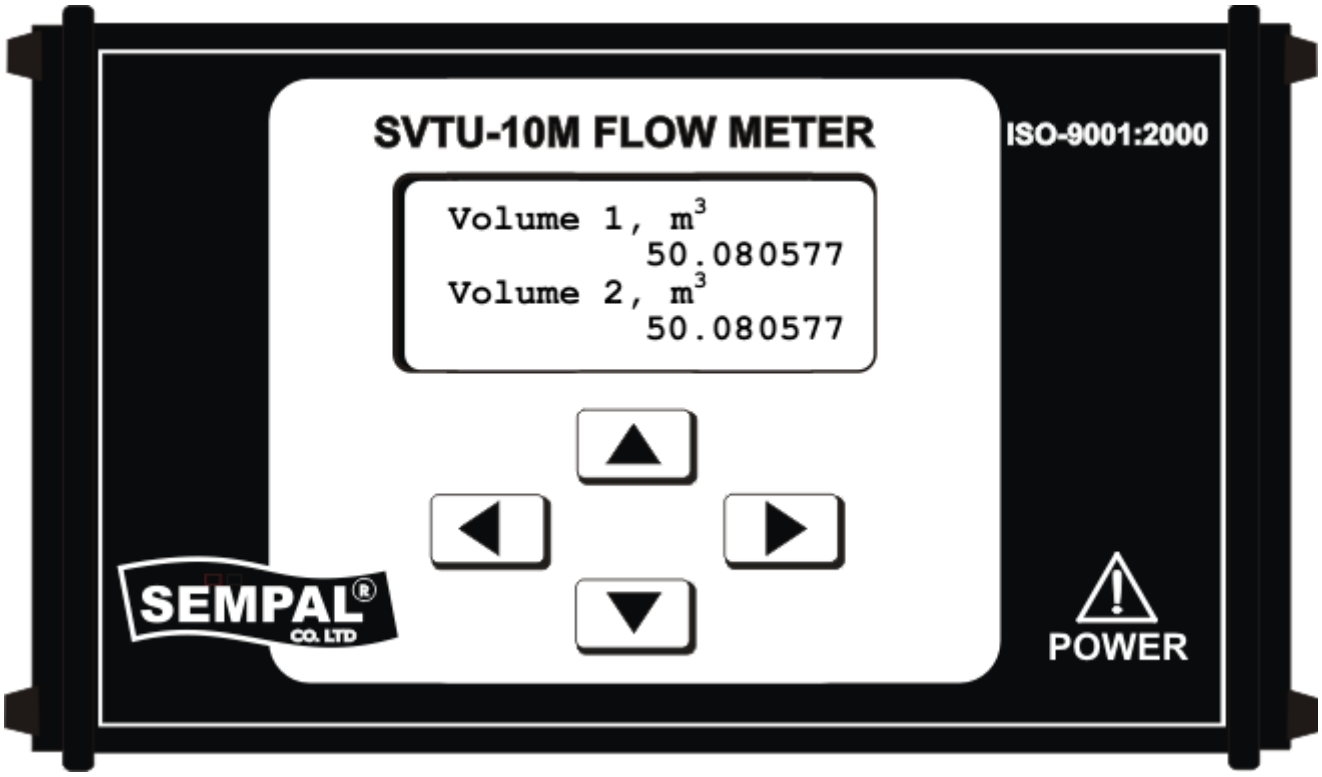
SVTU -10M

HEAT METER

FLOW METER

Modifications M1 and M2

With power backup (model RP)



Operating instructions

SMP.407251.003 RE

(Part 1)

June 2013

List of documents:

1 Operating instructions SMP.407251.003 RE Part 1.

2 Operating instructions SMP.407251.003 RE1 Part 2.
Integrated expansion unit of the heat meter SVTU-10M (M1, M2) RP

Contents

List of used abbreviations

OI – operating instructions.
FMS – flow metering section with ultrasonic flow sensors.
RTD – resistive temperature detector.
RTD-S – platinum resistive temperature detector manufactured by SEMPAL Co.
NSC RTD – nominal state characteristic of RTD.
FS – flow sensor.
TS – temperature sensor.
PT – pressure transducer.
DN – nominal diameter, in mm.
PN (or Ru) – nominal overpressure.
PC – personal computer.
PI – proportional-integral law of control
DR – data reader
X – digit on the display.

The following terms and definitions are used in this OI:

– **Heat meter SVTU-10M**: a combination of various measurement and calculation channels.
– **Ultrasonic flow rate measuring channel Q_U (volume V_u)**: a combination of the heat meter components (including FMS, single-beam or double-beam) used for measurement of flow Q_U (volume V_u) of the heat transfer liquid (water) by applying the ultrasonic method for determining the flow rate of water passing across the FMS.
– **Beam**: a combination of FMS components and ultrasonic flow sensors assisting in passing the ultrasonic signal through the flow of fluid passing across the FMS;
– **Pulse measurement channel volume V_P:** a combination of the heat meter components (including utility meter with pulsed output) intended for:
– Registration, transformation of input pulses coming from the utility meter;
– Calculation of volume Vp of the heat transfer liquid (water);
– Display of measured and calculated values.

Pulse channel measurement results of volume Vp can be used for metering the volume Vp of cold and/or hot water supply only.
– **Temperature measuring channel**: the combination of the heat meter components (including RTD) provided for measurements and display of temperature values.

Results obtained by one channel of temperature measurements can be used for various calculation channels (depending on the calculation channel versions).
– **Pressure measuring channel** is a combination of the heat meter components (including, PT) provided for measurements and display of overpressure.
– **Calculation channel** uses the results of measurements from one or several ultrasonic flow measurement channels Q_U (volume Vu), (depending on the calculation channel version), measurement results from one or several temperature measurement channels, measurement results from one or several pressure measurement channels (availability and their number complying with the order), guarantees calculation and display of measured and calculated heat transfer liquid parameters and the amount of measured thermal energy.
– **Calculation channel version** (hereinafter, version) determines the distinguishing functional features of the **calculation channel** (a set of applied measurement channels and performed calculations). Each version is unique and has a special designation (see Table 3.2).
– **Meter delivery variant** – a combination of calculation channels versions. Most frequently used delivery variants are indicated in Table 3.3.
– **Meter modification** (M1, M2) determines the maximum number of ultrasonic flow measurement channels and the value of the maximum permissible relative error in measuring volume and mass of the heat transfer liquid with regard to such measuring channels.
– **Meter configuration** is defined by a combination (including the number) of various measuring channels. It should be determined by the consumer in placing the order. Restrictions shall be applicable in case of excessive sheet-oriented capacities of the meter (see Table 3.1).

Information for buyers

SVTU-10M heat meters (hereinafter in the text, meters) are complex measuring devices, which require starting-up and adjustment works to be performed by qualified personnel in the course of commissioning operations.

The Manufacturer's guarantee (48 months from the date of shipment) covers the meters which were put into operation by specialized enterprises authorized by the company-manufacturer. Detailed information can be found in section 16 "Manufacturer's warranty".

With reference to positive results of state tests and the relevant decision of the Gostandard of Ukraine, the meters have been entered into the State Registry of measuring equipment allowed for application in Ukraine under designation number У947-07.

With reference to positive results of state tests and the relevant decision of the Federal Agency for technical regulation and petrology, SVTU-10M heat meters were registered with the State Registry of measuring instruments allowed for application in the Russian Federation under No. 24627-06.

Conclusion No. 365-RTD issued by the Agency for the supervision over electric power (Rostekhnadzor) confirms that SVTU-10M heat meter complies with requirements of current regulatory documents and they can be applied for commercial metering of heat energy and heat transfer liquids in heating systems using water as a heat transfer liquid.

Certificate of Conformance No. ROSS UA.ME65.B01023 issued by the Agency for certification of measuring instruments, "Somet" ANO "Potok -Test", systems of certification GOST R of Gosstandart of Russia confirms compliance of SVTU-10M heat meters with requirements to electromagnet compatibility as per GOST R 51649 (subclause 5.5) and GOST R 51522.
Calibration interval – not more than 4 years.

The quality system of the "SEMPAL Co. Ltd" has been certified to comply with **ISO 9001:2000**.

If you have any questions on procurement, maintenance, operation and servicing of meters, contact us or our authorized regional representatives.

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1 Introduction

These operating instructions (hereinafter in the text, OI) contain information on the purpose and the field of application, technical specifications and completeness, operating principle and design, rules for installation and commissioning, procedure for operation and technical maintenance of meters.

While meters are in operation, it is necessary to strictly comply with the requirements of these OI.

Subject to constant updating aimed at functional enhancement and improvement of performance capability and increase of the meter reliability, the manufacturing company SEMPAL Co LTD reserves the right to introduce changes into the meter design not described in these OI.

2 Application

SVTU-10M heat meters are intended for measurement of the heat transfer liquid volume and mass.

Meters also measure the volume, mass, temperature and overpressure of water or fluids with solid particles under 200 μm and solid residue mass of no more than 500 mg/l (hereinafter into text, heat transfer liquid).

2.1 Meters are applied for metering (including commercial metering) the amount of thermal energy (in closed or open heat supply systems) or water volume according to the applicable rules for the control of supply and consumption of water by industrial facilities and municipal services.

2.2 Meters are supplied for the needs of Ukrainian consumers and abroad.

3 Technical specifications

3.1 Meters, depending on the standardized values for maximum permissible error in measurements of heat, volume and mass of the heat transfer liquid, and the range of consumption measurements are been conducted, are manufactured in the following modifications: M1 (volume measurement error 1%) and M2 (volume measurement error 2%).

3.2 Meters comply with version UKHL 4 as per GOST 15150. With regard to their resistance to climatic factors of environment, meters belong to the group of version B4 as per GOST 12997, but they are intended for the range of the surrounding air temperature from 0 to + 50 °C with regard to the calculator, from - 40 to + 70 °C –with regard to the flow metering section with ultrasonic flow sensors and the resistive temperature detector RTD-S.

3.3 Meters may be operated under the following conditions:
– Atmospheric pressure from 84.0 to 106.7 kPa;
– Relative humidity not exceeding 95 %;
– Supplied network voltage:
– 220 V (187… 242 V, frequency (50 ± 1) Hz;
– or (36 ± 5.4) V, frequency (50 ± 1) Hz;
– or (24 ± 3.6) V, frequency (50 ± 1) Hz.

3.4 Meters complying with the requirements of DSTU 3339 «Heat meters. General technical requirements», GOST R 51649 «Heat meters for water heating systems. General technical requirements», GOST R 8.591 «Heat meters, double-channeled for water heating systems. Standardizing limits for permissible errors in measuring heat energy consumed by subscribers», TU U33.2-24579476.004-2001.

3.5 Meters consist of the following functional units:
– Flow metering sections with ultrasonic flow sensors (FMS). They may be represented by a single-beam and double-beam ones depending on the order;
– Resistive temperature detectors (RTD);
– Electronic unit SVTU-10M (calculator).
The maximum possible number of measuring and calculation channels is indicated in Table 3.1

Table 3.1

Channel name	Number of channels.	Notes
Ultrasonic flow measurement channel	1 or 2	Depending on the number of beams in FMS
Pulse Journal for measurement of volume	2	
Temperature measuring channel	5	
Pressure measuring channel	2	
Calculation channel	1or 2	Depending on the version and the number of beams in FMS

3.6 The meter has two independent calculation channels. Calculation channel uses flow rate, temperature, and pressure measurement results for calculation of measured heat, volume, mass, … Each of calculation channels may have different versions. Distinguishing functional

features of versions for calculation channels and the number of basic functional units used by the channel is indicated in Table 3.2 (see details in Appendix B).

Table 3.2

Distinguishing design and functional features	Version											
	1	2	2/1	2/2	4	5	7	9	10	11	11/1	12
1 Number of FMS	1	1	1	1	2	2	2	2	2	2	2	2
2 Number of RTD	1	2	2	1	2	2	3	4	3	4	3	2
3 Measuring water temperature in return pipeline	–	+	+	–	+	+	+	+	+	+	+	+
4 Measuring cold water temperature	–	–	–	–	–	–	+	+	–	+	+	–
5 Measuring temperature in hot water supply system	–	–	–	–	–	–	–	–	+	+	–	–
6 Measuring volume of the heat transfer liquid in supply line	+	+	–	+	+	+	+	+	+	+	+	+
7 Measuring volume of the heat transfer liquid in return line	–	–	+	–	+	+	+	–	+	+	+	+
8 Measuring volume of water in water supply system	+	–	–	–	–	–	–	–	–	–	–	–
9 Measuring heating temperature	–	+	+	+	+	+	+	+	+	+	+	+
10 Measuring hot-water supply system (HWSS) temperature	–	–	–	–	–	–	–	–	+	+	+	+
11 Water leaks display	–	–	–	–	+	+	+	–	+	+	+	+
12 Measuring volume of makeup water	–	–	–	–	–	–	–	+	–	–	–	–
In completing the meter with FMS with two measuring beams it is possible to use only those versions, which used the results of flow measurements in one line only.												

Any combinations of versions for calculation channels are possible by the following limitations shall be considered: the first calculation channel must use the same number of measuring channels as the second channel.

In Table 3.3 demonstrates the most frequently used meter delivery variants and their compliance with calculation channels versions.

Table 3.3

Meter delivery variant	Channel version	
	Channel 1	Channel 2
1. Single utility meter	1	–
2. Heat meter for unvented system	2	–
2/1. Heat meter for unvented system with FMS in «return water line»	2/1	–
2/2. Heat meter for unvented system without temperature measurements in return water line	2/2	–
3. Two utility meters	1	1
4. Heat meter for vented system without measuring $t_{cw\ (cold\ water)}$	4	–
5. Heat meter for unvented system with check utility meter	5	–
6. Heat meter for unvented system with independent utility meter	2	1
7. Heat meter for vented system with measuring t_{cw}	7	–
8. Two independent heat meters for unvented system	2	2
9. Heat meter for the heat source with measuring makeup water	9	–
10. Heat meter for vented system with measuring HWSS	10	–
11.Heat meter for vented system with measuring HWSS	11	–

Meter delivery variant	Channel version	
	Channel 1	Channel 2
11/1. Heat meter for vented system with measuring HWSS	11/1	–
12. Heat meter for vented system with measuring HWSS	12	–

3.7 Against special order, meters may incorporate one or two PTs converting overpressure to proportional current signal in the range from 4 to 20 mA.

Metrological specifications of PT shall be agreed in a separate order.

Maximum pressure measured by the meter – 40 kgf/cm^2.

3.8 Meters may incorporate up to five RTDs. Additional RTDs may be used for production medium temperature control.

3.9 Two external flow meters with impulse of puts can be connected to the meter. The meter, together with external flow meters, calculates volume, displays results and stores them in archive.

Meters with outputs of "open collector" type or with active outputs can be used. Maximum output voltage for active outputs – 10 V. Maximum input pulse frequency – 1000 Hz.

3.10 Meters display measurement results in SGS (Gcal/h, Gcal, kgf/cm^2) or SI (MW, GJ, MPa) units. The consumer shall select the required display mode and may change it in the process of operation.
Hereafter, all measurements units will be displayed in SGS.

3.11 The calculator allows displaying and transmitting the following physical quantities:

- Heat, GJ (Gcal);
- Thermal power, MW (Gcal/h);
- Thermal power of HWSS (for versions 10, 11, 11/1, 12), MW (Gcal/h);
- Heat of HWSS (for versions 10, 11, 11/1, 12), GJ (Gcal);
- Volume (mass) of the heat transfer liquid or water, m^3 (t);
- Volumetric discharge of the flow heat transfer liquid or water, m^3/h (t/h);
- Volumetric discharge of the HWSS flow water (for versions 10, 11, 11/1, 12), m^3/h (t/h);
- Temperature of the heat transfer liquid in the supply line, °C;
- Temperature heat transfer liquid in the return line, °C;
- Overpressure of the heat transfer liquid or water MPa (kgf/cm^2);
- Operation time and out-of-service time, h;
- Current time (hour, minute, second) and date.

3.12 The Calculator stores information on the measured values of thermal energy and volume (or mass) of the heat transfer liquid, operation time and out-of-service time, as well as on the measured temperature average values:

Hourly data – for 100 previous days (hourly records);
Daily data- for 3 previous years (day records).

The entire stored information and measured parameters may be transmitted via communication interface (RS232, RS485, …).

3.13 Number of digits displayed by the calculator:

- Thermal energy, volume (mass) of the heat transfer liquid or water – 8;
- Thermal power, volumetric discharge of flow heat transfer liquid or water – 5;
- Temperature of the heat transfer liquid in the supply and return lines, temperature of cold water – 5;
- Overpressure of the heat transfer liquid or water – 3;
- Operation time or out-of-service time, current time – 7;
- Date – 8.

3.14 The unit for the minimum digit of the digital indicator:

- Heat - from 10^{-7} to 1 Gcal (from 10^{-7} to 1 GJ);
- Volume (mass) of the heat transfer liquid or water – from 10^{-7} to 1 m^3 (from 10^{-7} to 1 t);
- Volumetric discharge of flow heat transfer liquid or water – from 0.001 to 0.1 m^3/h (from 0.001 to 0.1 t/h);
- Thermal power - from 0.001 to 0.1 Gcal/h (from 0.001 to 0.1 MW);
- Temperature of the heat transfer liquid in the supply and return lines, temperature of cold water and temperature water in HWSS - 0.01 °C;
- Overpressure of the heat transfer liquid or water – 0.1 kgf/cm^2 (0.01 MPa);
- Operation time or out-of-service time – from 10^{-5} to 1 h;
- Current time – 1 min.

3.15 Meters measure thermal energy and volume (mass) of the heat transfer liquid or water in ranges of volume throughput of the heat transfer liquid (water) and thermal power and the facilities consuming thermal power as specified in Table 3.4.

Table 3.4

Conventional designation of FMS	Hip range of volume throughput of flow heat transfer liquid (water), m^3/h			Range of thermal power, Gcal/h
	Minimum (Qmin)	Transitional (Qt)	Maximum (Qmax)	
FMS-20	0.06	0.12	6	From $7.5 \cdot 10^{-5}$ to 0.95
FMS-32	0.22	0.6	22	from 0.00055 to 3.5
FMS-50	0.7	1.4	70	from 0.0018 to 11
FMS-65	1.2	2.4	120	from 0.003 to 19
FMS-80	1.8	3.6	180	from 0.0045 to 28
FMS-100	2.8	5.7	280	from 0.007 to 43
FMS-125	4.5	8.8	450	from 0.011 to 68
FMS-150	6.5	12.7	650	from 0.016 to 100
FMS-200	11.5	23	1150	from 0.028 to 175
FMS-250	18	35	1800	from 0.045 to 272
FMS-300	26	51	2600	from 0.065 to 393

Conventional designation of FMS	Hip range of volume throughput of flow heat transfer liquid (water), m^3/h			Range of thermal power, Gcal/h
	Minimum (Qmin)	Transitional (Qt)	Maximum (Qmax)	
FMS-350	35	69	3500	from 0.087 to 530
FMS-400	45	90	4500	from 0.11 to 680
FMS-500	71	141	7100	from 0.17 to 1610
FMS-600	102	204	10200	from 0.25 to 1540
FMS-700	140	277	14000	from 0.35 to 2115
FMS-800	180	362	18000	from 0.45 to 2720
FMS-900	230	458	23000	from 0.575 to 3475
FMS-1000	285	565	28500	from 0.71 to 4275

3.16 Range of the heat transfer liquid temperature in the supply and return lines from 0 to 150 °C.

Range of assisting (ones not used for heat calculations) temperatures from -49 °C to 150 °C.

3.17 The meter design provides for the possibility to measure thermal energy at heat transfer liquid temperature difference in the supply and return lines (Δ T) from 0 to 150 °C. Within the range of difference from 2.5 to 150 °C, measurement error with regard to thermal energy shall be standardized.

3.18 Meter information communication channels:

Table 3.5

Communication channel	Completeness	Description
RS232C	Basic	Connection to computer, modem
USB Host	On request	Storage of archived information on USB Flash
RS485	On request	Modbus protocol support

Note. Either USB or RS485 may be ordered.

3.19 Depending on the order, meters may have two analog output voltage signals (0…10 V) or current (4… 20 mA), in proportion to the one of the below physical quantities:

- Temperature of the heat transfer liquid in the supply (return) line, water, cold water;
- Overpressure of the heat transfer liquid (water);
- Volume throughput of the heat transfer liquid (water).

Note. Depending on the consumer's order, analog signals may be in proportion to other physical quantities measured by meters.

Complete description of analog output signals functions is given in SMP.407251.003 RE1 («Integrated expansion unit»).

3.20 Output impedance of analog potential outputs – 50 Ohm, maximum load current – 10 mA.

Maximum load resistance for current outputs – 300 Ohm.

The limit for reduced voltage error for analog outputs at load resistance of not less than 20 kOhm - ±1%.

The limit for reduced current error for analog outputs at load resistance of not higher than 300 Ohm - ±1%.

3.21 Nominal supply voltage to meters may be 220 V or 36 V, or 24 V AC at standard frequency of 50 Hz.

3.22 As requested, the meter may have standby power supply block fitted (batteries). The standby power supply block operation time depends on the used meter configuration. At meter configuration without linear outputs and pressure measuring devices operation time of fully charged batteries is not less than 15 hours.

3.23 The Calculator is fitted with two active pulse outputs with voltage «1» 3.3 V.

Maximum pulse repetition frequency – 1000 Hz.

Maximum load resistance – 10 kOhm.

Range of pulse weight setting (set by the consumer) from 1 to 9999999 imp./unit. Where «unit» - unit of measurement of the converted physical quantity. The consumer may select the following physical quantities: volume (imp./м^3), mass (imp./t), heat (imp./GJ).

3.24 Power consumed by meters does not exceed 7 VA.

3.25 Diameters (DN), dimensions and mass of FMS, as well as length and weight of RTD depends on their type and is indicated in Tables 3.8., Tables 3.9., and in Figures3.1.,, 9.7.

Notes

1 It is permissible to increase the total length of FMS, if the straight-line section of FMS changed in front and behind ultrasonic flow sensors installation places.

2 DN – DN is the designation of nominal bore, which numerical value **is approximately equal** to internal diameter **of attached** pipe sections (as per GOST 28338).

3.26 Calculation channels of versions 2 and 5 modification M1 comply with accuracy class 2, modification M2 comply with accuracy class 2.5, and of versions 4, 7, 9, 10, 11, 12 – accuracy class 4 as per DSTU 3339-96.

Calculation channels of versions 2 and 5 modification M1 comply with accuracy class C, and meters of modification M2 – accuracy class as per GOST R 51649 2000.

Calculation channels of version 9 modification M1 comply with class B, and modification M2 – class A as per GOST R 51649 2000.

Limits of permissible relative error of several energy measurements of versions 4, 7, 10, 11 and 12 modification M1 and M2 comply with the design as per GOST R 8.591-2002.

3.27 Calculation channels of versions 7 and 11 relate to the double-channel heat meters of modification I as per GOST R 8.591 – 2002, Calculation channels of versions 4, 10 and 12 related to their double-channel heat meters of modification II as per GOST R 8.591 – 2002.

3.28 Limits of permissible relative error calculation channels of versions 2, 5 modification M1 in measuring have quantity of heat equal to:

– ± 1.5 % (± 4.5 %) ─ at ΔT from 20 °C (inclusive) to 150 °C (inclusive);

– ± 2 % (± 5.5 %) ─ at ΔT from 10 °C (inclusive) to 20 °C;
– ± 4 % (± 7.5 %) ─ at ΔT from 2.5 °C (inclusive) to 10 °C.

Standardized values of relative error in measuring quantity of heat in the interval of ranges of volume heat transfer liquid flow from Q_{min} (inclusive) to Qt are given in brackets.

3.29 Limits of permissible relative error of calculation channels of versions 2, 5 modification M2 in measuring quantity of heat equal to:
– ± 2.5 % (± 4.5 %) ─ at ΔT from 20 °C (inclusive) to 150 °C (inclusive);
– ± 3.5 % (± 5.5 %) ─ at ΔT from 10 °C (inclusive) to 20 °C;
– ± 5.5 % (± 7.5 %) ─ at ΔT from 2.5 °C (inclusive) to 10 °C

3.30 Limits of permissible relative error of calculation channels of versions 4, 7, 10, 11, 12 modification M1 in measuring quantity of heat equal to:
± 4% provided that:
– ratio of the heat transfer liquid mass passing along the return and supply lines **f** = Q2/Q1 ≤ 1.0;
– 20 °C ≤ Δ T ≤ 150 °C and ΔT ≥0.34·T1;
± 5% provided that:
– ratio of the heat transfer liquid mass passing along the return and supply lines **f** = Q2/Q1 ≤ 0.96;
– 10 °C ≤ Δ T < 20 °C and ΔT ≥0.25·T1;
± 8% provided that:
– ratio of the heat transfer liquid mass passing along the return and supply lines **f** = Q2/Q1 ≤ 0.87;
– 2.5 °C ≤ Δ T < 10 °C and ΔT ≥0.06·T1.

3.31 Limits of permissible relative error of calculation channels of versions 4, 7, 10, 11, 12 modification M1 in measuring quantity of heat for particular values (ranges) of **f** and **k** factors to respond to values given in Table 3.3.

Table 3.6

Value of factor **f**	Value of factor **k**	Limits of permissible relative error in measuring quantity of heat at throughput of the heat transfer liquid Q	
		Qt ≤ Q ≤ Qmax	Qmin ≤ Q < Qt
1	0.5 ≤ **k** < 1	± 4 %	—
1	0.275 ≤ **k** < 0.5	± 5 %	—
1	0.24 ≤ **k** < 0.275	± 6 %	—
0.95	0.5 ≤ **k** < 1	± 4 %	—
0.95	0.25 ≤ **k** < 0.5	± 5 %	—
0.95	0.2 ≤ **k** < 0.25	± 6 %	—
0.85	0.5 ≤ **k** < 1	± 4 %	± 6 %
0.85	0.25 ≤ **k** < 0.5	± 4 %	—
0.85	0.1 ≤ **k** < 0.25	± 6 %	—
0.75	0.5 ≤ **k** < 1	± 4 %	± 6 %
0.75	0.25 ≤ **k** < 0.5	± 4 %	—

Value of factor **f**	Value of factor **k**	Limits of permissible relative error in measuring quantity of heat at throughput of the heat transfer liquid Q	
		Qt ≤ Q ≤ Qmax	Qmin ≤ Q < Qt
0.75	0.06 ≤ **k** < 0.25	± 5 %	—
0.55	0.5 ≤ **k** < 1	± 4 %	± 6 %
0.55	0.25 ≤ **k** < 0.5	± 4 %	± 7 %
0.55	0.06 ≤ **k** < 0.25	± 4 %	± 8 %

Notes

1 f – Maximum value of ratio of flow in the return line to throughput of in the supply line.

2 k = (T1-T2)/T1, where values of T1 and T2 fixed at a certain time.

3 Minimum value of T1 is assumed to be equal to 40 °C.

4 Sign "—" means that under such heat transfer liquid parameters the error is not standardized.

3.32 Limits of permissible relative error of calculation channels of versions 4, 7, 10, 11, 12 modification M2 in measuring quantity of heat equal to:

- ± 4 % (± 6 %) ─ at ΔT from 20 °C (inclusive) to 150 °C (inclusive);
- ± 5 % (± 7 %) ─ at ΔT from 10 °C (inclusive) to 20 °C;
- ± 6 % (± 8 %) ─ at ΔT from 2.5 °C (inclusive) to 10 °C.

Note – specified limits of permissible relative error are true under conditions specified in subclause 3.33.

3.33 Limits of permissible relative error of calculation channels of versions 4, 7, 10, 11 and 12 modification M2 in measuring quantity of heat equal to:

4%, provided that:

- Ratio of the heat transfer liquid mass passing along the return and supply lines **f** =Q2/Q1 ≤ 0.95;
- Minimum possible value of water temperature in the supply line t1min = 40 C °;
- Minimum possible value of cold water temperature: t_{cw}/ min = 5 C°;
- Minimum possible value of k factor = (t1 – t2)/t1: k min = 0.5.

5%, provided that:

- Ratio of the heat transfer liquid mass passing along the return and supply lines f =Q2/Q1 ≤ 0.85;
- Minimum possible value of water temperature in the supply line t1min = 40 C °;
- Minimum possible value of cold water temperature: t_{cw}/ min = 15 with °;
- Minimum possible value of k factor = (t1 – t2)/t1: k min = 0.25.

3.34 Limits of permissible relative error of calculation channels of version 9 modification M1 in measuring quantity of heat equal to:

- ± 2 % (± 5 %) ─ at ΔT from 10 °C (inclusive) to 150 °C (inclusive);
- ± 5 % (± 7 %) ─ at ΔT from 2.5 °C (inclusive) to 10 °C.

3.35 Limits of permissible relative error of calculation channels of version 9 modification M2 in measuring quantity of heat equal to:

- ± 3.5 % (± 5 %) ─ at ΔT from 10 °C (inclusive) to 150 °C (inclusive).

– ± 5.5 % (± 7 %) ─ at ΔT from 2.5 °C (inclusive) to 10 °C;

3.36 Limits of permissible relative error of meters for measuring volume (mass) of the heat transfer liquid or water complies with data given in Table 3.4.

Table 3.7

Range of flow	Limits of permissible relative error, %, for modification	
	M1	M2
From Qmin (inclusive) to Qt.	± 3	± 3
From Qt (inclusive) to Qmax (inclusive)	± 1	± 2

3.37 Limits of permissible absolute error of meters measuring heat transfer liquid temperature - ± 0.2 °C.

Limits of permissible absolute error of meters measuring temperature difference equal to ± (0.1+0.001·ΔT)°C, where ΔT – number value of temperature difference expressed in degrees Celsius.

3.38 Limits of permissible reduced error of meters measuring pressure equal to:

– ± 0.5 % when PT from that meter's set are used;

– $\pm\sqrt{0.2^2+\delta_{PT}^2}$ when customer's PT are used,

Where,

δ_{PT} is permissible error limit of the customer's PT.

Specific coefficients of PT curve are entered into calculator's memory.

3.39 Limits of absolute error of meters measuring operation time and out-of-service time - ± 1 min in 24 h.

3.40 Measurement information on thermal energy, volume of the heat transfer liquid or water, as well as operation time and out-of-service time is stored in the meter nonvolatile memory for not less than 12 years after disconnected meter power supply.

3.41 Maximum overpressure of the heat transfer liquid (water) in FMS space:

– For DN up to 600 – 1.6 MPa (16 kgf/cm^2);

– For DN from 700 to 1000 – 2.5 MPa (25 kgf/cm^2).

3.42 Time required for setting the meter operation mode does not exceed 30 min.

3.43 Calculator enclosure protection class – IP 65 as per GOST 14254.

3.44 Calculating unit weight – not more than – 750 g.

3.45 Calculator dimensions do not exceed 170×110×35 mm, and with the device connector and wall fastening elements – 250×110×60 mm (see Appendix D).

3.46 Nominal diameters (DN), dimensions and weight of FMS, as well as length and weight of RTD depend on their type specified in Tables 3.5, 3.6 and in Figures 3.1, 9.8.

3.47 Average error-free operation of meters – not less than 50 000 h, calculators – 100 000 h.

3.48 Total average life of meters – not less than 12 years.

Table 3.8 Types, dimensions and weight of RTD-S

RTD type	Length, not more than, mm		Weight, not more than, kg
	L_{RTD}	L	
4	58	86	0.06
2	80	108	0.08
3	150	178	0.1
5	310	346	0.25
6	360	396	0.3
Note – RTD type is selected depending on the line DN in compliance with instructions given in Tables 9.2, 9.3 and in Figures 9.7, 9.8, 9.9			

Mounting dimensions of RTD types 2, 3, 4 see Fig.3.1. and Table 3.8. for RTD types 5 and 6 dimensions see Fig. 9.9 and Table 3.8.

RTD type	Length, not more than, mm		Weight, not more than, kg	Note
	L_{RTD}	L		
4	58	86	0.06	RTD type is selected depending on the line DN in compliance with instructions given in Figures 9.5 and 9.6
2	80	108	0.08	
3	150	178	0.1	

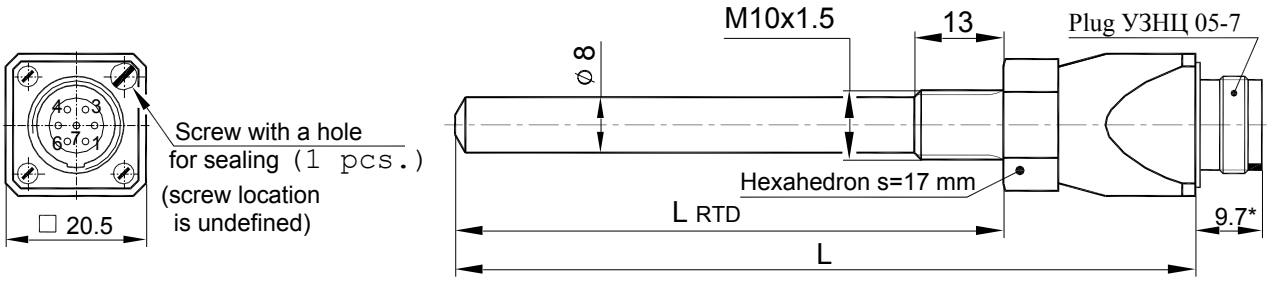


Figure 3.1

Table 3.9 Overall connecting dimensions and weight of FMS (drawings – see Appendix J)

FMS designation	Nominal diameter, mm	Nominal overall and mounting dimensions FMS, mm						n, pcs.	Weight, kg, not more than (no fastening items)	
	DN	L	$D_Φ$	H	D	d	d1		PFMS	Flanges
FMS-20	20	280	∅25[3]	54	∅20	-	-	-	1.0	0.9[1]
FMS-32	32	180	∅40[3]	79	∅32	-	-	-	1.2	3.5[1]
FMS-50	50	180	∅122	-	∅50	∅102		6	4.8	2.2
FMS-65	65	200	∅144	-	∅63	∅124			5.8	2.9
FMS-80	80	210	∅155	-	∅79	∅135	∅11		6.9	3.2
FMS-100	100	230	∅184	230	∅(95…105)[2]	∅164		8	7.8	4.1
FMS-125	125	265	∅210	270	∅(119…131)[2]	∅190		10	10.6	5.2
FMS-150	150	315	∅236	296	∅(143…156)[2]	∅212	∅13		20.0	7.7
FMS-200 1x	200	540	∅335	360	∅190	∅295	∅22	12	55	22
					∅205				59	
FMS-200 2x				317	∅205				65	
FMS-250 1x	250	620	∅405	415	∅235	∅355			74	30
					∅255				82	
FMS-250 2x				358	∅255				88	
FMS-300 1x	300	680	∅460	465	∅285	∅410	∅26		95	36
					∅310				103	
FMS-300 2x				405	∅310				109	
FMS-350 1x	350	740	∅520	515	∅335	∅470		16	125	52
					∅360				134	
FMS-350 2x				447	∅360				140	
FMS-400 1x	400	820	∅580	565	∅385	∅525	∅30		151	58
					∅410				161	
FMS-400 2x				490	∅410				167	
FMS-500 1x	500	970	∅710	670	∅480	∅650	∅33	20	280	112
					∅515				300	
FMS-500 2x				572	∅510				306	
FMS-600 1x	600	1110	∅840	765	∅585	∅770	∅36		400	162
					∅610				416	
FMS-600 2x				658	∅610				422	
FMS-700 1x	700	1240	∅960	855	∅700	∅875	∅45	24	569	244
FMS-700 2x				726	∅690				575	
FMS-800 1x	800	1360	∅1075	955	∅800	∅990			764	390
FMS-800 2x				813	∅795				770	
FMS-900 1x	900	1500	∅1185	1060	∅900	∅1090	∅52	28	1003	502
FMS-900 2x				902					1009	
FMS-1000 1x	1000	1550	∅1255	1160	∅1000	∅1170	∅56		1267	684
FMS-1000 2x				986					1273	

[1] Weight of straight sections with nuts.
[2] Nominal values of D channel diameter multiple of 1 mm
[3] Outside diameter of straight section
1x – single-beam FMS
2x – double-beam FMS

4 Completeness

4.1 Delivery set of meters is indicated in Table 4.1.

Table 4.1

Name and reference designation	Designation	Quantity	Additional information
Heat meter SVTU-10M, including:	SMP.407251.003	1 pcs.	Configuration and completeness - as per order (see Pos. 1…8)
1 SVTU-10M Calculator	SMP. 408843.003	1 pcs.	
2 Flow metering section (FMS) with fastening nuts for flow meters (no nuts for FMS-20 … FMS-80 in the FMS delivery set)	Designation from FMS-20 to FMS-1000 Inclusive – in Table 4.2	See additional information	Number, configuration and dimension-type in accordance with the order (see Appendixes A and tables 4.2, 4.3)
3 Ultrasonic flow sensor (FS) with fluoroplastic seal ring (FS for FS-20 aren't delivered separately. Flow measurement section FS-20 is delivered together with FS)	SMP.407151.009 (for FMS-32…80); SMP.407151.011-01 (for FMS-100…150); SMP.407151.008-01 (for FMS-200…1000);	See additional information	Number of FS for one FS is defined by number of places for their installation in accordance with the order (see table 4.2)
4 Resistive temperature detector RTD-S	SMP.405212.001-03 (–01,–02) SMP.405212.002 (-0.1)	See additional information	Number and configuration (type) in accordance with the order
5 Overpressure sensor (OS)	–	See additional information	Number, type and completeness according to the order. Complete set can include elements indicated in Appendix J
6 Connection cable (main)	SMP. 658694.012	1 pcs.	Number of communication lines and their length according to the order (see Appendixes A)
7 Set of cables for connection of external devices to the switching unit		-	Number of cables, designation and length – as per order
8 Heat meter SVTU-10M. Operating instructions	SMP.407251.003 RE	1 copy	

Name and reference designation	Designation	Quantity	Additional information
9 Package (set)	SMP.468927.005	1 set.	
10 Integrated expansion unit			Separate order
11 Modem	Type – by agreement with the customer		By agreement with the customer
12 Regulating valves	Type – by agreement with the customer		By agreement with the customer while ordering the MDM unit
13 Pump	Type – by agreement with the customer		By agreement with the customer while ordering the MDM unit
14 Pump control unit (MDM output matching)	Type – by agreement with the customer		By agreement with the customer while ordering the MDM unit
15 Data reader			Separate order
16 Meter panel	SMP.301538.006		Separate order
17 IMR –01 Flow Simulator	SMP.408845.001	1 pcs.	Separate order
18 Instructions. SVTU-10M Heat meter. Test Procedure.	SMP.407251.005 I1	1 copy	Separate order
19 Spare parts, tools and accessories (SPTA)	SMP.407251.004-3ИП		List and number as per separate order

Notes

1 FMS is delivered with flanges and fasteners see table 4.3.

2 FMS can be delivered in sets with straight pipe sections (length up to 25 internal diameters of the pipeline). The specified sections can be delivered both welded to flanges and be represented by separate sections of pipes. When ordering straight pipe sections all materials required for installation (for example, electrodes for welding, paint, sealing materials, etc.) can be delivered additionally.

3 SPTA may include sets of items listed in Table 4.1, Table 4.3, SVTU-10M calculator enclosure with the supply cable, the main board of SVTU-10M calculator and the board of SVTU-10M calculator expansion box in quantities as per the order.

4 The meter may be fitted with a platinum resistive temperature transducer (RTD) of a different type with Ro=100 Ohm, W_{100} =1.3850 with interpolational equation $W_t = 1 + 3.9083 \cdot 10^{-3} \cdot t - 5.7750 \cdot 10^{-7} \cdot t^2$ V temperatures range from 0 to 850 °C as per DSTU 2858-94 (GOST 6651-94), where, t – temperature, °C. If so delivered, their primary calibration is the obligatory in compliance with "Procedure for calibration of temperature transducers …" SMP.405212.001 I1.

5 DR may be delivered as a laptop-based device or as a separate single-purpose device USD-02. Laptop type is selected by the customer.

Designations and main dimensions of FMS are indicated in Table 4.2.
(Outline drawings FMS – see Appendix P)
Table 4.2

FMS designation	DN, mm	Marking applied on FMS		Number of pockets for flow meters	Designation
		Internal diameter	Conventional pressure		
Single-beam flow metering sections					
FMS-20	20	DN 20	PN 16	-	SMP.408828.001
FMS-32	32	DN 32		2	SMP.752292.002
FMS-50	50	DN 50			SMP.302436.021
FMS-65	65	DN 65			SMP.302436.021-01
FMS-80	80	DN 80			SMP.302436.021-02
FMS-100	100	DN 100			SMP.302436.007-03
FMS-125	125	DN 125			SMP.302436.007-04
FMS-150	150	DN 150			SMP.302436.007-05
FMS-200	200	DN 200		4	SMP.302436.012
					SMP.302436.012-01
FMS-250	250	DN 250			SMP.302436.012-02
					SMP.302436.012-03
FMS-300	300	DN 300			SMP.302436.012-04
					SMP.302436.012-05
FMS-350	350	DN 350			SMP.302436.012-06
					SMP.302436.012-07
FMS-400	400	DN 400			SMP.302436.012-08
					SMP.302436.012-09
FMS-500	500	DN 500			SMP.302436.012-10
					SMP.302436.012-11
FMS-600	600	DN 600			SMP.302436.012-12
					SMP.302436.012-13
FMS-700	700	DN 700	PN 25		SMP.302436.012-14
FMS-800	800	DN 800			SMP.302436.012-15
FMS-900	900	DN 900			SMP.302436.012-16
FMS-1000	1000	DN 1000			SMP.302436.012-17
Double-beam flow metering sections					
FMS-200	200	DN 200	PN 16	8	SMP.302436.020
FMS-250	250	DN 250			SMP.302436.020-01
FMS-300	300	DN 300			SMP.302436.020-02
FMS-350	350	DN 350			SMP.302436.020-03
FMS-400	400	DN 400			SMP.302436.020-04
FMS-500	500	DN 500			SMP.302436.020-05
FMS-600	600	DN 600			SMP.302436.020-06
FMS-700	700	DN 700	PN 25		SMP.302436.020-07
FMS-800	800	DN 800			SMP.302436.020-08
FMS-900	900	DN 900			SMP.302436.020-09
FMS-1000	1000	DN 1000			SMP.302436.020-10

Other completing items included into the delivery set as obligatory or by separate order are listed in Table 4.3.

4.2 Meter version, FMS type, connecting cables, number of communication channels and their length shall be defined in placing order. See meter order designation in Appendix **A**.

The FMS with DN 200 and higher can be manufactured both from the stainless steel and ferrous metals by agreement with the customer.

Description of the FMS design features and data (figures, mounting dimensions) required for designing of the metering unit are indicated in Appendix J.

Possible variants of connecting cables and the number of communication lines are indicated in Appendix H.

Warning!!!

In checking the standard size of the flow metering section (FMS) taken from the delivery set for compliance with data specified in Section 17 **"Parameters and specifications of meter components"** identification of the standard size of the flow metering section shall be carried out with reference to the designation of the FMS internal diameter applied on the metal.

In doing so, the digital value indicated in the FMS designation shall comply with the digital value of a specified internal diameter DN (see Table 4.2).

Examples:

– Marking "**DN 32**" is applied on the flow metering section with reference designation FMS-32. The next element of marking "**PN 16**" means that this flow metering section is intended for the use in heat- or water-supply systems with overpressure 1.6 MPa (16 kgf/cm^2);

– Marking "**DN 700**" is applied on the flow metering section with reference designation FMS-700. The next element of marketing "**PN 25**" (or "**FMS 25**") means that this flow metering section is intended for the use in heat- or water-supply systems with overpressure 2.5 MPa (25 kgf/cm^2).

Table 4.3 Completing items included into the delivery set

	Name	Designation	Application	Quantity	Part of delivery set	
					Compulsory	As requested
1	Branch pipe (160 mm)	SMP.302661.008	Output straight section FMS-32p for M2 and 5M2	1 pcs. на 1 FMS	+	
2	Branch pipe (320 mm)	SMP.302661.008-01	Input straight section FMS-32p for M2 and 5M2		+	
3	Branch pipe (230 mm)	SMP.302661.008-02	Output straight section FMS-32p for M1 and 5M1		+	
4	Branch pipe (480 mm)	SMP.302661.008-03	Input straight section FMS-32p for M1 and 5M1		+	
5	Branch pipe	SMP.752291.001	Connection of FMS-20 with a straight section	2 pcs. на 1 FMS	+	
6	Coupling nut	SMP.758422.006	Fastening of FMS-20		+	
7	Coupling nut	SMP.758422.001	Fastening of FMS-32p (threaded)		+	
8	Flange (companion)	SMP.711154.011	Fastening of FMS-32p (flange)		+	
9	Flange (companion)	SMP.711154.013-01, 013-03, 013-05 (to match DOCUMENTATION of FMS)	Fastening of FMS-50…80		+	
10	Flange (companion)	SMP.711154.004-03 … 004-05 (to match DN of FMS)	Fastening of FMS-100…150		+	

	Name	Designation	Application	Quantity	Part of delivery set	
					Compulsory	As requested
11	Flange (companion)	SMP.711154.008-18…-35 (to match FMS version)	Fastening of FMS-200…800	2 pcs. per 1 FMS	+	
12	Gasket (paronite)	SMP.754152.013	Sealing of flanges FMS-20		+	
13	Gasket (paronite)	SMP.754152.009	Sealing of flanges FMS-32р and FMS-32ф		+	
14	Gasket (paronite)	SMP.754152.007…007-16	Sealing of flanges FMS-50…800		+	
15	Protection sleeve (L_{TC}=58mm, type 4)	SMP.753137.002-03	RTD protection from hydrodynamic impacts	1 pcs. per 1TC		+
16	Protection sleeve (L_{TC}=80mm, type 2)	SMP.753137.002-01				+
17	Protection sleeve (L_{TC}=150mm, type 3)	SMP.302634.002				+
18	Protection sleeve (L_{TC}=310 mm, type 5)	SMP.302634.004			+	
19	Protection sleeve (L_{TC}=360 mm, type 6)	SMP.302634.004-01			+	
20	Sealing ring (fluorine plastic)	SMP.754176.003	Sealing of RTD types 2, 3, 4		+	
21	Sealing ring (fluorine plastic)	SMP.754176.003-01	Sealing of protection sleeve RTD types 2, 3, 4	1 pcs. per 1 гильзу		+
22	Gasket (paronite)	SMP.754152.012	Sealing of RTD types 5, 6	1 pcs. per 1 гильзу	+	
23	Gasket (paronite)	SMP.754152.012-01	Sealing of protection sleeve RTD types 5, 6	1 pcs. per 1 гильзу	+	
24	Bushing (for angle α=45º)	SMP.723144.007	Installation of RTD types 2, 3, 4 without protection sleeve	1 pcs. per 1 RTD	+	
25	Bushing (for angle α=60º)	SMP.723144.008			+	
26	Bushing (for angle α=90º)	SMP.723144.009			+	
27	Bushing (for angle α=45º)	SMP.723144.007-01	Installation of protection sleeve of RTD types 2, 3, 4	1 pcs. per 1 гильзу		+
28	Bushing (for angle α=60º)	SMP.723144.008-01				+
29	Bushing (for angle α=90º)	SMP.723144.009-01				+
30	Bushing (for angle α=90º)	SMP.723144.010	Installation of protection sleeve of RTD types 5, 6	1 pcs. per 1 гильзу	+	
31	Threaded sleeve (pipe 1/2" x 1/4")	SMP.716161.004	For installation of pressure transducer	1 pcs. per 1 PT	+	
32	Gasket (paronite or fluorine plastic)	SMP.754156.010	For PT		+	
33	Gasket (paronite or fluorine plastic)	SMP.754156.010-01	For threaded sleeve		+	
34	Gasket	SMP.754156.001	Sealing of the meter connector	1 pcs.	+	
35	Set AB 1000WLV: - pipe clip	without designation	Calculator attachment to the base	2 pcs.	+	
	- bracket			2 pcs.	+	
	- star washer			2 pcs.	+	
	- screw M4 (hexagous)			2 pcs.	+	
fasteners: (thread diameter *d* and bolt length *L* match holes in flanges and total flange thickness)						
36	- screw M3x10	GOST 17473-80	Fastening of the meter connector	4 pcs.	+	
37	- washer 3	GOST 10450-78 or 11371-78		4 pcs.	+	
38	Bolts A. (dxL).88.35.019	GOST 7805-70	FMS-50…150	Depending on the total number of flanges in FMS (see Table 3.3)	+	
39	Nuts A. (d). 9.35.019	GOST 5927-70			+	
40	Bolts A. (dxL). 46	GOST 7798-70	FMS-200…1000		+	
41	Nuts A. (d). 5	GOST 5915-70			+	
42	Washers (d). 5	GOST 11371-78			+	

5 Design and operation of meters

5.1 The meter integrates two calculation channels. Each calculation channel may service one circuit of heat or water consumption. So, the meter can perform metering in two circuits at the same time (depending on the required configuration).

Each of calculation channels is, actually, an independent calculator that may use available measuring channels (temperature, ultrasonic flow, pressure). One calculation channel may use from one to two ultrasonic flow measuring channels (for measuring quantity of heat or volume and weight of water), from 1 to 4 channels measuring temperature and up to 2 channels measuring pressure.

Each of calculation channels may be in one of the following metering modes:

- «Off register»
- «Register»
- «Off».

«Off register» mode.

This mode is set at the meter shipment and is intended for putting the meter in operation. It is not the mode for commercial metering of heat. In this mode, it is possible to set zeroes for channels measuring flow and to change such meter parameters, as system of units, …

«Register» Mode.

This is the mode for commercial metering of heat. In switching to this mode from the «Off register» mode, all integral parameters and archived data of the calculation channel concerned are deleted. In this mode, all operations that can influence measurement results are forbidden.

«Off» Mode.

This mode is intended for stopping operation of the channel heat calculation without terminating registration. Storage of all integral parameters and data archiving for this channel is suspended. No errors occurring in measuring channels are displayed and recorded.

This mode is used for suspending operation of the calculation channel for the summer, for example, when water is drained from the pipeline or when repairs are being performed. If this mode is not changed, the device will continuously display errors in the disconnected measuring channels and hamper operations with the meter.

When required, the channel can be switched once again to the «Register» mode without resetting archived data and integral parameters. If it is necessary to reset parameters, switch the channel to «Off register», and then to «Register» mode.

All changes in channel operation modes shall be fixed in the logbook, as well as the date and time the current mode has been initiated. Such data can be displayed on the return when reading the meter current status.

Impulse channels that are measuring volume have no connection with calculation channels and operate independently and are able to measure volume only.

The number and versions of calculation channels are limited by the maximum number of measuring channels available in the meter (flow, temperature).

Maximum number of ultrasonic channels measuring flow depends on type of applied FMS – single-beam or double-beam FMS.

In general, the following limitations as to the number of channels shall be applicable:

- Number of calculation channels – not more than 2 pcs.;

- Number of ultrasonic beams applied for flow measurement- not more than 2 pcs;
- Number of temperature sensors - not more than 5 pcs.

5.2 To simplify the meter configuring process the following meter delivery variants are provided for. Each such delivery variant determines the variant of calculation channels delivery (Table 3.3). Apart from the meter delivery variants indicated in this Table any other combinations of calculation channels versions are possible. For example, the first calculation channel may have version 2, and the second – 2/1.

5.3 Channels that are measuring pressure may be used for calculation of heat in any calculation channels. In this case, the pressure value used for enthalpy calculation the result of measurements performed by the pressure transducer is used, and not the constant introduced by the customer,. The consumer may designate the pressure transducer (or transducers) to be used for calculation of heat. Prior to shipment, meters are configured to meter heat by applying the customer's pressure constants.

5.4 The meter measures thermal energy delivered to the facility on the basis of measured volumes of the heat transfer liquid in the supply and return lines, temperature and pressure of the heat transfer liquid

5.5 The principle of the heat transfer liquid volume by applying the ultrasonic channel is based on measurements of the difference of time required by the ultrasonic signal to pass in the direction of the heat transfer liquid flow passing across the FMS and against it, which enables determining the flow velocity.

The average flow velocity in the section and the FMS cross-section area determine the instantaneous heat transfer liquid flow rate. Instantaneous values of flow integrated in time provide information on the volume of the heat transfer liquid passing across the FMS. The mass of the heat transfer liquid is calculated as water volume and density function depending on its temperature.

5.6 Temperature of the heat transfer liquid (water) is measured by platinum resistive temperature detectors.

5.7 The flow rate measuring process is continuous. It is conducted several dozens of time a second and the obtained data are collected. Once a second, flow data are read and thermal energy calculated.

Temperature and pressure measuring cycle – once in every 2 seconds.

Each measuring cycle lasting for 1 second includes both measurements of flow rate and the process of the devise self-diagnosis.

5.8 Tariffs.

The consumer may set the day/night tariff mode. If done so, the time for the beginning of the night tariff and the time for the beginning of the day tariff can be set.

When the tariff mode is on, all stored parameters, such as volume, mass, heat/cold are stored and archived in separate meters for day and night tariff.

5.9 Heat metering.

Meters are manufactured in 12 basic versions. Certain versions have modifications designated by digits after the slash. For example, «2/2» means versions 2 modification 2. Depending on the version, the number of measured parameters and thermal energy calculation algorithms is changed.

Basic meter versions determined versions of each of two calculation channels (Table 3.3).

Apart from that, variants of configuration not compliant with the basic ones are possible. For example, the first calculation channel has variant 2, and the second calculation channel – variant 2/2.

The below formulas used the following designations:
W – Thermal energy (J);
H – Specific enthalpy (J/kg);
Qm – Mass flow (kg/h);
t – Time (h).

Specific enthalpy depends on temperature and pressure, that is why, for the purpose of enhancing accuracy of enthalpy calculation, in the course of the meter putting into operation, values of overpressure in the relevant pipelines are entered.

In the event the delivery set includes PT, the consumer may set the pressure measured by any available PT was used for calculation of heat. If, in the process of operation, the PT becomes faulty, then, for the purpose of heat calculation, pressure value of 0.5 MPa will be used. This being the case, the error of pressure measurements and the error of heat measurements of group 4 will be recorded (see subclause 13.5).

The entered (measured) the values of pressure will be shown in the reports as Ps, P_{return} and P_{cw}. If the meter is no completed with the PT, then the report shows the preset values. If the meter is completed with the PT, Port shows the measured values.

Delivery variants 4, 10, and 12 apply customer preset (and not measured) value of cold water temperature. In this case, value of cold water temperature shall be agreed with heat supplying company and may be changed by the customer independently. This being the case, any changes in cold water temperatures shall be recorded in the log book.

The preset cold water temperature may be changed from 0 to 25.5 ºC with 0.1 ºC increment. *If 0.0 ºC is entered, then value of specific enthalpy is identically equal to 0*.

When versions of the meter with the entered temperature of cold water are used it should be noted that thermal energy measured by a heat meter does not comply with thermal energy provided by the heat supplying company. This relates to the fact that the entered temperature of cold water is not equal to the actual cold water temperature that is constantly changing in time. In this case, for the purpose of payment to the heat supplying company, it may be required (depending on the requirements to payments between the supplier and the consumer) to make adjustments in compliance with the current regulatory documents.

Diagrams of various versions of meters are given in Appendix B.

5.9.1 Heat and cold metering.

Depending on the difference between the supply and return water temperature, the meter can meter heat (if the difference is positive) and/or cold (if the temperature difference is negative).

Cold metering mode is possible for versions 2, 2/1, 2/2 and 5.
It is possible to meter heat or cold, or heat and cold. If cold and heat is metered, the meter automatically, depending on the difference in supply and return temperatures, carries out accumulation of heat or cold in separate meters.

5.9.2 **Closed heat-supply system** (versions of calculation channels **2, 2/1, 2/2, 5**). Calculation of thermal energy is conducted by formula:

$$W = \int_t Q_m \cdot (H_1 - H_2) \cdot dt \qquad (5.1)$$

Where,

Q_m – mass flow of the heat transfer liquid in the supply line, kg/h;

H_1 and H_2 – specific enthalpy of the heat transfer liquid at the input and output of heat exchange system, respectively, J/kg;

t – time, h.

5.9.3 **Open heat-supply system** without metering HWSS (variants 4 and 7):

$$W = \int_t Q_{m1} \cdot H_1 \cdot dt - \int_t Q_{m2} \cdot H_2 \cdot dt - \int_t (Q_{m1} - Q_{m2}) \cdot H_{XB} \cdot dt \qquad (5.2)$$

Where,

Q_{m1} and Q_{m2} – mass flow of the heat transfer liquid, respectively, in the supply and return lines, kg/h;

H_1, H_2 – specific enthalpy of the heat transfer liquid, respectively, in the supply and return lines, J/kg;

H_{MIN} – specific enthalpy of cold water.

At variant 4, temperature of cold water is not measured, but is preset (entered by the customer).

Meters of variant 4 and 7 carry out measurements of the heat transfer liquid flow in the supply and return lines and ***calculation of*** flow difference ΔG_M. Heat meters of variants 4 and 7 the ***do not measure*** leakage, and leakage ***is calculated*** as flow difference in the supply and return lines.

5.9.4 **Open heat supply systems with HWSS** (variants 10, 11, 11/1 and 12 of the heat meter). In this case, difference of flows in the supply and return lines is regarded as consumption of the HWSS. The total heat consumption by the system is calculated by formula:

$$W = \int_t Q_{m1} \cdot H_1 \cdot dt + \int_t Q_{m2} \cdot H_2 \cdot dt - \int_t (Q_{m1} + Q_{m2}) \cdot H_{XB} \cdot dt \qquad (5.7)$$

Where,

Q_{m1} and Q_{m2} – mass flow of the heat transfer liquid, respectively, in the supply and return lines by taking into account ***the flow sign***. Facilitate incoming flow – with sign «+», outgoing flow – with sign «-»;

H_1, H_2 –enthalpy of the heat transfer liquid in the supply and return lines, respectively, J/kg;

H_{XB} – enthalpy of cold water.

In case of this variants of delivering it is presumed that flows income into the facility are taken into account with sign «+», and flows outgoing from the facility – with sign «-». In this case, if both flows are entering the facility (summer mode), then both of them are depicted with sign «+».

For variants 10 and 12, cold water temperature is entered by the customer.

For variants 10...12, the meter can operate in four metering modes (Appendix B):

– **Winter** – heat transfer liquid is being supplied along the supply lines and returns along the return line. In this case, the sign of the flow in the supply line – «+», and in the return line – «-» (the flow goes out to the facility);

– **Summer 1 –** heat transfer liquid is fed along the supply line only and is used entirely in HWSS (heating is off);

– **Summer 2 –** heat transfer liquid is fed along the return line only and is used in HWSS. In this case, the sign of the return line flow – «+» (the flow is entering the facility);

– **Summer 3 –** heat transfer liquid is fed to the facility along both lines and is used entirely in HWSS (both flows – with sign «+»).

Switching between modes of operation can be performed automatically and manually. Automatic switching between modes shall be fixed in the logbook of HWSS modes and shall be printed out on a daily basis. Detailed information on operation algorithm is described in Appendix C. Manual mode switching is recorded in the general logbook.

Calculation of thermal energy consumed by HWSS shall be carried out as follows. In all summer modes, heat consumption by HWSS is equal to heat consumption by the system as a whole, that is, it is presumed that heating is off. In winter mode, consumption of heat by the HWSS shall be calculated by formula:

$$W_{ГВС} = \int_t \left(Q_{m1} + Q_{m2}\right) \cdot \left(H_{ГВС} - H_{ХВ}\right) \cdot dt \qquad (5.8)$$

Where,

$H_{ГВС}$ – specific enthalpy of hot water.

5.9.5 **Heat supply source** (variant 9).

$$W = \int_t Q_{m1} \cdot \left(H_1 - H_2\right) \cdot dt + \int_t Q_{ПП} \cdot \left(H_2 - H_{ХВ}\right) \cdot dt \qquad (5.9)$$

Where,

Q_{m1} and $Q_{ПП}$ – mass flow of the heat transfer liquid, respectively, in the supply and makeup lines, kg/h;

H_1, H_2, $H_{ХВ}$ – enthalpy of the heat transfer liquid, respectively, in the supply line, the return line and line of cold water, J/kg.

5.10 Data archiving.

When the meeting is operating heat stores the results of measurements in archive files.

Two types of archive are maintained – hourly and daily.

In forming daily archives the following features shall be taken into account:

– contract time

– summer/winter time

Contract time is time from the beginning to the end of the day. By default, it equals 0 (0 hour). Upon request of the heat supply company, a value arranging from 0 to 23 may be set, except for values 2, 3 and 4 (to exclude ambiguousness in transferring to summer/winter time). It is possible to change contract time without putting the meter out of service by applying «Set» menu. Such changes is recorded in the log book.

Contract time is attributed to the calendar time (by taking into account some and/winter time).

The archive preserves all measured meter parameters – temperature, pressure, flow rate (volume), and heat.

Apart from that, all customer's actions effecting the metrology are entered into the customer's actions logbook.

Calculation and storage (archiving) of temperature mean values used for calculation of thermal energy for the period of time t_0-t_1 but carried out by the device by applying the average weight values as per formula:

$$\overline{\Theta}_{\int} = \frac{\int_{t_0}^{t_1} \Theta(t) \cdot q_m(t) \cdot dt}{\int_{t_0}^{t_1} q_m(t) \cdot dt} \qquad (5.10)$$

Where,

$\Theta(t)$ – instantaneous (current) temperature values;

$q_m(t)$ – instantaneous (current) values of mass flow of the heat transfer liquid (water).

For time discrete measurements performed by the meter every 1-2 seconds the following formula is true:

$$\Theta_{\text{CP.B3B}} = \frac{\sum_i \Theta_i \cdot q_{mi}}{\sum_i q_{mi}} \qquad (5.11)$$

Where,

Θ_{mi} and q_{mi} − temperature and mass flow of the heat transfer liquid, respectively, for i-measurement.

When there is no flow of the heat transfer liquid, temperature shall be calculated as the arithmetic mean for all measured temperature values for a specified period of time.

For temperatures not taken into account in calculating heat the arithmetic mean temperature is calculated.

5.11 The meter performance measurements of flow from 0.5Qmin to 2Qmax, where Qmin and Qmax – minimum and maximum volume throughput of the heat transfer liquid (see Table 3.2), respectively.

For all types of FMS, measurement error specified in this OI is provided in the range [Qmin; Qmax], and in ranges [0.5Qmin; Qmin [and] Qmax; 2Qmax]. The above measurement errors are not standardized, but operation ability of the meter is maintained, and accumulation of the heat transfer liquid mass is conducted and heat calculated.

At measured instantaneous values of flow $Q_{chn} < 0.5Q_{min}$ the device induces «zero» flow and no accumulation of mass $m=Q \cdot \rho$ occurs.

5.12 In the course of operation, the meter is constantly taking operation ability of all devices and tolerance of measured parameters. In the event of an error, information on such error is stored in archive and includes the error code, measuring channel the error occurred in and error duration.

The meter may provide different interpretations of exceeding the limit for such parameters, as flow and temperature difference in the supply and return lines. The following situations may occur:

– Value of flow exceeds Qmax;

– Is within the range [0.5Qmin; Qmin];

– Temperature difference in the supply and return lines are always in the range of 0 - 2.5 ºC.

The meter, depending on the settings selected by the customer, may interpret such situations as follows:

– Does not register such situations;

– Registers, but does not suspend accumulation of parameters (the error is registered, but the volume and heat is metered)

– Regards such situations as an error. This being the case, the error is registered and accumulation of parameters is suspended. Heat and volume data accumulation is also suspended. Current flow is displayed.

Detailed information on errors is given in subclause 13.

5.13 Measurement of the heat transfer liquid or water overpressure (formed if the integrated extension block is available) is carried out through measuring current of the PT output signal. Value of overpressure $P_и$ (MPa) measured and displayed by the calculated and current I_{inp} (mA) at the input of the pressure measuring channel (at the calculator input) are related by the following equation:

$$P_и = (I_{изм} - I_1) \cdot \frac{(P_2 - P_1)}{(I_2 - I_1)} + P_1 \qquad (5.12)$$

Where,

P_1 and P_2 – pressure in two points of the pressure transducer curve (for example, minimum and maximum pressure);

I_1 and I_2 –current at the output of the PT in the above points, respectively;

$I_{ИЗМ}$ – value of current measured at the output of the PT.

5.1 In measuring time, the meter the meter carries out measurement of the following quantities: duration of correct operation, duration of incorrect operation (time of errors), power on time, power off time (non-work or idle time), and also displays current date/time (taking into account daylight saving).

Duration of correct operation (running time T_{op} or operation time) – duration of operation of each calculation channel when power is on and no error messages.

Duration of incorrect operation (duration of errors T_{err}) – duration of operation of each calculation channel when power is on and error messages are available.

Operation time T_{op} - total time of the meter operation. When the integrated standby power supply block is available, it exceeds the time of external power supply availability.

External power supply duration T_{ext} - total duration of external power supply.

Power off time (idle time T_{idle}) – total time when the device power supply voltage is off.

Current date/time – current time (taking into account daylight saving).

Measurements, display and registration of the above-listed parameters are carried out in hours. Figure 5.1 gives the time diagram explaining time correlations between the considered time intervals.

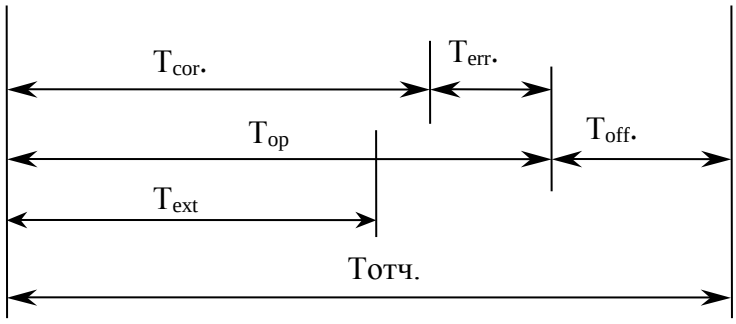


Figure 5.1

5.15 Interfaces.

5.15.1. Information interfaces.

The meter has the following interfaces for data reading and their inclusion into the system of metering automation:

- RS232;
- USB Host;
- RS485.

RS232 is delivered in basic variant and enables meter connection to a computer, modem (wire modem, GSM/GPRS modem). The same interface connects the data reader for data transfer from the meter to the computer.

USB Host is used for connection of USB Flash (no limitations as to the USB sticker storage capacity) with FAT or FAT32 initialization. Data storage on the Flash in «Control» mode is accomplished through connections of the USB Flash the relevant USB port. This being the case, all types of archived data collected by the meter are recorded.

To speed up the process of recording, the device records only information that has been stored from the time of the last recording of the current flash. If required, and the entire archive can be recorded.

RS485 supports two data communications protocols:

- “Sempal” internal protocol for data exchange between meters;
- Modbus RTU protocol.

The consumer is able to choose the type of the used protocol.

In applying “Sempal” protocol, meters can be integrated via RS485 interface. In this case, only one meter is connected to the external communication channel (modem, RS232). It provides access to the entire chain of meters.

Modbus protocol enables the meter connection to the Modbus network. Current status and archives are accessed. The interface rate is adjusted by the customer.

USB Host and RS485 interfaces are delivered against the customer's order. This being the case, only one of them can be mounted at a time.

5.15.2. Analog interfaces.

As requested by the customer an integrated expansion unit can be mounted into the meter.
The extension unit adds the following functionality:

– Possibility to measure pressure;
– Two line outputs;
– Two switching outputs.

Line outputs.

The consumer, at its own discretion, shall adjust the type of each output independently – voltage-operated or current-operated. Voltage-operated output may be used for voltage in the range from 0 to 10 V. Current-operated output may be used for current in the range of 0 - 20 mA.

Output capacity of a voltage-operated output – 20 kOhm. This being the case, accuracy of the measured value display does not exceed 1 %. Maximum current – not more than 10 mA.

"Switching" outputs.

For each of the switching outputs the following type can be set:

– Active output. Voltage «1» = 10 V with source current up to 10 mA. Input current – not more than 20 mA;
– Open collector. Maximum voltage 40 V, current 20 mA.

Type each of outputs is adjusted by the customer independently.

5.15.2.1. Line output functions.

Each of outputs is configured independently and can be operated in the following modes:

– Linear proportional output;
– Threshold output;
– Adjustment.

Proportional output.

Each of outputs may be adjusted to form the output signal (voltage or current), in proportion to a certain meter measured value (information-bearing parameter).

Information-bearing parameters may be represented by:

– t1, t2, t3, t4, t5 – temperatures measured by temperature sensors TS1…TS5, respectively;
– P1, P2 – pressure measured by pressure transducers PT1 and PT2, respectively;
– q1, q2 – heat transfer liquid volume throughput;
– m1, m2 – mass flows of the heat transfer liquid.

The consumer selects an information-bearing parameter and adjusts the parameter variation range and the output signal variation range.

Threshold output.

Threshold output operates by the following algorithm.

An information-bearing parameter is selected and two threshold values are set –on threshold and off threshold. If the value of information-bearing parameter exceeds the on threshold, output is set to «1», if the value falls below the off threshold – it is set to «0».

In addition to the above, current time may be selected as the information-bearing parameter On time (hour, minute) and off time shall be set.

Adjustment.

In this case, each output represents one PI adjustment channel.

The consumer sets parameters for circuit adjustment (transmission ratio for the channel and response speed) and regulated parameter.
The following adjustment algorithms are used:
– Temperature adjustment. The customer's preset temperature for the temperature sensor concerned is maintained;
– Heating adjustment. Return line temperature is adjusted.
Day/night mode and "day-off" mode can be preset for each adjustment mode, as well as outside air temperature-dependent correction scheme.

5.15.2.2. Switching outputs functions.
Each of switching outputs is configured independently. The output type and the information-bearing parameter is set.
Switching outputs always operate in the threshold mode. This mode corresponds to the threshold mode of line outputs.

5.15.2.3. All information on the expansion unit is given in SMP.407251.003 RE1, Part 2 «Integrated expansion unit of SVTU-10M (M1, M2) RP heat meter» to this OI (Part 2).

5.16. By their design, meters are represented by several separate units that are electrically interconnected – calculator, temperature sensors, flow metering section with ultrasonic sensors, pressure transducers.

5.16.1. The calculator is fitted into the rectangular enclosure containing controls (four keys), display (four-line 64-bit liquid crystal display), connecting cables electrical connectors and the power cable outlet.
Heat meter controls: four keys, functions of which are described in Section 11 and Appendix E.

The heat meter is fitted with the nightglow liquid crystal display. Nightglow is not available when the meter is operating from the inbuilt stand by power supply source.

5.16.2. The FMS is represented by a piece of pipe with flanges and bushings for attachment of ultrasonic flow sensors. Geometric dimensions of the FMS (linear and angular) are strictly standardized to attain the required accuracy of measurements and stable operation. Dimensions are indicated in Table 3.6, as well as in Appendix P.

The FMS with nominal diameter DN 200 and larger are designed with (should no sluice chambers be ordered for FS) backup branch pieces (bushings) for installation of backup pairs of ultrasonic flow meters. Backup pairs of flow meters are arranged in the same planes as the main FS. This similarly relates to single-beam FMS and to double-beam FMS. This being the case, either the main pairs of sensors operating or the backup sensors. Transferred to the backup sensors is carried out by changing connection on the cable.

That is: single-beam FMSs are fitted with 4 FS (one backup repair), double-beam FMSs are fitted with 8 FS (two backup pairs).

Warning: switching to the backup pair of FSs installed on the double-beam FMS is permissible only to the pair located in the same plane with the main pair.

5.16.3. RTDs are mounted on pipelines by applying bushings or sleeves (depending on the order) at the input and output of the heat exchange system.

5.16.4. Length of connecting cables is determined based on the layout and places for arrangement of the meter components, and may vary:

– From 2 to 100 m for ultrasonic flow sensors and temperature sensors (by special order, cable length to one of the RTD can be as long as 900 m),
– From 2 to 200 m for BS232 interface when the PC is connected,
– From 2 to 30 m for BS232 interface when a modem or a data reader is connected.

5.17. By its design the meter panel is represented by the rectangular lockable cabinet that is intended for counting and connection of the equipment manufactured by «SEMPAL».

6. Marking and sealing

6.1 Meter marking applied on the calculator complies with GOST 26828 and contains of the following:

- Name and reference designation of flow meters;
- Trade mark of the manufacturer;
- Type approval mark as per DSTU 3400;
- Meter modification– M1 or M2;
- Serial number (on the side panel) consisting of five digits of the serial number and two digits in front of the serial number designating the meter manufacturer year;
- Power supply voltage, consumed power.

In addition, RTD and FMS manufacturer serial numbers are stamped or engraved on their enclosures.

6.2 Marking of the FMS contain the nominal diameter value DN and maximum operational overpressure PN (Pu).

6.3 The meter components are sealed to prevent unauthorized access to adjustment components in places designated in the design documentation.

6.4 The calculator is sealed by applying to two ink seals. Seals are placed on side panel fixing screws. Special ceiling cups are provided above the screws.

Apart from that, for the purpose of additional thinning by applying lead seals, the side panels are provided with capstan screws. At the customer's request, such screws may be replaced by ceiling cups.

The meter cable is marked by the label affixed to the connector and containing the cable designation code.

Marking of connecting cables and applied to the label attached near the relevant connector.

7 Transport container and marking

7.1 Package (transport container) complies with Category CU-1 (type VU-II for operation documents and the meter) GOST 23216 and is manufactured in compliance with the manufacturer's drawings.

7.2 Marking on the transport container complies with GOST 14192 and is manufactured in compliance with the manufacturer's drawings and contains "FRAGILE", "UP" and "KEEP DRY".

7.3 Meter are packed into the boxes in accordance with drawings of manufacturer.

By agreement with the customer, it is permissible to deliver the FMS without transport containers or in the customer's container.

8 Safety instructions

8.1 Meters design complies with safety requirements as per GOST 12.2.003.

8.2 Short circuit protection design of 220 V meters comply with Class I, meters with power supply from the source of 36 V or 24 V comply with Class III as per GOST 12.2.007.0

8.3 Meters fire safety complies with GOST 12.1.004.

8.4 Electrical installation of the 220 V meter power circuits withstands 2100 V of direct current for 1 minute.

8.5 Electrical installation of the 36 V or 24 V meter power circuits withstands 700 V of direct current for 1 minute.

8.6 Electrical installation of the meter panel withstands 1500 V of direct current for 1 minute.

8.7 Electrical insulation resistance of the 220 V meter power circuits equals not less than:

– 20 MOhm - at 20 °C and relative humidity up to 80 %;
– 1 MOhm - at 35 °C and relative humidity 95 %.

8.8 Electrical insulation resistance of 36 V or 24 V meters equals to not less than 1 MOhm.

8.9 Electrical resistance between the grounding contacts of the triple-pole plug of the cable and the metal parts of the calculate enclosure - not more than 0.1 Ohm.

Electrical resistance between the grounding contacts of the triple-pole sockets and its enclosure must not exceed 0.1 Ohm.

8.10 In operating the meters, it is necessary to comply with the current safety rules for operation of electrical installations.

Warning! In applying a transformer as a source of power supply to the 36 V or 24 V meter, input and output windings of the transformer must be **galvanically isolated** and **doubled or reinforced insulation** must be provided between them**.**

9 Procedure for installation and mounting

9.2 Unpacking and degreasing

Unpacking and degreasing of meters are carried out after they have been kept indoors for 2 hours at ambient temperature from 10 to 30°C and relative humidity of no more than 80 %.

To unpack, please follow the instructions:

- Open the packing boxes;
- Take out the package with the calculator and operational documentation;
- Check completeness of the meters against the order;
- Take meter components out of the packing boxes, visually inspect and make sure that there are no mechanical damages, coating and isolation faults in connecting cables.

9.3 General requirements to the meter place of installation

9.3.1 Places of the meter components installation shall be chosen depending on the variant meters, the necessity to apply additional equipment and parameters of the heat consumer's facilities.

General layouts of meters installation depend on their variants and are indicated in Appendix B.

9.3.2 Ambient conditions must be:

1) At the place of FMS and RTD installation:

– Surrounding air temperature from –40 °C to +70 °C;

– Ambient humidity up to 95 % at 35 °C;

2) At the place of the calculator installation:

– Surrounding air temperature from 0 °C to +50 °C;

– Ambient humidity up to 80 % at 25 °C.

Climatic conditions at the place of additional equipment installation must comply with the operation conditions described in the operation instructions for such equipment.

9.3.3 External conditions are of importance: the meter installed on the stand and operating without any faults may be installed and plays with the level of interferences that does not affect its operation.

In selecting the place of the meter installation, one should pay attention to the fact that the place must not be subjected to radio and television stations interference (radiofrequency interferences), subways (impulse interferences and “noise” in power supply lines), close location to high-voltage overhead transmission lines (electromagnetic interference), powerful electric motors (supply line surges), equipment operating with large transformers (magnetism), and close vicinity of electric welding equipment (all types of interferences). Should such interferences be available, length of communication lines between FMSs, RTDs and the calculator must be minimal and their length shall be determined by the level of interferences at the particular facility.

To reduce the level of interferences from the overhead power transmission lines, it is recommended to install RF filters. The level of electronic interferences can be reduced by applying additional estimated screening devices around the meter and the source of interferences. The effect of interferences can be significantly reduced by using the shortest possible connecting lines.

9.3.4 Places of FMS and RTD installation must be protected from direct contact with water, dirt, oil and aggressive fluids.

The content of acid and alkali vapors in the area of premises where meter components are installed must be within the sanitary norms and rules.

In mounting the FMS in the open air, it is recommended to provide protection from direct contact of ultrasonic flow sensors with precipitations (canopy).

Installation of standard FMSs (without waterproofing of FS) in with possible short time flooding is permissible when the following means for protection of FMS and Paula supply cables are applied:

– Cables must be laid in protective sealed pipes resistant to the influence of environment (including high temperature);

– Places of protective pipes and ultrasonic flow sensors or RTD connection must be protected from contact with water by applying ceiling couplings, profiled sealing components or other means recommended by the manufacturers of protecting pipes.

9.4 Requirements to the place of installation and arrangement of FMSs

FMS shall be fitted into the gap of the pipeline.

The place of the FMS installation must be located as far from the source of vibration, physical shocks, electromagnetic interferences (electric motors, pumps, compressors, etc.) as possible. The line the FMS is to be fitted must be protected from effect of electric current to the protective grounding circuit.

The distance between the flow metering section and the place of the calculator installation must be minimal and should not exceed 100 m.

In any case, the FMS must be located within the area of the pipeline used to fill it up with water, as when the water is not available, meter stops operation and an error message is displayed (see Section 13 of the OI).

Flow metering sections can be mounted vertically, but, in this case heat transfer liquid must be supplied from below to provide for the filling of the FMS with water.

In operating the heat meter in conditions, when it is possible that the FMS is not completely filled with heat transfer liquid due to interruptions in the heat transfer liquid supply or when contaminated heat transfer liquid (detached scum, rust, etc.) is used, it is preferable to applying the variant of the FMS arrangement that depicted in Figure 9.1. In this case, complete filling of the FMS with water is guaranteed and the pipeline section, which is mostly effected by contaminations, is located below the FMS.

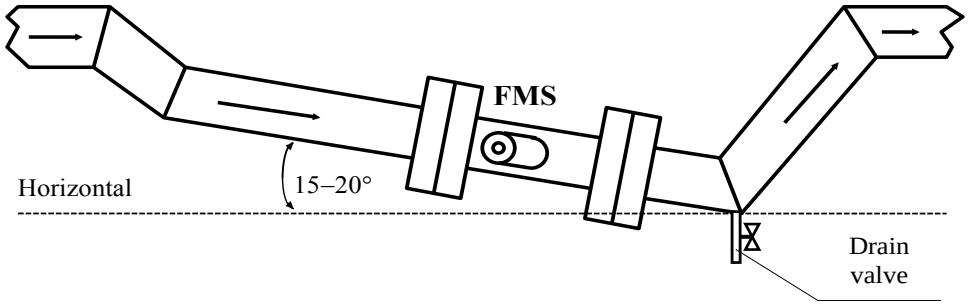


Figure 9.1

To remove remains of the heat transfer liquid from the lower section of the pipeline, the pipeline design must provide for the drain valve as it is depicted in Figure 9.1.

In installing the FMS, the below requirements must be complied with:

Section of the pipeline intended for fitting the FMS must be located in the horizontal plane (deviation from the horizontal should be within the limits of ± 20 °).

Bushings of flow meters should be also located in the horizontal plane with deviation from the horizontal not exceeding ± 20 °.

Maximum lengths of straight sections of the pipeline from the perturbing factor to the FMS must be not less than:

Table 9.1

Flow perturbing factor type	Modification M2	Modification M1		
		DN < 200	DN ≥ 200**	
			1 beam	2 beams
Taper with angle not more than 20 °	7 DN	10 DN	15 DN	10 DN
90 ° bend	10 DN	15 DN	50 DN	15 DN
Gates or two pipeline 90 ° bends in perpendicular planes	15 DN	20 DN	70 DN	20 DN
Pump	20 DN	30 DN	90 DN	30 DN

Notes:

* Full-opening ball valve used as the stop valve (not adjusting) shall not be classified as the "gate valve".

** Designations «1 beam» and «2 beams» mean the FMS design is based on one beam and two measuring beams, respectively.

Length of the rectangular pipeline section between two consecutive local resistances in front of the FMS must be not shorter than 5 DN. Otherwise, the straight section in front of the FMS must be increased to the length equal to the difference (in millimeters) between required and the actual distance between the local resistances.

Length of straight sections in front of and after the FMS-20, when tapers with angle not more than 20° are used, must be not less than 60 mm long, and in this case it is permissible to weld the special delivered branch directly to the taper.

All other requirements to length of straight sections, for FMS-20, may be reduced twice.

Length of the pipeline straight section at the output of the FMS must be not less than 5 DN for modification M2 and 10 DN – for modification M1 for the FMS with one chord and 5 DN for the FMS with two chords.

For delivery variants 10…12, for return line FMSs, length of straight sections in front of and after FMS must meet the requirements to straight sections at the input of the FMS. This is necessary when the flow in the return line may change direction depending on the mode of heating system operation.

If DN of the supply line and DN of the straight sections differ, application of tapers is compulsory.

Length of the pipeline straight section from the taper to the FMS must comply with requirements to all DN flow metering sections.

To calculate the minimum length of the pipeline straight section, the numerical value of DN in mm for the appropriate standard dimensions of FMS (DN 32 – 32 mm, DN 50 – 50 mm, etc.) must be applied.

It is not permissible to install control valves or straight sections in front of the FMS.

Internal diameter of the straight section or the pipeline used to perform its function must differ by not more than ± 5 % of:

– Numerical value of DN in mm for FMS-20, FMS-32, FMS-50, FMS-65, FMS-80, FMS-100;

– Actual diameter of the FMS given in Section 17 “Parameters and specifications of the meter components” for FMS-125…FMS-1000.

For modification M1, it is permissible for the internal diameter of the straight section to differ by not more than + 5 % (negative deviation is not permissible).

9.5 Procedure for installation and mounting the meter components

Warning!
In laying cables, it is STRONGLY forbidden to reply efforts to connectors.

9.5.1 Procedure for installation and mounting of the FMS

9.5.1.1 FMS is fitted in to line gap.

9.5.1.2 The FMS-20 and FMS-32 delivery set includes special branch pipes that can give welded to the straight sections of the pipeline.

All on the standard dimensions of FMSs for the straight sections are delivered under agreement with the customer.

Branch pipe with a coupling nut being part of the delivery set for FMS-20 and FMS-32, is part of the straight section that is used for the consecutive welding of the pipeline, or section of the pipeline that is joined to the branch pipe to obtain the required length of the straight section.

The axis of a branch pipe and straight section should be a uniform coaxial line without significant jogs and bends. Transition ‘jump’ from a branch pipe to a pipe should not exceed 0.5 mm (± 2.5%) for FMS-20 and 0.8 mm (± 2.5%) for FMS-32

9.5.1.3 In mounting FMSs, the delivered gaskets must be used. It is strongly forbidden to use self-made and rubber gaskets.

9.5.1.4 In mounting FMS-20 (connection of the FMS to brancg pipes with coupling nuts), it is necessary to fix the FMS position (to prevent it from turning) by applying the wrench S = 30 mm used for special FMS surfaces. Location of such services is depicted in the figure in Appendix П

It is strictly forbidden to use other components of the FMS to prevent если FMS from rotating (PS connectors, FS body, faces with marking).

To tighten coupling nuts, it is necessary to apply wrench S = 41 mm.

9.5.1.5 In case of the flange-mounted FMS, internal diameter of flanges, if necessary, shall be reamed to the outside diameter of the pipe with minimum possible tolerance. Example of flange welding is given in Figure 9.2 and Figure 9.3.

Pipeline flanges must be installed without formation of flowed metal on the internal surface of the pipe. Otherwise, the variations in the fluid flow rate may cause additional error in meter readings.

After mounting the FMS on the pipeline, it is recommended to coat flanges with paint.

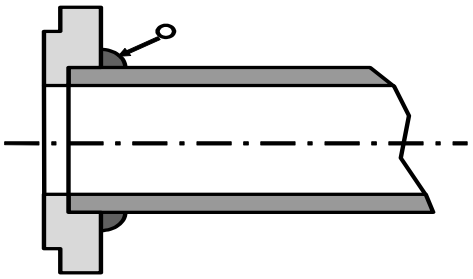


Figure 9.2

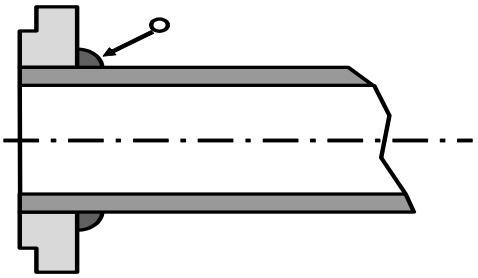


Figure 9.3

WARNING!

It is strongly recommended to avoid welding of flanges to pipelines when the FMS is installed as it may result in deformation of the FMS caused by overheating.

9.5.1.6 Pressure loss within the flow metering sections

The amount of pressure loss within the flow metering section at maximum flow Qmax does not exceed 0.085 kgf/cm^2 (for all standard dimensions of FMSs not specified separately).

For FMS-20, pressure losses in kgf/cm^2 are indicated on the curve (see Figure 9.4).

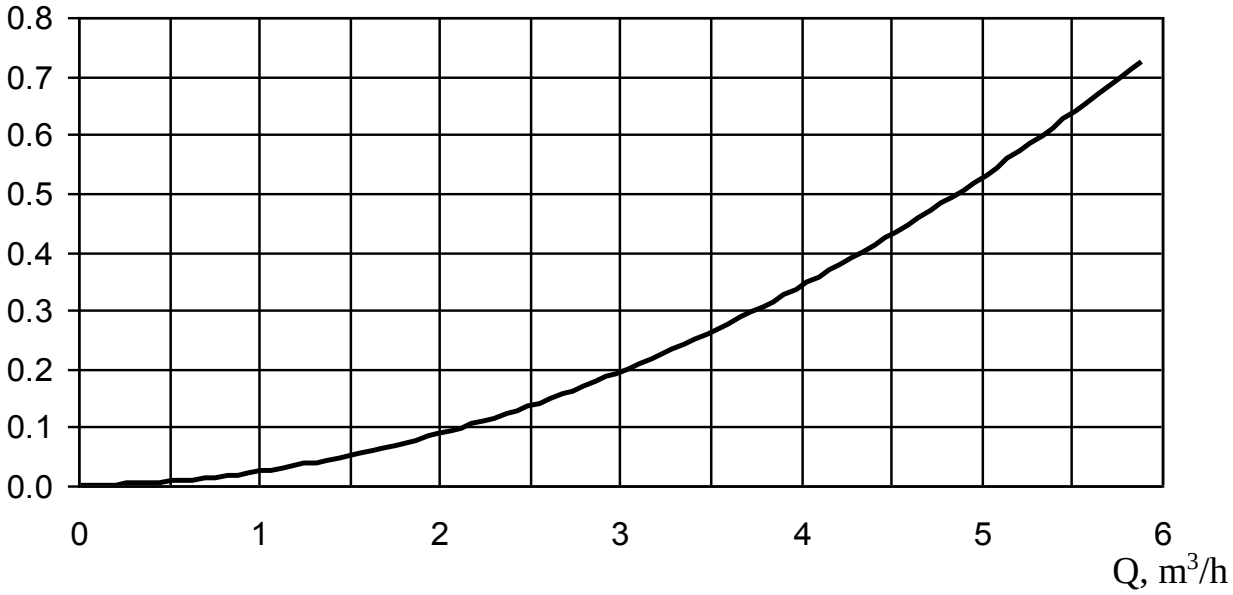


Figure 9.4

For FMS-32 pressure loss (with straight sections DN 32), in kgf/cm2, are indicated on the curve (see Figure 9.5).

Curve 2 depicts pressure loss directly on the FMS-32 (when mounted on DN 32 pipe). Curve 1 – pressure loss on the FMS, straight sections and tapers with angle 10° in mounting FMS-32 on DN 50 pipes).

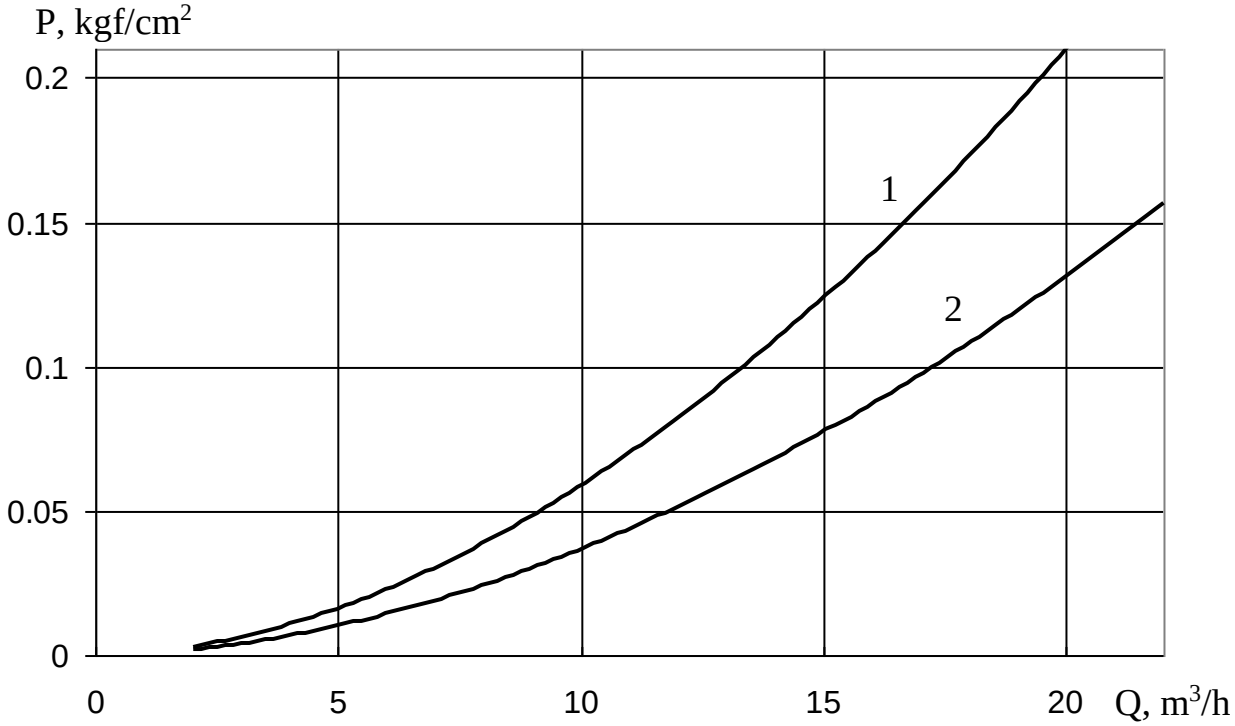


Figure 9.5

For FMS-50, pressure losses are indicated in Figure 9.6.

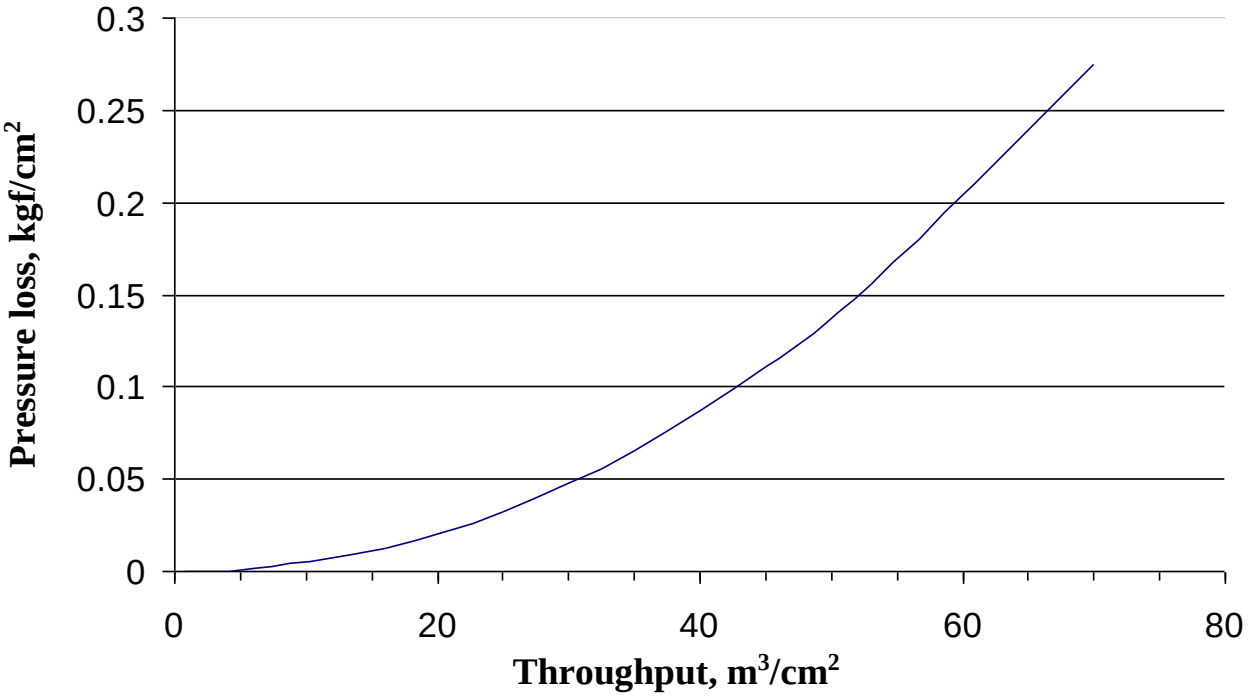


Figure 9.6

9.4.2 Procedure for installation of flow meters

9.4.2.1 The below procedure for installation of flow meters FS is applicable to FMS family with DN from 32 to 1000.

FMS-20 is delivered with the installed and sealed flow sensors that can be dismantled at the manufacturer's place only.

9.4.2.2 After mounting the FMS on the pipeline, it is necessary to install ultrasonic flow sensors as follows:

– If necessary, remove dirt and contaminations from the internal surfaces of bushings;

– To prevent fixing nuts and flow meters material from diffusion with the FMS materials, lubricate the bushing threads and the lateral cylindrical surface of ultrasonic flow sensors with these graphite containing lubricant, R–113 or CIATIM–221;

– Working surface of FS (butt end) must be free from lubricant;

– Install ultrasonic flow sensors into the bushings (pockets) of the flow metering section. Marking is applied on cable outputs for the delivered sensors of meters modification **M1***. This being the case, the FS with marking "11" (or "21" for the second flow measuring channel) must be inserted into the branch pipe of the FMS located **first downstream heat transfer liquid** (water), the FS with marking "12" (or "22" for the second flow measuring channel) into the second branch pipe of the FMS**.

In connecting FS used in the double-beam FMS, one should be guided by instructions given in Table 9.5

– In tightening the FS nut, the torque applied to the wrench must be equal to 40…45 N·m, and provide for the «zero» gap between the mounting surface of the FMS and the ring plane of the FS outside its sealing gasket. For FS fitted on FMS-32, the torque must be equal to 18…20 N·m.

* There may be no any marking on cable output of sensors delivered with meters modification **M2**.

** This instruction is compulsory for modification **M1** meters only.

WARNING!

Ultrasonic flow sensors contain piezoceramic elements and thin-walled design elements, which have the increased fragility and do not permit shock and excessive compressing loads.

Considering the above-mentioned,

IT IS FORBIDDEN TO:

– To change places of flow meters intended for different channel;

– To install sensors with marking "11" ("21") intended for installation on the first branch pipe of the FMS (downstream) on the second branch pipe, and sensors with marking "12" ("22") must be installed on the first branch pipe of the FMS (this instruction is compulsory for meters of **M1** modification).

– In transporting and mounting, to drop ultrasonic flow sensors or knock them;

– To install and dismantle FMS with installed ultrasonic flow sensors (except for cases when the FMS is delivered with installed FS);

– To carry out welding or fitter's works on the line near the FMS with installed ultrasonic flow sensors (except for cases, when the FMS is delivered with installed FS);

– To exceed the above mentioned torque for FMS tightening;

– To dismount flow sensors stuck to the FMS, while accomplishing current and regular servicing.

9.4.2.3 To remove the flow sensor, its design provides for special elements. The manufacturer has developed and can propose, against order, special removers or a complete set of design documentation for their manufacture:

- For FS DN 32…80 – puller SMP. 296454.004;
- For FS DN 100...1000 – puller SMP.296454.001.

Arrangement of flow meters soldered connections and pin connections is given in Appendix M.

9.4.3 Procedure for installation of temperature sensors

Platinum resistive temperature detectors manufactured by SEMPAL RTD-S may be installed into the pipeline by applying two variants:

- By screwing them down into the bushings (lugs) of the first type welded into the pipeline for direct contact of RTD with heat transfer liquid;
- By screwing them down into thermal pockets, which, in turn, are screwed into the bushings (lugs) of the second type welded to the pipeline for making contact with water through the protective thermal pocket.

In selecting the method of the RTD installation on the pipeline, it is necessary to take into account the fact that to provide for maximum accuracy of temperature measurement the sensitive element of the RTD must be placed as close to the pipeline axis as possible. Three types of RTD of 58, 80, 150 mm (type 4, 2, and 3, respectively) are provided for and variants of their angular installation to meet the specified requirement to the RTD installation on pipelines with various diameters. Inclination angle and the depth of the RTD setting is provided by the use of bushings (lugs), the design of which depends on the pipeline DN. Variants of the RTD installation are given in Table 9.2 and Figure 9.7. Variants of the RTD installation in thermal pockets are given in Figures 9.8 and 9.9.

Warning! In applying the lugs to obtain the inclination angle of 45 or 60 °, arrangement of lugs and inside the pipeline must provide for the flows of the heat transfer liquid contact with the lower section of the RTD where thermal sensing element is located, that is: the RTD must be inclined so that the lower section was meeting the flow first.

The installation place for each RTD included into the delivery set is determined by the meter scheme for installation (see Appendix C). The RTD that measures water temperature should be installed close to the FMS. The distance between the RTD and the calculator should not exceed 100 m.

The RTD can be installed on the upstream or downstream sections of FMS, but installation on the downstream section is preferable. In installing the RTD behind FMS, the distance between the bushing and the FMS must be not less than 5 DN and in installing in front of the FMS - not less than 10 DN.

After the bushing is welded, it is necessary to work its thread by a M10x1.5 or M16x1.5 tap (depending on the bushing type).

While installing the RTD with inclination 45° or 60°, it is necessary to drill a 10-mm hole (16 mm for a thermal pocket) and to ream it up to the required oval depending on the pipe wall thickness (see figure 9.7).

The sealing face of the bushing should be protected from splashes of fused metal.

Prior to inserting the sealing gasket (fluoroplastic ring), the sealing surface of the bushing should be lubricated with CIATIM 221.

In screwing the RTD into the bush, the force applied to a 200-mm long wrench should no exceed 5 kg to get the required hermetic sealing. Deformation of the fluoroplastic gasket in the gap between sealing surfaces of the RTD and the bushing is not permissible.

After the RTD is finally fitted in the pipeline, the bushing and the metal section of the RTD must be insulated to protect from environment influence.

Before screwing the RTD down into the thermal pocket it is necessary to make sure that the thermal pocket is clean and to fill it with high-temperature silicon lubricant of any type to 1/8 of its volume.

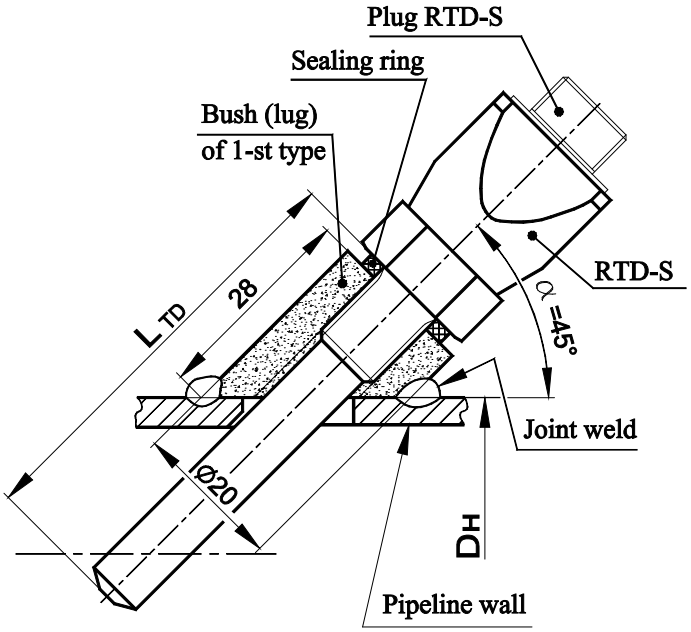
Table 9.2

DN, mm	**Configuration of RTD, nominal length (L_{TD}, mm), type**	**Configuration variants for bushings of first type (internal thread of bushings is M10x1.5)**		**Angle of inclination**
		Designation	**Marking**	
32	SMP.405212.001-03 L_{RTD}=58; type 4	SMP.723144.007	1	45°
50		SMP.723144.008	2	60°
65		SMP.723144.009	3	90°
80				
100	SMP.405212.001-01 L_{RTD}=80; type 2			
125				
150	SMP.405212.001-02 L_{RTD}=150; type 3	SMP.723144.007	1	45°
200		SMP.723144.008	2	60°
≥250		SMP.723144.009	3	90°

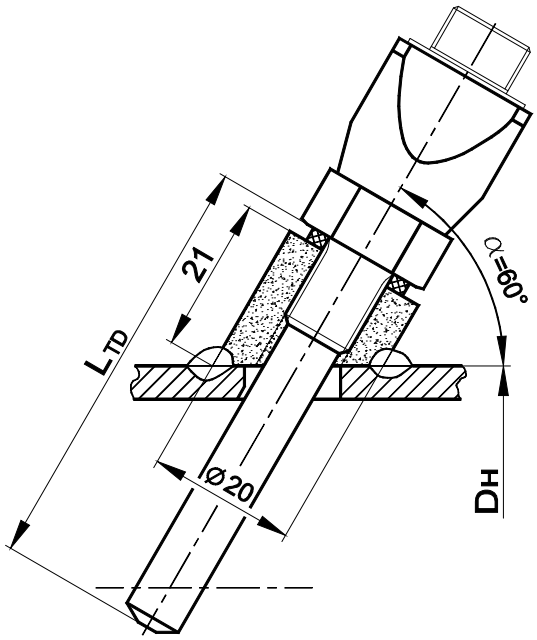
Table 9.3

DN, mm	**Configuration of thermal pocket, nominal length (L_{TP}), mm; nominal length of RTD (L_{TD}), mm**	**Configuration variants for bushings of second type (internal thread of bushings is M16x1.5)**		**Angle of inclination**
		Designation	**Marking**	
50	SMP.753137.002-03 (type 4) L_{TR}=56; L_{RTD}=58	SMP.723144.008-01	5	60°
65		SMP.723144.009-01	6	90°
80				
100	SMP.753137.002-01 (type 2) L_{TR}=78.5; L_{RTD}=80			
125				
150	SMP.302634.002 (type 3) L_{TR}=148; L_{RTD}=150	SMP.723144.007-01	4	45°
200		SMP.723144.008-01	5	60°
≥250		SMP.723144.009-01	6	90°
500	SMP.302634.004 (type 5) L_{TR}=303; L_{RTD}=310	SMP.723144.010 SMP	–	90°
600	SMP.302634.004-01 (type 6) L_{TR}=353; L_{RTD}=360		–	90°

RTDs of types 5 and 6 are fitted into the protection pocket only.

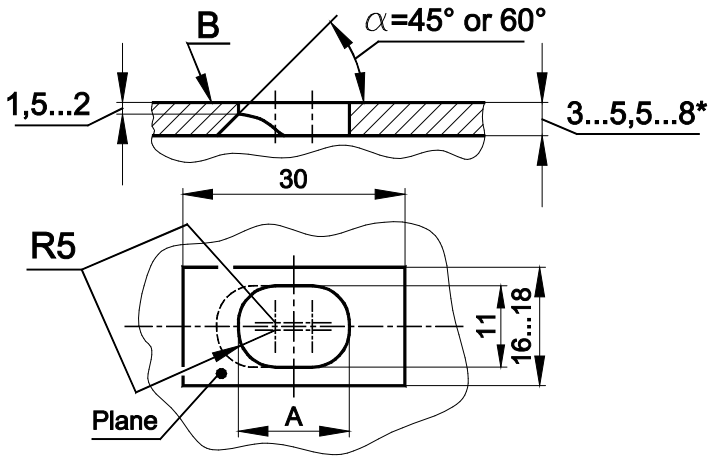


DN-32; DN-40; DN-150



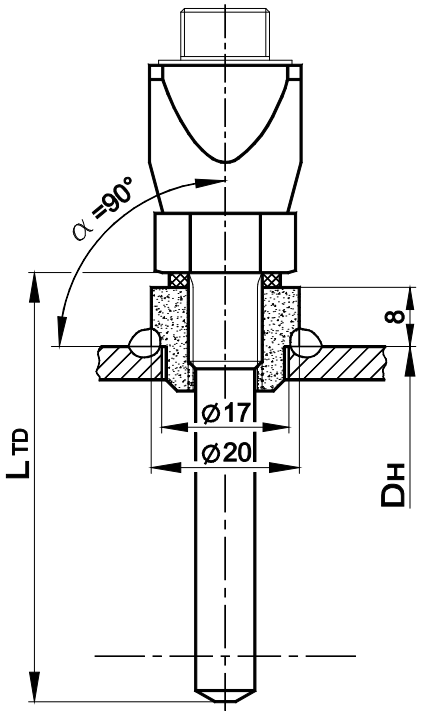
DN-50; DN-200

Marking and hole dimensions
for mounting of RTD-S with angle 45° or 60°



Angle α	A, mm
45°	15
60°	13

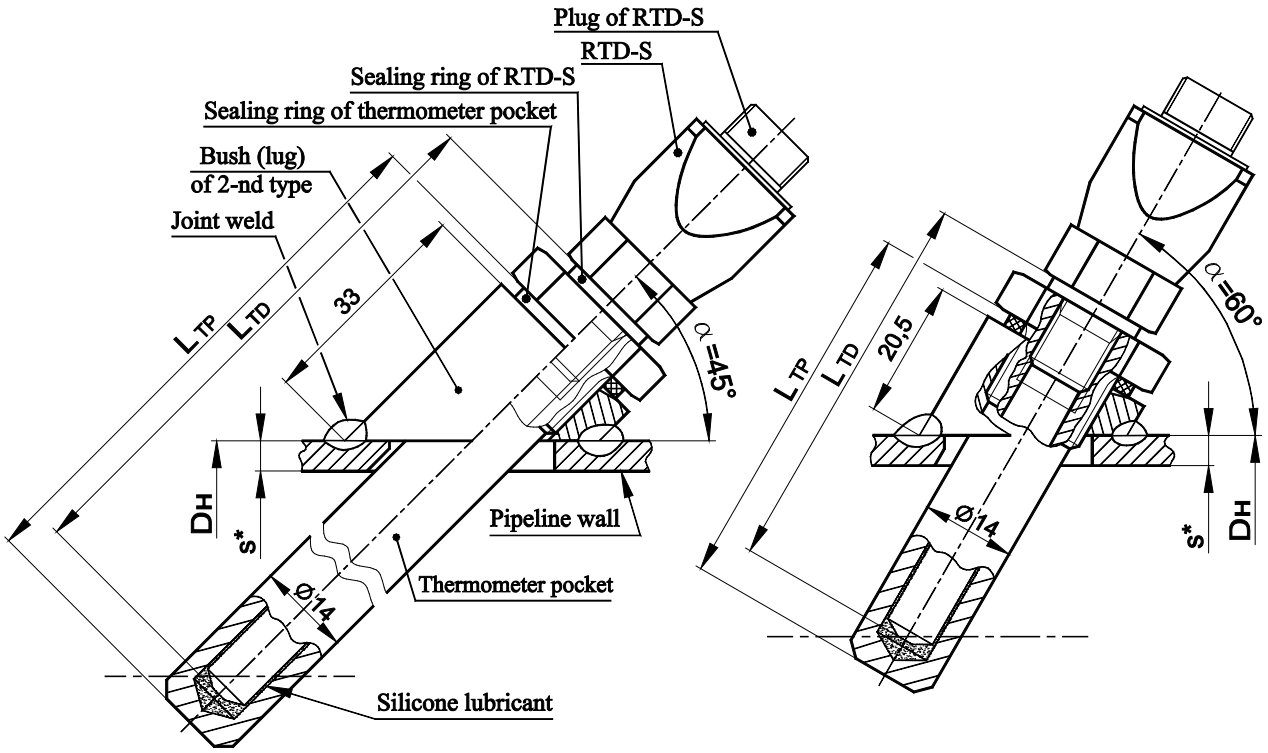
It is recommended to notch the plane
for bush of RTD-S for all variants
of installation on the sufrace B



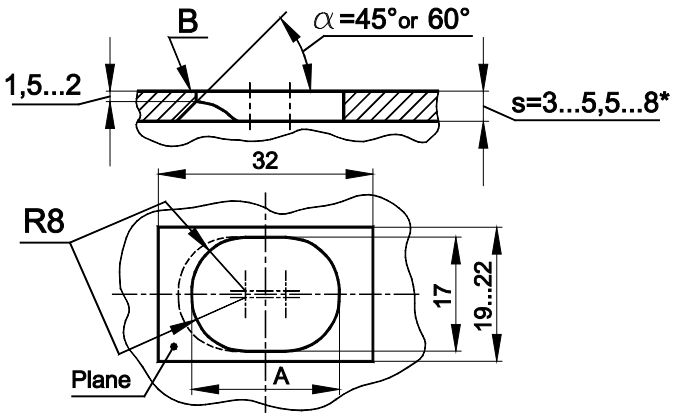
DN-65...125; DN-250...

Notices. 1. For pipelines DN-32...DN-150 position of thermo-sensitive element RTD-S is optimised relatively water and gas pipelines.
2. It is necessary to mount a reamer at installation of RTD-S on pipelines with nominal diameter under DN-32.

Figure 9.7 Installation of RTD-S Of types 2, 3 and 4 without protection sleeve

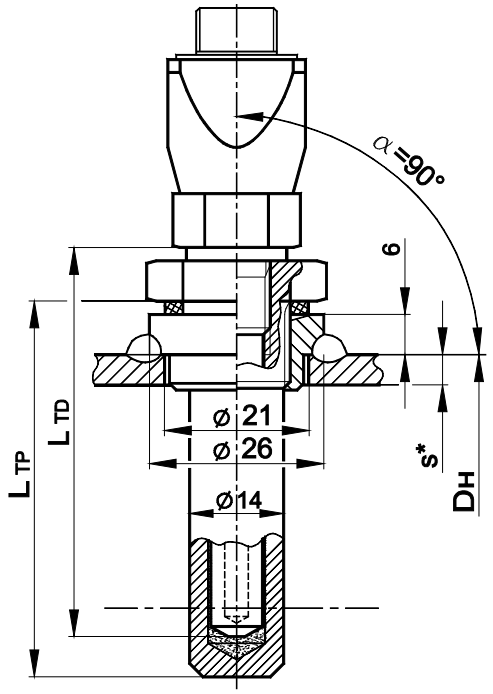


Marking and hole dimensions
for mounting of thermometer pocket for RTD-S
with angle 45° or 60°



Angle α	A, mm
45°	25
60°	22

It is recommended to notch the plane
for bush of thermometer pocket for all variants
of installation on the sufrace B



DN-65...125; DN-250...

Notices.

1. For pipelines DN-32...DN-150 position of thermo-sensitive element RTD-S is optimised relatively water and gas pipelines.
2. It is necessary to mount a reamer at installation of RTD-S on pipelines with nominal diameter under DN-50.

Figure 9.8 Installation of RTD-S of types 2, 3 and 4 with protection pocket

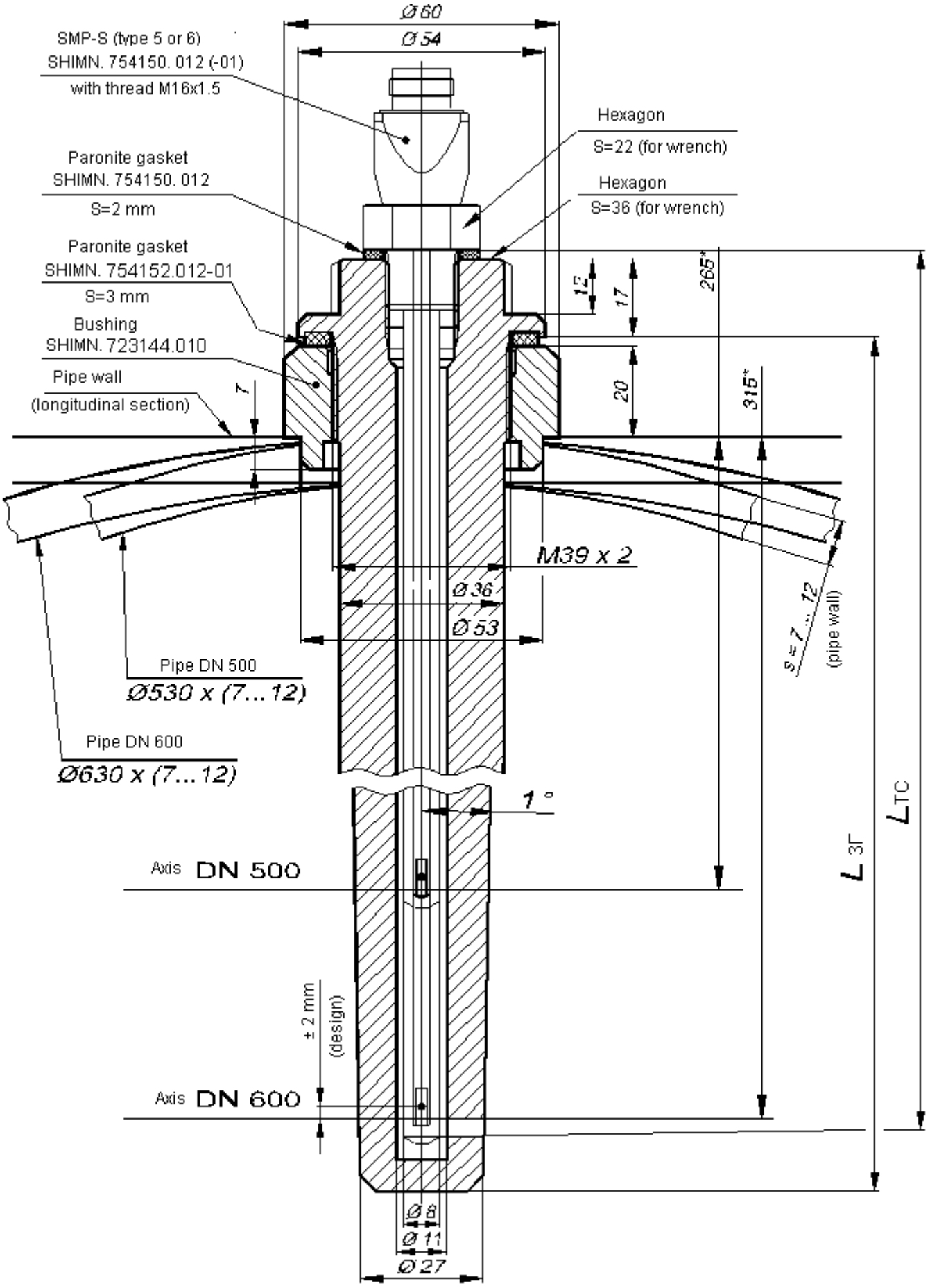


Figure 9.9 Installation of RTD-S types 5 and 6 with protective sleeve

9.4.4 Procedure for installation of pressure transducers

Pressure transducers shall be installed strictly in the vertical position. The scheme for installation of pressure transducers is given in Appendix H.

The use of taps is compulsory!

Requirements to the place of taps connection to the pipeline of the same as requirements to the place of RTD bushing welding (subclause 9.4.3).

9.4.5 Installation of the calculator

Calculator SMP.408843.003 can be mounted in the horizontal position (on the table, on the stand or on a special shelf) or vertically (on the wall or instrument board).

To install the calculator, use two angles (part of the delivered set) and brackets on the calculator side walls. Dimensions for layout work to mount angles are indicated in Appendix D.

The calculator ground contact is connected to the three-pole plug and must ensure reliable contact with the grounding circuit on the premises the device is mounted in.

9.4.6 Gasket and connection of cables

After installation of all meter components they must be connected by applying cables delivered with the device as follows:

1)Laying of cables;

2)Connection of cables to the calculator, the RTD and ultrasonic flow sensors.

Laying of cables shall be carried out by taking into account the below requirements:

– cable fastening elements must exclude the possibility of their contact with the pipelines and other elements of the construction that have temperature below minus 40 °C or exceeding 70 °C;

– Measures should be taken to protect cables from mechanical damage by laying them in pipes, hoses, boxes, etc. It is permissible to a cables intended for the same meter in one protection construction;

– In mounting two and more meters act of one heat consuming facility laying of cables to each of them must be carried out in separate protection constructions separated by not less than 5 cm to prevent any mutual electromagnetic interferences effects.

– After the cables had been laid, they must be connected to the meter components by taking into account the cables marking.

Excessive cable length must be carefully rolled and allocated in the device enclosure or nearby.

WARNING!

- **It is forbidden to lay cables along power supply lines or their protective constructions.**
- **In the event the meter is energized from the power supply network of 24 or 36 V, measures should be provided to exclude the calculator or sockets connection to 220 V - for example, 220 V sockets must be located at a distance that exceeds the meter power supply cable length.**

Connection of the cable and its components to the calculator and to all sensors must be carried out as follows:

In defining 'switch' positions on connectors of the connected units and elements of the cable, **plug connectors carefully without appreciable effort and avoiding mutual rotation of the components being joined**; the **sleeve nut should be tightened last** to prevent possible crumpling (bending, breaking) of the connector contact parts (pins) at partial lengthwise coupling.

In connecting sensors to cable connectors one should strictly comply with the marking applied on the label attached to cables and cable lugs of flow meters.

Table 9.4 provides information on compliance of communication lines marking with marking of flow meter cable lugs connected to them for meters with single-beam FMSs.

Table 9.4

Cable application (connected unit)	Marking on the cable	Marking on cable lugs of flow meters main (standby) and their arrangement with regard to the flow			
		For modification M1		For modification M2	
		Marking	Arrangement	Marking	Arrangement
FS1 of channel 1	A11	11 (11p)	first downstream	11 (11p)	without any reference to the flow
FS2 of channel 1	A12	12 (12p)	second downstream	11 (11p)	
FS1 of channel 2 (FS3)	A21	21 (21p)	first downstream	22 (22p)	
FS2 of channel 2 (FS4)	A22	22 (22p)	second downstream	22 (22p)	

Table 9.5 provides information on compliance of communication lines marking with marking of flow meter cable lugs connected to them for meters with double-beam FMSs.

Table 9.5

Cable application (connected unit)	Marking on the cable	Marking on cable lugs of flow meters and marking of branch pipes (bushings) of the double-beam FMS for installation of FS	
		Marking on the sensor, Main (standby)	Marking of branch pipe, Main (standby)
FS1 beam 1	A11	11 (11p)	1 (5)
FS2 beam 1	A12	12 (12p)	2 (6)
FS 1 beams 2 (FS3)	A21	21 (21p)	3 (7)
FS 2 beams 2 (FS4)	A22	22 (22p)	4 (8)

Table 9.6 provides information on marking of communication lines in the cable intended for connection to temperature sensors, pressure transducers and external devices.

Table 9.6

Cable application (connected unit)	Marking on the cable	Cable application (connected unit)	Marking on the cable
TS1	B1	RS232 interface	D1
TS2	B2	USB Host	D5
TS3	B3	RS485 interface	D3
TS4	B4		
TS5	B5		

In ordering one of the following cables:

- Impulse inputs;
- Impulse outputs;
- Cable to the PT;

– Linear and/or switching outputs

the switching unit containing terminals for connection of the above cables is added to the main devise cable. The specified cables are delivered in the form of not interconnected conductors with the prepared ends.

Table 9.7 provides information on the designation of cables connected to the switching unit.

Table 9.7

Cable application (connected unit)	Marking on the cable	Cable application (connected unit)	Marking on the cable
PT1	F11	Linear output 1	F41
PT2	F12	Linear output 1	F42
Impulse outputs	F2	Switching output 1	F51
Impulse input 1	F31	Switching output 2	F52
Impulse input 2	F32		

Structural and principal diagrams of the meter cable are given in Appendix L.

The calculator must be connected to the power supply network via three-pole socket.

After the meter is put in operation, as well as in the course of repairs, checks and readjustments, representative of the organization that is carried out specialized operations must enter comments in Table Section 19 “Information on putting into operation, repairs, checks, readjustments”.

WARNING! IT IS FORBIDDEN:

1 To break the procedure of cable connection according to marking given in tables 9.4 – 9.6.

2 To swap RTD of temperature sensors TS1, TS2, TS3 (see the Appendix B) and pressure sensors PT1 and PT2.

3 To increase or shorten the length of cables to ultrasonic flow sensors FMS.

4 To apply FMS, RTD, ultrasonic flow sensors FMS and calculators from different delivery sets.

5 Cable twisting, kinking and sharp bends is not permitted while connecting to FMS

WARNING!!!

If it was required to make welding in the process of the device commissioning, the meter should be switched off and device cable should be disconnected from the calculator enclosure. Otherwise, the meter can be damaged.

10 Preparation for operation

10.1 Each calculation channels has three metering modes – «No registration», «Register», «Stop».

«No registration» mode is preset. In this mode, the meter measures all parameters and stores information. It is possible to adjust the hydraulic zero, to measure the device parameters required for operation. The fact that a certain channel is in a certain mode can be determined by the message periodically displayed on the indicator «**Channel x no registration**» from time to time displayed on the screen indicates that the channel concerned is not registering.

«Register» mode - the main mode of the device operation after its commissioning. The word "commissioning" in this text means that each calculation channels is in «Register» mode. In switching the channel from the «No registration» mode to the «Register» mode, all archived and accumulated data from this channel are reset (apart from of meters menu and logbook events), and it is impossible to change any meter parameters. When the meter in this mode, no any additional messages are displayed.

«Stop» Mode is intended for temporary suspension of the metering process with regard to the chosen channel. For example, when repairs are being performed on the drain valve or in summertime. In this mode, metering of all parameters and display of metering errors concerning the chosen channel is suspended. The stored data are preserved. The archive is supplemented with zero values when the channel is in this mode. Switching from this mode to the «Register» mode initiate the process of parameters measurements and archiving. No reset of accumulated data and deletion of archives occur.

To change the meter parameters, it is necessary that both channel are in «No registration» mode.

Switching of metering modes is done in the «Setup» mode.

10.2 Prior to connecting the calculated to the power supply circuit, it is necessary to make sure that the supply voltage specified on the calculator plate response to the supply voltage.

10.3 When meters are operated together with additional devices, such devices must be connected to meters. In connecting meters to any related equipment one should be guided by instructions on the relevant operating documentation.

10.4 Connect the power supply cable to the three-pole socket.

10.5 To get skills of the meter operation after its purchase (prior to installation at the facility) and to check the device operation ability together with ultrasonic flow sensors, it is recommended:

1) To assemble the flow metering section with a 1-2-mm thick rubber or paronite gasket and process plug at the end, to set its into the vertical position, to install flow sensors and fill the FMS with water.

2) To check all items of the **«Display of basic parameters»** mode, all items of the **«Check»** mode, and zero must be set in the **«Setup»** mode to enable correct repetition of this operation while installing the meter on the pipeline. Description of operating modes is given in Section 11 “Operation procedure”.

10.6 **In mounting the meter of the pipeline,** fill the pipeline with the fitted FMS with water. Start passing the heat transfer liquid (water) through the FMS at the maximum possible flow rate for minutes. Make sure that there is no leaks at places of installation of the meter components on the pipeline and no error displays on the calculator display. This list of such messages is given in Section 13 “Typical faults and methods of their elimination”.

10.7 Perform the below operations in the **«Setup»** mode.
Procedure for entering the password to enter the **«Setup»** mode is described in subclause 11.2.4, procedure for the use of menu in the **«Setup»** mode is described in Appendix E.
In the **«Setup»** mode:

- Set hydraulic zero for the channel measuring volume;
- Entered the value of cold water temperature into the calculator (only for variants 4, 10, and 12);

– Set the required units of measurements;
– Set the required archiving format for the volume of the heat transfer liquid (water);
– Enter the value of the heat transfer liquid pressure in the supply and return lines;
– Reset all integral parameters of the meter.
– Warning!

Hydraulic zero setting must be done for all FMSs with DN less then 400 mm. For FMSs with DN = 400 mm and large, setting of hydraulic zero is not required. **For the FMSs with nominal diameter exceeding 400 mm, in connecting cables to flow sensors, it is necessary to strictly comply with the marking applied on the TS and on the relevant cable.**

For setting hydraulic zero, it is necessary to perform the following operations:

– Setting of zero must be carried out not earlier than in 30 minutes after the meter is turned on.

– Stop the flow of the heat transfer liquid (water), and this being the case, the FMS must remain completely filled with the transfer liquid (water).

– Set hydraulic zero in compliance with items of the «Setup» menu.

Failure to set or incorrect setting of flow zero, the measurement error may be increased and may attain the value exceeding the permissible one. Restating of the meeting displays is blocked, if no setting of hydraulic zero was performed. Detailed description of hydraulic zero setting is given in Appendix P **"Instructions on hydraulic zero setting".**

If, in the process of the meter commissioning, displays were not preset, the warning message will it appear all the time.

After completion of the above operations meters are ready for operation and are in the **«Display of basic parameters»** mode. The meter indicator displays values of temperature measured by two temperature sensors (TS1 and TS2).

10.8 To turn the meter off, it is necessary to disconnect the 3-pole plug from the socket.

WARNING!

– In the process of meters operation (for commercial metering of the heat transfer liquid) it is forbidden to disconnect sensors, changing their position (to prevent unauthorized actions, **mechanical sealing off connections to all** TS, TS and PT is provided for), to disconnect the calculator from the power supply, to operate meters on lines with incompletely (partially) filled FMSs or on lines used for the supply of the heat transfer liquid in the form of steam. All above cases (except for disconnection of meters from the power supply) the heat meter will register the time of incorrect operation that will be subtracted from the time of the heat transfer liquid metering. Period of time, during which power supply was not available (off time) is not included into the time of incorrect meter operation and is displayed in the **«Display of additional parameters» mode**.

– In the non-heating season, when no heat transfer liquid is consumed, it is recommended to fill the FMS with water or drain it and perform TM1. The calculation channel, in both cases, must be in the «Stop» mode.

– Formation of scum and the position of sediments on internal walls of the FMS reduces the actual diameter of the FMS with the resulting high displays of flow water and heat consumption. That is why, in operating the meter, once in two years, it is recommended to perform technical maintenance of meters (see Section 12 **"Technical maintenance"**).

– In the course of each operation cycle (1 – 2 sec) the heat meter performs diagnostics of technical condition with regard to several criteria. In the event of any fault in the measuring unit, breaking of flow or temperature meters cable, absence of the heat transfer liquid, etc., integral parameters (volume and weight of the heat transfer liquid, quantity of heat and period of incorrect operation) are not collected and the error message is displayed (see Section 13 “Typical faults and methods of their elimination”).

11 Operation procedure

11.1 Requirements to the personnel

Maintenance personnel must thoroughly read these OI. Only persons who have knowledge of safety rules for operations with electrical installations shall be allowed to operate the meter.

11.2 **Meter control menu**.

Control of the meter operation (display all the required information and setting the meter operation mode and parameters) is carried out by selecting the required menu option.

Meter control menu consists of a group of information lines (menu items) that are displayed on the meter indicator.

Menu allows to get information on values of the measured heat transfer liquid parameters, parameter of the meter, as well as to check the meter and adjust its parameters based on the carried out methodological specifications control.

Selection of the menu items and adjustment (entering, setting, setup) of parameters is accomplished by pressing the meter control keys. Sequence of key application to get to the required menu item and to enter the digital value of a parameter from the list is given in Appendix E.

All measured values, parameters of the meter and the meter control commands are described in several sections – meter control **modes**.

Separate service modes («Setup», "Verification") require a password to access.

When the meter is operating in «Basic menu», «Calculator channels» and «All measured parameters» modes and non-routine events occur, the fault code is being induced on the meter display (see Section 13).

The entire menu is described in Appendix E.

11.2.1«Display of all measured parameters» mode.

After being switched on, the device transfers into the mode of displaying all measured parameters: all temperatures being measured, all measured flow rates and volumes, and measured pressure.

To transfer to other meter display or operation modes, it is necessary to get to the main menu.

The main menu is used to select displayed of each parameter of the calculation channels, all measured parameters, or to select certain additional meter modes.

11.2.2«Calculator Channel» Mode.

Depicts all parameters selected for the chosen calculation channel.

For example, for the delivery variant 2, supply temperature, return line temperature, volume throughput, mass flow, volume, mass, thermal power, heat, time of correct operation, error time, and current calendar time will be displayed.

11.2.3«Service modes» mode.

In this mode, the following items of the menu are displayed: «Check», «Setup», "Verification", adjustment of communications channels parameters, modem, expansion unit, …

11.2.3.1 «Check» Mode

«Check» Mode is intended for display of parameters to be controlled. «Check» Mode does not interrupt the process of measuring and may be used both by representatives of supervising agencies and the customer. In particular, this mode depicts meters that are being in «Setup» and "Verification" modes.

This mode is used for reviewing the meter archives and the logbook of events. Copying of information to the USB Flash is possible in this mode.

11.2.3.2 "Setup" Mode.

"Setup" Mode is used by the consumer for putting the meter into operation and is intended for setting hydraulic zero of channels measuring volume (the required initial balancing of the measuring section), entering the required parameters (pressure, cold water temperature, …), as well as f selecting the metering mode.

It should be remembered that after the meter is put in operation (the meter is in the metering mode "Register") is not possible to access the "Verification" mode. Apart from that, there is no access to such items of "Setup" menu that must not be changed when the meter is measuring.

Note. Should incorrect data are entered, such incorrect data are not stored and they indicate the depicts data that have been on the display prior to any editing operations.

11.2.3.3 "Verification" mode.

"Verification" mode is intended for assessment of measurement errors and calculation errors in a number of basic metrological parameters of the heat meter, as well as for checking correctness of the display.

"Verification" mode is used for automation of the heat meter metrological characteristics checking in the course of the periodic verification. Verification can be carried out by the manufacturer only or its authorized representative with participation of the state inspector.

11.2.3.4 'Limit prolongation' Mode.

It is intended for password entering if time limit prolongation is needed.

In this menu, a password is requested to prolong the limits for operation or for disabling this mode. Passwords are issued for a certain date and are valid for 24 hours.

This mode is accessible only, if it disabled at shipment.

11.2.4 Description of the **«Password entering» mode**.

Access to service modes **«Setup» and "Verification"** is provided only after **the relevant passwords are entered to avoid unauthorized access to** parameters stored in the calculator. The consumer is to enter a password after a relevant mode has been chosen in the menu.

The manufacturing has set the following **standard passwords for service modes** (see Table 11.5):

Table 11.1

MODE	STANDARD PASSWORD
«Setup»	25205757
"Verification"	31415926

At the customer's request, the manufacturer may set **INDIVIDUAL PASSWORDS** for service modes**,** which is **equivalent to the additional ELECTRONIC SEALING of the** calculator and **guarantees protection of collected information from on authorized persons.**

The password is represented by 8 digits must be entered to get access to one of the service modes.

Symbols «*» on the indicator mark bits for entering password digits.

Non-masked (open) value of input digit is displayed only at the digit place, in which entering of the password digits is required (editing).

While entering a password, press the button ▶ to move the cursor one digit placed to the right of the to change certain places of the password.

Pressing buttons ▲ and ▼ changes the value of the edited digit.

Pressing button ◀ – terminates entering the password.

If in 10 min no button was pressed, the meter transfers from the «Enter password» mode to «Display of basic parameters» mode.

Figure 11.2 gives an example of password entering to get access to the «Setup» mode.

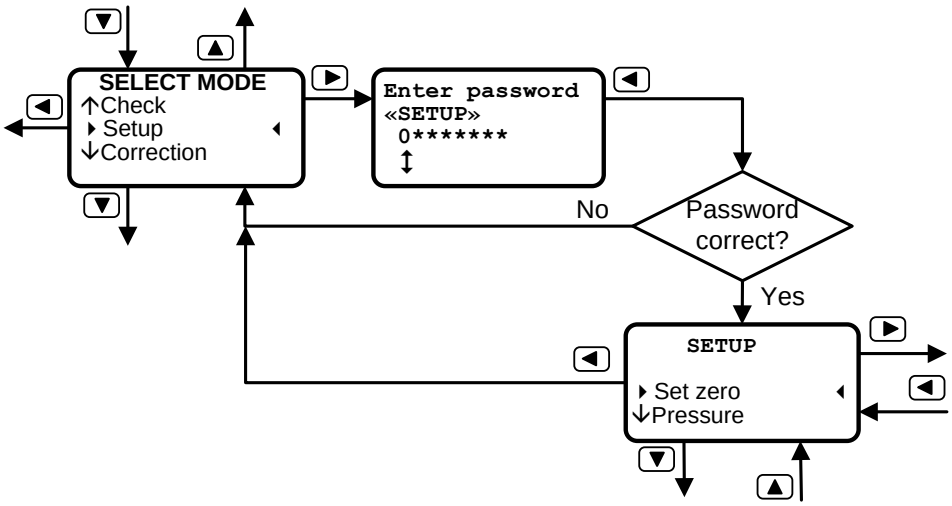


Figure 11.1

11.3 Data reading.

11.3.1Data reading from the indicate.

The main menu of the meter includes the following:

– Display of parameters used by each calculation channel: flow rates, temperature and pressure, as well as calculation channel results – current and integral parameters.

– Display of all measured initial parameters – all flow rates, temperature and pressure – current and integral parameters.

– Display of current errors (if errors are not available, the menu item is not highlighted)

– Access to service menu.

After energizing, the meter is in the mode displaying all measured parameters.

In «Check» mode, the user may review the archive (both hourly and dayly) and the logbook of events.

11.3.2Data copying to USB Flash.

If the meter has the interface for the USB Flash (depending on the order), ALL information can be copied to the USB Flash. Any USB Flash may be used, with FAT or FAT32 file system.

To copying, perform the following operations:

– Connect a USB Flash to the the relevant port;

– In «Check» menu, select “USB Flash”

– Select the data store mode – «Copy» or «Copy all».
– Wait for the message of operation completion.

«Copy» or «Copy all» modes differ, as in the first case, only that information is copied that hasn't been copied to the Flash before. The second mode is intended for copying all available information stored in the archive.

11.3.3Reading via RS232

In its basic configuration, the meter has RS232 interface, which enables connection of the computer, data reader or modem.

In connecting to the computer or data reader, the procedure is described in the operating instructions for the DR or data reader software. No additional operations with the meter require.

To work with modems, the meter must be configured. To do so, in menu «Block MDM», select the required type of modem. Modem drives can be downloaded by applying special software. If necessary, the consumer can add new or modified modem drives.

After connecting the modem, two variants of the communication channel control.

– wire modem or GSM modem in CSD mode of data transfer (hereinafter, CSD mode)
– GSM modem in GPRS mode of data transfer (hereinafter, GPRS mode).
–

In CSD mode, the meter waits for the incoming call. After that, the meter picks up the receiver and establishes the communication channel. After that, it waits incoming commands to transmit data.

In this mode, it is possible to set the time interval, during which the meter will pick up the receiver, as well as the number of ringing signals to respond. This procedure is used with wire modems connected in parallel to ordinary phone sets.

In GPRS mode, the meter communication with the server via Internet. To do so, network access parameters must be determined. Settings of GPRS (entered by applying a special software only - available free of charge on the company's site):

– Access point name GPRS – provided by the mobile network operator;
– User's name – provided by the mobile network operator;
– Password – provided by the mobile network operator;
– IP address of the server – real IP address of the computer to contact. This address is provided by the Internet provider;
– IP port of the server. This parameter depends on the server settings.

The device may communicate to provide information on the following events:

– At the request. In the event of the incoming call, the device immediately disables and initiates GPRS Channel
– By task scheduler. Periodicity of meter communications. The following time intervals are possible – once a month, once a week, once a day, or with preset interval in hours (for example, every 3 hours).

11.3.4Reading via RS485

The meter maintains two communication protocols (selected by the user from the menu) – Sempal and Modbus. In any case, the rate of data transfer (2400, 4800, 9600, 19200, 38400, 56000, 115200 baud) must be selected. In Modbus protocol, parity verification mode can be preset.

Sempal protocol is intended for connecting several meters. So, somewhat like a network can be created. In this case, it will be sufficient for only one meter to have access to the external network (modem, computer, …). Access to any network connected meter is accomplished through the main (the one with the external connection) meter.

Modbus protocol is intended for connection of meters to the Modbus network. The protocol is maintained by Modbus RTU. Options to enable reading current data and archived date of the meter are available.

12 Technical maintenance

12.1 The Instruction to the representative of inspecting service

12.1.1 The SVTU-10M heat meter is protected from both the consumer intervention, as well as intervention of the heat supply company. Any changes of the heat meter parameters can be carried out only in **'Setup' and 'Verification' service** modes. To prevent unauthorized access into the device operation and possible attempts to change any device constants (calibration factors of thermoresistor Kdl and Krc, flow rate conversion ratio, geometrical parameters of the flow metering section) that affect accuracy of measurements, the fact of login or running such modes is fixed in the **'Check'** mode. **The opportunity to check access to the specified modes** is equivalent to the mechanical sealing (i.e. it substitutes mastic seals, branded labels, etc.), so it is **an electronic way of sealing the calculator**. Therefore, special attention should be paid to the number of entries to **service** modes. Difference of this number from the recorded one at the moment of the device commissioning (acceptance certificate date) should be regarded as breaking the seal made by the supervisory company. So, the fact of intervening to the device operation should be registered through the analysis of the logbook of events. All user's actions, which resulted in the change of the device readings shall be entered into the logbook of events. If the logbook of events has a record of entering the service mode, but no records on changes in the meter parameters is available that should mean that the user logged in and immediately logged out without changing the meter parameters. In this case, no interference into the device operation on changes of its metrological specifications were done.

Device is provided with the possibility to mechanically seal the calculator block by applying sealing cups with holes in the meter enclosure sides.

12.1.2Prior to start the meter operation, it is desirable to check correctness of the following parameters settings (in addition to the metrological parameters specified in the certificate):

- System of units of measurements;
- Summertime metering;
- Entered pressure constants;
- Entered cold water temperature (if any);
- Range errors processing mode (subclause 5.12).

12.1.3The meter is put into operation after all calculation channels have been switched to the «Register» mode. After that changes in any parameters influencing the methodology will be forbidden.

12.1.4 Should any doubt arise as to correct installation or proper operation of the heat meter, it is necessary to run **'Check'** mode and to compare correctness of entered values for RTD temperature coefficients, exact diameters of FMSs, distances between flow sensor senders and the flow metering section conversion ratios with data specified in Chapter 17 'Parameters and characteristics of the meter components'. This being the case, the compared values shall not differ to the amount exceeding the dgt set forth in Chapter 17 of these OIs.

12.1.5 Difference between power on time and time of correct operation means that the heat meter has been operated incorrectly (switching-off, breakage or short circuit of the sensor cables, absence of the heat-transfer liquid, etc., See item 10.8). Therefore, sealing of flow sensors or their connectors is not compulsory. However, the heat sensing is

provided with means for mechanical sealing of heat sensors and their connectors with the use of holes in clamping nuts of FS and connectors.

12.1.6 To prevent unauthorized influence on the RTD parameters and consequently, on temperature measurement accuracy, it is necessary to mechanically seal the temperature sensor by using holes in RTD enclosure.

12.2 Technical maintenance shall be carried out by the representative of a servicing company. In performing technical maintenance it is necessary to adhere to safety measures set forth in Section 8.

12.3 Two types of the meter technical maintenance are regulated: No.1 and No.2.

12.4 **Technical maintenance No.1** shall be carried out at the place of the meter operation once in every six months and includes visual inspection and check of serviceability.
In conducting technical maintenance No.1 the following shall be checked visually:

- Absence of leaks at the place of the meter components installation on the pipeline;
- Reliability of contacts;
- Absence of chips and cracks on plastic parts;
- Integrity of connecting cables installation;
- Possibility to read measured data in compliance with subclause 11.2.1 and 11.2.3.

After the heating season is over, it is necessary to remove deposits of dirt from the flow meter surfaces by applying detergents, weak solutions of alkali or acid (without applying mechanical means of dirt removal). When the heat transfer liquid is not used for a long period of time, it is recommended to disconnect the device on the network or guarantee absence of the heat transfer liquid in the flow metering section.

12.5 **Technical maintenance No.2** of meters shall be conducted prior to conducting periodic verification of the meter.

Technical maintenance No.2 includes:

–Operations required for conducting technical maintenance No.1;

–Inspection of internal surfaces of the FMS in terms of availability of depositions;

–Should any significant depositions be discovered, the FMS must be dismantled and cleaned as per subclause 12.5.1 and dismantling and cleaning of the RTD.

Disassembly and cleaning of the FMS-20 shall be carried out at the manufacturer's place or authorize check facilities.

12.5.1 Disassembly and cleaning of the FMS to be carried out as follows:

- Dismantled ultrasonic flow sensors;
- Remove the FMS from the pipeline;
- Perform external inspection of the FMS and , if necessary, remove depositions from internal surfaces by applying mechanical means;
- Flush internal surfaces of the FMS with the solution of synthetic detergents of any type, and then with water.

12.6 Meters shall be submitted for verification after conducting technical maintenance No.2. Calibration interval – not more than 4 years. The calculator, ultrasonic TS, temperature sensors, flow metering sections are subject to verification.

Metrological verification of the meter of modification M2 it is permissible by applying flawless procedures and making use of IMP-01 flow simulator (see Table 4.1 Verification method SMP.407251.003 I2).

Flaw tests (if necessary) are allowed to conduct by applying certified reference flow metering sections for DN200 and larger.

Flaw tests of M1 modification meters that include FMSs with nominal diameter exceeding DN 100 shall be conducted by applying DN 100 certified reference flow metering sections.

13 Typical faults and methods of their elimination

In the course of their operation, the meter is constantly controlling operational ability of its components, as well as sensors connected to it (flow, temperature, etc.).

Diagnostic errors are subdivided into groups depending on their priority (significance for the normal measuring process). The smaller the number or the group the more important error is. Apart from that, error code includes its number and the number of the measuring channel the mistake occurred in.

The indicator displayed error as follows (example):

Error 1.3.1
Short-circuit in TS1

Here, 1.3.1 is an error code that denotes the group (first digit), error number (second digit) and the number of the measuring channel (third digit). In this case, the number of the measuring channel is the number of the temperature sensor. One error occupies two lines on the indicator. Therefore, two different errors may be displayed at the same time (indicator has 4 lines).

*The printed out error report, the error code is represented in somewhat changed form – points between figures are substituted by break character. Code of the above error will be represented in the printout is «***1_3_1».**

13.1 System errors.

As mentioned above, the lower the number of the error, the higher its priority. System errors which have no priorities - errors of internal meter's hardware, which generally close out operation of the meter. If such errors occur, no parameter is measured and data concerning such parameters collected. Such errors are displayed on the indicator as follows (example):

«System Error 02»

The number means the error type. If possible, the system errors are registered in the logbook of events with comments.

In case of a system error, the meter should be returned to the manufacturer for repair.

13.2 **Group «0» errors**.

This group «0» includes the following errors:

– «**0.1.0**» - Error of year flow rate measuring unit. Flow rate measurement in both channels is impossible.

– «**0.2.0**» - Error of ADC. Temperature measurement in all channels is impossible.

– «**0.3.0**» - Error of temperature detector calibration parameters.

– «**0.4.0**» - Communication in error with expansion unit. Knowing any changes in measurements or calculations. The expansion unit (if installed) does not display information on analog and switching outputs (including adjustment channels).

– «**0.5.0**» - Error of Pressure detector calibration parameters.

13.3 Group «1» errors.

This group includes errors referring to temperature measurement (sign «x» specifies the channel number):

– «**1.1.0**» - break in one or several TS from the line of TS1...TS2.

– «**1.2.0**» - break in one or several TS from the line of TS3...TS5.

– «**1.3.x**» - short-circuit TSx. The specified TS is short-circuited.

– «**1.4.x**» - Faulty TSx. Resistance on the specified TS exceeds the permissible limit.

– «**1.5.x**» - Error of TSx coefficients. Wrong coefficients have been entered for the specified TS. May occur after entering RTD liberation coefficients in the process of verification.

– «**1.6.x**» - TSx is below the permissible level. Temperature measured by the specified TS is below the permissible level (below -50 ºC).

– «**1.7.x**» - TSx exceeds the permissible level. Temperature measured by the specified TS exceeds the maximum permissible level (above +160 ºC).

If the faulty TS is used for measuring the flaw rate, then the relevant flow measuring channel is also faulty. If the TS is used for calculation of thermal energy, then thermal energy is also not calculated.

13.4 Group «3» Errors.

This group includes errors relating to measuring of flow (sign «x» indicates the channel number):

– «**3.1.x**» - measuring of FMSx. Flow measurement in the specified FMS is impossible. This error may be caused by the following:

– Faulty flow meters;

– Faulty cable of flow meters –obreak or short-circuit;

– Absence of water in the FMS.

– «**3.2.x**» - temperature of FMSx. As the TS measuring temperature in the specified FMS is faulty it is impossible to measure flow. This error indicates the error of TS measurements. This error is displayed (stored in errors archive) to point to the relation between the temperature measuring error and the error of flow measuring.

– «**3.3.x**» - it is too high in FMSx. Volume throughput in the specified FMS exceeds the maximum permissible for this type of FMS by more than 2 times.

– «**3.4.x**» - reverse flow in FMSx. Possible only for delivery variants 10, 11 and 12. Indicates that the flow direction in the specified FMS does not correspond to the established mode of metering for the HWSS.

– «**3.5.x**» -throughput in FMSx is within the range of [0.5·Qmin, Qmin]. Accumulation of data on volume and heat depends on the mode of such a situation registration (subclause 5.12). If the mode of interpretation is set as an error, then accumulation of data concerning volume and heat is suspended.

– «**3.6.x**» -throughput in FMSx exceeds Qmax. Accumulation of data on volume and heat depends on the mode of such a situation registration (subclause 5.12). If the mode of

interpretation is set as an error, then accumulation of data concerning volume and heat is suspended

If the error occurred in the channel measuring the flow used for calculation of thermal energy, then thermal energy is not calculated.

13.5 Group «4» errors.

This group includes errors relating to calculation of thermal energy (sign «x» indicates the calculation channel number). Here, errors are analyzed with regard to temperatures required for calculation of thermal energy:

– «**4.1.x**» - tобр > tпр + 2.5 ºС. Temperature of the return pipeline exceeds the temperature of the supply pipeline by more than 2.5 ºС. Calculation of thermal energy is impossible. If the increase is within the range of 0 - 2.5 ºС, the difference of temperature is presumed to be equal to 0, and the error is not registered.

– «**4.2.x**» - tхв > tпр + 2.5 ºС. Cold water temperature exceed the temperature of the supply pipeline by more than 2.5 ºС. Calculation of thermal energy is impossible. If the increase is within the range of 0 - 2.5 ºС, the difference of temperature is presumed to be equal to 0, and the error is not registered.

– «**4.3.x**» - tхв > tобр + 2.5 ºС. Cold water temperature exceed the temperature of the return pipeline by more than 2.5 ºС. Calculation of thermal energy is impossible. If the increase is within the range of 0 - 2.5 ºС, the difference of temperature is presumed to be equal to 0, and the error is not registered

– «**4.5.x**» - error of supply pressure measuring. Registered, if measured pressure is used for calculation of heat.

– «**4.6.x**» - error of returned pressure measuring. Registered, if measured pressure is used for calculation of heat.

– «**4.7.x**» - error of cold water pressure measuring. Registered, if measured pressure is used for calculation of heat.

– «**4.8.x**» - error of makeup pressure measuring. Registered, if measured pressure is used for calculation of heat.

– «**4.9.x**» - $(t_{пр} - t_{return}) \in [0; 2.5[$ ºС. Accumulation of heat depends on the mode of this error registration (subclause 5.12).

No effect of such errors on measurements of flow and temperatures.

13.6 Group «6» errors.

This group includes pressure measuring errors (sign «x» indicates the channel number):

– «**6.1.x**» - PTx is below the limit. The measured pressure is below zero. That may be caused by facility conditions (the vacuum was created) or faulty PT.

– «**6.2.x**» - PTx is about the limit. The measured pressure exceeds 4 MPa That may be caused by increased pressure at the facility or faulty PT.

No effect of such errors on measurements of flow and heat.

The meter archives contain the value of errors duration (Terr) for the first and second calculation channels. Such value includes an error of all measuring channels that are used by the calculation channel concerned.

Apart from that, printouts formed by Sempal Device Manager software (provided by the manufacturing) has the field «Types of errors» that displays availability of this or that type of

errors. Up to four different types of errors can be displayed in the course of an hour and up to eight types of error in the course of 24 was. An error is listed in the printout only if it's duration exceeds 1 min.

Errors are designated by Latin letters. Each type of an error is assigned its letter:

A – system errors (errors of Group 0);

B – errors of temperature measuring (errors of Group 1);

C – errors of flow rate measuring (errors of Group 3);

D – errors of pressure measuring (Group 6);

E – errors of heat calculations (Group 4);

For example, record «BD» means that there were errors belonging to Group 1 and Group 2. Detailed information on such errors can be received from the error archive printout.

The error archive printout specifies the error code in the above format and its duration in hours. Up to four different errors can be registered in the course of one hour, and eight different errors – in the course of 24 hours. If the number of errors exceeds the specified amount, the most significant are archived. For example, the error in one TS may result in several others errors, and in this case, the TS error will be registered only.

List of typical faults and methods of their elimination is indicated in Table 13.1.

Table 13.1.

Fault	**Possible cause**	**Remedy**
1. No information on the indicator	Calculator power supply cable breakage or the cable is not connected to their power supply network.	Repair the cable (plug the cable in)
2. The meter is not responding to button pressing	Faulty calculator	Repair the calculator

Note: calculators shall be repaired by the specialized manufacturer's subdivision.

14. Storage

14.1. The heat meter shall be stored in heated and unheated storerooms.

Shelflife of meters:

- Inside heated storeroom - not less than 10 years;
- Inside unheated storerooms - not less than 5 years.

14.2. Meter storage conditions:

1) Inside heated storerooms:

- Surrounding air temperature - from 0 to 50 °C;
- Relative humidity of the surrounding air - up to 80 % at 30 °C and below without condensate;

2) In unheated storerooms:

- Surrounding air temperature from minus 5 °C to 50 °C;
- Relative humidity of the surrounding air - up to 95 % at 35 °C below without condensate;

14.3. For long-term storage in unheated storerooms the meter must be placed into the placed bag.

15. Transportation

15.1. Packaged meters are allowed for transportation by all types of vehicles provided that they are protected from direct influence of atmospheric precipitations.

In transporting by air, packaged meters must be placed in sealed cargo bays.

15.2. Transportation conditions:

- Surrounding air temperature:
- For the calculator - from minus 20 °C to 50 °C;
- For the FMS - from minus 50 °C to 50 °C;
- Relative humidity of the surrounding air - up to 98 % at 35 °C;
- Rough riding with acceleration 30 m/sec^2 and frequency ranging from 80 to 120 shocks per minute.

15.3. Meters are resistant to influence of sinusoidal vibration in the range of frequencies from 5 to 35 Hz and amplitude up to 0.35 mm.

15.4. Meters must be handled with care.
In placing the FMS onto the vehicle or into the transport box with the calculator it should be secured to prevent possible movement.

16. Manufacturer's warranty

16.1. The manufacturer warrants compliance of the manufactured heat meters with all technical requirements for **48 months from the date of shipment,** if the customer meets the following conditions:

- Installation and startup operations of the heat meter is carried out by the company authorized by the manufacturer to perform such installation operations;
- Availability of the stamp of the company that has carried out installation and start up operations of the heat meter in Section 19 OI;
- Operation conditions, conditions for transportation and storage specified in sections 8-11, 14 and 15 of the Operating Instructions.

16.2. The warranty covers defects of the meter components that are part of the delivery set and were closed by a workmanship defect, defects in the material and completing items.

16.3. The warranty provides for the replacement of defective parts and check of their serviceability by the manufacturer.

16.4. The faulty device should the delivered to the manufacturer for testing and repair.

16.5. Under no circumstances the calculator unit shall be opened (integrity of seals violated) prior to being returned to the manufacturer.

16.6. The warranty does not provide for compensation of dismantling, transportation and reinstallation costs, as well as any other fault related expenses.

16.7. Should the fault the revealed within the warranty period, the customer must submit the claim to the manufacturer's address:

SEMPAL Co. LTD
3 Kulibina Str., Kyiv, Ukraine, 03062
Phone/Fax: (+38 044) 239-2197, 239-2198.

16.8. The claim with regard to the heat meter shall not be submitted in the following case:

– Installation and startup operations have been conducted by the company that has not been authorized by the manufacturer for the performance of such operations;

– Seals have been violated on the calculator unit;

– The warranty period has expired;

– The consumer has violated operational rules, rules for storage and transportation set forth in the operation instructions.

16.9. Upon termination of the warranty period or forfeiture of a right to free-of-charge warranty servicing by the manufacturer the heat meter shall be repaired for money.

17. Parameters and specifications of the meter components

18. Acceptance certificate and primary calibration certificate

19. Information on putting into operation, repairs, checks, and readjustments

Information on putting into operation, repairs, checks and readjustments is indicated in Table 19.1.

Table 19.1

Date	Work description	Carried out by	Signature and stamp

20. Information on periodic tests

20.1 Information on periodic tests is indicated in Table 20.1

Table 20.1

Serial number	Date of check	Date of next check	Inspector's signature	Stamp

Appendix A

Meter order designation

Example:
SVTU10MR–M1–2/2_2–RU250_2TSpm2/RU50–4b45sh/4b60/0/0/0–3/5–3/5/0/0/0–1/1/0–1/1–2/3/5–1/2–1/2–1/2–0/0–220A

Code deciphering: (all Latin letters)

1	2	3	4	5
SVTU10MR –	**M1 –**	**2/2_2 –**	**RU250_2TSpm2/RU50 –**	**4b45sh/4b60/0/0/0 –**
Heat meter name	Heat meter modification	Variants of calculation channels. (first channel - variant 2, second channel - variant 2/2)	Standard dimensions of the FMS. _2 – double-chord f – with flanges s – with straight section (if any straight section are available, then always without flanges), p - high-pressure (24 atm), m2 – model of the FMS (m2 – sealed, m3 – sluice chamber),	Standard dimensions of applied RTD (0 – RTD not applied) b45 – type of bushings (e – jacket for the external RTD), s – availability of pocket, h –sealing

6	7	8	9
3/5 –	**3/5/0/0/0 –**	**1/1/0 –**	**1/1 –**
Cable length to relevant FMSs, m	Cable length to relevant FMSs, m	Cable length to RS232 / availability of USB cable / availability of RS485 cable	Availability expansion unit / cable length to communication unit, m

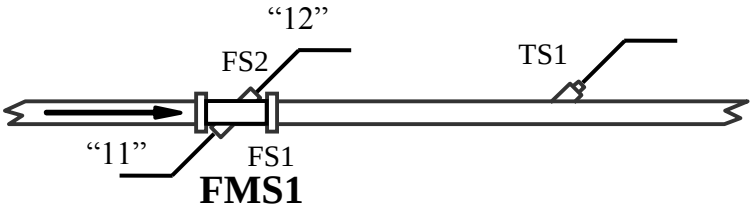
10	11	12	13	14	15
2/3/5 –	**1/2 –**	**1/2 –**	**1/2 –**	**0/0 –**	**220A**
Number of delivered PTs / Cable length to PT, m	Cable length for imp. outputs	Cable length for imp. inputs	Cable length for linear outputs	Cable length for switching outputs	Supply voltage. A – availability of the battery

Appendix B

Circuit diagrams for installation of various variants of calculation channels

The below equations use the following designations:
W – thermal energy (J);
H – specific enthalpy (J/kg);
Q_m – mass flow (kg/h);
t – time (h).

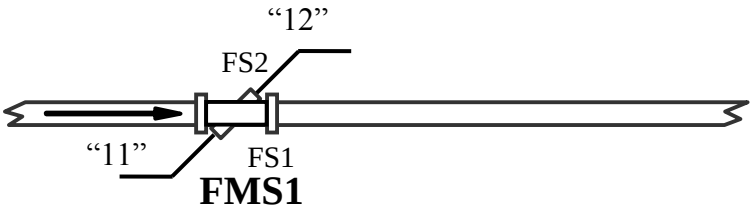
Variant 1



One water meter

Main function - measuring the volume (mass) of water

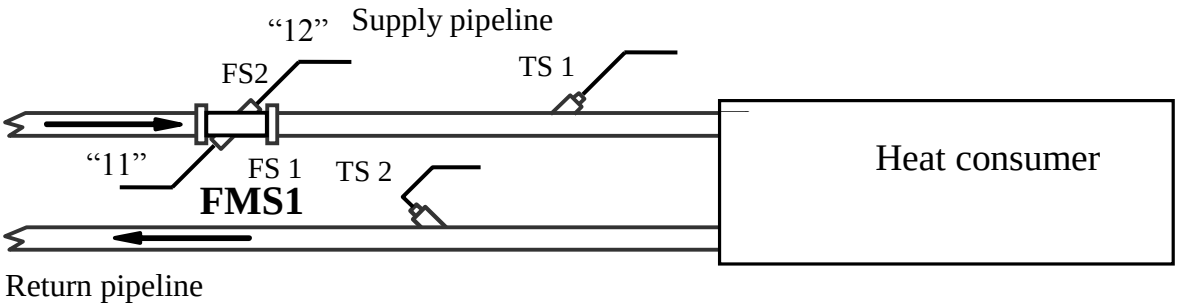
Variant 1/1



One water meter

Main function - measuring the volume of water

Variant 2



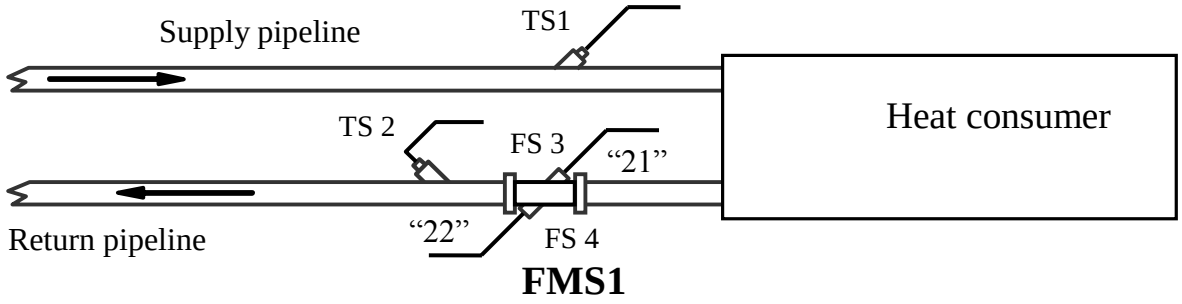
$$W = \int_t Q_{m1} \cdot (H_1 - H_2) \cdot dt$$

Heat meter for unvented heat supply system

Main function - thermal energy measuring

Note - Numbering of flow meters and marketing of cables is given as per Table 9.1.

Variant 2/1

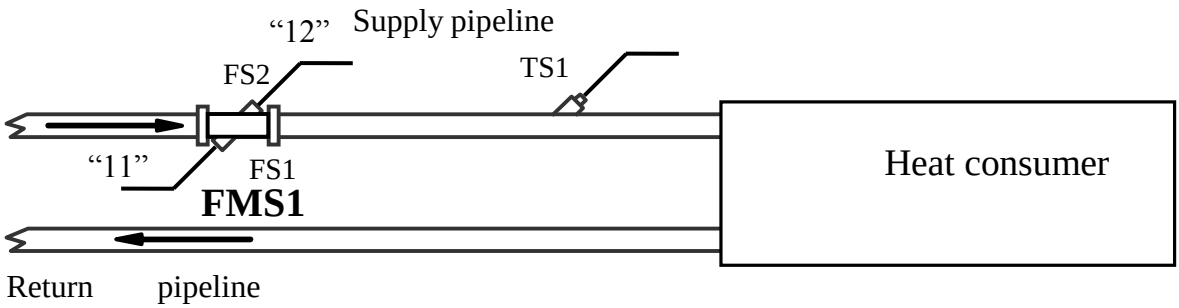


$$W = \int_t Q_{m2} \cdot (H_1 - H_2) \cdot dt$$

Heat meter for unvented heat supply system

Main function - thermal energy measuring. FMS is fitted into the return line.

Variant 2/2

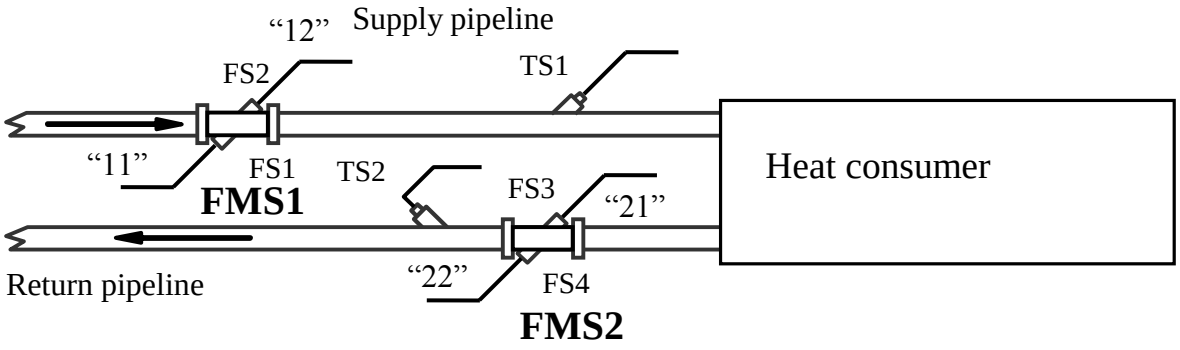


$$W = \int_t Q_{m1} \cdot (H_1 - H_2) \cdot dt$$

Heat meter for HWSS

Main function - thermal energy measuring. Temperature in the return pipeline is set by software

Variant 4

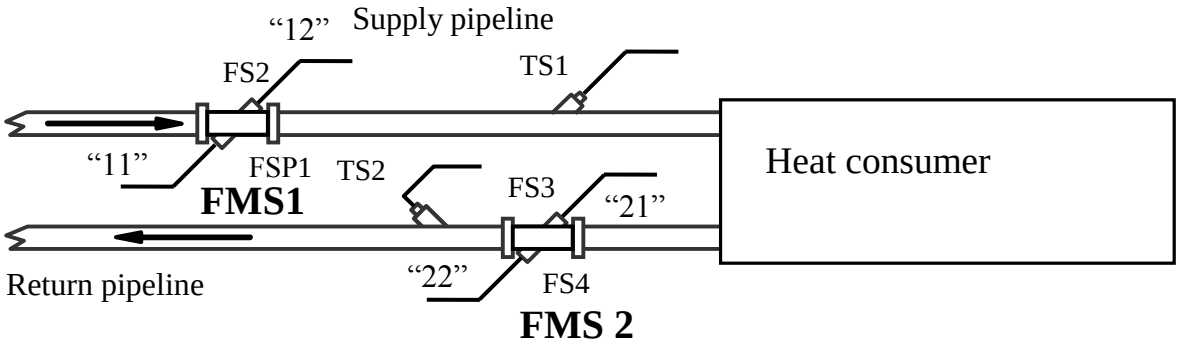


$$W = \int_t Q_{m1} \cdot H_1 \cdot dt - \int_t Q_{m2} \cdot H_2 \cdot dt - \int_t \left(Q_{m1} - Q_{m2} \right) \cdot H_{XB} \cdot dt$$

Heat meter for vented heat supply system without cold water supply pipeline

(cold water temperature T_{cw} is set by software)

Variant 5



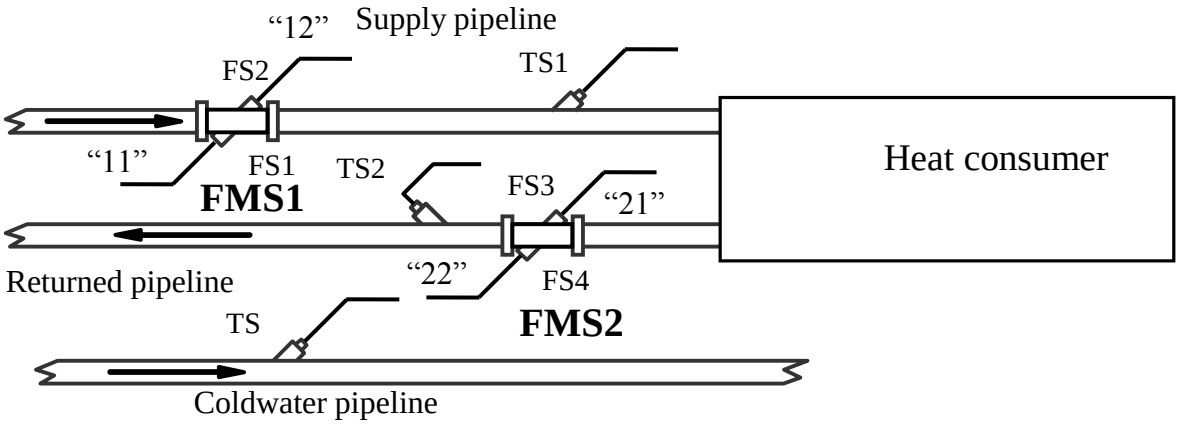
$$W = \int_t Q_{m1} \cdot \left(H_1 - H_2 \right) \cdot dt$$

Heat meter for unvented heat supply system with controlled water meter on the return line

Main function – thermal energy measuring, additional – measuring the volume of the heat transfer liquid passing through the return pipeline.

Note - Numbering of flow meters and marketing of cables is given as per Table 9.1.

Variant 7



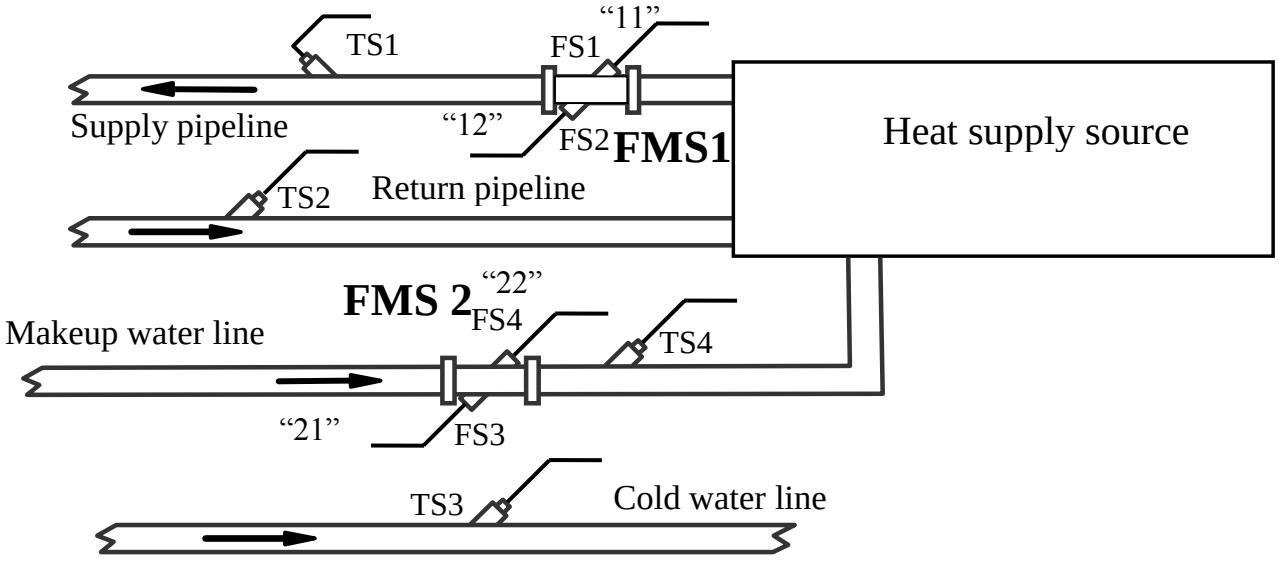
$$W = \int_t Q_{m1} \cdot H_1 \cdot dt - \int_t Q_{m2} \cdot H_2 \cdot dt - \int_t \left(Q_{m1} - Q_{m2} \right) \cdot H_{XB} \cdot dt$$

Heat meter for vented heat supply system with cold water pipeline. Cold water temperature is measured

Main function – thermal energy measuring.

Note - Numbering of flow meters and marketing of cables is given as per Table 9.1.

Variant 9



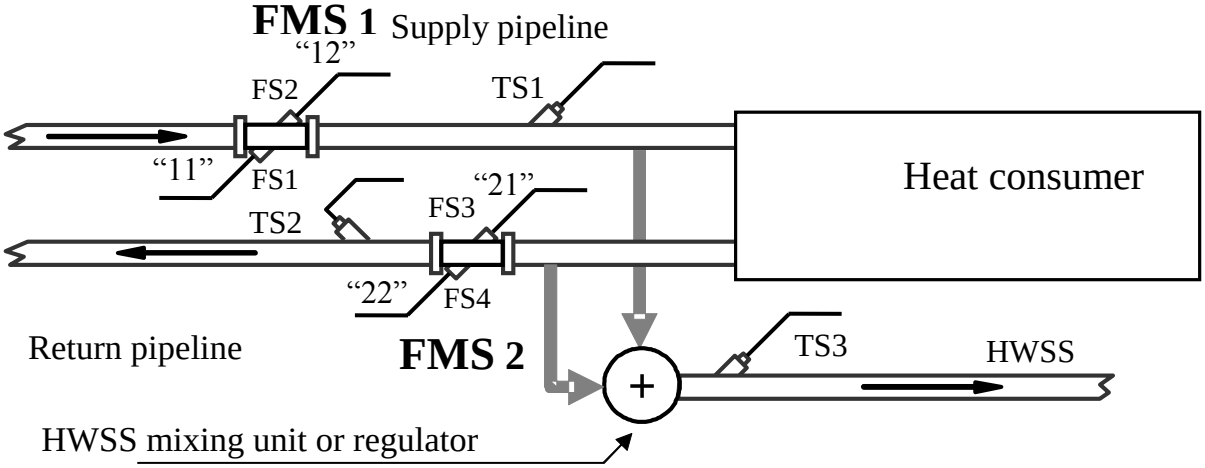
$$W = \int_t Q_{m1} \cdot \left(H_1 - H_2 \right) \cdot dt + \int_t Q_{ПП} \cdot \left(H_2 - H_{XB} \right) \cdot dt$$

Heat meter with measuring flow rate in the supply line and makeup water line

Main function - thermal energy measuring on heat supply source.

Note - Numbering of flow meters and marketing of cables is given as per Table 9.1.

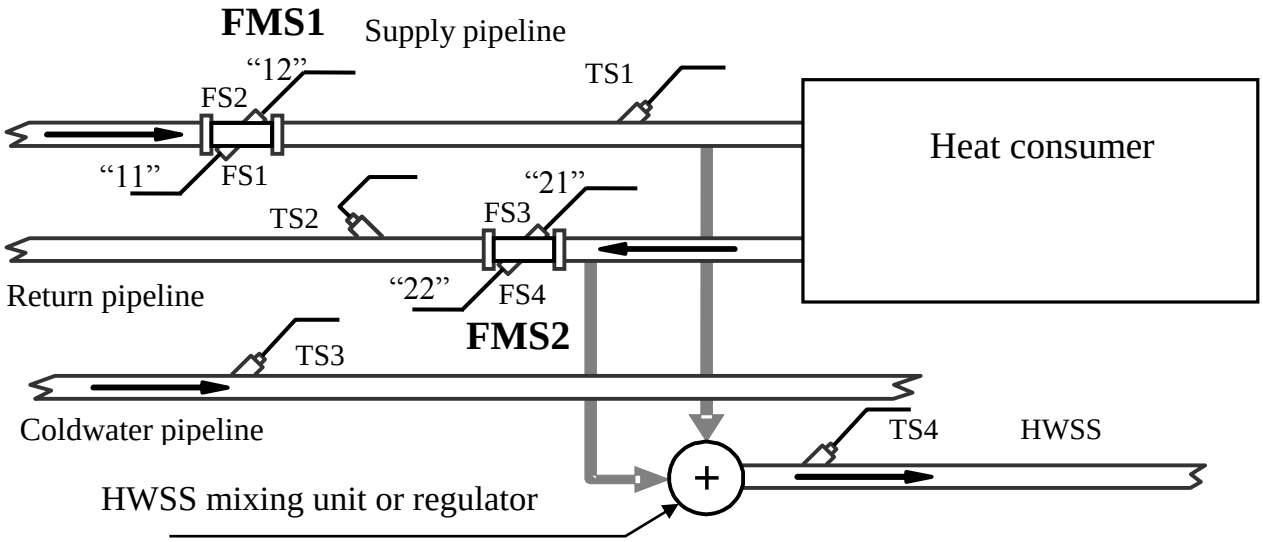
Variant 10



Calculation of heat is carried out by formulas (B.1) and (B.2)

Heat meter for vented heat supply system without cold water supply pipeline and water filling for HWSS.

Variant 11

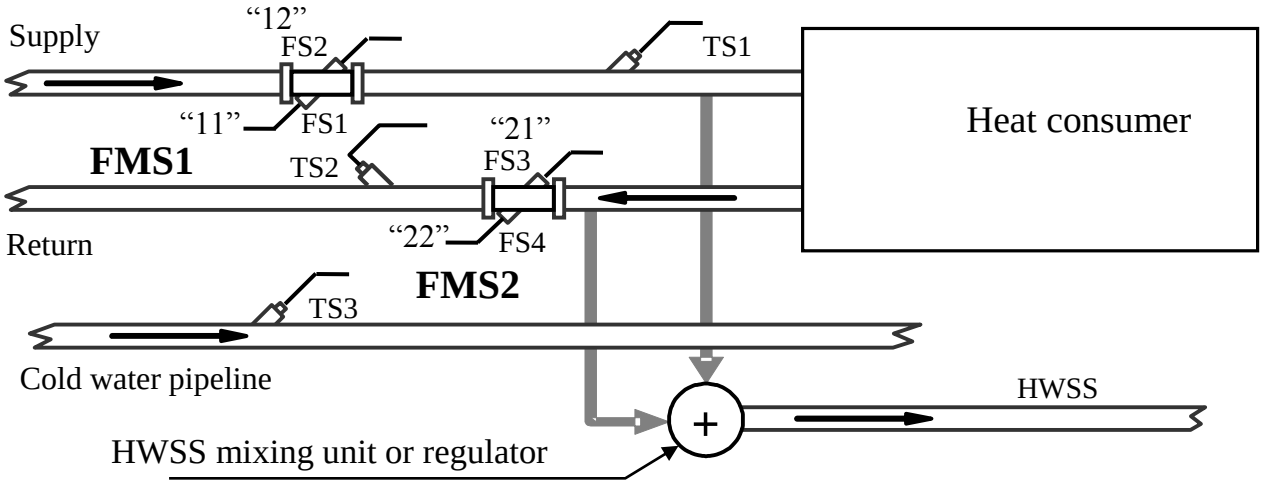


Calculation of heat is conducted by formulas (B.1) and (B.2)

Heat meter for vented heat supply system
With cold water supply and water filling to HWSS

Note - Numbering of flow meters and marketing of cables is given as per Table 9.1.

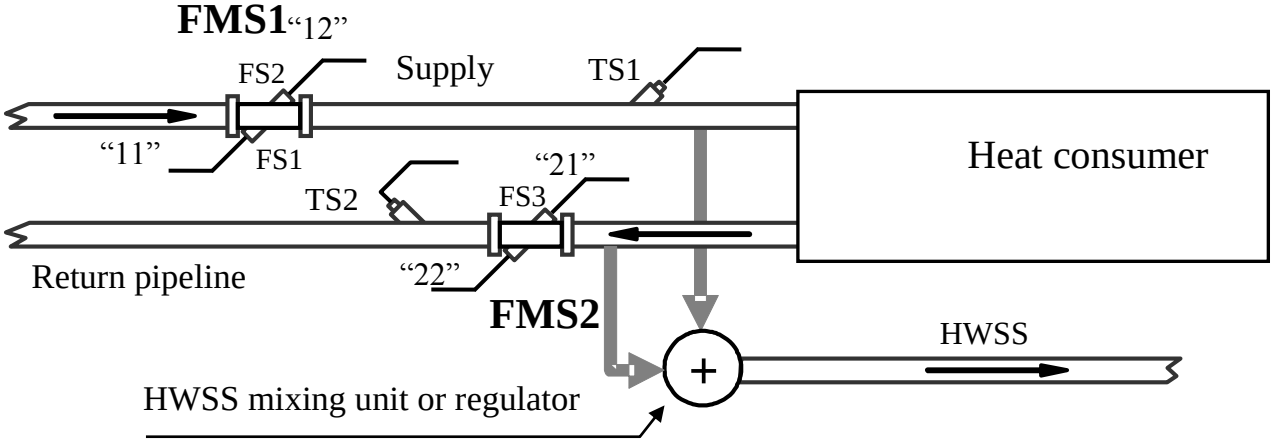
Variant 11/1



Calculation of heat is conducted by formulas (B.1) and (B.2)

Heat meter for vented heat supply system
With cold water supply pipeline and water filling for HWSS without measuring temperature in HWSS

Variant 12



Calculation of heat is conducted by formulas (B.1) and (B.2)

Heat meter for vented heat supply system without cold water supply pipeline and filling of water to HWSS without measuring HWSS temperature.

Note - Numbering of flow meters and marketing of cables is given as per Table 9.4

For variants 10, 11, 11/1 and 12 it is necessary to comply with flow sensor cable connection diagram.

In variants 10…12, calculation of heat is conducted by the following equations:

Total heat consumed to the calculated by formula:

– $$W_{\Sigma} = \int_{t} Q_{m1} \cdot H_1 \cdot dt + \int_{t} Q_{m2} \cdot H_2 \cdot dt - \int_{t} \left(Q_{m1} + Q_{m2}\right) \cdot H_{XB} \cdot dt \quad (\mathbf{B}.1)$$

Consumption of heat by HWSS shall be calculated by formula:

– $$W_{ГВС} = \int_{t} \left(Q_{m1} + Q_{m2}\right) \cdot \left(H_{ГВС} - H_{XB}\right) \cdot dt \quad (B.2)$$

In the above equations, Q_m is used by taking into account the flow sign:

— Sign «+» for the incoming flow to the heat consumer facility

— Sign «–» for the flow escaping the heat consumer facility.

Variants 10, 11, 11/1 and 12 have several operation modes: one winter and three summer (depending on the heat supply mode) modes. Total number of the consumed heat in all modes is determined by the difference between the supplied and consumed thermal energy and does not depend on the operation mode (difference in the below formulas is explained by the simplified equations after taking into account the flow sign). Winter mode differs from summer modes only by the fact that from the total amount of the consumed heat W_{Σ} thermal energy of HWSS W_{HWSS} and heating thermal energy W_{HT} is subtracted. In summer modes, heating is always presumed to be disconnected, and heating thermal energy W_{HT} is presumed to be equal zero.

Mode **«Winter»** - heat is delivered along the supply pipeline, and the remaining part is returned along the return pipeline.

Mode **«Summer 1»** - heat is delivered along the supply pipeline, return pipeline is disconnected (flow rate in the return line equals zero or water is drained).

Mode **«Summer 2»** - heat is delivered along the return pipeline, supply pipeline is disconnected (flow rate in the straight line equals zero or water is drained).

Mode **«Summer 3»** - heat is delivered along the supply pipeline and the return pipeline.

In variants 10 and 11, HWSS temperature is measured; in variant 12, HWSS temperature is not measured and is determined as follows:

Mode	$\mathbf{t_{HWSS}}$	**Note**
Winter, Summer 1	$\equiv t_S$	
Summer 2	$\equiv t_O$	
Summer 3	$(M1 \cdot t_П + M2 \cdot t_O)/(M1 + M2)$	Water is supplied to the HWSS from two pipelines at the same time

The below formulas are intended for heat calculations for different operation modes for variants 10…12.

Mode	W_{Σ}	$W_{ГВС}$
Winter	$W_{\Sigma} = M1 \cdot (h_{П} - h_{ХВ}) + M2 \cdot (h_{О} - h_{ХВ})$	$W_{ГВС} = (M1 + M2) \cdot (h_{ГВС} - h_{ХВ})$
Summer 1	$W_{\Sigma} = M1 \cdot (h_{П} - h_{ХВ})$	$W_{HWSS}=W_{\Sigma}$
Summer 2	$W_{\Sigma} = M2 \cdot (h_{О} - h_{ХВ})$	$W_{HWSS}=W_{\Sigma}$
Summer 3	$W_{\Sigma} = M1 \cdot (h_{П} - h_{ХВ}) + M2 \cdot (h_{О} - h_{ХВ})$	$W_{HWSS}=W_{\Sigma}$

Where,

W_{Σ} - total thermal energy,

$W_{ГВС(HWSS)}$ – thermal energy of HWSS

$h_{П(s)}$, $h_{О}$ and $h_{ГВС(HWSS)}$ – specific enthalpy of supply, return waters supply pipelines, and HWSS, respectively.

$h_{XB(CW)}$ – enthalpy of cold water. For variants 10 and 12, cold water temperature is set by the customer via software. For variant 11, cold water temperature is measured by TS3.

M1 and M2 – mass of water in the supply and return lines, respectively. In all equations, the value of mass should have the ***sign***.

Thermal energy of heating in winter mode is calculated as follows: $W_{НТ} = W_{\Sigma} - W_{HWSS}$. In all summer modes $W_{НТ} \equiv 0$.

Operation mode is set by the customer or changed automatically. Categories of automatic switching modes:

Mode	Supply flow	Return flow
Winter	«+»	«–»
Summer 1	«+»	0 or no water
Summer 2	0 or no water	«+»
Summer 3	«+»	«+»

Where,

«+» - water is supplied to the heat consumer

«–» - water is leaving the heat consumer's facility.

When the mode of operation is selected automatically the process is completed within 5 min. after the heat supply mode is changed and the time and date is entered into the logbook of operation modes. The last events registered in the logbook of the events are printed out in the daily report.

The current date is also applicable for the automatic switching of modes. The Customer shall set two boundary date (date and month) – the date of switching to the winter mode and the date of switching to the summer mode. Automatic switching to the winter mode occurs only after the preset date for the winter mode and switching conditions are complied with (flow signs). Switching to the summer mode is performed only after the date set for the summer mode. Switching between different summer modes is possible only after the date of switching to the

summer mode. The date switching mode can be disabled by presetting the same date for the winter and summer modes.

Emergency situations:

Mode	**Situation**	**Calculation of heat**
Winter	Supply direction – «+», return direction – «+»	$W_{\Sigma} = W_{ГВС} = M1 \cdot (h1 - hхв) + M2 \cdot (h2 - hхв)$ $W_{ОТ} = 0$
Summer (1, 2, 3)	Supply direction – «-», return direction – «+»	$W_{\Sigma} = W_{ГВС} = M1 \cdot (h1 - hхв) + M2 \cdot (h2 - hхв)$ $W_{ОТ} = 0$

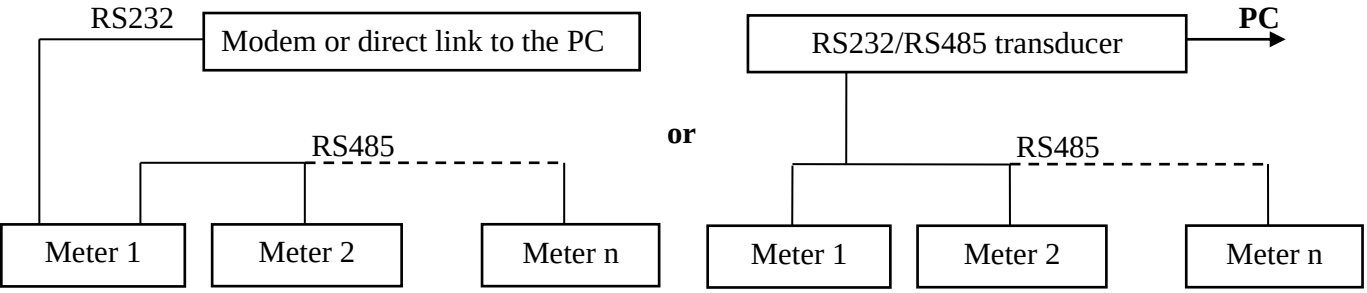
All current values of flow rates (volume, mass) and integral values of volume and weight are indicated on the indicator or in the printout of archive data by taking into account the sign. Positive sign – the flow enters the facility, negative – leaves. For example, in «Winter mode» supply will have sign «+», and the return is with sign «-» (integral value of volume and weight in the return line will also be with sign «-». Then, in switching to the «Summer 2» mode, supply will be equal zero (accumulation of integral volume and weight with regard to supply equals zero), and the return will be with sign «+».

Appendix C

The use of RS485 interface with Sempal communications protocol

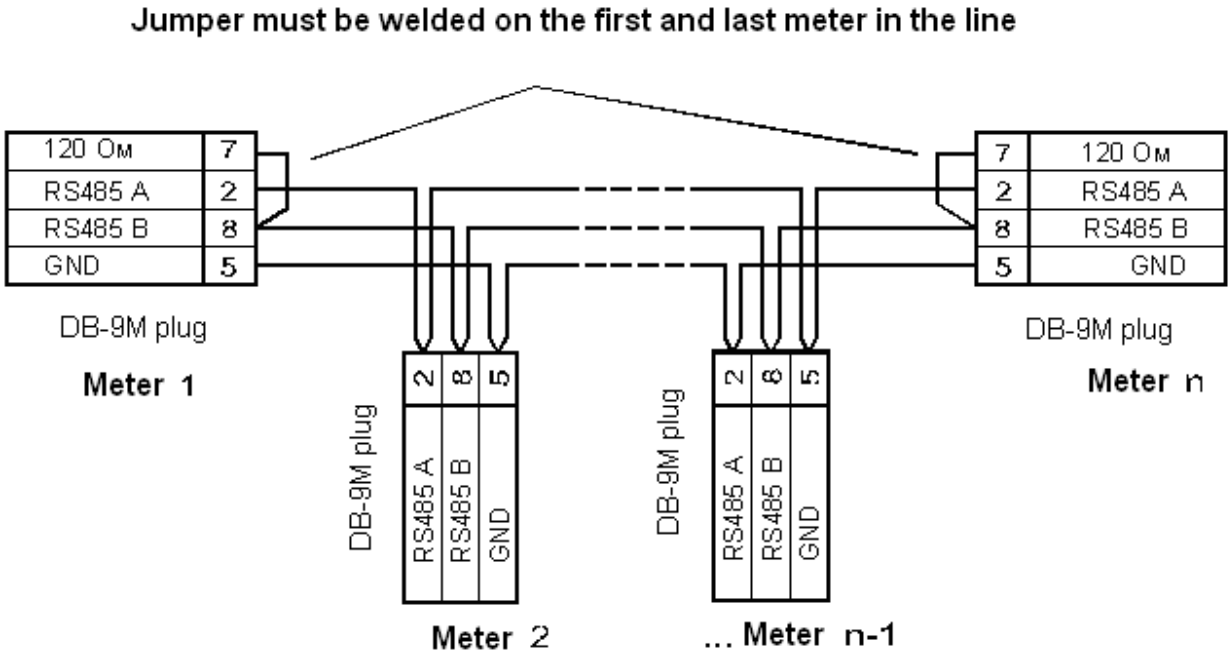
By applying RS485 interface is possible to connect several meters (or other devices manufactured by SEMPAL), and this being the case, to have access to any of them it is sufficient for the one of the devices to have access to the external network.

The total length of RS485 communication line must not exceed 2 km. This being the case, the

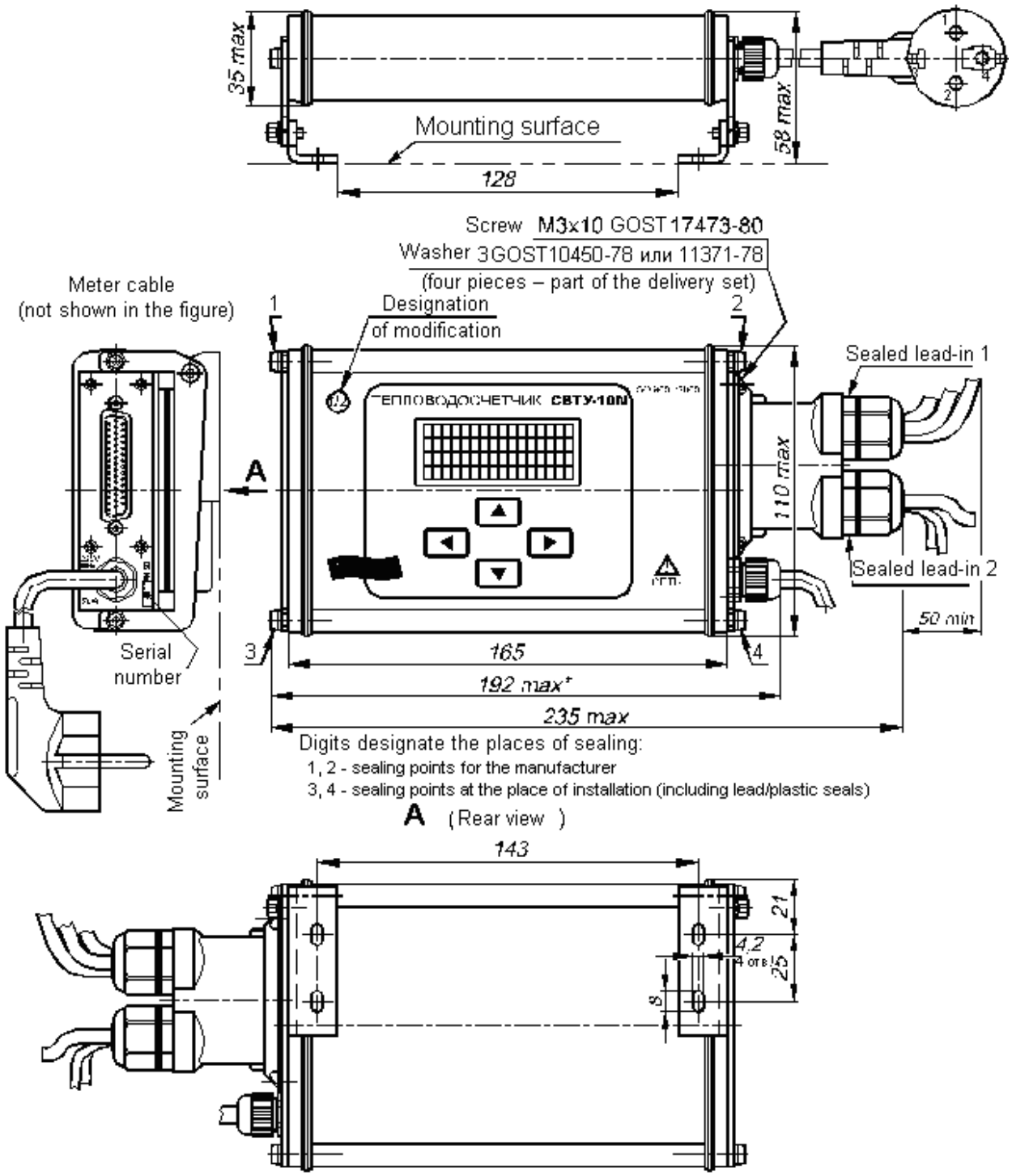


devices might be connected in series. The connecting cable must have 120 Ohm resistance (jumper between 7 and 8 contacts of the connector). The below diagram is intended for connection of the RS485 cable (wired by the customer). Twisted pair must be used for the wiring.

Cable connectors must be connected to connector 71 of the meter cable of each meter.



Appendix D
Calculator overall and mounting dimensions



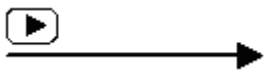
Appendix E

Meter control menu

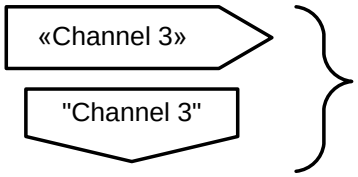
Reference designations

These buttons have the following functionality:

- Right, - Up, - Down, - Left.



Moved to the next item, if the corresponding button has been pressed (in this case, button "Right")



"Channel 3" – means that there is a continuation on the next page with the relevant heading

Items of the menu with (★) are indicated for the corresponding meter variant. For example, hot water temperature input is indicated for the delivery variant 4, 9, 10, and 12.

Display of menu items on the indicator

Signs "► ◄" indicate the item all the menu that has been selected and will be initiated, if button "*Right*" is pressed. Press button "*Left*" to return to the previous menu.

Arrows "↑" and "↓" indicate the item of the menu to transfer after pressing buttons "Up" and "Down", respectively.

To get access to certain modes, the password is required. In this case, after pressing the button "Right" it is required to enter the password.

Parameter editing

Editing of parameters can be done in three following steps:

- Indication of parameter current value;
- непосредственно процесс редактирования начинается по кнопке «Ввод»;
- Indication of the result of editing after ending of editing process.

After pressing «Enter» button the « » symbol is appeared on the indicator and it means that editing mode is activated.

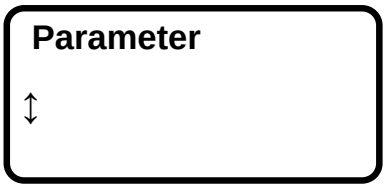
There exist two modes of editing:

- ***Editing of the digital value***
- ***Selection of the variant from the list***

Editing of the digital value

Sign "⇳" indicates to the digit position being changed at the moment. To changed digit position, press buttons "Up" and "Down". To transfer to the next digit position – press button *"Right"*. To complete editing, press button *"Left"*. After that the sign "⇳" disappears and the indicator will display the stored parameter value. When editing digits with the floating point, the value may be different from the entered one by dgt, as it is related to the special features of the internal representation of data.

Selection of the variant from the list

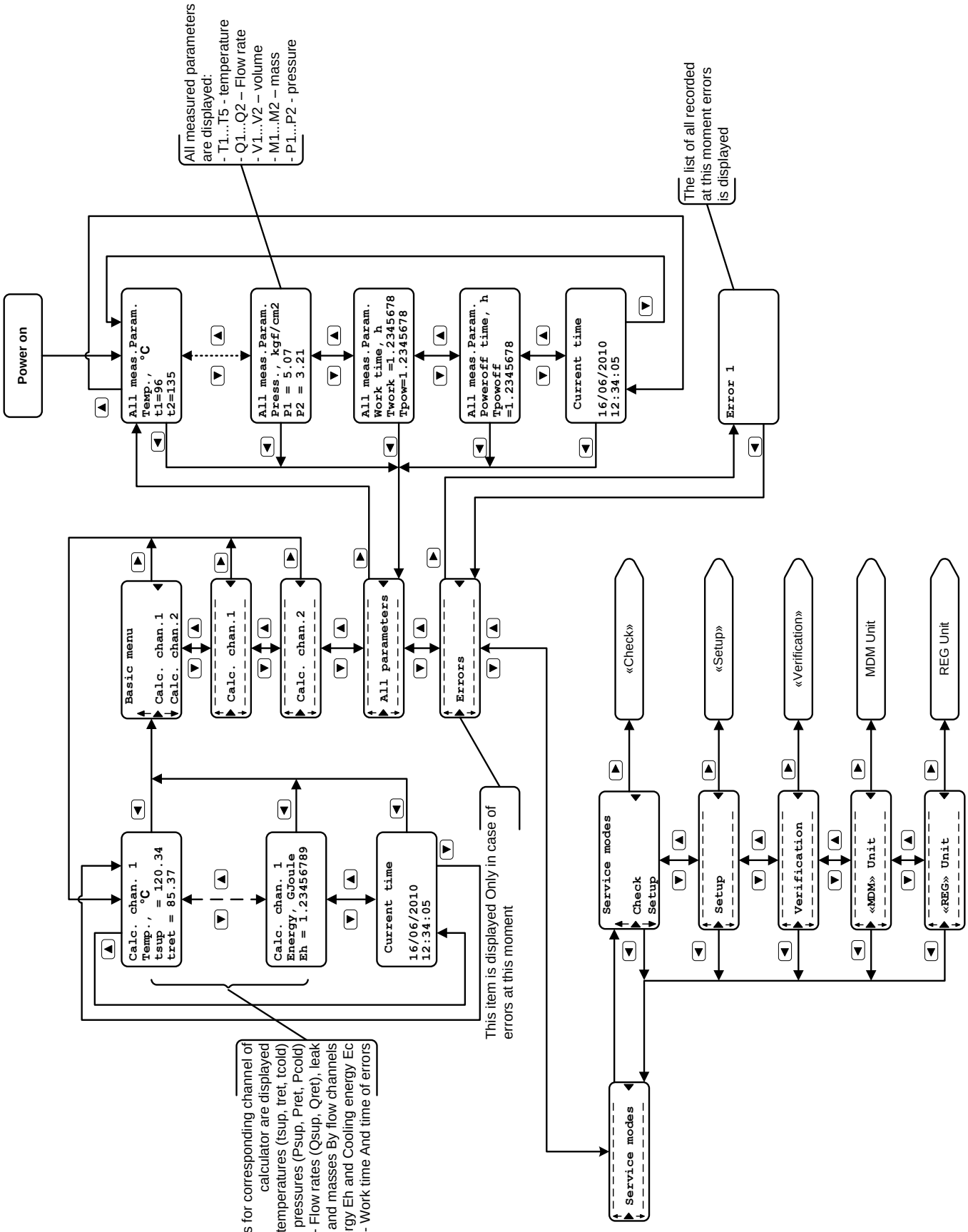


Sign "⇳" to the left from the parameter value indicates that it is suggested to make selection from the list. Change of their parameter value is carried out by pressing buttons "Up" and "Down". To complete editing, press button "Left".
If, in the course of editing process, it became clear that the parameter should be left unchanged (for example, "Right" has been pressed), the process of editing may be interrupted without changes in the parameter values by pressing buttons "Up" and "Down" at the same time.

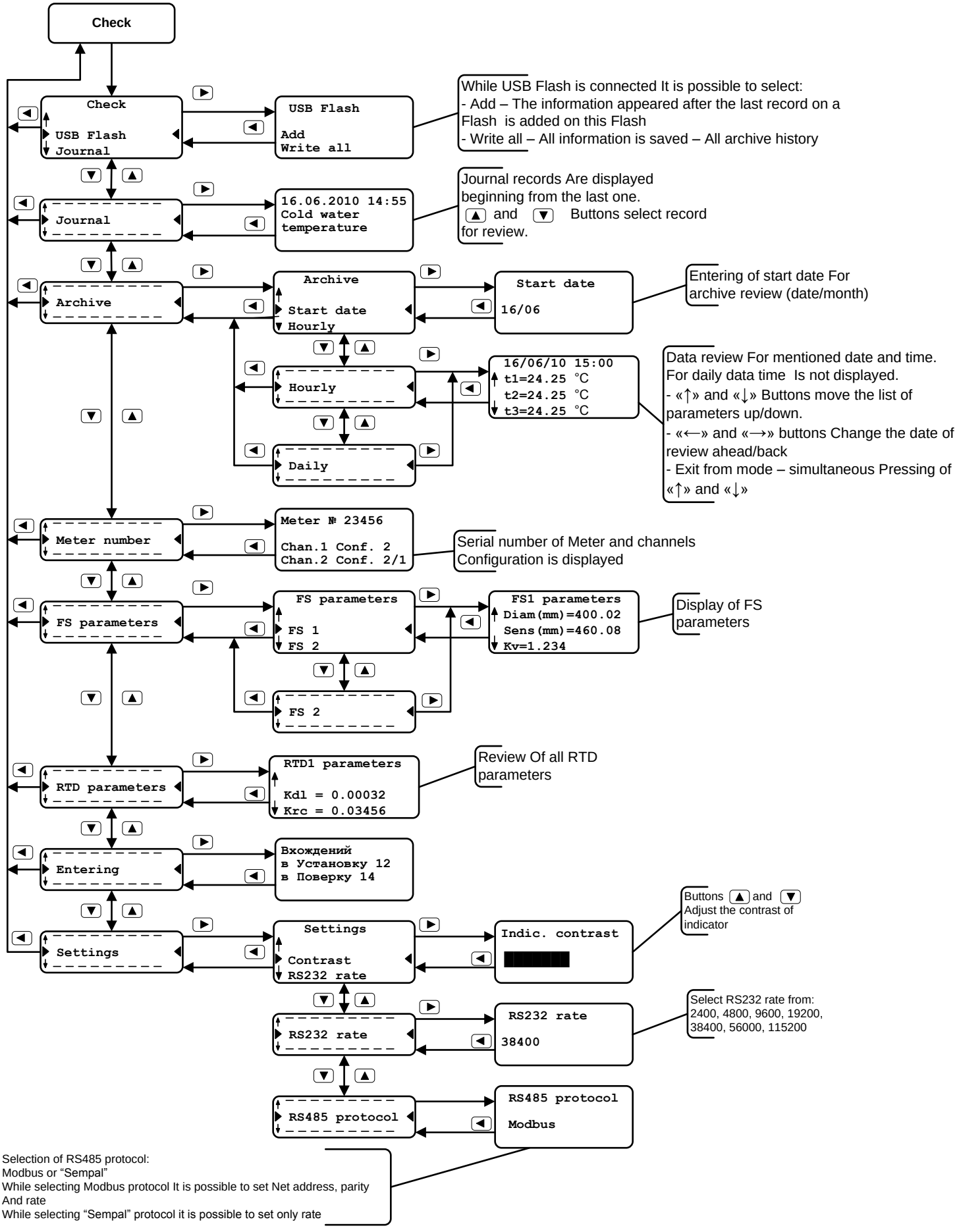
Notes:
1. It should be noted that continued pressing of any button will initiate, in 0.5 sec, repeated entering of the button digit at the rate of 3 times a second.
If, in the course of 10 min., no button was pressed, the meter will switch from selection of the mode or password entering to the "Indication of basic parameters" mode.

2. If an invalid parameter is entered, the meter will display an error message. Pressing any button will delete the error message and return to the previous menu item.

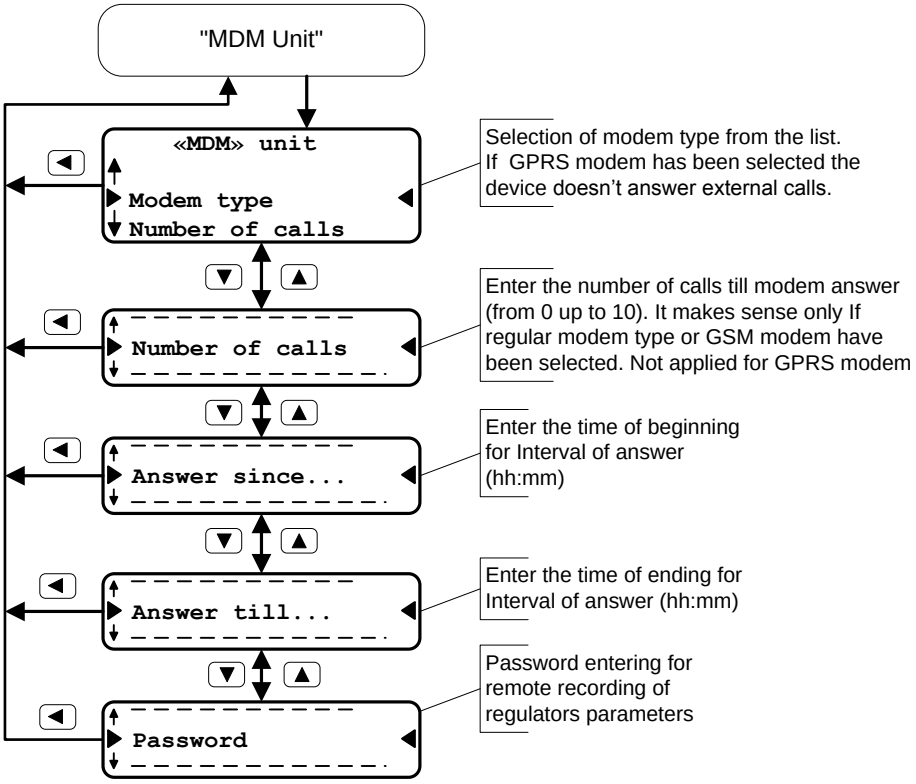
Basic mode

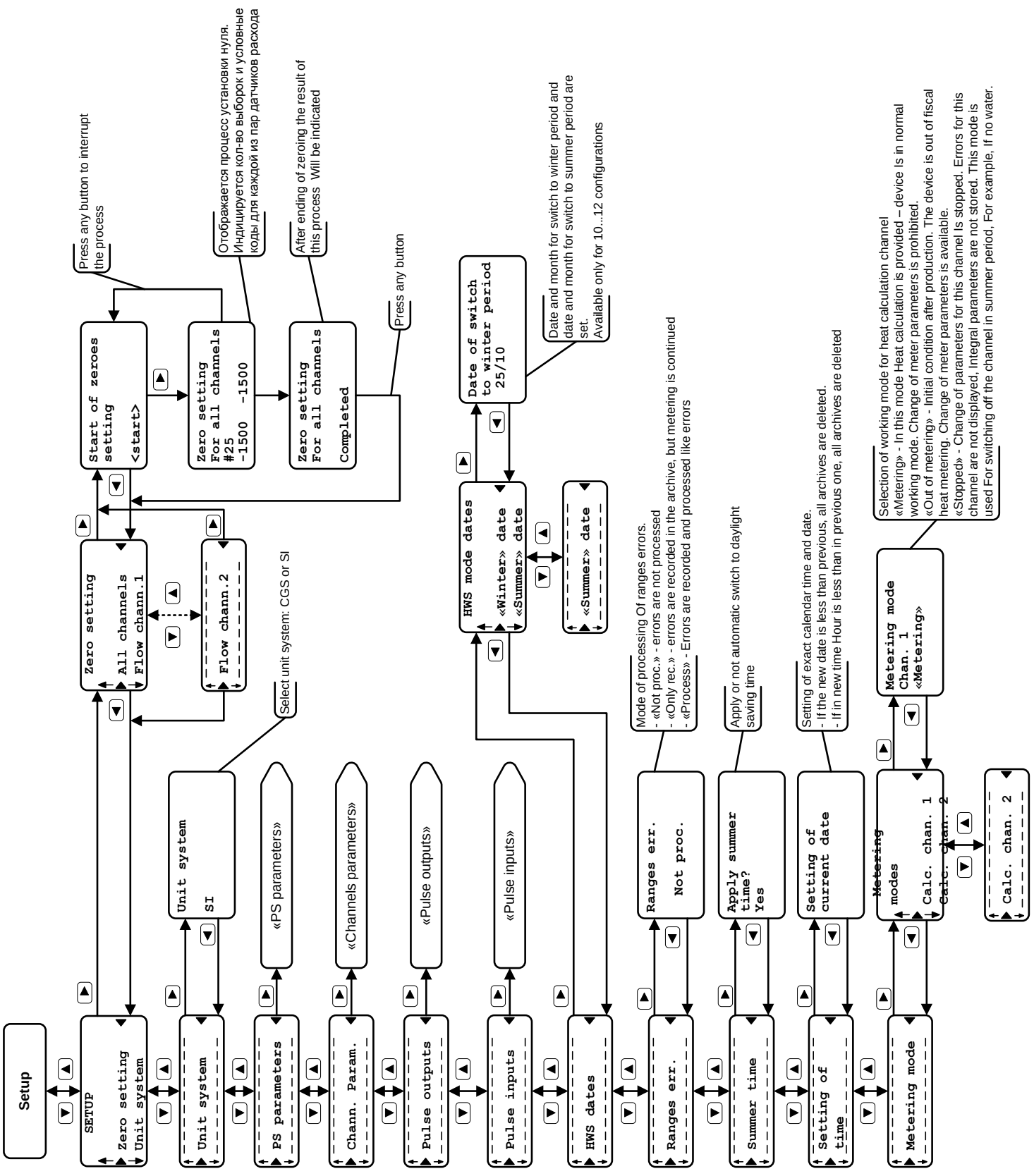

Power on
All meas.Param.
Temp.,
°C
t1=96
t2=135
All meas.Param.
Press., kgf/cm2
P1 = 5.07
P2 = 3.21
All meas.Param.
Work time, h
Twork =1.2345678
Tpow=1.2345678
All meas.Param.
Poweroff time, h
Tpoweroff
=1.2345678
Current time
16/06/2010
12:34:05
Error 1
All measured parameters are displayed:
- T1...T5 - temperature
- Q1...Q2 – Flow rate
- V1...V2 – volume
- M1...M2 – mass
- P1...P2 - pressure
The list of all recorded at this moment errors is displayed
Basic menu
Calc. chan.1
Calc. chan.2
Calc. chan.1
Calc. chan.2
All parameters
Errors
Calc. chan. 1
Temp., °C
tsup = 120.34
tret = 85.37
Calc. chan. 1
Energy, Gjoule
Eh = 1.23456789
Current time
16/06/2010
12:34:05
«Check»
«Setup»
«Verification»
MDM Unit
REG Unit
Service modes
Check
Setup
Setup
Verification
«MDM» Unit
«REG» Unit
Service modes
All parameters for corresponding channel of calculator are displayed
- temperatures (tsup, tret, tcold)
- pressures (Psup, Pret, Pcold)
- Flow rates (Qsup, Qret), leak
- Volumes and masses By flow channels
- Heat energy Eh and Cooling energy Ec
- Work time And time of errors
This item is displayed Only in case of errors at this moment

"Check" mode

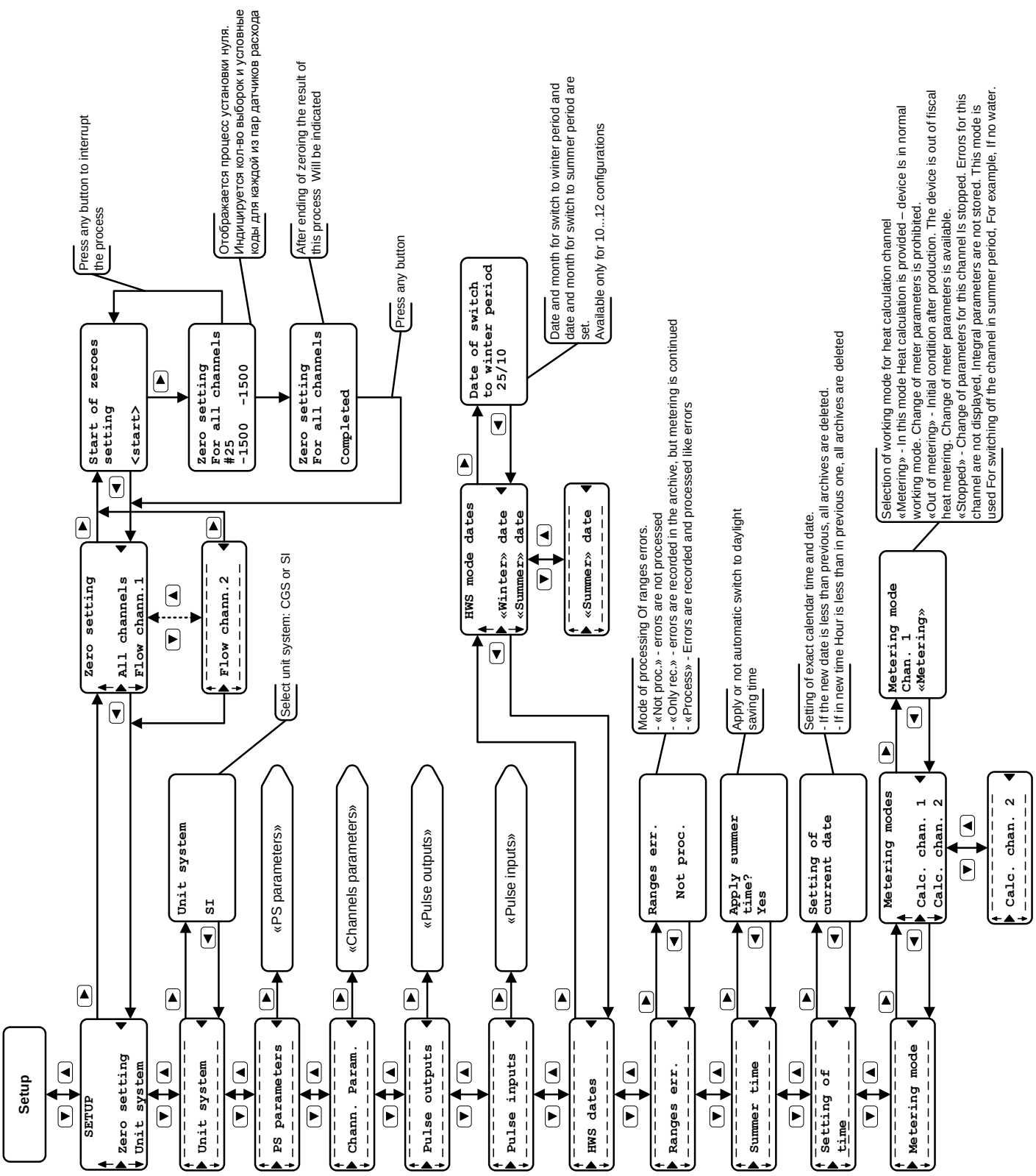

Check
Check
USB Flash
Journal
USB Flash
Add
Write all
While USB Flash is connected It is possible to select:
- Add – The information appeared after the last record on a Flash is added on this Flash
- Write all – All information is saved – All archive history
Journal
16.06.2010 14:55
Cold water temperature
Journal records Are displayed beginning from the last one.
▲ and ▼ Buttons select record for review.
Archive
Archive
Start date
Hourly
Start date
16/06
Entering of start date For archive review (date/month)
Hourly
16/06/10 15:00
t1=24.25 °C
t2=24.25 °C
t3=24.25 °C
Daily
Data review For mentioned date and time. For daily data time Is not displayed.
- «↑» and «↓» Buttons move the list of parameters up/down.
- «←» and «→» buttons Change the date of review ahead/back
- Exit from mode – simultaneous Pressing of «↑» and «↓»
Meter number
Meter № 23456
Chan.1 Conf. 2
Chan.2 Conf. 2/1
Serial number of Meter and channels Configuration is displayed
FS parameters
FS parameters
FS 1
FS 2
FS1 parameters
Diam(mm)=400.02
Sens(mm)=460.08
Kv=1.234
Display of FS parameters
FS 2
RTD parameters
RTD1 parameters
Kdl = 0.00032
Krc = 0.03456
Review Of all RTD parameters
Entering
Вхождений
в Установку 12
в Поверку 14
Settings
Settings
Contrast
RS232 rate
Indic. contrast
Buttons ▲ and ▼ Adjust the contrast of indicator
RS232 rate
RS232 rate
38400
Select RS232 rate from: 2400, 4800, 9600, 19200, 38400, 56000, 115200
RS485 protocol
RS485 protocol
Modbus
Selection of RS485 protocol:
Modbus or "Sempal"
While selecting Modbus protocol It is possible to set Net address, parity And rate
While selecting "Sempal" protocol it is possible to set only rate

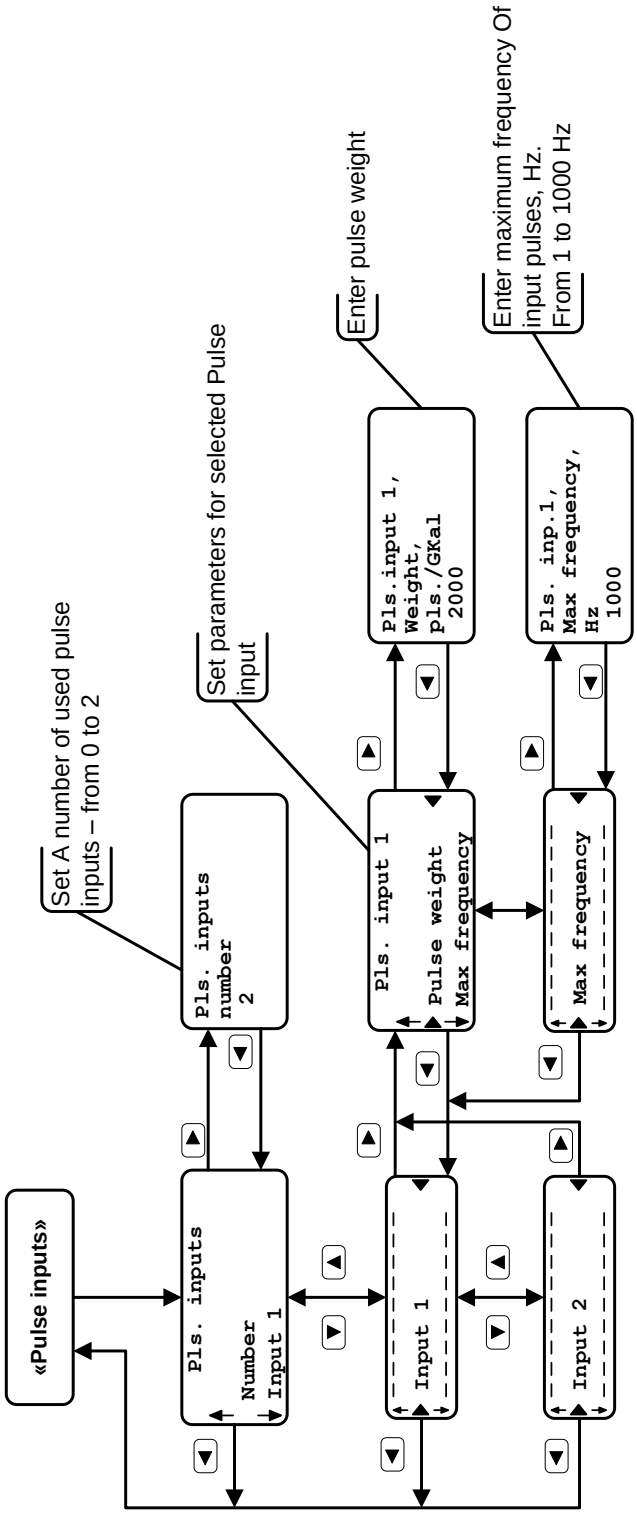
MDM mode


"MDM Unit"
«MDM» unit
Modem type
Number of calls
Number of calls
Answer since...
Answer till...
Password
Selection of modem type from the list. If GPRS modem has been selected the device doesn't answer external calls.
Enter the number of calls till modem answer (from 0 up to 10). It makes sense only If regular modem type or GSM modem have been selected. Not applied for GPRS modem
Enter the time of beginning for Interval of answer (hh:mm)
Enter the time of ending for Interval of answer (hh:mm)
Password entering for remote recording of regulators parameters

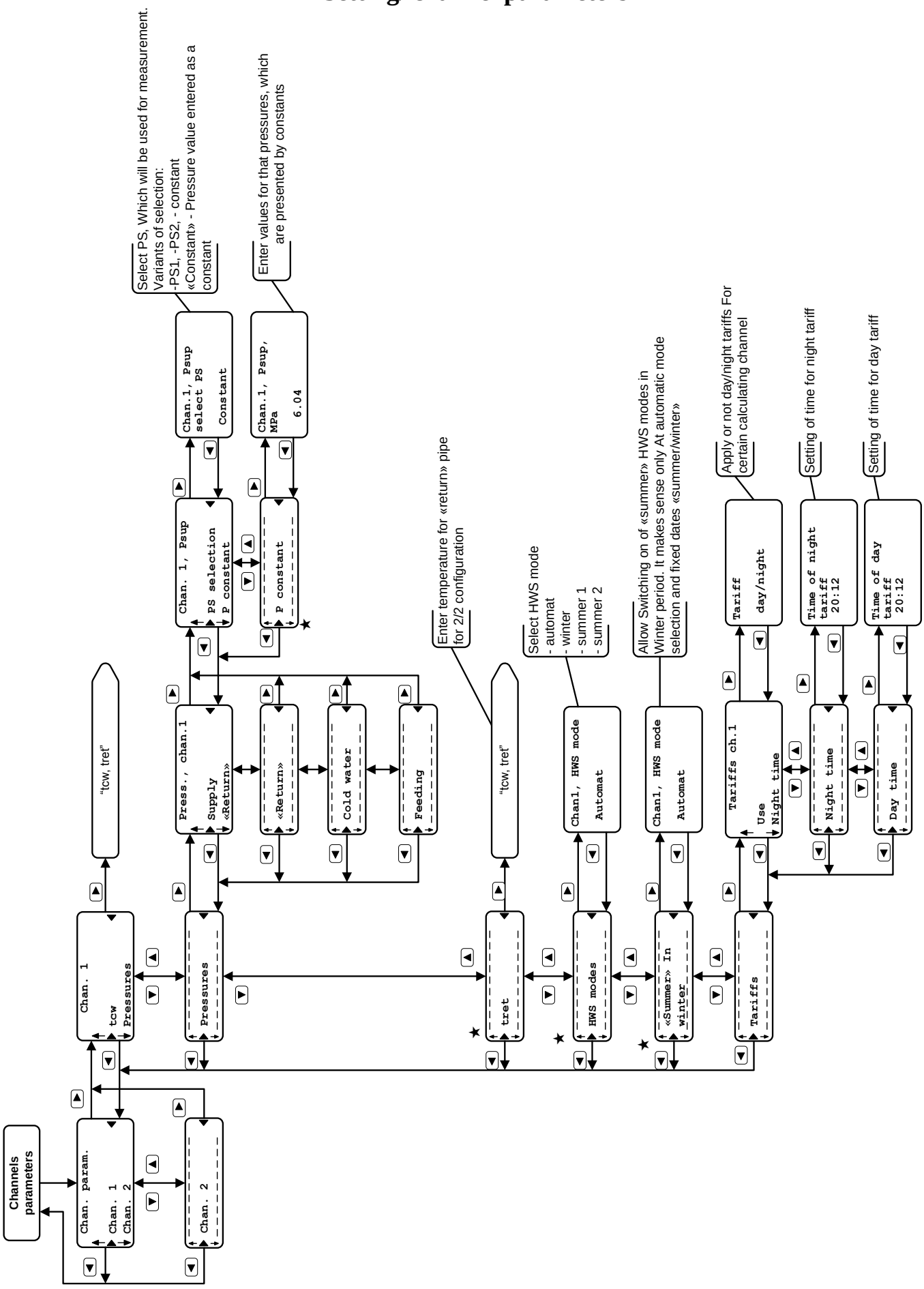

Setup
SETUP
Zero setting
Unit system
Zero setting
All channels
Flow chann.1
Flow chann.2
Start of zeroes setting
<start>
Press any button to interrupt the process
Zero setting
For all channels
#25
-1500 -1500
Отображается процесс установки нуля.
Индицируется кол-во выборок и условные коды для каждой из пар датчиков расхода
Zero setting
For all channels
Completed
After ending of zeroing the result of this process Will be indicated
Press any button
Unit system
SI
Select unit system: CGS or SI
PS parameters
«PS parameters»
Chann. Param.
«Channels parameters»
Pulse outputs
«Pulse outputs»
Pulse inputs
«Pulse inputs»
HWS dates
HWS mode dates
«Winter» date
«Summer» date
Date of switch to winter period
25/10
Date and month for switch to winter period and date and month for switch to summer period are set.
Available only for 10...12 configurations
«Summer» date
Ranges err.
Not proc.
Mode of processing Of ranges errors.
- «Not proc.» - errors are not processed
- «Only rec.» - errors are recorded in the archive, but metering is continued
- «Process» - Errors are recorded and processed like errors
Summer time
Apply summer time?
Yes
Apply or not automatic switch to daylight saving time
Setting of current date
Setting of exact calendar time and date.
- If the new date is less than previous, all archives are deleted.
- If in new time Hour is less than in previous one, all archives are deleted
Setting of time
Metering mode
Metering modes
Calc. chan. 1
Calc. chan. 2
Metering mode
Chan. 1
«Metering»
Selection of working mode for heat calculation channel
«Metering» - In this mode Heat calculation is provided – device Is in normal working mode. Change of meter parameters is prohibited.
«Out of metering» - Initial condition after production. The device is out of fiscal heat metering. Change of meter parameters is available.
«Stopped» - Change of parameters for this channel Is stopped. Errors for this channel are not displayed, Integral parameters are not stored. This mode is used For switching off the channel in summer period, For example, If no water.
Calc. chan. 2

"Setting/ PT parameters"

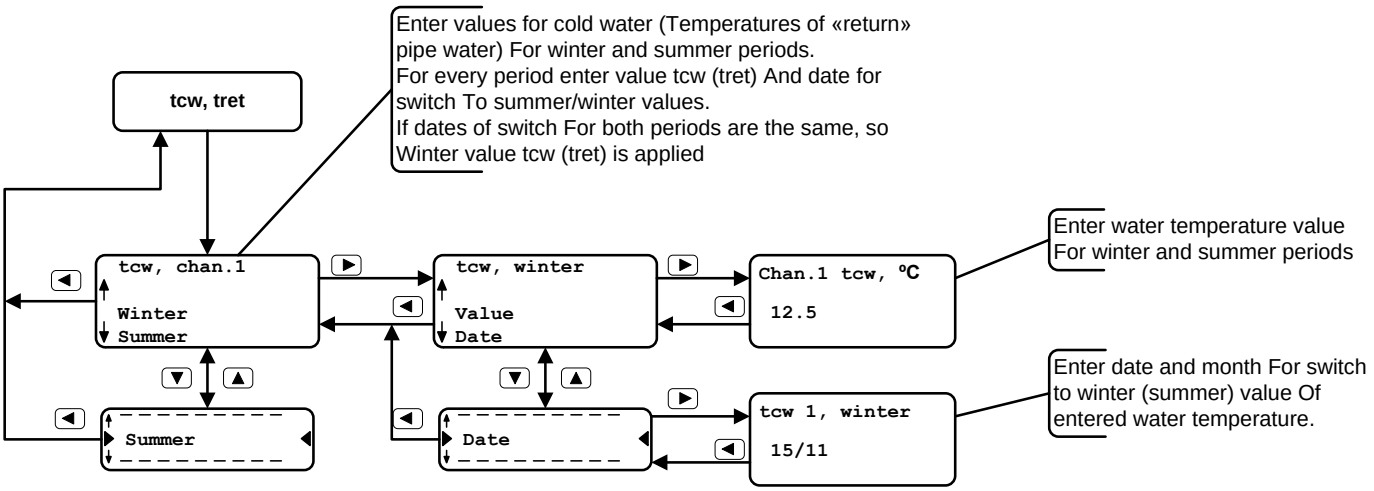



«Pulse inputs»
Pls. inputs
Number
Input 1
Set A number of used pulse inputs – from 0 to 2
Pls. inputs number 2
Input 1
Set parameters for selected Pulse input
Pls. input 1
Pulse weight
Max frequency
Input 2
Max frequency
Enter pulse weight
Pls.input 1, Weight, pls./GKal 2000
Enter maximum frequency Of input pulses, Hz. From 1 to 1000 Hz
Pls. inp.1, Max frequency, Hz 1000

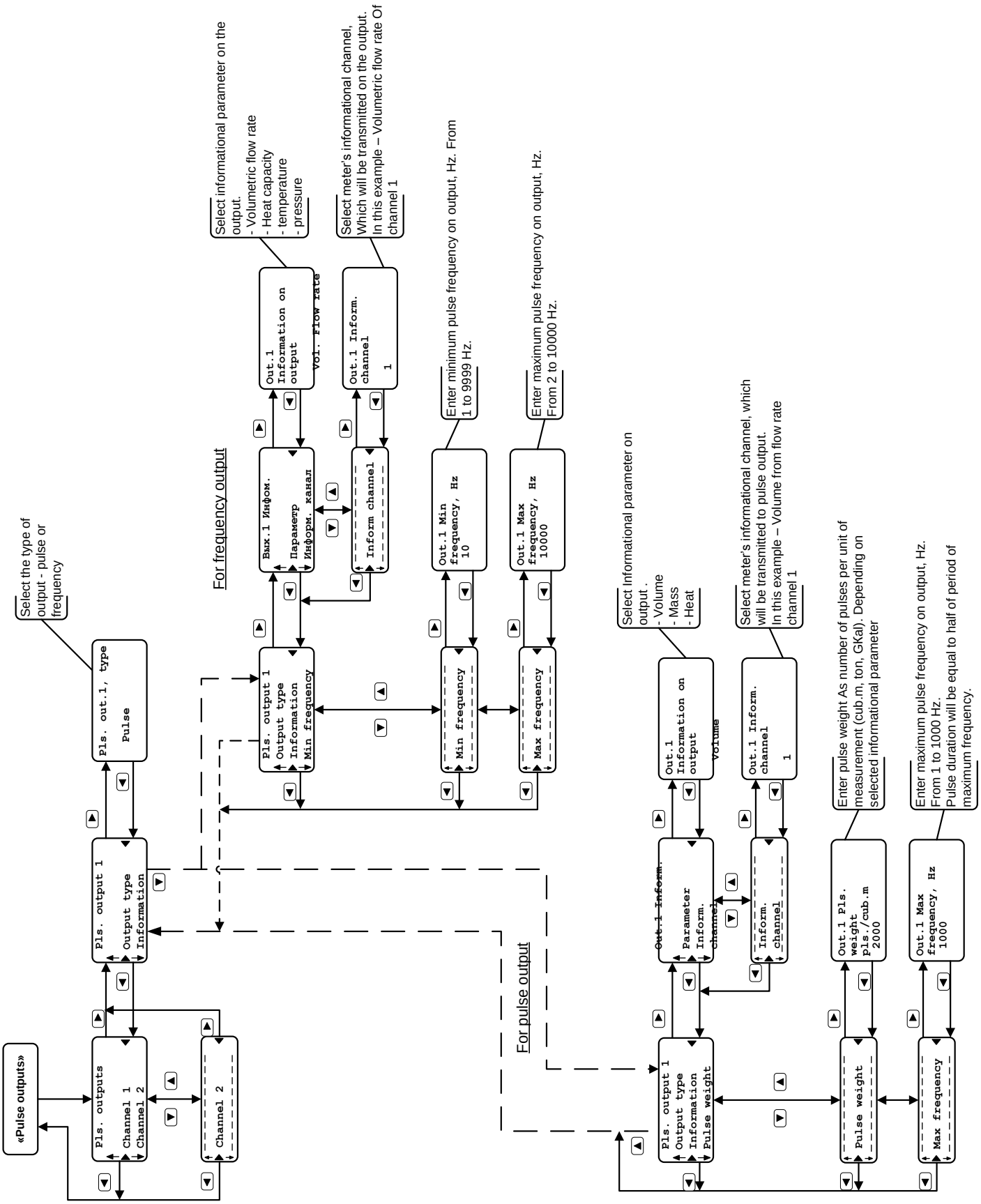
"Setting/ channel parameters"



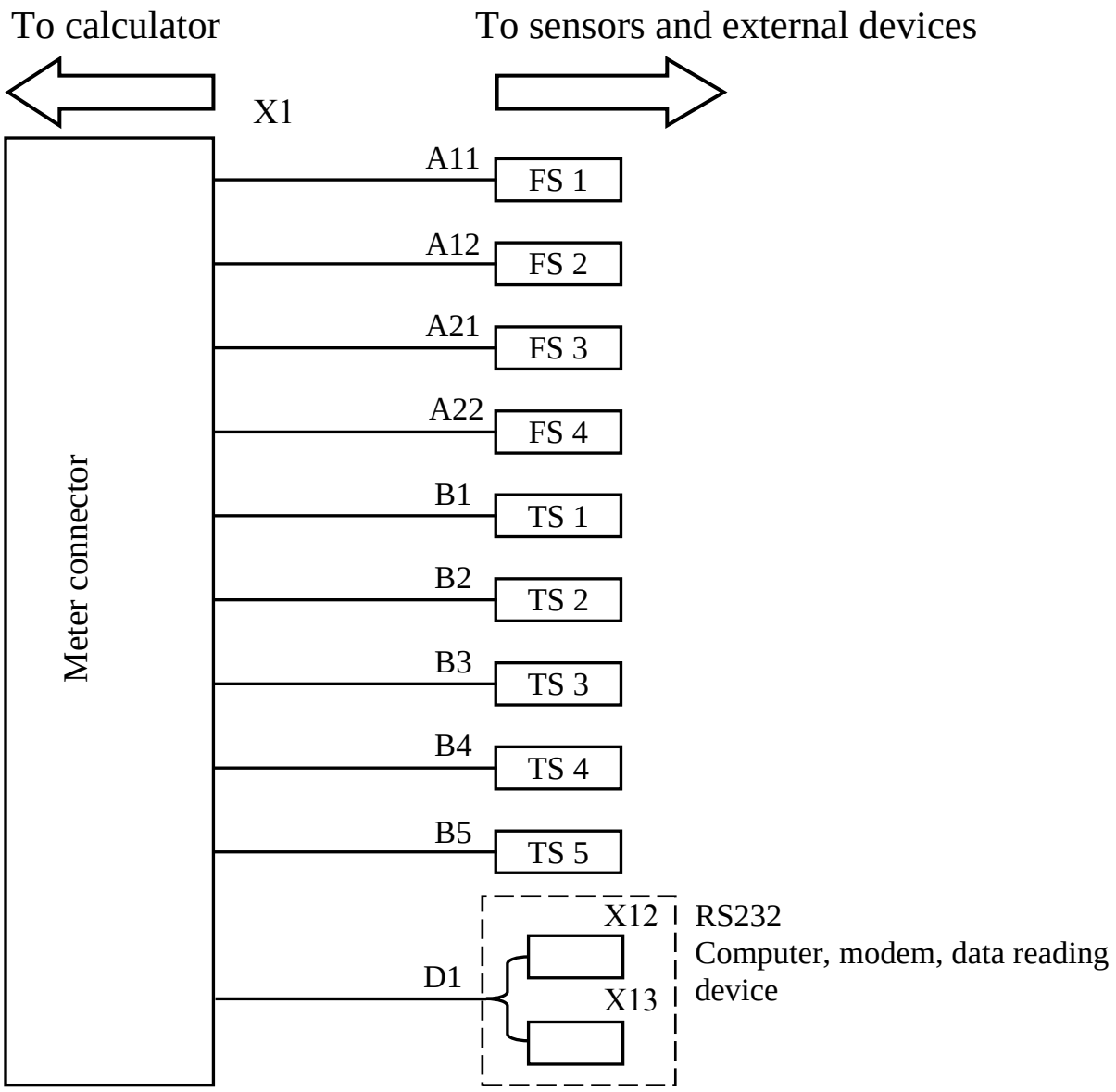
"Setting/Channel parameters/t_{cw}, t_{return}"



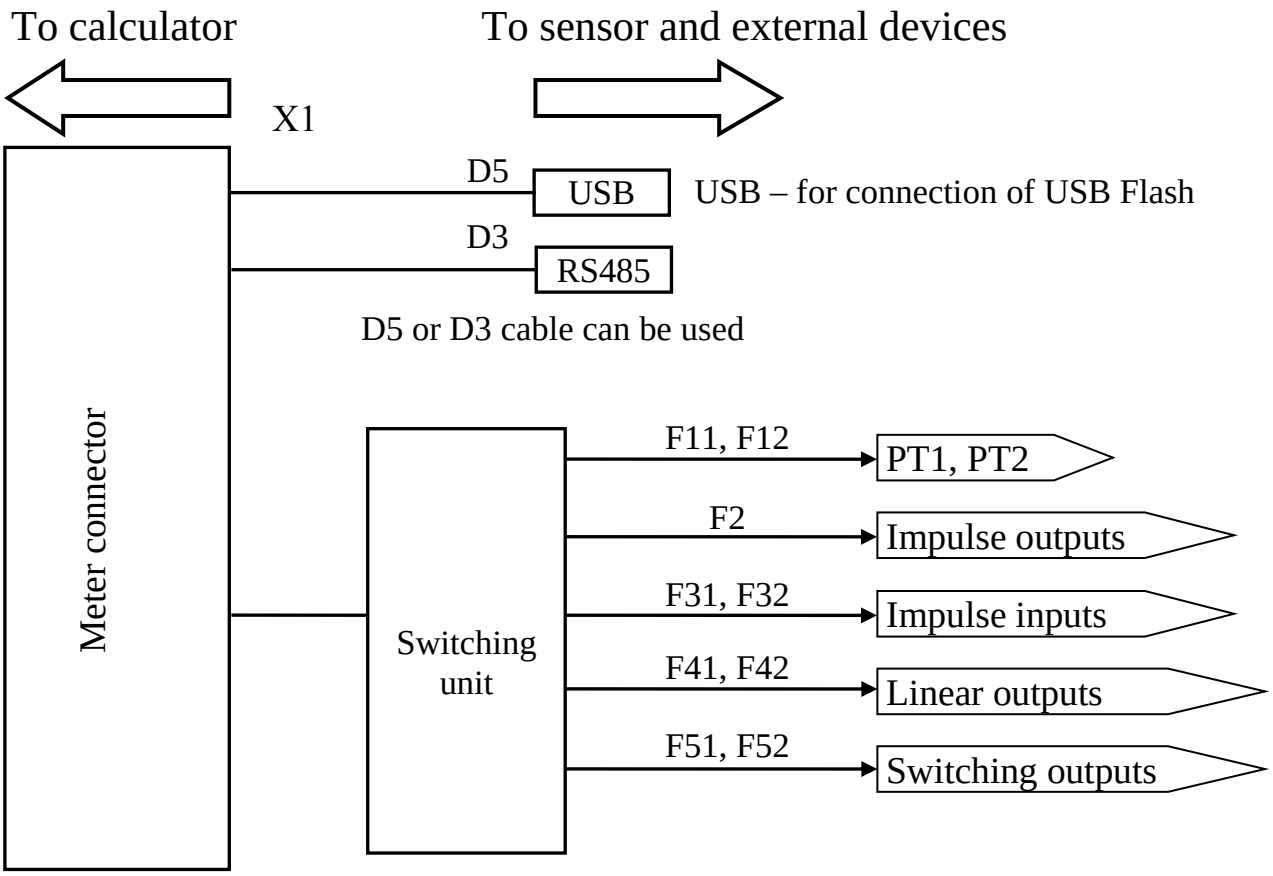
"Setting/ Impulse outputs"



Meter cable


To calculator
To sensors and external devices
X1
Meter connector
A11
FS 1
A12
FS 2
A21
FS 3
A22
FS 4
B1
TS 1
B2
TS 2
B3
TS 3
B4
TS 4
B5
TS 5
D1
X12
X13
RS232
Computer, modem, data reading device

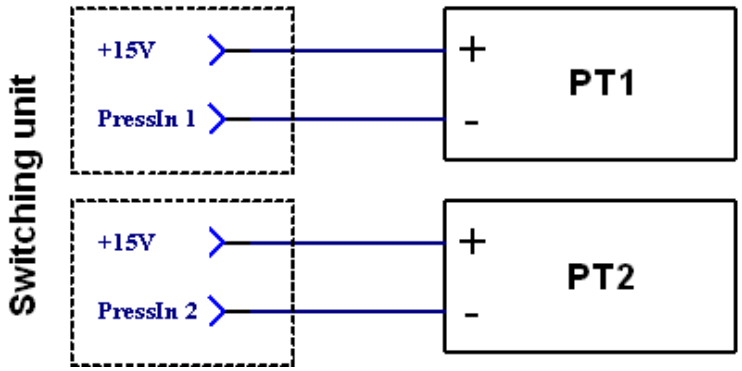
Meter cable
Additional devices



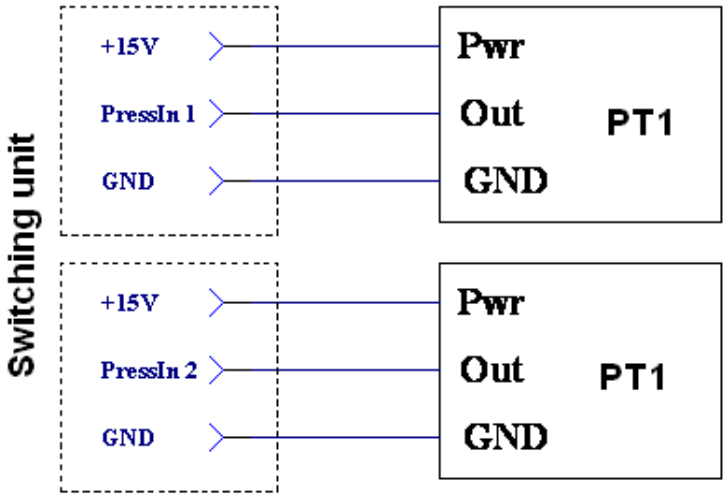
Application switching unit terminals

Designation	Application
PulsOut1	Impulse output 1
PulsOut2	Impulse output 2
PulsIn1	Impulse input 1
PulsIn2	Impulse input 2
LinOut1	Linear output 1
LinOut2	Linear output 2
SwOut1	Switching output 1
SwOut2	Switching output 2
+15V	Power +15 V for pressure transducers
PressIn1	Output PT1 (input for pressure transducer 1)
PressIn2	Output PT2 (input for pressure transducer 2)
GND	Ground – common leg for all signals. All GND contacts are interconnected

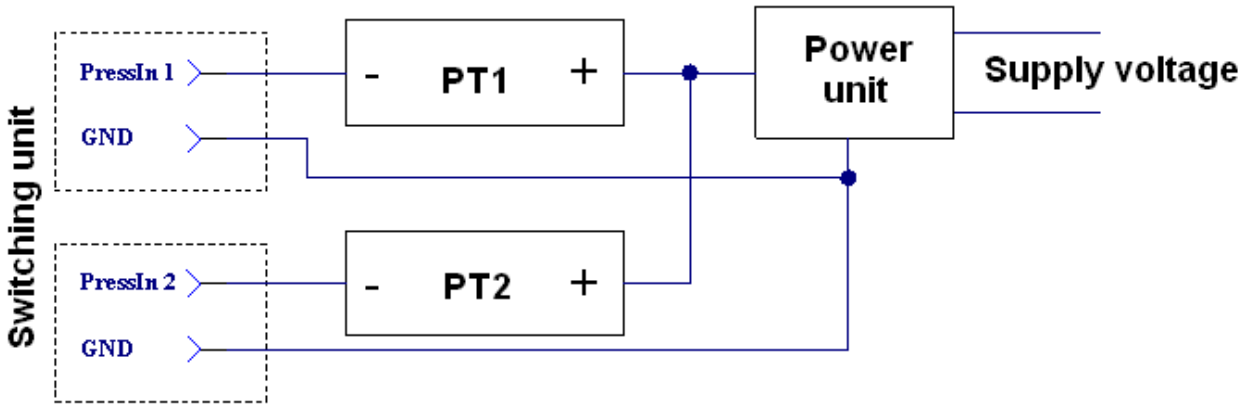
Variants of pressure transducers connection



Two-wire connection of the PT (if PT has only two outputs – «+» and «-»).

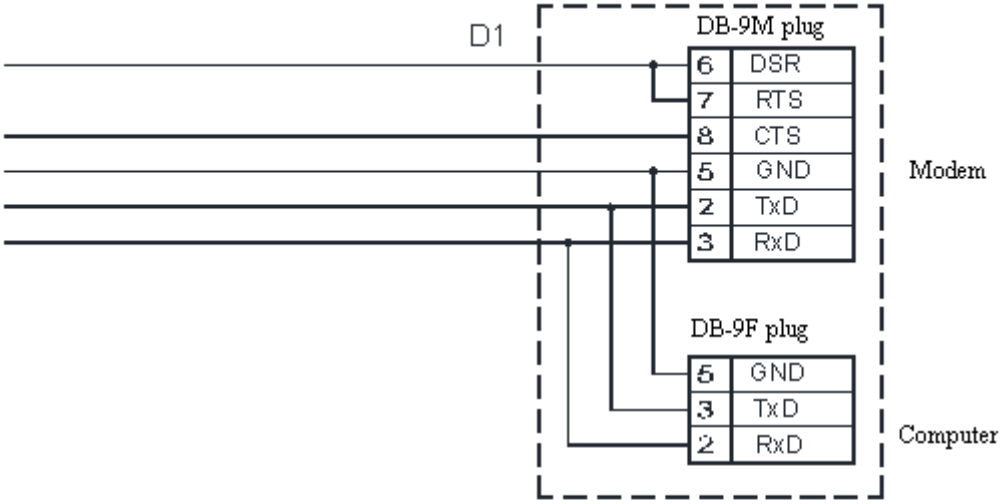


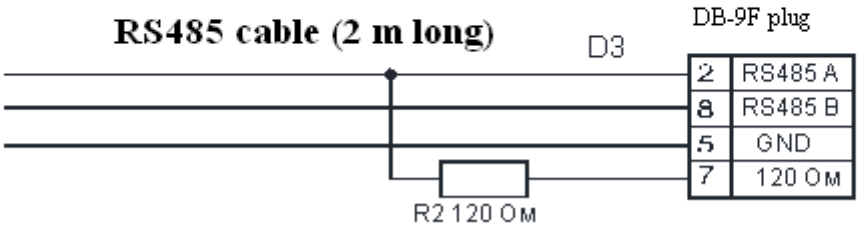
Three-wire connection of the PT (if PT has three outputs – power, ground and output).



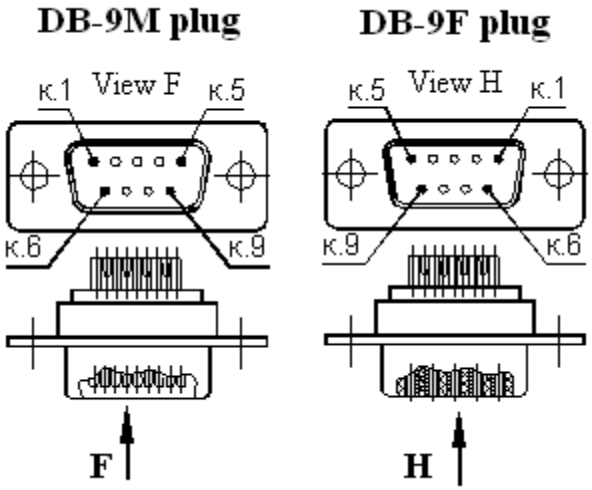
Connection of the PT by applying external power supply unit.

RS232 and RS485 connector wiring





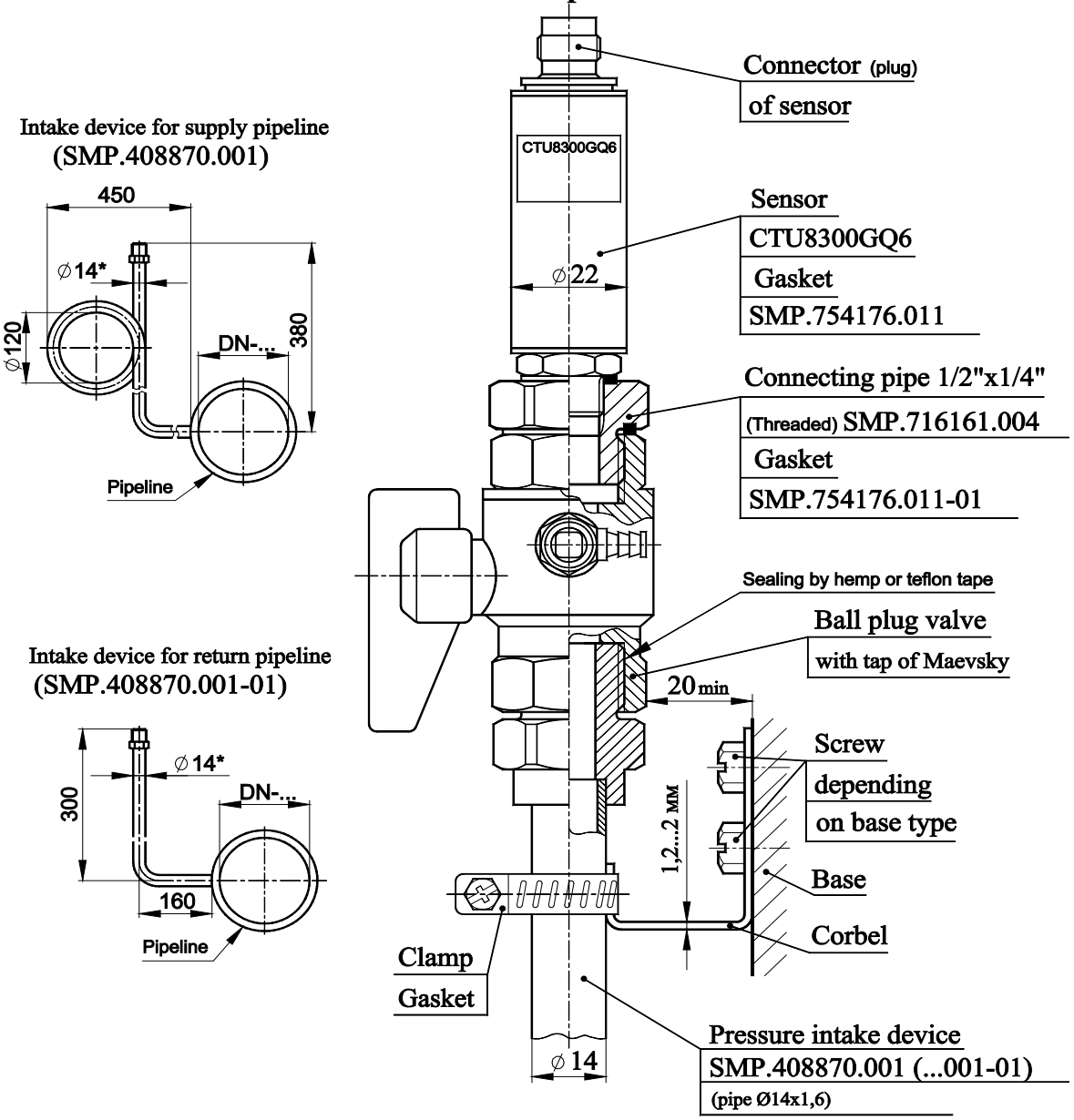
Connectors pinout schemes



Appendix I

Pressure sensor installation diagram

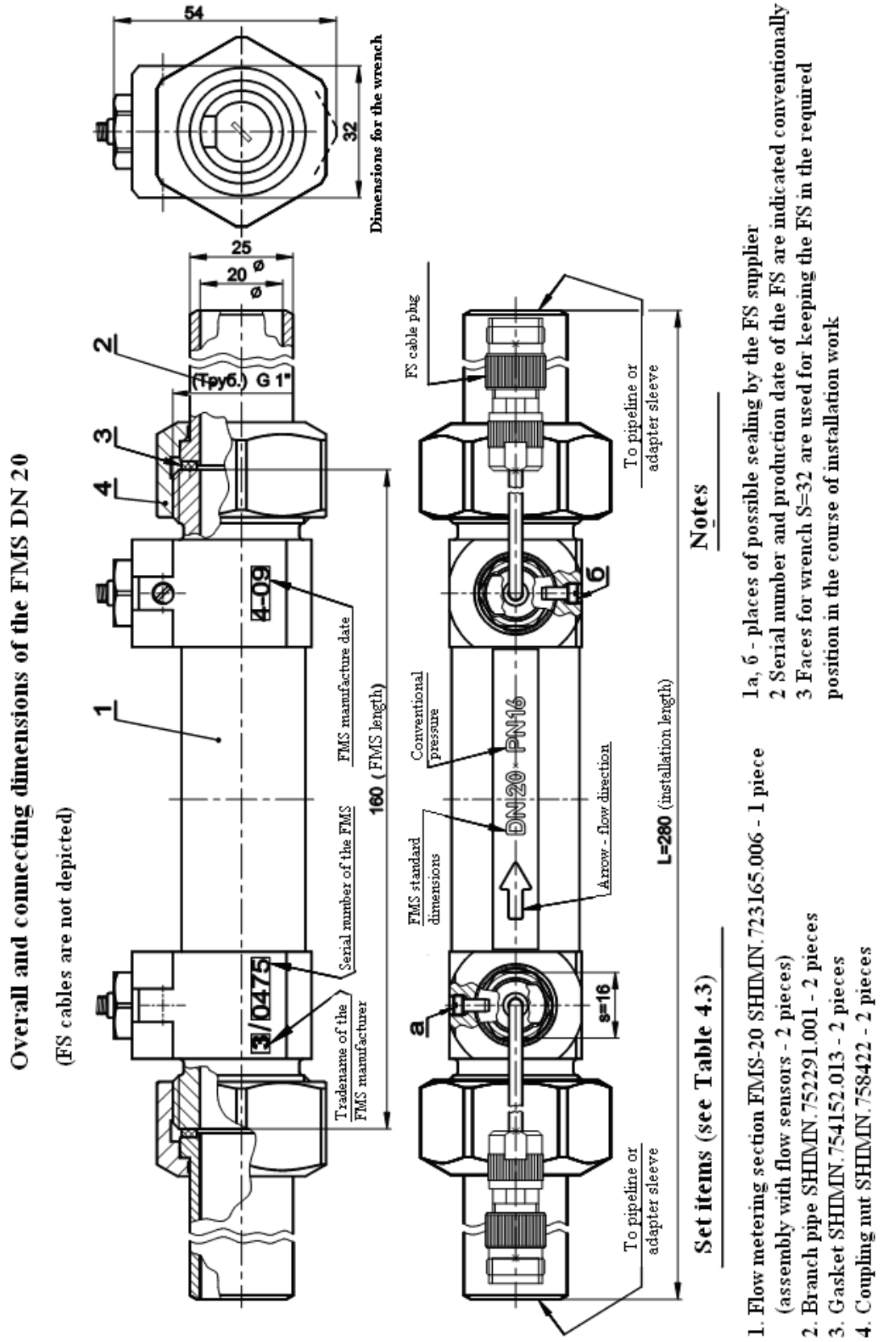
Recommended pressure sensor installation diagram
(for example CTU8300GQ6)
and dimensions of pressure transducers



1. The sensor shall be mounted in the strictly vertical position (see Figure).
2. Should water fail to comply with technical requirements with regard to polymerizing, crystallizing and other contaminations getting onto the sensitive element (diaphragm) of the sensor, it is necessary to provide a diaphragm seal by applying the separating organosilicon fluid No.2.
3. Length of time fuses must provide for water cooling to temperature not exceeding 70°C.

Appendix J

Overall and connecting dimensions of the flow metering section (FMS)

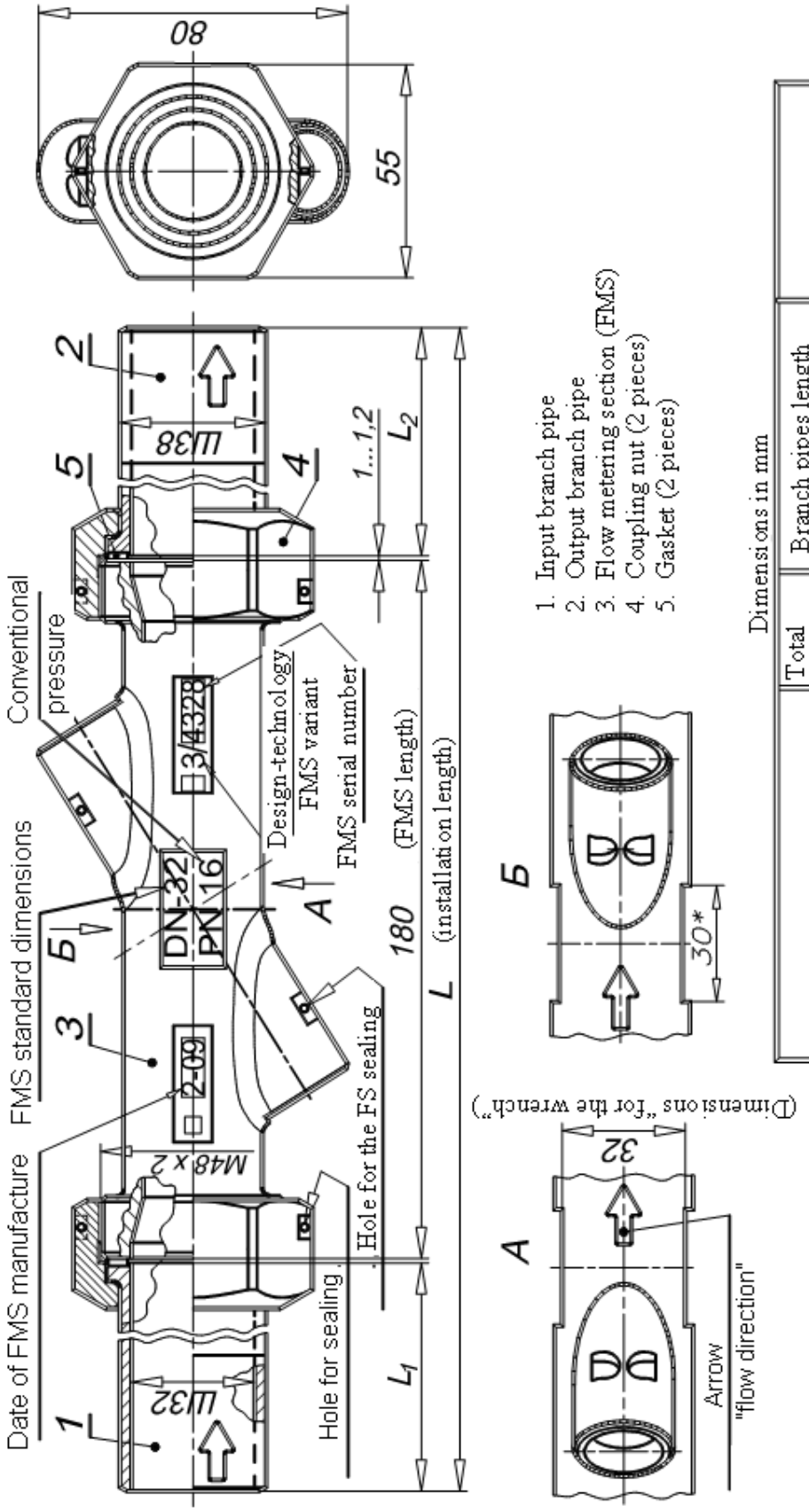


Notes

1а, б - places of possible sealing by the FS supplier
2 Serial number and production date of the FS are indicated conventionally
3 Faces for wrench S=32 are used for keeping the FS in the required position in the course of installation work

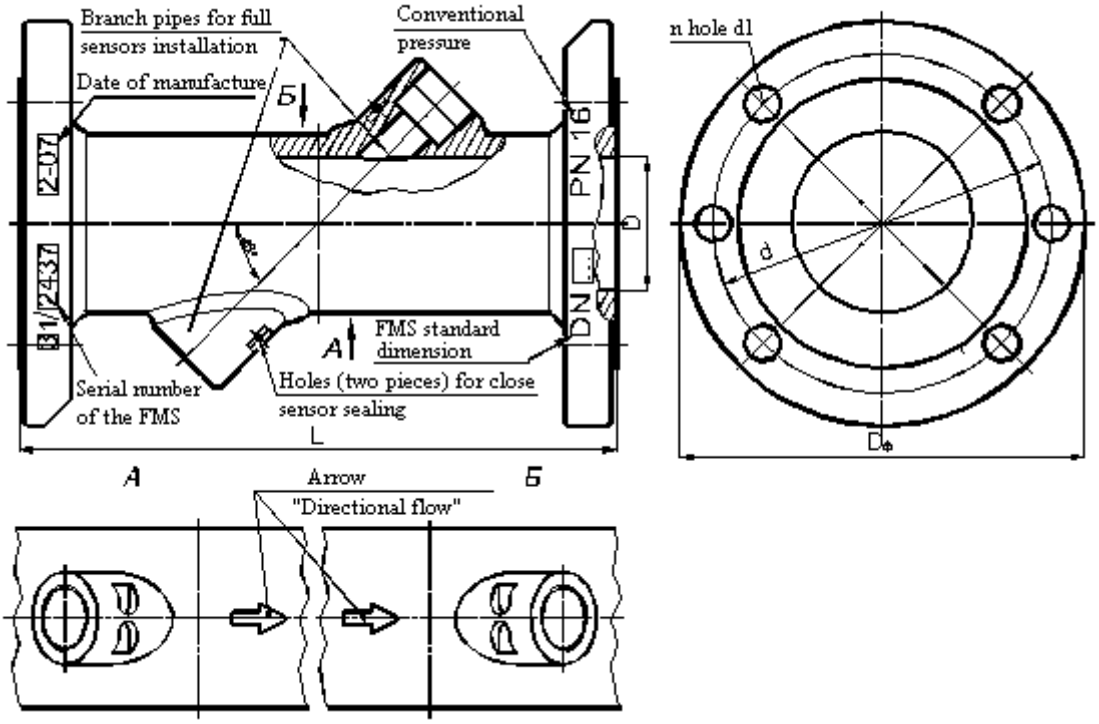
Set items (see Table 4.3)

1. Flow metering section FMS-20 SHIMN.723165.006 - 1 piece (assembly with flow sensors - 2 pieces)
2. Branch pipe SHIMN.752291.001 - 2 pieces
3. Gasket SHIMN.754152.013 - 2 pieces
4. Coupling nut SHIMN.758422 - 2 pieces

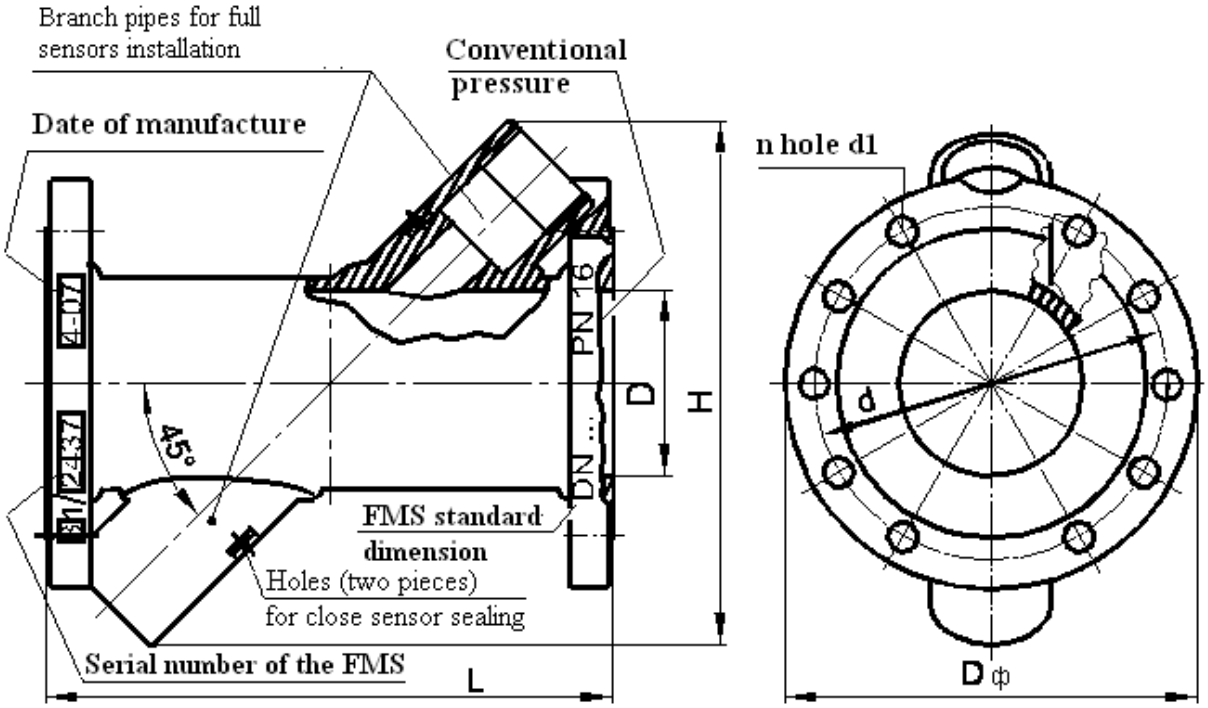


Set purpose – for heat and water meters	Total length of assembly	Branch pipes length		Notes
		pos. 2	pos. 3	
	L	L_1	L_2	
SVTU-10M M2; ...5M2	662	320	160	
SVTU-10M M1; ...5M1	892	480	230	

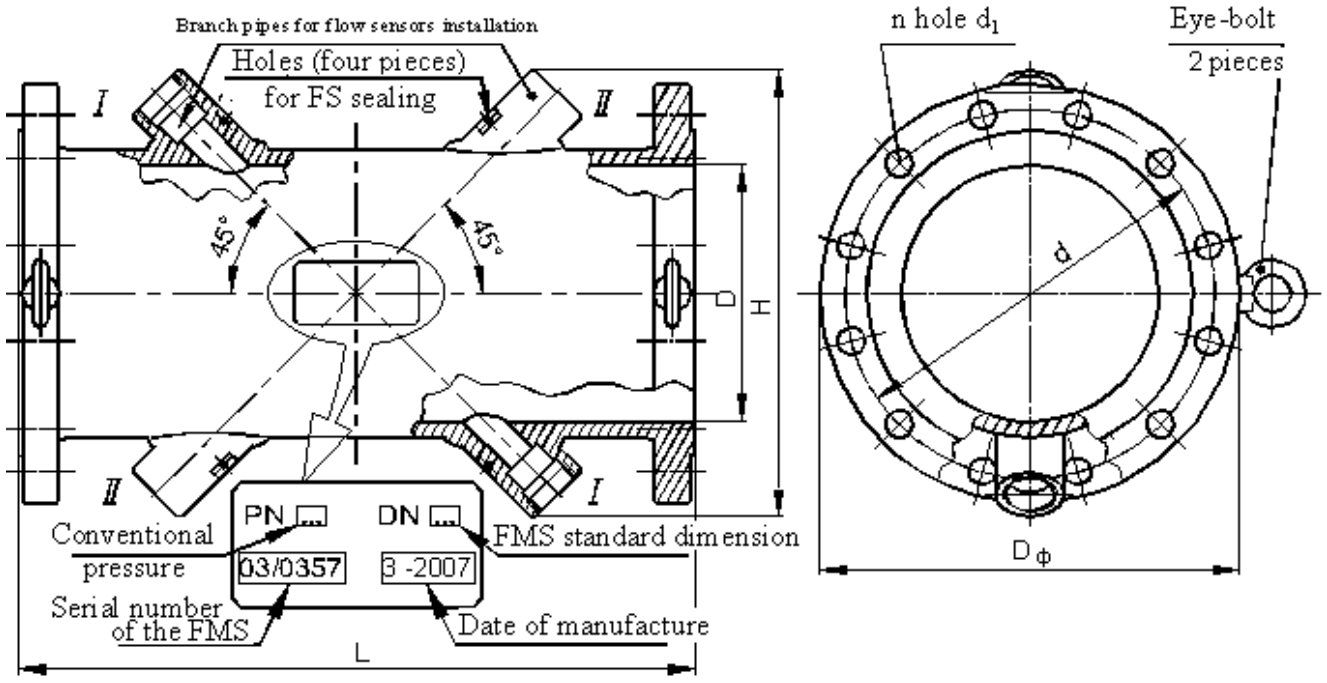
Overall and connecting dimensions FMS-32



FMS DN 50…100 (see Table 3.9)



FMS DN 125…150 (see Table 3.9)



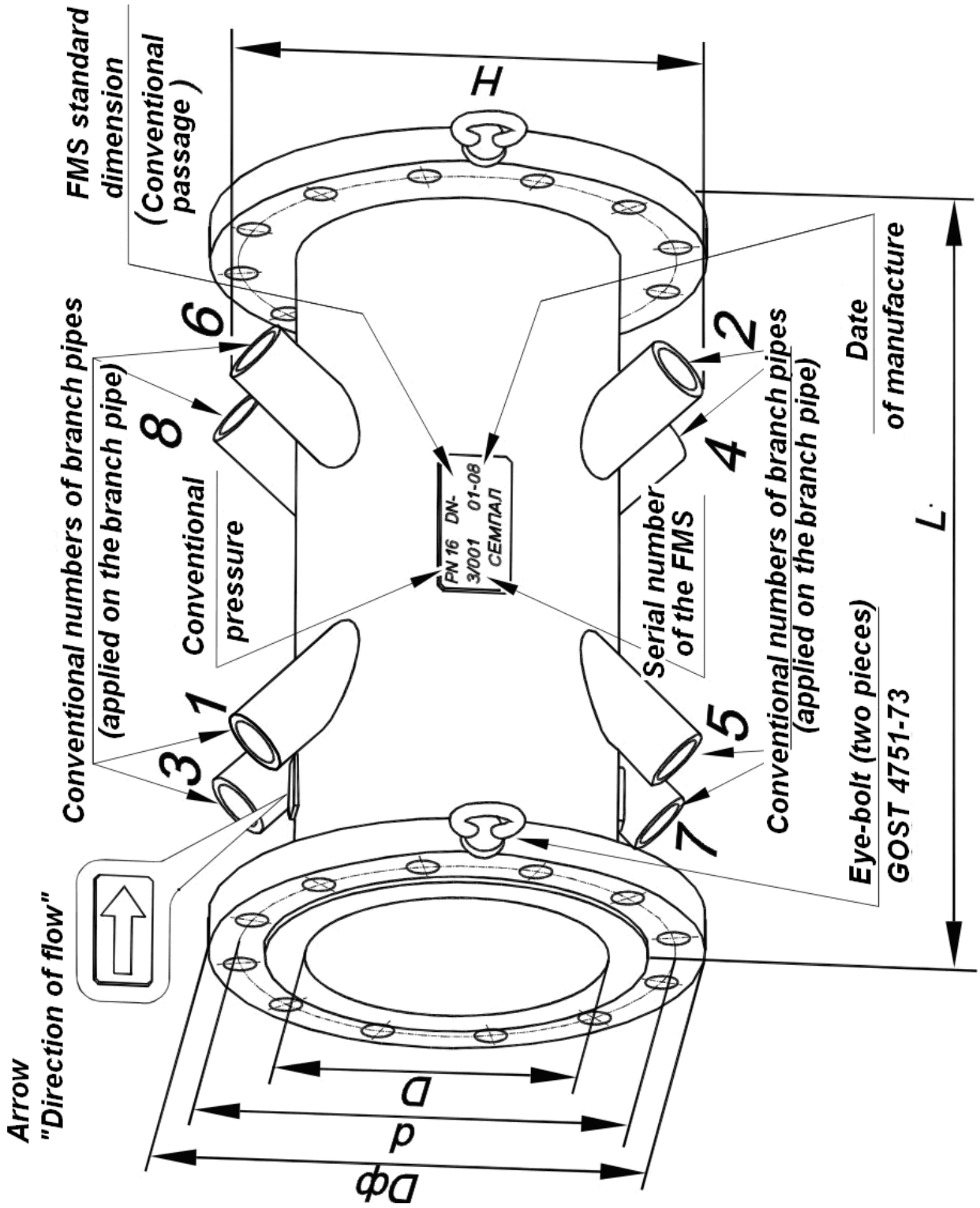
FMS DN 200…1000

Notes

1 Branch pipes *II* – II for standby FS and eye-bolts in FMS DN 200…300 shall be installed by agreement with the customer, and in the FMS DN 350…1000 –compulsory.

2 Channel diameter D for the FMS DN 200…600 may have one of two fixed values (indicated in Table 3.5) to facilitate selection of pipes for straight sections and must be specified in the order for the FMS.

3 FMSs may be manufactured of stainless steel and ferrous metals by agreement with the customer.


FMS standard dimension (Conventional passage)
H
Conventional numbers of branch pipes (applied on the branch pipe)
6
8
3
1
Conventional pressure
Serial number of the FMS
PN 16 DN-
3/001 01-08
СЕМПАЛ
2
4
5
7
Conventional numbers of branch pipes (applied on the branch pipe)
Date of manufacture
L
Eye-bolt (two pieces) GOST 4751-73
Arrow "Direction of flow"
D
d
Dф

Appendix K

Instructions on hydraulic zero setting

Hydraulic zero setting is necessary to prevent systematic errors in the elements that are possible due to the difference in conditions for setting hydraulic zero at the time of the meter manufacture and the operation conditions at the facility.

It is represented as the difference in the meter readings from the zero readings at the actual flow rate value equaling to zero.

This operation allows avoiding systematic errors in measurements in future measurement results.

The meter operation without installation of hydraulic zero or incorrect setting of zero may result in occurrence of significant errors in flow rate measurements, especially at low values of flow rate.

Setting zero must be carried out:

- At putting the meter in operation;
- After dismantling-installation of the flow meter (ДР) in the course of scheduled maintenance operations;
- After changes in cables connection to the flow metering section (FMS);
- In the course of checking the flow metering channel operation ability.

Requires skills of the meter operation, zero setting for each heat meter channel is recommended to be carried out by the consumer on the «deadened» FMS first, and then, compulsory, at the facility. At facilities where it is impossible to reliably close the flow of the heat transfer liquid, setting of zero on the «deadened» FMS is the only way to correctly put the device in operation. This being the case, it is necessary to provide for the duplication of the flow metering channels and FSs cables connection diagram used at the laboratory setting of zero. In this case, the FS shall not be dismantled from the «deadened» FMS.

As, after zero setting process is completed, a certain constant characterizing the particular connection is stored in memory, changes in cables connections may result in systematic errors of flow rate.

Such negligence committed in the course of the meter installation may result in «shunt running», when, at zero rate of the heat transfer liquid flow, the device will display a certain flow rate.

1 Check of zero setting accuracy of the «deadened» FMS:

1.1 Assemble the flow metering section with the temporary cover on its end, place it into the vertical position, install flow sensors and fill the flow metering section with preliminary boiled or settle water (for 24 hours) to remove air bubbles. Remove air bubbles from the sensor ends by hand or a brush, if they formed in the course of the flow metering section beem filled with water.

1.2 Connect the FS and thermal resistance (TR) to the appropriate cables.

1.3 After connecting the device to the power supply the indicator must not display any flow and temperature measurements errors.

1.4 Enter «Installation of zero» mode and form setting of both channels at the same time or separately. In the course of installation, two groups of digits are displayed on the screen. The first is devoted to the hardware information on the zero rate of the heat transfer liquid and is stored in the devise till the next setting is performed. The second group indicates the number of cycle of zero rate measurements. In case of similar types of FMSs, such number of cycles of measurements, as a rule, coincides. In case of different types of FMSs, they also may differ, within the range of 30-50 cycles, but not exceeding 63.

1.5 If setting of zero has been completed without a positive result, it is necessary to check the integrity of cables, quality of contacts in connectors, and then repeat the procedure once again.

2 To provide for the successful installation of the hydraulic zero at the facility, it is necessary to guarantee**:**

- Reliable shutting of the heat transfer liquid flow from two sides of the flow metering section by applying gate valves;

- Quality of installation and serviceability of flow meters, temperature sensors, as well as connecting cables;
- Availability of reliable electrical contact between the grounding contact of the socket used for the power supply of the calculator and the grounding circuit of the premises in which the meter is installed;
- Electromagnetic situation created by the equipment must not exceed the level acceptable for the meter operation, that is, it must comply with standards set forth in GOST R 51649-2000 and in GOST R 51522-99.

Prior to setting hydraulic zero, it is necessary to pass the heat transfer liquid (water) through the system of heat and water supply of the facility for half an hour at the maximum possible flow rate, and then close the gate valve installed after of the flow metering section, for after that the gate valve located in front of the flow metering section. Hydraulic zero setting shall be carried out in several minutes after that to prevent water fluctuation in the blanked-off section.

If the value of the first group of digits displayed on the meter indicator and registered by the meter as the zero heat transfer liquid flow rate exceed 500 or number of measurement cycles significantly larger than the number determined at the time of zero setting on the «deadened» FMS, then the following is possible:

- Air bubbles in the FMS;
- Leakage of the heat transfer liquid through gate valves;
- Significant level of external electromagnetic interferences.

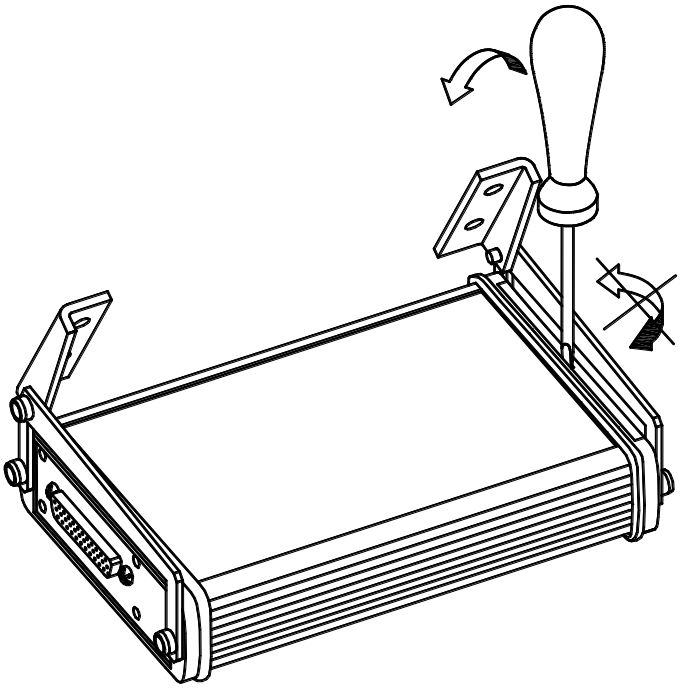
The level of interferences can be reduced by reducing the potential between the grounding circuit of the power supply socket (grounding circuit of the premises) and the FMS.

Availability of external standby units of power supply or external power supply filter pluged into the ungrounded socket will not reduce the level of interferences. The use of the above devices may provide positive effect only when the quality grounding circuit (certified) is used.

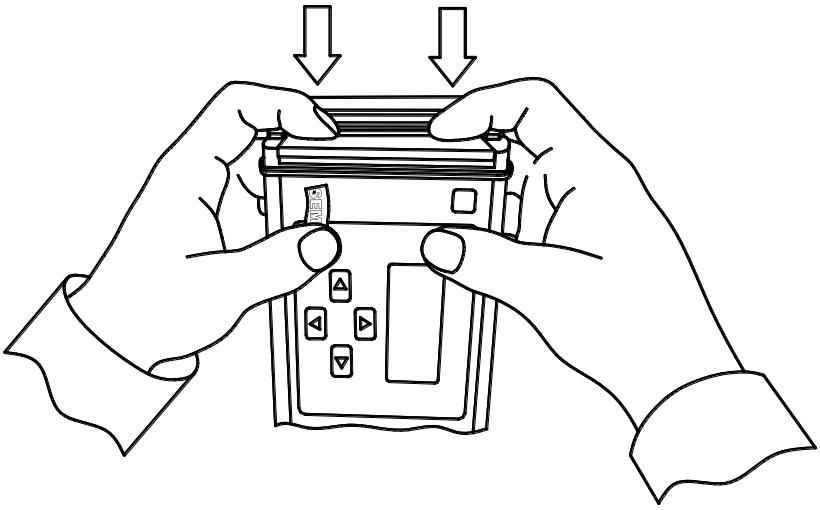
Appendix L

Battery installation and removal

To open the battery section cover

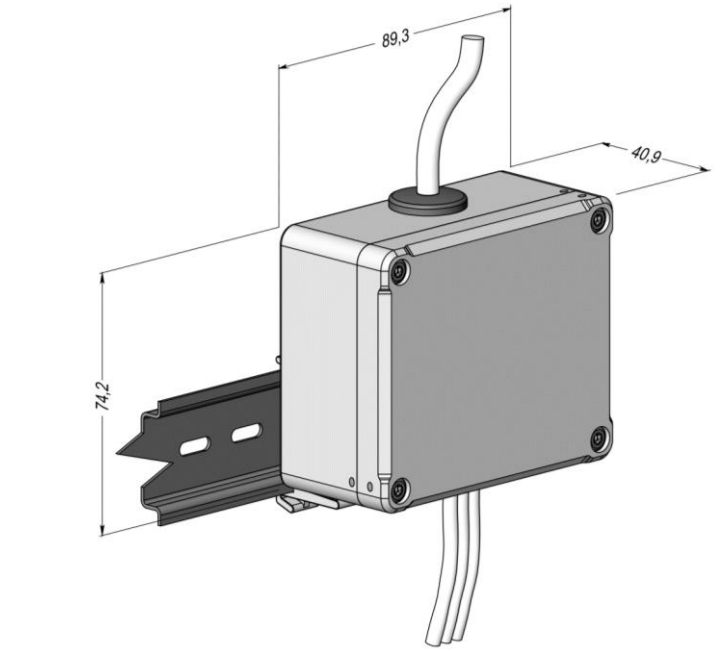


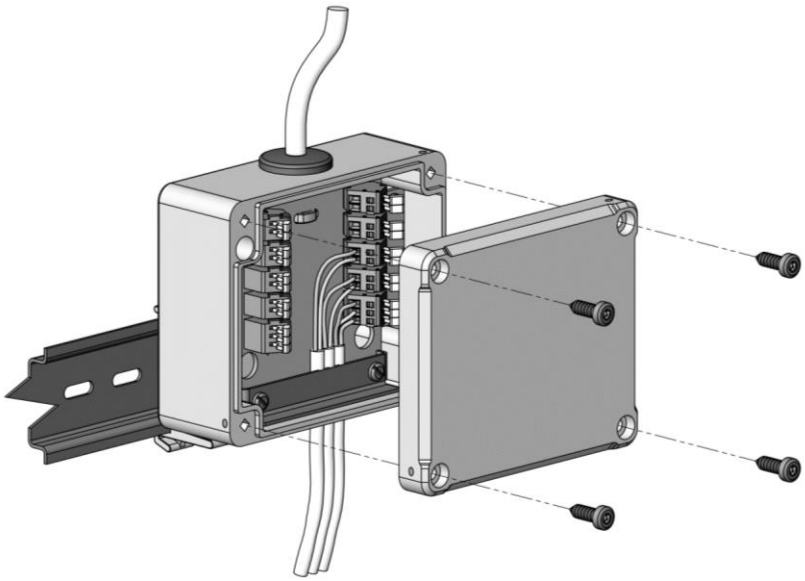
To close the battery section cover



Appendix M

Switching unit





Connection of wires to terminal blocks

Press force direction