Ultrasonic Flowmeters

SONOELIS SE4015
SONOELIS SE4025

CONTENT

1. APPLICATION

The **SONOELIS SE4015 and SE4025** ultrasonic flowmeters are intended for **a** measurement of instantaneous flow rate and the total volume passed through fully flooded pipes of large diameters. The meter configuration includes both hardware and software for a communication with master control systems.

The method used for measurement of flow rate allows the propagation of ultrasonic waves in both electrically conductive and non-conductive liquids. To ensure high measurement accuracy, the meters are calibrated on a calibration rig.

Flowmeters SONOELIS are used with one beam (SE4015) or double beam (SE4025) ultrasonic sensor.

2. MEASUREMENT PRINCIPLE

The flowmeter uses the transit time pulse method where the time needed for the ultrasonic signal to pass the distance between the probes in the piping is measured and evaluated. To eliminate any error due to asymmetric placement of the ultrasonic probes, the ultrasonic beam travels in both downstream and upstream direction of flow.

3. TECHNICAL DESCRIPTION

3.1 General information

The SONOELIS SE4015 and SE4025 ultrasonic flowmeters are electronic device used for the measurements of flow of liquid in a fully flooded piping. The flowmeter consists of two parts: the flow sensor to be installed in the piping and a remote transmitter, usually attached to a vertical plate or wall and interconnected with the sensor by a cable.
The SE4015 and SE4025 flowmeters can be used in the piping systems of nominal diameter between DN 200 and DN 1200 where the meters intended for piping sizes DN 200 to DN 500 have probes under the angle α = 45° and those for piping sizes DN 600 to DN 1200 have probes under the angle α = 60° (see the drawing below):

DN 200 ÷ DN 500 DN 600 ÷ DN 1200

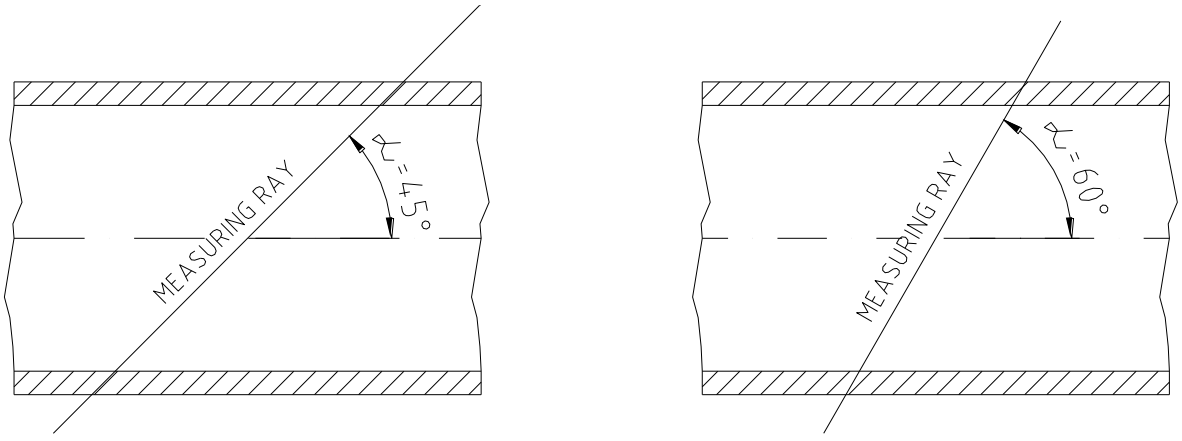


Fig.1 - The ultrasonic probe angle with respect to the piping axis

In its standard configuration, the flowmeter includes one frequency and one pulse output, electrically insulated from the rest of the meter circuitry. On customer's request the meter can be provided with various optional devices such as interface to the RS-485 communication line or isolated current output. Upon adding the Pt 100 thermometer to measure the liquid temperature, it is possible, based on the liquid volume, to calculate the mass of the liquid passed through the piping. In another optional configuration, the meter can measure the flow in both directions and indicate the actual flow direction.

On request, the meter sensor can be supplied with the IP 68 housing.

3.2 Design specifications

3.2.1 Sensor dimensions

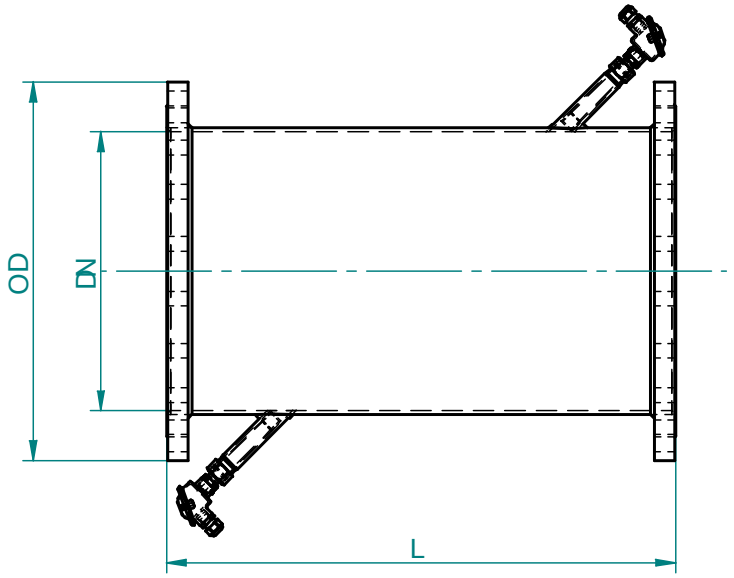


Fig.2 - Dimensional sketch of the meter sensor

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 Transmitter housing dimensions

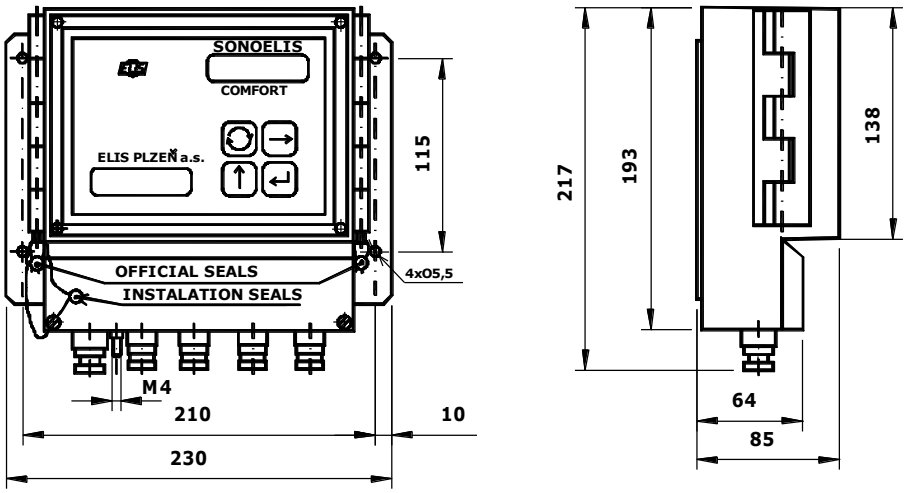


Fig. 3 - Dimensional drawing of transmitter housing

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 probes (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 EN 1092-1 standard; the sensor 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 or PN 25 (piping sizes up to DN 500)

Sensors for drinking water applications are coated with powder epoxy paint KOMAXIT E 2110 of blue hue (RAL 5017).

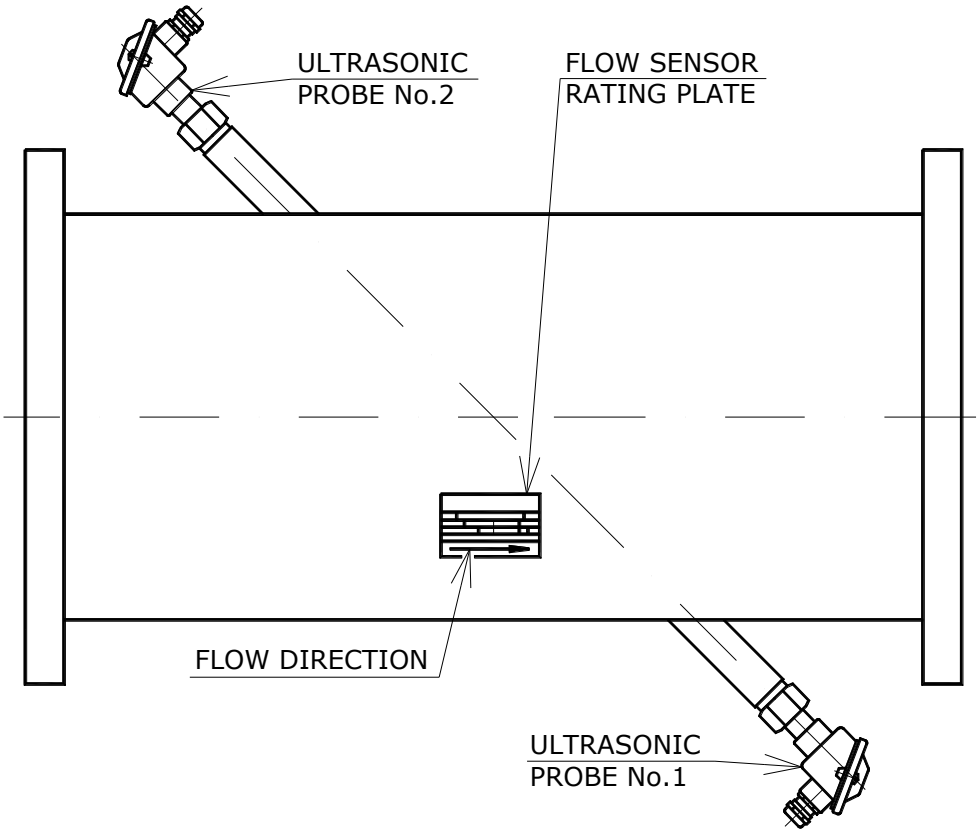


Fig. 4 - Ultrasonic sensor - description

3.2.4 Transmitter

The transmitter (see Fig. 5) has a plastic housing with a steel sheet attached at the back for vertical mounting. At the front panel, there are meter type designation and product name, production serial number, manufacturer's name and logo, two-line back-lighted display unit and a membrane keypad. At the bottom of housing under a removable plastic cover are plastic cable glands for cables of circular cross-section (one PG 9 and six or seven PG 7). The cable glands 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 housing there is also a grounding bolt. Both the front panel and the terminal box cover can be sealed. Instead of one PG 7 cable gland it is possible to fit a four-pole connector for the RS-485 communication line.

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

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

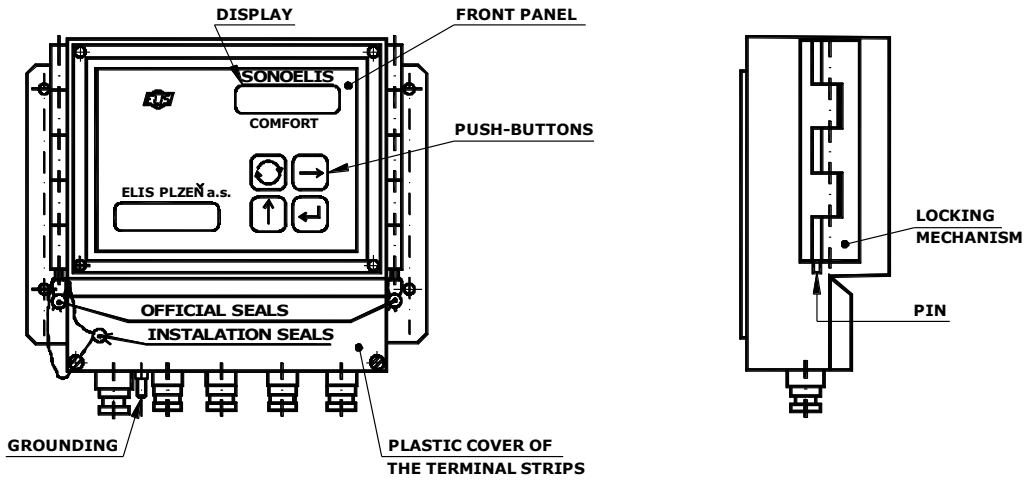


Fig. 5 - Transmitter – description

3.2.5 Flowmeter handling

The arrows indicate **the correct way** of manipulating with the meter sensor. Lift the sensor body holding it by the lifting eyes bolts screwed into both flanges (see Fig. 6).

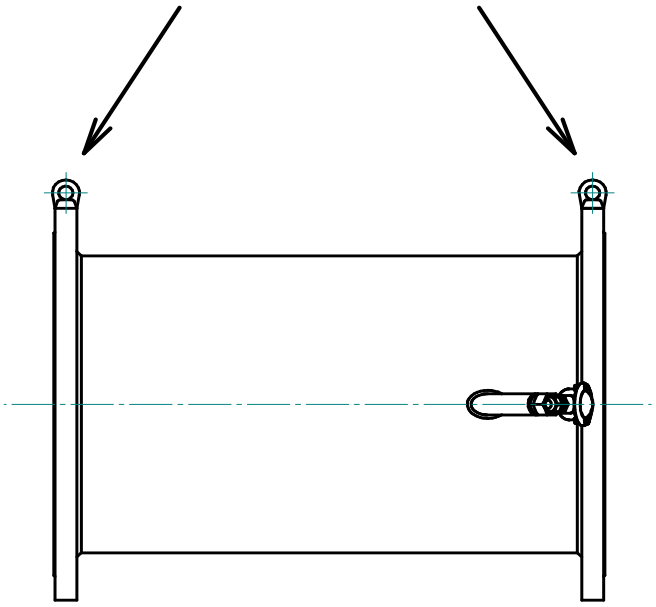


Fig. 6 - Correct grip on the meter sensor

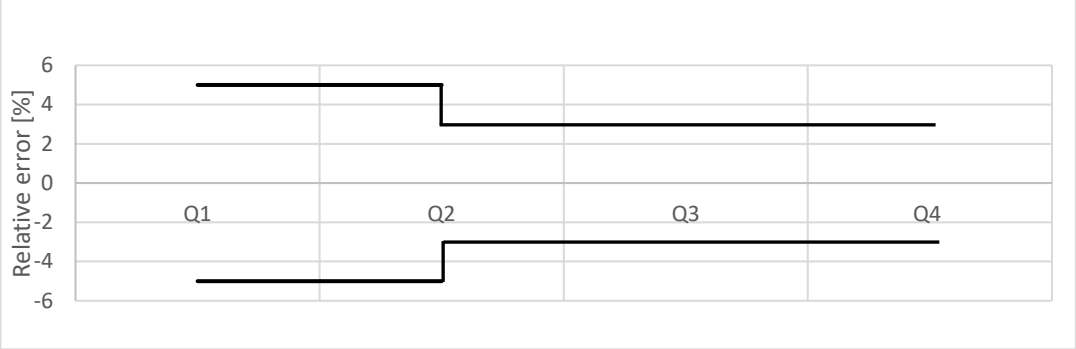
4. TECHNICAL SPECIFICATIONS

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

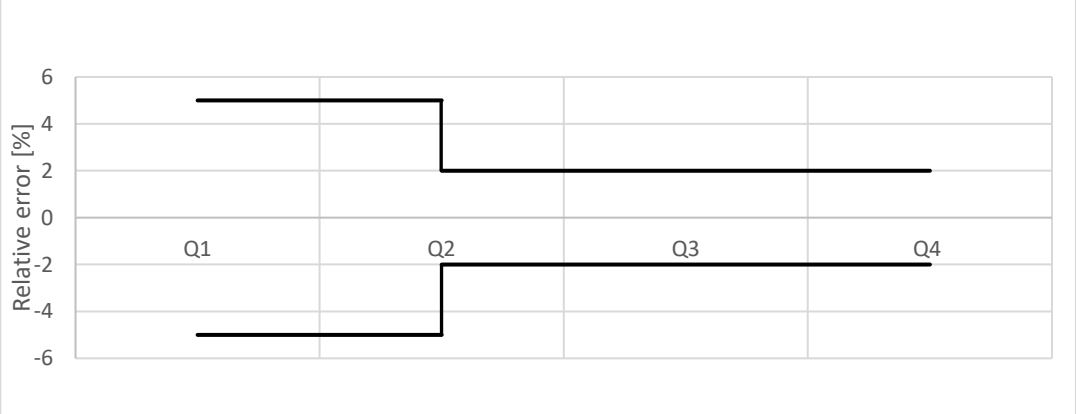
Basic paramters of the flow meters are designed according to standard EN ISO 4064-1 (OIML R 49). The ratio of following flow are shown below:

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

Flow meter precision rating in accordance with standard EN ISO 4064-1 (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



The figures in the table are based on standard EN ISO 4064-1 (OIML R 49).

The flow rate values Q_1, Q_2, Q_3 and Q_4 related to individual design versions and meter dimensions are shown below:

Nominal piping size DN		200	250	300	350	400	450	500	600	700	800	1000	1200
Q_4 Overload flow rate	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 flow rate	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 flow rate	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 flow rate	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} Threshold flow rate	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

Table 2 - Ranges of measured values for given 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 (Q_{NEC}) is the minimum flow rate at which the meter starts to indicate and process the flow parameters. At the manufacturer's plant, Q_{NEC} is set at a value corresponding to the flow velocity of 20 mm/s. On customer's request, the threshold flow rate can be set at any value within the range of Q_{NEC} = 0.1 to 25% Q_4.

The maximum permitted error in measurement of volume of liquid at flow rates between Q1 (including) and Q2 (excluding) is: 5% irrespective of the liquid temperature.

Piping inner diameter	DN 200 to DN 1200
Nominal pressure	PN 10, on request PN 16 or PN 25 for piping sizes DN 200 to DN 500
Accuracy class according to EN ISO 4064-1 (OIML R 49) and EN 1434 (OIML R 75)*) **)	2 (up to T30) 3 (over T50)
Liquid temperature	0 to +150 °C
Ambient temperature	0 to +50 °C
Ambient relative humidity	not exceeding 80%
Storage temperature	-10 to +70 °C
Visual output via	two-line 16-character alphanumeric LC display unit
Power supply	100 to 260 V, 50/60 Hz
Back-up power supply	Li battery 3 V (lifetime 5 years)
Power requirement	6 VA
Line fuse	T 250 mA, 250 V
Protection against electric shock according to standard ČSN 332000-4-41	automatic disconnection from power source in the TN – S network
Protect. class; transmitter	IP 65
Protection class; sensor probes	IP 54 (on request IP 68/2m)
Outputs (isolated by means	pulse output, 0.1 to 10,000 l/imp, pulse length 50ms
of optocouplers)	frequency output 0 to 1,000Hz (corresponding to flow rates 0 to Q_4)
	relay output 24VAC/ 0.1A
	RS 485 line
Optional accessories	insulated current output 0/4 ÷ 20mA (corresponding to flow rates 0 ÷ Q_4)
	mass flow rate information
	flow rate measurements in both directions, flow direction indication
	extended range of liquid temperature (up to +180°C)
	sensor protection class IP 68
	drinking water meter version
	sensor's flanges according to alternative standards (ANSI, JIS, ….)

Table 3 - SE4015 / SE4025 flowmeter specifications

*) 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 (SE4015) ± 0,5 % for flow rate Q > Q_2 (see Tab. 2) and temperature up to 50 °C (SE4025)

**) The flow meter for heat meters of type SONOELIS SE4011 with MID certification has the own manual Es90630K, where the accuracy acc to standard EN1434 (OIML R 75) is presented.

5. PROJECT DESIGN AND METER INSTALLATION

5.1 Project design of systems with ultrasonic flowmeters

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

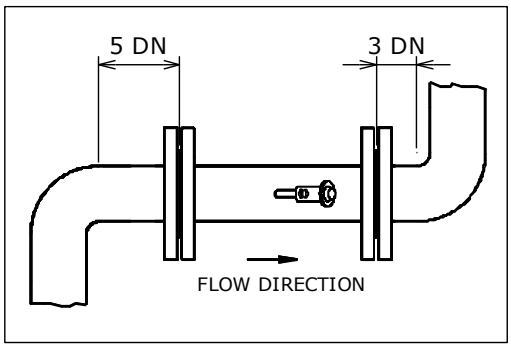


Fig. 7 - Minimum lengths of straight piping

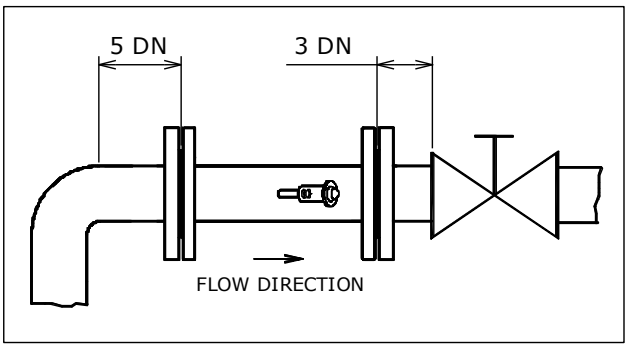


Fig. 8 - Minimum length of straight piping section at the inlet side of closing valve

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

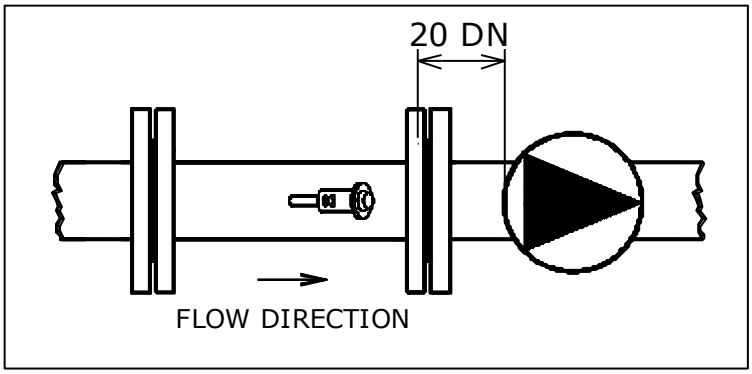


Fig. 9 - Minimum length of straight piping section before a pump

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

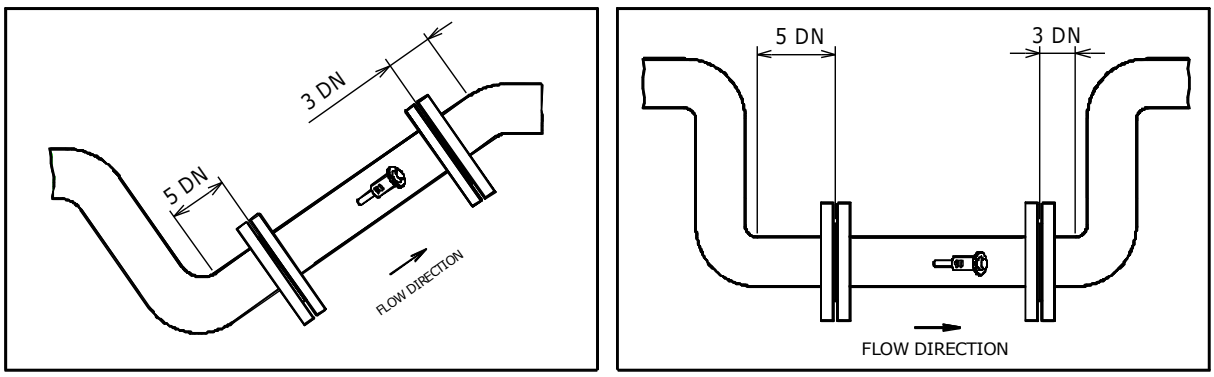


Fig. 10 - Sensor locations ensuring complete flooding at all times

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

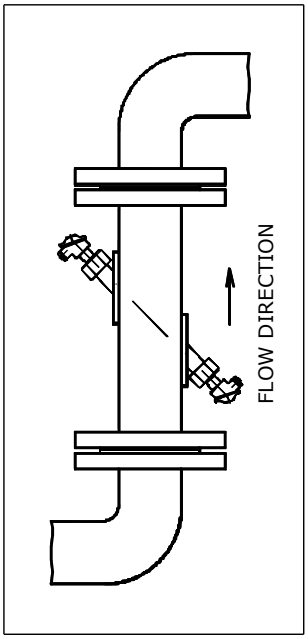


Fig. 11 - Sensor fitted into a vertical piping section

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

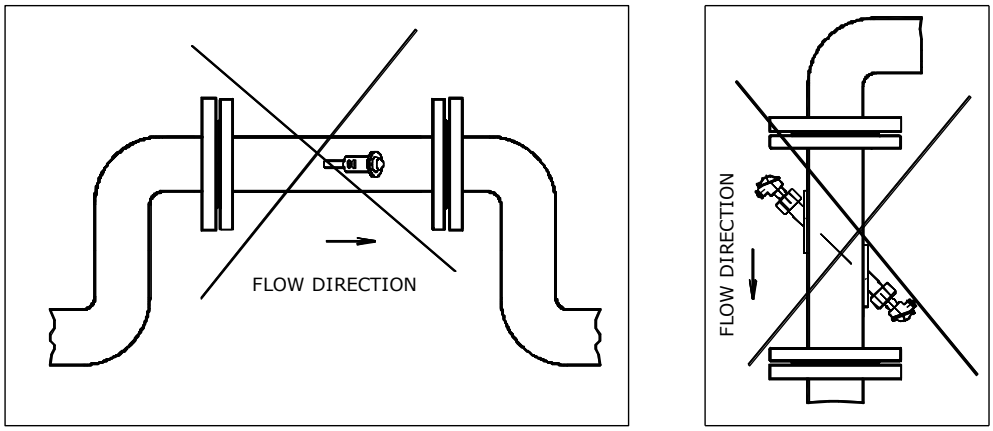


Fig. 12 - Examples of incorrect sensor placement

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 of welded probe holders where they would disrupt the measuring process. To effectively prevent this from occurring, the sensor probes should best be in the horizontal position (see Fig. 13a). If for any reason such position is not possible, the sensor body may be fitted in angular position where the probe plane and horizontal plane form an angle not exceeding 30°
The probes positions of dual beam sensors (SE4025) and vertical position form an angle of 45° (see Fig. 13b)

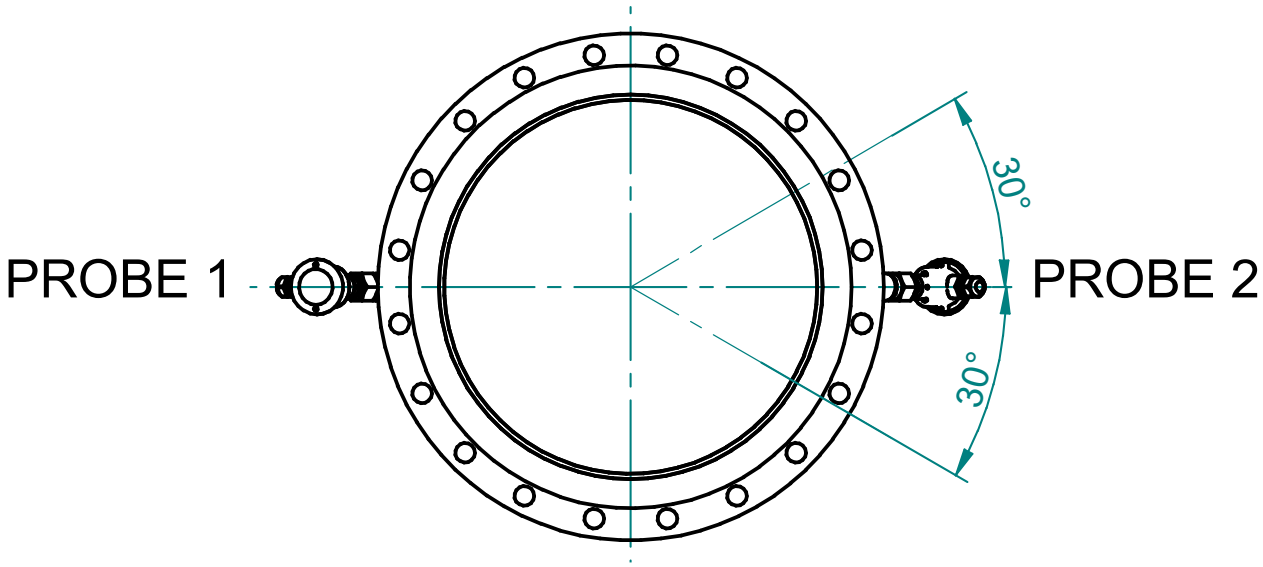


Fig. 13a - Permitted range of single beam sensor rotation with respect to its longitudinal axis (SE4015)

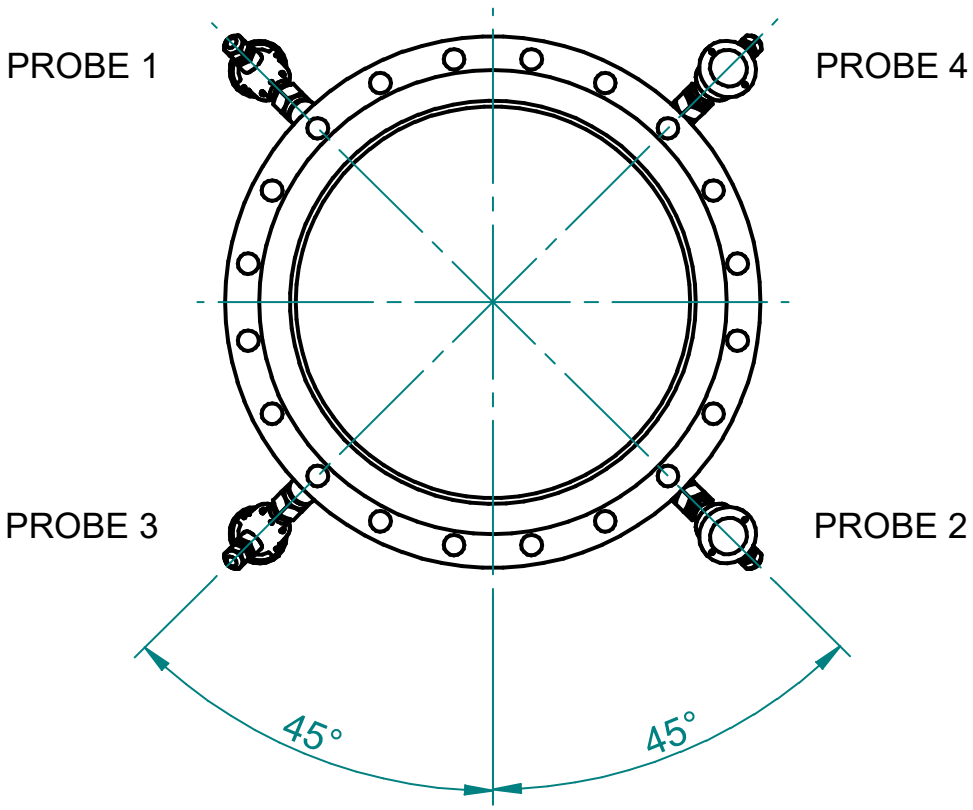


Fig. 13b - Angle between probes position and vertical position of dual beam sensor (SE4025)

5.2 Assembly

5.2.1 General directions

During meter assembly and installation, strict observance of the guidelines and principles given in this manual is necessary.
The meter installation shall follow the requirements of standard EN ISO 4064-5.

The inner diameter of adjoining piping must not be smaller than the inner diameter of sensor and shall not be bigger than the inner diameter of sensor by more than 1 %.

To prevent undesirable electromagnetic interference, the power cables shall be laid at least 25 cm away from the meter signal wires. Any signal wire connections shall be carried out by soldering and the soldered joints shall be protected against climatic and mechanical stresses by means of suitable installation boxes. All cables shall be laid outside thermal insulation layers on piping (if any). Connections to the Pt 100 thermometer, current output and RS-485 communication interface shall be done by shielded wires. The shielding shall be grounded at only one end (connected to the respective terminal on the X1 terminal strip in the meter transmitter). Shielded conductors are also recommended to be used at the frequency and pulse outputs. The shielding shall be grounded at one end only, in this case on the side of a master control system.
Both meter parts need to be properly earthed. Use grounding conductor of cross-section of at least 4mm^2 to connect the grounding bolts on the transmitter housing and the flow sensor body as shown in Fig. 14.

Note:

When using the RS-485 communication line, it is needed to follow these instructions:

1) Frequency of device calls is max. once per ten seconds
2) Call repeating by an unsuccessful call is possible after five seconds (in case the device didn´t respond)
3) It can be requested only one service by call proceeding

The test device is running during the communication. The test is indicated a with short-term display blinking. It does not mean a fault of device in any case.

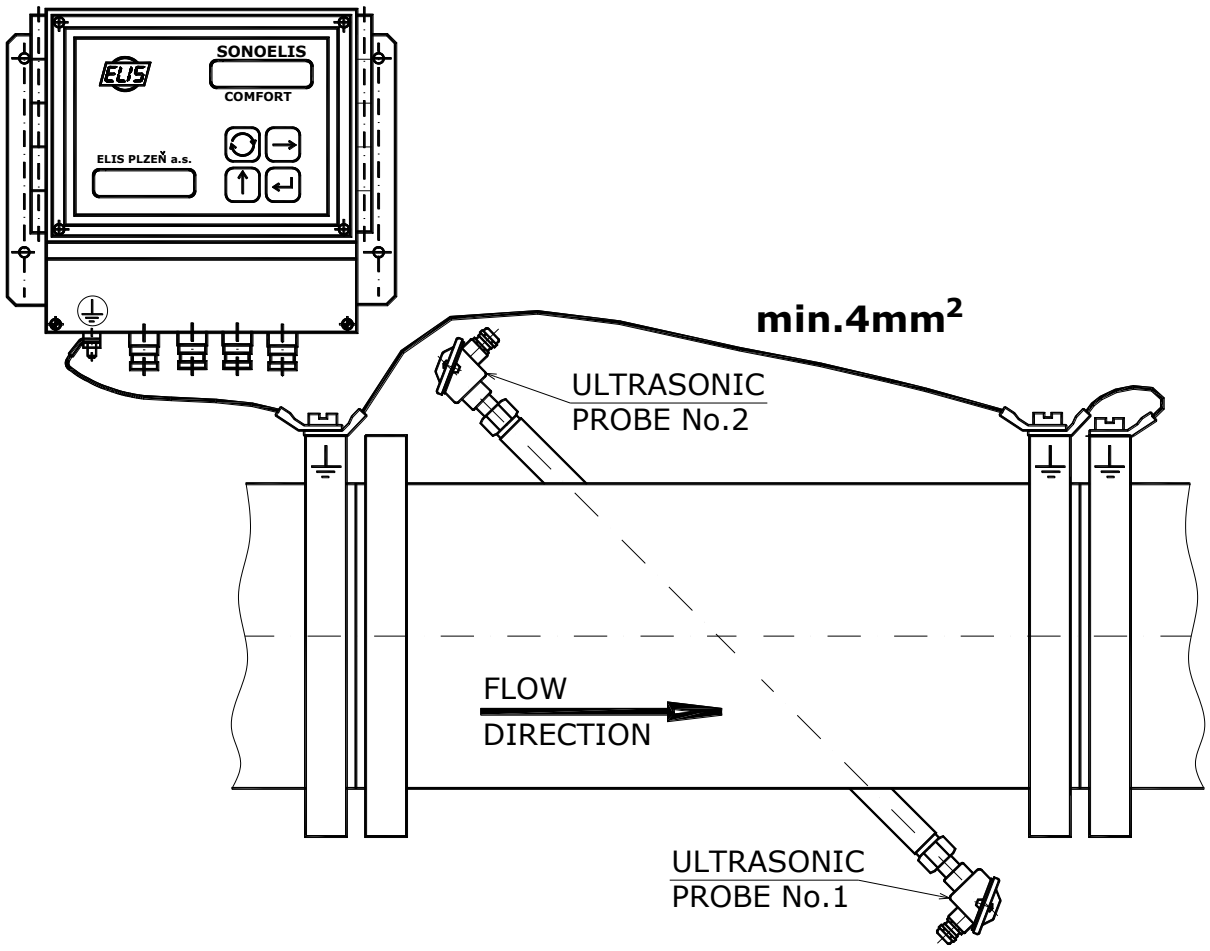


Fig. 14 - Grounding of transmitter and sensor

IMPORTANT NOTICE: If installed outdoors, the transmitter shall by protected against a direct sunlight by means of a suitable sun shield. On the other hand, it shall not place into an unventilated cabinet.

5.2.2 Mechanical connections

The ultrasonic sensor shall be fitted into the 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).

5.2.3 Electrical connections

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

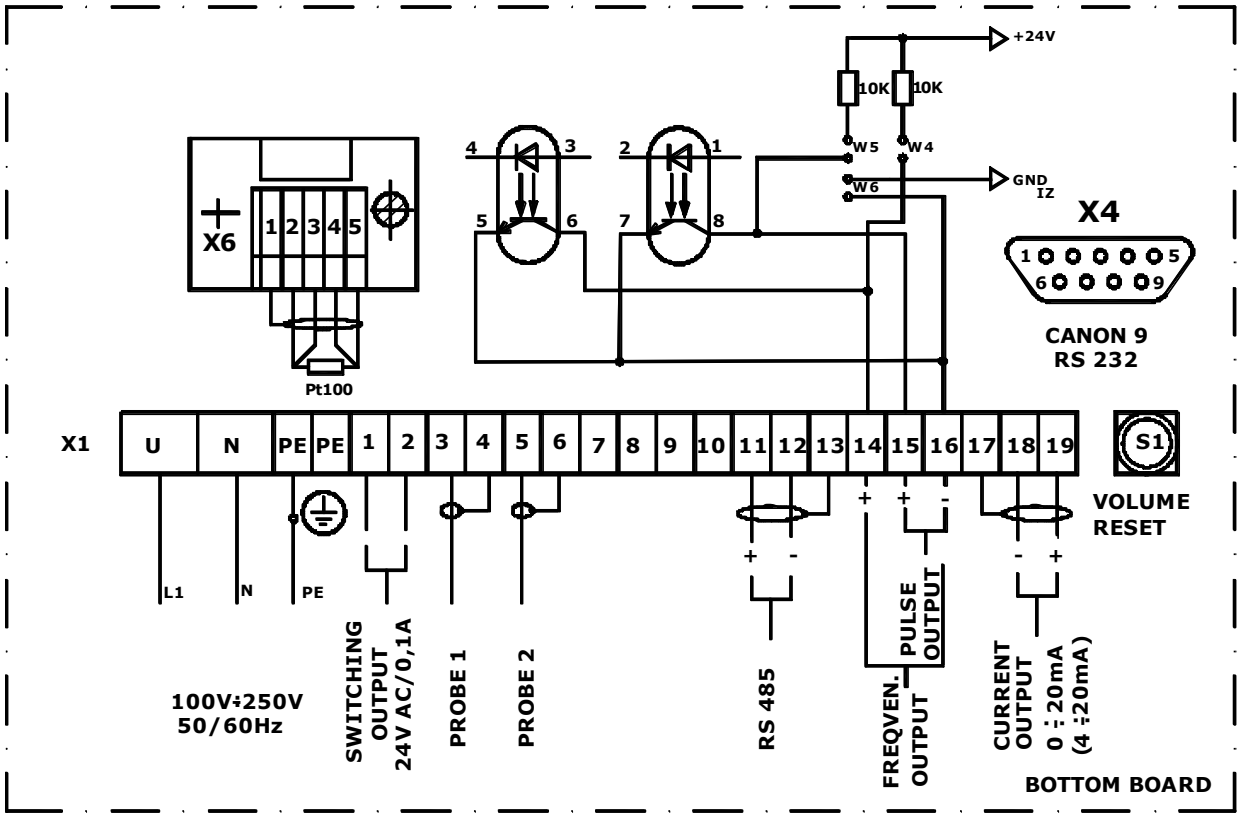


Fig. 15a - Schematic drawing of connections of SE4015 ultrasonic flowmeter

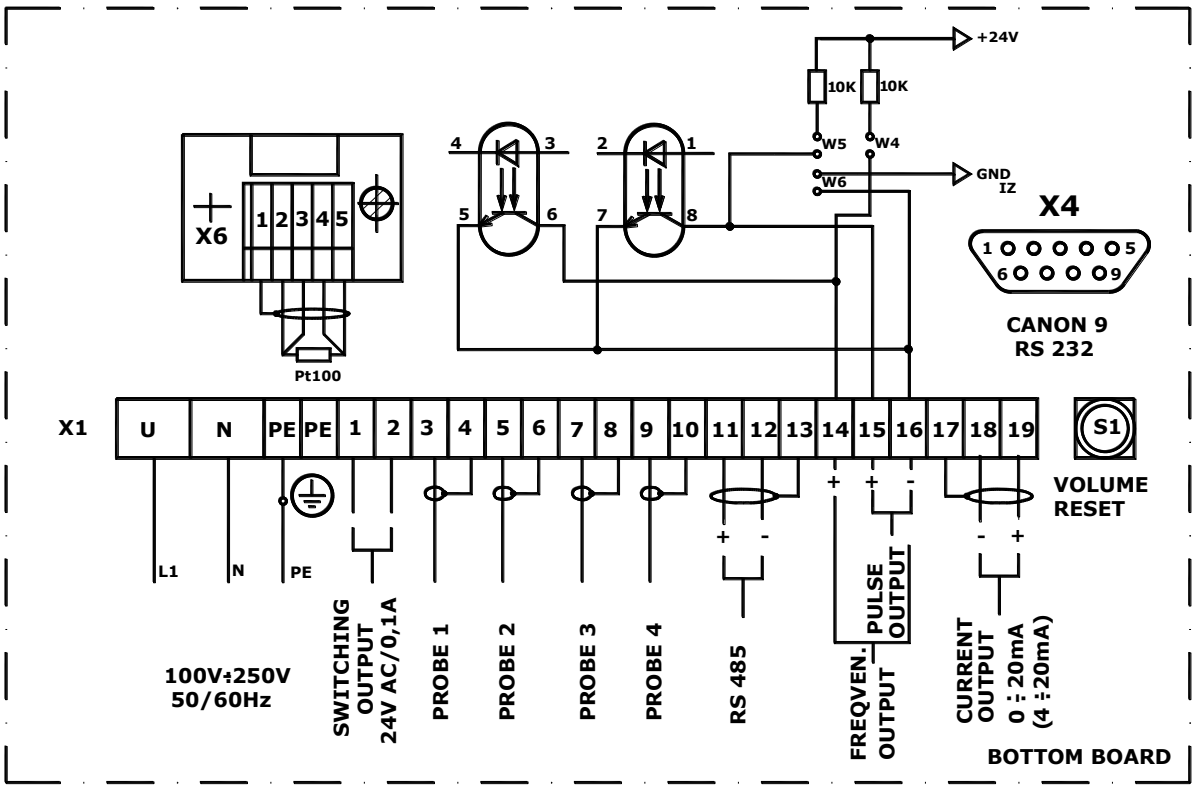


Fig. 15b - Schematic drawing of connections of SE4025 ultrasonic flowmeter

Note the connections of probes 1 and 2 (1,2,3 and 4 at SE4025), necessary for the correct meter operation. For probe marking see Fig. 13.
Connected to terminal strip X1, apart from the ultrasonic probes, are also the feeding power lines, signal outputs (the pulse, frequency, current and relay outputs) and the RS-485 communication interface.
The X4 CANON 9 connector serves the purpose of connecting the RS-485 interface used in the meter calibration, servicing and in-company operational setting.
The X6 terminal strip is used to connect the Pt 100 thermometer in the optional mass flow rate meter configuration.

By shorting the jumpers W4 and W6 the pulse output will be activated; the same action on jumpers W5 and W6 activates the frequency output. If the pulse or frequency outputs are used in the passive mode of operation (jumpers W4 through to W6 disconnected), the optron current shall not exceed 20mA. The S1 key can be used to reset the total liquid volume reading to zero; the same command can be sent via the RS-485 line. To indicate the liquid 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.

Push the arresting pin on the right-hand side of the transmitter housing upwards and lift off the front panel to the left to gain access to switch S3 through the respective circular hole in the top printed circuit board of the unit.

Note: Terminals X1 14 and 16 are used for uniform pulses

Switches S2 and S3 – location and functions

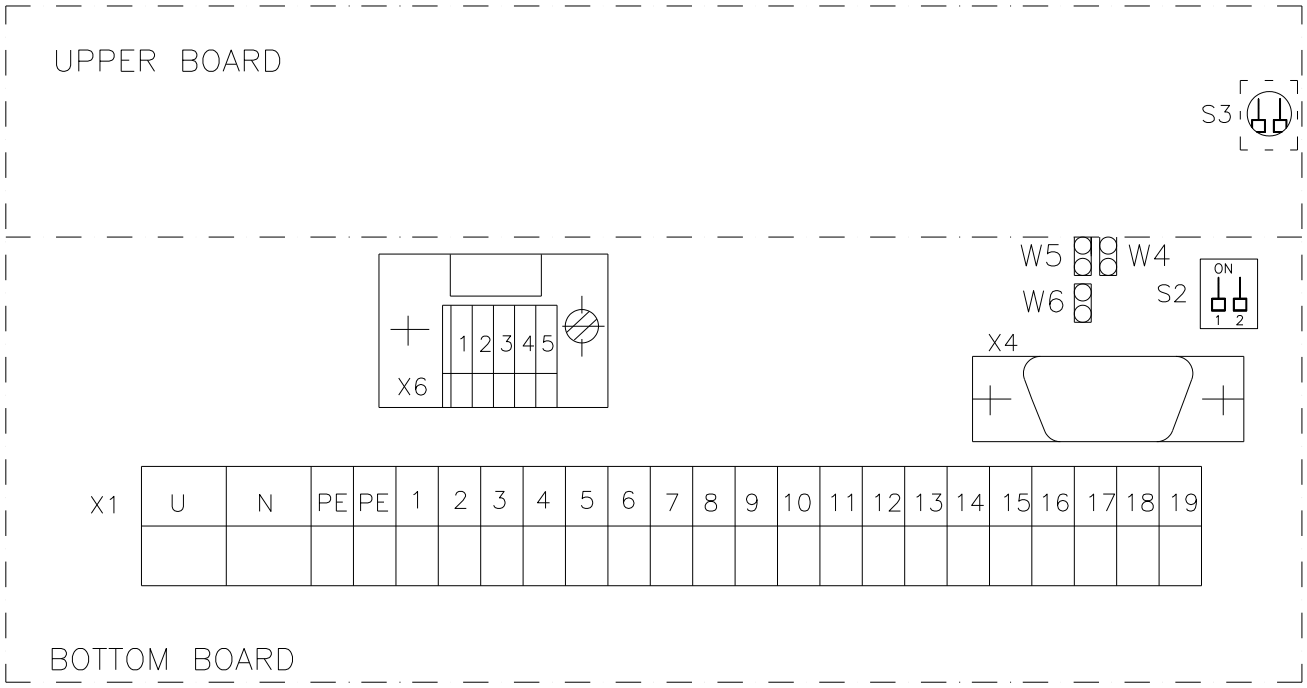


Fig. 16 - Location of switches S2 and S3

Flowmeter mode of operation	***Information on the display unit***	***Combination of switch positions***
Measurement	Instantaneous flow rate	S2 ON 1 2 S3 ON 1 2
Measurement	Instantaneous velocity	S2 ON 1 2 S3 ON 1 2
Programming	EEPROM programming	S2 ON 1 2 S3 ON 1 2
Servicing	Service	S2 ON 1 2 S3 ON 1 2

The servicing mode is reserved for the purposes of meter production and special services by the manufacturer.

Product marking

Meter rating plate (located on the transmitter housing):

Manufacturer
Production serial number
Type certification
Electromagnetic compatibility class (EMC)
Environment protection class
Ambient temperature
Communication address
Limit flow rate values Q_1, Q_3, Q_4
Output signals and calibration information
List of system components including type designation and production serial numbers
System production serial number / year of manufacture
List of all system components including type designation, quantity and production serial numbers

Transmitter rating plate (located on the transmitter housing):
Manufacturer
Type designation
Production serial number / year of manufacture
Power source
Protection class information

Flow sensor rating plate (located on the flow sensor body):

Manufacturer
Production serial number / year of manufacture
Type designation
DN information
Liquid temperature range
Nominal pressure PN
Liquid flow direction
Protection class information

Sealing of technological meters

The SONOELIS flowmeters are provided with factory and assembly seals – see Fig. 5. Should the factory seals be found removed or damaged, the product warranty shall be void.

6. COMMISSIONNING AND CONTROL OF THE METER FUNCTIONS

6.1 Commissioning

6.1.1 Display data

6.1.1.1 Connecting the meter

The first three seconds after connecting the meter to the power source the display reads

Flowmeter
E L I S

6.1.1.2 Meter status information

In the normal operation, the symbol at the last digit position on the second line informs about the current mode of operation of the signal processing transmitter. The characters used and their meanings are as follows:

I	transmitter initialization
+	measurements in the positive flow direction
-	measurements in the negative flow direction
C	calculation of measured values, output signal generation and display
W	stand-by mode
T	data communication (data being sent).

Under normal operating conditions the above characters regularly replace one another. In case of an error due to a sensor failure, loss of a sensor´s signal due to a cable failure, presence of an air bubble or a mechanical particle in the liquid, an “R” will appear at the last position on the first line and the “I” and “+” signs will appear in turns at the last position on the second line of the display unit. A failure of the transmitter will usually be indicated by discontinued regular changes of the system status symbols on the display.

6.1.1.3 Display of measured data

Up to three measured quantities can be displayed simultaneously; one on the first line, and the other two in turns on the second line of the display unit. The switching frequency can be selected in terms of the number of measuring cycles per display time of one measured quantity.

Most often the first display line is used to show the volumetric flow rate (in m^3/h) or the mass flow rate (in metric tons per hour), and the second display line to display the total volume (in m^3) or the total mass (in metric tons) alternatively with the liquid temperature in °C. However, the customer is free to define other combinations of the data to be displayed and/or to select other optional data units from the software menu available.

6.1.2 Review of the measured quantities

Volumetric flow rate
- Relative volumetric flow rate (in % of Q_4)
- Mass flow rate [T]
- Relative mass flow rate (in % of Q_4) [T]
- Volume (total value)
- Volume + (volume of liquid passed in the positive direction) [O]
- Volume - (volume of liquid passed in the negative direction) [O]
- Mass (total mass) [T]
- Mass + (mass of liquid passed in the positive direction) [T], [O]
- Mass - (mass of liquid passed in the negative direction) [T], [O]

Temperature [T]
Density [T]
Sound propagation velocity
Flow velocity through the sensor flange
Start of the measurement period (date and time of the last resetting command)
Duration of the measurement period
Duration of a meter error condition
Duration of a power failure period
Date
Time

Comment:
Quantities denoted [T] will only be measured and displayed if the meter configuration includes a thermometer; quantities denoted [O] require that the flowmeter has been set for measurements in both liquid-flow directions.

6.1.3 Review of the measured quantity units

Volumetric flow rate	Mass flow rate	Volume	Mass
m^3/hour	t/hour	1,000 m^3	1,000 t
m^3/min	t/min	m^3	t
m^3/s	t/s	l	kg
l/hour	kg/hour	1,000 bbl	1,000 tons
l/min	kg/min	bbl	ton
l/s	kg/s	1,000 ft^3	lb
bbl/hour	tons/hour	ft^3	
		ft^3	
bbl/min	tons/min	1,000 gal	
bbl/s	tons/s	gal	
ft^3/hour	lb/hour		
ft^3/min	lb/min		
ft^3/s	lb/s		
gal/hour			
gal/min			
gal/s			

Temperature	Density	Velocity
°C	t/m^3	m/s
°F	kg/m^3	ft/s
	g/cm^3	
	tons/m^3	
	lb/ft^3	

Table 4 - Review of the measured quantity units

Names of selected units

bbl	American barrel
ft	Foot
gal	American gallon
ton	American ton
lb	Pound
m^3	Cubic meter
l	Liter

s	Second
min	Minute
hour	Hour
°C	Degree Celsius
°F	Degree Fahrenheit
t	Metric ton
kg	Kilogram

Table 5 - Names of selected units

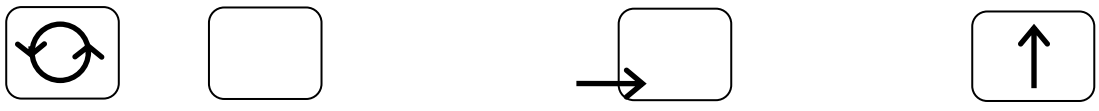
6.1.4 Unit conversion table

Volumetric flow rate	1 m^3/hour =	0.01666667 m^3/min 0.0002777778 m^3/s 1,000 l/hour 16.66667 l/min 0.2777778 l/s 6.289387 bbl/hour 0.1048231 bbl/min 0.001747052 bbl/s 35.31467 ft^3/hour 0.5885778 ft^3/min 0.009809630 ft^3/s 264.1708 gal/hour 4.402846 gal/min 0.07338077 gal/s
Mass flow rate	1 t/hour =	1.102311 tons/hour 0.01837185 tons/min 0.0003061975 tons/s 2,204.623 lb/hour 36.74371 lb/min 0.6123952 lb/s
Volume	1 m^3 =	6.289387 bbl 35.31467 ft^3 264.1708 gal
Mass	1 t =	1.102311 tons 2,204.623 lb
Density	1 t/m^3 =	1.102311 tons/m^3 62.42797 lb/ft^3
Temperature	t_F =	32 + 1.8 t_C
Velocity	1 m/s =	3.280840 ft/s

Table 6 - Unit conversion table

6.2 Keyboard control functions

The keypad allows for a wide range of the meter functions to be controlled and modified with respect to the requirements of specific operating conditions at the user's plant. The keys T1 to T4 are provided with the following graphic symbols:



T1 **T2** **T3** **T4**

The key control of the meter is shown in a schematic diagram in Fig. 17. The system can be operated in two different modes where the switching-over action between the operation modes and individual functional blocks within a selected mode can be initiated by pressing the key the image of which is depicted at the given transition position. From the diagram, it follows that a transition from one block to the next one (on the right-hand side) will be done by pressing the T2 key, while a transition to the previous block (next on the left-hand side) by pressing the T3 key. The Zero Reset block can only be activated in cases of technological meters (the software switch in the "NF" position). In case of commercial (invoicing) meters, where the switch is in the "F" position, the Zero reset block is missing.

Upon energizing, the meter will automatically adopt the display mode with the pre-selected (initial) quantity displayed (see description below). The display mode will also become operative if no key has been pressed over the period of 300 measurement cycles (5 minutes for a measurement cycle of 1 s).

Any key control actions will not disturb the measuring functions of the meter in any way. A detailed description of individual "block" functions controlled by the key unit is given in the following paragraphs.

6.2.1 Data display mode

The flowmeter in full configuration can measure and evaluate any of the 20 physical quantities listed in section 6.1.2 above. In the data display mode, any of the measured quantities can be displayed. The display format is as follows:
Line 1 – name of the measured quantity in the selected language (Czech, English, German, Spanish, Italian or French);
Line 2 – the measured value in the selected unit system.

Upon switching the power on, the system activates the data display mode whereby the measured value of the pre-selected ("initial") physical quantity is displayed. Each of the 20 physical quantities available can be selected as the initial one.

If the operator presses the T1 key, another measured quantity will be displayed (the next on the list in section 6.1.2). Then, unless T1 is pressed again within 5 minutes, the initial quantity will be displayed again.
To leave the Data Display Mode for the Parameter Setting Mode, press the T4 key (see Fig. 18). Select the desired operating mode (function block) by pressing the T1 key and confirm the selection by pressing T4 again.

6.2.1.1 Volumetric flow rate

The value of the measured volumetric flow rate is displayed as a 3- or 4-digit number (this is determined by the manufacturer with respect to the meter application). Provided the flowmeter has been set for measurements in both directions of flow, the sign before the reading indicates the flow direction ("+" for the flow direction shown by the arrow sign on the meter body, "-" for the opposite direction).

6.2.1.2 Relative volumetric flow rate

The displayed reading shows the ratio (in per cent) of the measured volumetric flow rate to the specified maximum volumetric flow rate.

6.2.1.3 Mass flow rate

The mass flow rate can be measured and the measured data displayed only on condition that the meter configuration includes a thermometer and that the liquid density vs. temperature characteristic is known. For more technical details of the readings see the comments to section 6.2.1.1 above. If a thermometer is not installed, the mass flow rate function block is skipped when selected by key T1.

6.2.1.4 Relative mass flow rate

See the comments to section 6.2.1.2 above concerning the relative volumetric flow rate.

6.2.1.5 Volume

The total liquid volume passed through the flow sensor during the measurement period, i.e. from the moment the volume data were reset by the reset button on the meter, or since the measurement start command from the master control system was received via the RS-485 communication line, or since the data-resetting command was actuated using the T keys as described in section 6.2.2.8 below. The displayed value can have up to 7 digits; higher readings are shown in the form of products of real numbers and appropriate powers of 10 (the "E" format). The reading sensitivity is 0.01 l, the maximum reading is $2.8.10^9$ m^3. In case of bi-directional measurement, the total volume reading is the difference between the volume passed in the positive and the negative direction of the liquid flow. The displayed value includes the polarity sign.

6.2.1.6 Volume +

Applicable only in case of bi-directional measurement. The reading represents the total liquid volume passed in the positive flow direction (see the arrow on the meter body). The reading format and the range of the measured values are as described in section 6.2.1.5 above.

6.2.1.7 Volume -

See section 6.2.1.6, for the reverse flow direction.

6.2.1.8 Mass

See section 6.2.1.5, for the total mass of the liquid passed through the flow sensor. The reading sensitivity is 0.01 kg.

6.2.1.9 Mass +

See section 6.2.1.6, for the total mass flow in the positive direction.

6.2.1.10 Mass -

See section 6.2.1.7, for the total mass flow in the reverse direction.

6.2.1.11 Temperature

The temperature reading is only available if a thermometer is included in the meter configuration. The reading sensitivity is 0.1 °C.

6.2.1.12 Density

The liquid density readings are available provided a thermometer has been installed.

6.2.1.13 Sound propagation velocity

Velocity of the acoustic signal propagating in the measured liquid.

6.2.1.14 Liquid flow velocity

Velocity of the liquid passing through the sensor flange.

6.2.1.15 Start of the measurement period

The calendar date, hour and minute when the measurement period commenced (the last resetting of the total flow data).

6.2.1.16 Duration of the measurement period

The length of the period (in hours, minutes and seconds) from the measurement start (see section 6.2.1.15) during which the flowmeter continuously performed the flow rate measurements.

6.2.1.17 Duration of failure condition

The total duration of the period (s) (in hours, minutes and seconds) from the measurement start during which the meter was energized but could not perform measurements due to a failure condition.

6.2.1.18 Power failure period

The total duration of the period (s) (in hours, minutes and seconds) from the measurement start during which the meter was not energized.

6.2.1.19 Date

The display shows the actual calendar date.

6.2.1.20 Time

The display shows the actual time of the day.

6.2.2 Parameter setting mode

When selecting the parameter setting mode (see section 6.2.1), the operator will be requested to enter a four-digit password.

6.2.2.1 Password

The first display line will read

PASSWORD

and the first digit position on the second line will display 0. Press key T3 repeatedly to increase the number by 1 at a time (after 9 will follow 0 again). Select the correct number at the first digit position and then press key T2 to move to the second digit position and repeat the number setting procedure with key T3. Progress to the third and fourth digit positions and enter the correct password – a combination of four numbers (see the schematic diagram in Fig. 19).

Confirm the entry of the correct password by pressing key T4. Provided the password entered is correct, the system will proceed to the language selection block. In case of an incorrect password the system will request a new password entry. After three consecutive entries of incorrect passwords the system will switch over to the data display mode and will not permit further entry into the parameter setting mode. A new attempt at the password entry is only possible after system de-energising and repeated switching on of the power supply.

Should the operator forget the password, it is possible to use the manufacturer's password supplied with the system (0200). This shall be done as follows: switch off the power, press and hold key T4 and switch the power on again.

The user password can be changed at any time in the parameter setting mode using the procedure described in section 6.2.2.5 below.

6.2.2.2 Meter setting procedures

The meter parameters that can be defined or re-defined in the parameter setting mode include: the language of the messages appearing on the display, units of the displayed quantities, the user password required for entry into the parameter setting mode, the initial measured quantity, specified values of some measured quantities (Q, pulse number – liters per imp., threshold/sensitivity level, and the maximum/limit values of liquid flow rate, volume and temperature), as well as the date, day of the week, time of the day, start of the measurement period and meter zero position (only with the technological meters).

The procedures to be used in setting particular parameters are described below. Upon initialization of a particular parameter setting mode, the name of the function block concerned will appear on the first line of the display in block letters, e.g.

LANGUAGE

At the same time, the current parameter name or value will appear on the second line. If you wish to pass on to the next parameter, press T2; by pressing key T3 you will return to the previous parameter. Any parameter changes are done using key T1, confirmation of the new value by key T4. The display will then read

PARAMETER SET

To leave the current parameter setting mode and proceed to another parameter block, press key T2. If you wish to return to the previous block, press T3. To leave the parameter setting mode completely (and enter the data display mode for the parameter just set), press key T4.

6.2.2.3 Language selection

The operator can choose from any of the six languages available (see Fig. 20). The language setting mode will be initiated as soon as the system acknowledges the correct user password. The first line on the display will then read

LANGUAGE

or a message to the same effect in the actually defined language. On delivery, the language selected will be Czech unless the customer has specified their required language in the product order. The second display line will identify one of the languages available (e.g. English). Press repeatedly key T1 to select the desired language. Upon selecting the language, confirm the setting by pressing key T4. The message on the display will inform the operator of completion of the parameter setting in the newly selected language.

6.2.2.4 Measuring unit selection

In this parameter setting mode, the desired measuring unit can be associated with each measured physical quantity (see Fig. 21). Upon initiating this mode, the first line of the display will read

UNITS

while the name a physical quantity will appear on the second line. Press repeatedly key T1 to select the desired quantity and confirm by pressing T4. The quantity name will then appear on the first line and the second line will display one of the measuring units available. Select the desired unit by T1 and confirm by T4. Press key T3 to access another measured quantity or use T2 to proceed to another parameter to be set.

6.2.2.5. New password definition

NEW PASSWORD

In this mode, the operator/user may modify the existing password used to access the parameter setting mode (see Fig. 22). Press key T4. The first digit position on the second line will display 0. Set the new password (a combination of four numbers) using the procedure described in section 6.2.2.1 above. Upon final confirmation by pressing key T4, the legend Parameter Set will appear on the display. From then on, only the new password will be effective.

6.2.2.6 Initial quantity selection

Upon accessing this parameter setting mode, the first line of the display will read

INITIAL QUANTITY

and the second line will give the quantity's name (see Fig. 23). Select the desired initial quantity using key T1 and confirm the selection by T4.

6.2.2.7 Definition of limit values

LIMIT VALUE

Here the operator can set altogether 11 (limit) values of parameters. The detailed description of the procedures concerned is shown in Fig. 24. Select the desired parameter by key T1 and confirm the selection by T4. The name of the parameter and the associated measuring unit will then appear on the first line of the display and the second line will show the previously defined limit value (with the exception of the date and time). The limit value unit shall always be the same as that selected for data display. For example, if the volumetric flow rate is displayed in litres per second, the limit value of volumetric flow rate shall also be defined in l/s. If the mass flow rate measurement mode is selected and the data are displayed in metric tons, the pulse number shall also be defined in t.

Upon pressing key T2, the previously set limit value will disappear from the second line and 0 will be displayed in the first digit position. Use keys T3 and T2 to set the digital value and T1 to insert the division signs (a comma in the position of a decimal point, dot in the date and colon in case of time).

The day in the week information is to be set as follows:
0 – Sunday
1 – Monday
2 – Tuesday
3 – Wednesday
4 – Thursday
5 – Friday
6 – Saturday

A figure entered may have up to seven digits. The date and time data shall include initial zeroes; e.g. the date of 3 July 2001 shall be recorded as 03.07.01 and the time 7 minutes past 9 a.m. as 09:07:00. Confirm the selection by pressing key T4. In case of a commercial (invoicing) meter, neither Q_4 pulse number or sensitivity (low flow cutoff) can be reset by the user as these settings are reserved to the duly authorized testing authority. Therefore, for commercial meters, these parameters will not appear on the list of limit values to be reset.

List of parameters (limit values, date and time)

Qmax	Maximum (overload) flow rate Q4 in the given measuring units
ICIS	Pulse number, defining liquid volume or mass (in selected units) per one pulse at the pulse output
Date	The actual calendar date
Day of the week	The actual day of the week
Time of the day	The actual time of the day
Low flow cutoff	The flow rate level, in per cent of Q4, below which the meter will display and at its outputs indicate zero flow rate
Vol. flow limit	Maximum volumetric flow rate level; where a binary output is associated with this parameter, it will indicate values exceeding this limit
Mass flow limit	Maximum mass flow rate; where a binary output is associated with this parameter, it will indicate values exceeding this limit
Volume limit	Maximum total volume; where a binary output is associated with this parameter, it will indicate values exceeding this limit
Mass limit	Maximum total mass; where a binary output is associated with this parameter, it will indicate values exceeding this limit
Temp. limit	Maximum temperature; where a binary output is associated with this parameter, it will indicate values exceeding this limit value.

Comment: The limit values for all the above parameters shall be given in units selected using the procedure described in section 6.2.2.4 above. Should new parameter units be selected, the limit values need be re-defined accordingly; otherwise the meter function would be incorrect.

6.2.2.8 Resetting total quantities

Upon entering this mode, the corresponding message will appear on the display (see Fig. 25). If resetting of total quantities is not required, press key T2 to access the next parameter-setting block. Confirm your intention to reset the total quantities by pressing T4. The display will then ask

RESET ?

At this stage, you can still return to the initial step of the resetting mode by pressing T3. Press T4 to reset the total readings of the flow volume and flow mass, the operational information (the meter operation time, the error time and power loss time) and define the start of a new measurement period (the date, hour and minute of the same). The system will respond with a confirming message (Parameter Set).

6.2.2.9. Meter zero setting

Before leaving the manufacturing plant, every flowmeter is carefully set for correct operation. One of the key parameters in this respect is the meter zero. A correctly set meter zero implies that at zero flow rate (or zero liquid flow velocity through the meter sensor) the meter indicates a zero flow rate (zero liquid flow velocity). The setting value (a meter zero shift) is expressed in mm per second. The meter zero shift as identified in the manufacturing plant is stored in the meter memory under the name of initial (in-production) zero setting value.

Meter component ageing and other factors acting over long-term operational periods may result in minor meter zero displacements. To eliminate these, use the automated zero resetting function. However, great care should be taken in employing this function. First of all, the zero-flow rate condition shall be ensured (make sure that the closing valve in the piping is not leaking). Only then the zero-resetting function may be used.

A detailed description of the zero-resetting block is shown in Fig. 26. Upon initiating this function, the operator shall select either the in-production or automated meter zero setting mode. The selection is done by key T1, confirmation by T4. When the in-production setting mode is selected, the meter zero is reset using the zero-shift value determined in the manufacturing plant.

In the automated zero setting mode, the meter will first ask whether the liquid flow rate through the meter sensor is really zero (the main requirement for a successful zero setting). If it is not so, cancel the setting process using key T3. Upon confirmation by key T4 the display will show the message “WAIT FOR 100”. The zero-setting procedure lasts 100 measuring cycles. The actual number of measuring cycles performed is shown on the second display line.

After 100 measuring cycles the zero displacement is evaluated. If it is smaller than 50 mm/s, the shift value is stored and the display with read “PARAMETER SET”. If the value is greater than 50 mm/s, a notice to this effect is displayed. However, this is highly unlikely; in such as case it is recommended to check again whether the liquid flow has indeed been completely stopped. Use key T3 to invalidate the setting and key T4 to run the setting procedure anew.
The meter zero setting function is available only with technological flowmeters.

6.2.2.10 End of parameter setting

At the end of the parameter setting procedure, the display will read

PAR. SETTING END

Press key T4 to access the data display mode. However, should you wish to perform any additional parameter setting action, press T3 to return to the previous parameter setting function block (see Fig. 27).

6.3 Automated meter test

The test shall only be used in extraordinary situations where the meter function is incorrect although all operational conditions are within specified limits. Its purpose is to handle extraordinary situations where the meter function is incorrect although all operational conditions are within specified limits.

Prior to initializing the test, check the correct interconnection between the evaluation transmitter and the meter sensor, the power supply line, the full sensor flooding and zero flow rate. Then switch off the power, press key S1 (resetting the total volume) and, with S1 pressed, switch on the power again. Upon releasing S1, the display will read

TEST
SENSOR FULL?

Press and release S1 again, whereby, provided the sensor is fully flooded, the following message will appear on the display:

LIQUID
DOES NOT FLOW?

Check the zero-flow rate condition and press and release S1. The test will continue by checking whether the passage route for the ultrasonic ray in one direction is free. The display will read

TEST
UTS THROUGH.1

If this test is successful, the message “OK” will appear on the display for four seconds, whereby a test of the ray passage route in the other direction will commence.

TEST
UTS THROUGH.2

After successfully passing this test section, the display will show the amplification values associated with the ultrasonic ray passage in both directions; e.g.

UTS THROUGHPUT
D1 = 4,56 D2 = 4,55

Under normal circumstances, the amplification values should be between 4.50 and 4.60, and their difference should not exceed 0.10.

After four seconds, the measurement of the ultrasonic wave propagation velocity will commence. The message on the first display line will read:

UTS RATE

After the velocity measurement, which takes approximately 1 s, the measured value will appear on the second line, e.g.

1510.6 m/s

If the measured value lies within the limits specified for the given liquid, the following message will appear on the display

RATE LIMITS OK
END OF TEST

and, after another 4 seconds, the meter will resume the normal measurement mode.
Should a fault be indicated at the ray passage test stage, the display will show ER instead of OK. After 4 seconds, automated probe cleaning procedure will start and last for 5 minutes. The display will then read

CLEAN.UTSP 5 MIN
11111111 ……...

On the second line is displayed step by step, the actual number of the minute of the cleaning procedure is displayed. Every fourth seconds one numeral is added, the line will be filled up by 15 same numbers within 1 minute, after elapsing this time the displayed numbers disappear and next new numbers start to display for a time 1 minute. After the probe cleaning, another ray passage test is performed. Should even then the test result be negative, the following message will appear on the display:

DEFECT
END OF TEST

The meter needs be put out of service and either sent for repair to the manufacturing plant or a service technician be asked to come and repair the meter on site.

Should a fault be indicated at the ultrasonic wave propagation velocity measurement and the measured velocity lie outside the range of physically defined limits (VUTS < 900 m/s, VUTS > 1700 m/s), the probe cleaning procedure will be initiated (unless it has already been performed) and the velocity measurement will be repeated. Should even then the test result be unsatisfactory, the display will read:

DEFECT
END OF TEST

and the test sequence will be terminated.

Should the measured velocity lie outside preset limits but within the range of physically possible values, the following message will appear on the display

UTS RATE LIMITS
ADJUSTMENT

and the actual limits will automatically be re-adjusted with respect to the measured value. The display will in that case read

RATE LIMITS OK
END OF TEST

and, after another 4 seconds, the meter will resume the normal measurement mode.
Should the meter function still be unsatisfactory, it is possible to repeat the tests. In case of repeated failure to set the meter right, contact the meter manufacturer.

PUSH-BUTTON CONTROL OF THE FLOW METER FUNCTIONS

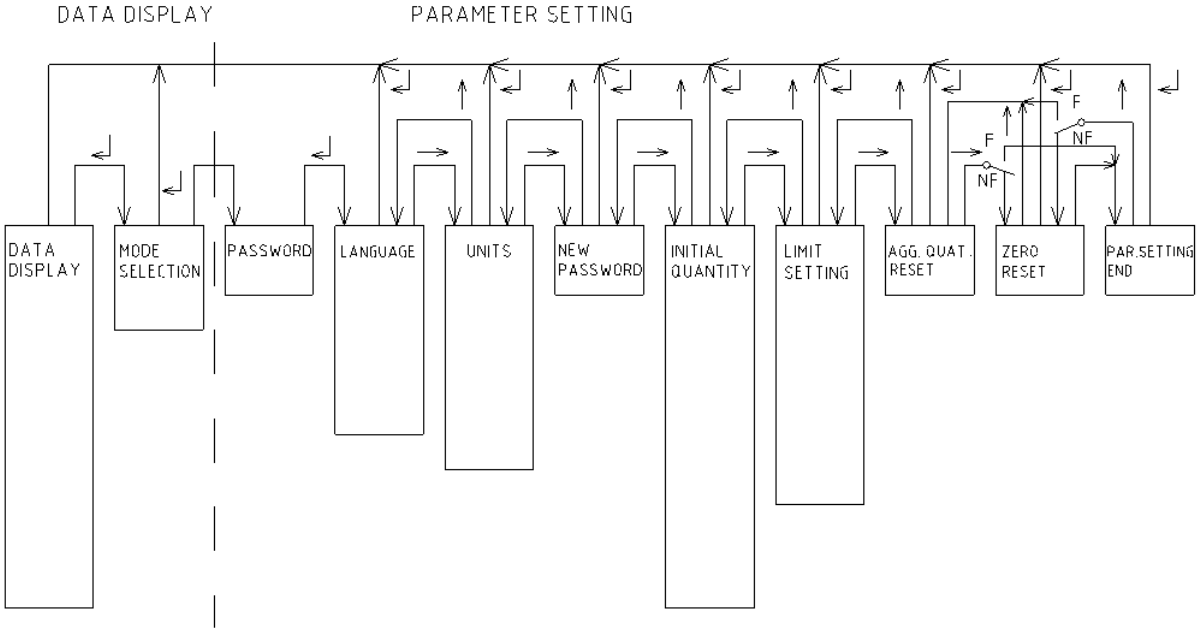


Fig. 17

DATA DISPLAY

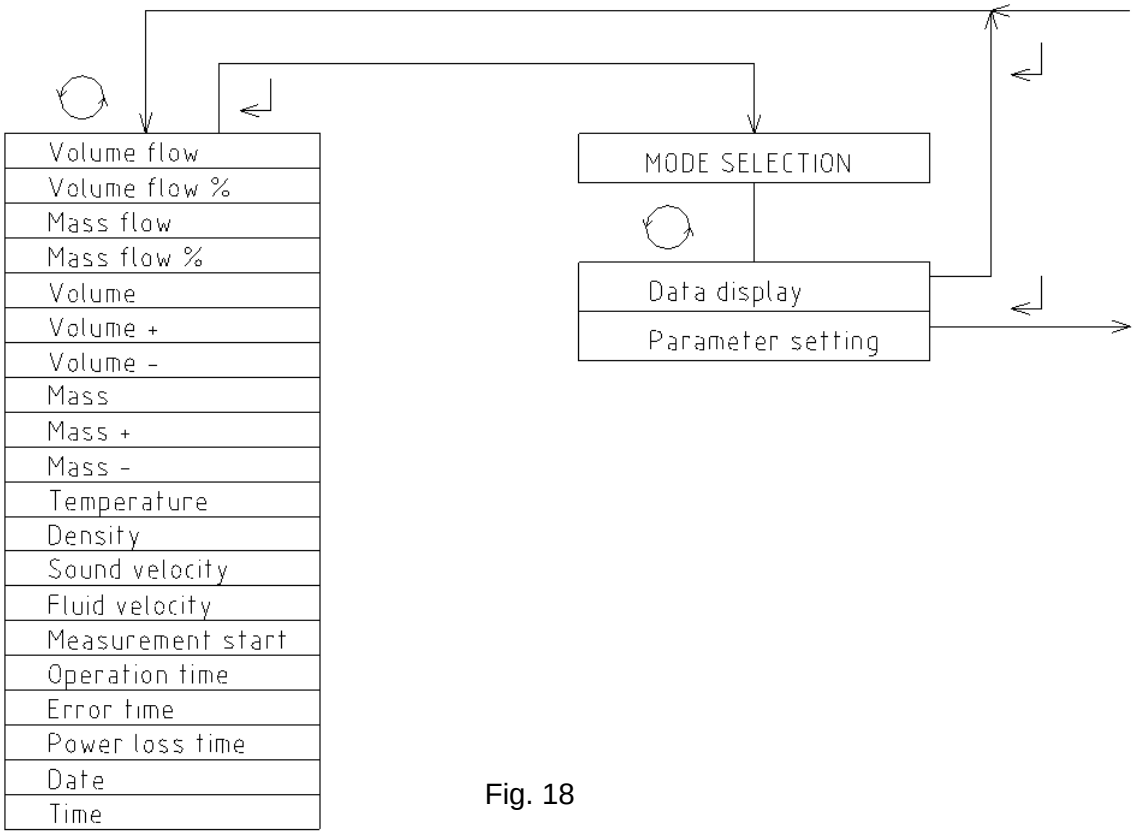


Fig. 18

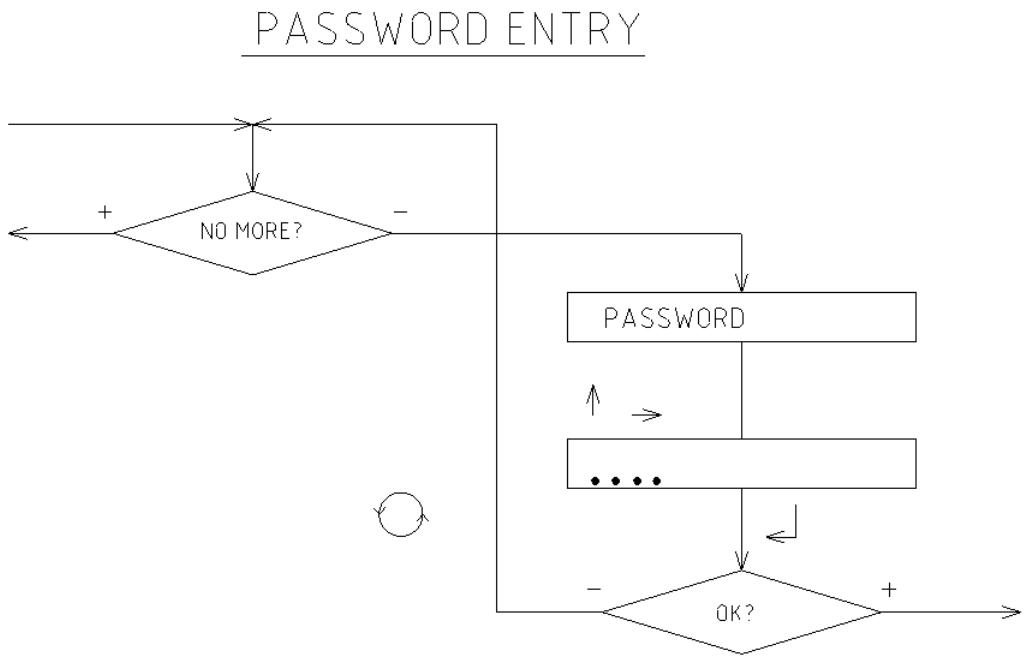

PASSWORD ENTRY
+
NO MORE?
–
PASSWORD
• • • •
–
OK?
+

Fig. 19

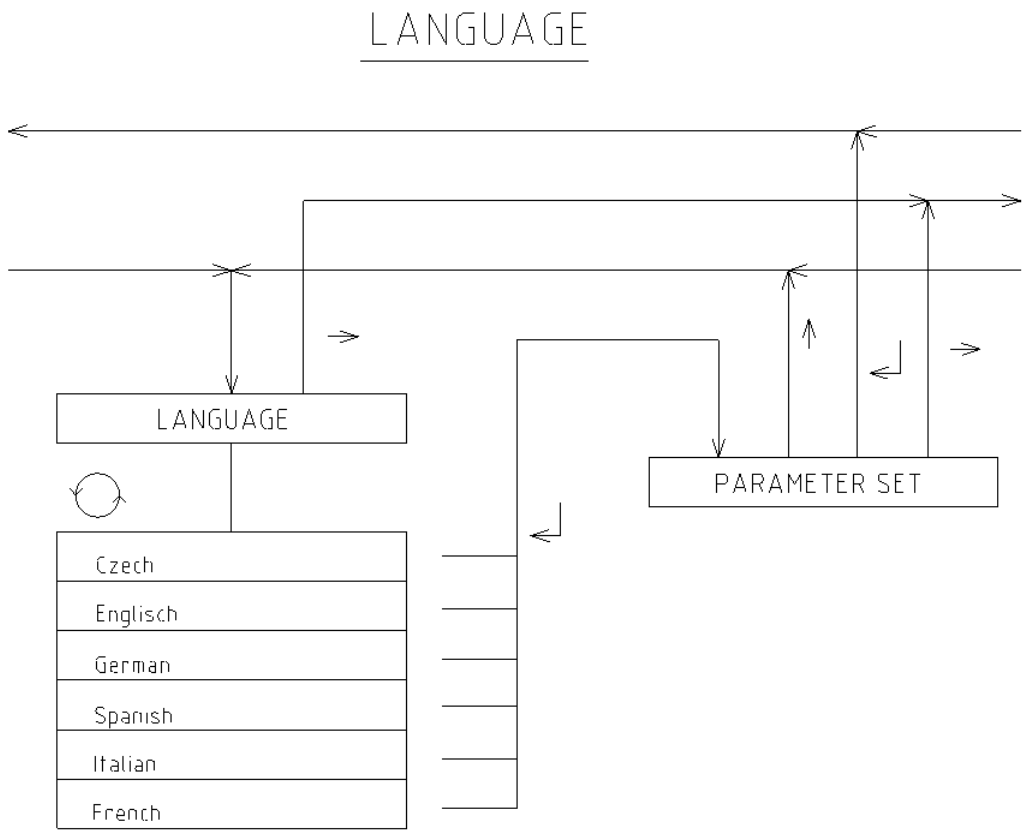

LANGUAGE
LANGUAGE
PARAMETER SET
Czech
Englisch
German
Spanish
Italian
French

Fig. 20

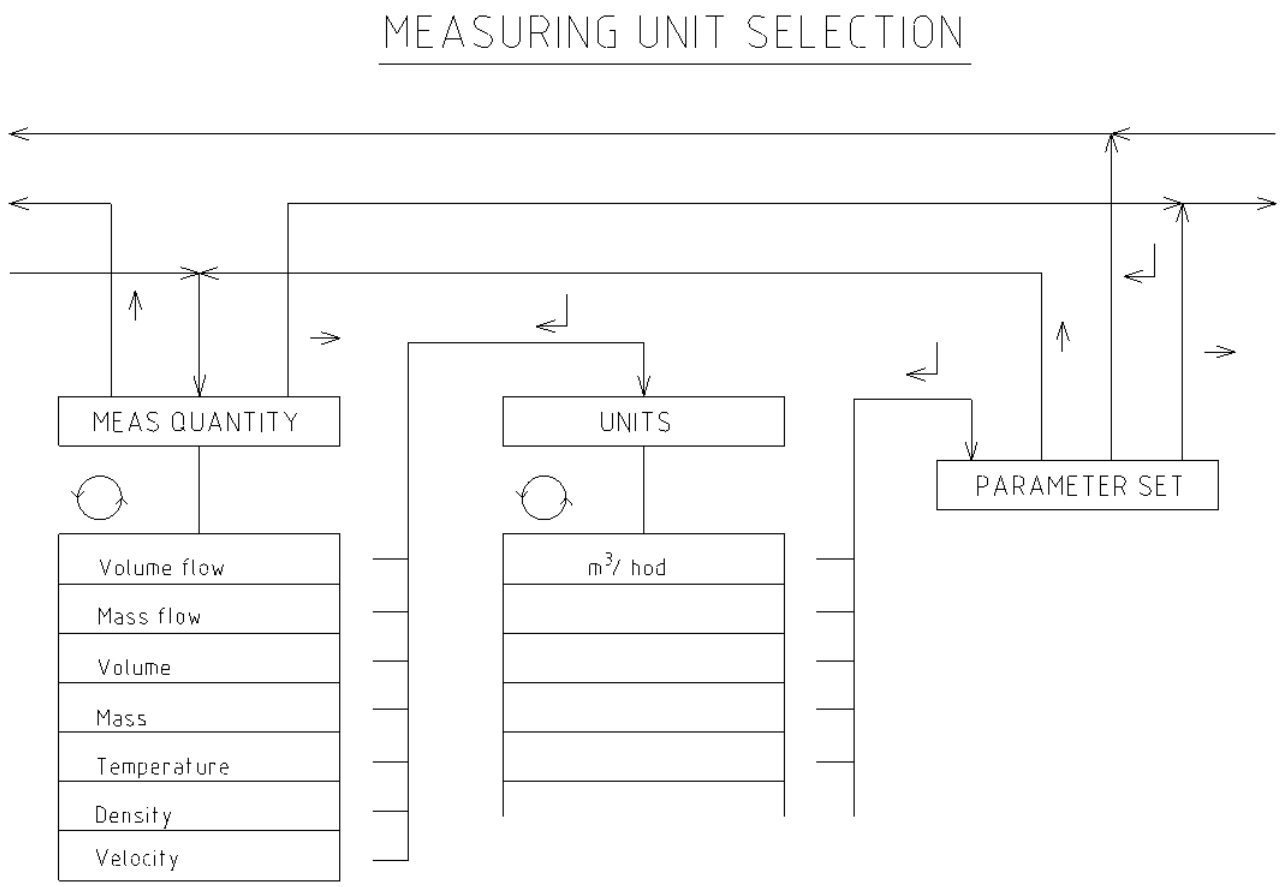

MEASURING UNIT SELECTION
MEAS QUANTITY
UNITS
PARAMETER SET
Volume flow
Mass flow
Volume
Mass
Temperature
Density
Velocity
m3/ hod

Fig. 21

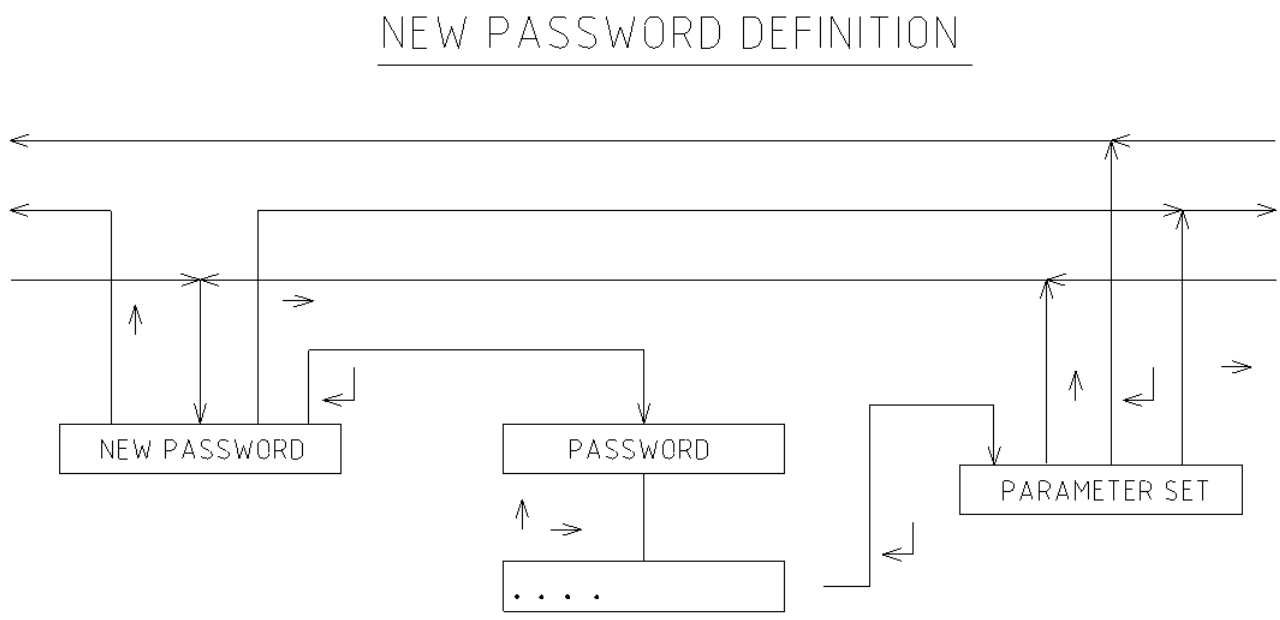

NEW PASSWORD DEFINITION
NEW PASSWORD
PASSWORD
PARAMETER SET
. . . .

Fig. 22

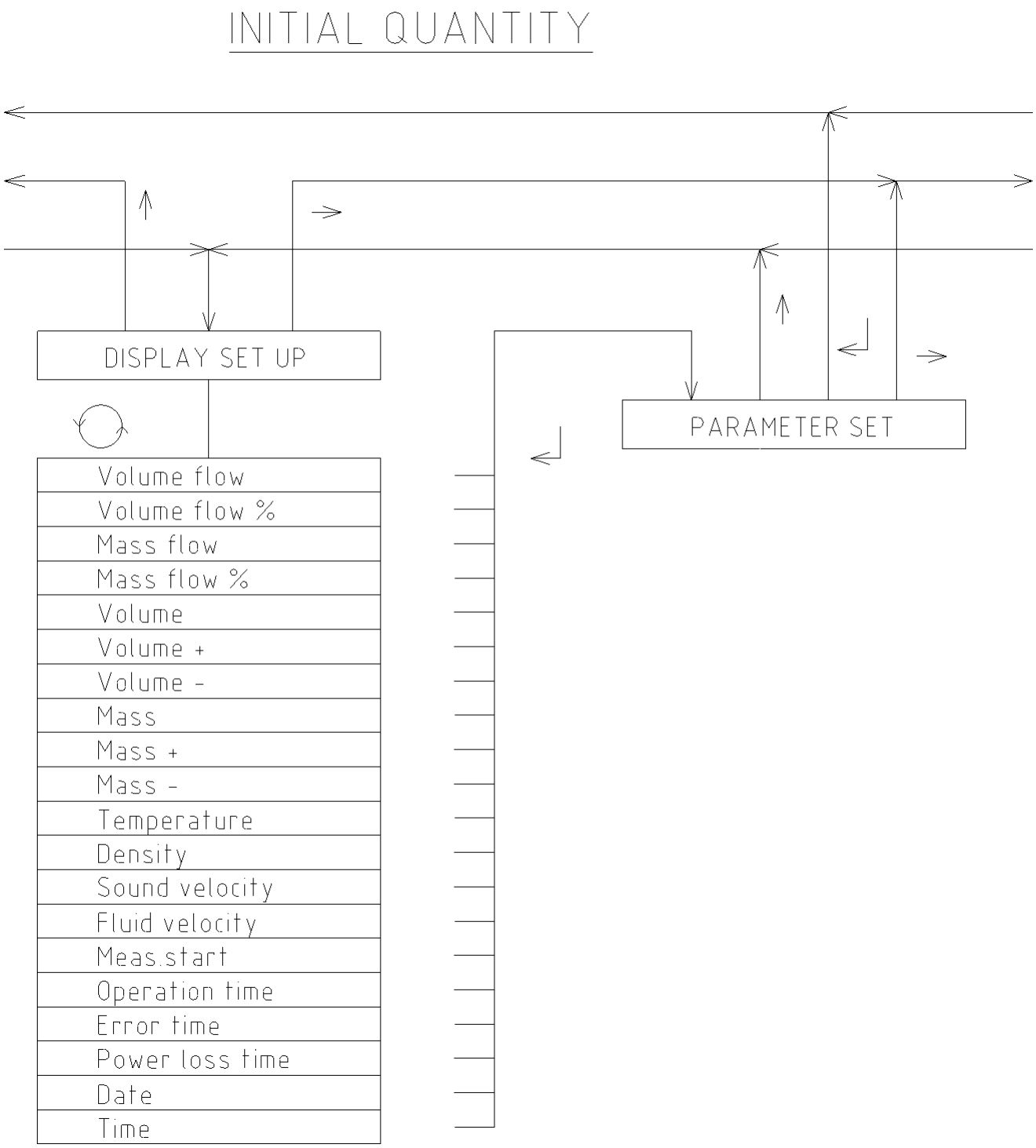

INITIAL QUANTITY
DISPLAY SET UP
PARAMETER SET
Volume flow
Volume flow %
Mass flow
Mass flow %
Volume
Volume +
Volume -
Mass
Mass +
Mass -
Temperature
Density
Sound velocity
Fluid velocity
Meas.start
Operation time
Error time
Power loss time
Date
Time

Fig. 23

DEFINITION OF LIMIT VALUES

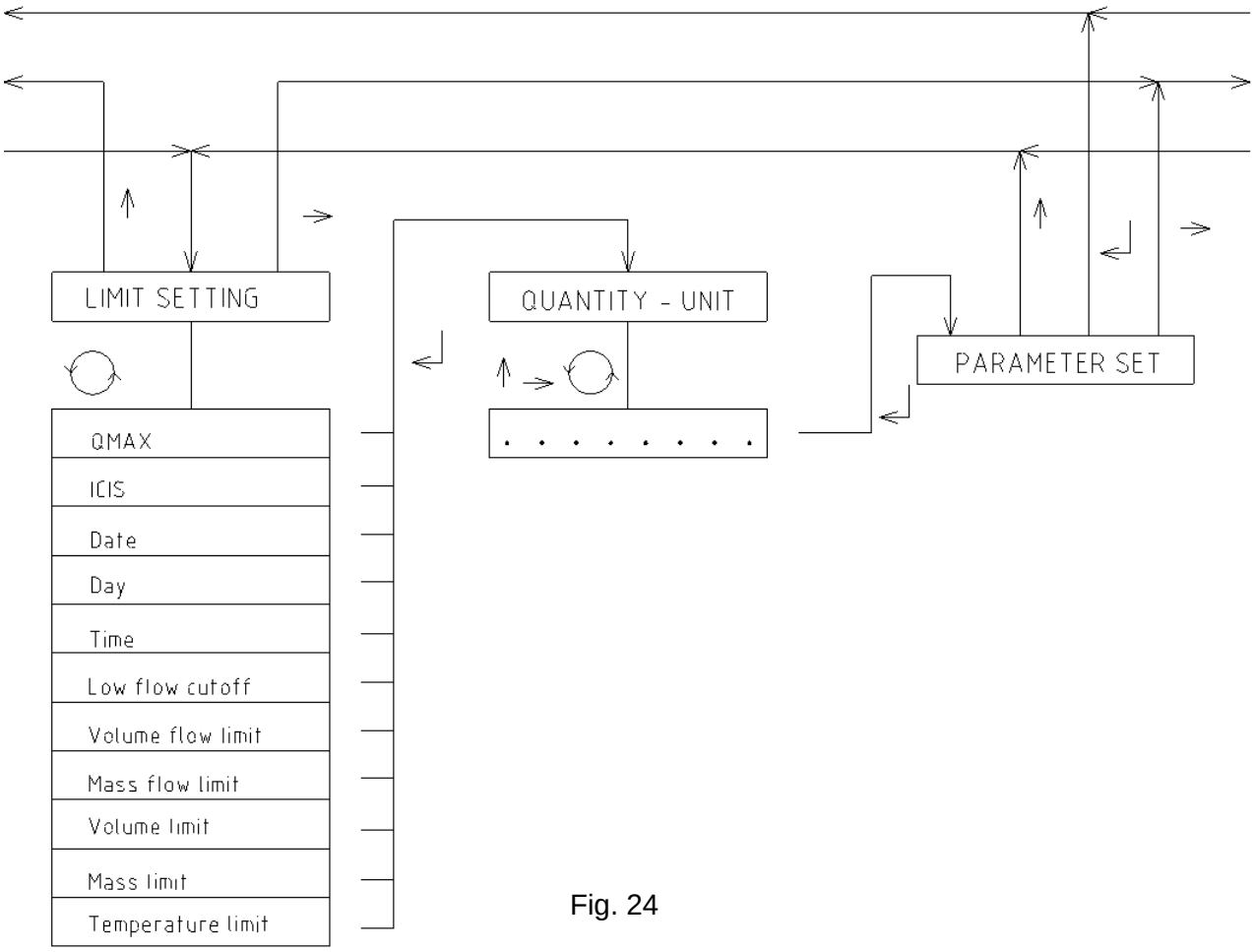


Fig. 24

RESETTING AGGREGATE VALUES

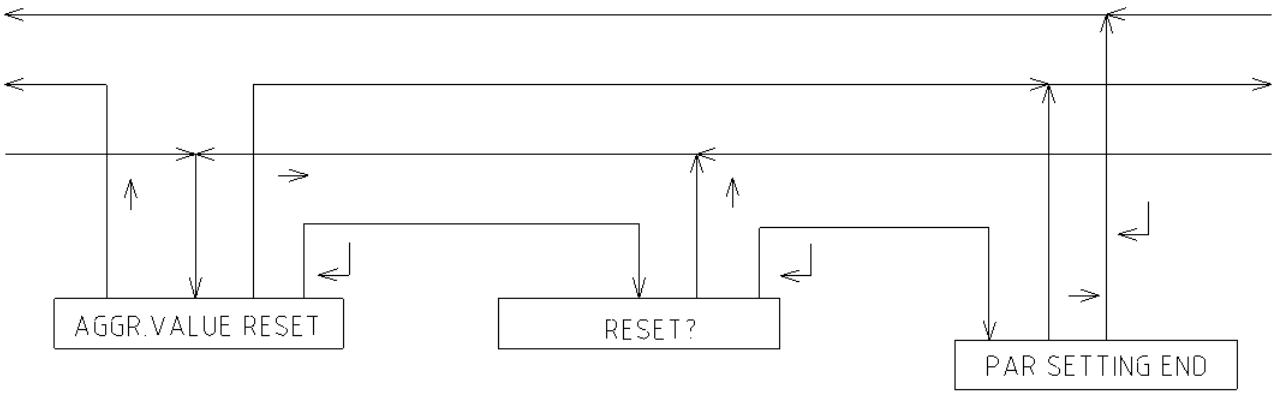


Fig. 25

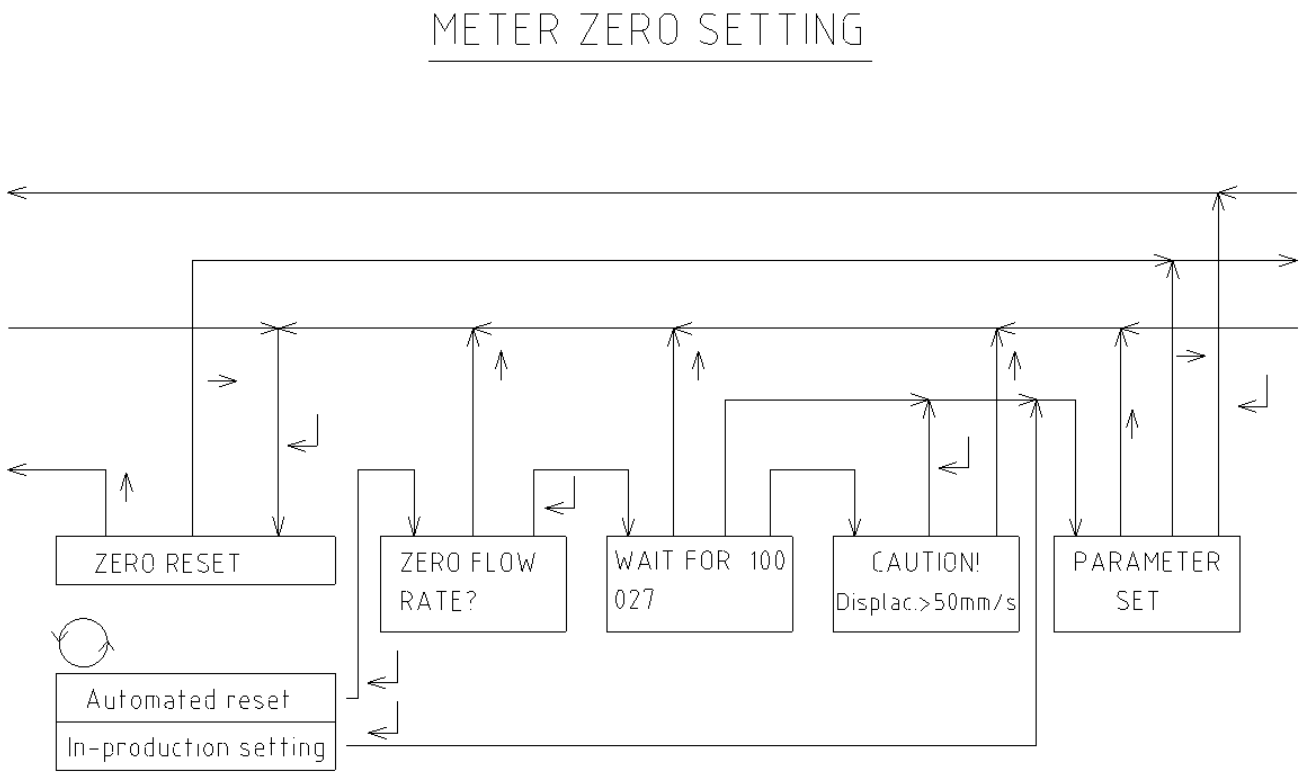

METER ZERO SETTING
ZERO RESET
ZERO FLOW RATE?
WAIT FOR 100 027
CAUTION! Displac.>50mm/s
PARAMETER SET
Automated reset
In-production setting

Fig. 26

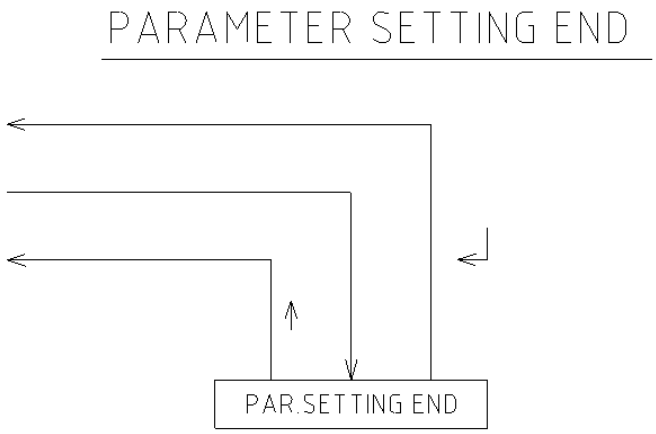

PARAMETER SETTING END
PAR.SETTING END

Fig. 27

7. WARRANTY AND POST-WARRANTY SERVICES

7.1 Warranty service

The product warranty service is provided free of charge throughout the agreed warranty period either at the manufacturer's facility 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).

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 email, 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.

7.2 Post-warranty service

Post-warranty service includes 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).

8. 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.

Warning:

If not agreed otherwise with the customer, flowmeters are calibrated with the 0 to 1 kHz frequency output. Upon agreement with the manufacturer, flowmeters can be calibrated nominal by means of other outputs, i.e. pulse or current.
Guaranteed parameters of measurement accuracy always apply only to the electrical output used for the flowmeter calibration. The other outputs, not used for calibration purposes, are 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 frequency output.

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

9. 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.

10. 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 SE4015 system, optional assembly and testing fixtures, this manual, a statement on the product compliance and delivery note.

11. 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.

12. ORDER NUMBER

When you order your SONOELIS flowmeter, make sure you specify correctly your requirements using the following table to identify the correct product order number. The same table can be found on the Internet address www.elis.cz.

Manufacturer's address:

ELIS PLZEŇ a. s.
Luční 425/15
301 00 Plzeň
Czech Republic
Tel.: +420 377 517 711
Fax: +420 377 517 722
Email: sales@elis.cz
www.elis.cz

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