ULTRASOUND FLOWMETER
SONIX 10D

TECHNICAL INFORMATION

SONIX®
Industrial Electronic Devices
mgr inż. Krzysztof Kołodziej
ul. Leopolda Lisa-Kuli 12, 05-270 Marki, Poland
phone:+48 22-7811133, fax: +48 22-7811644
www.sonix.com.pl

Spis treści

Act. 12.08.2005

DESCRIPTION OF THE METER CIRCUIT

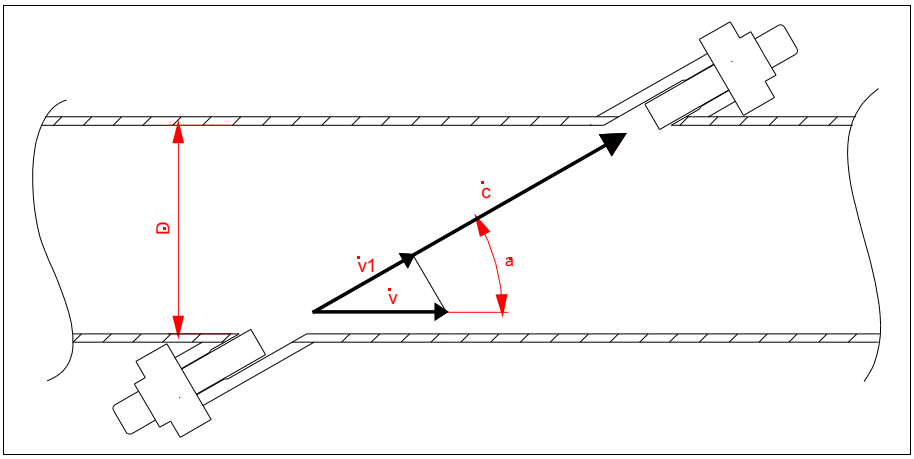
Meter Circuit

The flowmeter consists of a flow sensor and a measuring transducer.
The flow sensor in which ultrasound probes are located is available in 3 versions: 1. A U-shaped section of the pipeline ended with screw threads or flanges (DN15...40)
2. A section of the pipeline ended with flanges (DN50...1200) 3. An existing pipeline in which probes are installed (DN250..2000)
The separately assembled measuring transducer is connected with cables to two or four probes located in the flow sensor.
The transducer with a 32 character display is operated with two push buttons. .
An additional SONIX P5 reading panel may be attached to the transducer as well as other devices which use output signals. The SONIX P5 panel enables readings in large distances from the measuring spot.

The Principle of Functioning

A sound wave of high frequency is sent askew in relation to the direction of the liquid between the probes located next to the wall of the pipeline. If the wave is sent in accordance with the direction of the liquid, the component dependent on the speed of the liquid increases its propagation speed, and decreases it in the opposite direction. The flow meter measures the times of transfer of the sound wave through the liquid in both directions. The difference between such times is proportional to the speed of the flowing liquid. For small liquid speeds, the flow in the pipeline may be of a laminar character and change into a turbulent one for bigger speeds. Depending on the configuration of the pipeline, the distribution of the speed in the cross-section may be symmetrical or distorted. Both phenomena decide on the accuracy of the flow measurement. The influence of both phenomena is limited in the SONIX 10D flow meter owing to the application of two ultrasound paths and appropriate correction systems.

D-inside diameter
c-speed of sound propagation in the liquid
v-speed of the liquid
v1-speed component which adds (or subtracts) to the speed of sound propagation
a-angle between the flow direction and the direction of sending the sound wave



PURPOSE

Range of Application

Flow measurements of liquids in closed, fully filled pipelines. Pure and contaminated liquids in which the content of small solid bodies does not exceed 2% in weight. The liquid may not contain gas bubbles in the amount exceeding 2% in volume. Examples of applications:

- waterworks
  -untreated water from abyssal and river intakes
  -conditioned water
  -rinsing water
- power engineering and heat engineering
  -lattice water, feed and return
  -measurement of heat energy
  -cooling water
  -condensation water
  -demineralized water
- sewage purification and pumping
  -untreated municipal and industrial sewage
  -purified sewage
  -hydrated settings
- food industry
  -oils
  -syrups
  -potable liquids
  -chemical and pharmaceutical industry
  -liquid chemicals
  -technological and fire water
  -crude oil, heavy fuel oil
- mines
  -salted water
  -drainage water

TECHNICAL DATA

Displayed values

- Flow intensity: unit m^3/h, range 0.001...99999 m^3/h, resolution 0.001 m^3/h
- Sum of liquid volume: unit m^3, 10 digit counter, resolution 0.001 m^3
- Work time: feed time of the device, counter up to 99999 hours, accuracy 0.01%
- Time of correct work: work time without error signaling, counter up to 99999 hours, 0.01%accuracy
- Upper threshold: adjustable in the following range: 0.001...99999 m^3/h
- Lower threshold: adjustable in the following limit 0.001...99999 m^3/h
- Liquid speed: unit m/s, range: 0.001...15m/s
- Influence of interferences on the measurement: 0...100%

It is possible to replace the volume units (m3) by mass units (tones). It is then required to provide current temperature of the liquid through the RS485 link. If the device has been verified, the unit change does not concern the impulse output.

Output Signals

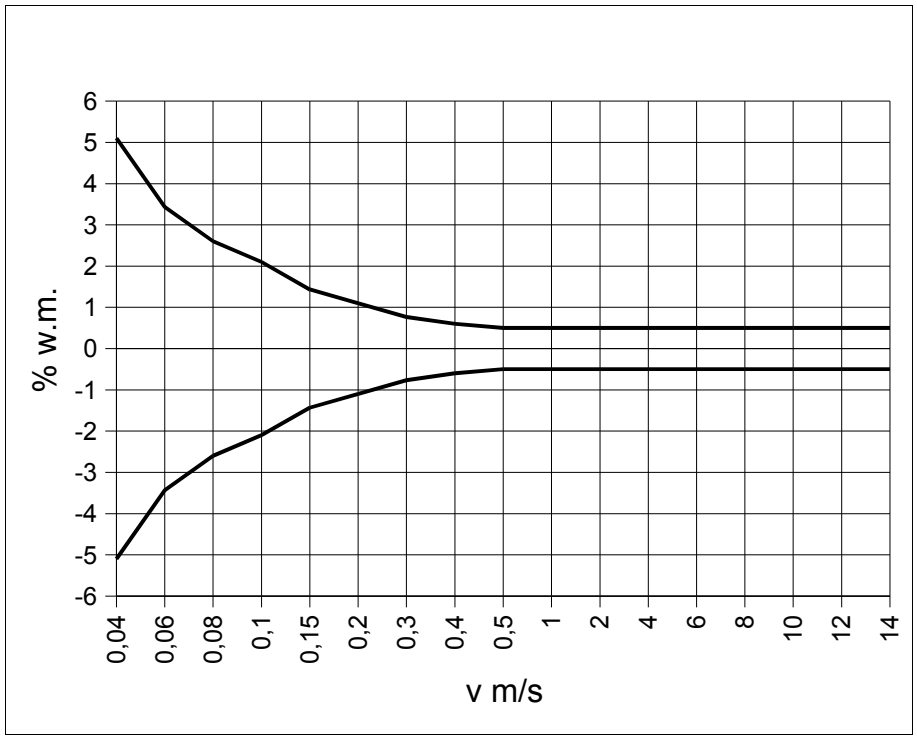
- Impulse output
  -Passive output, galvanically isolated, the open collector type
  -Impulses in the form of rectangular wave with a 50% filling
  -programming unit in the following range: 0.0001...999 m^3/impulse
  -Maximal output frequency 300Hz (up to 700Hz with the 30/70 filling)
  -Maximal voltage in the collector UcEmax=48V
  -Maximal current of the collector I_{max}<10mA
  -Resistance of the transistor's short circuit R<200Q for I_c=1mA
  -Current of the transistor's leakage conductance I_D<0.1uA dla U_{CE}<48V and T_a<55°C
  -Voltage of the isolation 3750V_{rms}
- Current output
  -Active output, galvanically isolated 0/4...20mA
  -0/4mA change and the way of acting for the negative flow programmed by the user
  -Load resistance R_L<500Q
  -nonlinearity <0.2%
  -resolution 5uA
- Lower threshold output
  -passive output, galvanically isolated, open collector type, a flow smaller than the set threshold causes short circuit of the transistor
- Upper threshold output
  -passive output, galvanically isolated, open collector type,
  -a flow larger than the set threshold causes short circuit of the transistor
- Flow direction output
  -passive output, galvanically isolated, open collector type,
  Reverse flow (with a minus sign on the display) causes short circuit of the transistor
  NB:The transistors' emitters of threshold outputs and flow direction are linked, limiting parameters are identical as in the case of the impulse output
- Digital, serial output RS485
  -isolated, galvanically polarized with the 120om termination
  -possibility of shutting off the termination and polarization by the user
  -transmission protocol compliant with MODBUS RTU
  -serial output parameters programmable by the user: parity control, transmission speed in the 1200...9600B/S range, address in the 01_H...FF_H range

Accuracy of Measurement

Relative error of the measurement is defined by the following formulae:
o=±(0.1+0.2/v)% w.m. for v<0.5m/s
o=±0.5% w.m. for v>0.5m/s
v – liquid speed in m/s
The formulae are applicable for the impulse output and summing the volume in the inside counter of the two-path flow meter wet calibrated on the flow stand.
Additional nonlinearity for the current output: <±0.2%.

In the case if the flow meter is theoretically calibrated (ultrasound probes installed directly in the existing pipeline), the relative error might increase by 0.5-1.5% w.m.

Scope of Error



Metrological Control and Verification

- The flow converters for heat meters are verified in the verification premises with cold or hot water.
- The cold water meters are verified in the verification premises.
- The flow meters which do not require verification with the flow sensor ended with a flange or a screw thread of the DN15... DN1200 diameters are calibrated with cold water in the SONIX flow stand or other.
- Flow meters which do not require verification with probes installed in the existing pipeline (DN250...DN2000) are calibrated with the theoretical method in accordance with the Polish PN/M-42370 Norm.

Constant of Time

It is programmable be the user in the 0.5...30s range.

Length of probe Cables

DN15...200 -up to20m
DN250..2000-up to 50m

Flow Measurement in Both Directions

Summing the volume for the negative flow takes place in a separate volume counter.
Output signal of the flow direction (short circuit of the transistor)
Calibration in the flow stand in the verification premises and in the SONIX company is done for positive flows.

Temporary Volume

An additional volume counter enabling dosing liquid is controlled with push buttons or via the RS485 link.

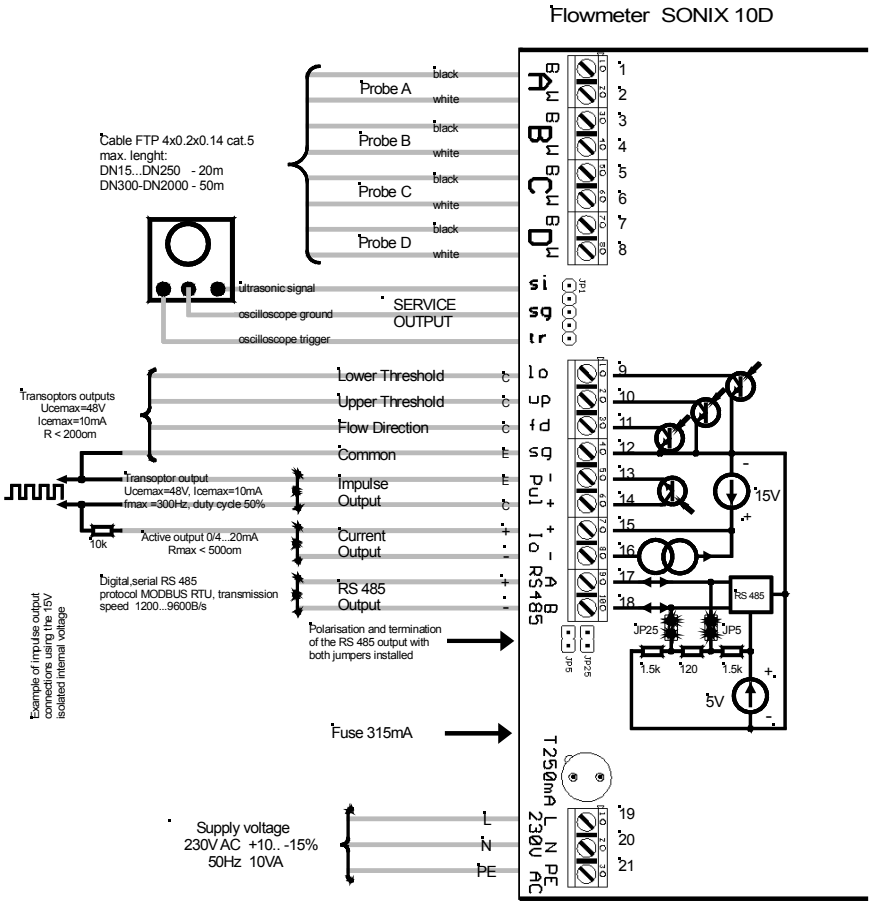
Range of Measurement

Flow measurement in the 0-15m/s range of liquid speed. Value of the flow corresponding to the 20mA output current is programmable by the user.
Measurement dynamics better than 300 : 1

Power supply

230V AC +15% -10%, 50Hz ±2%
24V AC +15% -10%, 50Hz ±2% (optional)
Power consumption <10VA
The 315mA fuse (3.15A for 24V AC) in the measuring transducer
Power failures do not cause data loss or the loss of programmed parameters.

Electrical Connections



Error Signaling

Errors in the work of the flowmeter are divided into two groups:

I. Errors causing incorrect measurement and requiring immediate servicing. The occurrence of such error is signaled by periodical blanking of the display every 0.3s. All outputs return to non-active states. Volume counting and the counter of correct work are blocked. The description of the error is displayed on the servicing screen.

II. Errors of lesser importance which do not influence the accuracy of measurement but require servicing within a few weeks or months. The occurrence of such error is signaled by periodical blanking of the display every 4s. All functions and outputs remain active. The description of the error is displayed in the servicing screen.

WORK CONDITIONS

Environment

Flow sensor
-temperature of the liquid and the environment -4O...+15O°C, further than 10cm from the surface one should provide the ultrasound probe cables temperature not higher than +70°C
-relative humidity up to 100%

Measuring transducer
-Temperature of the environment O...+55°C
-Relative humidity up to 93%

Level of Protection

Measuring transducer IP54 (IP65 optional)
Flow sensor IP67 (IP68 optional)

Liquid Parameters

Temperature:
-flow transducer for heat meters 0...130 C
-cold water meters 0...30PC
-flow meters not requiring verification -40...150 C
Temporary exceeds up to 180 C are allowed.
Working pressure up to 2.5MPa (4MPa optional)
PH3...11
Content of small solid impurities up to 2% in weight
Content of gas bubbles up to 2% in volume
Liquid pressure of >50kP must be provided for pipelines of gravitational flow.

Electromagnetic Compatibility

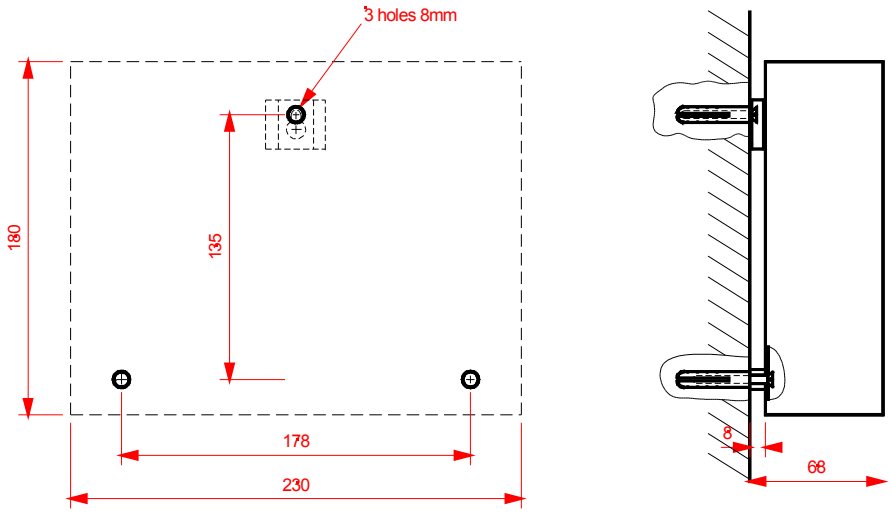
Compliant with EN 61000

ASSEMBLY CONDITIONS

Measuring Transducer

On-wall steel powder painted casing or made of acid-resistant steel of the following dimensions 230x180x60mm. Cables attached from below via chocking coils of the acceptable cable diameter of 5-7mm.

Method of Attachment



Recommendations for Assembly

It is acceptable to assembly the device in the open air in a heated protective cabinet. Due to temperature range of 0-55 C during the summer months, the cabinet should be located in the shadow.

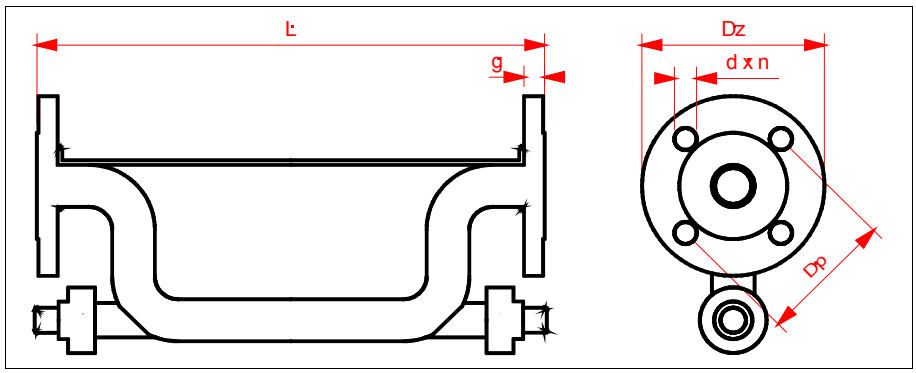
Flow sensor

Standard realization:

- DN15...40, 0H18N10 steel, screwed or flanged terminals,pressure of 1.6MPa
- DN50...200, I R35 steel powder painted or the 0H18N10 steel, flanged terminals 1.6MPa.
- DN250...300, R35 steel, painted, flanged terminals 1.6MPa,
- DN350...1200, R35 steel, painted, flanged terminals LOMPa,
- DN250...2000, assembly on an existing pipeline

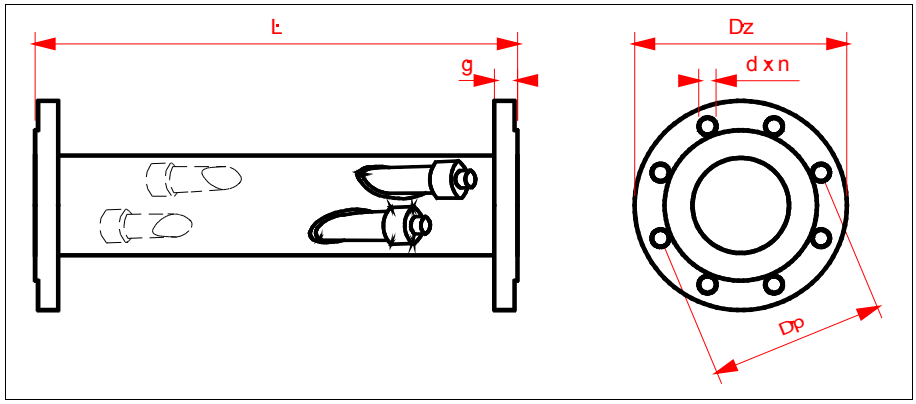
Dimensions of the flow sensors

DN15...40



DN	dimensions	L	D_z	D_p	g	d	n
15	21.3x2	300	95	65	14	M12	4
20	26.9x2	320	105	75	16	M12	4
25	33.7x2	340	115	85	16	M12	4
32	42.4x2	360	140	100	16	M16	4
40	48.3x2	400	150	110	16	M16	4

DN50...1200



DN	dimensions	L	D_z	D_p	g	d	n
50	60.3x3.6	500	165	125	20	M16	4
65	76.1x4	500	185	145	20	M16	8
80	89x4	500	200	160	22	M16	8
100	108x4	500	220	180	24	M16	8
125	133x4	500	250	210	26	M16	8
150	159x4.5	500	285	240	26	M20	8
200	219.1x6.3	500	340	295	30	M24	12
250	273x7.1	600	405	355	30	M24	12
300	323.9x8	600	460	410	32	M24	12
350	355x8.8	600	505	460	30	M20	16
400	406x8.8	600	565	515	32	M24	16
500	508x11	700	670	620	34	M24	20
600	610x11	700	780	725	38	M27	20
800	813x11	800	1015	950	44	M30	24
1000	1016x12	900	1230	1160	60	M33	28
1200	1220x12	1000	1455	1380	75	M34	32

NB:
DN15..DN300 – pressure of 1.6MPa
DN350...DN1200 – pressure of 1.0MPa

Recommendations for assembly of the flow sensor

The choice of location and manner of the assembly of the flow sensor decides on the metrological properties of the device.
The following conditions must be met in order to provide correct measurement:

1. Lack of aeration of the liquid
2. 100% filling of the pipeline
3. Small suppression of the sound wave
4. Stabilized and symmetrical profile of liquid speed

The U-shaped sensor must be assembled horizontally or at the 45° angle max. The assembly position of the remaining type of sensor depends on the choice of the user. The probes must be located in the horizontal surface i.e. at both sides of the pipeline and not below and above it. The acceptable deviation from the level equals 25°.

Lack of liquid aeration

Cavitation cannot occur before the measurement spot. Overflows and cascades in gravitational pipelines and places in which the liquid sucked in from the open tank carries foam or air bubbles much be separated from the sensor with an deaerating element.

100% filling of the pipeline

The flow sensor must not be assembled in the highest point of the pipeline.
In gravitational pipelined, flows near the filling limit must be avoided by using a min. 50cm water seal.

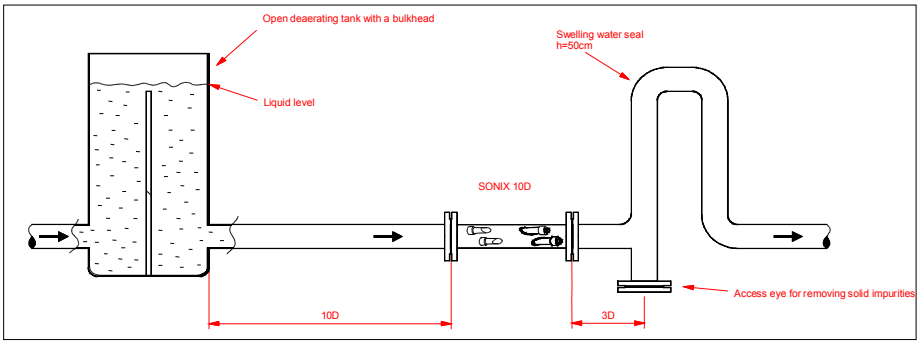
Stabilized and symmetrical profile of liquid speed

One should elongate the connecting straight sections behind the pumps, not entirely open valves etc. The usage of stream straightening machines enables diminishing the required lengths of straight sections of the pipeline.

Suppression of the sound wave

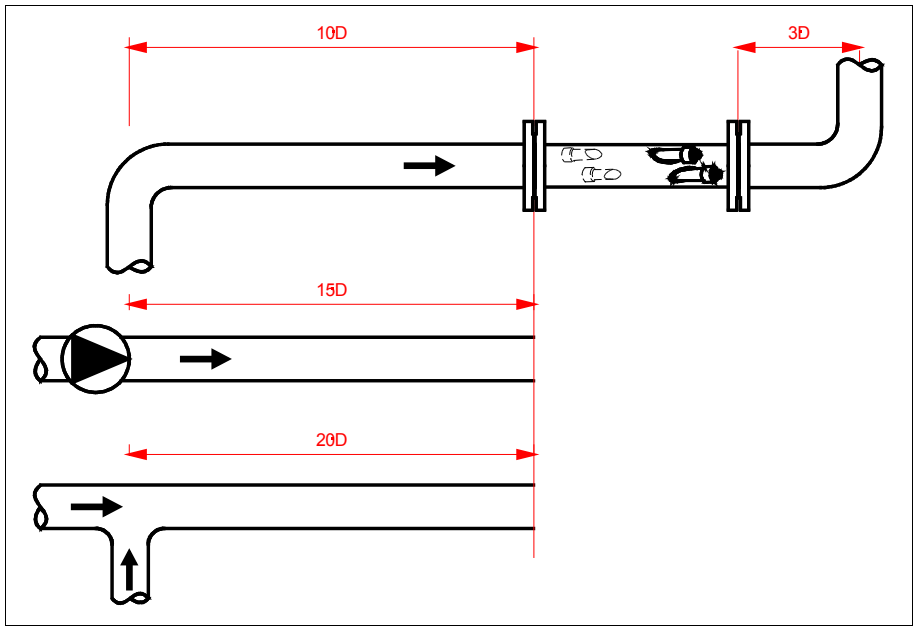
One should prevent the accumulation of impurities near the flow sensor. In the case of sewage periodically pumped out from the tank, one should provide possibly homogeneous contents of the liquid, e.g. by means of using an initial mixing pump.

Example of assembling the flow sensor in measuring sewage flow in a gravitational pipeline.



Straight sections

In the majority of cases, straight sections of the following lengths are sufficient:
-Inlet: 10D
-Outlet: 3D
Two- or more surface spatial configurations of the pipeline, the pump, not entirely closed valves, side inlets etc. require appropriate elongation of the straight sections before and behind the measuring spot. The U-shaped flow sensor does not require inlet straight sections.



RECOMMENDED MEASUREMENT RANGES

Metrological parameters of flow transducers for heat meters

DN	q_i	q_p			
Nominal diameter (mm)	Minimal flow (m^3/h)	Nominal flow (m^3/h)			
		SONIX 10D-1	SONIX 10D-2	SONIX 10D-3	SONIX 10D-4
50	0,3	4	10	15	25
65	0,5	8	15	25	40
80	0,8	10	20	40	60
100	1,2	15	30	60	90
125	2,5	20	45	90	130
150	3	30	60	130	180
200	5	60	120	220	350
250	8	100	190	380	500
300	12	130	270	500	-
350	16	170	350	500	-
400	20	220	430	500	-
500	30	330	500	-	-
600	43	500	-	-	-

Authorization of the type: decision no ZT 229/2004
Authorization mark of the type: PLT 0436
Maximal flow: qs = 2qp

Metrological parameters of cold water meters

DN	Q_1	Q_3	Q_4
Nominal diameter (mm)	Minimal stream of volume (m^3/h)	Constant stream of volume (m^3/h)	Overloading stream of volume (m^3/h)
50	0,3	15	30
65	0,5	25	50
80	0,8	40	80
100	1,2	60	120
125	2	100	200
150	3	150	300
200	5	250	500
250	8	400	800
300	10	500	1000

Metrological parameters for flow meters not requiring verification

DN	Q_1	Q_3
Nominal diameter (mm)	Minimal stream of volume (m^3/h)	Recommended range of the constant stream of volume/ the nominal flow (m^3/h)
15	0,05	0,4...2
20	0,1	0,7...4
25	0,2	1,4...8
32	0,3	2...12
40	0,4	2,6...16
50	0,3	5...25
65	0,5	10...40
80	0,8	13...60
100	1,2	18...90
125	2,5	25...130
150	3	40...180
200	5	80...350
250	8	130...550
300	12	150...750
350	16	180...950
400	20	250...1100
500	30	380...1800
600	43	600...2500
800	80	1000...4200
1000	120	1500...7000
1200	180	2100...10000
1400	240	2800...12000
1600	307	3800...16000
2000	480	5800...25000

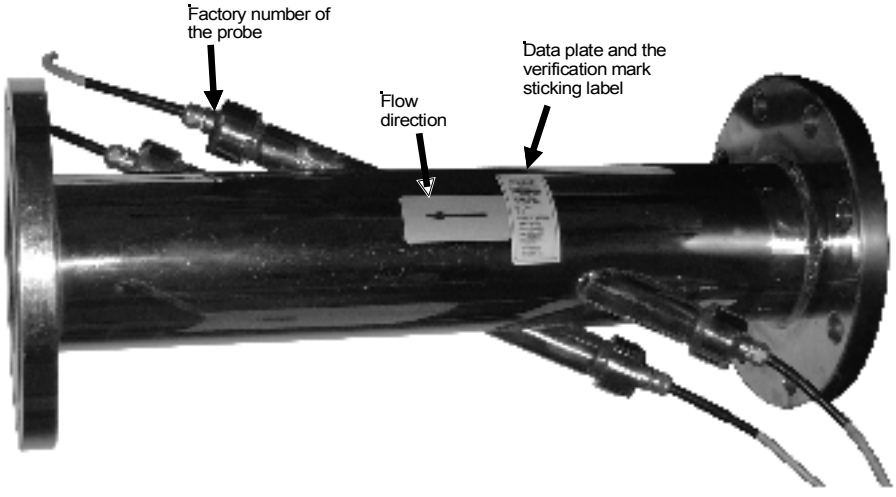
LABELS

General Information

- Measuring transducer:
  -data plate
  -description of the terminal strip
  -user protection mark (a seal)
  -protection mark (a seal)
  -verification mark (a sticking label)
- Flow sensor
  -data plate
  -flow direction
  -factory number located on each probe
  -verification mark (a sticking label)
- Probe cables
  -A, B, C and D letters on each cable

Location of labels

Flow sensor



Measuring transducer