

AB “AXIS INDUSTRIES”

ULTRASONIC FLOW SENSOR SDU – 1M



TECHNICAL DESCRIPTION, OPERATING INSTRUCTION

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1. APPLICATION

Ultrasonic flow sensor SDU-1M is designed as sub-assembly of heat meter. SDU-1M is used for measuring fluid flow rate in heating systems and conversion it into electrical pulse signal.

As a component of heat energy meter the SDU-1M flow sensor could be used for commercial account of energy quantity in district heating plants, in factories, in single or multi family houses.

SDU-1M corresponds to essential requirements of the Technical Regulation for Measuring Instruments, dated 30 March 2006 (transposing in the NB's country law Directive 2004/22/EC of 31 March 2004 on measuring instruments):

- Annex I Essential requirements
- Annex MI-004 Heat meter ,

SDU-1M meets the requirements according to accuracy class 2 of EN1434.

SDU-1M meets the requirements according environmental class C of EN1434-1.

Ambient temperature: 5 ...55 °C

Mechanical environment class: M1

Electromagnetic environment class: E2

Type reference example for technical documentation and order placing:

	Sensor	SDU-1-M	- 10	- 0,05	- 0*	- 01*	-
Type , modification							
Permanent flow rate, m ³ /h							
Value of pulse, l/pulse							
Battery: 0 – without battery/ 1 – with internal battery							
Pulse cable (length): 01 – 3 m; 02 – 5 m; 03 – 10 m; 04 – 15 m; 05 – 20 m 06 – 40 m; 07 – 60 m; 08 – 80 m; 09 – 100 m; 10 – 125 m 11 – 150 m; 12 – 175 m; 13 – 200 m; 00 – none							

Remark: * - marked numbers are used only for order coding.

2. TECHNICAL DATA

2.1. The measured parameter is a fluid volume that is converted into normalized pulse sequence.

2.2. Table of the flow sensors flow rates, lengths, connection thread (flanges) and the pressure losses ΔP , at $q = q_p$:

Permanent flow rate, q_p	Length, mm	Connection	Limits of flow rate, m ³ /h			Pressure losses Δp , at q_p , MPa, less than	Fig. No. A appendix
			lower q_i	permanent q_p	upper q_s		
3,5	260	Thread G 1 1/4	0,035	3,5	7,0	0,004	Fig. A1
6,0	260	Thread G 1 1/4	0,06	6,0	12,0	0,01	Fig. A1
10,0	300	Thread G 2	0,1	10,0	20,0	0,01	Fig. A2
15,0	270	Flange DN50	0,15	15,0	30,0	0,012	Fig. A3
25,0	300	Flange DN65	0,25	25,0	50,0	0,02	Fig. A4
40,0	350	Flange DN80	0,4	40,0	80,0	0,018	Fig. A4
60,0	350	Flange DN100	0,6	60,0	120,0	0,018	Fig. A4

- 2.3. Flow measurement threshold $0,2 q_i$
 2.4. Admissible measuring error according to EN1434 (class 2):

$$E_f = \pm (2+0,02q_p/q)$$

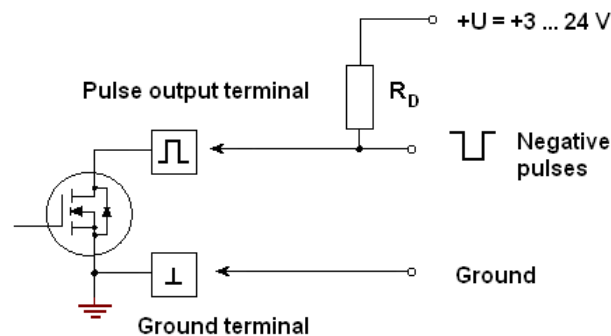
2.5. Table of default settings of the pulse value depending on the permanent flow rate and sensor size:

Permanent flow q_p , m ³ /h	3,5	6	10	15	25	40	60
Pulse value, liter/ pulse	0,02	0,02	0,05	0,05	0,2	0,2	0,5

Other pulse value settings could be selected according user needs by ordering the flow sensor. The pulse value is also indicated on the label of the flow sensor.

2.6. The two modes of output pulse transmission are possible: passive (open drain) and active. The output pulses can be selected by choosing the location of the jumper JP (appendix B)

2.6.1. The passive output pulse transmission mode is set when jumper JP is located on the 2 and 3 pins (lower position). The circuit of connection to the device output pulse terminal is shown below.



The drain supply voltage ranges +3 ... +24 V

The maximum drain current 30 mA

The output pulse circuit meets „OD“ class requirements.

Load resistance R_D must be chosen in accordance to avoid of exceeding the maximum drain current.

2.6.2. The active output pulse transmission mode is set when jumper JP is located on the 1 and 2 pins (upper position). Such pulse transmission mode is recommended to use for transferring pulses to heat energy calculator.

The voltage ranges during the pauses between pulse transmissions +3,0... + 3,6 V

The voltage ranges during the pulse transmission 0 ... + 0,6 V

The output pulse circuit meets „OD“ class requirements.

2.6.3. In the case of normal operating of the flow sensor the output pulses are transmitted in “meander” style frequency packages every second. The period of signal is not shorter than 4 ms, the durations of the high and low level signal are not shorter than 2 ms.

In the cases of the opposite flow, $q < 0,2 q_i$ or empty pipe condition the logical signal level is high and no pulse transmission appears.

In the case of device error the logical signal level is low. The external devices that can analyze the output pulse signal level (for example: heat energy calculator SKS3) can detect the situation of device error if the low signal level lasting longer than 2 second.

2.7. Device status testing.

Visually the device status can be tested by pushing the test button (that is located on the inner device panel - see appendix B) and observing the indication of green and red light emission diodes (LED). Other way of recognizing the device status is possible by analyzing the logical status of pulse output signal and direction (D) output signal:

Device status	Green LED ⁽¹⁾	Red LED ⁽¹⁾	Output pulse	Direction output (D)	Error output (E)
1. Normal flow	Blinking light	No light	Transmission of pulses	Low level	Low level
2. Opposite flow	Blinking light	Blinking light	High level	High level	Low level
3. Empty pipe	Steady light	No light	High level	Low level	High level
4. Device error	No light	Steady light	Low level	Low level	High level

5. $q > 1,1 q_s$	No light	Blinking light	Amount of pulses corresponds to $q = 1.1 q_s$	Low level	Low level
6. $q < 0,2 q_i$	Steady light	Blinking light	High level	Low level	Low level

Remark: 1. LED indication begins when the button is pushed down.

Status signals E (Error) and D (Direction) are passive signals and should be wired using the open drain output signal connection diagram such shown in 2.6.1 p.

2.8. When the measured flow rate exceeds maximal flow q_s per +10 %, the flow sensor transmits the amount of pulses which corresponds to the flow rate $q_s +10$ % and indicates corresponding overflow status code.

2.9. The flow sensor is powered:

- From an external power source DC 3,6V $\pm 0,2V$ (average current less than 35 μA),
or
- From internal +3.6V lithium battery, size C, with up to 12 years lifetime.

2.10. Table of flow sensor weight, corresponding with the nominal diameter:

Permanent flow q_p , m ³ /h	3,5	6	10	15	25	40	60
Weight, less than, kg	3,0	3,0	3,2	6,0	10,5	13,5	14

Dimensions of the flows sensors and its connection flanges is presented in the A appendix.

2.11. Environmental conditions:

- ambient temperature 5 °C to 55 °C,
- ambient humidity < 93 %,
- atmospheric pressure 86 kPa to 106,7 kPa,
- fluid temperature 10 °C to 130 °C,
- fluid pressure <1,6 MPa.

2.12. Degree of protection IP65 or IP67 (with separate order)

2.13. The flow sensor meets the requirements according to 89/336/EEC, EN50082-2, EN50081-2

3. PACKAGE CONTENT

Components included in the complete	Quantity	Remark
1. Flow sensor SDU-1	1	
2. Set of additional connection flanges	1	*
3. Technical description, operating instruction of SDU-1	1	
4. Pulse cable (length from 3 m to 200 m)	1	**
5. 3,6V lithium battery, 8Ah, size C	1	*
REMARK: * - included on demand only ** - cable length depending on the order. Standard length – 3 m.		

4. OPERATING PRINCIPLE

4.1. The ultrasonic flowmeter SDU-1 is microcontroller based device that consists of flow sensor and electronic part mounted on the flow sensor.

Flow measurement is based on the time-of flight measurement method. Fluid volume is calculated according the formula:

$$V = K_H * K_M * (1/t_+ - 1/t_-) * T ,$$

where: V - measured fluid volume, m³;

T – time of integration, s;

t₊ - measured upstream time of flight of ultrasonic pulse, s;

t₋ - measured downstream time of flight of ultrasonic pulse, s;

K_H – hydrodynamic correction factor;

K_M – coefficient that depends on the flow sensor dimensions.

Measured flow rate is converted into the pulses quantity that is transferred in output pulse terminal.

5. SEALING

- 5.1. Manufacturer seals:
 - One or two seals on ultrasonic transducers mounted in flow sensor (Appendix A, Figures A3 and A4).
 - One or two seals on the bolts of cover protecting ultrasonic transducers (Appendix A, Figures A1 and A2).
- 5.2. Calibration seal:
 - Seal on the inner cover inside electronic box (Appendix B1).
- 5.3. Mounting seal:
 - Seal on the bolt on top cover of the electronic box (Appendix A).

6. SAFETY

- 6.1. Risk factors during the flowmeter installation and service is a heat conveying fluid flowing within flow sensor with inner pressure up to 1,6 MPa and temperature up to 130 °C. To eliminate this risk the service and installation works must be performed by qualified staff. Mounting of the flowmeter is permissible only after ensuring of absence of heat conveying fluid in the pipeline.
- 6.2. By connecting the flow sensor to the external pulse registration device which is powered via AC 230V check the proper grounding of external device.

7. INSTALLATION

- 7.1. The dimensions of the flow sensor and its connection flanges are presented in appendix A. The wiring of signal cables is presented in appendixes B.
- 7.2. Check installation of the flow sensor corresponds to the notes on the label (Flow sensor placed in forward or return line).
- 7.3. It is necessary to rinse out the flow sensor installation place in pipeline before installing the flow sensor. It is recommended to use any piece of pipe as a substitute for the flow sensor during pipe installation and rinsing out.
- 7.4. Flow sensor meets requirements of mechanical class M1 (minimal vibrations, fixed mounting place). Avoid mounting of flow sensor near the sources of possible vibration (pumps, etc.).
- 7.5. Requirements for flow sensor installation in pipeline:
 - For flow sensors with threaded end connection G1 1/4 ($q_p = 3,5 \text{ m}^3/\text{h}$ and $6,0 \text{ m}^3/\text{h}$): no requirements for straight pipeline length in upstream and down stream directions.
 - For flow sensors with threaded end G2 ($q_p = 10 \text{ m}^3/\text{h}$) and flanged connection DN50... DN100 ($q_p = 15,0 \text{ m}^3/\text{h} \dots 60,0 \text{ m}^3/\text{h}$):
 - upstream straight pipeline length must be not less 5DN and downstream straight pipeline length must be not less 3DN when flow disturbance is pipe elbow (1 or 2 elbows);
 - upstream straight pipeline length must be not less 10DN and downstream straight pipeline length must be not less 3DN when flow disturbance is valve, pump or other;
- 7.6. Avoid the flow sensor installation near after the pumps which can cause cavitations.
- 7.7. Flowmeter can be mounted both vertically and horizontally in pipelines. Vertically mounting of the flowmeter is allowed only if flow direction in the pipeline is from down to up.
- 7.8. The direction of the sensor installation (is indicated with the arrow on the label of flow sensor) must mach with the flow direction in pipeline.
- 7.9. When flow sensor is mounted in horizontal pipeline, it is recommended to turn electronics box on the one side of flow sensor as shown in (Fig. 1 b,c,d):
 - for flow sensors with $q_p = 3,5 \dots 15,0 \text{ m}^3/\text{h}$;

- if there is a possibility of the increase of fluid temperature above 100⁰ C;
- flow sensors with $q_p = 25,0...60,0 \text{ m}^3/\text{h}$ should be turned in downward position of ultrasonic transducers (Fig 1 d).

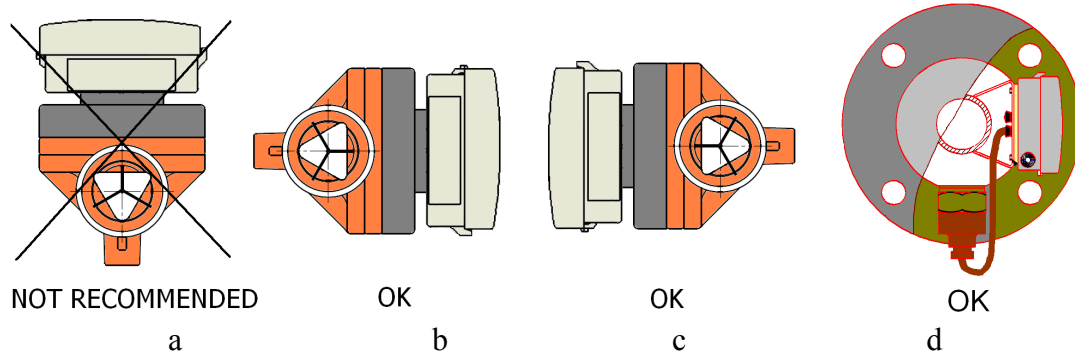


Fig.1. Positioning of flow sensors: a) – not recommended position; b) and c) – recommended positions for flow sensors with threaded end connection G1 1/4 ($q_p = 3,5 \text{ m}^3/\text{h}$ and $6,0 \text{ m}^3/\text{h}$), G2 ($q_p = 10,0 \text{ m}^3/\text{h}$) and flanged connection DN50 ($q_p = 15,0 \text{ m}^3/\text{h}$); d) recommended position for flow sensors with flanged connection DN65, DN80, DN100 ($q_p = 25,0 \text{ m}^3/\text{h}... 60,0 \text{ m}^3/\text{h}$).

7.10. The flange gaskets must mach with the pipe diameter. During the installation gasket must be exactly centered with the center of the pipe cross-section to avoid sticking out gaskets inside the pipe.

7.11. The connection of the output pulse cable or battery power supply cable must be performed with the grounded cables with signal wires with the cross-section not less than 0.12 mm^2 . These cables must be laid at least 0,5 meter from the high voltage power cables. The connection terminals and wiring of signal cables is presented in appendix B. It is recommended to use cable with external diameter of 4... 6 mm.

7.12. Connection of power supply:

- See connection diagram in appendix B2 if flow sensor is powered from external source,
- Connect battery connector to contact BAT if flow sensor includes inner lithium battery (Appendix B1).

7.13. After installation flow sensor in the pipeline check the device status that is indicated via LEDs (after pushing the test button) and corresponding status on the indicator of heat/flow energy calculator.

IMPORTANT !

- Sensor can be installed in the pipeline only after completing welding works.
- It is prohibited to carry out welding works on the pipeline, in which is mounted flow sensor.

8. CALIBRATION

8.1. It is recommended to perform calibration and testing of the flow sensor in the „Test“ mode. The „Test“ mode is set on by placing the 2,54 mm contact pitch jumper on the 13-14 pins in contactor J1. The contactor J1 is located under the cover on the right side in PCB board (Appendix B3).

8.2. For measuring the quantity of the output pulses during the flow sensor calibration it is recommended to use passive output pulse transmission mode (open drain electrical connection). This mode is set on by placing the jumper JP on the 2 - 3 pins. (see p.2.6.1. and appendix B3).

8.3. The recommended minimal quantity of the output pulses and measurement duration for flow sensor operation modes:

Flow	Pulse quantity	Measurement duration of in “Test” mode	Measurement duration in working mode
$0.1 q_p < q \leq q_s$	$N \geq 1000$	$T > 2 \text{ [min]}$	$T > 5 \text{ [min]}$
$q_i \leq q \leq 0.1 q_p$	$N > 500$	$T > 2 + 8 q_i/q, \text{ [min]},$	$T > 5 + 10 q_i/q, \text{ [min]},$

The both conditions must be satisfied by performing the calibration and testing.

8.4. After the testing and calibration procedures the “Test” mode must be off by removing the jumper from the pins 13-14 in contactor J1. The access to the inner contactors in PCB board must be protected with the cover. The screw of the cover must be sealed with calibration seal.

9. TRANSPORTATION AND STORAGE

9.1. Packed equipment may be transported in any type of covered vehicle. Equipment should be anchored reliably to avoid shock and possibility to shift inside vehicle.

9.2. Equipment should be protected against mechanical damage and shock.

9.3. Equipment should be stored in dry, heated premises, where environment temperature is not lower than +5 °C. No aggressive chemical substances should be stored together because of corrosion hazard.

10. INDIVIDUAL DATA

Flow sensor SDU – 1M serial number	
Minimal flow rate q_i , m ³ /h	
Permanent flow rate q_p , m ³ /h	
Maximal flow rate q_s , m ³ /h	
Output pulse value, l/pulse	

11. ACCEPTANCE CERTIFICATE

Flow sensor SDU-1M serial No.. corresponds to EN 1434 requirements and may be put into operation.

Signature Acceptance date: / / 200.....

12. WARRANTY

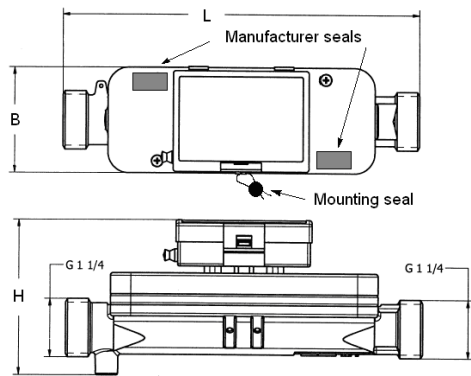
12.1. Manufacturer gives the warranty that equipment parameters will meet the technical requirements, listed in the paragraph 2 of this document, if transportation, storage and operation conditions will be followed.

12.2. Warranty period - 12 months from bringing into operation, but not more than 18 months from manufacturing date.

Manufacturer's address:

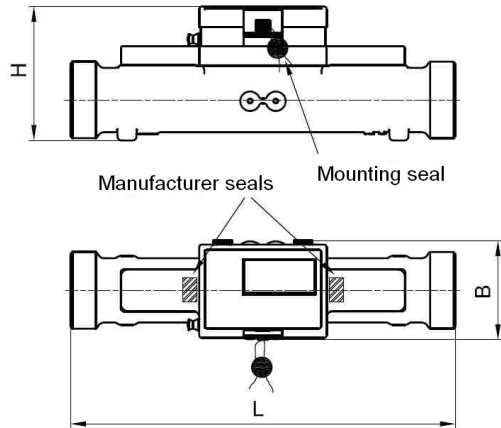
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Appendix A. Sizes and dimensions



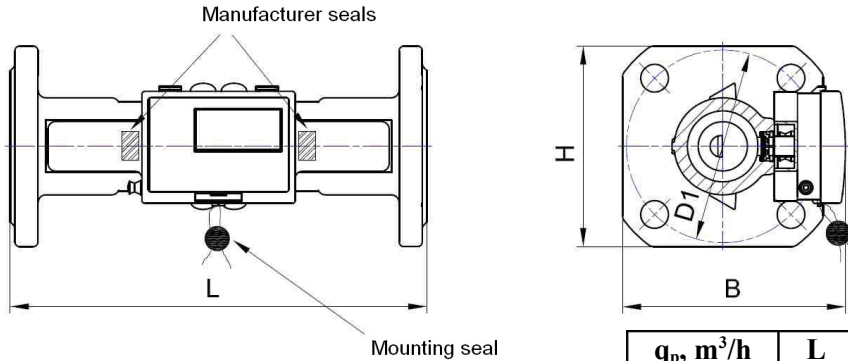
$q_p, \text{m}^3/\text{h}$	L	H	B	Connection
3,5	260	112	76	Thread G1 1/4
6,0	260	112	76	Thread G1 1/4

Fig. 1. Dimensions of flow sensors with $q_p = 3,5 \text{ m}^3/\text{h}; 6,0 \text{ m}^3/\text{h}$.



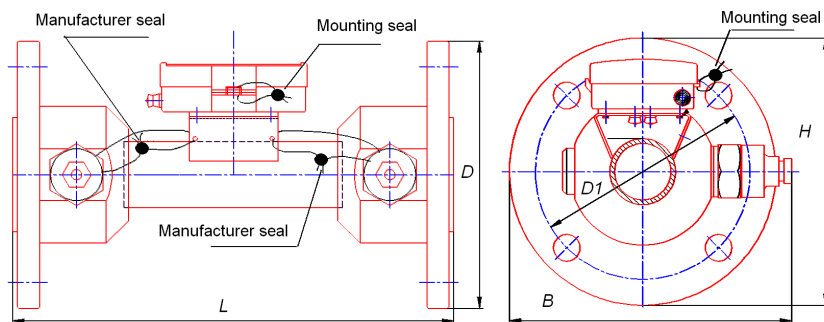
$q_p, \text{m}^3/\text{h}$	L	H	B	Connection
10,0	300	95	120	G 2

Fig. 2. Dimensions of flow sensor with $q_p = 10,0 \text{ m}^3/\text{h}$.



$q_p, \text{m}^3/\text{h}$	L	D1	H	B	Connection
15,0	270	125	130	145	DN50

Fig. 3. Dimensions of flow sensor with $q_p = 15,0 \text{ m}^3/\text{h}$ (DN 50).

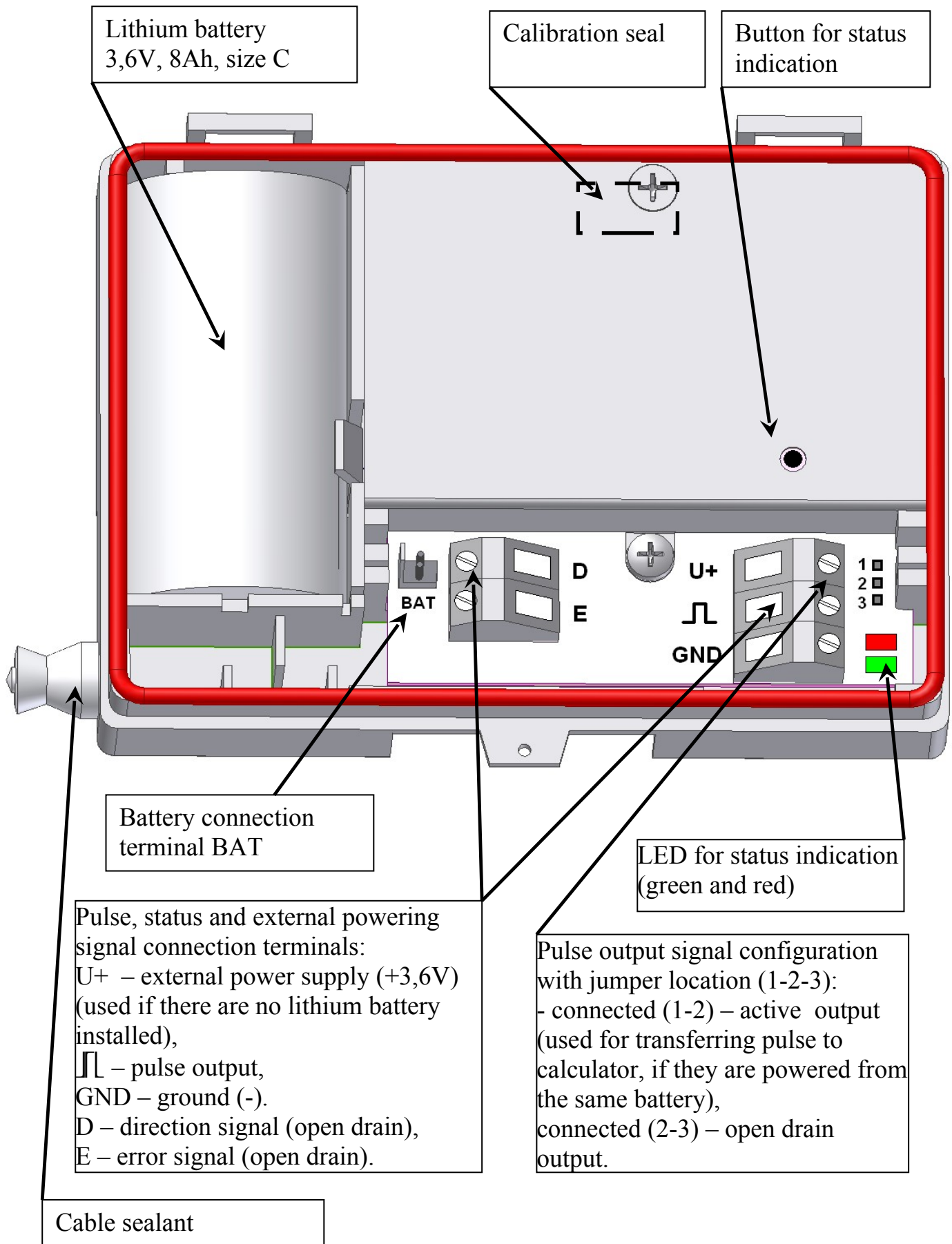


$q_p, \text{m}^3/\text{h}$	L	D	D1	H	B	Connection
25,0	300	180	145	180	205	DN65
40,0	350	195	160	195	210	DN80
60,0	350	215	180	215	230	DN100

Fig. 4. Dimensions of flow sensors with $q_p = 25 \text{ m}^3/\text{h}$ (DN 65), $q_p = 40 \text{ m}^3/\text{h}$ (DN 80), $q_p = 60 \text{ m}^3/\text{h}$ (DN 100),

Appendix B1

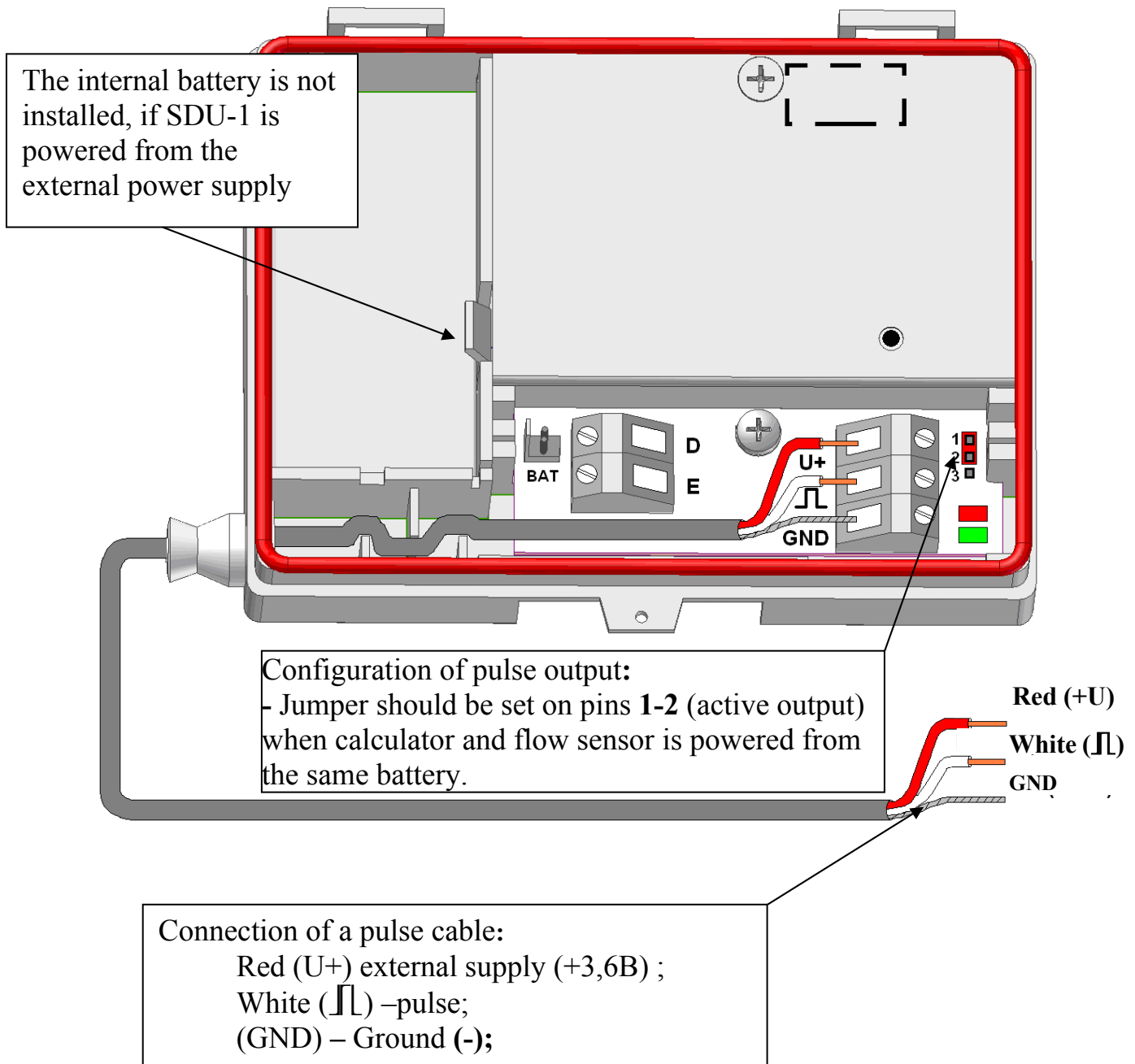
Connection terminals of flow sensor SDU-1



Appendix B2

Connection of pulse cable

Supply of flow sensor SDU-1 from external (calculator) battery



Appendix B3

Set up of "Test" mode and configuration of output pulse signals for calibration

