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V 3112

EU-TYPE EXAMINATION CERTIFICATE

Number: TCM 142/18 - 5542

In accordance: with Directive 2014/32/EU of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments (implemented in Czech Republic by Government Order No. 120/2016 Coll.).

Manufacturer: Przemyslowe Urzadzenia Elektroniczne SONIX
ul. Leopolda Lisa-Kuli 12
05-270 Marki
Poland

For: ultrasonic flow sensor for thermal energy meters

Type: SONIX 30D

Accuracy class: 2

Mechanical environment class: M1

Electromagnetic environment class: E1

Valid until: 10 April 2028

Document No: 0511-CS-A009-18

Description: Essential characteristics, approved conditions and special conditions, if any, are described in this certificate.

Date of issue: 11 April 2018

Certificate approved by:

Český metrologický institut -3-

v. z.

RNDr. Pavel Klenovský

1. Measuring device description

Measuring method

The measurement channel of the **ultrasonic flow sensor for thermal energy meters (in next text flowmeter)** is devided into two parts: the flow sensor and the electronic transducer. The flow sensor is a flanged pipe section with mounted ultrasonic probes, which collects information about liquid flow velocity. Electronic transducer generates the signals that cause the mechanical vibrations of piezoceramic plates in the probes, collects the received signals from the probes and converts them into output signals. Simplified structural diagram of a ultrasonic flowmeter is presented on fig. 1 and measuring steps are explicated below. Blocks 1- 4 execute the processing equation (next text) while in block 5 the recovery of the measured value q_v^* takes place.

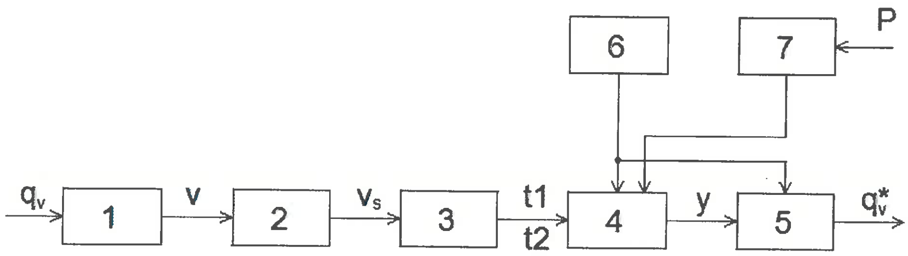

Fig. 1 Structural diagram of the ultrasonic flowmeter.

1 - transformation of the volume flow q_v into liquid velocity distribution v
2 - obtaining average velocity v_s on the acoustic path
3 - transformating v_s into two times t_1 and t_2
4 - processing these times in the electronic transducer into digital output signal y
5 - recovery of the measured value q_v (q_v^* - this value includes also an error of measurement. From this value, impulse outputs of flowmeter are generated)
6 - power supply
7 - programming the electronic transducer during calibration of the flowmeter with the parameters P (eg. pipe diameter, wall thickness, correction coefficients, etc.)

The method of measurement uses the phenomena associated with the transmission of ultrasonic waves through the flowing liquid. High frequency ultrasonic wave is transmited between the ultrasonic probes mounted on the pipe wall (see fig.2). For simplicity, the drawing only applies to one of the three acoustic path. When the wave is transmitted in line with the direction of the liquid motion, the liquid velocity-dependent component increases its propagation speed, in opposite direction propagation speed decreases. The flowmeter measures transit times t_1 and t_2 in both directions and based on them calculates the average velocity of the liquid on the acoustic path. For small liquid velocity, the flow in the pipeline can be laminar and changes to turbulent for larger one. Depending on the configuration of the pipeline, the cross-sectional velocity distribution can be symmetrical or distorted. Both of these phenomena determine the accuracy of flow measurement. Three parallel acoustic paths used in the SONIX 30D flowmeter and the suitable correction algorithms limits the effect of both these phenomenas.

Simplified flowmeter work equations:

$t_1 = \frac{L}{c+v_s cos\alpha}$ - transit time in line with the flow direction

$t_2 = \frac{L}{c-v_s cos\alpha}$ - transit time against flow direction

where are:

L - distance between probes
c - velocity of sound propagation in liquid
v_s - average liquid velocity on an acoustic path
α - the acoustic wave transmission angle with respect to the pipe axis

To eliminate the propagation velocity c from the formula and thus make the measurement result independent of the temperature and other liquid properties, the difference between the reciprocal of the transition times t_1 and t_2 is calculated

$$\frac{1}{t_1} - \frac{1}{t_2} = \frac{2v_s cos\alpha}{L}$$

The liquid speed v_s is determined on an ultrasonic path with a diameter of a dozen or so millimeters passing through the flowing liquid at an angle α at a fixed distance from the axis of the pipeline.

In order to obtain the average speed in the entire pipeline cross section, the correction coefficient should be applied.

$$v_{av} = \frac{kL}{2cos\alpha}\left(\frac{1}{t_1} - \frac{1}{t_2}\right)$$

where are:
v_{av} – average speed of the liquid throughout the entire pipeline cross-section
k – correction coefficient

The average volume flow is then calculated from the formula :

$$q_v = \frac{\pi v_{av} D^2}{4}$$

where:
D - it is a pipeline diameter

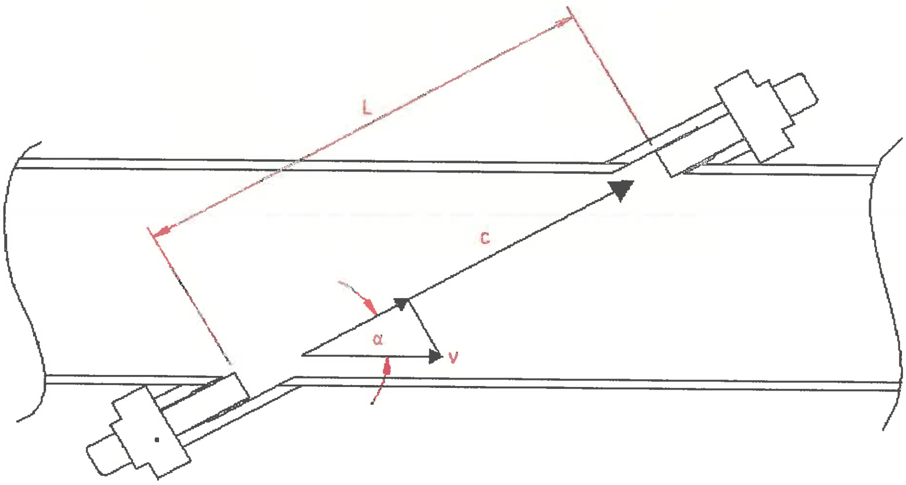

Fig. 2 One of three ultrasonic paths. Speed of liquid is marked here only as *v*, more precise defined in over presented equation.

Description of the device's construction

Ultrasonic probes
All types of ultrasonic probes used in the SONIX 30D flowmeter have identical electrical and acoustic properties. They differ only in mechanical construction. Therefore replacing the probes does not change the metrological properties of the flowmeter. The choice of the type of probes is made depending on the pipeline diameter, available space, kind of application and customer requirements. The probes have contact with water in the pipeline. It is not possible to remove or replace the probe when the pipeline is under pressure. Next table 1 specifies a types and utilization of different probes.

Table 1

Flowmeter type	Probes type	Pipe diameter range DN
SONIX 30D	MKT	65 – 300
	SKTK	200 – 1400
	SKT	200 – 1400
	DKTK	250 – 1400
	DKT	300 – 1400

Flow sensor
The flow sensor is a section of steel pipeline ending with flanges. There are 6 ultrasonic probes forming 3 parallel acoustic paths in the flow sensor. One path passes through the pipeline axis, the other two are arranged at equal distances below and above the axis. The paths form an angle with the direction of the liquid movement, the value of which is selected depending on the diameter of the flow sensor.

Measuring transducer
PCB with electronics is in a steel casing adapted for vertical mounting on the wall. The housing is closed with two covers. The inner cover protects access to the PCB, while the outer cover, removable after unscrewing four M3 screws, protects access to the terminal block and the power supply fuse. Both covers can be sealed independently of each other.
In the lower part of the housing there are 9 cable glands for cables with an outer diameter of 4.5-6.5mm.
The measurement results are read on a 2x16 characters LCD display visible through a transparent window in the outer cover. Under it there are two control buttons.

Ultrasonic flowmeters SONIX 30D are manufactured according to the technical documentation of the company SONIX:
- Electrical diagrams SONIX 30D, dated 6.6.2016
- Instruction for Assembly and Operating, dated 17.2., 14.06.2017
- Software Description, dated 2.02.2018.

All documents are deposited in CMI.

2. Basic technical data

2.1 Diameters DN, lengths, flow parameters

Next table 2 presents over specified information concerning the flowmeter

Table 2

Nominal diameter DN	Minimum flowrate q_i [m³/h]	Permanent (nominal) flowrate q_p [m³/h]	Maximum flowrate q_s [m³/h]	Flow sensor length [mm]
65	0,8	40	60	500
80	1,2	60	90	500
100	1,8	90	135	500
125	2,6	130	195	500
150	3,6	180	270	500
200	7	350	525	500
250	10	500	750	600
300	15	750	1125	600
350	18	900	1350	600
400	24	1200	1800	600
450	28	1400	2100	700

Table 2 continue

Nominal diameter DN	Minimum flowrate q_i [m³/h]	Permanent (nominal) flowrate q_p [m³/h]	Maximum flowrate q_s [m³/h]	Flow sensor length [mm]
500	36	1800	2700	700
600	50	2500	3750	700
700	60	3000	4500	800
800	80	4000	6000	800
1000	130	6500	9750	900
1200	200	10000	15000	1000
1400	280	14000	21000	1200

2.2 Technical data common to all DN diameters:

Following table 3 specifies these parameters.

Table 3

Name	Value
Permanent flow/Minimal flow	50
Maximum flow/Permanet flow	1,5
Flow sensor orientation	arbitrary, see manual
Accuracy class	2
Liquid temperature Tmin/Tmax	10/135°C, shortly up to 180°C
Maximum working pressure PS	up to 40 bar
Pressure loss at permanent flow	max 0,1 bar
Enviromental class	A
Mechanical environment class	M1
Electromagnetic environment class	E1
Flow profile classes	U10D3
Pulse output	OC, npn, U_{max}=50V, I_{max}=0,1A
Lenght of pulse output cables	up to 1,2 m
Lenght of signal cables (from probes to transducer)	unlimited
Pulse output unit	0,05...1000 l/pulse
Power supply	230V AC ±10%, 6VA
Software version	19.17
Software checksum	9C57
Hardware version	30D-6-06.2016

3. Test

Technical tests of ultrasonic flowmeters SONIX 30D were performed in compliance with the International Recommendation OIML R 75 Edition 2006 (E) and with conformity to EN 1434:2015.
EMC test and shock/vibration tests were performed in accordance with relevant points of standard EN 1434,-4:2015 and of document OIML D11:2013 (also in accordance with other relevant documents and standards).
SW validation was performed concerning relevant points of document WELMEC Guide 7.2.
Results of all performed tests are presented in:

- Test report Nr. 6015-PT-0013-18 from March 15th 2018 (elaborated by CMI), metrological tests
- Test report Nr. 8553-PT-S1001-18 from February 8th 2018 (elaborated by CMI), SW validation
- Test report Nr. 16/2016 from July 4th 2016 (elaborated by Military Institute of Armament Technology, Poland, accredited laboratory), EMC tests
- Test report Nr. 24/2017 from December 4th 2017 (elaborated by Military Institute of Armament Technology, Poland, accredited laboratory), EMC tests
- Test report Nr. 78a/2017 from December 6th 2017 (elaborated by Instytut Tele – i Radiotechnyczny, Poland, accredited laboratory), climatic tests, statement, explication of manufacturer Nr. 64/R/18 from February 15th 2018 concerning MPE by these tests
- Test report Nr. 704216-01/01 November 29th 2017, (elaborated by Electrotechnical testing institute Prague, CZ, accredited laboratory), vibration/shock tests.

All documents are deposited in CMI.
Remark: Concerning results of tests, construction and dimension of ultrasonic flowmeters SONIX 30D, next verification of these meters (after spending a valid time period for verification) can be performed by cold water. Also statement of manufacturer Nr. 191/R/18 from 3rd April 2018.

4. The measuring device data, inscription, labeling, SW version, CRC

There are a following information and marking on SONIX 30D ultrasonic flowmeters:

Information and labeling are separated on 4 parts:

a)
An arrow indicating the flow direction - on the flow sensor, Fig. 3

b)
The rating plate, label - on the flow sensor, Fig. 3
- manufacturer name and address
- measuring device type
- serial number/year of manufacture
- pipeline diameter DN
- pulse output unit
- flow range qi,qp,qs
- maximum admissible pressure PS
- liquid temperature range
- flow profile class
- PED directive reference

Detail label, see you Fig. 4

c)
Main metrological label - on the left side of the flowmeter housing (case), Fig. 5 and 6
- manufacturer name
- the "CE" and metrology marking
- number of EU-type examination certificate
- accuracy class

d)
Supplementary label - on the right side of the flowmeter housing, Fig. 7, 8
- manufacturer name and address
- measuring device type
- serial number/year of manufacture
- software version
- software checksum CRC
- parameters checksum P
- pipeline diameter DN
- pulse output unit
- flow range qi, qp, qs
- maximum admissible pressure PS
- liquid temperature range
- power supply data
- environmental and mechanical classes
- accuracy class

On Fig. 9, there are given the values of SW version, CRC, and checksum P (depending on programmed parameters) on display of meter.

5. Sealing

Main metrological seal of SONIX 30D ultrasonic flowmeter is placed above the screw on the inner cover of PCB. It is under a housing (case) of transducer. It prevents access to PCB and processor programming connectors. The seal is a plastic sticker. It is displayed on Fig. 10.

An installation seal is placed on the case of transducer in holes of two pins: one in outer cover and the second in the housing base. It protects access to the terminal block, preventing the cables from being unscrewed. The seal is clamped on a cord. Installation seal is presented on Fig. 5.

Ultrasonic probes of all types (presented in table 1) are protected by installation seals. Each of 6 probes installed in the pipe of flow sensor are sealed separately. Wire, connecting a probe with the pipe of flow sensor and assured by seal avoids a dismantling of the probe which could cause a wrong function of flowmeter. This sealing of the probes is realized inspite of text in chapter 1 that probes can not be removed when flow sensor is under pressure. Example of installation seal of probe type DKT is presented on Fig.11.

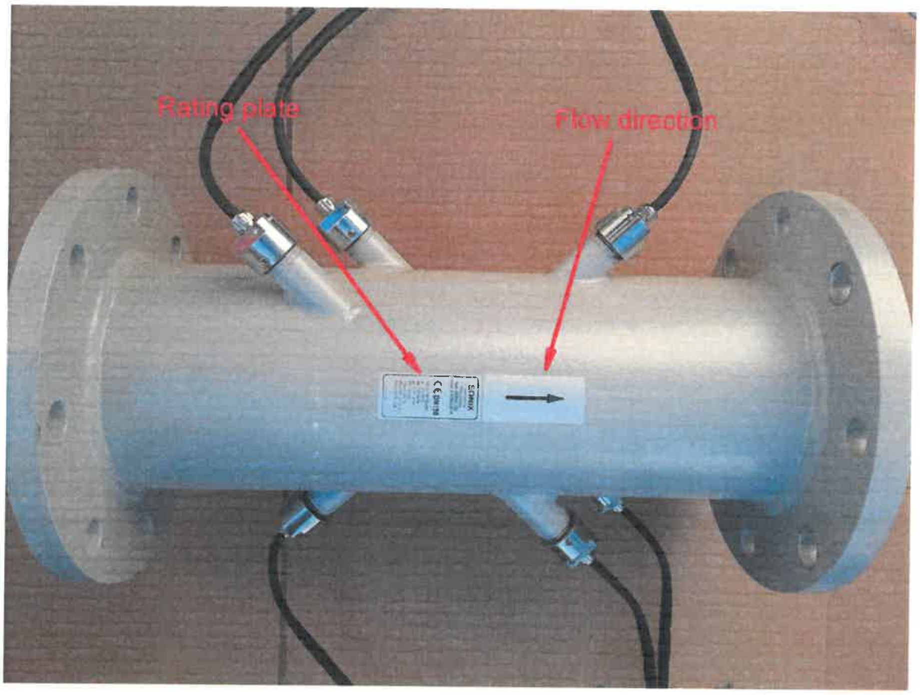

Fig 3, labels on the flow sensor

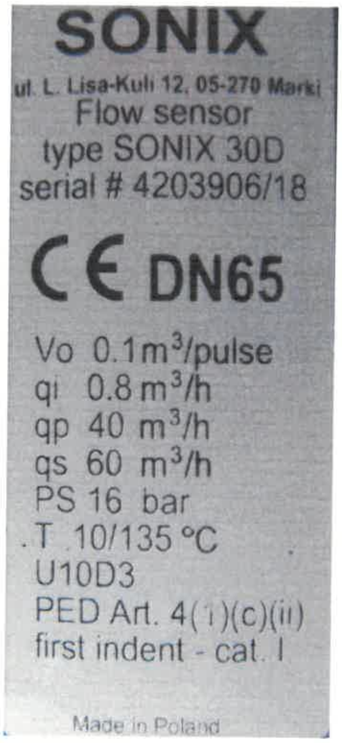

Fig 4, label on flow sensor, detail

Fig 5, main metrological label on case of transducer, installation seal

Fig 6, main metrological label in detail

Fig 7, supplementary label on right side of transducer case

Fig 8, supplementary label in detail

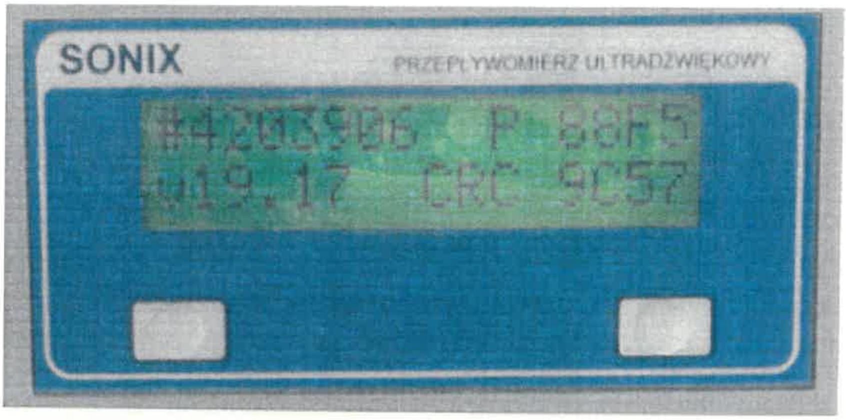

Fig 9, SW version, CRC and checksum P

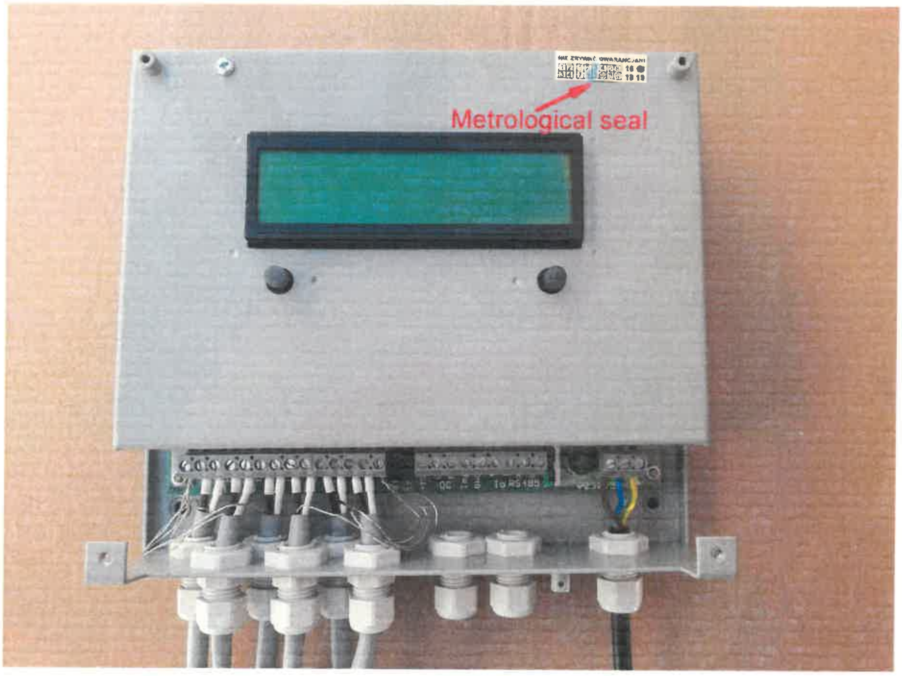

Fig 10, main metrological seal covering PCB platine under a housing of transducer

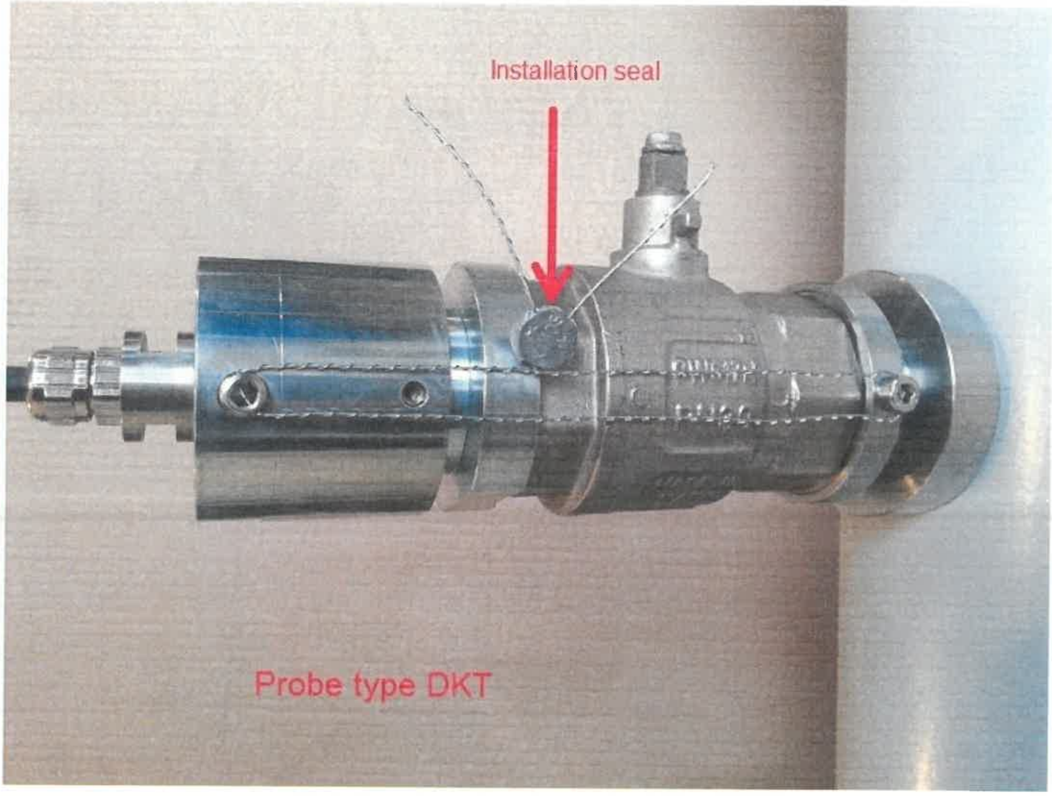

Fig 11, installation seal of ultrasonic probe, here of type DKT