THE INSTITUTE OF FLOWMEASUREMENT TECHNOLOGY *ELKORA*

STEAM METER

ELKORA S-23

Operating Manual
E1.003 TA

2004

Content

1. INTRODUCTION

Steam meter ELKORA S-23 is intended for commercial and technological accounting of consumed and developed steam thermal energy, as well as for determination of steam flow and quantity in steam systems in industry and communal farms. The steam meter is designed for continuous operation.

The steam meter can be connected to data processing and energy accounting computing equipment.

The steam meter meets the requirements of the European standard EN 1434.

2. STRUCTURE AND PRINCIPLES OF OPERATION

2.1. The composition of the steam meter

The steam meter consists of the following functional units:

• computer block;

• flow sensor;

• resistance thermometers;

• pressure sensor

The computer block has two constructive versions - the one for installation in a column and one for wall mounting.

The rack-mounted computer unit includes separate functional modules combined in one housing:

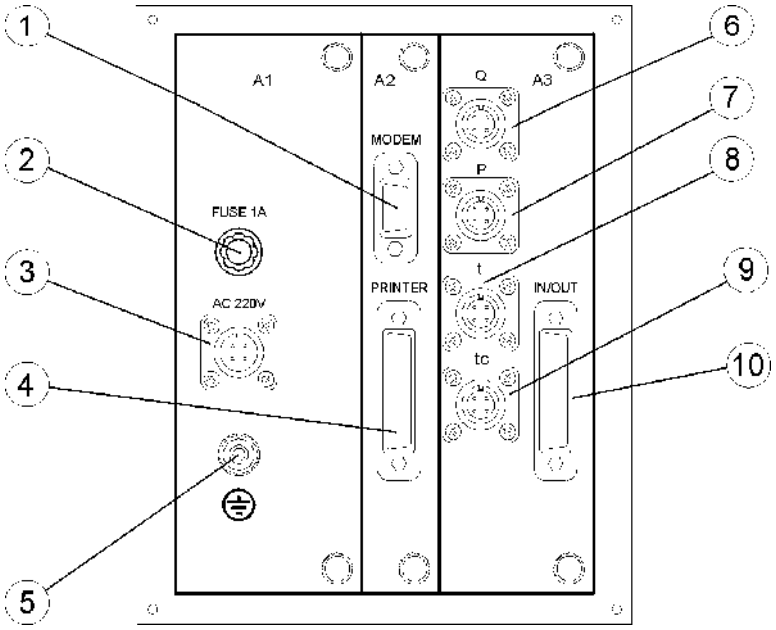
• power supply module A1;

• processor module A2;

• analog signal module A3;

• indication device module.

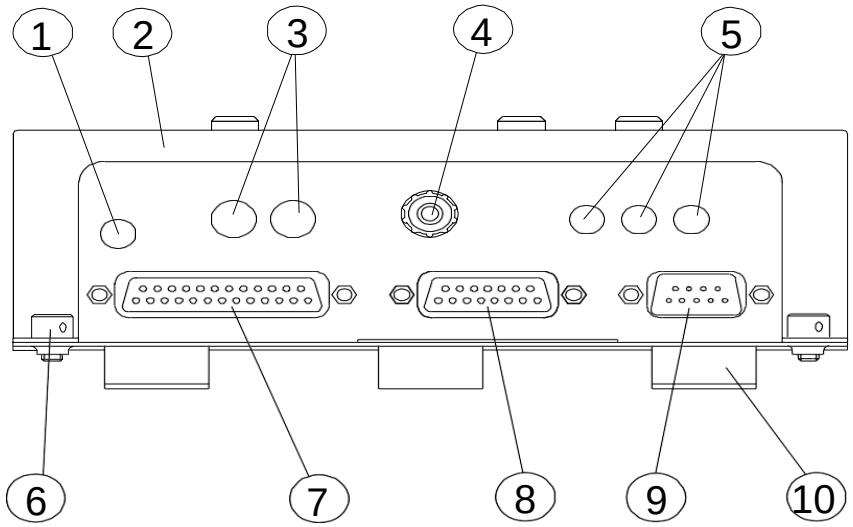
The drawing shows the back of the rack mount computer unit.



Markings:

1 "MODEM" port;
2 power supply fuse "FUSE 1A";
3 power supply socket «AC 220V»;
4 port «PRINTER»;
5 ground terminal;
6 flow sensor «Q» port;
7 pressure sensor «p» port;
8 resistance thermometer «t» port;
9 resistance thermometer «tc» port;
10 socket "IN/OUT" frequency, pulse and current outputs.

In the rear part of the detachable housing of the wall-mount computer unit, a board with the functional nodes of the power supply, analog signal processing and processor is fixed. An indication device is placed in the front part of the case. 2.2. the drawing shows the lower part of the wall mount computer unit.



2.2.image. The lower part of the wall mount computer unit

Markings of 2.2.image:

1 - power cable entry;

2 - the front part of the body;

3 - input of flow and pressure transmitter cables;

4 - earth terminal;

5 - input of resistance thermometer cables;

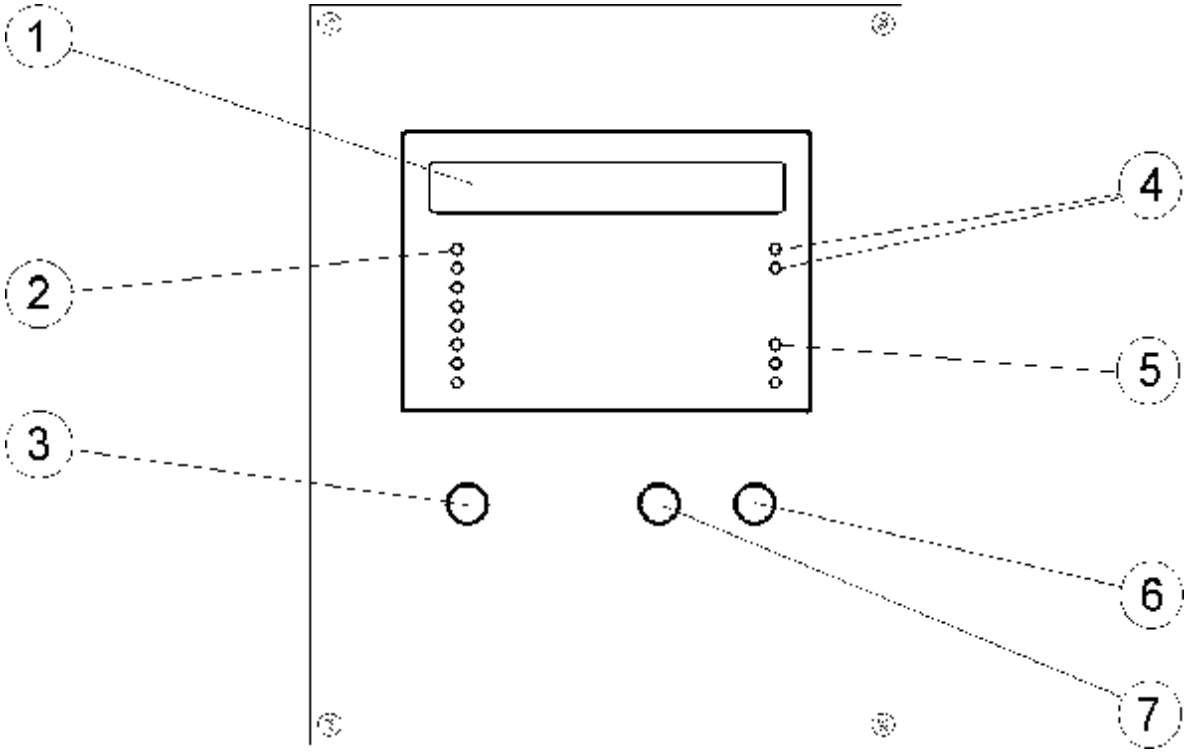
6 - screw with block sealing;

7 - printer port for the "Centronics" interface;

8 - frequency, pulse and current outputs «IN/OUT»;

9 - peripheral device port for RS-232 interface; 10 □ rear part of the body.

Figure 3 shows a block view of the calculator



2.3. image. Calculator block preview

Designations for 2.3.image :

1 - liquid crystal display;

2 - indicator LEDs of the considered parameter;

3 - «**ON**» key;

4 - LEDs that signal the working mode of the system;

5 - LEDs that signal the operating status of the flow, temperature and pressure transducers (green light - normal operating mode, red light - unacceptable operating mode);

6 - key «⇨»;

7 - key «⇦»

2.2. Flow measurement principle

The principle of flow measurement is based on the measurement of the frequency of vortices in the steam flow behind the flow body. A prism is installed inside the measured section of the flow sensor, perpendicular to the flow of the medium to be measured, behind which, at certain values

of the flow speed and viscosity of the medium, a Karman vortex path occurs - vortices with a certain frequency, which in turn break off from the prism's edges. Frequency, according to Struhal's criterion:

$$f = v\,Sh/d,$$

proportional to **v/d**, therefore, at constant characteristic prism size **d**, proportional to speed **v**, therefore, proportional to volume consumption. A piezoelectric element is installed behind the flow body, which registers the frequency of the eddies, converting it into electrical signals.

The flow value is calculated by the processor of the electronic unit with the calibration coefficients for the vortex transducers, which are determined during the calibration run and written to the permanent memory.

2.3. Principle of temperature measurement

The temperature of the steam in the pipeline is measured using resistance thermometers with 100П, Pt 100 or Ni 100 characteristic curves. Resistance thermometers are connected according to the 4-wire scheme, which ensures the independence of the measurement results from the length of the connecting cables.

With the help of an electronic commutator, the measuring current is passed alternately through resistance thermometers and reference resistors. The voltage drop measurements are processed in the computer block, where the thermometer resistance R(t) is calculated. From now on, the temperature value is calculated according to the following relationship

$$t = a\left[\frac{R(t)}{R_0} - 1\right] + b\left[\frac{R(t)}{R_0} - 1\right]^2,$$

where

$\mathbf{R_0}$ = 100 Ω,

a and **b** – coefficients that depend on the characteristic curve of the resistance thermometer.

2.4. Principle of pressure measurement

The pressure is measured by pressure sensors that have a unified output current signal of 4 20 mA. The connection is made according to the two-wire scheme, and the power source of the sensors is the steam meter itself.

2.5. Calculation of heat capacity and energy

The heat capacity of steam is calculated according to the formula:

$$P = Q \rho h$$

Where **Q** – steam flow,
r – vapor density,
h – specific enthalpy of steam.

Vapor density and specific enthalpy depend on vapor temperature and pressure and are taken from the tables: "*Вода. Удельный объем и энтальпия при температурах 0...800 С и давлениях 0,001...1000 МПа.* М.: 1995-68 с."

Thermal energy is calculated according to the formula:

$$W = \frac{T}{T_o} \int P(T)d$$

Where

T_0 – start of heat energy summation time

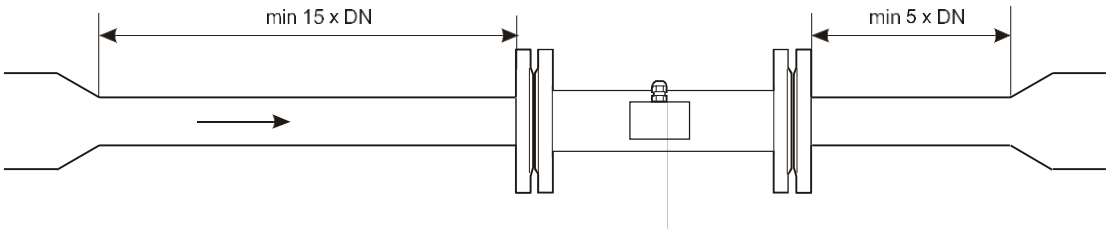
T – current time.

3. MECHANICAL ASSEMBLY

3.1. Assembly of the flow sensor

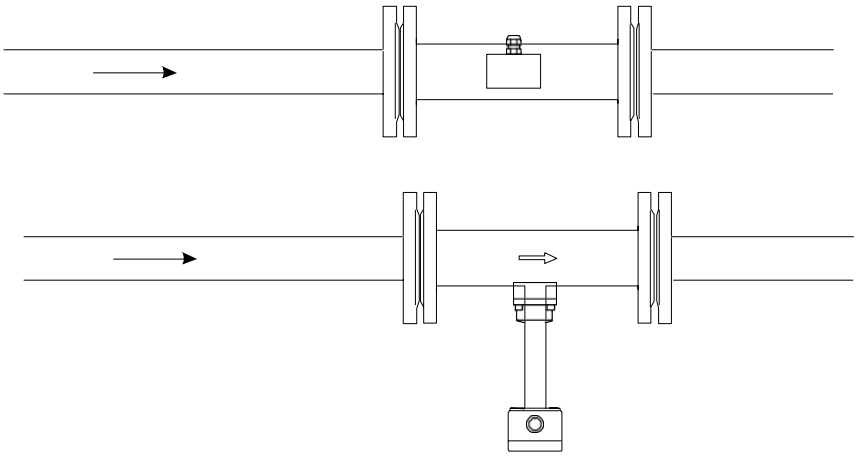
When assembling the flow sensor, it is necessary to observe the following rules:

- The mounting location of the flow sensor must be located in the straight section of the pipeline, the length of which is not less than 15 internal diameters before the sensor and 5 internal diameters behind the sensor (3.1.image).



3.1. image

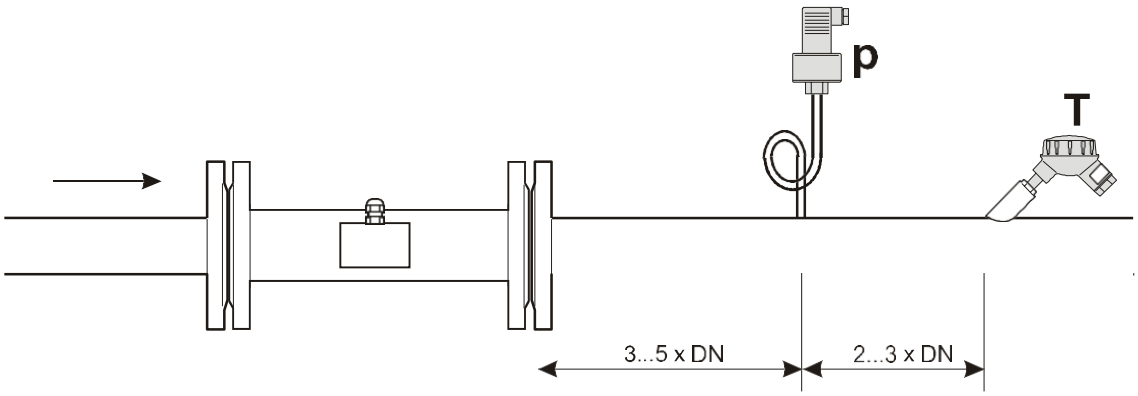
- The flow sensor can be mounted both on a horizontal and on a vertical pipeline. When mounting on a horizontal pipeline, the flow sensor should be placed as shown in 3.2. image.



3.2. image

- The direction of flow must match the direction of the arrow on the flow sensor.
- The internal diameter of the flow sensor must be equal to the internal diameter of the pipeline.

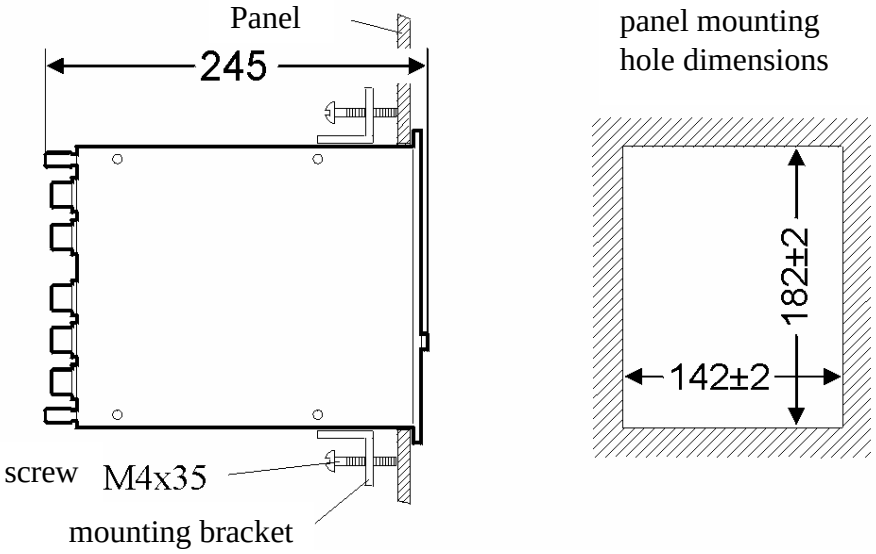
3.2. Assembly of resistance thermometer and pressure transmitter



3.2.1. image

3.3. Block assembly

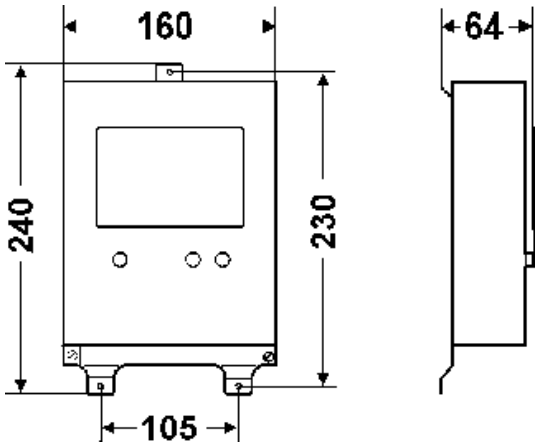
The rack-mounted computer unit is mounted in the rack so that convenient access to the unit's contacts is provided. Block assembly and placement parameters are specified in 3.3.1. image.



3.3.1. image. Assembly and placement scheme of the rack-mountable computer block

The wall mount computer unit mounts directly to the wall.

Overall and installation dimensions are specified in 3.3.2.image



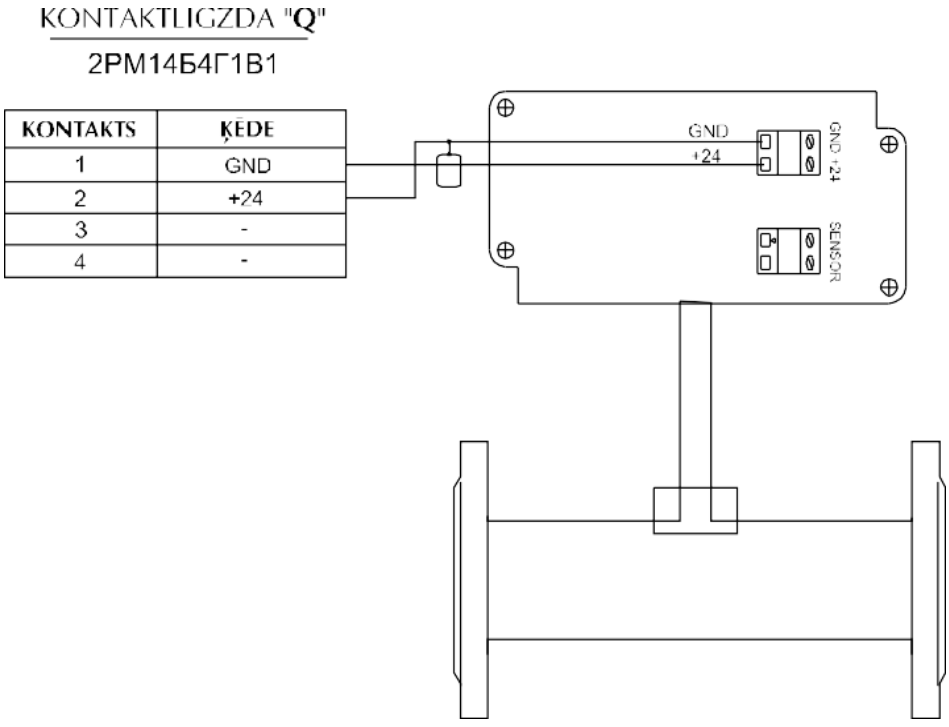
3.3.2. image

4. ELECTRICAL ASSEMBLY

The flow sensor is connected to the computer unit using a coaxial cable, the length of which does not exceed 300 m and the diameter of which does not exceed 6 mm.

Resistance thermometers are connected to the computer unit using any 4-wire copper wire cable with a cross-sectional area of wires from 0.25 mm^2 to 0.75 mm^2 and its length does not exceed 300 m.

The pressure sensor is connected to the computer unit using any 2-core copper cable with a wire cross-sectional area of 0.25 mm^2 to 0,75mm^2

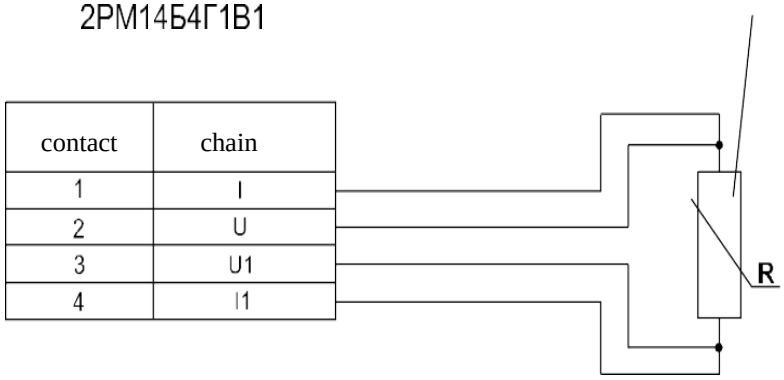


4.1. image. Connection diagram of flow transducers for a rack-mounted computer unit.

Sockets “**t**” and “**tc**” resistance thermometer

2PM14Б4Г1В1

contact	chain
1	I
2	U
3	U1
4	I1



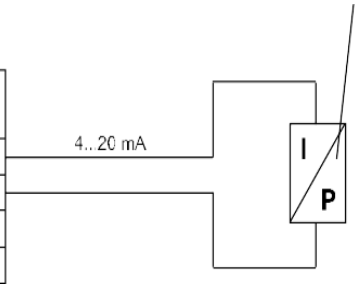
4.2. image. Connection diagram of resistance thermometers for a rack-mounted computer unit.

pressure transmitter

Socket “**p**”

2PM14Б4Г1В1

contact	chain
1	+24 V
2	GND
3	-
4	-



4.3. image. Pressure sensor connection diagram for a rack-mounted computer unit.

Outlet **“AC 220V”**

2PM14Б4Ш1В1

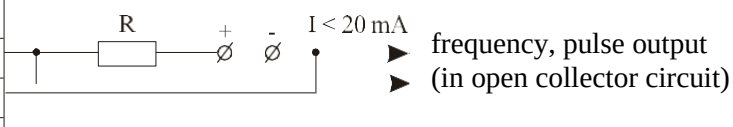
contact	chain
1	
2	~220V
3	nulle
4	zeme

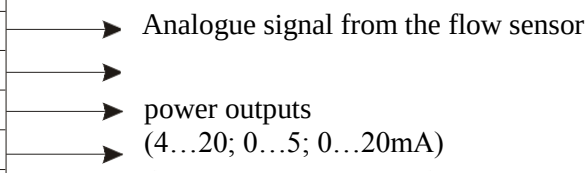
4.4. image. Mains voltage connection diagram for a rack-mounted computer unit

Socket “**IN/OUT**”

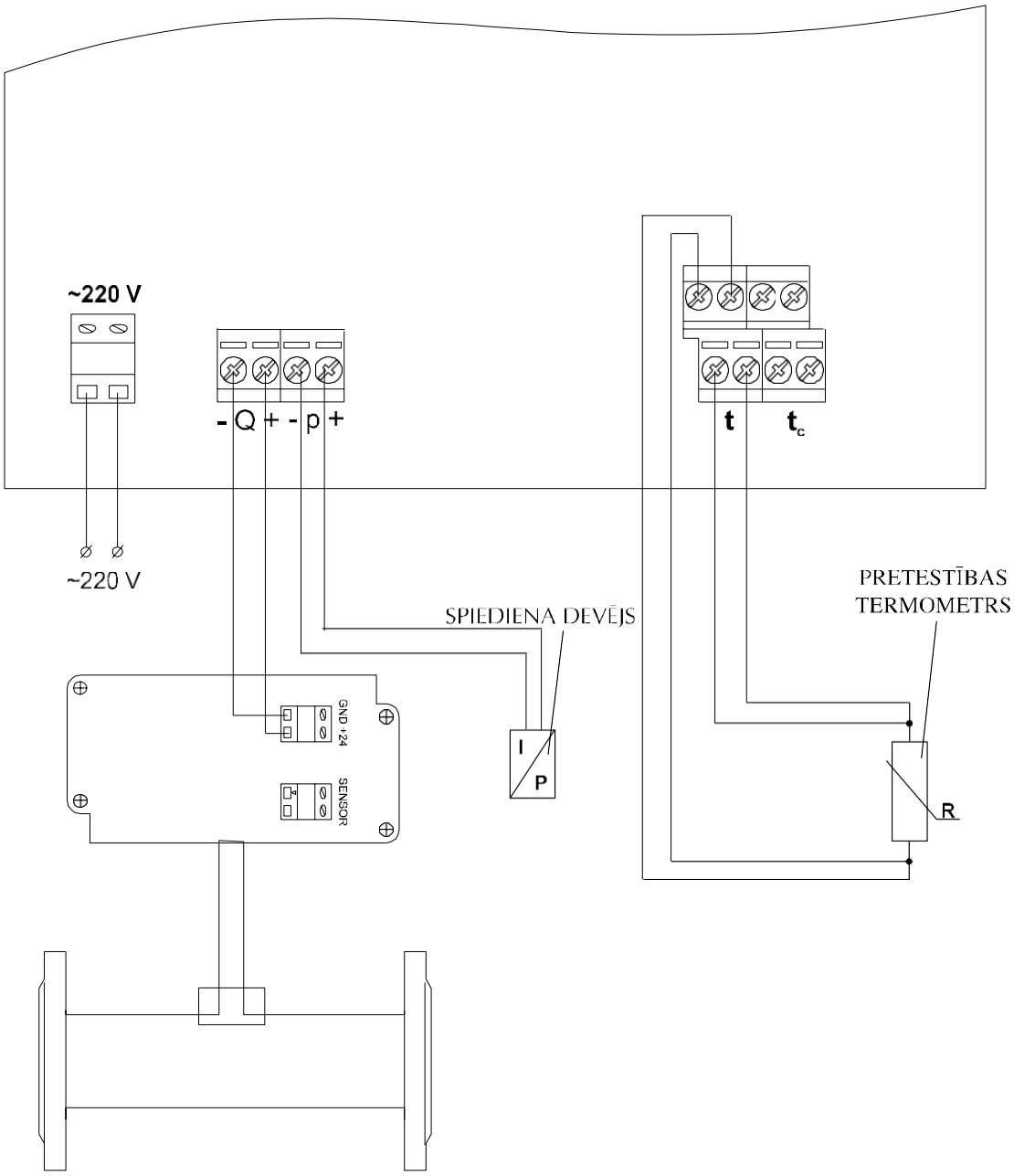
DBRI - F15

contact	chain
5	FOK
6	FOE
13	+5 V
14	N1
15	N2
19	I1
20	GND
24	GND
25	GND



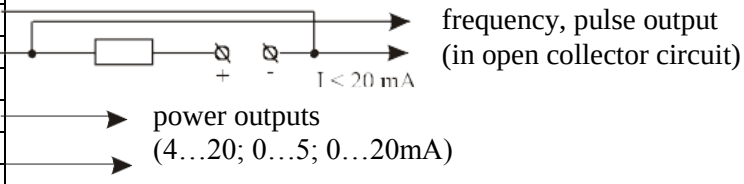


4.5. image. Connection diagram of frequency, pulse and current outputs, as well as flow sensor analog signal outputs for a rack-mounted computer unit



4.6. image. Connection diagram of supply voltage, flow and pressure transducers and resistance thermometers to the wall mounting computer unit (resistances connecting the thermometer "tc" is analogous to the "t" connection scheme)

Contact	chain
1	24
2	-
3	-
4	-
5	-
6	FOE
7	FOK
8	-
9	GND
10	11
11	-
12	-
13	-
14	-
15	-



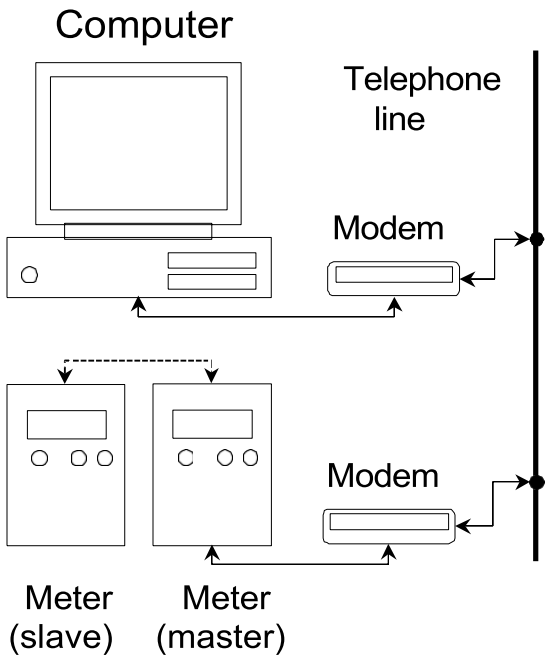
4.7.image. Connection diagram of frequency, pulse and current outputs for wall mounting computer unit.

The connecting cables must not be located closer than 0.5 m from the power circuits through which alternating current with an industrial network frequency of 50 Hz flows.

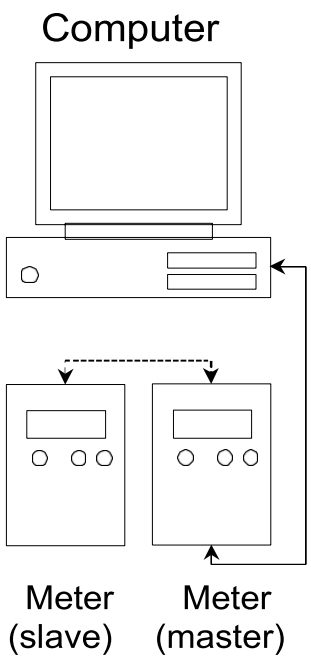
When connecting the 3-core power cable of the electrical network to the socket of the computer unit - «AC 220V», the generally accepted color of wire insulation should be taken into account: blue - "phase", brown - "zero", yellow-green - "ground".

It has a built-in RS-232 serial interface to connect the steam meter to a computer or modem. Using a remote connection to the steam meter, it is possible to read the measured values as well as the data accumulated in the meter. This option facilitates access to steam meter data, and also expands its operational capabilities through automated data collection and processing systems.

The connection can be made using a modem connected to the telephone line (fig. 4.8), or through serial interface ports, connecting directly to the computer using a null modem cable (fig. 4.9). It is possible to connect several steam meters (up to 10) simultaneously with one line.

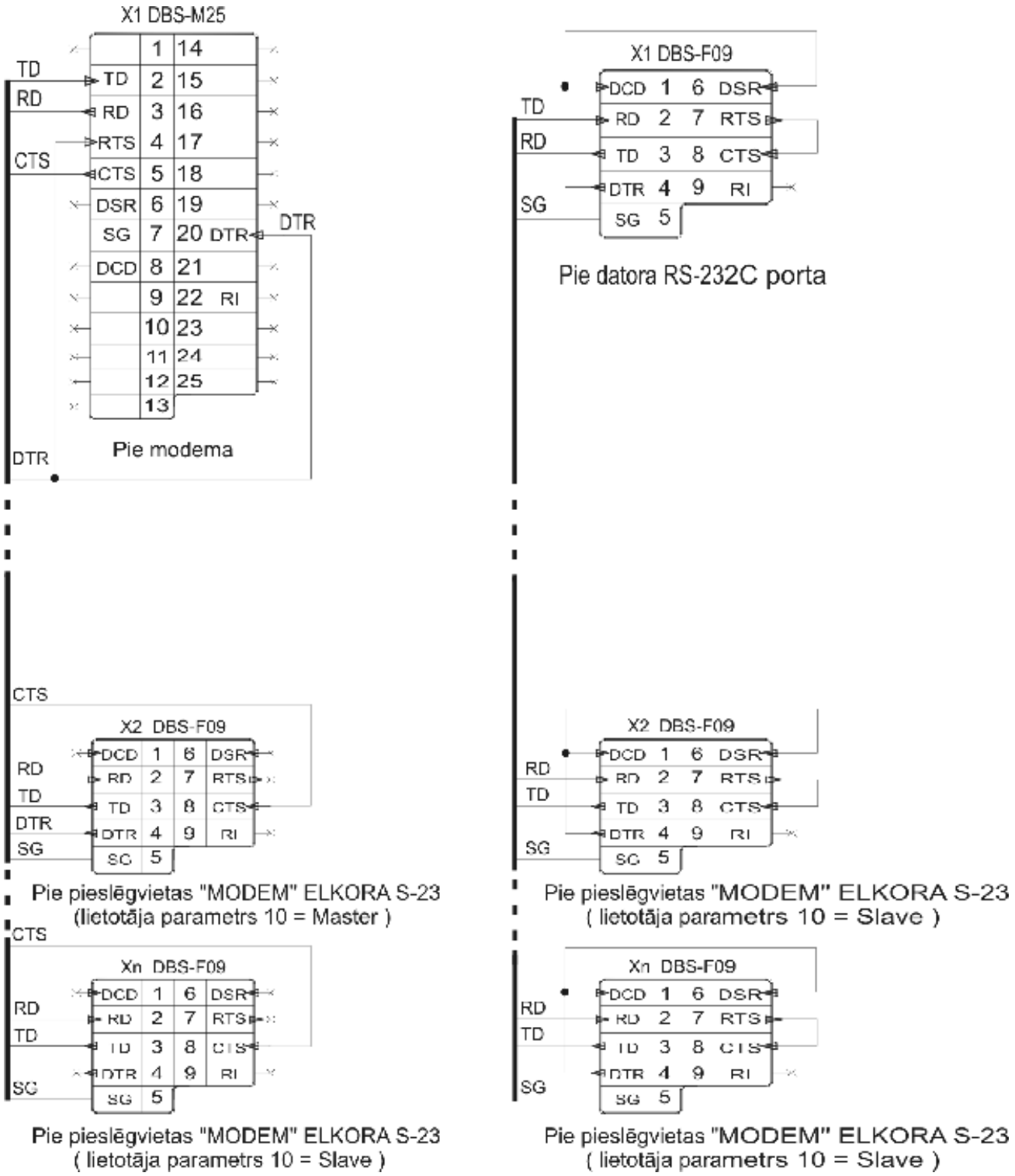


4.8. image



4.9. image

Note: 4.10. image shows the diagram of the modem cable and the connecting cables of the steam meters. When purchasing the necessary equipment and software, you should contact the manufacturer or one of its representatives.

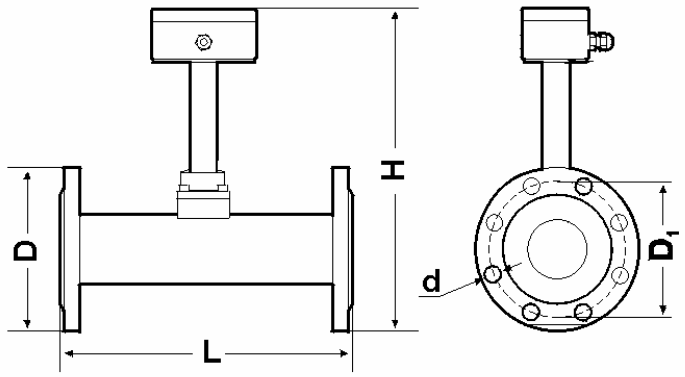


4.10.image. Connection diagram of a steam meter connected to a modem and a computer (maximum length of connection cables 50m)

5. KEY TECHNICAL INDICATORS

5.1. Dimensions and mass of gauges

ELKORA S-23



DN	L, mm	H, mm	D, mm	D_1, mm	d, mm
40	300	307	145	110	18
50	300	320	160	125	18
80	350	352	195	160	18
100	350	372	215	180	18
150	500	430	280	240	22

5.1.1.image. Flow sensor

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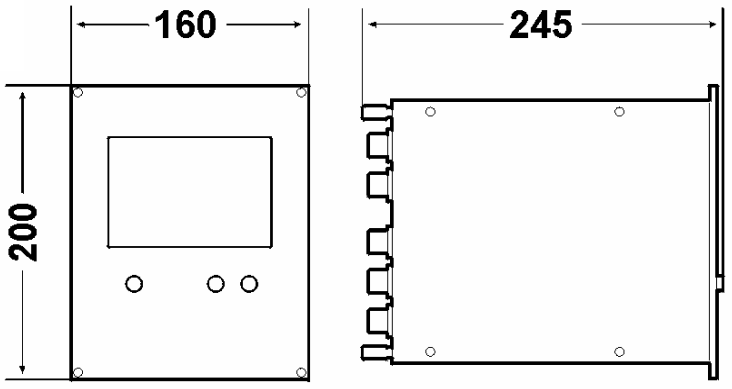
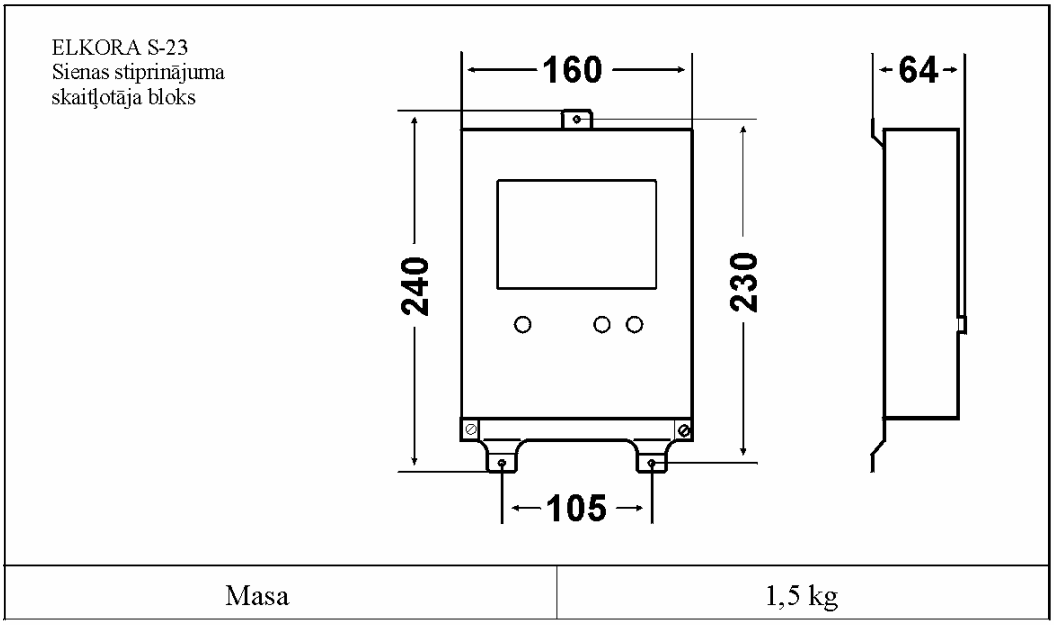
the rack-mounted computing unit



Masa	3,9 kg

5.1.2. image. the rack-mounted computing unit



Masa	1,5 kg

5.1.3. image. Wall mount computer unit

5.2. Measuring range

The dependence of the minimum Q_{min} and maximum Q_{max} values of the flow on the nominal diameter DN of the pipeline is given in table 5.1.table.

5.1 table

DN	Q_{min}, m^3/h	Q_{max}, m^3/h
40	20	400
50	30	600
80	70	1400
100	100	2000
150	250	5000

Temperature measurement range. . . . . 0... +300 ^{0}C

Temperature difference measurement range. . . . +3... +300 ^{0}C

Overpressure measurement range. . . . . 0... 16 bar

5.3. Measurement accuracy

Relative fundamental error of flow measurement ..... < ±1,5 %

Absolute fundamental error of temperature measurement.< ±(0,2+0,001×t) ℃

Reduced fundamental error of pressure measurement..... < ±1,5 %

Power …… **220$^{+10\%}_{-15\%}$ V, 50 Hz**

Power consumed ..... **< 5 VA**

Environmental class. . . **class C of LV EN 1434 (+5.....+55 C)**

Frequency and pulse output ..... **I_{max} = 20 mA, f_{max} = 32000 Hz**

Power outlet…… **0...5; 0...20; 4 ..... 20 mA**

Interface ..... **RS 232**

parallel Centronics

6. USER DESCRIPTION

6.1 Indication of parameters

When the steam meter is turned on, the liquid crystal display (LCD) and LEDs on the front panel of the computer unit light up. The selection of parameters displayed on the control panel is done with the help of the «□», «□» keys, and the parameter is displayed in the left part, and the numerical value of this parameter is shown in the right part.

By manipulating the «□», «□» keys, it is possible to output the following parameters to the control panel:

● **ENERGY**	**W**
● **MASS**	**M**
● **WORKING TIME**	**T**
● **TIME AND DATE**	
● **POWER**	**P**
● **FLOW**	**G, Q**
● **TEMPERATURE**	**t, t_c**
● **PRESSURE**	**P**

6.2. Average and integral values of parameters

To view the average and integral values of the parameters, it is necessary:

- With key «⇧», «⇩» choose the parameter you need.
- Press the «ON» key once or twice (see tab. 6.2), the average or integral numerical value of the selected parameter is shown in the right part of the liquid crystal display, and the time interval during which the averaging or integration took place is shown in the left part.
- Use the «⇧», «⇩» keys to select the desired time interval.
- Switching back to working mode occurs by pressing the «ON» key or automatically after 30 seconds.

6.2.1. table

	ON	ON+ON
ENERGY MASS	Monthly totals (archive 32 months) Month. year	Daily summary values (archive 96 days) day. Month. year
WORKING TIME	Monthly downtime (archive 32 months) month. year	24-hour idle time (archive 96 days) 24- hour. month
POWER FLOW TEMPERATURE PRESSURE	Hourly average values (archive 768 hours) month. year	Daily average values (archive 96 days) day. month. year

6.3. Error messages during operation of the steam meter

LEDs and LED display the operating mode of the transducers:

• The normal operating mode of the corresponding sensor (flow, temperature, pressure) is indicated by the blinking of the LEDs in green.

• Flashing of the LEDs in red, as well as the message “ERROR” instead of the parameter to be measured, indicates the damage of the respective sensor or an unacceptable operating mode.

• If the corresponding LED is not flashing, the sensor is in the off state.

Archive in browse mode:

Symbol ″*****″ after the date, indicates that there has been a mains voltage disturbance during the given time period.

Symbol ″*****″ according to the parameter value indicates incorrect operation of the

respective sensor during the time period shown in the left part of the liquid crystal display.

Instead of the current parameter, the message “POWER” indicates the absence of mains voltage for the entire time period shown in the left part of the liquid crystal display.

6.4. Description of user parameters

User parameters are intended to set:

- printing mode;
- working with a modem;
- current outputs;
- frequency and pulse output;
- clock.

To set the parameters of the user's steam meter, it is necessary:

With key «⇧», «⇩» select the parameter ″**TIME AND DATE**″.

Press and hold the key «**ON**». After a few seconds, the steam meter will go into user parameter setting mode. A flashing number on the left side of the LCD corresponds to the user parameter number.

With key «⇧», «⇩» it is possible to select the required user parameter number.

To activate the selected user parameter, the key must be pressed «**ON**», then the value of the parameter starts flashing in the right part of the LCD.

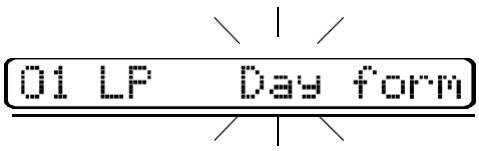
With key «⇧», «⇩» select the required parameter value.

Switching back to user parameter selection mode is done by pressing the key «**ON**».

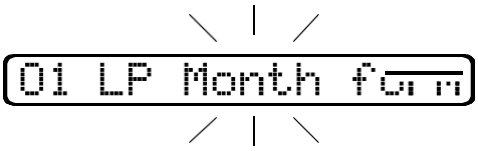
Switching back to working mode is done by pressing the key «**ON**» again or automatically after 30 seconds.

7.SETTING THE PRINTING PARAMETERS

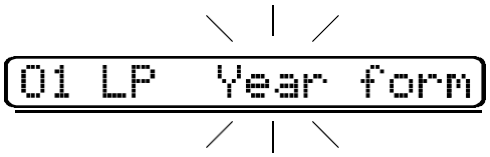
01 Printing form:



Average and summary parameter values for each hour of the day.

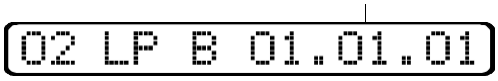


Average and total parameter values for each day of the month.



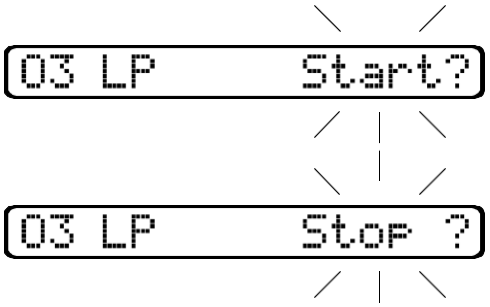
Average and summary parameter values for each month during the year.

02 Setting the print start date:



Setting the time (hours, days, months, years depending on the set user parameter 01).
starting from which the data will be printed.

03 Start / stop printing

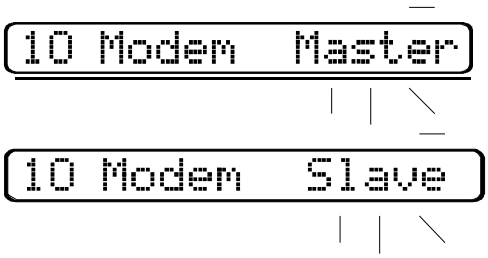


printing can be started at the selected command **Start?**, with key «⇧» vai «⇩» help

Printing can be stoped at the selected command **Stop?**, with key «⇧» vai «⇩» help

Setting the parameters for working with the modem

If only one steam meter is connected to the modem, then the value must be set to Master.



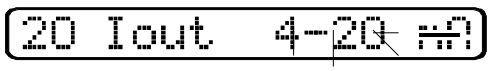
If several steam meters are connected to the modem, the **Master** value should be set only for the meter that is directly connected to the modem, the **Slave** value should be set for all other meters. In addition, if more than three steam meters are connected to one modem, then for all meters that have the **Slave** value set, it is necessary to remove the jumper located on the processor board next to the power element.

11 Setting the serial interface speed:

Setting the serial port speed for exchange with a remote machine (computer, etc.). It is possible to set the following link speed values: 1200; 2400; 4800; 9600; 19200; 38400 biti/s.

Power outlet installation

20 Setting the current output range:

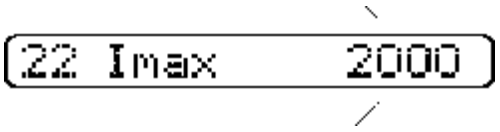


Installation of all current ranges. The following ranges of current values are possible: **4 20**; **0 5**; **0 20 mA**.

21 Setting the current output parameter:

Setting the parameter whose value is set in the current output. It is possible to choose the following parameters: G, t/h; Q, m^3/h; t, °C;p, bar; t_c, °C; P, MW (Gca

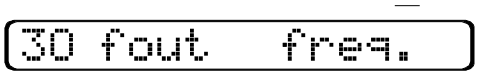
22 Setting the maximum current parameter value of the current output



Setting the maximum value of the current output parameter, which corresponds to the specified maximum current with user parameter 20 (zero value for the measured parameter corresponds to for the minimum current value at the output set by user parameter 20)

Installation of frequency and pulse output

30 Frequency or pulse mode selection:

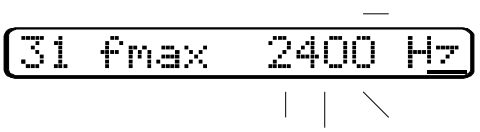


Installation of frequency outputs.

Installation of pulse output.

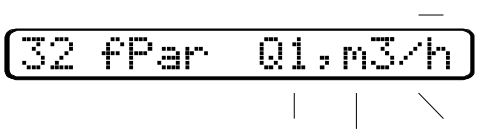
Viewing and setting user parameters 31, 32 and 33 is only possible if user parameter 30 is set to frequency output.

31 Maksimālās frekvences uzstādīšana:



Setting the maximum frequency in the frequency output, values from 10 Hz to 32000 Hz.

32 Setting the output parameter in the frequency output:



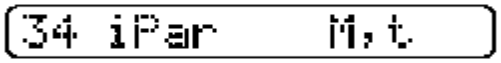
Setting the parameter whose value will be output to the frequency output. The content of the menu depends on the working mode of the steam meter. In general, it is possible to choose the following parameters: G, t/h; Q, m^3/h; t_1, ℃; p_1, bar; t_c, ℃; P, MW (Gcal/h).

33 Setting the frequency output maximum parameter value:

Setting the maximum value of the frequency output parameter with the corresponding maximum frequency set by user parameter 31**.**

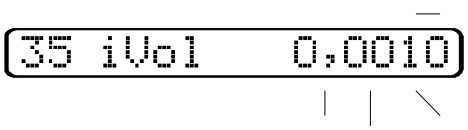
Viewing and setting user parameters 34 and 35 is only possible if user parameter 30 has pulse output set.

34 Setting the output parameter in the pulse output:



Setting the parameter whose value will be output to the pulse output. The content of the menu depends on the working mode of the steam meter. In general, it is possible to choose the following parameters: M, t; W, MWh (Gcal).

35 Setting pulse unit values:



Setting the amount of volume or energy (depending on user parameter 34) to which one pulse corresponds.

Clock installation

50, 51, 52, 53, 54, 55 □ according to the setting of hours, minutes, seconds, date, month and year.

8. SAFETY RULES

Operation and maintenance of steam meters may only be performed by qualified personnel who are familiar with work safety regulations.

When working with steam meters, increased attention should be paid to electrical assembly elements with high voltage.

It is categorically forbidden to disconnect the cables from the steam meter, to carry out assembly and repair work when the supply voltage is switched on. Operation of steam meters with damaged or no grounding is prohibited.

10. WARRANTY

The guaranteed service life of the steam meter is 3 years from the moment of commissioning, provided that the user observes the assembly and operation rules found in this Technical Description.