

MID Certification

TCM 142/16-5353



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1. APPLICATION

The **SONOELIS** ultrasonic flow meter of the type series **SE4011** (single beam) is intended for measurements of instantaneous flow rate and the total volume passed through fully-flooded piping of a large diameter. It is intended mainly for measurement of heat/cold energy with connection of a calorimetric counter.

The measurement method used is suitable for measurement of fluids permitting propagation of ultrasonic waves including electrically non-conductive fluids. To ensure high measurement precision, the meters are calibrated on a test stand.

2. MEASUREMENT PRINCIPLE

The meter uses the “transit-time” impulse method where the time needed for the ultrasonic signal to pass the distance between the transducers imbedded in the fluid piping is measured and evaluated. To eliminate any error due to asymmetric placement of the ultrasonic transducers, the ultrasonic beam is sent in turns in and against the fluid flow direction.

3. TECHNICAL DESCRIPTION

3.1 General information

The SONOELIS SE4011 ultrasonic flow meter is an electronic device used for the fluid flow measurements in a fully flooded piping. It consists of two parts: the flow sensor to be installed on the piping and associated electronic unit, usually attached to a vertical plate or wall and interconnected with the sensor by a cable.

The SE4011 flow meter can be used within piping systems of rated diameter between DN 200 and DN 1200 where the meter, which is intended for piping sizes DN 200 to DN 500, has a slant of the transducers under the angle $\alpha = 45^\circ$ and for piping sizes DN 600 to DN 1200 has a slant of the transducers under the angle $\alpha = 60^\circ$ (see the drawing below):

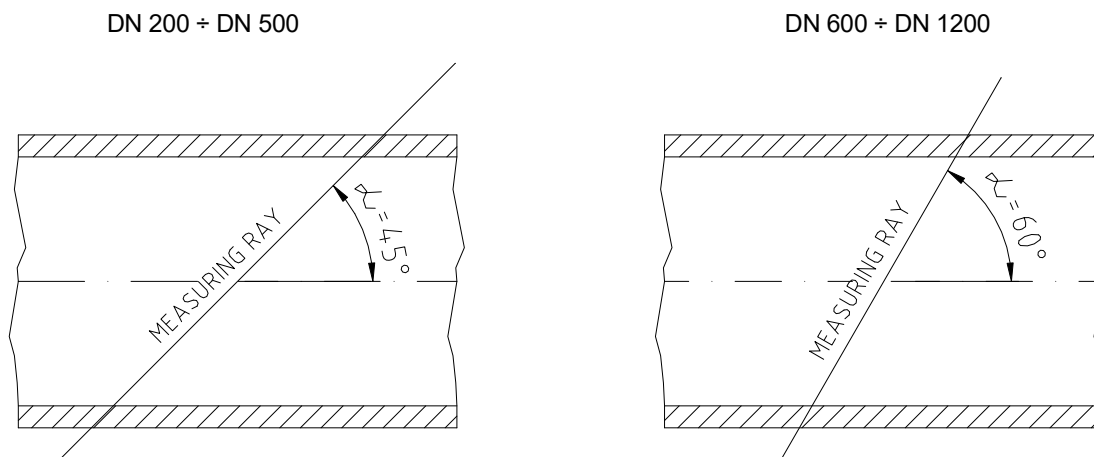


Fig.1 - The ultrasonic ray angle with respect to the piping axis

In its standard configuration, the flow meter includes pulse output, electrically insulated from the rest of the meter circuitry. In another optional configuration the meter can measure the fluid flow in both directions and indicate the actual fluid flow direction.

On request, the meter sensor (transducers) can be supplied in an IP 68 protection (2 m under water permanently).

3.2 Design specifications

3.2.1 Sensor dimensions

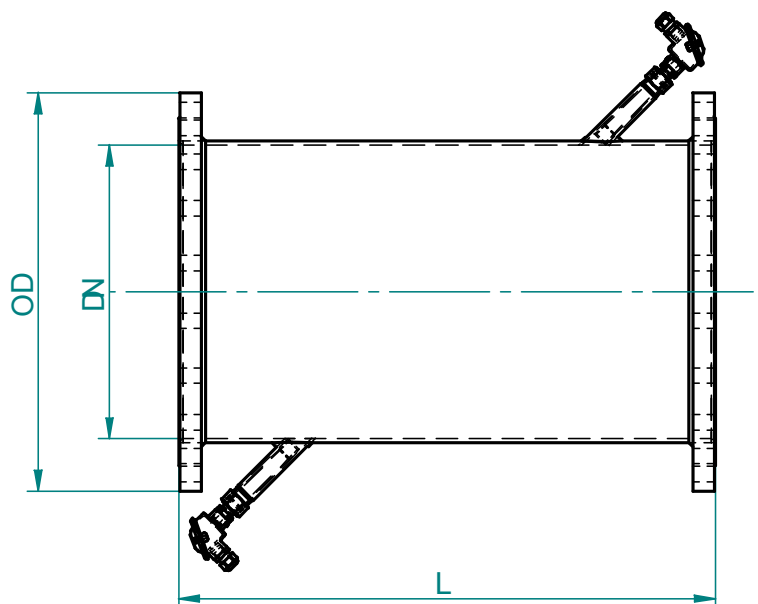


Fig.2 - Dimensional sketch of the meter sensor UC7.0

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 Dimension

3.2.2 Electronic unit box dimensions

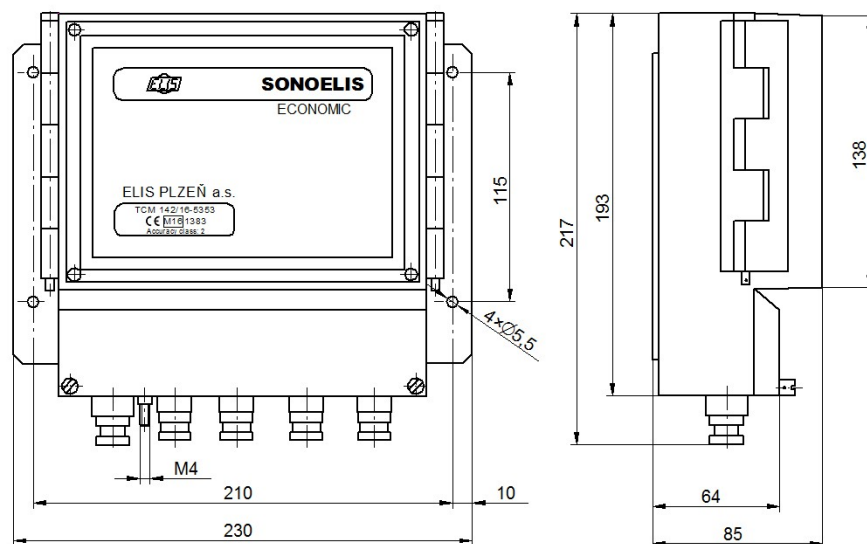


Fig. 3 - Dimensional sketch of the electronic unit box UP2.10

3.2.3 Ultrasonic sensor

The sensor body is a welded piece consisting of two end flanges to be connected to the piping, the main pipe section and two pipe branches holding the ultrasonic transducers (see Fig. 4). In the standard sensor version the body is designed for operating pressure PN 10, made of high-quality steel and the flanges are according to standard ČSN EN 1092-1; the whole assembly is coated with powder epoxy paint KOMAXIT E 2310 of light grey hue (RAL 7035).

On special request, the sensor body can be supplied:

- in a stainless-steel version
- with ANSI or JIS flanges
- in version for PN 16 (piping sizes up to DN 1200)
- in version for PN 25 (piping sizes up to DN200 to DN 800)

Sensors for application in drinking-water supply systems are coated with powder epoxy paint KOMAXIT E 2110 of blue hue (RAL 5017).

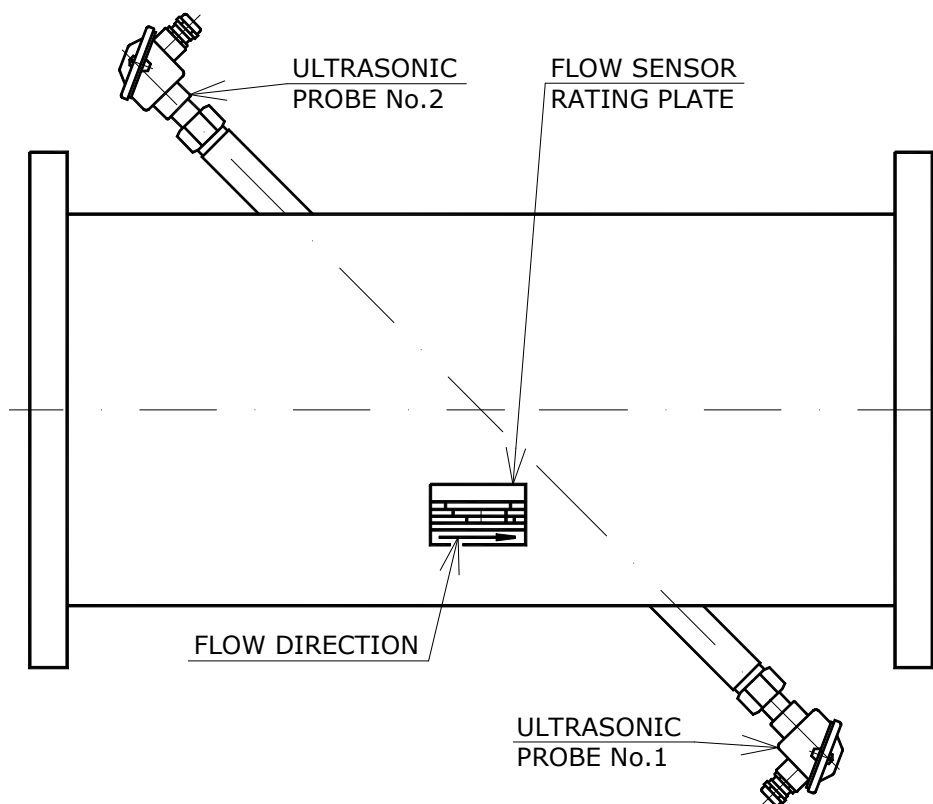


Fig. 4 - Ultrasonic sensor UP7.0 – description

3.2.4 Electronic unit

The flow-meter electronic unit (see Fig. 5) is embedded in a plastic box with a steel sheet attached at the back for vertical mounting. At the front panel on the box there are product name, manufacturer's name and logo. At the bottom of the box under a removable plastic cover are plastic grommets for cables of circular cross-section (one PG 9 and six or seven PG 7 grommets). The grommets are intended for tight fitting of cables of external diameter 6 to 8mm (PG 9) and 4 to 6mm (PG 7). At the bottom of the box there is also an earthing bolt. Both the front panel and the terminal board cover can be sealed.

IMPORTANT NOTICE: Prior to putting the meter in operation, check the proper tightening of all grommets with cables and blinding of the unused ones.

IMPORTANT NOTICE: The electronic unit shall not be exposed to direct sunlight.

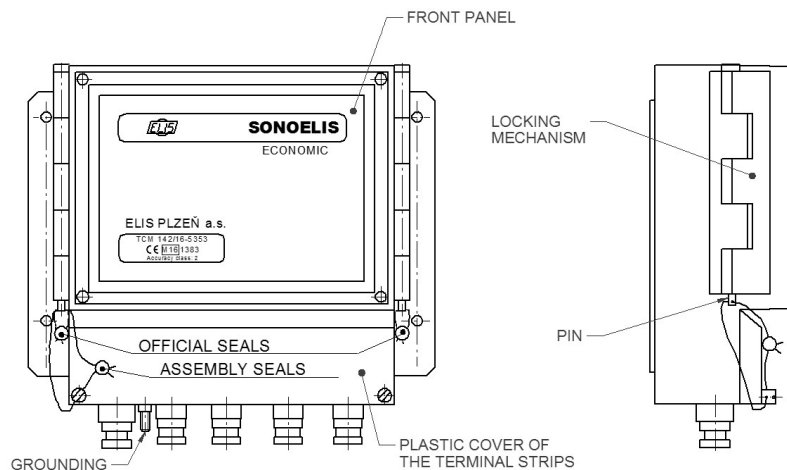


Fig. 5 - Electronic unit UP2.10 – description

3.2.5 Flow meter handling

The arrows indicate **the correct manner** of the meter sensor handling. Lift the sensor body holding it by the handling eyes screwed into both flanges (see Fig. 6).

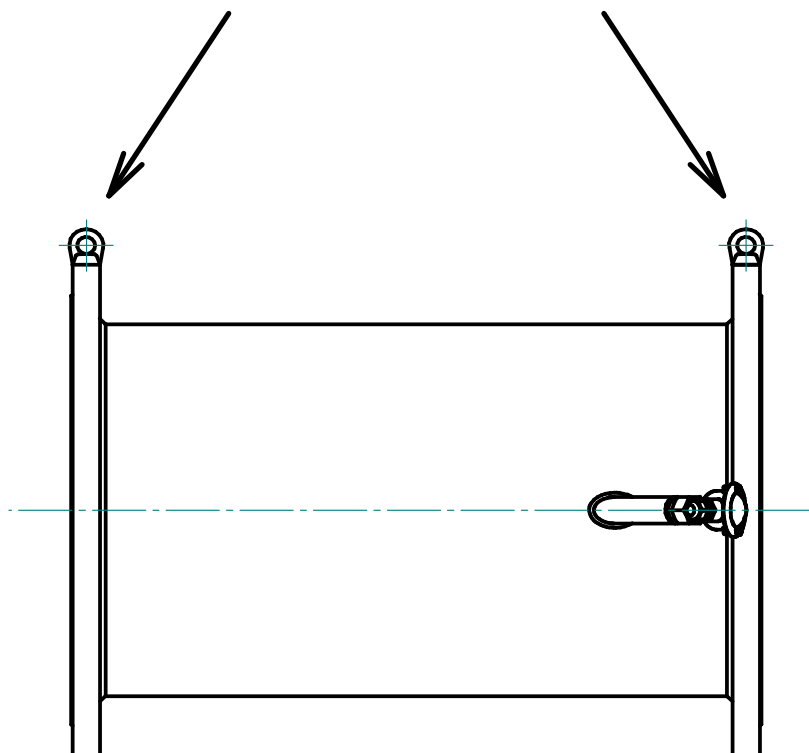


Fig. 6 - Correct grip on the meter sensor UC7.0

4. TECHNICAL SPECIFICATIONS

Using Table 2, select the correct sensor size with respect to the required measuring range.

DN	200	250	300	350	400	450	500	600	700	800	1000	1200
q_s [m ³ /h]	1000	1200	1500	1800	2000	2300	2500	3000	3600	4100	5100	6100
q_p [m ³ /h]	500	600	750	900	1000	1150	1250	1500	1800	2050	2550	3050
q_i [m ³ /h]	16	19,2	24	28,8	32	36,85	40	48	57,6	65,6	91,6	97,6
q_{NEC}	1,25	1,72	2,5	3,6	4,5	5,75	7,14	10	14,4	20,5	25,5	30,5

Table 2 - Ranges of measured values for given piping sizes

q_s is the overload (maximum) fluid flow rate,
 q_p is the steady-state (rated) fluid flow rate,
 q_i is the minimum flow rate for specified measurement accuracy, and
 q_{NEC} is the sensitivity threshold (flow rate) level of the sensor concerned.

The minimum flow rate at which the flow meter starts to measure and deliver measured data is set by the manufacturer at the value of q_{NEC} . On customer's request this threshold level can be reset within the range of $q_{NEC} = 0 \div 0,25q_s$.

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4.1 Technical parameters

Type of sensor	UC 7.0
Rated pressure	PN 10, on request PN 16 for piping sizes DN 200 ÷ DN 1200 or PN 25 for piping sizes DN 200 ÷ DN 800
Type of evaluating electronics	UP 2.10
Measurement class	2
Ratio q_p/q_i	50
Ratio q_s/q_p	2
Orientation limitation	Arbitrary, H (preferred)
Fluid temperature	0 ÷ +150°C
Ambient temperature	0 ÷ +50°C
Ambient relative humidity	not exceeding 80%
Storage temperature	-10 ÷ +70°C
Power source	90 ÷ 260 V, 50/60 Hz
Back-up power source	Li battery 3 V (lifetime 5 years)
Power requirement	6VA
Line fuse	T 250mA, 250V
Protection against electric shock according to standard ČSN 332000-4-41	automatic disconnection from power source in the TN – S network
Protect. class; electronic unit	IP 65
Environmental class	A
Electromagnetic class	E1, E2
Protect. class; sensor, transducers	IP 54 (on request IP 68)
Outputs (optoelectronically isolated)	pulse output, 0.1 ÷ 10,000 l/imp, impulse length 50ms, power supply (U_{max}/I_{max}) = max 30V DC/0,2 A
Optional equipment	Uni-directional with reverse flow direction
	extended range of fluid temperature (up to +180°C)
	sensor protection class IP 68
	drinking-water meter version
	sensor flanges according to alternative standards (ANSI, JIS)

Table 3 - SE4011 flow meter specifications

5. PROJECT DESIGN AND METER INSTALLATION

5.1 Project design of systems including ultrasonic flow meters

In designing any project it is necessary to observe specific rules concerning placement of the meter sensors in piping so that the measuring precision would not be adversely affected. In the case of the SONOELIS flow meters, the required lengths of straight piping sections before and after the meter sensor are 5DN and 3DN, respectively (see Fig. 7).

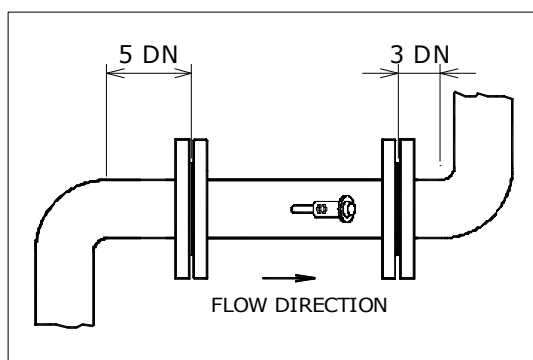


Fig. 7 - Minimum lengths of straight piping sections

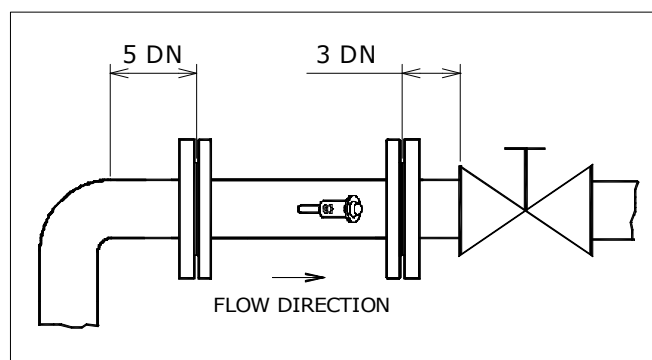


Fig. 8 - Minimum length of straight piping section at the input side of closing valve

If there is a pump near the meter sensor, it should be located at the distance of at least 20DN from the sensor output (see Fig. 9).

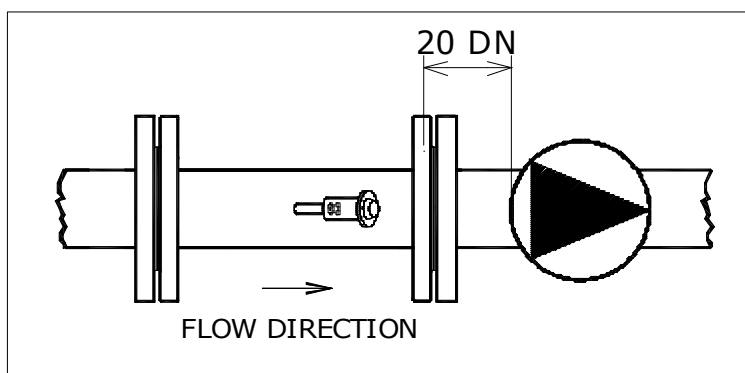


Fig. 9 - Minimum length of straight piping section before a pump

In cases where complete flooding of the piping cannot be guaranteed at all times, the meter sensor should be located so as to ensure meeting of this condition (see Fig. 10).

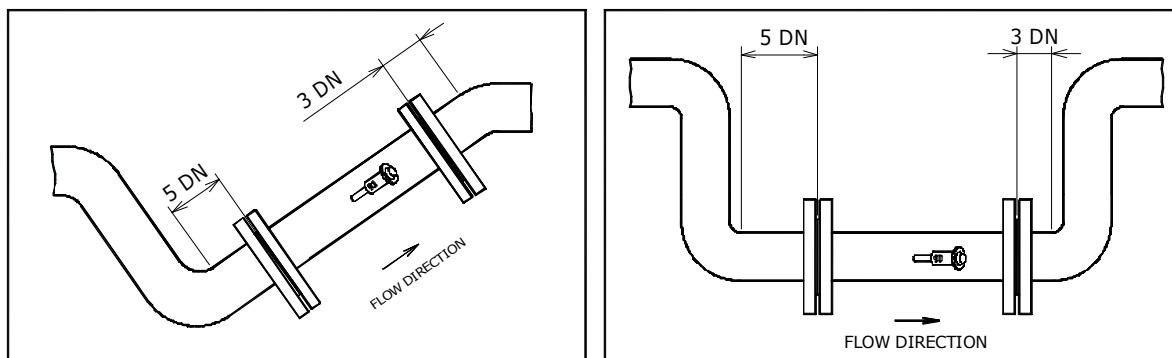


Fig. 10 - Sensor locations ensuring complete flooding at all times

If the sensor is to be fitted into a vertical piping section, the fluid flow direction in such section shall be upwards (see Fig. 11).

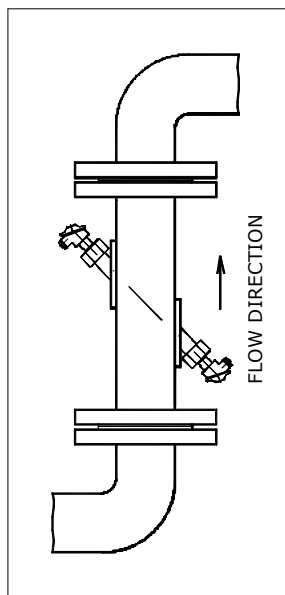


Fig. 11 - Sensor fitted into a vertical piping section

Errorless meter operation cannot be guaranteed unless the sensor is completely filled with the measured fluid at all times. Therefore the sensor should not be located at the highest piping sections or in vertical piping sections if the fluid flow direction is downwards, in particular in situations where there is a piping outlet into open reservoirs or tanks anywhere near (see Fig. 12).

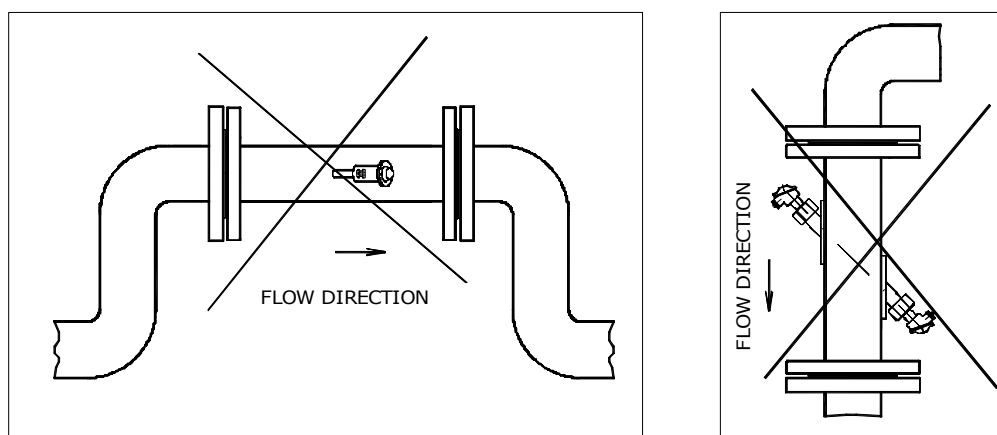


Fig. 12 - Examples of incorrect sensor placement

Another factor that may influence the meter function is the sensor angle position with respect to its longitudinal axis. Occasional air bubbles in the piping may get caught in the hollow welded-on transducer holders where they would disrupt the measuring process. To effectively prevent this from occurring, the sensor transducers should best be in the horizontal plane (see Fig. 13). If for any reason such position is not possible, the sensor body may be fitted in angular position where the transducer plane and horizontal plane form an angle of not more than 30°.

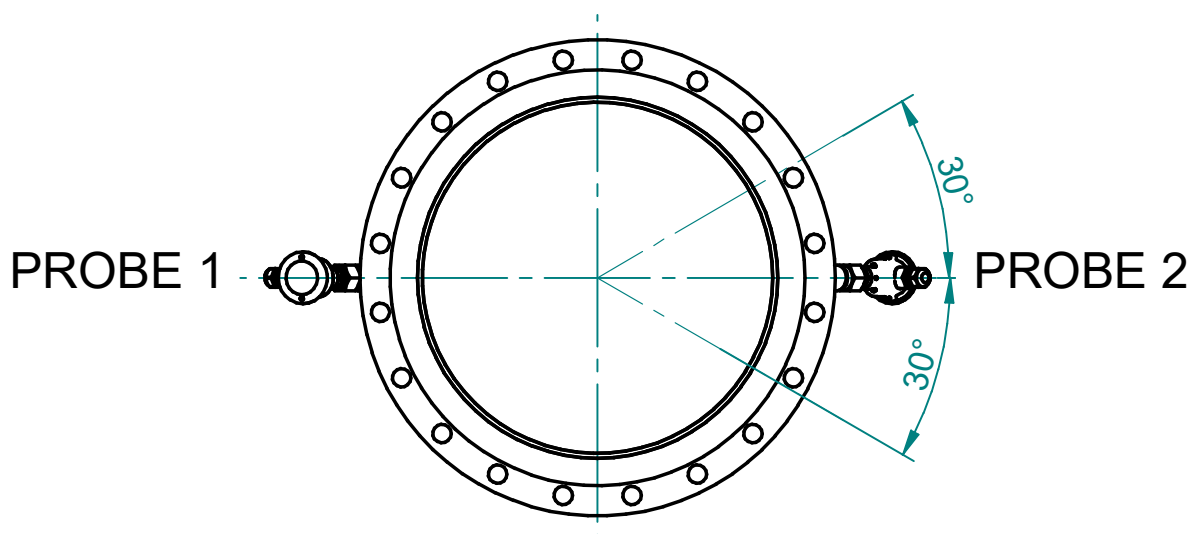


Fig. 13 - Permitted range of one-beam sensor rotation with respect to its longitudinal axis (SE4011)

5.2 Assembly

5.2.1 General directions

In meter assembly/fitting, strict observance of the guidelines and principles given in this manual is necessary. The meter installation shall be in compliance with the requirements of standard ČSN EN 14154-2, chapter 5.

5.2.2 Rules for the connection of the electronics UP 2.10 to the sensor UC7.0

5.2.2.1 The matching of the electronics UP 2.10 to the sensor UC7.0

Main series label with system series number is placed at the side of the evaluating electronics.

SYSTEM LABEL SE4011										SN/Year 35678/16										PRODUCER ELIS PLZEN a.s.											
CLASS EMC		E1, E2, M1			ENVIR. CLASS		A		ACCURACY CLASS		2		TRANSMITTER		UP2.10		SN/Year 12345/16		SENSOR		UC 7.0		SN/Year 123456/16								
TEMP. RANGE		0 ÷ 180			°C		TEMP. DIFFERENCE				°C		MAX. ADMISSIBLE PRESSURE PN				40				PROBE		US2.1 SN/Year 123456/16								
FLOW LIMITS		MIN. q_i							m^3/h		OUTPUT		FREQUENCY						PROBE		US2.1 SN/Year 123456/16										
		PERMAN. q_p							m^3/h				PULSE																		
		OVERLOAD q_s							m^3/h				CURRENT								SW VERSION: Program Es90460 D/01										

Important warning:

It is important to keep the correct serial numbers of all parts of one system.

Mark 1 - S/N of the system

Mark 2 - S/N of the evaluating electronics UP2.10

Mark 3 - S/N of the sensor UC7.0

5.2.2.2 Installation rules

To prevent undesirable electromagnetic interference, the power cables shall be laid at least 25cm away from the meter signal wires. Any signal wire connections shall be done by soldering and the soldered joints shall be protected against climatic and mechanical stresses by means of suitable installation boxes. All cables shall be lead outside thermal insulation layers on piping (if any). Both meter parts need be properly earthed. Use earthing conductor of cross-section of at least $4mm^2$ to connect the earthing bolts on the electronic unit box and the flow sensor body as shown in Fig. 15.

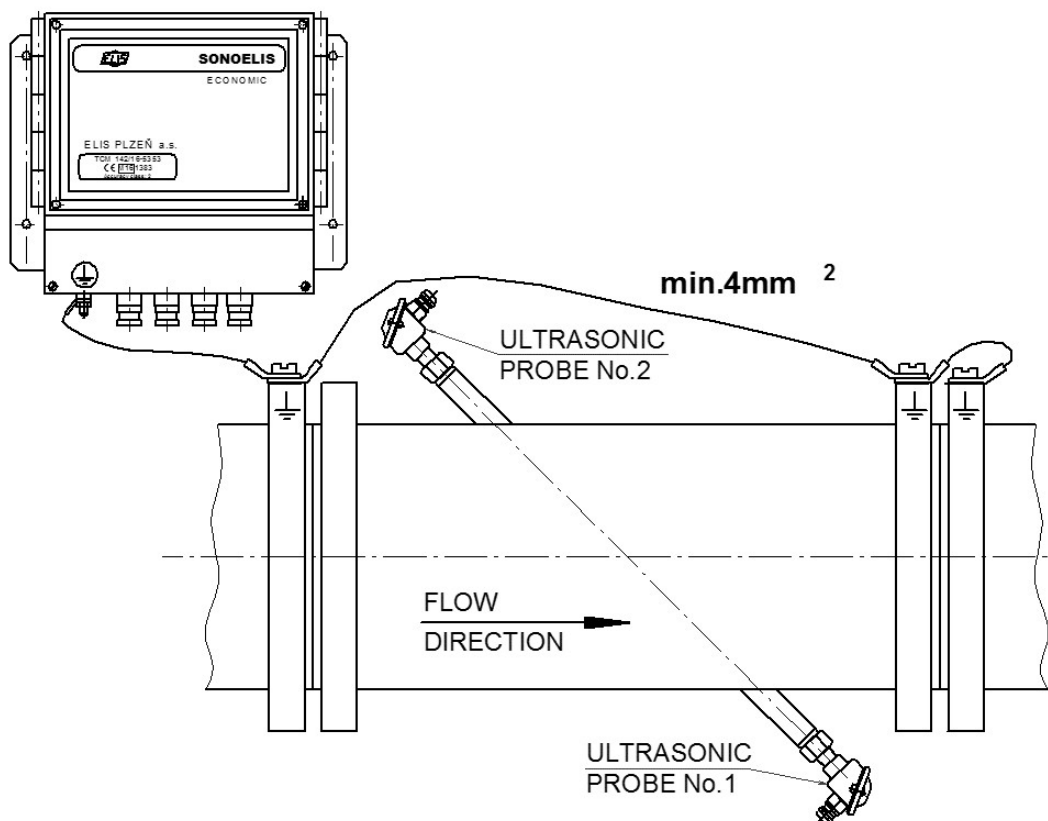


Fig. 15 - Earthing of the electronic unit UP2.10 and flow-meter sensor UC7.0

IMPORTANT NOTICE: In the cases of outdoor installation, the electronic unit shall be protected from direct sunlight by means of a suitable sun blind. On the other hand, it shall not be placed into an unventilated cabinet.

5.2.3 Mechanical connections

The ultrasonic sensor shall be fitted into the fluid piping by means of flanges ensuring exact match with the respective counter-flanges on the piping ends (see the specifications on the flange circumference). Unless required otherwise, the sensor shall be supplied with flanges according to standard EN 1092-1 (the alternative solutions are ANSI or JIS flanges).

5.2.4 Electrical connection

Remove the cover held in place by two M4 screws at the bottom part of the front panel on the electronic unit box to gain access to the terminals and connectors for external electrical connections to the unit as shown in the following figure:

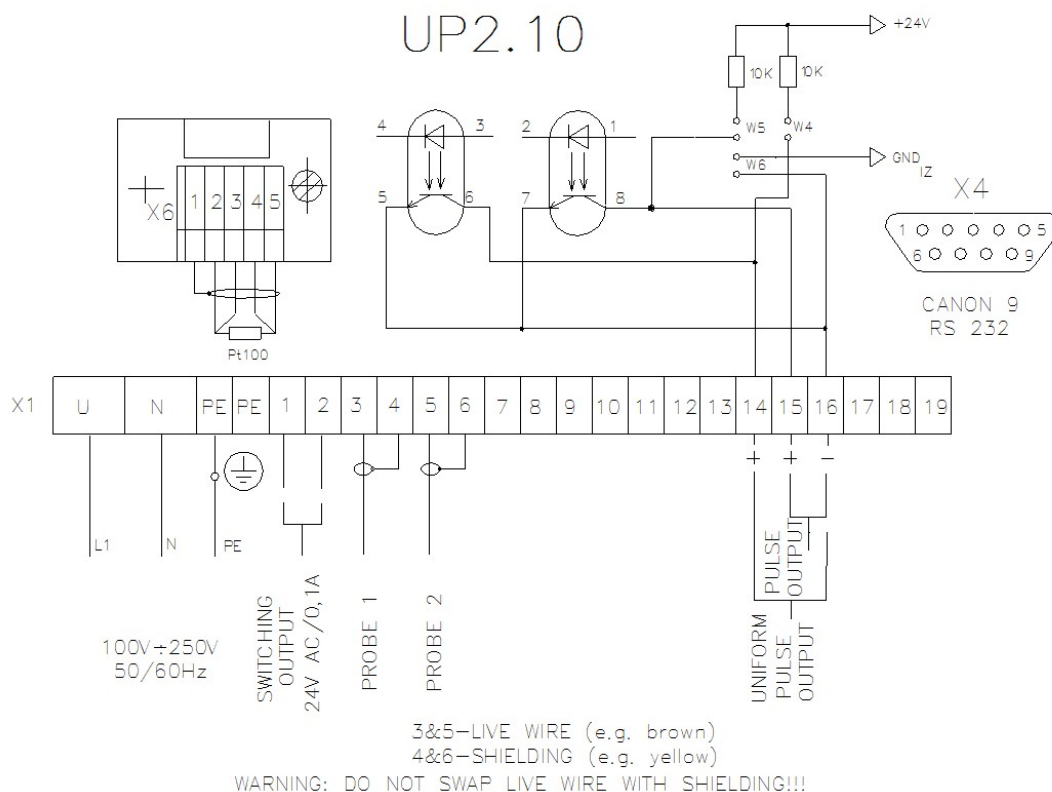


Fig. 16 - Schematic drawing of connections to the SE4011 ultrasonic flow meter

Note the connections of transducers 1 and 2, necessary for the correct meter operation. For transducer marking see Fig. 15.

Connected to terminal strip X1 are, apart from the ultrasonic transducers, the feeding power lines, signal output - the pulse,

By connection of the jumpers W4 and W6 the pulse output will be activated; the same action on jumpers W5 and W6 activates the pulse output (uniform pulses for the connection with calorimetric counter). If the pulse output is used in the passive mode of operation (jumpers W4 through to W6 disconnected), the optron current shall not exceed 20mA. To indicate the fluid flow direction, connect to terminals 1 and 2 on terminal strip X1 a relay coil in series with external alternating voltage source 24 V/100 mA.

Note:

- Connection transducers to terminals: terminals 3 and 5 = live wires (e.g. brown), terminals 4 and 6 = shielding (e.g. yellow)
- Terminals X1 14 and 15 are used for standard pulses
- Terminals X1 14 and 16 are used for uniform pulses (for connection with a calorimetric counter)
- Connector X4 is used for services purposes which can be done from a Producer's Authorized Service center only.

Switches S2 and S3 – location and functions

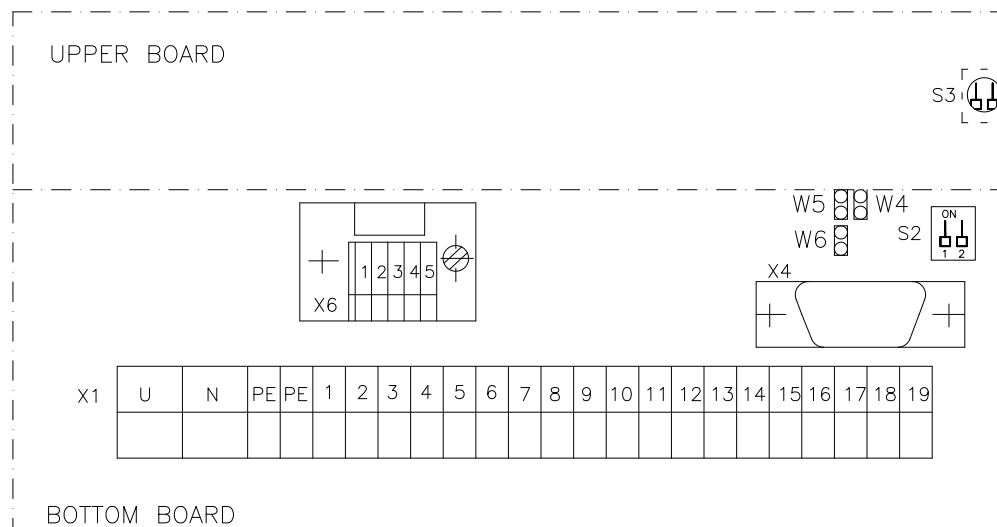


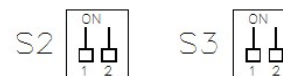
Fig. 16 - Location of switches S2 and S3

Flow meter mode of operation

Combination of switch positions

Measurement

Instantaneous flow rate



The signal output pulse is isolated and power from a separate isolated power source. The pulse output can be used in either passive or active operational modes. Pulse outputs are used in the passive mode (pins W4 through to W6 are disconnected), the optocoupler current shall not exceed 20 mA. If isolated voltage of pulse output is required, the W-pins shall be connected as shown in the table below:

Type of el. unit	UP 2.10
pulse output	W4 W5 W6

6. WARRANTY AND POST-WARRANTY SERVICES

6.1 Warranty services

The product warranty services are provided free of charge throughout the agreed warranty period either at the manufacturer's factory or at the premises of a duly licensed servicing organisation.

The warranty repair is understood to be repair a product defect caused by defective material, product component part or workmanship, performed free of charge within the agreed warranty period.

Should a product prove irreparable due to any of the above defects, it shall be replaced free of charge.

Warranty repair work can only be performed by the product manufacturer (ELIS PLZEŇ a. s.) or a duly licensed servicing organisation or an official product distributor (having a licence in writing to do so and duly trained to perform the product repair work by the manufacturer).

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Exempt from the product warranty are:

- products with damaged company;
- product defects due to incorrect assembly or fitting;
- product defects due to non-standard product use;
- products stolen or otherwise disposed of;
- product defects due to events of force majeure including natural disaster.

A requirement for warranty repair shall be communicated to the manufacturer by a notice in writing (by e-mail, fax or registered letter).

Should the manufacturer find the warranty claim unjustified, the claiming customer shall be informed accordingly by a notice in writing and the repair costs shall be invoiced to the same.

6.2 Post-warranty services

Post-warranty services include all repairs of product defects originating or identified after the end of the agreed warranty period. All such repairs, whether performed at the manufacturer's factory or elsewhere as directed by the customer shall be invoiced to the same.

A requirement for post-warranty repair shall be communicated to the manufacturer by a notice in writing (by e-mail, fax or registered letter).

7. TESTING

Every product is subject to individual checks on product completeness and quality in reference to the respective quality-assurance directive of the manufacturer. Then the product is tested using the approved test procedure. Finally, prior to shipment, the product is subject to at least 15-hour burn-in test at the factory test station.

8. VERIFICATION TEST

In the case of a commercial (invoicing) meter, the manufacturer shall provide for initial product testing at a duly authorized Metrological Centre. There the meter functions and accuracy are verified under three different operational conditions within the specified range of the fluid flow rate. Upon agreement with the customer and/or in the cases of higher accuracy requirements, the scope of tests can be extended up to nine verification tests under different operational conditions.

Important notice: The verification tests on the flow meters SE4011 are recommended to be executed on a running-start testing facility. The verified flow meter is sealed by metrology seals and a Certificate of compliance with EC-type examination can be issued.

9. PRODUCT MARKING

9.1 Main metrological label

- Manufacturer's mark or label
- The "CE" marking and metrological marking
- Number of EC-type examination certificate

9.2 Supplementary labels (shields) - (located on the electronic unit box):

- Year of Manufacture
- Measuring device type
- The serial number
- Accuracy class 2
- Then maximum admissible pressure PN
- Limits of flow parameters
- Limits of temperature range
- Place of the flow sensor installation (flow or return)
- Direction of flow arrow on the meter body
- Environmental and mechanical classes E1, M1
- SW identification

9.3 Sealing of technological meters

The SONOELIS flow meters are provided with clamping and stick-on factory and assembly seals – see Fig. 5.

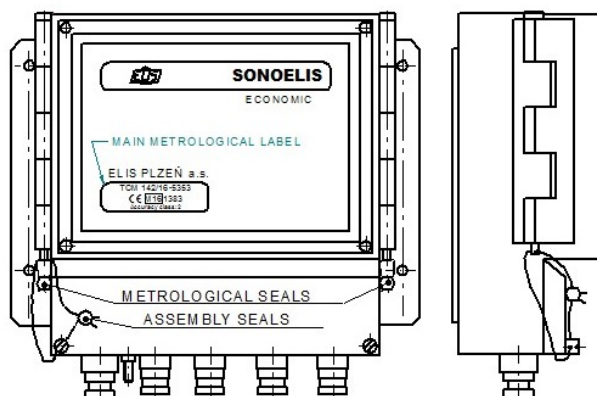


Fig: 17 Sealing of electronics UP2.10

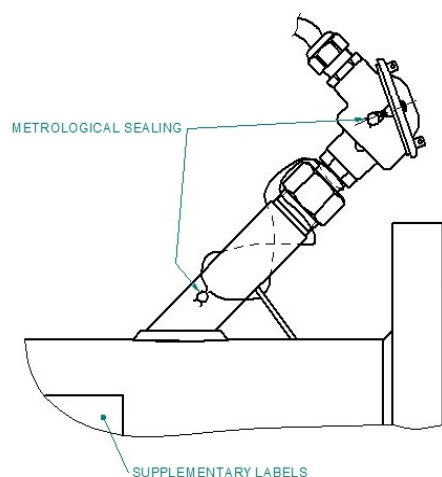


Fig: 18 Sealing of ultrasonic transducers US2.1

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Note:

If the factory seals be found removed or damaged, the product warranty shall not be valid!!!!

10. PACKAGING

Unless agreed otherwise with the customer, the product shall be packed in a suitable way to withstand the stresses associated with domestic and international transport.

The product packaging shall comply with the requirements of the internal directive of the company ELIS PLZEŇ a. s.

11. ORDERING

To order and specify the flowmeters, you can use the Order Number generated by the Specification Table after entering the required technical parameters.

This Specification Table for the required type of flow meter can be found on the website www.elis.cz/en in the "download" section.

If you need help, please contact us.

12. PRODUCT ACCEPTANCE

The product acceptance procedure consists of visual inspection and checking the completeness of the delivered product in reference to the delivery note.

The standard delivery package includes the complete SE4011 system, optional assembly and testing fixtures, this manual, a statement on the product compliance and delivery note.

13. WARRANTY CONDITIONS

Unless agreed otherwise between the manufacturer and customer, the product warranty term is 12 months counted from the date of sale. During the warranty period all product defects due to faulty materials or component parts shall be repaired or otherwise made good free of charge. The warranty term shall be extended by the time the defective product was under repair. This warranty shall not cover any product defects due to incorrect assembly, incorrect operation, wilful damage, product disposition or damage due to any force-majeure event.

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