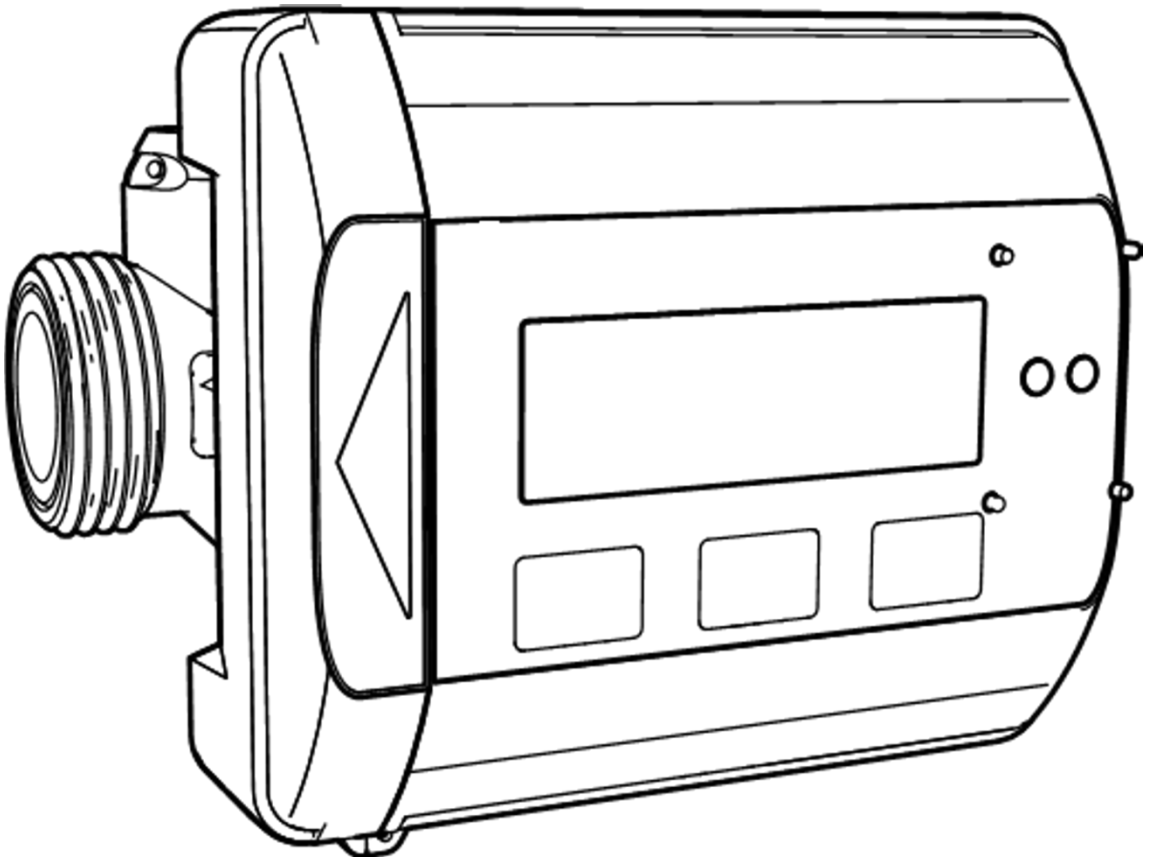
Ultrasonic Heat Meter

S1H

Technical description



Attention:

- **Installation should only be carried out by qualified, trained personnel**
- **Violation and removal of the manufacturer's seals is not allowed, otherwise the warranties are void**
- **Welding on pipes near the meter is prohibited. The device must be dismounted before welding**
- **The distance from any of the meter elements, including its cables, to power and high-frequency cables, as well as to sources of electromagnetic interference, must be at least 50 cm**
- **Eliminate the possibility of flooding the electronic unit**
- **The ambient temperature should be between 5 °C and 55 °C**
- **Environmental class C according to EN1434 (industrial application)**

Table of Contents

Abbreviations

FS – flow metering section with ultrasonic sensors
RTD - Resistive Temperature Detectors
TS - temperature sensor

1 Common information

Heat meter S1H type is an ultrasonic meter of heating, cooling or heating/cooling energy. The meter is intended for measuring energy in any water systems used for district heating, heating and hot water supply.

In accordance with EN1434, meter is recognized as hybrid (or compact) one. It means that in the course of its manufacture and primary verification the meter consists of a calculator, a pair of temperature sensors and flow metering section. However, once produced, the meter will be deemed a single heat meter with integrated component parts.

That is, if any of its parts is separated from the meter and lead seals are damaged, the meters will become unsuitable for commercial use and warranty therefore will be lost.

The meter employs ultrasonic principle of the flow rate measurement. Ultrasonic waves are in turn transmitted downstream and upstream the flow; current volumetric water flow rate is measured based on the difference between the propagation times of said waves.

The temperature is measured by a pair of calibrated Pt1000 platinum temperature sensors (RTD). Calibration coefficients are entered into the calculator thus allowing to measure the temperature and temperature differential with very high accuracy. The meter is delivered with a pair of calibrated temperature sensors. One of these is installed into the flow metering section, while the second temperature sensors will be mounted in the course of meter installation (into a ball valve usually).

The measured heat energy may be displayed in kWh, MWh, GJ, GCal. Indicator displays 8 significant digits.

The indicator will never be turned off thus allowing to monitor operation of the meter and to take readings without pressing any pushbuttons.

Additional measured and displayed parameters (measurement units are shown in brackets) includes:

- flow rate (m^3/h or l/h)
- accumulated volume (m^3)
- accumulated mass (t)
- thermal energy (MW, kW, GCal/h)
- temperature and temperature differential (°C).

The meter includes 4 tariff counters to accumulate data on the thermal energy (heating and cooling), volume and mass.

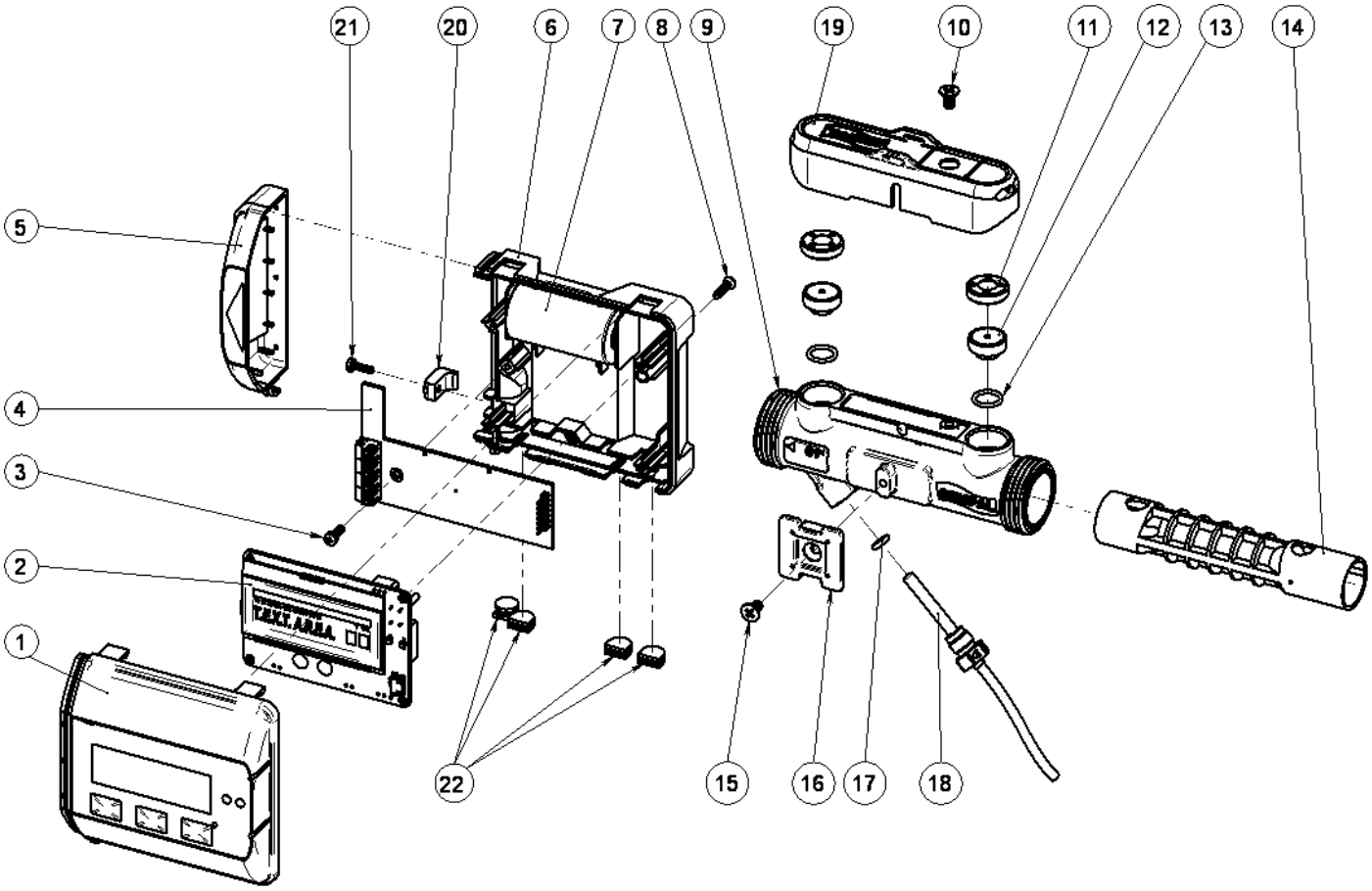
Power source of the meter - built-in lithium battery. Service life of such battery is 16 years.

The meter may be equipped (in the course of its manufacture) by an additional communication module extending communication ability of the meters (M-Bus, RS232, Modbus, …) thus allowing to connect two additional flow rate meters with output pulse signals to register water consumption.

Besides the built-in communication modules, data may be obtained from the meter through an iRDA head at the rate of 9600 baud. EN1434 A mode and Sempal protocols are supported.

This technical description is intended for operating service units, installers and for verifying and testing organizations.

1.1 Structure of the meter



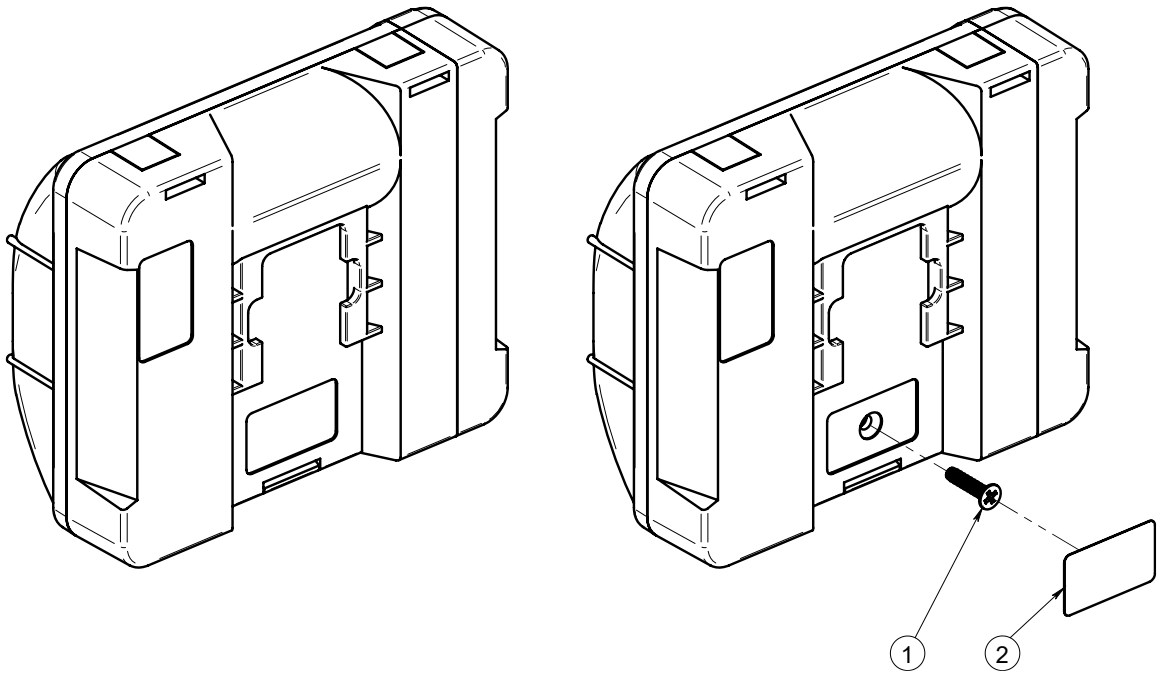
Item No.	Description	Item No.	Description
1	Upper calculator cover	10	Screw fastening of the flow metering section cover
2	Printed board with electronics	11	Clamp of flow sensor
3	Screw fastening the communication module	12	Flow sensor
4	Communication module	13	Flow sensor sealing element
5	Side calculator cover	14	Measuring insert
6	Lower calculator cover	15	Screw fastening of the calculator holder
7	Battery	16	Calculator holder
8	Screw fastening the upper cover	17	Sealing element of temperature sensor
9	Flow metering section	18	Temperature sensor

1.2 Sealing

1.2.1 Calculator sealing

The upper cover of the calculator is connected with the lower one by means of three snaps that are not sealed. To seal the calculator a fastening screw is used, head of which is covered with a sealing sticker.

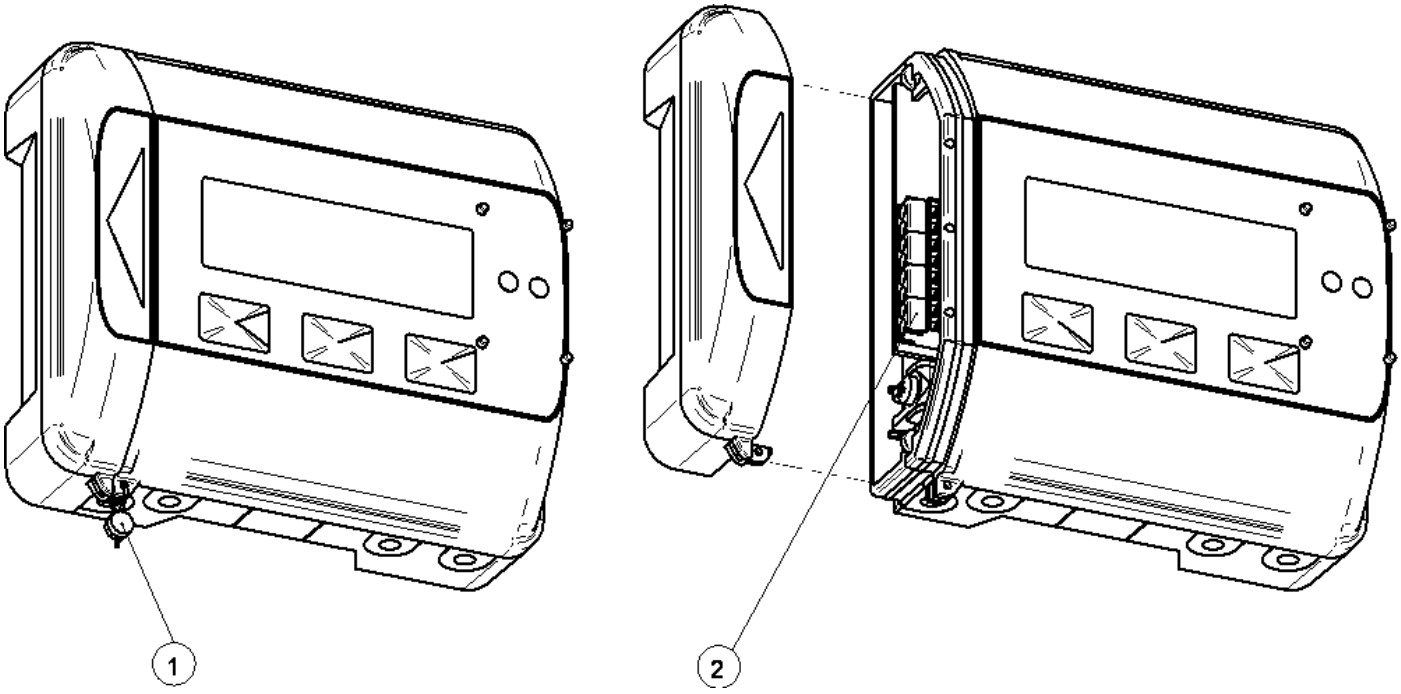
If the screw is not removed, the calculator may be disassembled only by breaking the snaps.



1 – fastening screw; 2 – sealing sticker

If the snaps or the sealing sticker is damaged, the meter may not be used for billing and its warranty will become null and void.

The side cover providing access to communication module contacts will be sealed by an organization registering the instrument.



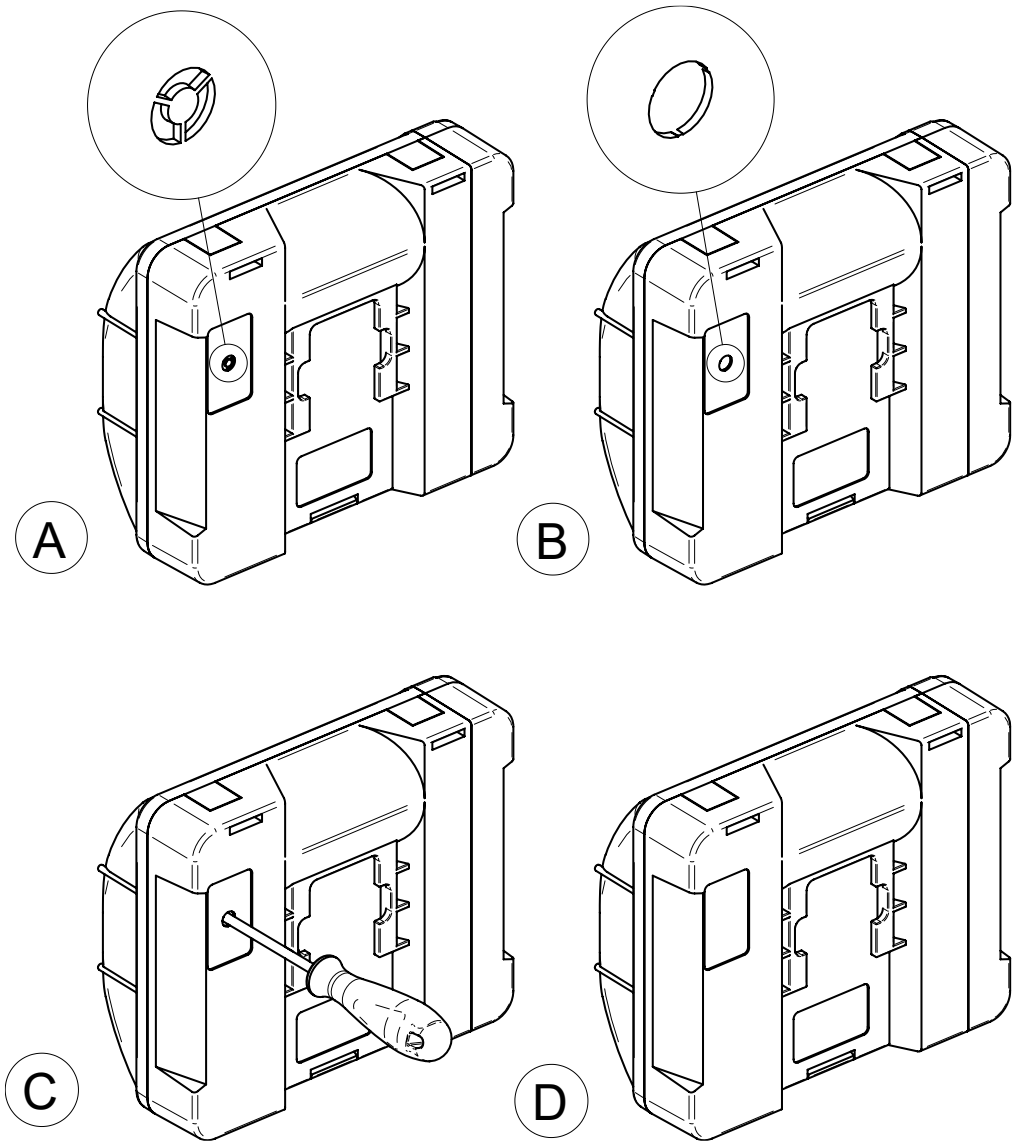
1 – lead sealing; 2 - contacts for the communication module connection

1.2.2 Transition to Setup and Test modes

Setup mode is used for initial setting of the instrument, while **Test** mode is used for its regular verifications.

Entering the **Setup** mode does not require further verification of the device.

Transition to these modes will be carried out by depressing a special pushbutton located on the lover calculator cover. After manufacture, this pushbutton is hidden under a solid plastic protecting element. Access to the pushbutton will be provided only if such protecting element is broken. Such protecting element will be glued with a sealing label after the check.



A – status of the protecting element after manufacture; B- status of the protecting element when broken; C – depressing the pushbutton; D – installed sealing sticker

2 Specifications

2.1 Metrological parameters

Temperature measurement range	Θ: 2 °C …+130 °C	- for error characteristics rating
Temperature differential range	ΔΘ: 3 K…130 K	
Measurement temperature range	Θ: -49 °C …+150 °C	- limiting values to be measured
Temperature differential range	ΔΘ: 0 K…200 K	by the meter
Temperature sensors	Pt1000 - EN60751	
Rating of the characteristics	As provided for in EN1434	
Accuracy class	2	
Climatic environment class	EN1434 class C	
Operating time on failure	150000 hours	

DN	FS type	qp	qi	qs	q0	qb	Pressure loss Δp @ qp	Flow metering section connection	Length
		[m³/h]	[m³/h]	[m³/h]	[m³/h]	[m³/h]	[bar]		[mm]
15	015A	1.5	0.015	3	0.003	5	0.17	G ¾ B	110
20	020A	1.5	0.015	3	0.003	5	0.1	G 1 B	130
	020C	2.5	0.025	5	0.005	7			
	020F							Flange DIN 1092	190
	020G							G 1 B	
25	025C	3.5	0.035	7	0.007	10	0.08	G 1 ¼ B	160
	025F							Flange DIN 1092	260
	025G							G 1 ¼ B	
	025E	6	0.06	12	0.012	15	0.1		
	025H							Flange DIN 1092	
32	032F	6	0.06	12	0.012	15	0.1	Flange DIN 1092	260
	032G							G 1 ½ B	
40	040F	10	0.1	20	0.02	25	0.1	Flange DIN 1092	300
	040G							G 2 B	
50	050F	15	0.15	30	0.03	40	0.17	Flange DIN 1092	270
	050W		0.06						

qi – lower flowrate limit. Is the lowest flowrate, that can be measured by the meter without exceeding maximum permissible error

qp – nominal (long-term) flowrate

qs – upper flowrate limit (maximal flowrate). Is the highest flowrate at which the meter operates without exceeding its maximum permissible error

q0 – sensitivity threshold - is the minimum flowrate that the meter can measure

qb – marginal flow - the maximum flowrate that can be measured by the meter

At flowrates less than the minimum (qi) and above the maximum (qs) the error of measurement is not normalized.

2.1 Pressure loss

2.1.1 EN1434 normalizes pressure loss 0.25 bar at a flowrate qp.

Pressure losses at other flowrates are calculated as:

$$\Delta P_c = \Delta P_0 \cdot \left(\frac{q_c}{q_p}\right)^2 \qquad (2.1)$$

where: q_c – flowrate
q_p – nominal flowrate
ΔP_0 – pressure loss at nominal flowrate
ΔP_C – pressure loss at selected flowrate

2.1.2 For example, if the pressure loss at the flowrate qp is 0.25 bar, then at the flowrate qs (it is 2 times higher than qp) the pressure loss will be 1 bar.

2.1.3 The minimum pressure at the outlet of the FS must be not less than 1 bar.

2.2 Configurations

The meter can be delivered in several configurations.

Features of configurations are given in the table:

Features	Configuration number		
	2	2/1	2/2
Installation of FS in return pipe	–	+	–
Number of used RTD	2	2	1
Use of return pipe temperature constant	–	–	+

2.2.1 Configuration 2

Heat, cooling or heat/cooling meter installed in supply pipe.

2.2.2 Configuration 2/1

Heat, cooling or heat/cooling meter installed in return pipe.

2.2.3 Configuration 2/2

This is a heat meter in which the return temperature is set by a constant. Two integer constants in the range from 1 to 30 are used as the water temperature of the return pipe (cold). One of them sets the temperature of return water in winter, the other - in summer. Switching between summer and winter temperatures is carried out according to the calendar (enter the dates of transition to winter and summer constants), or manually (if the dates are not set and the constants for summer and winter are different).

The temperature used to calculate the reverse temperature is archived.

2.3 Electrical parameters

Calculator	
Heat calculation error	Ec = ±(0.1+2/ΔΘ) %
Indicator	Consists of two areas: Main LCD – 8 significant digits. It is operated permanently. Menu line: a text line. It is operable only during the navigation through menu.
Energy measurement units	kWh, MWh, GJ, GCal
Flowrate measurement units	m^3/h or l/h
Power measurement units	MW, kW, GCal/h
Archiving	1680 hours (70 days), 500 days, 36 months, 16 years. User actions log – 100 entries
Clock/Calendar	Real time clock (clock deviation does not exceed 3 seconds a day); calendar with consideration of leap years, summer/winter time, accounting month commencement date

Data exchange through iRDA optical port	Used heads - IEC 62056-21 standard with a maximum speed of at least 9600 baud, with echo suppression - EN1434 protocol for iRDA, mode A with CRC (read only) - Sempal protocol – reading and configuring
Communication modules	- wired M-Bus. Load: 1 unit (1.5 mA). EN 1434-3, EN 13757-2 and EN 13757-3. Transfer rate may be selected from the sequence: 300, 600, 1200, 2400, 4800 and 9600 baud. - RS232. Transfer rate is 9600 baud, 8 bit, parity check – none, 1 stop bit. Sempal protocol. - pulse output. One active pulse output. Maximum frequency is 100 Hz. Weight of a pulse and data to be transferred are adjustable.
Pulse signal inputs	Pulse signal inputs (up to 2 inputs) may be used only if the communication module support this function. Such inputs are used to measure water volumes by meters with electrically isolated outputs. Active input: maximal frequency – 100 Hz Passive input: the loading resistance of 680 kOhm is connected with +3 V. Maximum pulse signal frequency is 1 Hz.
Electromagnetic compatibility	Meets requirements of EN1434, class C
Power supply voltage	$3.6^{+0.1}_{-0.3}$ В

Temperature measurement		
Temperature measurement error	Et = ±(0.5 + 3 $\Delta\Theta_{min}/\Delta\Theta$) %	
Pt1000, two- or four-wire connection	T1, T2 Temperatures of supply and return waters	ΔΘ Measurement of hot/cold water
Measurement range	-49 °C …+150 °C	0 K…200 K

Battery	3.6 V DC, 1 lithium cell of C size
Replacement interval	16 років[1] More frequent replacement may be needed when communication modules are used or data are read frequently or when the meter is used at a high temperature
Lithium content	2.5 g

[1] Under the following operating conditions:
- frequency of integration 4 seconds
- duration of menu navigation - 5 minutes a day
- reading the hourly archive once an hour (via one of the communication units)
- reading of the current state once a minute (through one of the communication units)
- reading all available information via the iRDA port once a month

2.4 Feature of design

Climatic Environment class EN1434, class C

	Protection class	Ambient temperature	Classification with respect to environment	
Calculator	IP65	5…55 °C	Non-condensed humidity	Indoors
Flow metering section (assembled)	IP68		Condensed humidity	

Heat transfer liquid type	Water	
Water temperature	2…150 °C	If the water temperature is below 15°C or above 90°C, installation of the calculator on a wall will be obligatory requirement (to avoid moisture condensing and calculator overheating, respectively).
Storage temperature	-25…+60 °C (FS must be dry)	
Operating pressure	16 bar	
Testing pressure	25 bar during 1 minute	
Cable length to flow metering section	1 m (cannot be disconnected)	
Cable length to temperature sensor (non disconnectable, two-wire)	1.15, 2, 3 m - for DN15…40 mounted into FS - for DN50 and more – mounted into pipe	
Cable length to temperature sensor (disconnectable, four-wire)	From 5 to 20 m, mounted into pipe	

2.5 Materials

Wetted parts (depends of FS type)

	flow metering section	CW617N, AISI304
	flow sensor	PES+30% GF or titatium
	sealing elements	EPDM
	flow metering section	PES+30%GF
	mirrors	AISI 304
Flow metering section cover, calculator, wall installation fixtures		ABS+PC
Cables		Cable: Silicone + PTFE

2.6 Errors

Error components	Normalized by EN1434	Rated for the meter
Flow rate measurement	$Ef = \pm(2 + 0.02q_p/q)$ %	$Ef = \pm(2 + 0.02q_p/q)$ %
Calculator	$Ec = \pm(0.5 + \Delta\Theta_{min}/\Delta\Theta)$ %	$Ec = \pm(0.1 + 2/\Delta\Theta)$ %
Temperature measurement	$Et = \pm(0.5 + 3\ \Delta\Theta_{min}/\Delta\Theta)$ %	$Et = \pm(0.5 + 3\ \Delta\Theta_{min}/\Delta\Theta)$ %
Total error	$Etot = Ef + Ec + Et =$ $\pm(3 + 0.02q_p/q + 4\Delta\Theta_{min}/\Delta\Theta)$ %	$Etot = Ef + Ec + Et =$ $\pm(2.6 + 0.02qp/q + 11/\Delta\Theta)$ %

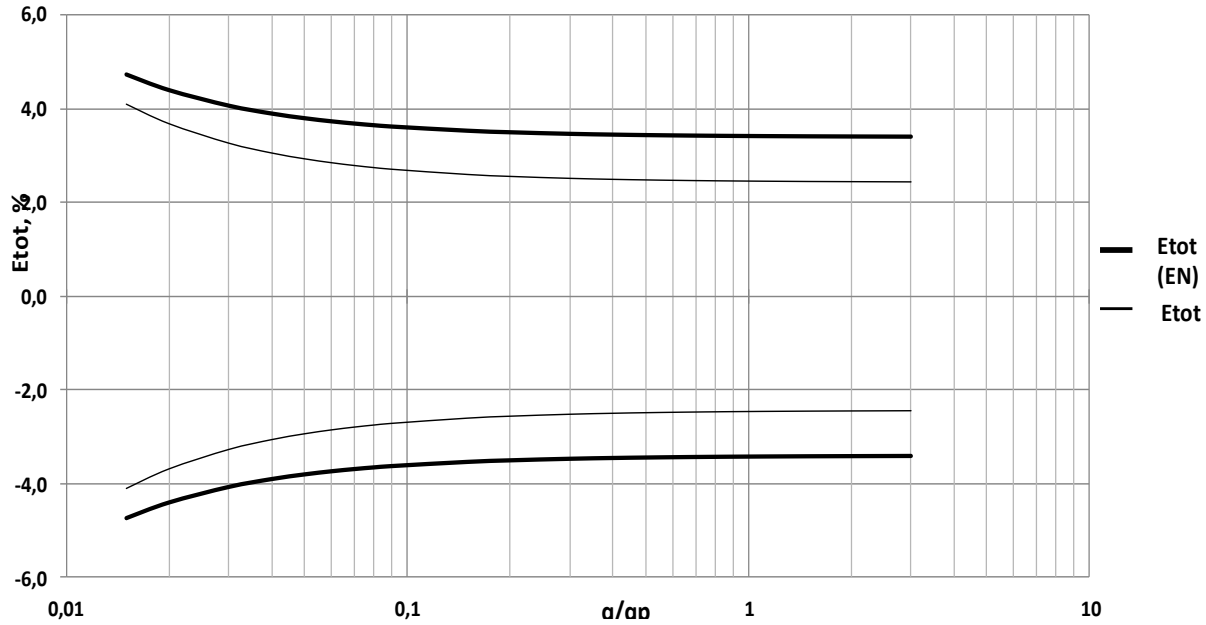
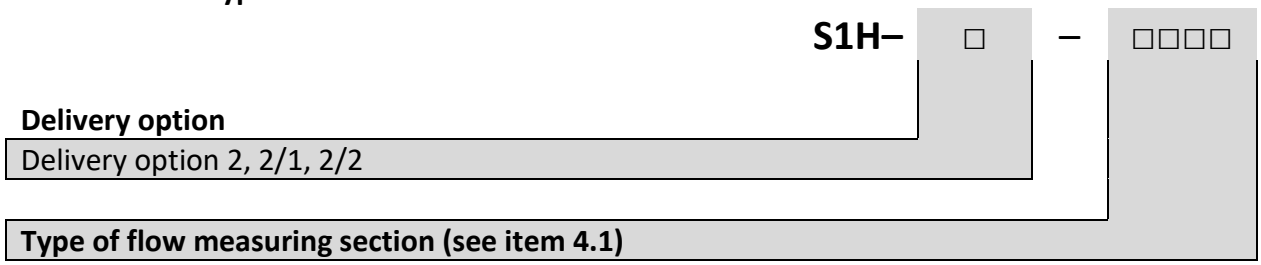


Figure 1: Total error as compared with requirements of EN1434-1
$\Delta\theta = 30$ K

3 Meter type and configuration

The meter type is indicated on the upper cover of the calculator and may not be changed.

3.1 Meter type



An example of the meter type: **S1H - 020A**

3.2 Heat meter configuration

Configuration will be shown in the menu line on the instrument indicator.

Cfg –	□□	□ –	□	□ –	□	□	□ –	□ –	□	□
Communication module (Error! Reference source not found.**)**										
Not installed	**00**									
RS232	**10**									
M-Bus	**20**									
Pulse output	**30**									
RS485 Modbus	**50**									
Pulse inputs in the communication module										
No pulse inputs		**0**								
Pulse inputs are available		**1**								
Flow metering section position (supply/return) (3.2.1)										
Supply			**1**							
Return			**2**							
Number of temperature sensors				2						
Integration periodicity (3.2.2)										
Integration period, s / Flow rate measurement period, s										
2 / 0.5					**1**					
4 / 1					**2**					
8 / 1					**3**					
16 / 2					**4**					
System of heat energy units (3.2.3)										
Energy units / Power units										
GJ / MW						**1**				
kWh / kW						**2**				
MWh / MW						**3**				
GCal / GCal/h						**4**				
Flowrate system units (3.2.4)										
m^3/h							**1**			
l/h							**2**			
Tariffing (3.2.5)										
Not used								**0**		
P (power)								**1**		
Q (flow rate)								**2**		
dT (temperature differential)								**3**		
T1 (supply water temperature)								**4**		
T2 (return water temperature)								**5**		
Time								**6**		
PQ (power and flow rate)								**7**		
HC (Heating/cooling amount)								**8**		
Region code (3.2.6)										
Ukraine									**1**	

The meter is configured when put into operation by means of SmpSetup program (operable in Windows 7 and higher) or from the meter's keyboard. Any configuration can be changed only when the instrument is in **Setup** mode.

3.2.1 Position of flow metering section

Flow metering section may be installed either in supply or in return pipeline (reverse water supply).

3.2.2 Integration periodicity

Integration periodicity determines the time interval to calculate volume, thermal energy content and information updating on the indicator.

Periodicity of the flow rate measurement will depend on the integration periodicity.

Temperature measurement periodicity is always equal to 32 seconds.

3.2.3 System of heat units

The meter will always measure the thermal energy content in GJ, while any other units are intended for indication purposes only.

3.2.4 System of flowrate units

The meter will always measure the flow rate in m^3/h, while conversion to any other units will be made for indication purposes only.

Volume will always be displayed in **m^3**.

Number of digits displayed on the indicator will depend upon the selected measurement units.

Total number of significant digits of the indicator will always be equal to 8. Only the number of figures after the decimal point will be changed:

	Number of digits (figures after decimal point)									
qp, m^3/h	MW	kW	GCal/h	kWh	MWh	GJ	GCal	m^3	l/h	m^3/h
0.6	3	1	3	1	3	3	3	3	0	3
1.5	3	1	3	1	3	3	3	3	0	3
2.5	3	1	3	1	3	3	3	3	0	3

Temperature and temperature differential will always be 0.01°C.

3.2.5 Tariffing

The instrument is provided with 4 tariff cells. Depending on the tariffing mode, different parameters will be stored in T1…T4 cells. Regardless of the mode, the tariffed value will be accumulated in any case in the basic adder and will additionally be accumulated in tariff counters. The tariffing will be described in more details below (clause 3.4).

3.2.6 Region code

The region code determines initial settings of time zone, usage of summer time …

3.3 Communication modules

The Communication module are installed in the course of instrument manufacture and cannot be changed by the user.

3.3.1 Pulse inputs

Communication module may be delivered either with pulse signal inputs or without them (depends of type of module).

The meter will support up to 2 pulse inputs signal. Each of the inputs may be connected with an additional water meter with pulse signal outputs, for which the volume will be accumulated.

The following options of delivery of pulse inputs are possible:

	Input 1	Input 2
Input 1 – active, input 2 – passive	IC	IB
Both inputs - passive	IB	IB

Parameters of pulse signal inputs:

active input (IC)

Pulse input class by EN1434	IC (for active pulse output)
Maximal pulse frequency	100 Hz
Pulse duration	≥ 4 ms
Power from the meter:	
voltage	3.6 V

Maximal supply current	7 μA
Maximal voltage at the input	3.6 V
Voltage of «1»	2 V
Voltage of «0»	0.5 V
State of the inactive output (flowrate is equal 0)	«1»

Output cascade of flowmeter must be galvanically isolated

passive input (IB)

Pulse signal input class according to EN1434	IB
Maximum pulse repetition rate	1 Hz
Pulse duration	≥ 100 ms
Loading resistor (boosting to 3 V voltage)	680 kOhm

Must be used only with electrically isolated contacts

Communication module RS232

It uses TxD, RxD and GND signals

Port parameters:

Dara transfer speed	9600 baud
Data length	8 bit
Parity check	None
Stop bit	1
Protocol used	Sempal

M-Bus communication module

Load	1 unit (1.5 mA)
Data length	8 bit
Parity check	Even
Stop bit	1
Speed	300, 600, 1200, 2400, 4800, 9600 baud
Addressing	Primary and secondary

Module of pulse signal output

The module forms active pulse output of OD by EN1434

Output class according to EN1434	OB
Pulse length	4 ms ± 1%
Max frequency	100 Hz
Power source voltage (VCC)	3.0 …5.0 V
Output voltage	(VCC – 0.1) V
Output resistance	100 Ohm
Supply current	3 uA
Galvanically isolated	Yes

There are no pulse inputs in this module

3.4 Setup and Test service modes

The meter has two service modes: **Setup** and **Test**

Setup mode will be used for initial setting of the instrument, while **Test** mode will be used for periodical verifications of the instrument.

These modes may be accessed by means of a special covered pushbutton placed on the rear instrument cover. When the instrument leaves the production line, said pushbutton is covered with a plastic protecting element to be broken if access to the pushbutton is needed. Further, this hole will be covered with a special sealing sticker.

To enter into **Setup** mode, you have to depress the pushbutton and hold it depressed for 5 – 15 seconds. The indicator during such operation will display

If you release the pushbutton during the above-mentioned time interval, the instrument will switch over to **Setup** mode

If the pushbutton will be held depressed for another time interval (from 15 to 30 seconds), message on the indicator will be changed as follows:

On release the pushbutton during the above-mentioned time interval, the instrument will switch over to **Test** mode

If you continue to hold the pushbutton depressed, the indicator will be switched to the standard display mode and operating mode of the instrument will not change.

Configuration of the meter will be set before registration of the meter. Configuration can be set only in **Setup** mode.

When the meter leaves the production line, a special transport mode is set. This mode is equivalent to **Setup** mode, but unlike it, flow rate and temperature will be measured once every 60 seconds. The indicator is switched off and will be switched on when any pushbutton will be depressed.

3.5 Tariffing

The instrument has 4 tariff counters. Each tariff counter includes an adder (T1… T4) and a threshold (TT1… TT4). Logics of their operation depend on the type of the selected tariffing mode.

Regardless of the tariffing type, data is **ALWAYS** accumulated in the basic adder (thermal energy, volume, …) and is **additionally** summed in tariff adders in the events when a condition for relevant tariff is met.

Threshold values is set in the same units that are used to display data on the indicator.

3.5.1 Tariffing mode 0

When such mode is set, no tariffing will be carried out.

3.5.2 Tariffing mode P (code 1 in configuration)

Such mode is used in heating or cooling mode (this will not be used in the automatic mode).

Tariff counters will accumulate thermal energy.

Tariffing will be made by thermal power thresholds (heating or cooling).

$\|P\| \le TT1$	Basic register only
$TT1 < \|P\| \le TT2$	Basic register and T1
$TT2 < \|P\| \le TT3$	Basic register and T2
$TT3 < \|P\| \le TT4$	Basic register and T3
$\|P\| > TT4$	Basic register and T4

$TT1<TT2<TT3<TT4$

3.5.3 Tariffing mode Q (code 2 in configuration)

Volumetric flow rate is analyzed.

Tariff counters will accumulate thermal energy.

q ≤ TT1	Basic register only
TT1 < q ≤ TT2	Basic register and T1
TT2 < q ≤ TT3	Basic register and T2
q > TT3	Basic register and T3
q < qi	Basic register and T4. Values when the flow rate is below *qi* but exceeds the sensitivity threshold will be added here

TT1>TT2>TT3

3.5.4 Tariffing mode dT (code 3 in configuration)

Module of differential temperature **Δt =** |**t1-t2**| is analyzed

Tariff counters will accumulate thermal energy.

Δt ≥ TT1	Basic register only
TT2 ≤ Δt < TT1	Basic register and T1
TT3 ≤ Δt < TT2	Basic register and T2
TT4 ≤ Δt < TT3	Basic register and T3
Δt < TT4	Basic register and T4

TT1>TT2>TT3>TT4

3.5.5 Tariffing mode T1 (code 4 in configuration)

Supply water temperature is analyzed

Tariff counters will accumulate thermal energy.

When flow metering section is installed in the supply pipeline, this means t1 temperature, while when installed in the return pipeline, this means t2.

t ≥ TT1	Basic register only
TT2 ≤ t < TT1	Basic register and T1
TT3 ≤ t < TT2	Basic register and T2
TT4 ≤ t < TT3	Basic register and T3
t < TT4	Basic register and T4

TT1>TT2>TT3>TT4

3.5.6 Tariffing mode T2 (code 5 in configuration)

Return water temperature is analyzed.

Tariff counters will accumulate thermal energy.

When flow metering section is installed in the supply pipeline, this means t2 temperature, while when installed in the return pipeline, this means t1.

t ≤ TT1	Basic register only
TT1 < t ≤ TT2	Basic register and T1
TT2 < t ≤ TT3	Basic register and T2
TT3 < t ≤ TT4	Basic register and T3
t > TT4	Basic register and T4

TT1<TT2<TT3<TT4

3.5.7 Tariffing mode *Time* (code 6 in configuration)

Tariffing is made depending on the time of the day

Tariff counters will accumulate thermal energy.

Tariff threshold contain time of the day: hours and minutes

TT1 ≤ time < TT2	Basic register and T1
TT2 ≤ time < TT3	Basic register and T2
TT3 ≤ time < TT4	Basic register and T3
TT4 ≤ time or time < TT1	Basic register and T4

TT1<TT2<TT3<TT4

If some of the thresholds are not defined and if time is in interval between maximal threshold and TT1, then accumulation are produced in main register and T4. For example, if TT3 and TT4 are not defined, then if time exceeds TT2 or less TT1, accumulation will be in T4.

3.5.8 Tariffing mode PQ (code 7 in configuration)

Capacity and flow rate are analyzed. T1 and T2 tariffs will be used for the capacity, while T3 and T4 will be used for the flow rate.

Tariff counters will accumulate thermal energy.

P ≤ TT1 and q ≤ TT3	Basic register only
TT1 < P ≤ TT2	Basic register and T1
P > TT2	Basic register and T2
TT3 < q ≤ TT4	Basic register and T3
q > TT4	Basic register and T4

Values may be accumulated in T1 (T2) and T3 (T4) simultaneously

TT1<TT2

TT3<TT4

3.5.9 Tariffing mode HC (code 7 in configuration)

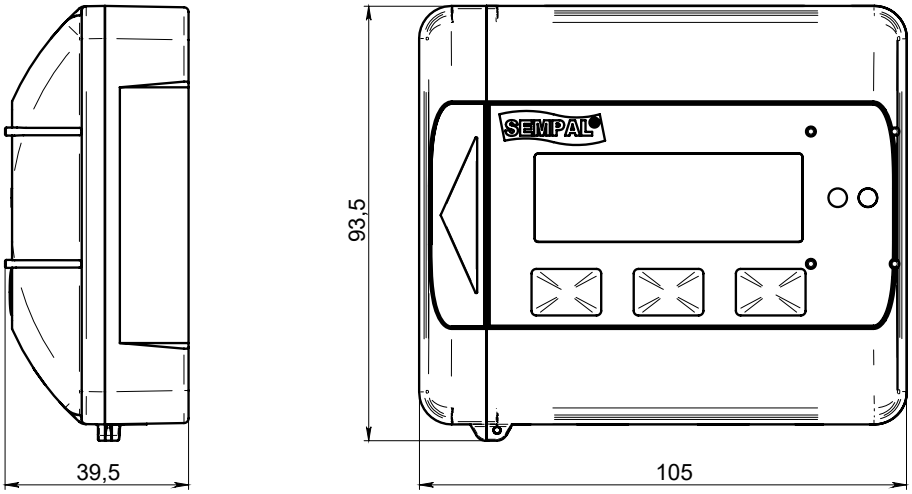
This tariff will be used in the automatic switching mode heat/cold only.

Only tariff counters T1 and T2 are used. Threshold values are not used.

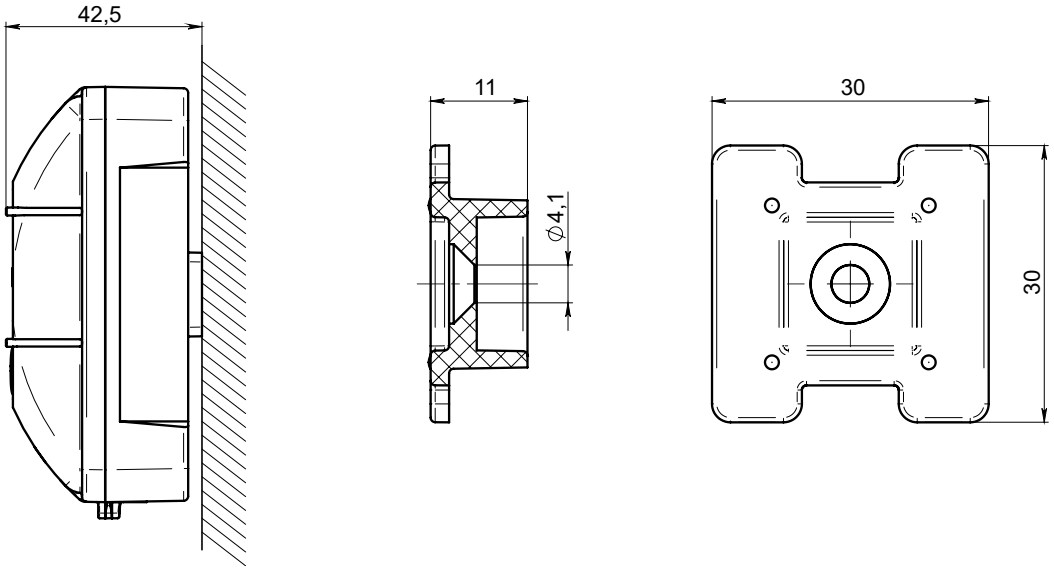
T1 will accumulate the heating water volume, while T2 will accumulate the cooling water volume.

4 Overall dimensions

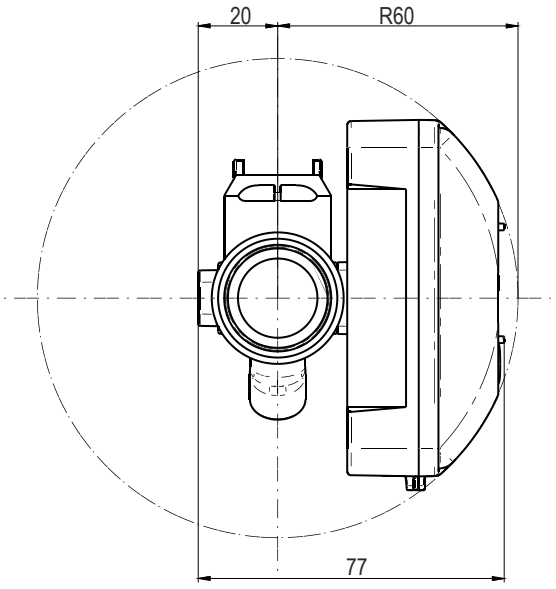
4.1 Calculator



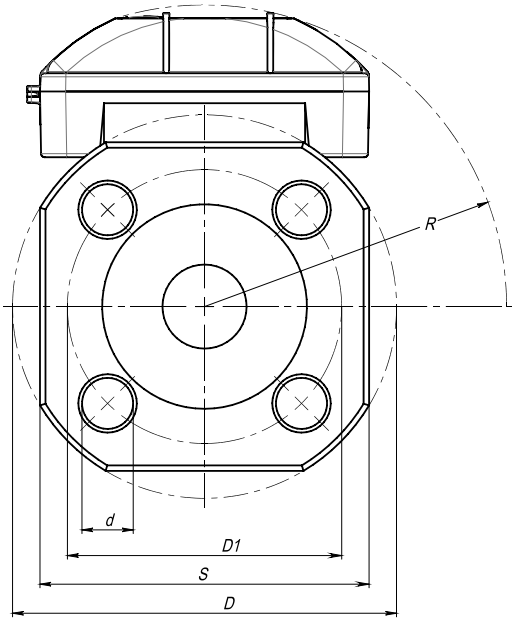
Wall mounting

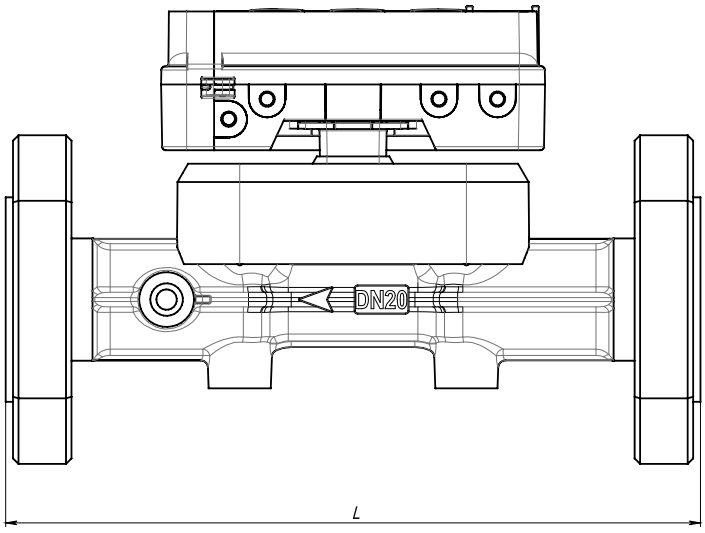


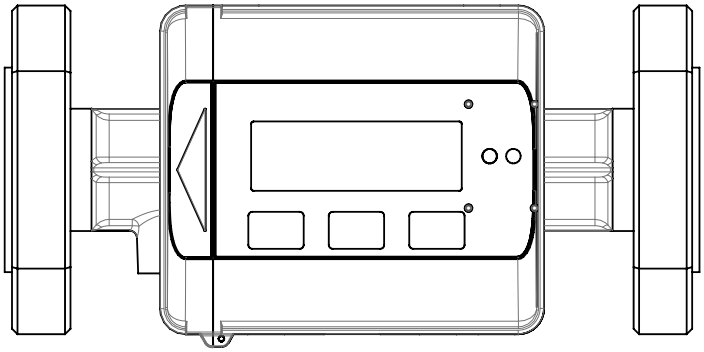
Calculator installation onto flow metering section



4.2 Flowmetering sections DN20…DN50 with flange connectivity

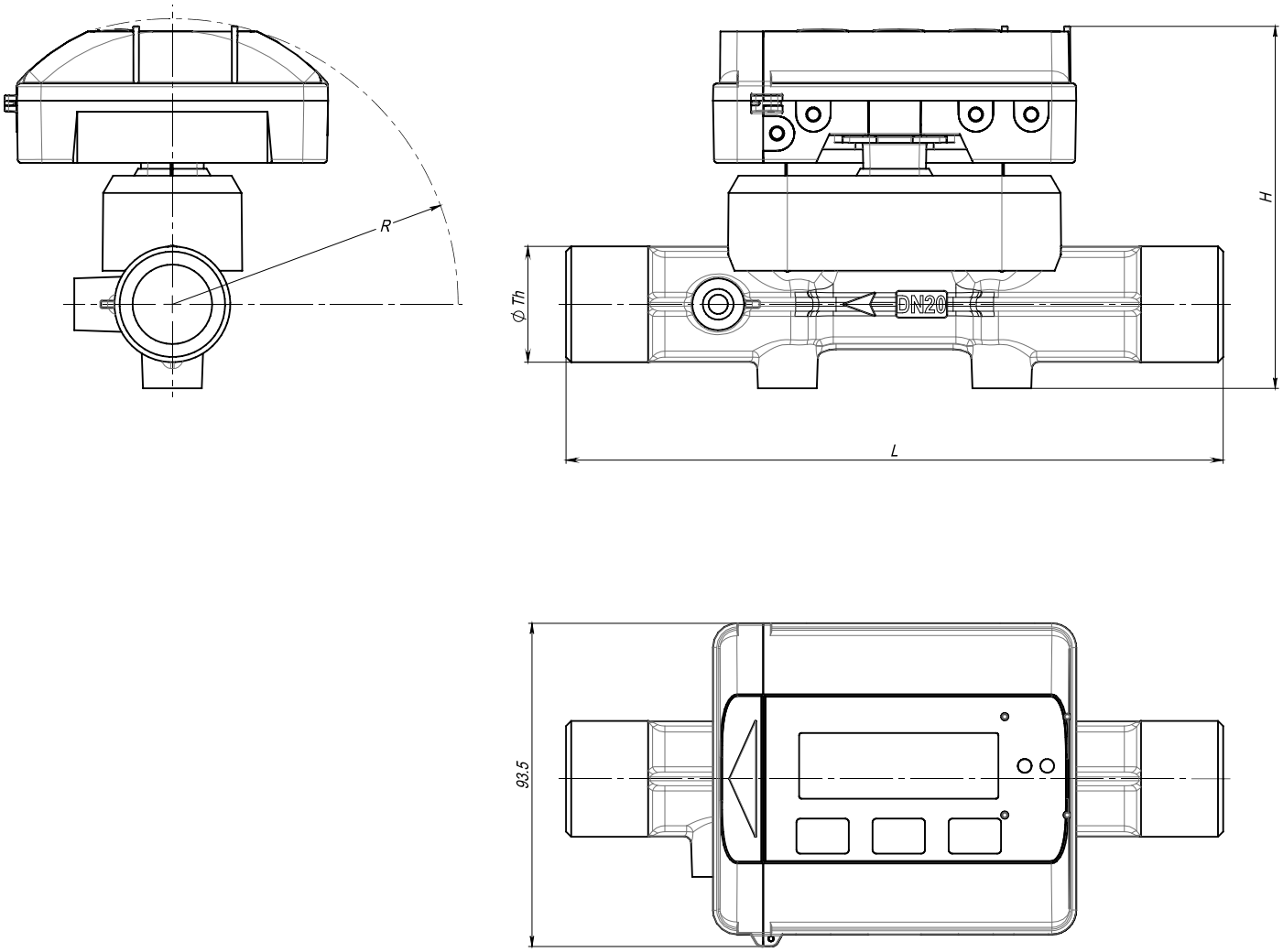






FS type	L, мм	D, мм	D1, мм	d, мм	Number of holes, шт	S, мм	R, мм
020F	190	105	75	14	4	90	83
025 (F, H)	260	115	85	14	4	100	85
032F	260	140	100	18	4	115	87
040F	300	150	110	18	4	125	91
050 (F, W)	270	160	125	18	4	140	100

4.1 Flowmeter sections DN15…DN40 with threaded connection



FS type	L, мм	R, мм	H, мм	Th, мм
015A	110	83	105	G ¾ B
020C	130	83	105	G 1 B
020G	190	83	105	G 1 B
025C	160	85	110	G 1 ¼ B
025 (G, E)	260	85	110	G 1 ¼ B
032G	260	87	116	G 1 ½ B
040G	300	91	124	G 2 B

5 Installation

5.1 Installation requirements

Prior to the meter installation, the system must be flushed to remove big pieces of iron scale, stones and the like. Flushing must be made with a repair insert.

Only new sealing elements included into the delivery set must be used for flow metering section installation.

Before tightening the screw connections to make sure that progress is sufficient to seal the thread

To facilitate maintenance of the meter, it is advisable to install ball cocks before and after the meter.

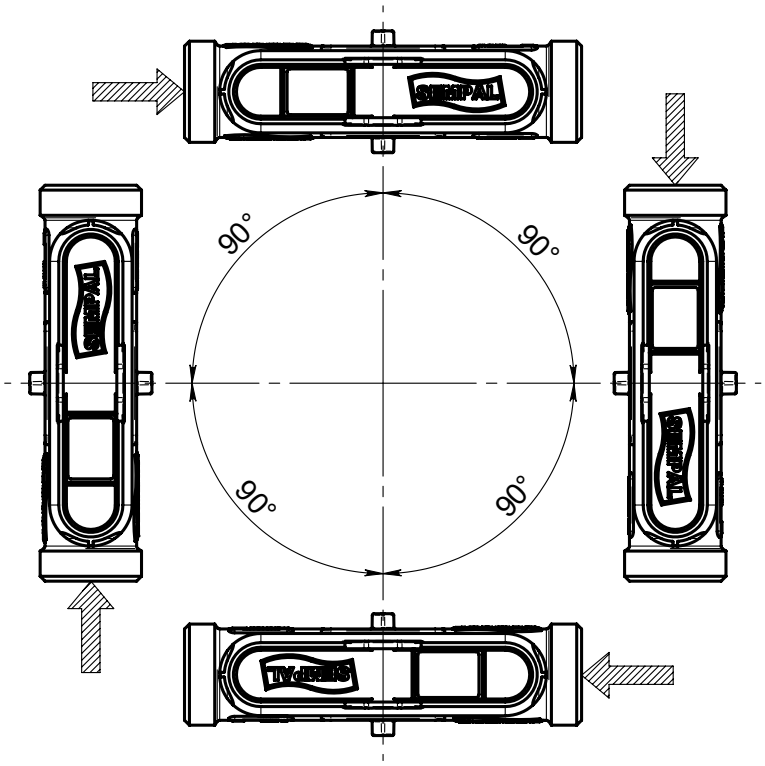
Installation of flow metering section onto the supply or return pipeline will depend upon the meter configuration to be read on the indicator.

Operating conditions

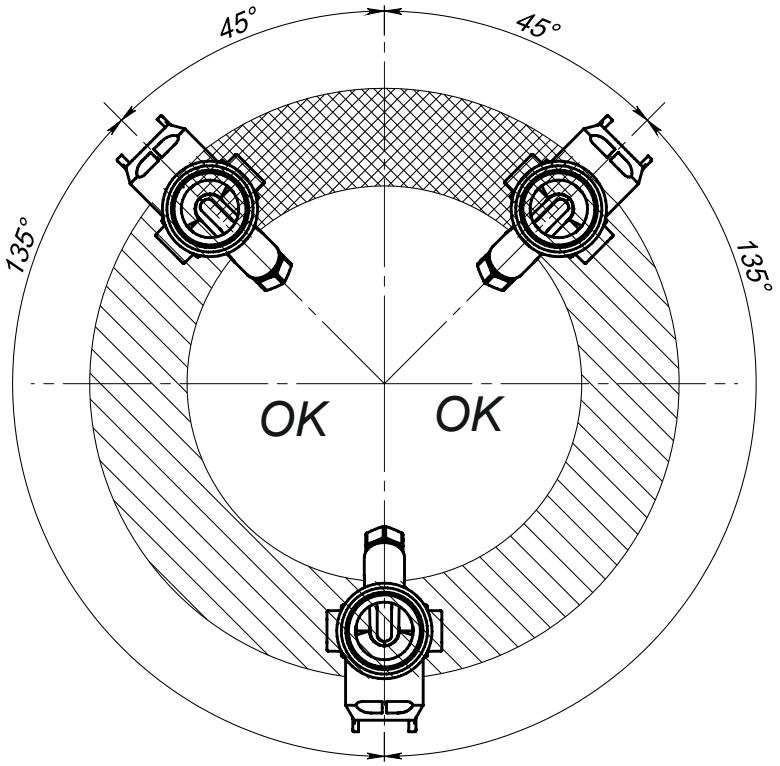
Ambient temperature	5…55 °C (indoors installation) The temperature must not exceed 30 °C for maximum lifetime of the battery
Water temperature	2…150 °C when the calculator is installed on a wall 15…90 °C when the calculator is installed onto the flow metering section
Pressure in the system	1…16 bar

Warning! It is mandatory to install a strainer in front of the flow meter of the heat meter

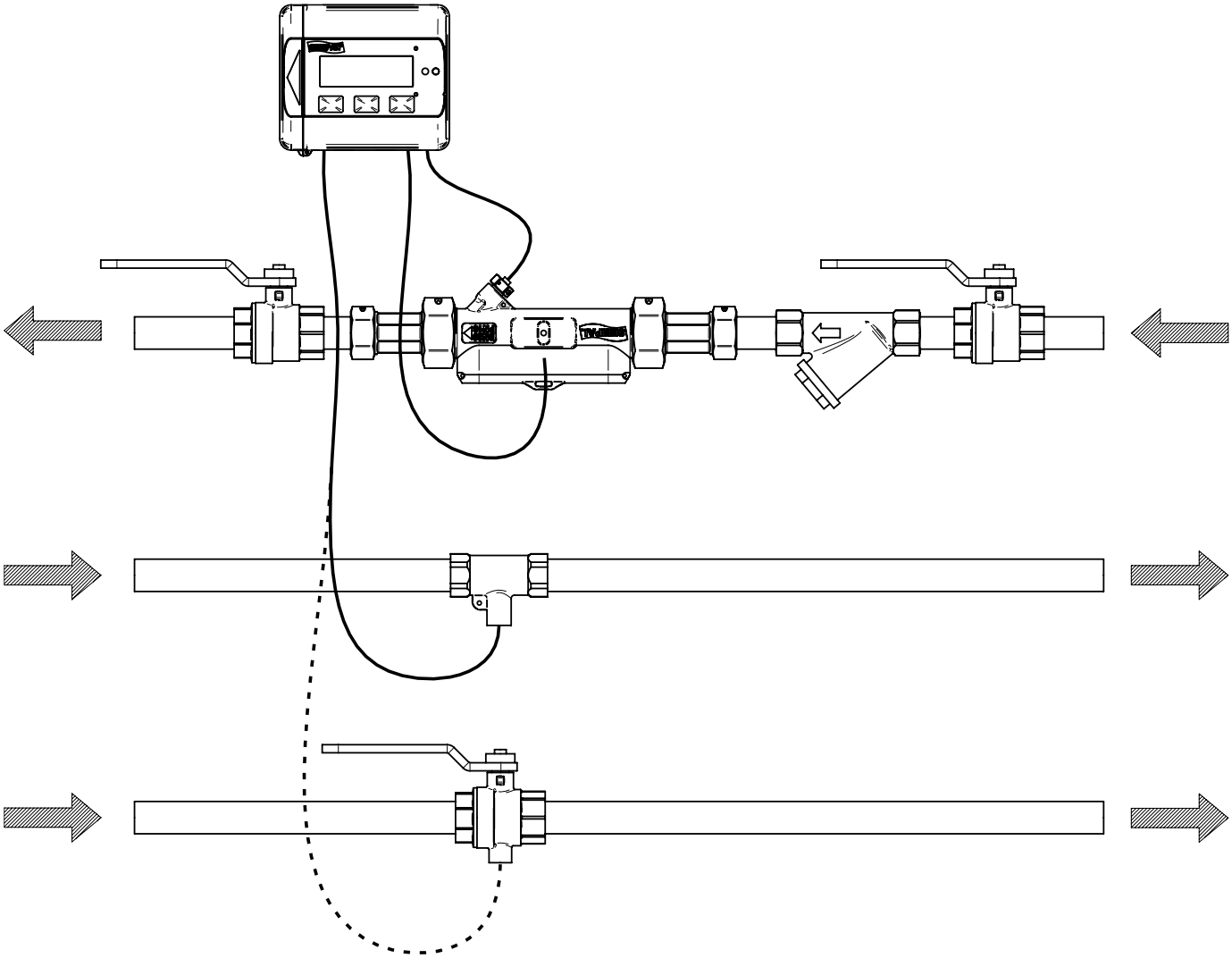
5.2 Flow metering section location in a pipeline



Flow metering section may be installed vertically, horizontally or at any arbitrary angle.



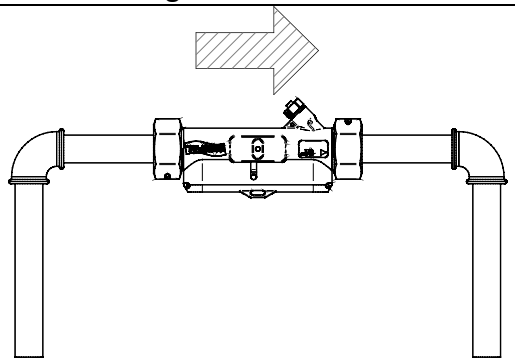
Flow metering section must be turned 45° and more degrees. Vertical installation or installation with the turn angle less than 45° is not allowed.



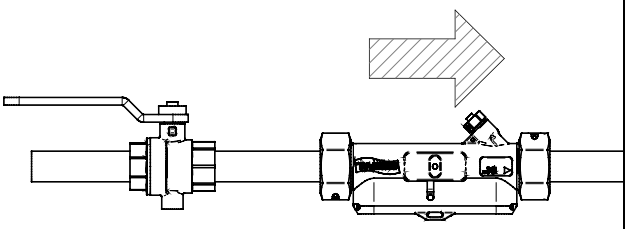
Example of installation of TSP of the return pipeline by means of a tee or the ball valve

5.3 Requirements for straight line sections

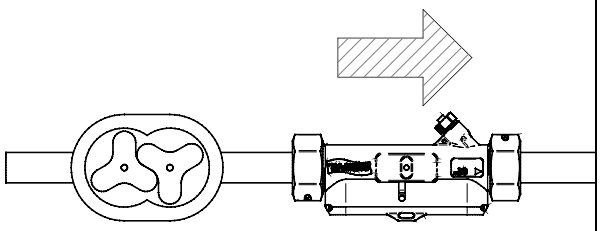
Flow metering section DN15…50 does not require to have straight sections before and after of FS.



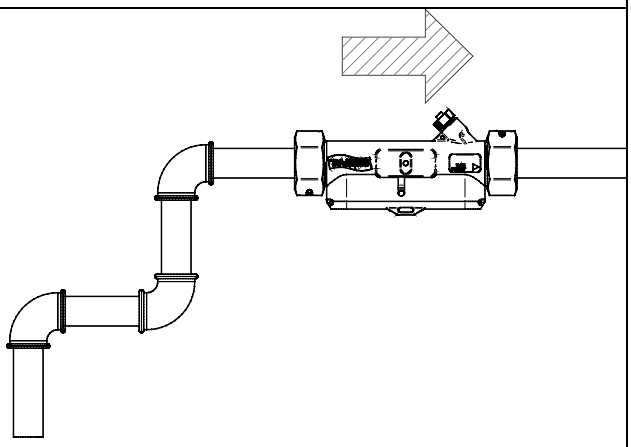
Installation at the highest point of the system is not allowed.



Installation after the valve at a distance shorter than 5D without straight sections prohibited (fully opened full-bore ball valve excluded).



Installation after the pump at a distance shorter than 5D is not allowed



Installation at a distance shorter than 5D to a double bend is not allowed

Such straight-line sections are required only in the case of strong flow disturbance in front of flow metering section. Such disturbances may be caused by a pump, double turn in different planes, availability of shutoff fittings (fully opened full-bore ball cock excluded).

Internal diameter of straight section must not differ by more than ±5% from the nominal value of DN.

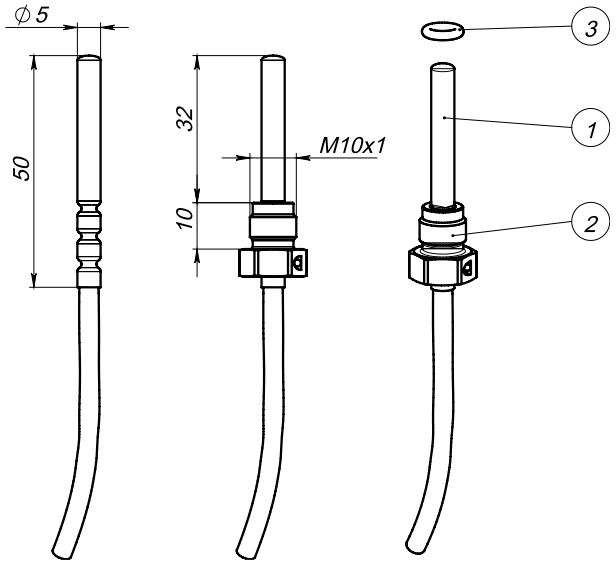
5.4 Temperature sensor installation

For heat measurement the meter use two RTD.

One of it T1 (with read label) **always** mounted into forward pipe, another T2 (with blue label) **always** mounted into return pipe.

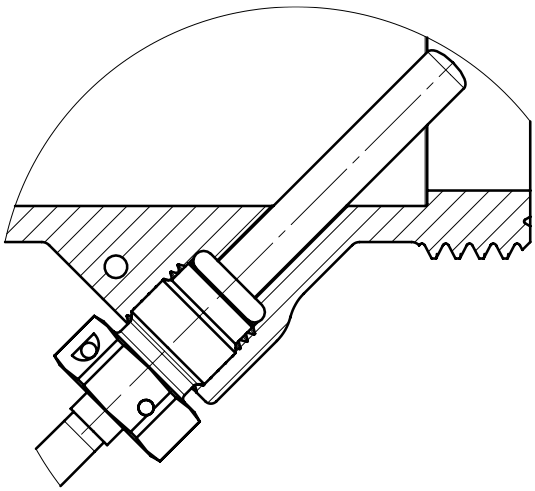
If the meter is configured for return pipe installation, then T1 mounting into the same pipe as flow metering section. In heat metering mode T1 always will be grater than T2. In cool metering mode T1, accordingly, will be less than T2.

5.4.1 Mounting RTD with cable length up to 3 m inclusively (two-wired non-disconnectable cable).

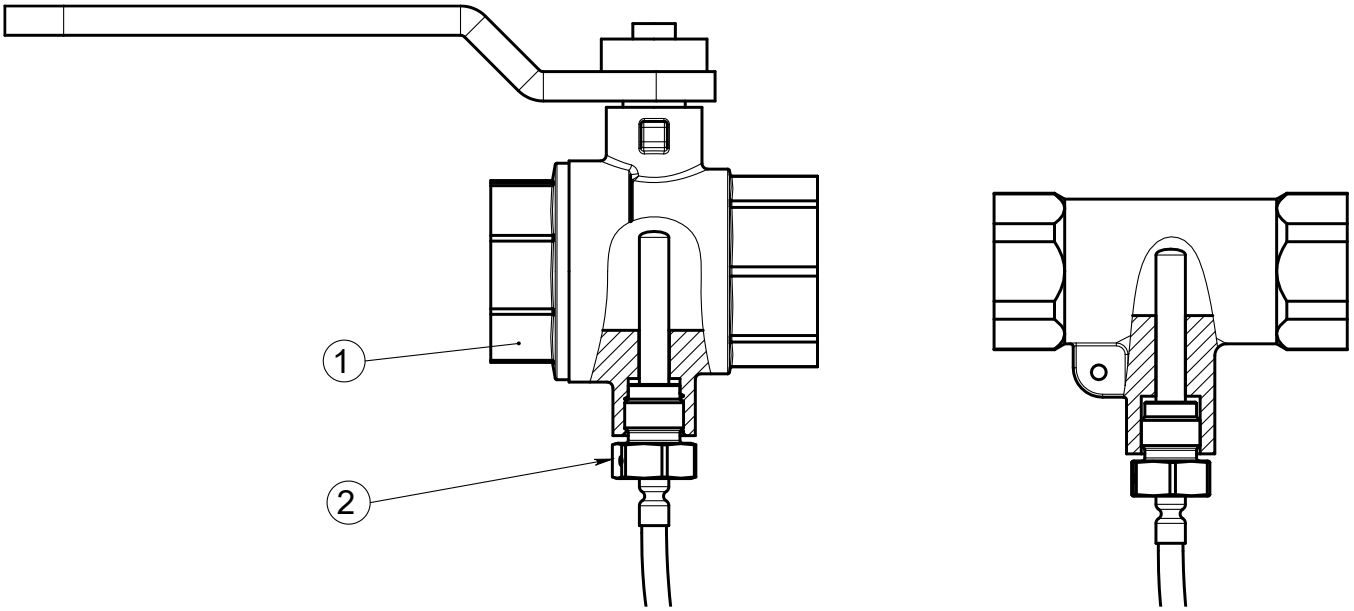


1 – temperature sensor; 2 – Temperature sensor holder; 3 – Sealing ring

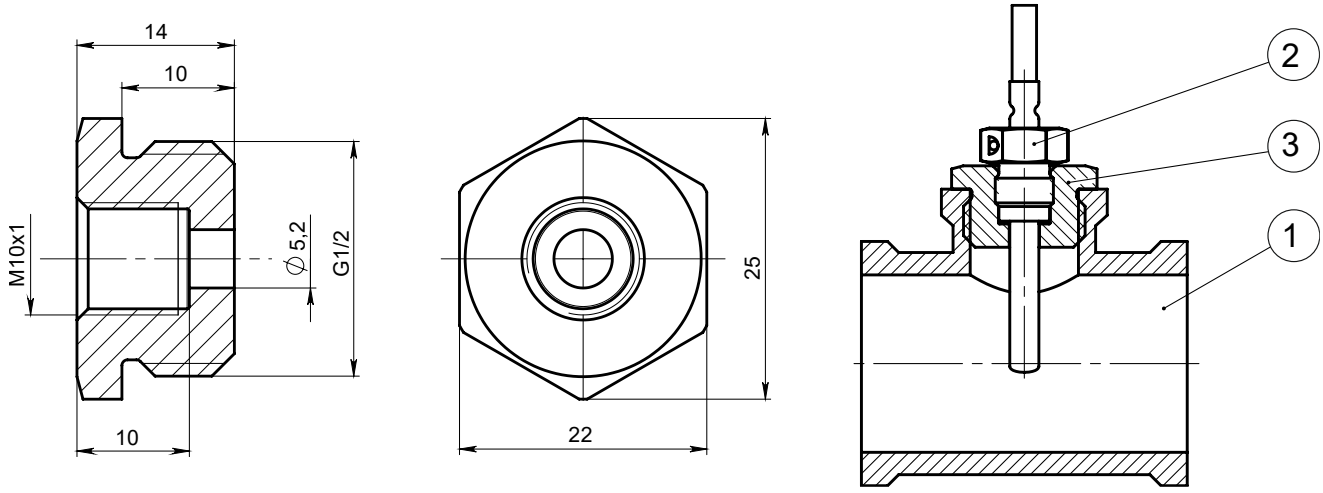
For DN15…40 T1 can be installed into FS (see figure):



T2 should be installed in specialized fittings for DN15…25 with a thread for connecting RTD. Installation into such fittings does not require additional sealing.



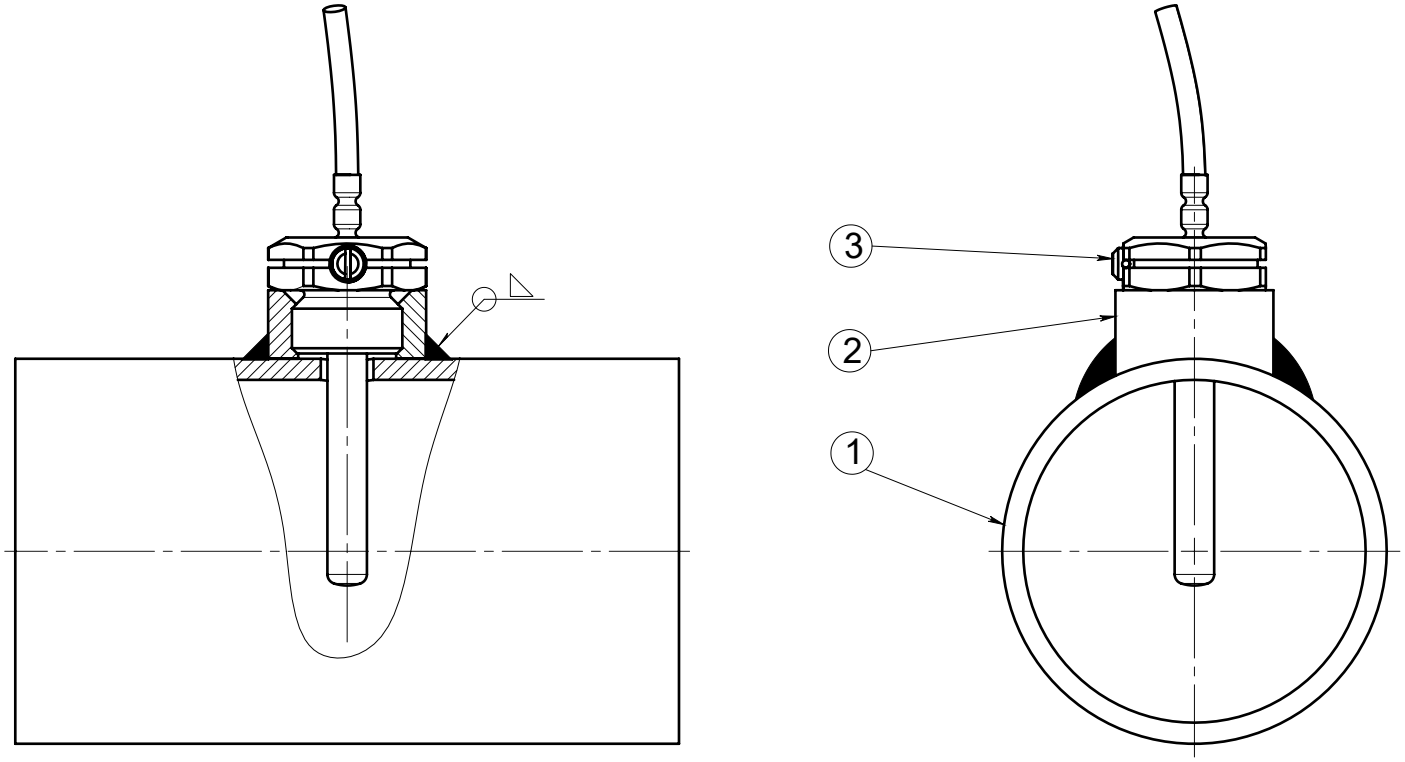
RTD can also be installed in a tee. To do this, use a special adapter (pos.3), which is directly screwed into the RTD holder (pos.2)..



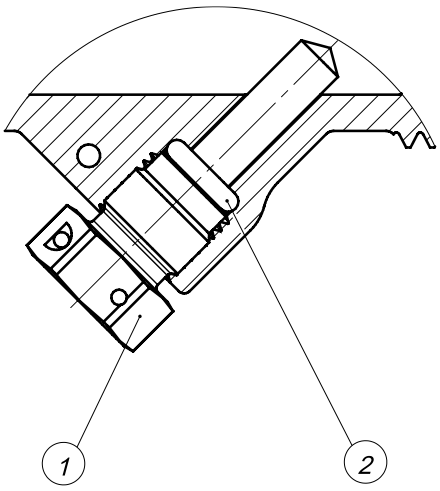
This adapter requires additional sealing materials (Fum tape, thread, tow, paste, thread sealant).

For DN greater than 50 installations of both RTD is carried out by means of a protective sleeve (pos.3), fig. below, and a welded lug (pos.2) of the corresponding size which are included in the delivery set. Welding of the lug to the pipeline (pos.1) is performed at the place of installation.

When using a sleeve, it is necessary to provide airless contact of a bottom of a protective sleeve and RTD by filling of backlashes with high-temperature thermally conductive substance (for example, transformer oil or thermal paste).

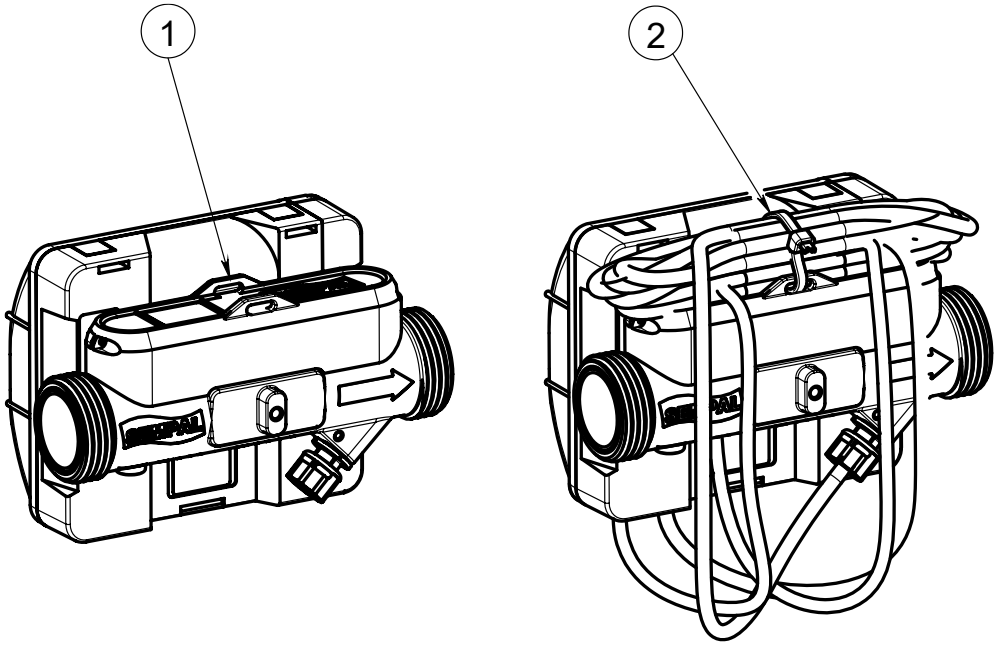


If Temperature sensor t1 has to be installed separately (not inside flow metering section), orifice in the flow metering section must be plugged with a blind plug from the delivery set of the meter



1 – blind plug; 2 – sealing ring

5.5 Laying cables



Laying cables from the electronic unit

1 - place of cable laying

2 - a plastic coupler from a set of delivery of the counter

5.6 Commissioning

After installation, you must fill the system with water and configure the calculator to work in the desired configuration.

5.6.1 Filling the system

Open the valves, check the system for leaks and remove air from the system.

The air must be removed until the indication of flow measurement errors disappears and the flow displayed on the indicator stabilizes.

After that it is possible to seal all parts of the heat meter.

5.6.2 Setting up the calculator

At release the calculator is entered into a transportation mode (6.2.1). This mode is equivalent to the **Setup** mode and differs only in the reduced power consumption.

In this mode, you can edit the installation settings of the device.

The following parameters must be set for commissioning:

- heat metering mode (heat, cold or heat and cold)
- heat system units
- flowrate system units
- reporting date of the month (report date)
- configure pulse inputs, if any, and to be used
- configure the tariff, if necessary

After completing the configuration of the device, when the correctness of all entered data is checked, you need to exit the **Setup** mode as indicated in the menu description. At this time the device will pass to a normal mode of work and will start accumulation of integral parameters and archive.

Further entry into the **Setup** mode is possible only as described in (3.4)

5.7 Maintenance

5.7.1 After installation of the meter welding works or freezing of the meter are not allowed. The meter must be dismounted for welding work.

5.7.2 It is forbidden to dismount flow sensors from the flow meter section. In this case, the warranty is void.

5.7.3 In cases where the flow area needs to be cleaned, it must be dismounted and cleaned with any household liquid detergent that is designed to remove layers.

6 Calculator

6.1 Performance of measurements

Measurement cycle of a meter consists of two independent cycles – integration cycle and temperature measurement cycle.

The temperature measurement cycle during a normal measurement mode will always be equal to 32 seconds.

The integration cycle may be changed in the course of the meter setting (see clause 3.2). Flow measurement cycle depends on the integration cycle.

When the meter is shipped, its integration cycle will be set to 16 seconds. Periodicity of the flow rate measurement then will be once every two seconds.

If shorter measurement cycles are installed, you must take into account that service life of the battery will be shorter as a result.

6.1.1 Energy calculation

The IAPWS-97 formulation is used to calculate energy.

The enthalpy is calculated for a pressure of 16 bar.

For delivery options 2, the energy E is calculated by the formula:

$$E = \sum M \cdot (H_1 - H_2) \qquad (6.1)$$

where M - is the mass of the coolant

H_1 and H_2 - are the enthalpies for supply and return pipelines, respectively, as a function of temperature.

For option 2/1, the formula looks like this:

$$E = \sum M \cdot (H_2 - H_1) \qquad (6.2)$$

where M is the mass of the coolant

H_2 and H_1 are the enthalpies for supply and return pipelines, respectively, as a function of temperature.

Simplified schematics of metering units for different delivery options are given in Annex A.

All internal calculations are made in GJ, expression of energy in other measurement units is made by virtue of the following calculations:

E[MWh] =	E[GJ] * 0.27778
E[kWh] =	E[GJ] * 277.778
E[GCal] =	E[GJ] * 0.23885

6.2 Working modes of the meter

There are several modes of operation of the meter:

- transport
- normal
- Setup
- verification (Test)

6.2.1 Transportation mode

The transportation mode is equivalent to **Setup** mode except for the periodicity of measurement and the indicator work.

This mode is set when the meter leaves the production line. It is intended for maximum curtailment of the consumption.

In this mode, the integration cycle and temperature measurement cycle will be equal to 60 seconds each. The indicator is turned off. When any pushbutton is depressed, the indicator will be turned on. It will be turned off again 5 minutes thereafter, if no pushbutton is depressed.

iRDA port continues its work as in the normal mode.

When the possibility of correct flow rate measurement (flow metering section is filled with water) appears, periodicity of measurement becomes equal to that in normal operation mode.

If absence of water in flow metering section is registered for 5 minutes, the meter will be switched over to the transportation mode again.

6.2.2 Normal mode

This is the main working mode of the meter. The integration cycle here is set to a value to be determined by the user. The temperature measurement cycle will be 32 seconds.

Indicator is on. iRDA port is operable.

All measured parameters are archived and tariffed in this mode.

6.2.3 Setup mode

This mode is intended for initial meter setting.

Periodicity of measurements in this mode will correspond to the periodicity of measurements in the normal mode.

Integral parameters in this mode will be accumulated but will not be memorized. That is, when this mode is turned on, the integral parameters will have the same meaning as of immediately before entering this mode.

No archive is kept.

Log of user's actions is kept.

Duration of this mode will not exceed 2 hours if no pushbuttons are depressed. When this period expires, the instrument will automatically be switched over to the normal operation mode. If any introduced changes require archive emptying and initial parameters resetting, these will be performed automatically, without additional requests of the user.

6.2.4 Test mode

This mode is intended for verification of the meter.

In this mode, integration cycle is 2 seconds, while periodicity of flow rate measurement will be 2 times a second. The temperature measurement cycle will be 2 seconds.

It is made to accelerate the verification process.

Integral parameters will not be memorized in this mode. That is, when you exit from this mode, the integral parameters will restore the values they have prior to entering this mode.

Duration of this mode will not exceed 8 hours if no pushbuttons are depressed.

6.3 Functions of the meter

6.3.1 Logging

The meter will keep a log of user's actions to register everything that can influence over the measurement result.

The following events will be registered in the log:

- Entering into and exiting from **Setup** and **Test** modes;
- Editing of any parameters while in **Setup** mode

Depth of the logging: 100 entries

In addition, every entry into service modes will increment the relevant entry counter. Readings of these counters may be seen on the indicator and their current status may be read through any available interface.

6.3.2 Combined measurement of heating/cooling

When you are in this mode, switching over from heating to cooling measurement and vice versa is made automatically depending on the sign of the temperature differential between supply and return waters.

If T1>T2, heating will be measured, while if T1<T2, cooling will be measured.

The heating and cooling energies will be summarized and memorized in different cells.

Thermal energy content will be displayed with a sign, '+' sign will mean heating, while '-' will mean cooling.

6.3.3 Maximum values

The meter will register maximum values of flow rate, heating and cooling capacities. Such values will be memorized in all archive types. This means that hourly, monthly and yearly maximum values will be stored.

Such maximum values will be calculated as the maximum for averaged measurement results during a fixed time interval. Possible values of the averaging interval: 1, 2, 3, 4, 5, 10, 15, 20, 30 minutes. When the meter is shipped, the averaging time is set to 30 minutes.

6.3.4 Archiving

When operated in the normal mode, the meter will keep the following archives:

Archive type	Depth
Hourly	1680 hours (70 days)
Daily	500 days
Monthly	36 months (3 years)
Yearly	16 years

The following data will be placed into archives;

- date
- volume and mass
- average weighted temperature of supply and return water
- heating and cooling energy
- tariff counters (4 items) (if used)
- volumes by pulse signal inputs (if used)
- maximum values of volume, heat and cold
- codes and durations of errors registered during the time interval corresponding to the archive type

6.3.5 Average weighted temperature

In order to be able to calculate energy content based on the archive data, so-called average weighted temperature will be placed into archive instead of the average temperature.

Such average weighted temperature will be calculated with the formula:

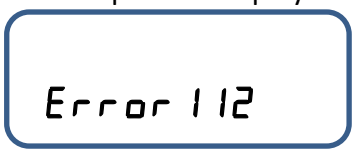
$$\bar{t} = \frac{\sum_i t_i \times M_i}{\sum_i M_i} \qquad (6.3)$$

where I - is the index of the current measurement
ti - is the temperature of the current measurement
Mi - mass or volume of the current measurement - accumulated mass since the end of the previous measurement

6.4 Processing errors

The counter in the course of its operation will continuously monitor correctness of measurements made. If any errors are detected, they will be displayed in the main area of the indicator. If that is the case, the measured parameter will appear in turn with the error code with 4-second interval. The measured parameter will be displayed for 4 seconds followed by indication of the error for another 4 seconds. If several errors are detected simultaneously, they will be displayed in turn.

An example of a displayed error



Any error code consists of three groups of digits (from the left to the right)

- Error group
- Error No.
- Channel No. where the error took place

In the above example, error code indicates the following: error group – temperature measurement (1), error code – 1 (temperature sensor wiring break), Channel – 2 (error took place in Temperature sensor2).

More detailed description of any error may be seen in the instrument menu. In this case, the menu line will contain a text describing the error, while the main display will show the error code.

Error codes

Information on the indicator	Text in the menu line	Description
Error111	Err. Break TS1	Temperature sensor 1 wiring break
Error112	Err. Break TS2	Temperature sensor 2 wiring break
Error121	Err. Short TS1	Temperature sensor 1 short-circuit
Error122	Err. Short TS2	Temperature sensor 2 short-circuit
Error131	Err. Coeff. TS1	Erroneous calibration coefficients RTD1
Error132	Err. Coeff. TS2	Erroneous calibration coefficients RTD2
Error141	Err. TS1 low	Temperature RTD1 is below the permitted limit (-49 °C)
Error142	Err. TS2 low	Temperature RTD2 is below the permitted limit (-49 °C)
Error151	Err. TS1 high	Temperature RTD1 is above the permitted limit (+150 °C)
Error152	Err. TS2 high	Temperature RTD2 is above the permitted limit (+150 °C)
Error311	Err. No water	No water
Error321	Err. Low signal	Low signal level
Error331	Err. Temper. FS	Determination of the water temperature in flow metering section is impossible
Error341	Err. High speed FS	Flow rate exceeds a permitted limit
Error351	Err. Reverse flow	Reverse flow
Error411	Err. tret > ts	The return water temperature exceeds the supply water temperature for more than 2 °C For heating measurement mode only
Error421	Err. ts > tret	The supply water temperature exceeds the return water temperature for more than 2 °C For cooling measurement mode only

If any error is detected, calculation of heat will be stopped.

6.4.1 System errors

System errors means errors in the calculator hardware, which make measurement impossible completely and cannot be remedied in site. To remedy any system errors (or faults causing systemic errors), the instrument will be sent to the manufacturing enterprise.

The system errors will be displayed on the indicator as follows:

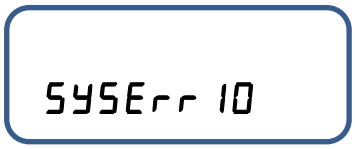


Figure denotes the error number.

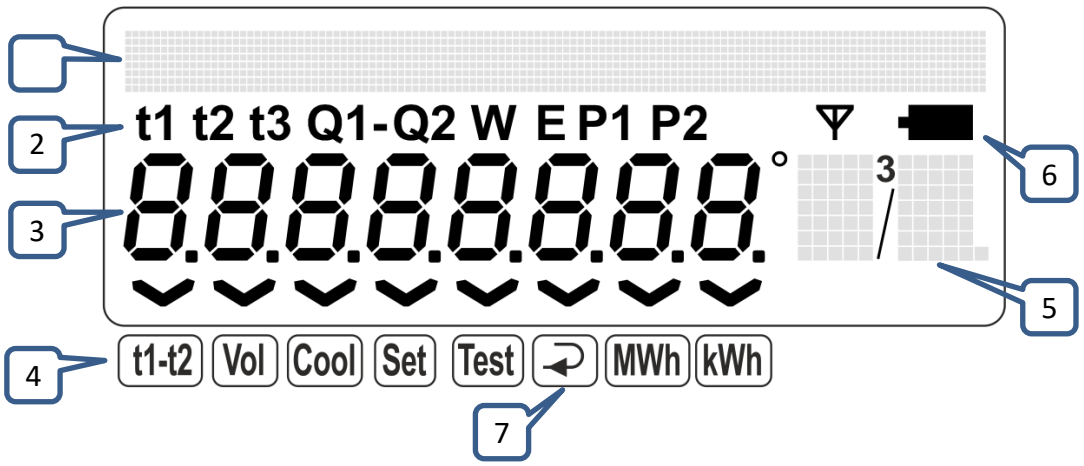
6.4.2 Setting date and time

The instrument will be shipped with pre-set date and time corresponding to the relevant time zone of the supplying country.

Where necessary, date and time may be set by SmpSetup program. If no data is set, the following message will appear on the indicator

6.5 Indicator and keyboard

6.5.1 Indicator



1 – Menu line
2 – Displayed value
3 – Main screen
4 – Mode indicators
5 – Measurement units
6 – Battery charge indicator
7 – indication that FS is installed in the return pipe

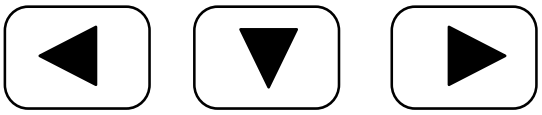
Indicator is divided into two areas: main screen and menu line

Main screen is operable always (except for transportation mode), while the menu line will be displayed only when work with menu is commenced. The menu will remain active for 2 minutes, if no pushbutton is depressed. If no pushbuttons were depressed for 2 minutes, the menu line will be turned off and the instrument will be switched over to the main indication mode.

Mode indicators in the bottom section of the indicator extend the displaying ability of the indicator main screen. Thus, when cooling energy will be displayed, the displayed value line will highlight **'E'** together with the **Cool** mode indicator.

6.5.2 Keyboard

The meter is equipped with a keyboard comprising three pushbuttons: 'to the right', 'down' and 'to the left'.



"Left" "Down" "Right"

When navigating the menu, the menu item number is displayed on the left side of the line. The number of each subsequent menu attachment (next menu level) is separated from the previous by a dot.

6.6 Counter control menu

The counter is controlled by long (3… 5 seconds) or short (1… 2 seconds) button presses.

Long presses are used in the following cases:

◀ ▶	Transitions between titles
◀	Go from **any** menu item to the **energy** display item (E) of the main menu
▼	Go from **any** menu item to the **title** of the current menu branch

With short presses, the following happens:

– "Down" button - go to the next menu item;
– "Left" button - returns to the previous item (if necessary, for example, or reset the previous value);

– when selecting one of the parameters from the list, which consists of three or more positions: button "Right" - the beginning of the search, "Down" - alternate search, "Left" - fix the selected parameter;

– when selecting one of the two parameters: "Down" - alternate search. Go "Left" or "Right" is already performed with the selected parameter value.

Number editing.

– "Right" button - start editing the next digit (flashing of the selected digit with a frequency of 1 Hz)

– The "Down" button changes the selected digit

– after selecting the desired digit, the "Right" button moves to the next digit. After reaching the last digit, the first digit is selected again

– finish editing - on the "Left" button

6.6.1 Short description of the menu

The "**Control**" menu allows the representative of the servicing, or inspecting, organization to check up correctness of establishment of parameters of the account. Menu items 2.1, 2.2 help to assess the facts of authorized or unauthorized access to these parameters. Section 2.9 - see the configuration of the device.

The "**Setup**" menu is used to set the configuration of the meter and enter it in the account.

IMPORTANTLY! Exiting the "**Setup**" menu requires special attention, because each time you enter the "**Setup**" mode (for example, when you mistakenly exit the mode and then enter it) increases by one counter the number of occurrences in this mode. Each additional entry into this regime may be regarded by the inspector as an attempt at falsification.

When exiting the "**Installation**" mode through this menu item, you can:

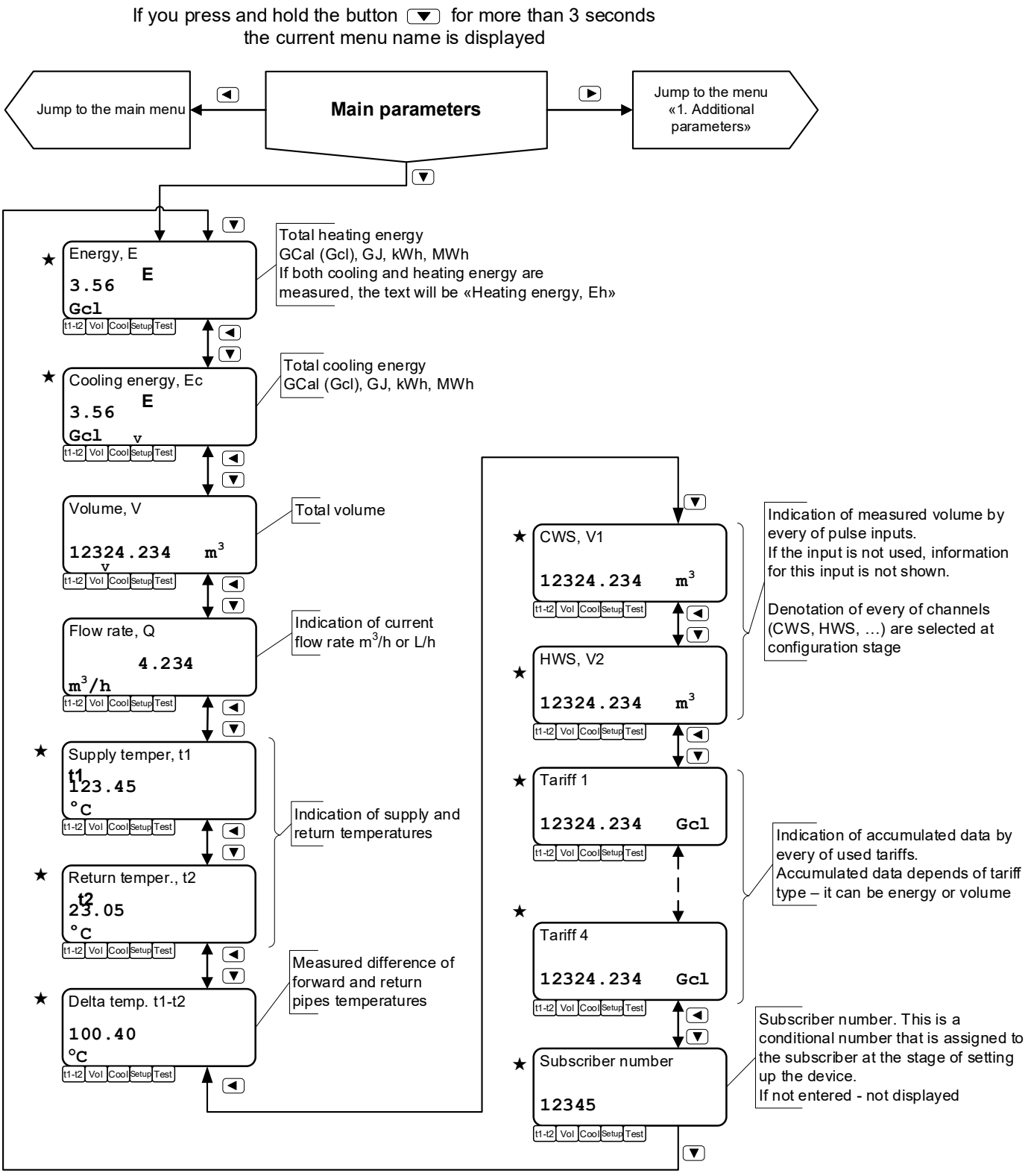
– return to the beginning of the menu if you need to check something again or correct it

– before entering the account, save or reset ("Exit without reset" or "Exit with reset") integral parameters.

When you log in (exit Installation mode), you are prompted to confirm the transaction. If everything is done correctly and there is confidence in the correctness of the entered data, you must select "Yes" and click "Right".

Thus, the device will be registered and it will exit the "**Setup**" mode.

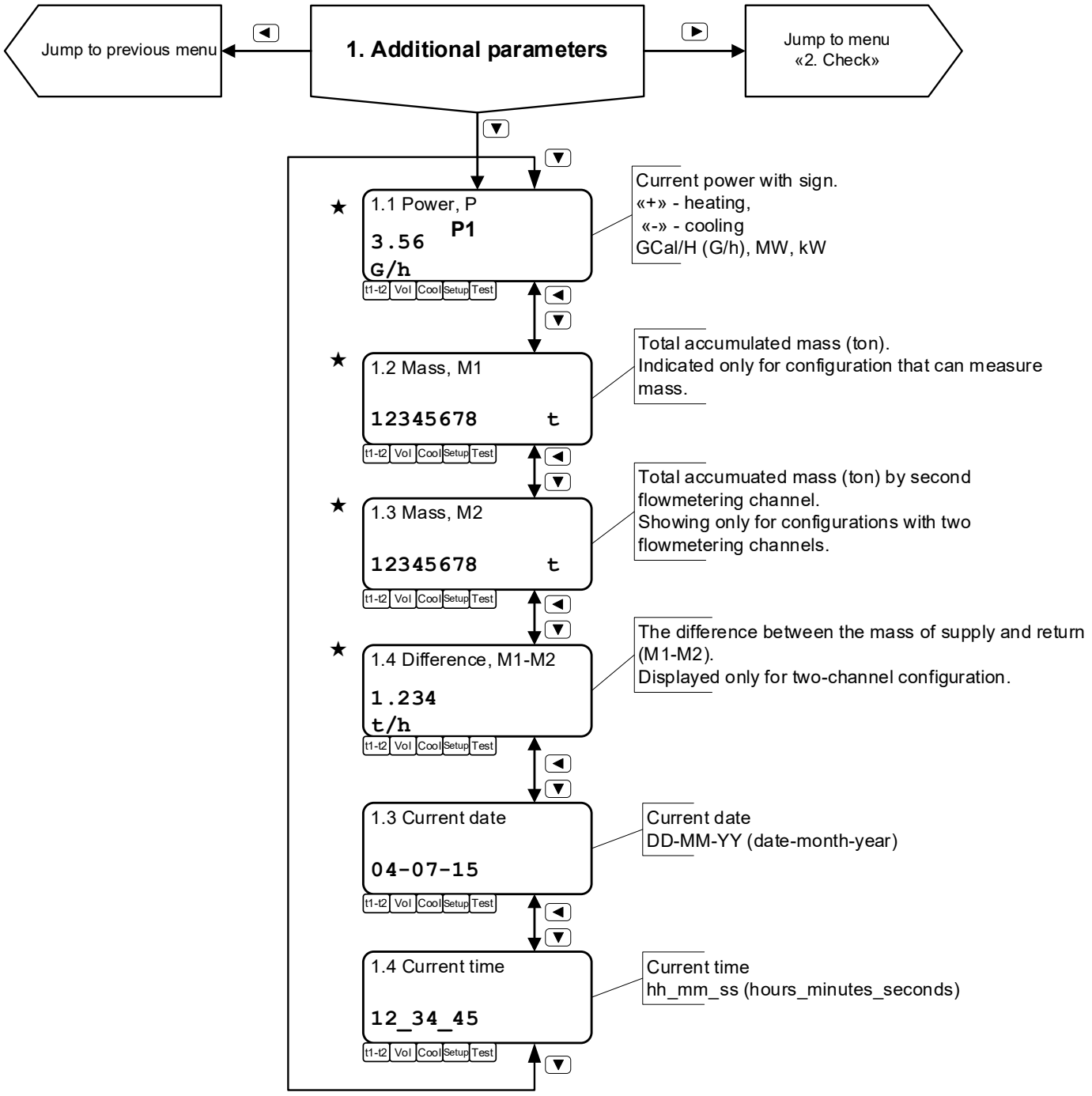
6.7 Information displayed in main mode



* Denotes menu items visible under certain conditions depending on the configuration and instrument operation mode

6.8 Menu additional parameters

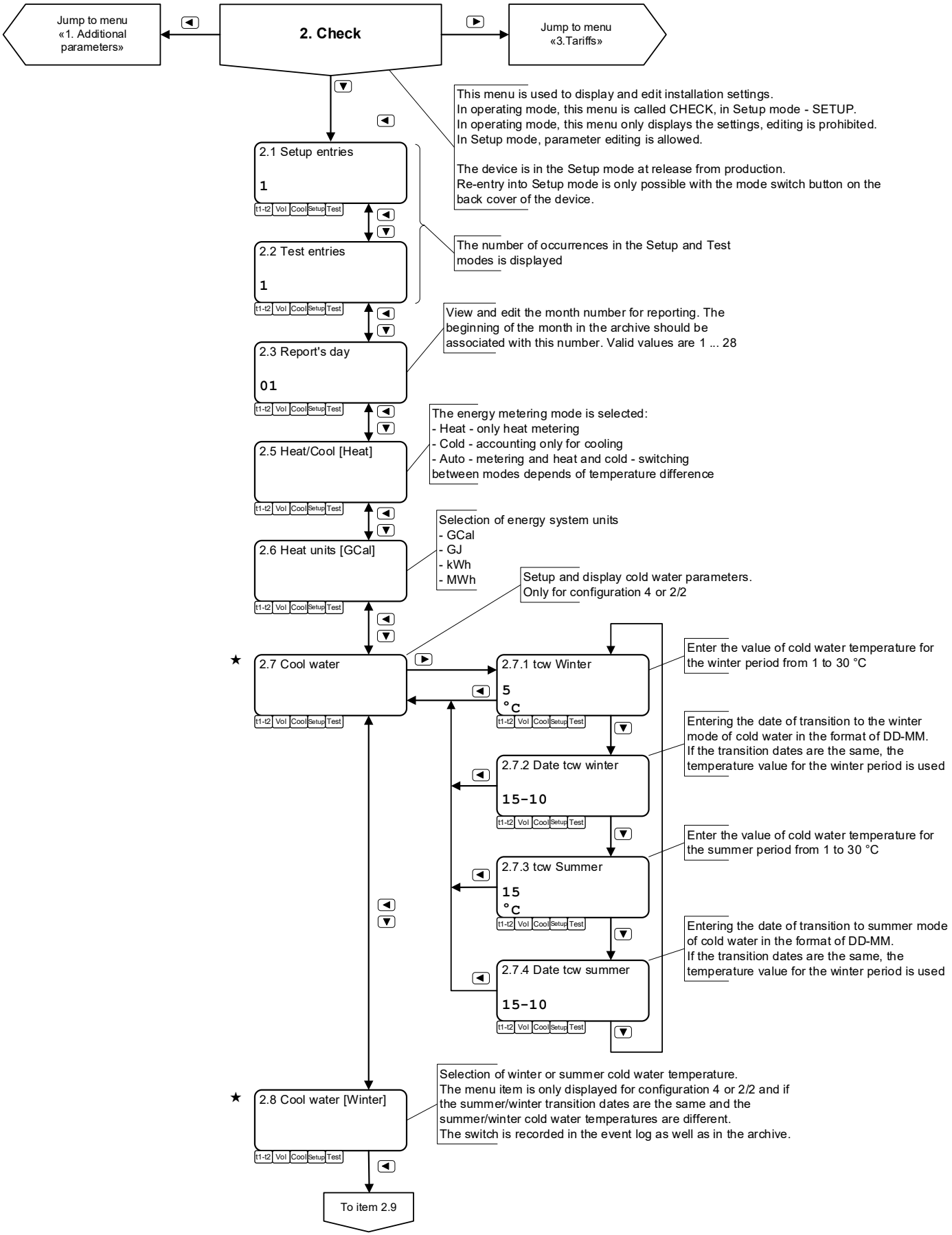
If you press and hold the button ▼ for more than 3 seconds
the current menu name is displayed

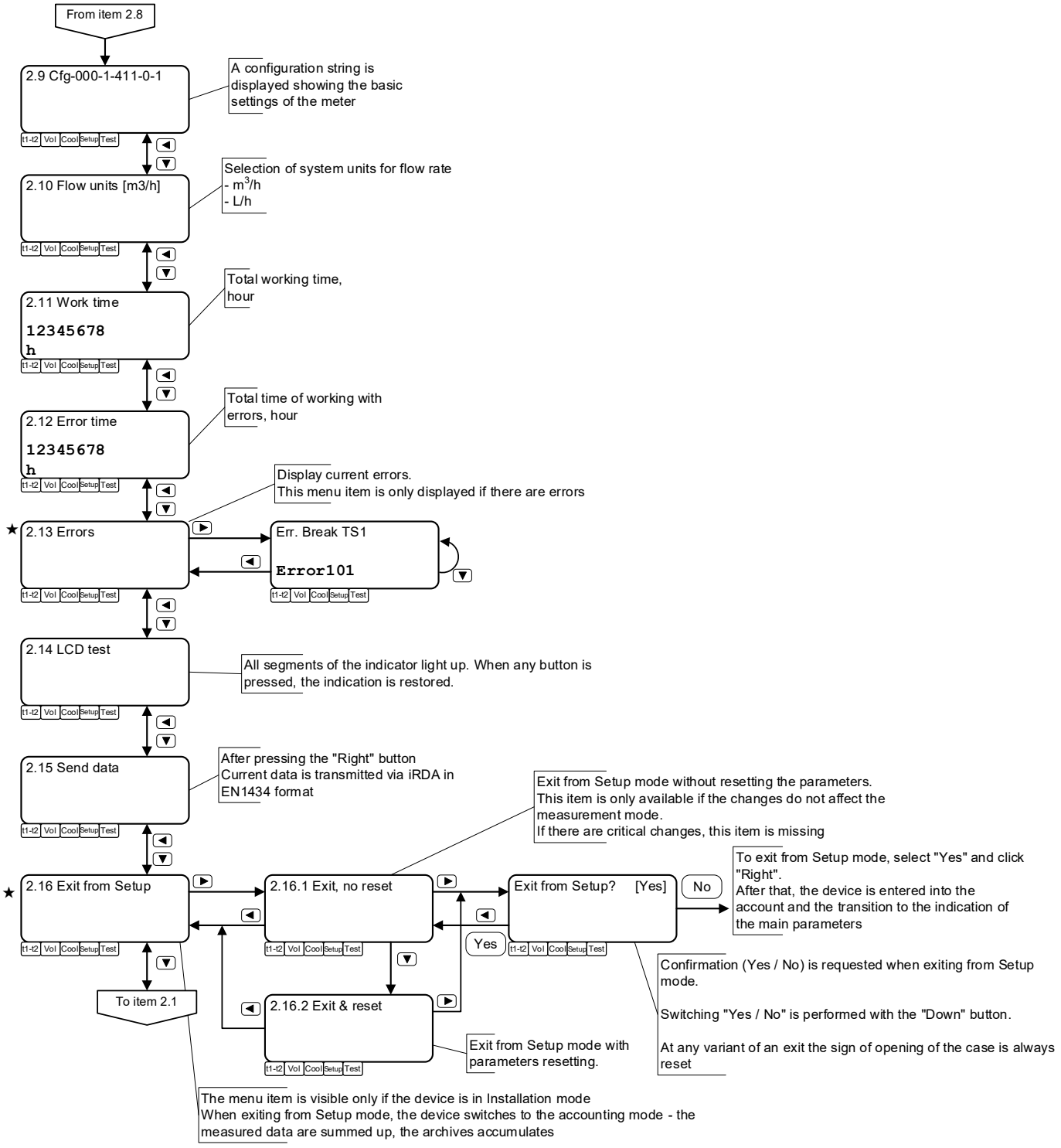


* Denotes menu items visible under certain conditions depending on the configuration and instrument operation mode

6.9 Menu check (Setup)

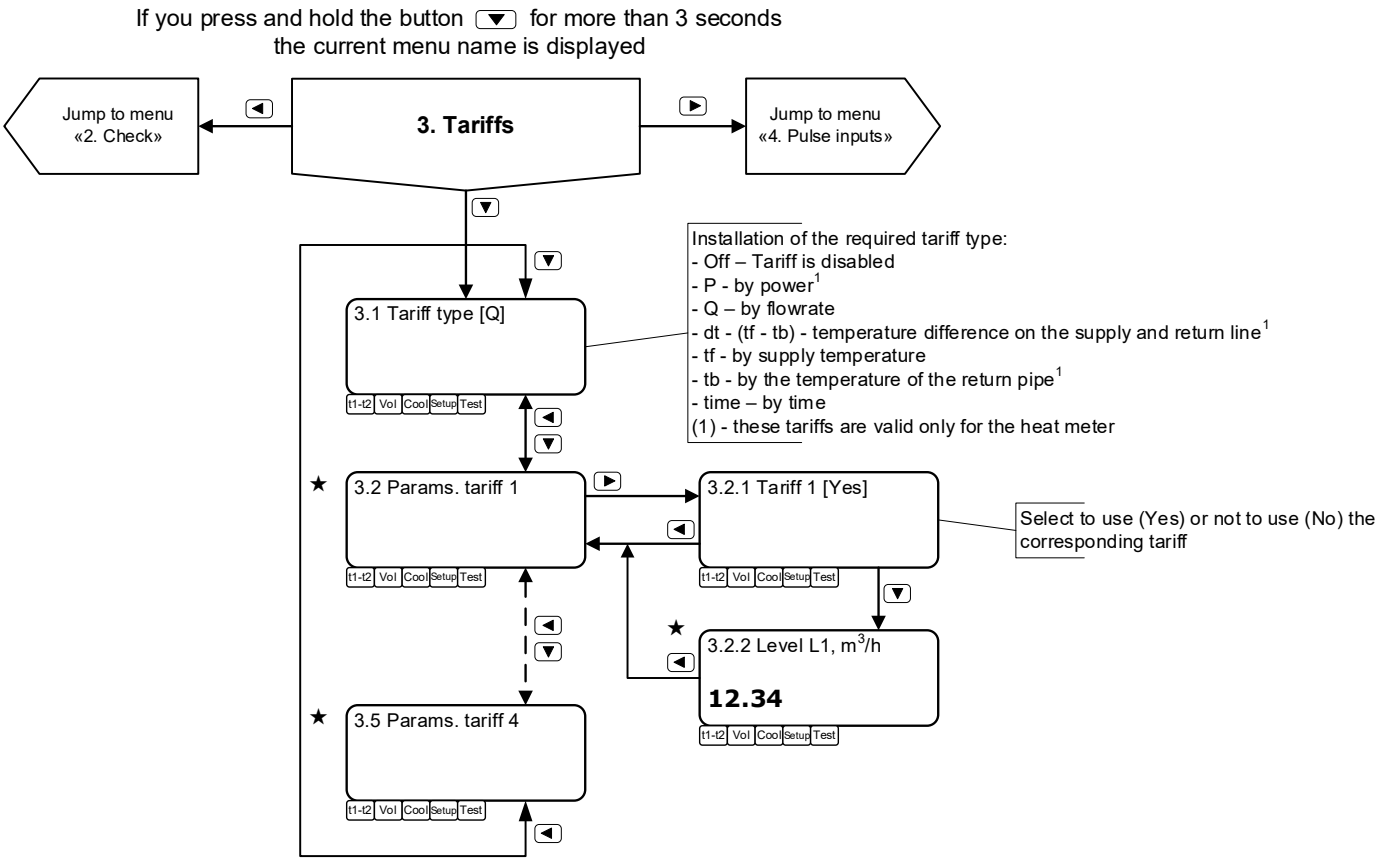
If you press and hold the button ▼ for more than 3 seconds
the current menu name is displayed





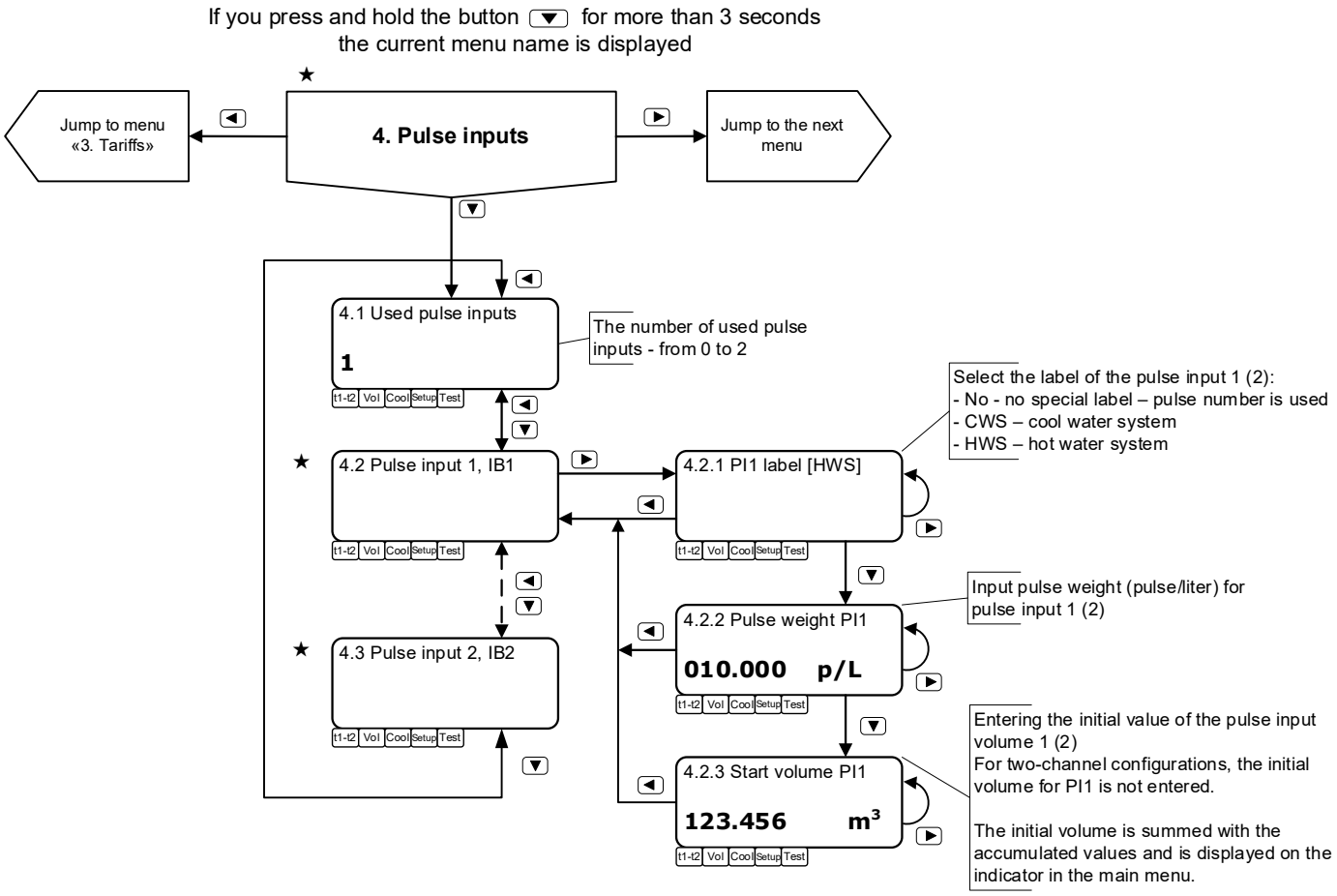
If you press and hold the button ▼ for more than 3 seconds
the current menu name is displayed

6.10 Menu tariffs



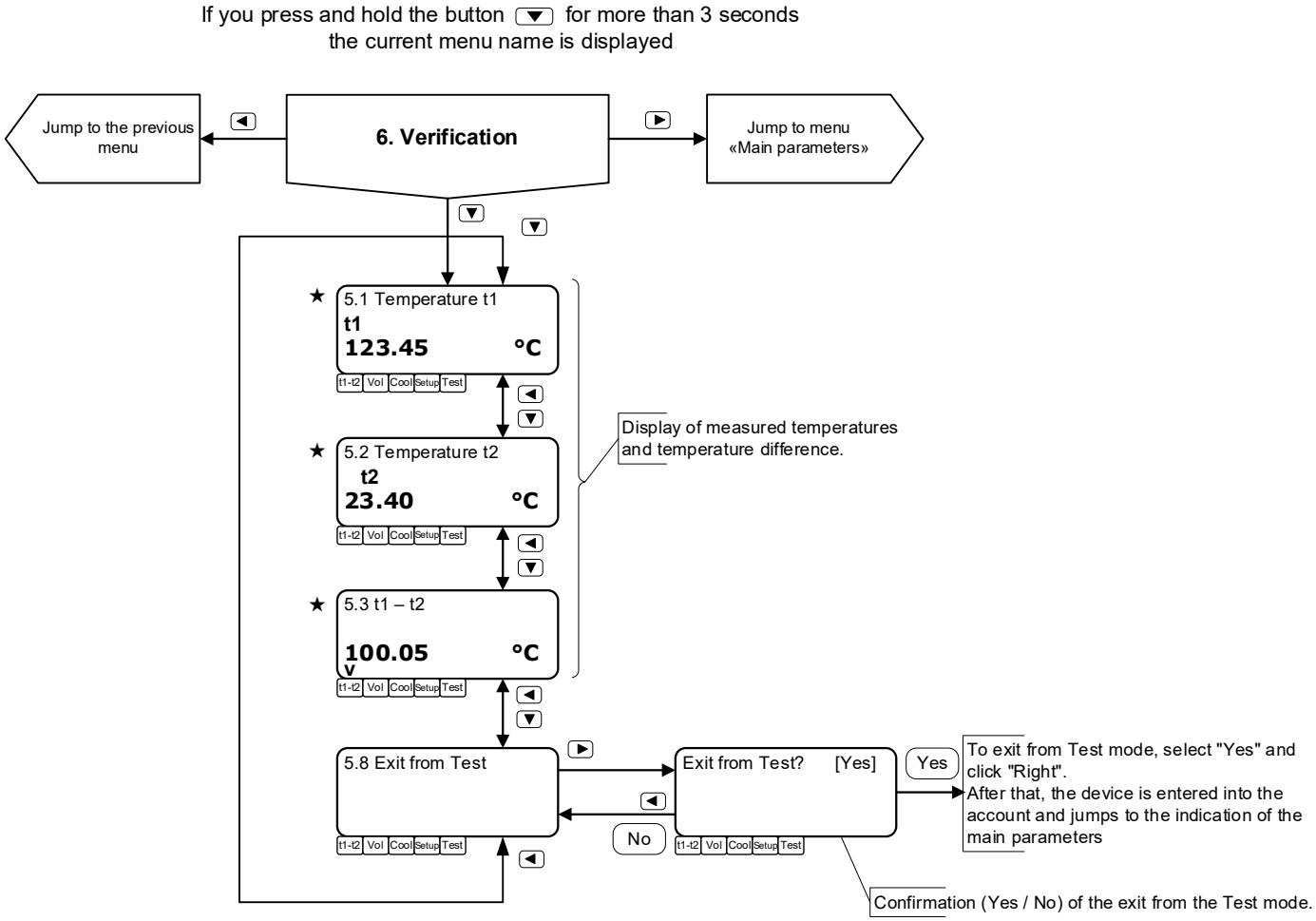
* Denotes menu items visible under certain conditions depending on the configuration and instrument operation mode

6.11 Menu “Pulse inputs”



* Denotes menu items visible under certain conditions depending on the configuration and instrument operation mode

6.12 Menu “Verification”



* Denotes menu items visible under certain conditions depending on the configuration and instrument operation mode

7 Manufacturer's warranty

The manufacturer warrants operation of the meter for 4 years following the shipment date of the meter to a user.

The warranty provides for replacement of any defective parts and checking operability of the instrument within the premises of a service center of the manufacturing enterprise.

The warranty covers defects of any component parts of the instrument included into the delivery set if caused by workmanship defects, defects of materials and component items.

Any failed instrument must be delivered to the manufacturing enterprise for testing and repairing.

The calculator may not be opened (integrity of seal lead may not be damaged) under any circumstances prior to redelivery of the instrument to the manufacturing enterprise.

Warranty will not include any indemnification of any costs related to de-installation, return and reinstallation of the instrument, as well as indemnification of any consequential damages related to the failure.

If any defect is found during the warranty term, the user will be obliged to produce the claim to the manufacture enterprise at the following address:

Firm "Sempal Co Ltd", str. Kulibina, 11, Kyiv, Ukraine, 03062

Tel.: +38 (044) 3371188, (044) 3381188
+38 (098) 1638888, (050) 1428888

No claims related to the heat meter will be recognized in the following cases:

- Installation and commissioning works have been carried out by any organization not authorized by the manufacturing enterprise to carry on such works;
- Integrity of lead seals on the calculator is damaged;
- Expiry of the warranty period;
- Infringement by user of the operation, storage and transportation rules as prescribed in operating documentation.

If the warranty period expires or if the right for free of charge warranty services is lost, the manufacturing enterprise will carry out paid repair of the heat meters.

8 Storage, transportation, utilization

Packaging

Packaging (transport packaging) is performed according to the drawings of the manufacturer.

Marking of transport containers is performed according to the drawings of the manufacturer and contains manipulation signs "CAREFULLY CRISPY", "PROTECT FROM MOISTURE", "TOP".

The components of the meters are packed in boxes of the manufacturer. Upon agreement with the customer, delivery of flow meter section without transport packaging or in the customer's packaging is allowed.

Storage conditions

In unheated storage, the shelf life is not more than 5 years at an air temperature of -25 ° C to +60 ° C without moisture condensation.

During long-term storage in unheated storage, the meters must be packed in an additional cover made of polyethylene film.

It is allowed to transport meters by all types of transport in packing, on condition of protection against direct influence of atmospheric precipitations.

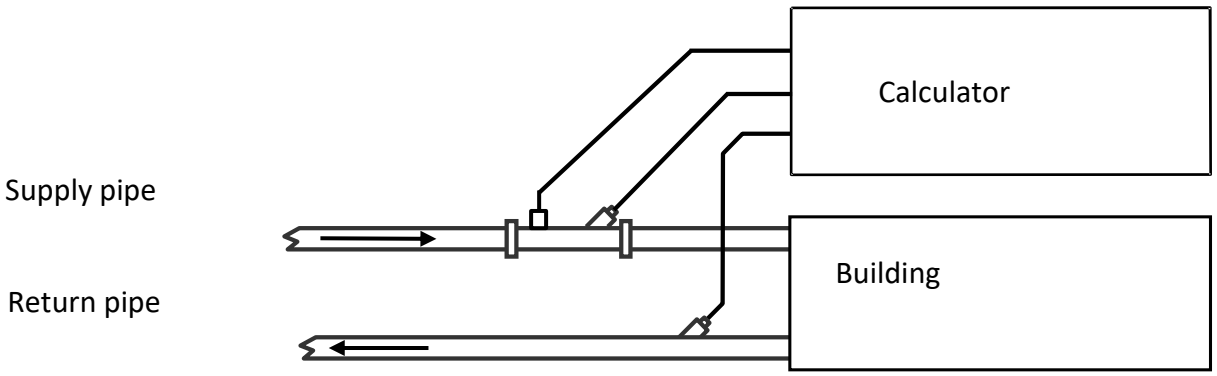
Utilization of the meter parts:

Description	Material	Utilization method
Lithium battery C	Lithium and thionyl chloride 2.5 g of lithium	Certified places for storage of lithium batteries
Printed circuit board without LCD	Metallized glass fiber laminate with components installed thereon	Metal extraction from the printed circuit boards
Liquid crystal display	Glass and liquid crystals	LCD recycling
Cables to temperature sensor and flow sensor	Copper and silicone casing	Cable recycling
Upper calculator cover Lower calculator cover Calculator holder	Polycarbonate Acrylonitrile-butadiene-styrene Polycarbonate	Plastics recycling
Flow metering section	Brass	Metal recycling
Package	Cardboard	Waste paper recycling

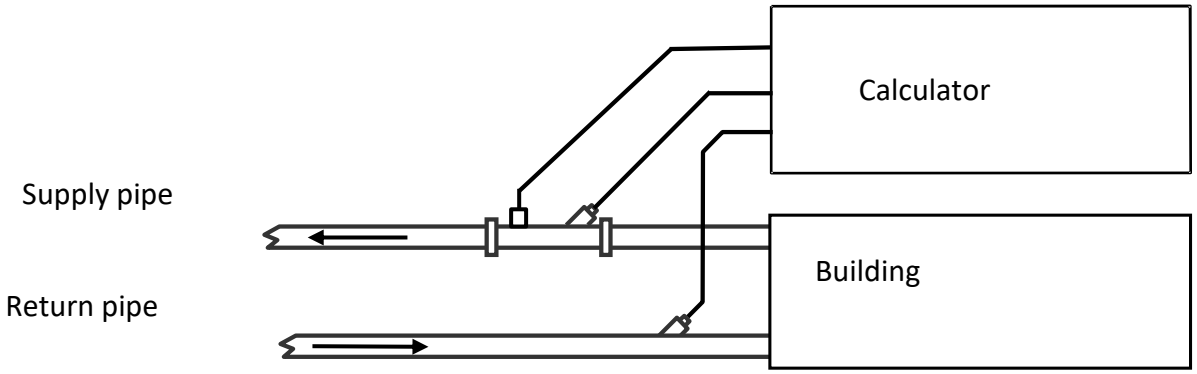
Appendix A.
Simplified scheme of meter installation

The following are simplified schematics of installation of the meter.

Configuration 2



Configuration 2/1



Configuration 2/2