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V 3112

EU-TYPE EXAMINATION CERTIFICATE

Number: TCM 142/16 - 5353

In accordance: with Directive 2014/32/EU of the European Parliament and of the Council on the harmonisation 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: ELIS PLZEŇ a.s.
Luční 15
301 64 Plzeň
Czech Republic

For: flow sensor (sub-assembly of thermal energy meters)
type SONOELIS SE 4041 and SONOELIS SE 4011

Accuracy class: 2
Temperature range ($\Theta_{min} \div \Theta_{max}$): 0°C - 180°C
Mechanical environments class: M1
Electromagnetic environments class: E1, E2

Valid until: 8 May 2026

Document No: 0511-CS-A014-16

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

Date of issue: 9 May 2016

Certificate approved by:

Český metrologický institut NOTIFIKOVANÁ OSOBA 1383 AO 250 2

RNDr. Pavel Klenovský

1. Measuring device description

The flow meter section is based on a single-channel "transit-time" impulse method where the flow rate of the measured liquid is determined from the flight time of ultrasonic signal between the sensor probes. The ultrasonic signal is sent and flow-rate measurements are performed in turns in and against the flow direction whereby the error due to non-symmetric positions of the ultrasonic probes is eliminated.

The ultrasonic signal propagation time in the flow direction in flow sensor UC 3.0 is defined by the equation

$$t_1 = \frac{l}{c + v.\cos\alpha} + \frac{l_1}{c_1} \qquad [s]$$

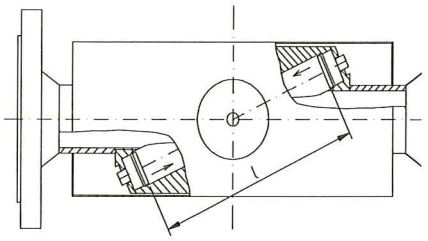

Fig. 1 Ultrasonic flow sensor (UC 3.0)

where
- l - distance between the head parts of ultrasonic probes [m]
- c - signal propagation speed in the given liquid [m/s]
- v - flow speed of the measured liquid [m/s]
- l_1 - aggregate thickness of bottom parts of both probes [m]
- c_1 - signal propagation speed in the probe material [m/s]

When the ultrasonic signal travels in the direction against the flow, the expression for the signal propagation time t_2 differs from t_1 in that the flow speed is negative:

$$t_2 = \frac{l}{c - v \cdot \cos\alpha} + \frac{l_1}{c_1} \qquad [s]$$

Parameters l1 a c1 are constants for the given sensor probe.

The ultrasonic signal propagation speed can be expressed as follows:

$v_1 = c + v.\cos\alpha$ for measurements in the flow direction

$v_2 = c - v.\cos\alpha$ for measurements against the flow direction

The difference between the ultrasonic signal propagation speeds in and against the flow direction is proportional to the liquid flow speed v [m/s].

$$v = \frac{v_1 - v_2}{2.\cos\alpha}$$

The instantaneous flow rate can be determined using the equation:

$$q = v \cdot s \cdot k(v) \qquad [m^3 / s]$$

where
- v - liquid flow speed [m/s]
- s - sensor cross-section [m2]
- $k(v)$ - correction coefficient (a function of the instantaneous liquid speed). This coefficient modifies the resulting q with respect to the liquid flow speed profile in the sensor.

The ultrasonic signal propagation time in the flow direction in flow sensor UC 7.0 is defined by the equation

$$t_1 = \frac{l}{c+v} + \frac{l_1}{c_1} + \frac{l_2}{c} \qquad [s]$$

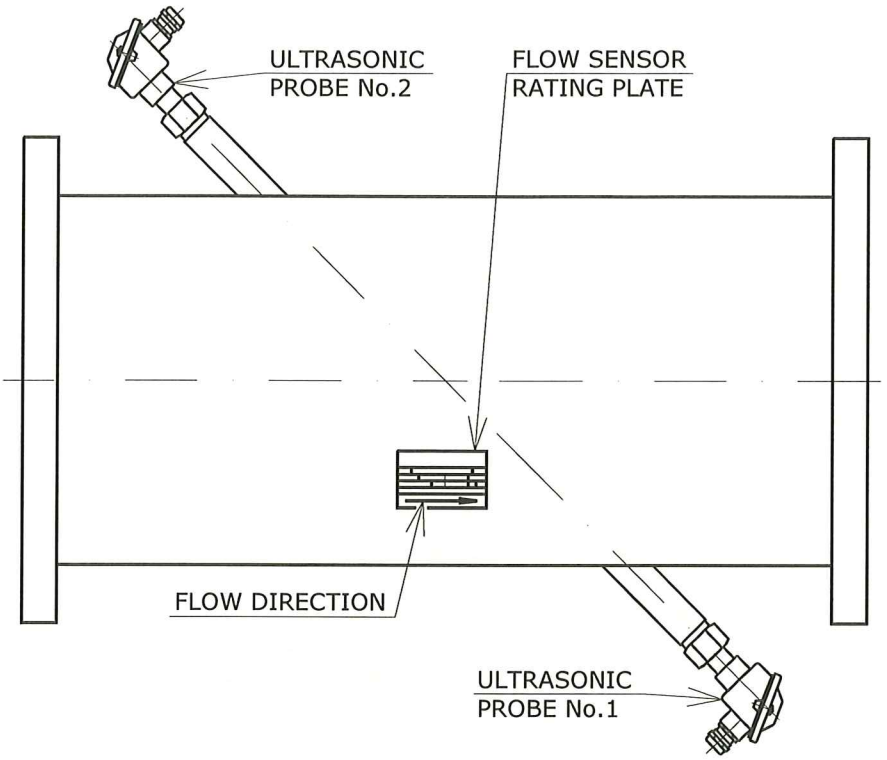

Fig. 2 Ultrasonic flow sensor (UC 7.0) - description

where
- l - distance between the reflectors [m]
- c - signal propagation speed in the given liquid [m/s]
- v - flow speed of the measured liquid [m/s]
- l_1 - aggregate thickness of bottom parts of both probes [m]
- c_1 - signal propagation speed in the probe material [m/s]
- l_2 - dimension (see the above drawing)

When the ultrasonic signal travels in the direction against the flow, the expression for the signal propagation time t_2 differs from t_1 in that the flow speed is negative:

$$t_2 = \frac{l}{c-v} + \frac{l_1}{c_1} + \frac{l_2}{c} \qquad [s]$$

Parameters l1 a c1 are constants for the given sensor probe.
The ultrasonic signal propagation speed can be expressed as follows:

$v_1 = c+v$ measurements in the flow direction

$v_2 = c-v$ measurements against the flow direction

The difference between the ultrasonic signal propagation speeds in and against the flow direction is proportional to the liquid flow speed v [m/s] :

$$v = \frac{v_1 - v_2}{2}$$

The instantaneous flow rate can be determined using the equation:

$$q = v \cdot s \cdot k(v) \qquad \left[m^3 / s\right]$$

where v - liquid flow speed [m/s]
s - sensor cross-section [m2]
k(v) - corrective coefficient (a function of the instantaneous liquid speed).
This coefficient modifies the resulting q with respect to the liquid flow speed profile in the sensor.

Electronic unit:
The flow-meter electronic unit is embedded in a plastic box with a steel sheet attached at the back for vertical mounting. At the front panel on the box there are meter type designation and product name, production series number, manufacturer's name and logo, two-line back-lighted display unit and a membrane keyboard. At the bottom of the box under a removable plastic cover are plastic grommets for cables of circular cross-section (one PG 9 and six or seven PG 7 grommets). The grommets are intended for tight fitting of cables of external diameter 6 to 8mm (PG 9) and 4 to 6mm (PG 7). At the bottom of the box there is also an earthing bolt. Both the front panel and the terminal board cover can be sealed. Instead of one PG 7 grommet it is possible to fit. See you next figure 3:

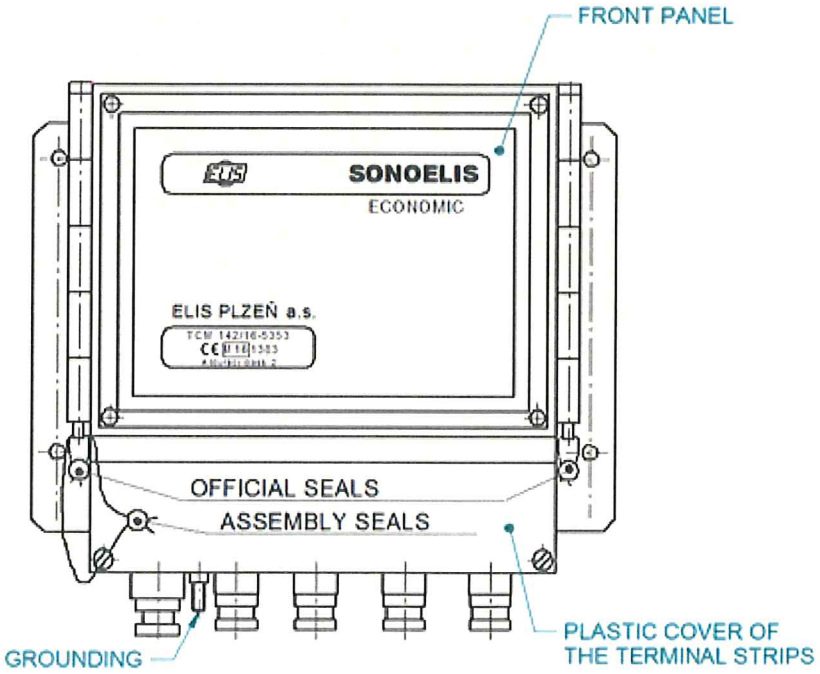

Fig. 3 - Electronic unit UP 2.10 – basic view

In next table 1 a designation of flow meter is given (Type and model designations of flow meters and their components):

Table 1:

Model name	Meter model code	Evaluation electronic unit	Flow sensor	Diameter (DN) [mm]
SONOELIS	SE 4041	UP 2.10	UC 3.0	DN 32 – DN 300
SONOELIS	SE 4011	UP 2.10	UC 7.0	DN 200 – DN 1200

Ultrasonic flow meters SONOELIS SE 4011 and SE 4041 are manufactured according to the technical documentation of the company ELIS PLZEŇ a.s.:

Electric diagram, 18.6.2013
- Product application, installation and service manual SE404X 406X CZ M Es90200K March 2016
- Product application, installation and service manual SE401X 402X CZ M Es90336K March 2016

2. Basic technical data

2.1 Flow meters

Table 2, Sonoelis SE 4041:

Type of flowmeter	SONOELIS SE 4041					
Type of sensors	UC 3.0					
Nominal diameter (DN) [mm]	32	40	50	65	80	100
Overload flowrate (q_s) [m^3/h]	20	32	50	80	150	240
Permanent flowrate (q_p) [1] [m^3/h]	10	16	25	40	75	120
Minimum flowrate (q_i) [m^3/h]	0.20	0.32	0.50	0.80	1.50	2.40
Ratio q_p/q_i	50					
Ratio q_s/q_p	2					
Orientation limitation	Arbitrary, H (preferred)					
Accuracy class	2					
Effective output signal [l/pulse]	0,1-10000					
Pulse output – powe supply (Umax / Imax)	max. 30Vcc/ 0.2 A					
Temperature range ($\Theta_{min} \div \Theta_{max}$) [$°C$]	0-180°C					
Max. admissible working pressure [bar]	PS 40					
Maximum pressure loss classes at q_p [bar]	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10
Environmental class	A					
Electromagnetic class	E1, E2					
Mechanical class	M1					
Flow profile sensitivity classes	U5 D3					
Length [mm]	360	360	360	360	360	360
Connection type	standard flange					
Direction of flow	uni-directional with reverse flow detection					
Version of software	Program Es 90460 D/01					

Hardware version of PC board	UP 2.10 – Es100080
Power supply	90 ÷ 260 V AC, 50/60Hz

Table 2, continue:

Type of flow meter	SONOELIS SE 4041				
Type of sensors	UC 3.0				
Nominal diameter (DN) [mm]	125	150	200	250	300
Overload flowrate (q_s) [m^3/h]	350	500	900	1400	2000
Permanent flowrate (q_p) [m^3/h]	175	250	450	700	1000
Minimum flowrate (q_i) [m^3/h]	3.5	5.0	9.0	14	20
Ratio q_p/q_i	50 [2]				
Ratio q_s/q_p	2				
Orientation limitation	Arbitrary, H (preferred)				
Accuracy class	2				
Effective output signal [l/pulse]	0,1-10 000				
Pulse output – powe supply (Umax / Imax)	max. 30V/ 0.2 A				
Temperature range ($\Theta_{min} \div \Theta_{max}$) [$°C$]	0-180°C				
Max. admissible working pressure [bar]	max. PS 40				
Maximum pressure loss classes at q_p [bar]	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10
Environmental class	A				
Electromagnetic class	E1, E2				
Mechanical class	M1				
Flow profile sensitivity classes	U5 D3				
Length [mm]	360	360	450	450	450
Connection type	standard flange				
Direction of flow	uni-directional with reverse flow detection				
Version of software	Program Es 90460 D/01				
Hardware version of PC board	UP 2.10 - Es100080				
Power supply	90 ÷ 260 V AC, 50/60Hz				

Table 3, Sonoelis SE 4011

Type of flow meter	SONOELIS SE 4011					
Type of sensors	UC 7.0					
Nominal diameter (DN) [mm]	200	250	300	350	400	450
Overload flowrate (q_s) [m^3/h]	1000	1200	1500	1800	2000	2300
Permanent flowrate (q_p) [1] [m^3/h]	500	600	750	900	1000	1150
Minimum flowrate (q_i) [m^3/h]	16	19.2	24	28.8	32	36,85
Ratio q_p/q_i	50					

Ratio q_s/q_p	2					
Orientation limitation	Arbitrary, H (preferred)					
Accuracy class	2					
Effective output signal [l/pulse]	0,1-10000					
Pulse output – powe supply (Umax / Imax)	max. 30Vcc/ 0.2 A					
Temperature range ($\Theta_{min} \div \Theta_{max}$) [°C]	0-180°C					
Max. admissible working pressure [bar]	PS 40					
Maximum pressure loss classes at q_p [bar]	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10
Environmental class	A					
Electromagnetic class	E1, E2					
Mechanical class	M1					
Flow profile sensitivity classes	U5 D3					
Length [mm]	600	650	700	750	800	850
Connection type	standard flange					
Direction of flow	uni-directional with reverse flow detection					
Version of software	Program Es 90460 D/01					
Hardware version of PC board	UP 2.10 - Es100080					
Power supply	90 ÷ 260 V AC, 50/60Hz					

Table 3, continue

Type of flow meter	SONOELIS SE 4011					
Type of sensors	UC 7.0					
Nominal diameter (DN) [mm]	500	600	700	800	1000	1200
Overload flowrate (q_s) [m^3/h]	2500	3000	3600	4100	5100	6100
Permanent flowrate (q_p) [1] [m^3/h]	1250	1500	1800	2050	2550	3050
Minimum flowrate (q_i) [m^3/h]	40	48	57.60	65.6	91.6	97.6
Ratio q_p/q_i	50					
Ratio q_s/q_p	2					
Orientation limitation	Arbitrary, H (preferred)					
Accuracy class	2					
Effective output signal [l/pulse]	0,1-10000					
Pulse output – powe supply (Umax / Imax)	max. 30Vcc/ 0.2 A					
Temperature range ($\Theta_{min} \div \Theta_{max}$) [°C]	0-180°C					
Max. admissible working pressure [bar]	PS 40					
Maximum pressure loss classes at q_p [bar]	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10	Δp 0.10
Environmental class	A					
Electromagnetic class	E1, E2					

Mechanical class	M1					
Flow profile sensitivity classes	U5 D3					
Length [mm]	900	700	800	850	1000	1150
Connection type	standard flange					
Direction of flow	uni-directional with reverse flow detection					
Version of software	Program Es 90460 D/01					
Hardware version of PC board	UP 2.10 - Es100080					
Power supply	90 ÷ 260 V AC, 50/60Hz					

3. Test

Technical tests of the flow meters SONOELIS SE4011 and SE4041 were performed in compliance with the International Recommendation OIML R 75 Edition 2006 (E) with conformity to EN 1434:2007. Results are presented in Test Report No. 6015-PT-P0007-16 from April 2016.

EMC conformity concerning a standard EN 1434 has been performed repeatedly, the results are given in reports: ETL 15-34 2015

Validation of SW is concerning WELMEC guide 7.2. In accordance with Test report 8553-PT-S0012-16 from 15 April 2016.

3.1 The measuring device data

There are following data on the measurement device (outside of electronic box and sensors) see also next pictures Figure 4, Figure 5, Figure 6:

Main metrological label:

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

Supplementary labels (shields):

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

4. Sealing

The flow meter is secured by metrological and installation seals as described in Figure 4, 5, 6
Position of metrological seals:

- on case of measuring transducer at minimum 2 screws on the bottom of the case of the transducer
- on flow sensor: UC 3.0, figure 5, UC 7.0 figure 6

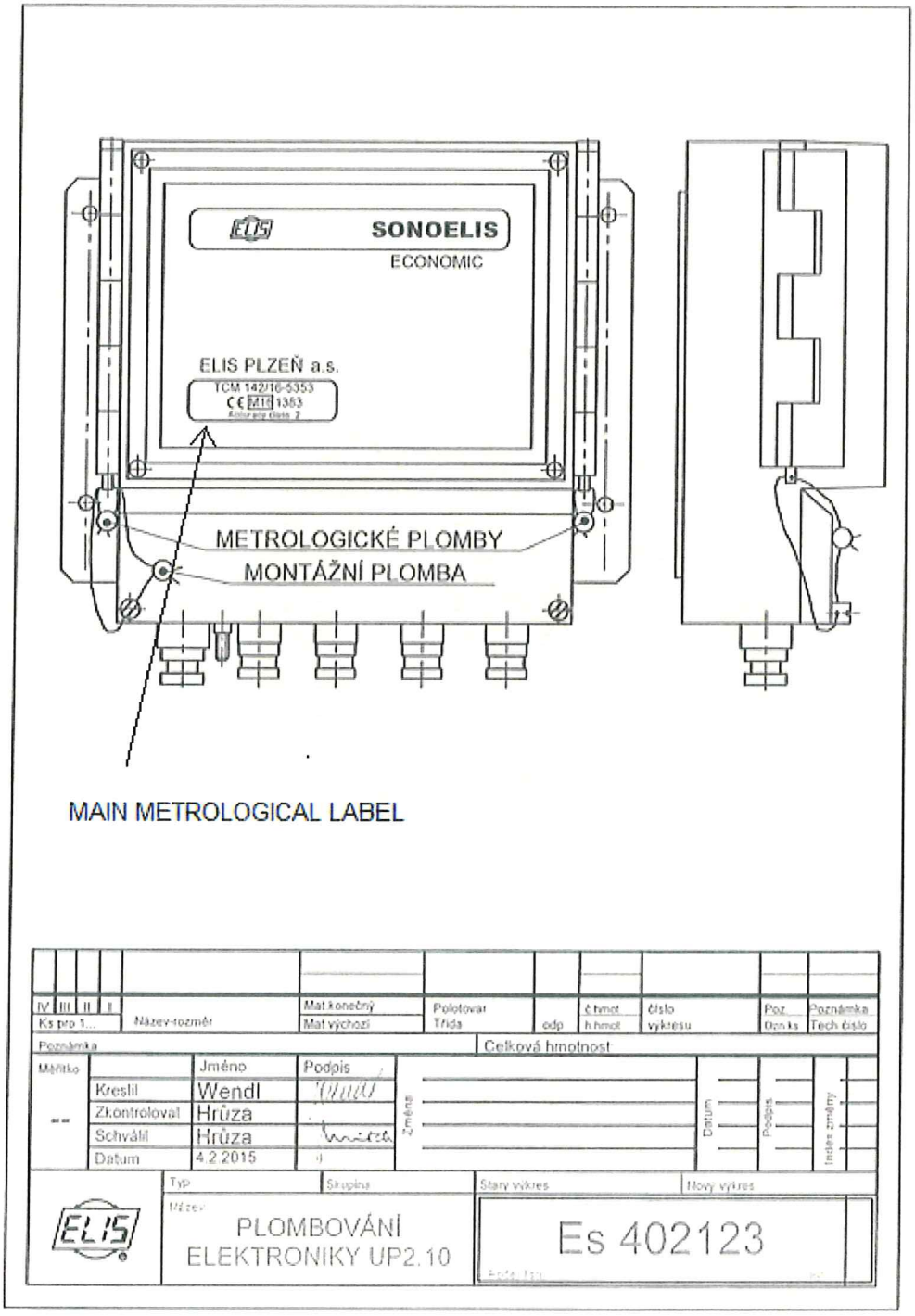

Figure 4: Electronic unit UP 2.10

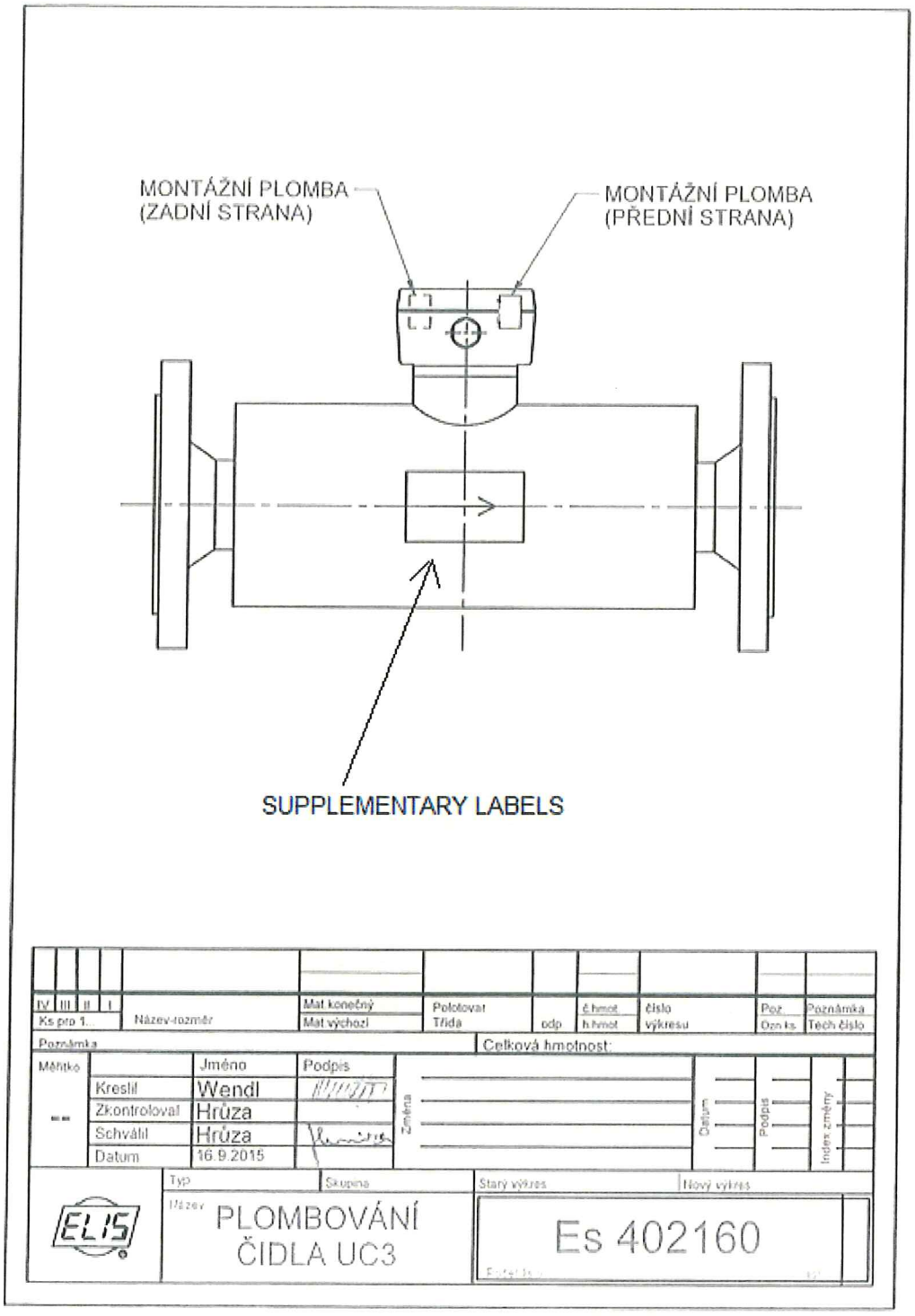

Figure 5: Flow sensor UC 3.0

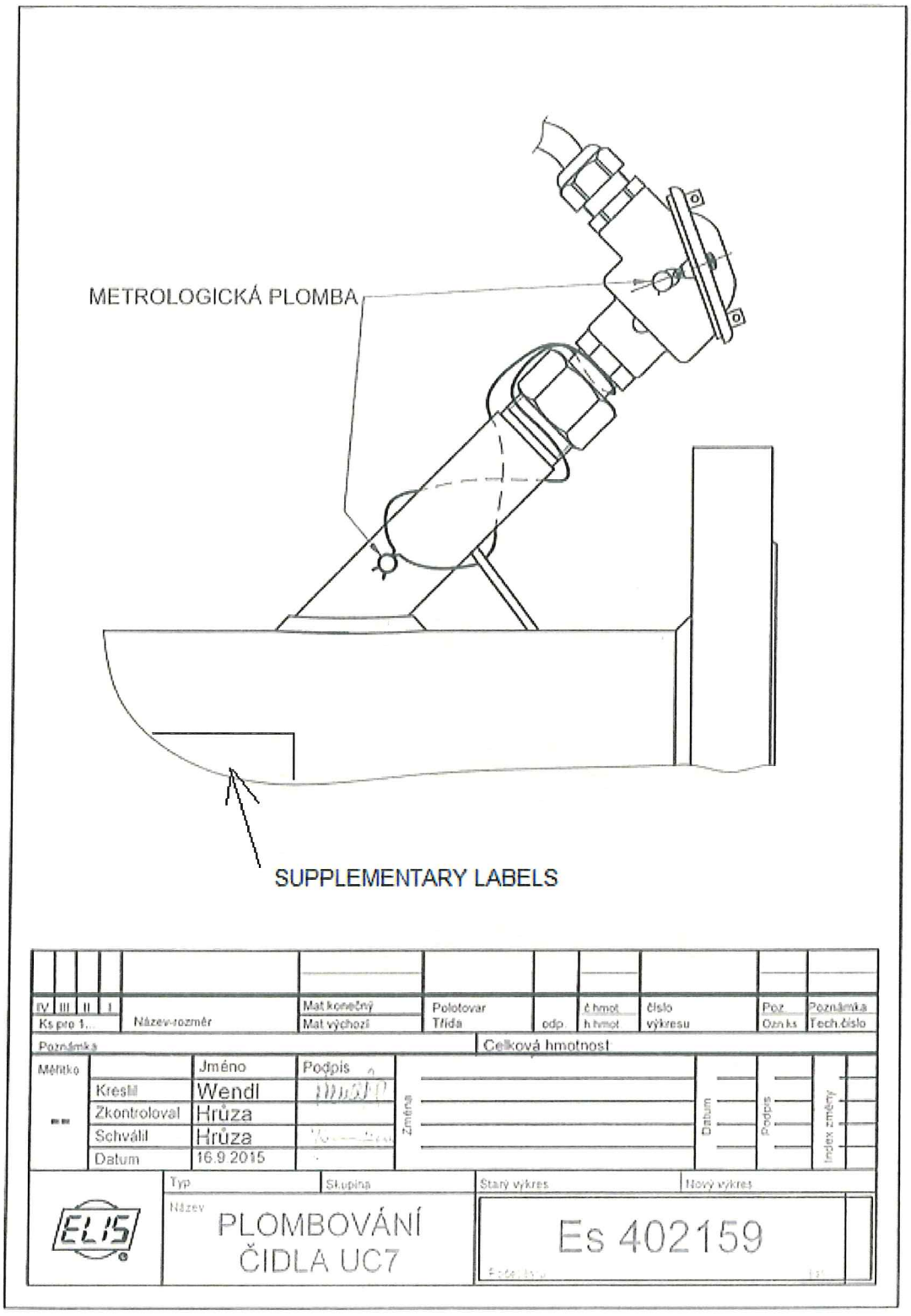

Figure 6: Flow sensor UC 7.0