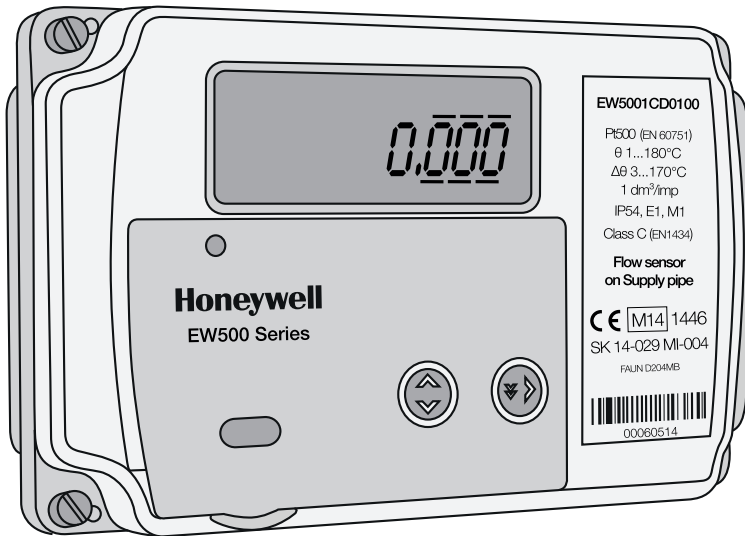


## EW500 Series

Calculator for Heat Meters in Heating or Cooling Systems

### Operating Instructions

CE



Read carefully before starting up!  
Keep instructions for later use!

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## 1 General description

The EW500 calculator, together with a sensor pair and a flow sensor, forms a heat meter for measuring consumption of energy in heating and cooling systems which use water as energy-carrying medium.

Depending on build and configuration, the calculator can operate as any of the following:

- Heat meter for cooling systems
- Heat meter for a heating and cooling system as part of the same circuit
- Heat meter for heating systems

The calculator can work with any flow sensor with a pulse output, e.g. impeller-type and ultrasonic flow sensors. The rated flow range of the flow sensors which the calculator can work with is 0.6 ... 3.000 m<sup>3</sup>/h, the pulse value range is 1 ... 10.000 dm<sup>3</sup>/imp and 0.01 ... 300 imp/dm<sup>3</sup>. The possible power range depends on the configuration performed during the production process and on the calculator's operating range.

For temperature measurement PT500 sensors in a 2 wire system can be used.

## 2 Terms and definitions

The chapter below presents the definitions of the terms used in the manual:

- **Main energy:** depending on the main energy register calculator the heating (heat meter mode) or cooling (cool meter mode) energy is calculated. The energy is calculated on the basis of the main volume increase.
- **Cool energy:** cooling energy calculated when the calculator is configured as a heat and cool meter and the cool calculation conditions are met. The energy is calculated on the basis of the cool volume increase.
- **Main volume:** volume of the heating (heat meter mode) or cooling (cool meter mode) medium calculated on the basis of the pulses from the main flow sensor.
- **Cool volume:** volume of the cooling medium calculated on the basis of the pulses from the main flow sensor when the calculator is configured as a heat meter and the cool calculation conditions are met.
- **Auxiliary volume:** heating and cooling medium volume calculated on the basis of the pulses from the auxiliary flow sensor. In the heat and cool meter mode the volume is the sum of volume for both operating modes. This value may be used to leak-test the system when the calculator is configured for the leak detection system.
- **Volume difference:** a difference between the medium volume values indicated by both flow sensors. Regardless of the main flow sensor placing this value is the difference between the volume for the flow sensor installed on the flow pipe and the volume for the flow sensor installed on the return pipe. E.g. when the main flow sensor is installed on the return pipe the volume difference is: auxiliary volume - main volume. This value is available when the calculator is configured for the leak detection system.
- **Main/auxiliary mass:** mass of the heating and cooling medium calculated with the main/auxiliary flow sensor and the temperature sensor provided in the pipeline where the main/auxiliary flow sensor is installed. In the heat and cool meter mode it is the total medium mass for both operating modes. These values may be used to leak-test the system.
- **Mass difference:** a difference between the medium mass values indicated by both flow sensors. Regardless of the main flow sensor placing this value is the difference between the mass for the flow sensor on flow pipe and the mass for the flow sensor on return pipe. E.g. when the main flow sensor is installed on the return pipe the flow difference is: main mass - auxiliary mass. This value is available when the calculator is configured for the leak detection system.
- **Flow:** an instant flow rate determined on the basis of the pulses from the main flow sensor.
- **Auxiliary flow:** an instant flow rate determined on the basis of the pulses from the auxiliary flow meter. This value is available when the calculator is configured for the leak detection system.
- **Flow difference:** a difference between the flows indicated by both flow sensors. Regardless of the main flow sensor placing this value is the difference between the flow for sensor on flow pipe and the flow for sensor on return pipe. E.g. when the main flow sensor is installed on the return pipe the flow difference is: auxiliary flow - flow. This value is available when the calculator is configured for the leak detection system.
- **Main error code:** includes the calculator and the main flow sensor error codes.
- **Additional error code:** includes the auxiliary flow sensor error codes. This value is available when the calculator is configured for the leak detection system.
- **Main flow sensor:** a flow sensor used to determine the increase in volume, medium mass and main energy or cool volume and energy when used in the heat and cool meter mode and the cool calculation conditions are used.
- **Auxiliary flow sensor:** a flow sensor used to determine the increase in volume and auxiliary mass of the medium. It is also used to leak-test the system when the calculator is configured for the leak detection system.
- **Cool meter:** a calculator configured to calculate the cooling energy. The calculated cool energy and volume are saved in the main calculator registers.
- **Heat and cool meter:** a calculator configured to calculate the heating energy with the active cooling energy calculating register. The calculated heating energy is saved in the main register whereas the calculated cooling energy is saved in the cool register.

### 3 Technical data

#### 3.1 General data

The calculator conforms to the following standards:

- EN 1434 – heat meters, 6 parts
- EN 13757 – Communication systems for meters and remote reading of meters, parts 1-4

Main operating parameters of the calculator		
Manufacturer	-	APATOR SA
Model designation	-	EW500 Series
Energy unit	-	MWh or kWh
Volume unit	-	m <sup>3</sup>
Temperature range limits	°C	$\Theta_{\min} = 1\text{ °C}$ $\Theta_{\max} = 180\text{ °C}$
Temperature difference range limits	°C	$\Delta\Theta_{\min} = 3\text{ °C}$ $\Delta\Theta_{\max} = 175\text{ °C}$
Power range		1
Nominal flow range	m <sup>3</sup> /h	0.6 ... 3 000
Pulse constant range for flow sensor	dm <sup>3</sup> /imp	1 ... 10 000
	imp/dm <sup>3</sup>	0.01 ... 300
Permissible error limit, MPE	%	$E_C = \pm (0,5 + \Delta\Theta_{\min} / \Delta\Theta)$
Compatible temperature sensors	-	PT 500 – 2-wire
Compatible flow sensors	-	ultrasonic or impeller-type flow sensors
Flow sensor place of installation	-	return pipe
Calculator operating mode	-	<ul style="list-style-type: none"> <li>• heat meter</li> <li>• cold meter</li> <li>• heat meter and cold meter</li> </ul>
Switching to cold measurement when configured as heat meter and cold meter	-	flow temp. < return temp. and flow temp. above the set threshold
Minimum energy integration time (according to EN 1434-2)	s	10
Calculator operating position	-	horizontal, vertical or in between: 0 ... 90°
Power supply	-	C cell 3.6 V lithium battery optionally 230 V AC power supply unit or 24 V AC power supply unit
Environmental class EN1434	-	C
MID	-	E1, M1
Protection rating	-	IP54
Ambient temperature	°C	5 ... 55
Relative humidity	%	<93 % (no condensation)

1.The power range depends on the calculator's set operating range.

<b>Other calculator parameters</b>		
Display type	-	LCD, 8 main digits, 4 additional digits, graphical symbols
Change of indications	-	two buttons: mechanical or capacitive
Size of memory for data storage	MB	min. 4
Maximum energy meter range	-	9 999 999.9 kWh ... 9 999 999.9 MWh
Maximum volume meter range	m <sup>3</sup>	99 999.999 ... 99 999 999

<b>Additional modules</b>		
Maximum number of modules installed in the calculator	pcs.	2
Default module input configuration	-	Slot 1: M-Bus, 2,400 Baud Slot 2: Modbus, 9,600 Baud, 8E1
Types of modules available	-	M-Bus, RS 232, RS 485, 2 pulse outputs, 2 pulse outputs + 2 pulse inputs, 2 analogue outputs, Wireless M-Bus, LonWorks

<b>Optical port</b>		
Transmission speed	-	300, 600, 1200, 2400, 4800, 9600 <sup>1</sup>
Stop bits	-	1
Data bits	-	8
Parity	-	even <sup>1</sup> , odd, no parity
Optical port mode of activation	-	with calculator button or with a suitable string of characters according to EN 13757
Optical port's readiness time for communication once activated	s	configurable: 1 ... 255

1. default settings



### 3.2 Electrical data

The following table presents the parameters of the pulse input, which is used for connecting the main flow sensor, as well as the parameters of the additional inputs. The primary pulse input can work with any ultrasonic or propeller-type flow sensors.

The additional inputs can work in four different modes, depending on the configuration.

These are:

- **deactivated input**, default setting, high impedance input,
- **pulse input**, allows for counting pulses from auxiliary equipment connected to the calculator: water meters, gas meters, electricity meters, etc.,
- **alarm input**, allows for detecting external malfunctions,
- **communication input**, allows for digital communication with a flow sensor.

The calculator can be powered from a battery or a power supply unit.

Parameters of the primary pulse input and of the additional inputs			
(volt-free – closing contacts, open collector, open drain)			
Input class (according to EN 1434)	main/auxiliary flow sensor input	-	IB, IC
	additional inputs	-	IB
Input signal		-	Pullup 750kΩ to battery or additional power supply unit voltage (max. 3.7 V)
Open contact leakage current		μA	< 1
Maximum pulse frequency for primary input	ultrasonic	Hz	150
	propeller-type		22
Maximum pulse frequency for additional inputs		Hz	3
Minimum duration of an input pulse		ms	0.5
Minimum interruption time of an input pulse		ms	5
Voltage for pulse active state		V	< 0,4
Voltage for pulse interruption		V	> 2,5
Maximum wire length		m	10
Maximum cross-section of service connection wires		mm <sup>2</sup>	2.5 (maximum cable outer diameter 5.5 mm)
Number of primary inputs		pcs.	1
Maximum number of additional inputs		pcs.	4 <sup>1</sup>

1. The maximum number of additional inputs depends on the calculator's hardware configuration.

The calculator can be powered from a battery or a power supply unit.

<b>Calculator's power supply parameters</b>		
Supply voltage	V DC	3.2 ... 3.7
Current consumption (without setting pulses and historic records)	μARMS	< 15
Calculator's power supply mode	-	C cell 3.6 V lithium battery optionally 230 V AC, 50/60 Hz power supply unit or 24 V AC, 50/60 Hz power supply unit (with two outputs for supplying additional modules)
Calculator's operating time using battery	-	12 + 1 years
Calculator's backup power mode (after a failure of the main power supply), allowing for the readout of energy indications from the LCD	-	1/2AA cell 3.6 V lithium battery
Voltage at which backup power source is activated	V	3.2
Time until backup power source is automatically activated		immediately
Voltage range for power supply unit	V AC	230 V ± 15 %
Voltage range for the 24 VAC power supply	V AC	24 V ± 25 %
Auxiliary power supply unit's power consumption at rated voltage	W	0.8

<b>Temperature measurement parameters</b>		
Compatible temperature sensors	-	PT500: 2-wire
RMS value of current powering temperature sensor	μA	1.5
Maximum wire length/minimum cross-section	m/mm <sup>2</sup>	PT500 (2-wire): 7.5/0.75; 15/1.5
Maximum cross-section of service connection wires	mm <sup>2</sup>	2.5 (cable max. outer diameter 5.5 mm)

### 3.3 Mechanical data

<b>Calculator's mechanical parameters</b>		
Storage temperature	°C	- 25 ... + 60
Case protection rating	-	IP54
Case flammability class	-	V2
Case material	-	cover: natural polycarbonate (PC) base, guard and bracket: grey polycarbonate (PC)
Case dimensions: length/width/height	mm	159/100/ 46.5
Weight without power supply battery	kg	0.35
Calculator's installation mode		To a flow sensor or on a wall. Wall plate is included.

The dimensions of the case in IP54 version is shown below.

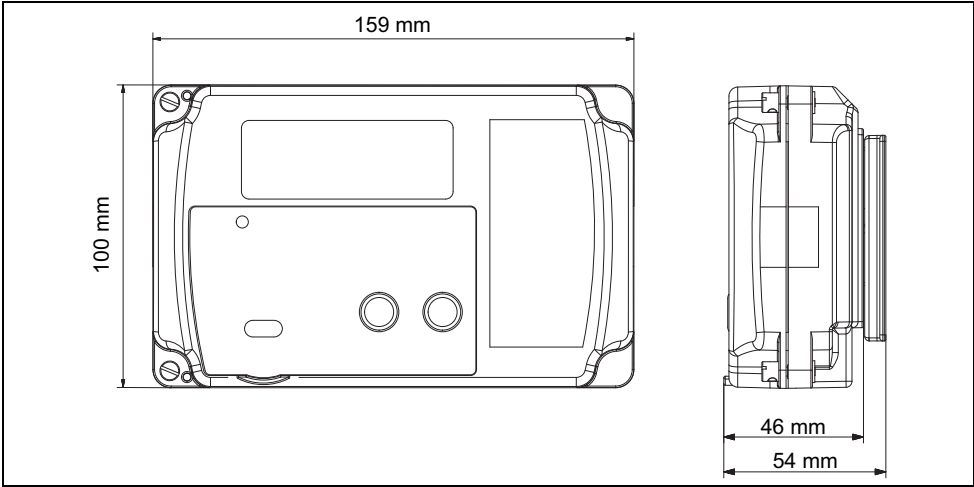


Figure 1: IP54 case view and dimension

## 4 Calculator's method of operation

The following chapter discusses the calculator's method of operation as well as the mode and type of the instantaneous data, including average and peak values for various cycles. It also discusses the types of the detected malfunctions and events, the scope of the stored data and the method of operation of the additional inputs.

### 4.1 Measurement of energy and main volumes

The increase in energy (heating or cooling energy) is calculated according to the formula in EN 1434.1:2007. For calculating the heat coefficient  $k$ , a pressure value of 16 bar has been adopted (water is the heat carrier). The calculator can be configured to work on the flow or return pipe.

$$Q_H = \int_{V_1}^{V_2} k(t_1 - t_2) dV$$

$$Q_C = \int_{V_1}^{V_2} k(t_2 - t_1) dV$$

where:

- $Q_H$  - heating energy increase
- $Q_C$  - cooling energy increase
- $k$  - heat coefficient for water, depending on the place of installation
- $t_1$  - flow temperature
- $t_2$  - return temperature

Energy can be determined in one of the two units: kWh or MWh. Irrespective of the settings, the energy increase is always calculated in J, and then converted into a suitable energy unit. Every 10 seconds the energy increase is calculated and the summing-up into energy registers takes place. For calculating the energy increase, the increase in volume since last integration is taken into account. The volume and mass of medium are calculated at the same time the energy is calculated irrespective of whether the energy calculation conditions are met. The mass is determined on the basis of the accumulated volume and the temperature of the medium at the flow sensor placement.

The recommended minimum temperature difference is 3 °C. The energy increase is calculated only if the temperature difference is higher than the set threshold. The threshold range is: 0.1 ... 3.0 °C.

In addition, in every cycle in which the energy and volume increase is determined, a so called metrological test is calculated, which can be used to quickly check the calculator's accuracy.

When the cooling energy is calculated and the calculator is configured as a heat and cool meter the energy value is displayed with the cool symbol: \*



#### 4.1.1 Operation as heat meter for heating or cooling systems

If the device operates as a heat meter for measuring heat or cold, the sensor marked in red (T1) should be installed in the flow pipe and the sensor marked in blue (T2) should be installed in the return pipe.

When configured as:

- **heat meter for heating system:** The energy is calculated to the main register if the flow temperature  $t_1$  is higher than the return temperature  $t_2$ , and the temperature difference is higher than the set minimum difference.
- **heat meter for cooling system:** The energy is calculated to the main register if the return temperature  $t_2$  is higher than the flow temperature  $t_1$ , and the temperature difference is higher than the set minimum difference.

#### 4.1.2 Operation as heat meter for a heating and cooling system in a single circuit

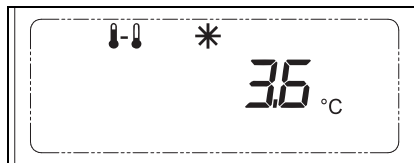
If the device operates as a heat meter for measuring heat with an active cold calculation register, the sensor marked in red ( $t_1$ ) should be installed in the flow pipe and the sensor marked in blue ( $t_2$ ) should be installed in the return pipe.

The calculated energy is saved in the main register – heat or cool register depending on the current operating status:

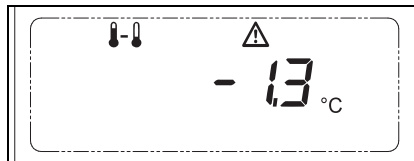
- **The calculated heating energy** is saved in the main (heat) register when the flow temperature ( $t_1$ ) is higher than the return temperature ( $t_2$ ) and the temperature difference is higher than the specified minimum difference,
- **The calculated cooling energy** is saved in the cool register when the flow temperature ( $t_1$ ) is lower than the return temperature ( $t_2$ ) and the temperature difference is higher than the specified minimum difference.

In addition, if the cool register is active, you can activate the threshold below which the cooling energy is calculated. The cooling energy is calculated if the condition regarding the temperature relation is fulfilled and the instantaneous flow temperature is below the set threshold.

If the cool register is active,  $t_1 < t_2$ , the cold measurement threshold is deactivated or active and the flow temperature is lower than the threshold, the screen showing the temperature difference displays the cold symbol: \*



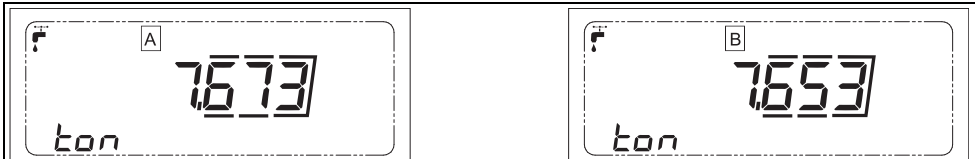
If the cold register is active,  $t_1 < t_2$ , the cold measurement threshold is active and the flow temperature is higher than the threshold, the displayed temperature difference is negative and error 16 may be signaled.



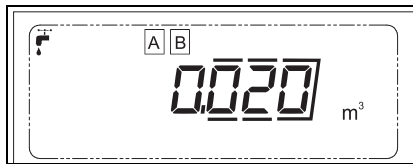
### 4.1.3 Heat meter mode in systems with the leak detection option

Similarly to the main flow sensor the following values are determined for the auxiliary flow sensor: volume, mass, flow and error code (depending on the flow sensor used it is error 2, 32 and 512, 1024, 2048, 4096). For the configuration including two flow sensors: the values related to the main flow sensor are marked with "A" on the display and the values related to the auxiliary flow sensor are marked with "B".

The calculator can be used in the closed system with two flow sensors installed on the flow and return pipe. To ensure proper operation you must use flow sensors with the identical configuration (pulse constant and nominal flow) and with similar metrological parameters. The main flow sensor operation is standard as if one flow sensor was used. The auxiliary flow sensor allows to detect the system leaks. The leaks can be detected on the basis of the differences of the increase in volume, mass or on the basis of the flow for both sensors.



Moreover, the following values are determined: volume difference, medium mass difference and flow difference. Regardless of the main flow sensor placing the value difference is determined as a value for the flow pipe minus the value for the return pipe. The value difference is marked with "AB" on the display:



**NOTE:** when used as a heat meter for the heating and cooling system in a closed thermal system:

- mass is determined for the main flow sensor as a sum of the medium mass values during heating and cooling,
- volume for leak error detection is determined as a sum of the heating and cooling volume.

#### Operation mode enabling:

To enable the leak detection operation mode set the operation system to "the leak detection operation system". When this mode is enabled the additional input 3 operation mode is automatically changed to the mode used for the operation with the auxiliary flow sensor. When the leak detection mode is disabled the additional input mode is automatically deactivated.

### 4.1.4 Calculation of energy and volume in tariff registers

The calculator has two tariff registers: for energy and for volume. However, irrespective of the registers' configuration, energy and volume are always summed up to the calculator's main registers.

The calculation to the tariff registers takes place once the thresholds set for the individual tariffs are exceeded. The threshold type for both registers is freely configurable, and the thresholds can be of the same or different type. If the thresholds are of the same type, tariff 1 threshold  $P_{T1}$  must be lower than tariff 2 threshold  $P_{T2}$ : ( $P_{T1} < P_{T2}$ ). The following thresholds can be set:

- power
- flow
- flow temperature
- return temperature
- temperature difference
- no threshold: calculation to the tariff register not active (default setting).

The calculation to the tariff registers can be activated at any time during operation. It is deactivated by default. Activating or changing the tariff threshold type does not result in the loss of any historic data because the history for the individual records also contains tariff settings.

The average value from the averaging cycle is used for comparison with the tariff threshold:  $P_{A1}$  – average value for comparison with tariff 1 threshold,  $P_{A2}$  – average value for comparison with tariff 2 threshold, and  $P_{A12}$  – average value for comparison with tariff 1 and tariff 2 threshold (if the thresholds are of the same type). The method of calculation to the tariff registers depends on the tariff type configuration. If:

- **one tariff or two tariffs with different threshold types are active:** the calculation to the tariff registers is done independently for both tariffs once the threshold is exceeded:
  - $P_{Ax} > P_{Tx}$  - no calculation to tariff x register,
  - $P_{Ax} < P_{Tx}$  - calculation to tariff x registers.
- **two tariffs are active and the tariff thresholds are of the same type ( $P_{T1} < P_{T2}$ ):** the calculation to the tariff registers is done once the corresponding conditions are fulfilled:
  - $P_{A12} < P_{Tx}$  - no calculation to tariff registers,
  - $P_{T2} > P_{A12} > P_{T1}$  - calculation to tariff 1 registers,
  - $P_{A12} > P_{T2}$  - calculation to tariff 2 registers,

Once the threshold is exceeded, the date and time when the threshold is exceeded are recorded. When the threshold is no longer exceeded, the tariff history registers the date and time when the threshold was exceeded and when the exceeded threshold status discontinued, as well as the current status of the tariff registers and the summary time during which the threshold was exceeded. The summary time during which a given threshold is exceeded is calculated in minutes.

The method for calculating values to the tariff registers:

- **in whole** – once the threshold is exceeded, during integration, the whole calculated energy and volume increase is summed up to the respective tariff register.
- **proportionately** – once the threshold is exceeded, during integration, the energy and volume increase proportionate to the exceeded threshold (WT) is summed up to the respective tariff register.

$$W_T = W \left( \frac{P_C - P_{Tx}}{P_C} \right)$$

where:

- $W_T$  – value proportionate to the exceeded threshold, summed up to the tariff registers
- $W$  – calculated energy or volume
- $P_{Tx}$  – threshold of calculation to tariff X register
- $P_C$  – instantaneous value of the same type as the threshold

**NOTE:** If the calculator is configured as heat meter or cool meter, the tariff registers calculate respectively energy and volume for heating or cooling. If the calculator operates as a heat meter with cold calculation, the tariff registers calculate energy and volume for heating.

#### 4.1.5 Calculator's possible operating ranges

Given the wide range of the rated flows and the pulse constants of the flow sensors compatible with the calculator, the calculator's operation has been grouped into four ranges. The operating range is configured during the production process according to the pulse constant and the rated flow specified in the order. Listed below are the possible configurations of flow sensors for the available ranges:

- for slow impulsing, pulse constant  $\text{dm}^3/\text{imp}$ :

Range	Pulse constant [ $\text{dm}^3/\text{imp}$ ]	Rated flow [ $\text{m}^3/\text{h}$ ]
1	1 ... 10	0,6 ... 6
2	10 ... 100	1 ... 60
3	100 ... 1 000	10 ... 600
4	1 000 ... 10 000	100 ... 3 000

- for fast impulsing, pulse constant  $\text{imp}/\text{dm}^3$ :

Range	Pulse constant [ $\text{imp}/\text{dm}^3$ ]	Rated flow [ $\text{m}^3/\text{h}$ ]
1	100 ... 25	0,6 ... 6
2	25 ... 2,5	1 ... 60
3	2,5 ... 0,25	10 ... 600
4	0,25 ... 0,01	100 ... 3 000

For every range, the energy and volume registers, and the instantaneous power and flow values are displayed with various resolutions and units:

Range	LCD readout resolution					
	Energy			Volume	Flow	Power
1	0,001 GJ	0,001 Gcal	0,1 kWh	$0,001 \text{ m}^3$	$0,001 \text{ m}^3/\text{h}$	0,1 kW
2	0,01 GJ	0,01 Gcal	1 kWh	$0,01 \text{ m}^3$	$0,01 \text{ m}^3/\text{h}$	1 kW
3	0,1 GJ	0,1 Gcal	0,01 MWh	$0,1 \text{ m}^3$	$0,1 \text{ m}^3/\text{h}$	0,01 MW
4	1 GJ	1 Gcal	0,1 MWh	$1 \text{ m}^3$	$1 \text{ m}^3/\text{h}$	0,1 MW



## 4.2 Current data available

### 4.2.1 Instantaneous data

The calculator measures or determines the following Instantaneous data: flow and return temperature, temperature difference, thermal power, flow and metrological test.

#### 4.2.1.1 Temperature measurement

The temperature measurement is done using a high-resolution analogue to digital converter. To avoid network interference, the measurement is done in mains period. To minimize the impact of the measurement on the temperature difference, the same measuring circuit is used for measuring both temperatures.

The measurement is done every cycle in which the energy increase is determined, i.e. every 10 seconds, but if the temperature or the temperature difference is displayed, the measurement is taken more frequently: every 2 seconds. Once the temperatures have been measured, the temperature difference is determined. Each temperature is determined at a resolution of 0.001 °C, and it is displayed on the LCD and transmitted to remote readout devices at a resolution of 0.1 °C. The temperature values are determined as an average value from the four most recent measurements.

#### 4.2.1.2 Flow measurement

The instantaneous flow is determined using one of two methods, depending on the calculator's configuration. The flow value is updated every cycle in which the energy increase is determined, i.e. every 10 seconds.

- **Flow sensors with slow pulses** (pulse constant  $\text{dm}^3/\text{imp}$ ): For a slow pulses sensor, e.g. a propeller-type flow sensor, the instantaneous flow value is determined based on the time elapsed between the recent two pulses. This value is not averaged.

If the flow decreases and there is no pulse during the next update, the flow gradually decreases depending on the time elapsed since the last pulse. If there are no pulses, the instantaneous flow resets completely once the time since the last pulse elapses, corresponding to the minimum flow. The minimum flow is determined based on the set rated flow and the flow sensor dynamic range.

- **Flow sensors with fast pulses** (pulse constant  $\text{imp}/\text{dm}^3$ ): For a fast pulses sensor, e.g. certain ultrasonic flow sensors. The instantaneous flow value is determined based on the number of pulses counted since the last determination of the flow value. This value is averaged. The flow value is reset if here has been no pulse since the last determination of the flow value.

#### 4.2.1.3 Thermal power measurement

The instantaneous power is determined based on the calculated temperature difference, the volume coefficient and the determined instantaneous flow. Irrespective of the set energy unit, power is always determined in Watt. Depending on the set operating range, the power is available in a suitable resolution and unit: kW or MW.

#### 4.2.1.4 Metrological test

This value corresponds to the amount of heat per water volume unit at a given temperature difference. The value can be used for a fast check whether the calculator operates correctly. It is determined every temperature measurement cycle in a manner resulting from the heat increase measurement:

$$Q = k * (t_z - t_p)$$

where:

- Q - heat, metrological test
- k - heat coefficient for water (according to EN 1434:2007)
- $t_z$  - flow temperature
- $t_p$  - return temperature.

Irrespective of the set energy unit, the metrological test is always available in  $\text{kJ/m}^3$ .

**NOTE:** The value of the read metrological test is determined on the basis of the average temperature from the four last measurements. Therefore, to quickly check the calculator metrology by using the metrological test values you should wait until the result is averaged after setting the appropriate the temperature difference.

#### 4.2.2 Average and peak values

The calculator allows for determining and recording a number of average, maximum and minimum values for all of the measured instantaneous values, such as:

- flow temperature,
- return temperature,
- temperature difference,
- flow,
- thermal power.

The average and peak data can be determined for constant and configurable cycles. These include:

- **Averaging cycle** – a cycle configurable from 1 to 1,440 minutes (24 hours), the default setting is 60 minutes. The averaging cycle is synchronised to full hours or to 24 hours if the cycle is set at 1440 minutes. The data determined in the averaging cycle is used for determining the selected statistical data for other cycles (according to the tables below) as well as for determining the values for switching between the tariffs and for error signalling. More details are included in the chapters discussing tariffs and error codes. The data from the averaging cycle is available in the subgroup 2 menu.
- **Minute cycle** – a cycle configurable from 1 to 20,160 minutes (2 weeks) – the default setting is 15 minutes. The data for this cycle is determined based on the instantaneous values.
- **Hourly cycle** – a constant cycle. The values for this cycle are determined in the first second of a full hour. The data for this cycle is determined based on the instantaneous values.
- **24-hour cycle** – a constant cycle. The values for this cycle are determined at the selected full hour. The data for this cycle is determined based on the hourly cycle values.
- **Monthly cycle** – a constant cycle. The values for this cycle are determined at the selected full hour and on the selected day of the month. The data for this cycle is determined based on the values from the averaging cycle.
- **Annual cycle** – a constant cycle. The values for this cycle are determined at the selected full hour, and on the selected day of the selected month. The data for this cycle is determined based on the values from the monthly cycle.

More details on the configuration of the cycles are presented in chapter 4.5.1, which discusses the cyclical historic data registration cycles closely related to the cycles in which the statistical data is determined. The data from all cycles, except for the averaging cycle, can be registered in the historic data storage. For every minimum and maximum value, the date and time when a given value occurred is also registered.

**NOTE:** For peak data determined based on the instantaneous values and the peak values for other cycles, the registered occurrence time is the exact time when a given value occurred. For peak data determined based on the average value from another period, the registered occurrence time is the time when the average value was determined.

The table below presents the values based on which the average values for the individual averaging cycles are determined:

	Values for determining average values			
	Instantaneous value	Cycle average	Hourly average	Monthly average
For the cycle	X			
Minute	X			
Hourly	X			
24-hour			X	
Monthly		X		
Annual				X

The table below presents the values based on which the maximum and minimum values for the individual peak determination cycles are determined:

	Values for determining peak values			
	Instantaneous value	Cycle average	Hourly average	Monthly average
For the cycle	X			
Minute	X			
Hourly	X			
24-hour			X	
Monthly		X		
Annual				X

#### 4.2.3 RTC time and operating time

The calculator's real-time clock (RTC) operates with an accuracy of  $\pm 0.5$  second / 24 hours (at a temperature of  $25 \pm 5$  °C). The date and time indicated by the clock are used mainly for determining the historic data registration cycles. Automatic switching to summer/winter time can be activated.

The time switching occurs under the following conditions:

- **Switching to summer time:** the last Sunday of March at 2 a.m. The clock is adjusted forward from 2 a.m. to 3 a.m.
- **Switching to winter time:** on the last Sunday of October at 3 a.m. The clock is adjusted backward from 3 a.m. to 2 a.m.

**NOTE:** It is not recommended to adjust the RTC time during the summer/winter switching period because it may result in an incorrect time setting.

The calculator has two operating time counters:

1. **Operating time** – time in hours since the calculator's manufacturing. The timer increments at the full hour.
2. **Error operating time** – displayed time which can be read in hours however it is counted to an accuracy of 1 minute. It specifies the actual operation time with any error. The counter is enabled when the failures registration is enabled.


### 4.3 Malfunction and event signaling

The calculator allows for the signaling and registration of a number of malfunctions and events related to its operation. The potential calculator errors are categorized as follows:

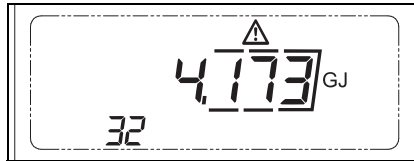
- **Malfunction:** a state which may continue for some time and disappear automatically, e.g. the exceeding of the maximum flow, or which are permanent are require intervention by the servicing personnel, such as damage to the temperature or flow sensor. The error code is set at the time of occurrence and deleted when the malfunction discontinues.
- **Event:** a temporary state which signals, e.g. open or closed cover, activation of malfunction registration. The event codes are set at the time of occurrence and deleted when the event is registered.

The following chapters describe the possible error codes in detail.

#### 4.3.1 Malfunctions codes

Malfunctions are signaled with a blinking or lit-up error symbol  depending on the displayed menu screen. If there is a failure when the main energy is displayed the error symbol is flashing and the current main error code is displayed below the energy value. When two flow sensors are used the failure codes are divided into two groups:

- group of codes for the calculator and the main flow sensor (symb. A) - main error code,
- group of codes for the auxiliary flow sensor (symb. B) - additional error code.



**NOTE:** Errors with codes higher than 4096 and the auxiliary flow sensor errors are signalled on the main screen only by a flashing error symbol, without the code being displayed. The code is displayed on the error code screen.

**NOTE:** The error code displayed on the LCD constitutes a sum of codes. As an example, if error code 268 is displayed, the following errors have occurred: 4 – Error: flow temp. sensor, 8 – Error: return temp. sensor and 256 – Additional input alarm. To facilitate error identification, the error code can be translated into a binary code  $268 = b100001100$ , which constitutes the occurrence of errors: 2, 3 and 8.

In addition, the screens displaying the value to which an error is related show a lit-up error symbol and a message describing the error type.

The table presents error codes, response time and the option to enable/disable signaling and recording:

Error code	Main error code	Additional error code	Description	Response time	Enable/Disable
0	1	-	Long-time leak	Configurable	Yes
1	2	2	No flow, $\Delta T$ difference correct	Configurable	Yes
2	4	-	Error: flow temp. sensor	< 10 s	No
3	8	-	Error: return temp. sensor	< 10 s	No
4	16	-	Error: reverse temperature difference	< 10 s	No
5	32	-	Error: (maximum) flow exceeded	< 10 s <sup>1</sup>	No
6	64	-	Low main battery or no mains power	< 10 s/ < 24 h <sup>2</sup>	No
7	128	-	Low backup battery	< 24 h	No
8	256	-	Additional input alarm	< 1 s	No
9	512	-	Wrong flow direction	< 3 min	No
10	1024	-	Air in flow meter	< 3 min	No
11	2048	-	Flow meter's measuring system damaged	< 3 min	No
12	4096	-	Error: no communication with flow sensor	< 3 min	No
13	8192	-	"Short-time" leak	Configurable	No
14	16384	-	Incorrect module 1	< 10 s	No
15	32768	-	Incorrect module 2	< 10 s	No

1. If an average value is selected for detecting the exceeded flow error, the response time depends on the set averaging cycle.
2. The response time to error code depends on the power supply mode. If battery power is used, the response time is less than 24 hours. If mains power is used, the response time is less than 10 seconds.

The error codes are described in detail below:

- **Long-term leak error** (error code 1): the error detection option can be enabled/disabled when the calculator is configured to operate with two flow sensors. Depending on the configuration leaks can be detected on the basis of the difference of the increase in volume and mass. When the error detection option is enabled the increase in volume that has occurred since the last check was performed is determined as well as the increase difference is indicated at specified intervals. When the absolute difference value is higher than the set threshold the error is set and when this difference is lower than the threshold the error is cancelled.

- **Error: no flow (error code 2):** The 'no flow' error is signalled if the set temperature difference and the average flow from an hourly cycle are exceeded, and the flow is below the set configurable threshold (the default threshold setting is the minimum flow). For the error to be set, the above condition must continue for a specified period of time. You can disable error signalling and recording. In addition, the 'no flow' error is signalled on the screen displaying the instantaneous flow:



User-configurable values used for detecting error 2:

- **Time to detect no flow error [h]:** minimum time to detect the error. If a condition for [h] signalling is fulfilled, the error flag will be set once the set full number of hours have elapsed.
- **Temperature difference to detect error [°C]:** threshold compared to the temperature difference.

**NOTE:** The error is detected if the calculator operates as a heat meter and a cold meter. Detecting the 'no flow' error is also possible if the calculator operates as a heat meter with an active cold calculation register.

- **Error: (maximum) flow exceeded (error code 32):** error set once the specified flow value is exceeded. The error is deleted automatically once the flow decreases below the threshold. You can select one of the two values based on which the error is detected:
  - **Average value for flow cycle:** The averaged flow value determined each cycle is compared to the set threshold. The error response time depends on the set averaging period.
  - **Instantaneous flow value:** The instantaneous flow value determined every 10 seconds is compared to the set threshold.

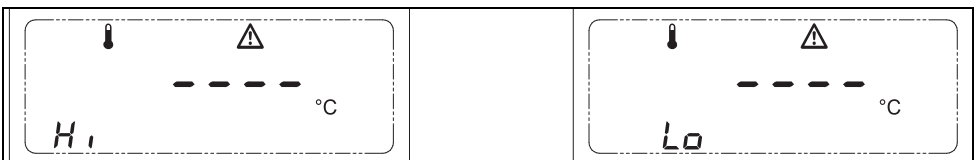
In addition, the 'exceeded flow' error is signalled on the screen displaying the instantaneous flow:



User-configurable values used for detecting error 32:

- **Type of value to compare with threshold:** average, instantaneous,
- **Threshold to detect exceeded flow error [m³/h]:** value compared to the flow value; if this value is exceeded, the error is set.

- **Error: measurement range exceeded or damaged flow/return temp. sensor (error code 4/8):** This error is signalled if the temperature sensor's measurement range is exceeded. The error may be caused by the closing or opening of the sensor's wires and by damage to the sensor. In addition, the temperature sensor error is signalled on the screen displaying a temperature value. If the value of the signal from the sensor is too high/if the sensor's input is opened, 'Hi' message is displayed. If the value of the signal from the sensor is too low/if the sensor's input is closed, 'Lo' message is displayed.



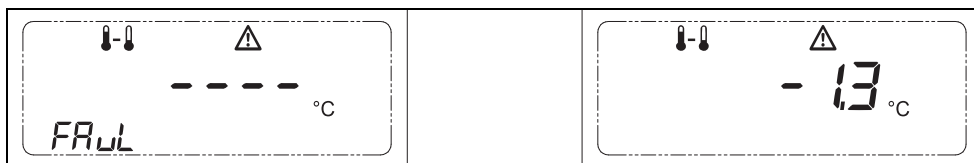
- **Error: reverse temperature difference** (error code 16): This error is signalled if :
  - the calculator is configured as a heat meter and  $\Delta T = T_{\text{flow}} - T_{\text{return}} < 0.25 \text{ }^\circ\text{C}$ ,
  - the calculator is configured as a cold meter and  $\Delta T = T_{\text{return}} - T_{\text{flow}} < 0.25 \text{ }^\circ\text{C}$ ,
  - the calculator is configured as a heat meter and a cold meter with activated cold calculation threshold and  $\Delta T = T_{\text{flow}} - T_{\text{return}} < 0.25 \text{ }^\circ\text{C}$  i  $T_{\text{flow}} >$  (cold calculation threshold) – the cold calculation condition is not fulfilled.

You can disable the signaling and recording of the reverse temperature difference error.


In addition, the reverse temperature difference error is signaled on the screen displaying the temperature difference. If error 4 or error 8 occurs, the temperature difference screen signals the error and displays 'Faul' message.

**NOTE 1:** The error status can change only if the flow and return temperature measurement is correct.

**NOTE 2:** If the temperature values are reversed, even with disabled error signalling, the temperature differences are not summed up to the buffer of average values and the peak values are not determined.



- **Error: low main battery or no mains power** (error code 64): Once the case is closed, the calculator automatically detects the power supply mode. If battery power is used, the low battery error is set when the battery is detected as discharged on three subsequent occasions. Increasing and subsequently reducing the supply voltage does not change the error status. The error is deleted only when the battery is replaced and the battery voltage is detected as correct after the case is closed.

A record is made in the malfunction history for each one of these situations. The low battery error is signalled additionally on every screen with the following battery symbol  and a number identifying the battery (1 – main battery, 2 – backup battery).

**NOTE:** In the event of a low battery error, the calculator's functionality is not limited and the user has time to replace the battery. Temperature, energy and communication measurements are only blocked when the battery is completely discharged and does not permit further use.

- **Error: low backup battery** (error code 128): The low backup battery error is signalled when, similarly to the main battery, the battery is detected as discharged on three subsequent occasions or if the maximum operation time of the case without the replacement of the battery is exceeded (irrespective of the battery's condition).
- **Additional input alarm** (error code 256): A selected additional input can be configured as an alarm input. The error is set if there is a low state and deleted if there is high state at the input.
- **Error: ultrasonic flow sensor:** The calculator allows for the readout of errors affecting flow sensors. The readout takes place every minute. If there is no communication with the flow sensor, the 'no communication' error (4096) is set. The following errors can be detected and signalled:
  - **Wrong flow direction** (error code 512): The flow sensor has detected a reverse flow direction.
  - **Air in flow meter** (error code 1024): The flow sensor has detected air trapped in the circuit.
  - **Flow meter's measuring system damaged** (error code 2048): The flow sensor has detected damage to the flow measuring system, e.g. damage to the measuring probe.
  - **Error: no communication with flow sensor** (error code 4096): This error is set if the calculator is unable to communicate with the flow sensor or if communication errors prevent the correct readout of the error status.

**NOTE:** To activate communication with the flow sensor, configure the respective additional input. Once the settings of the additional input set for communication with the flow sensor are changed, the flow sensor errors are deleted automatically.



- **“short-term” leak error** (error code 8192): the error detection option can be enabled/disabled when the calculator is configured to operate with two flow sensors (operation system set up as a closed leak detection operation system). When the error detection option is enabled the average flow difference is determined for the main and auxiliary flow sensors at specified intervals. When this difference is higher than the value resulting from the set threshold the error is set and when this difference is lower than the threshold than the threshold the error is cancelled.  
User-configured values used to detect error code 8192:
  - **error indication threshold [%]**: a percentage value of the nominal flow which when exceeded leads to the indication of error,
  - **time until the error is detected [s]**: a period when the average flow difference is determined to be compared with the threshold, minimum time after which the error status can change.
- **Incorrect module 1/2** (error code 16384 / 32768): The error applies only to pulse input/output modules and analogue output modules, for other module types these codes are not used. This error is signalled if a module has been configured incorrectly, e.g. excessive resolution has been set for the pulse output of a given category of outputs, there is no physical module for the configured port or the module is of a different type. It is also indicated when there are problems with the communication with module.

#### 4.3.2 Event codes

The occurrence of an event is not signaled in any way on the calculator’s screen. Immediately after an event has occurred, it is recorded in the event archive.

Detectable events are listed below:

- archive data recording unlocked,
- archive data recording locked,
- cover opened,
- cover closed,
- recording of malfunction history and error operating time activated,
- manufacturer’s servicing event.

#### 4.3.3 Activating malfunction recording

By default, the calculator’s malfunction history recording is disabled, and it is only possible to signal the malfunctions on the calculator’s screen. Recording is activated automatically once the calculator is installed correctly and average power other than zero from the hourly cycle is set for the first time.

#### 4.3.4 LED indicating a failure

The selected errors can be indicated by the flashing LED located below the display line.

### 4.4 Additional inputs

The calculator has 4 additional inputs, which have different functions depending on the configuration. Detailed electrical data of the additional inputs is discussed in chapter 3.2. Each input can operate in a specified mode (deactivated input, pulse input, alarm input, and input for digital communication with the main and auxiliary flow sensor). See the table below.

Additional input no.	Pulse input	Alarm input	Input for communication with flow sensor	Input for auxiliary flow sensor
Input 1	+	-	-	-
Input 2	+	-	+ (main flow sensor)	-
Input 3	+	+	-	+
Input 4	+	-	+ (auxiliary flow sensor)	-

#### 4.4.1 Mode: pulse input

Operating mode allowing for the connection of any device with a pulse output, e.g. water meter, gas meter, electricity meter. The pulse constant must be configured for correct operation. The pulse constant can be provided in one of the three units: dm<sup>3</sup>/imp, imp/dm<sup>3</sup> or imp/kWh. In addition, you can set an eight digit serial number of the connected device.

One of four ranges can be selected. Depending on the selected range, the calculated volume or energy is displayed and transmitted at varying resolutions. For any constant, any range can be selected, but the limited range (up to 8 digits) of the energy or volume register must be considered.

Range	LCD readout and communication resolution	
	Energy	Volume
1	0,1k Wh	0,001 m <sup>3</sup>
2	1k Wh	0,01 m <sup>3</sup>
3	0,01k MWh	0,1 m <sup>3</sup>
4	0,1k MWh	1 m <sup>3</sup>

Recommended pulse constants for the individual ranges, with the pulse constant units imp/dm<sup>3</sup> and imp/kWh:

Range	Resolution	Pulse constant [imp/dm <sup>3</sup> , imp/kWh]
1	0,001 m <sup>3</sup> / 0,1 kWh	1 000 ... 100
2	0,01 m <sup>3</sup> / 1 kWh	100 ... 10
3	0,1 m <sup>3</sup> / 0,01 MWh	10 ... 1
4	1 m <sup>3</sup> / 0,1 MWh	1 ... 0,1

Recommended pulse constants for the individual ranges, with the pulse constant unit dm<sup>3</sup>/imp

Range	Resolution	Pulse constant [dm <sup>3</sup> /imp.]
1	0,001 m <sup>3</sup>	1 ... 10
2	0,01 m <sup>3</sup>	10 ... 100
3	0,1 m <sup>3</sup>	100 ... 1 000
4	1 m <sup>3</sup>	1 000 ... 10 000

**NOTE:** If the additional inputs are configured at the calculator, the range is selected automatically according to the above data.

#### 4.4.2 Mode: alarm input

This input mode allows for controlling any alarm signal, e.g. violation of entry into the heating station. The alarm state corresponds to low state at the input. Normal operation corresponds to high state. A violation of the alarm input is recorded in the malfunction history. Malfunctions can be read using remote devices.

#### 4.4.3 Mode: input for digital communication with flow sensor

This input mode allows for digital communication with selected flow sensors. Using digital communication with the flow sensor, you can read the current flow sensor status. For a detailed description of the detectable malfunctions, see chapter 4.3.1.

#### 4.4.4 Mode: auxiliary flow sensor input

The input mode that allows to connect the auxiliary (rotor or ultrasonic) flow sensor with the same parameters as the main sensor. This flow sensor is used to detect leaks.

**NOTE:** this input mode can only be enabled by changing the operation system to the closed leak detection system.

## 4.5 Data history recording

The calculator allows for the recording of a wide range of data, including basic measurement data such as energy and volume, statistical data, malfunctions, events and changes in the calculator's configuration. Depending on the recording cycle, the recording can be categorised as:

- **cyclical:** regular recording at a specific time or recording cycle,
  - **asynchronous:** recording occasioned by various events, malfunctions and changes in configuration.
- Data history recording is done using additional FLASH memory. The available space can be freely assigned to cyclical, billing and tariff archives. A fixed space is allocated for the malfunction, event and configuration changes history. The range of data recorded in the cyclical, billing and tariff history is widely configurable. If record consist of minimum data set, more than 6,000 data records can be saved to the whole memory space available for the archive.

**NOTE:** For every data record, its unique number and record time stamp is saved, including day, month, year and time (hours, minutes and seconds). The data record's ID is unique for the whole history of a given archive type and is not reset when the maximum number of data records for a given archive type is exceeded. Once the entire area designated for a given archive type is full, the oldest records are deleted and replaced with new records.

### 4.5.1 Cyclical archives

Cyclical archives with the following recording cycles are available:

- **Minute/configurable:** variable cycle, configurable from 1 to 20,160 minutes (2 weeks).
- **Hourly:** a constant cycle. The values for this cycle are determined and recorded at the full hour.
- **24-hour:** a constant cycle. The values for this cycle are determined and recorded once every 24 hours, at the full hour (similarly to the hourly cycle). You can configure the hour of recording (0-23).
- **Monthly:** a constant cycle. The values for this cycle are determined and recorded once a month, at the full hour on the selected day of the month. The data recording hour is the same as the 24-hour data recording hour. You can configure the day of the month (1-31) in which the data for this cycle is recorded. If the set day of the month value is higher than the number of days in a given month, the recording is done on the last day of a given month.
- **Annual:** a constant cycle. The values for this cycle are determined and recorded once a year, at the full hour on the selected day and in the selected month. The data recording hour and day are the same as the monthly data recording hour and day. You can configure the month (1-12) in which the data is recorded.

You can select the method of registration of the main energy and volume values in the archive, you can use the following methods:

- **total values**, the current counter values will be saved in the archive,
- **incremental values**, the increase in the counter values that has occurred since the last registration will be saved in the archive.

The range of the data recorded in the cyclical histories is freely configurable. By decreasing the amount of the recorded data, you can record a greater number of data records. The data recorded in the cyclical histories can be divided into two groups:

1. **Data which is always recorded and displayed**, having a fixed space assigned in the data record, irrespective of the configured range of the recorded data.
2. **Data which is recorded and displayed if the register is active**, having a fixed space assigned in the data record, but recorded only if the registers are active.

Data type	Data always recorded	Data recorded if the register is active
Record ID	+	-
Record timestamp		
Calculator operating time		
Error operating time		
Main error code		
Main energy (sum or increase)		
Main volume (sum or increase)		
Main mass		
Cool energy		
Cool volume		
Energy value – tariff 1		
Volume value – tariff 1		
Energy value – tariff 2		
Volume value – tariff 2		
Auxiliary volume (sum or increase)		
Auxiliary mass volume	-	+
Additional input 1 (volume/energy)		
Additional input 2 (volume/energy)		
Additional input 3 (volume/energy)		
Additional input 4 (volume/energy)		

3. **Data recorded depending on user configuration.** You can configure the type of the recorded data: instantaneous, average, maximum and minimum. For every minimum and maximum value, the date and time when a given value occurred is also recorded. You can configure the recording of any combination of the following data.

	Data type	Minute	Hourly	24-hour	Monthly	Monthly
Instantaneous	Power	Configurable recording	Configurable recording	Configurable recording	Configurable recording	Configurable recording
	Flow					
	Flow temperature					
	Return temperature					
	Temperature difference					
Average	Power	Configurable recording	Configurable recording	Data always recording	Configurable recording	Configurable recording
	Flow					
	Flow temperature					
	Return temperature					
	Temperature difference					
Maximum	Power	Configurable recording	Configurable recording	Configurable recording	Configurable recording	Configurable recording
	Flow					
	Flow temperature					
	Return temperature					
	Temperature difference					

	Data type	Minute	Hourly	24-hour	Monthly	Monthly
Minimum	Power	Configurable recording	Configurable recording	Configurable recording	Configurable recording	Configurable recording
	Flow					
	Flow temperature					
	Return temperature					
	Temperature difference					

For the monthly and 24-hour history, you can read the selected data from the last recording using the M-Bus protocol. For more details, see chapter 5.1.1.

**NOTE:** If the configuration of the range and number of the data records is changed, all of the recorded data will be lost.

#### 4.5.2 Tariff archive

The calculator allows for the recording of tariff data. In a single memory space, the data records for both tariffs are recorded. The maximum number of records in the archive can be configured by the user and it depends on the memory used for the other archives. Once a threshold is exceeded, the occurrence time is recorded, and the calculation to the tariff registers and the calculation of the summary time during which the tariff threshold is exceeded starts. The data record is made when the exceeded tariff threshold status discontinues. The tariff records consist of the following data:

- record ID,
- number of tariff related to the record,
- currently set threshold,
- data record recording time, which is equivalent to the time when the exceeded threshold status discontinues,
- exceeded threshold time,
- summary time during which a tariff threshold is exceeded (in minutes),
- calculator operating time,
- main energy meter,
- main volume meter,
- energy meter for the registered tariff,
- volume meter for the registered tariff.

#### 4.5.3 Billing archive

The calculator allows for the recording of data in a special billing archive. The range of the data recorded in the register is fixed. The archive records the following data:

Data type	Data always recorded	Data recorded if the register is active
Record ID	+	-
Record timestamp		
Calculator operating time		
Error operating time		
Main error code		
Main energy		
Main volume		
Main mass		

Data type	Data always recorded	Data recorded if the register is active		
Cool energy	-	+		
Cool volume				
Energy – tariff 1				
Volume – tariff 1				
Energy – tariff 2				
Volume – tariff 2				
Auxiliary volume				
Auxiliary mass				
Additional input 1 (volume/energy)				
Additional input 2 (volume/energy)				
Additional input 3 (volume/energy)				
Additional input 4 (volume/energy)				
Instantaneous thermal power			+	-
Instantaneous flow				
Instantaneous flow temperature				
Instantaneous return temperature				
Instantaneous temperature difference				

You can change the maximum possible number of data records registered in the history. A record is stored every cycle. Two recording cycles are available:

- **Monthly:** recording hour and day of the month can be set,
- **Annual:** recording hour, day and month can be set.

**NOTE:** If the set day of the month value is higher than the number of days in a given month, the recording is done on the last day of a given month.

For the billing archive, it is possible to read the selected data from the last recording using the M-Bus protocol. For more details, see chapter 6.1.1.

#### 4.5.4 Malfunction and event history

The calculator has two independent archives where the occurrence and disappearance of malfunctions or events is recorded. The space allocated to the histories is fixed. The failure archive may include at least 78 last registered failures, while the event history can store a minimum of 256 recent event recordings.

The **malfunction history** registers the following data:

- record ID,
- data record date and time: when the malfunction occurred/stopped,
- calculator operating time and error operating time,
- error code before and after the failure,
- main, cool, tariff energy and main and auxiliary volume,
- instantaneous flow and return temperature.

The **event history** registers the following data:

- record ID,
- data record date and time: when the malfunction occurred/stopped,
- calculator operating time and error operating time,
- code of event or events if they occurred simultaneously,
- main energy and volume.

For a detailed list of the recorded malfunctions and events, see chapters 4.3.1 and 4.3.2.

#### 4.5.5 Configuration change history

The calculator has two independent archives where the changes in the metrological configuration and the changes in the user configuration are recorded. The space allocated to the configuration change histories is fixed. The history of changes in the metrological configuration can store a minimum of 62 recent recordings, while the history of changes in the user configuration can store a minimum of 83 recordings.

The **history of changes in the user configuration** records the following:

- record ID,
- change date and time,
- the manner in which the change has been introduced (calculator menu, communication via module, optical port),
- security status when the change was introduced,
- type of the introduced change and full configuration of selected parameters after the change was introduced.

The history records the following events:

1. RTC setting,
2. operating time and error operating time reset,
3. change in communication settings: network number/client number, optical transmission speed, M-Bus frame configuration,
4. configuration of additional inputs 1/2/3/4 (pulse constants, type and serial number),
5. setting of the additional input 1/2/3/4 initial registers value,
6. configuration of communication modules 1/2,
7. configuration of parameters for recording auxiliary energy or tariffs,
8. configuration of parameters for detecting and recording malfunctions
9. configuration of space allocation to histories,
10. configuration of data recording cycle or averaging cycle.

The **history of changes in the metrological configuration** records the following:

- record ID,
- change date and time,
- ID of the user introducing the change (HASP key ID for FaunSerwis),
- operating time and error operating time,
- current values of registers:
  - main energy,
  - cool energy,
  - energy - tariff 1 and 2,
  - main volume,
  - cooling medium volume,
  - volume - tariff 1 and 2,
- full configuration of metrological parameters after the change is introduced:
  - calculator configuration: type, place of installation and energy unit
  - flow sensor configuration, including: pulse constant and pulse unit, and rated flow,
  - configuration of temperature sensors: type and measurement mode.

The history records the following events:

1. change in the calculator configuration, including: type, place of installation and energy unit,
2. change in the flow meter configuration, including: type, pulse constant and rated flow,
3. change in the configuration of temperature sensors: type and measurement mode,
4. resetting of the values of the main energy and volume registers, cool registers, tariff registers and main mass registers
5. setting the initial value for the auxiliary flow sensor registers: volume and mass
6. optical port and module transmission number reset

## 4.6 Calculator configuration

The following chapter lists the user-configurable parameters, grouped by functionality.

### 4.6.1 Configuring additional inputs and setting the status of input counters

The following parameters can be configured for each of the four additional inputs:

Additional input configuration parameters	Possible parameter settings
Input type <sup>1</sup>	<ul style="list-style-type: none"> <li>deactivated</li> <li>pulse</li> <li>alarm</li> <li>communications: flow sensor</li> <li>auxiliary flow sensor</li> </ul>
Pulse constant and unit <sup>2</sup>	<ul style="list-style-type: none"> <li>dm<sup>3</sup>/imp, constant format: xx xxx.y</li> <li>imp/dm<sup>3</sup>, constant format: x xxx.yyy</li> <li>imp/kWh, constant format: x xxx.y</li> </ul>
Counter register resolution <sup>2</sup>	<ul style="list-style-type: none"> <li>0,001 m<sup>3</sup> / 0,1 kWh</li> <li>0,01 m<sup>3</sup> / 1 kWh</li> <li>0,1 m<sup>3</sup> / 0,01 MWh</li> <li>1 m<sup>3</sup> / 0,1 MWh</li> </ul>
Equipment serial number <sup>2</sup>	8-digit value: 00000000 ... 99999999
Counter register initial status	-

1. The available input type depends on the input number,
2. Setting available for pulse-type input.

### 4.6.2 Configuring communication parameters

The following calculator communication parameters can be configured:

Additional input configuration parameters	Possible parameter settings
Network address/M-Bus	1 ... 250
Client ID	8-digit value: 00000000 ... 99999999
LUMBUS address	0 ... 63
MODBUS address	1 ... 247
Transmission speed for optical port	300, 600, 1200, 2400, 4800, 9600
Even parity	<ul style="list-style-type: none"> <li>odd</li> <li>even</li> <li>no parity</li> </ul>
Configuration of optical port activity time	1 ... 255 s
Configuration of M-Bus frame data	<sup>1</sup>

1. For the details on the possible configuration of the M-Bus frame, see chapter 6.1.1.3.

### 4.6.3 Configuring additional module interface

The following parameters can be configured for each additional module. Some of the parameters are available only for a specific module type.



Module parameters	Possible parameter settings
Module type	<ul style="list-style-type: none"> <li>• M-Bus</li> <li>• RS 232 / RS 485</li> <li>• LonWorks</li> <li>• WM-Bus radio</li> <li>• 2 pulse outputs</li> <li>• 2 pulse inputs + 2 pulse outputs</li> <li>• 2 analogue outputs deactivated</li> </ul>
Transmission speed	<ul style="list-style-type: none"> <li>• 300, 600, 1200, 2400, 4800, 9600,</li> <li>• 19200, 38400, 57600, 76800, 115200<sup>1</sup></li> </ul>
Even parity	<ul style="list-style-type: none"> <li>• no parity</li> <li>• even</li> <li>• odd</li> </ul>
Protocol type <sup>2</sup>	<ul style="list-style-type: none"> <li>• M-Bus, configuration and readout,</li> <li>• MODBUS,</li> <li>• LUMBUS.</li> </ul>
Analogue output data type 1/2 <sup>3</sup> (instantaneous values)	<ul style="list-style-type: none"> <li>• output deactivated</li> <li>• flow</li> <li>• power</li> <li>• flow temperature</li> <li>• return temperature</li> <li>• temperature difference</li> </ul>
Starting data value for analogue output 1/2 <sup>3</sup> range <sup>4</sup>	4
End data value for analogue output 1/2 <sup>3</sup> range	4
Pulse output 1/2 <sup>5</sup> data type	<ul style="list-style-type: none"> <li>• main energy increase</li> <li>• main volume increase</li> <li>• cool energy increase</li> <li>• cool volume increase</li> <li>• energy increase - tariff 1</li> <li>• volume increase - tariff 1</li> <li>• energy increase - tariff 2</li> <li>• volume increase - tariff 2</li> </ul>
Impulsing resolution for pulse output 1/2 <sup>5</sup>	<ul style="list-style-type: none"> <li>• 0,1</li> <li>• 1</li> <li>• 10</li> </ul>

1. Transmission speed: 19200, 38400, 57600, 76800, 115200, available only for RS485 module, additionally.

NOTE 1: when set to one of the above speed on one of the modules, the second module can work only at speeds greater than 9600.

NOTE 2: when you configure the module to work with one of the above speeds, and the second module operates at a speed of less than 19200, it will be switched off and defaults configuration have been restored.

2. The protocol can be selected for the following modules: M-Bus, RS 232 and RS 485.
3. Setting available for analogue output module.
4. The value depends on the set calculator operating range and the selected instantaneous value for the output.
5. Setting available for pulse output module, a detailed description of the settings of the pulse value in the table below.

### Pulse input/output module:

In the case of a pulse output module, it is possible to configure the resolution of the pulse output, i.e. value of the energy or volume increase corresponding to a single pulse. The pulse value depends on the calculator's operating range set during the production process, and it can be as follows:

Range	Pulse value for a given output setting				
	Output resolution	Energy			Volume
1	0,1	0,1 MJ/imp	0,1 Mcal/imp	0,01kWh/imp	0,1 dm <sup>3</sup> /imp
	<b>1</b>	<b>0,001 GJ/imp</b>	<b>0,001 Gcal/imp</b>	<b>0,1kWh/imp</b>	<b>0,001 m<sup>3</sup>/imp</b>
	10	0,01 GJ/imp	0,01 Gcal/imp	1kWh/imp	0,01 m <sup>3</sup> /imp
2	0,1	0,001 GJ/imp	0,001 Gcal/imp	0,1kWh/imp	0,001 m <sup>3</sup> /imp
	<b>1</b>	<b>0,01 GJ/imp</b>	<b>0,01 Gcal/imp</b>	<b>1 kWh/imp</b>	<b>0,01 m<sup>3</sup>/imp</b>
	10	0,1 GJ/imp	0,1 Gcal/imp	0,01 MWh/imp	0,1 m <sup>3</sup> /imp
3	0,1	0,01 GJ/imp	0,01 Gcal/imp	1 kWh/imp	0,01 m <sup>3</sup> /imp
	<b>1</b>	<b>0,1 GJ/imp</b>	<b>0,1 Gcal/imp</b>	<b>0,01 MWh/imp</b>	<b>0,1 m<sup>3</sup>/imp</b>
	10	1 GJ/imp	1 Gcal/imp	0,1 MWh/imp	1 m <sup>3</sup> /imp
4	0,1	0,1 GJ/imp	0,1 Gcal/imp	0,01 MWh/imp	0,1 m <sup>3</sup> /imp
	<b>1</b>	<b>1 GJ/imp</b>	<b>1 Gcal/imp</b>	<b>0,1 MWh/imp</b>	<b>1 m<sup>3</sup>/imp</b>
	10	10 GJ/imp	10 Gcal/imp	1 MWh/imp	10 m <sup>3</sup> /imp

### Analogue output module:

For correct operation of the analogue outputs, it is necessary to configure the module parameters listed in the table: data type at the output (one of the instantaneous values) and output range, i.e. the instantaneous value corresponding to the output range start (1 V or 0 / 4 mA) and the instantaneous value corresponding to the end of range (10 V or 20 mA). For the instantaneous values within the set range, the output value is determined based on linear approximation between the set points. For values from outside the range (output saturation), the value corresponding to the start or the end of the range is set.

#### 4.6.4 Configuring history recording

The configuration of history recording can be grouped into two parts: configuring the recording time and cycle, and configuring the memory space for the individual histories – maximum number of data records to be recorded in a given history and the range of the recorded data.

Time parameters of history recording	Possible parameter settings
History recording hour: 24-hour, monthly and annual	0 ... 23
History recording day: monthly and annual	1 ... 31 <sup>1</sup>
Month of annual history recording	1 ... 12
Cycle of recording billing data	month year
Billing history recording hour	0 ... 23

Time parameters of history recording	Possible parameter settings
Billing history recording day	1 ... 31 <sup>1</sup>
Billing history recording month <sup>2</sup>	1 ... 12
Configurable/minute history recording cycle	1 ... 20.160 min (2 weeks)
Averaging cycle	1 ... 1.440 min

1. If the set recording day value is greater than the maximum number of days in a given month, the recording is done on the last day of a given month.
2. Setting available for the annual billing data recording cycle.

For the annual, monthly, 24-hour, hourly and minute history recording cycle, the range of the recorded data can be configured.

Range parameters of history recording	Possible parameter settings
Range of data recorded in history	<ul style="list-style-type: none"> <li>• instantaneous values: <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• average values: <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• maximum values: <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• minimum values: <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> </ul>
Method of the main energy and volume values registration	<ul style="list-style-type: none"> <li>• total values</li> <li>• incremental values</li> </ul>
Archives capacity	<sup>1</sup>

1. The maximum number of data records which can be saved in a given type of archive depends on the range of the recorded data and on the memory allocated to the other archives.

#### 4.6.5 Configuring tariff registers and the cool registers

For the tariff registers, the threshold and the method of calculating energy and volume can be configured. For the cool register you can set the threshold flow temperature below which the cool energy calculation starts.

Parameters	Possible parameter settings
dT energy measurement threshold	0.1 ... 3.0 °C
Activation of the cold calculation registers	<ul style="list-style-type: none"> <li>• active</li> <li>• deactivated</li> </ul>
Activation of cold measurement threshold	<ul style="list-style-type: none"> <li>• active</li> <li>• deactivated</li> </ul>
Cold measurement threshold – minimum flow temperature	1 ... 3.0 °C
Threshold type for calculation to tariff registers 1/2 (average values)	<ul style="list-style-type: none"> <li>• tariff register not active</li> <li>• flow</li> <li>• power</li> <li>• flow temperature</li> <li>• return temperature</li> <li>• temperature difference</li> </ul>
Threshold value for calculation to tariff registers	1
Method for calculating values to tariff registers	<ul style="list-style-type: none"> <li>• in whole</li> <li>• proportionately</li> </ul>

1. The range and the unit depend on the selected tariff.

#### 4.6.6 Configuring malfunction detection

For some of the malfunctions, selected parameters can be configured and malfunction signalling can be deactivated.

Malfunction signaling parameters	Possible parameter settings
Detection of reverse temperature difference error	<ul style="list-style-type: none"> <li>• active</li> <li>• deactivated</li> </ul>
No flow error detection	<ul style="list-style-type: none"> <li>• active, determined based on average value</li> <li>• deactivated</li> </ul>
Detection of maximum flow exceeded error	<ul style="list-style-type: none"> <li>• active, determination on the basis of the temporary flow value</li> <li>• active, determined based on average flow value for the averaging cycle</li> <li>• deactivated</li> </ul>
Value for maximum flow exceeded error	1.5 ... 7.500 m <sup>3</sup> /h
Time to detect no flow error	1 ... 24 h
Temperature difference to detect no flow error	1 ... 175 K
Temporary flow value until the no flow detected error is generated	1
Long-term leak detection method	<ul style="list-style-type: none"> <li>• volume difference,</li> <li>• mass difference.</li> </ul>
Long-term leak indication threshold	2
Time until the long-term leak is detected	1 ... 24 h
Short-term leak indication threshold	10 ... 100 %

Malfunction signaling parameters	Possible parameter settings
time until the short-term leak is detected	10 ... 360 s
LED indicating the failure	on/off
type of errors indicated by the LED	error codes

1. Value range and unit depend on the calculator operation range.
2. Value range and unit depend on the calculator operation range and the failure detection method

#### 4.6.7 Configuring the display of current and historic data

The calculator allows for comprehensive configuration of the range and mode for displaying data on the LCD. You can configure the range of data displayed in the current and archive data group to a great extent (for the minute, hourly, 24-hour, monthly and annual archive). In addition, it is possible to configure the maximum number of the recently registered data records displayed.

Display parameters	Possible parameter settings
Range of data displayed in current data group – 1	<ul style="list-style-type: none"> <li>• cool energy</li> <li>• cool volume</li> <li>• energy - tariff 1</li> <li>• volume - tariff 1</li> <li>• energy - tariff 2</li> <li>• volume - tariff 2</li> <li>• main and auxiliary mass</li> <li>• flow temperature</li> <li>• return temperature</li> <li>• temperature difference</li> <li>• flow</li> <li>• auxiliary flow</li> <li>• power</li> <li>• main error code</li> <li>• additional error code</li> <li>• additional input 1/2/3/4 (volume/energy)</li> <li>• metrological test</li> <li>• display test</li> </ul>
Automatic return to main energy display	<ul style="list-style-type: none"> <li>• active</li> <li>• deactivated</li> </ul>
Time of automatic return to main energy display	1 – 255 s

Display parameters	Possible parameter settings
Range of data displayed in statistical data group- 2 <sup>1</sup> / Range of data displayed for data records in archive group – 5 <sup>2</sup>	<ul style="list-style-type: none"> <li>• instantaneous values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• average values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• maximum values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• minimum values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> </ul>
Maximum number of historic data records displayed	3



1. It is possible to activate/deactivate the display of all values from the statistical data group.
2. The range of configurable values depends on the configured range of the recorded data. The maximum possible configuration range of the displayed data is presented.
3. Independent settings for each type of archive whose data is available on the LCD. The possible parameter settings depend on the archive configuration.

#### 4.6.8 Setting date and time

The user can set the current date and time, and activate automatic switching to daylight saving. When the automatic time change option is enabled it is not recommended to set the time when the time is changed from the summer time to the standard time (on the last Sunday in March and October, between 2:00 am and 3:00 am) because the time can be set incorrectly.

## 4.7 Securing access to configuration

The configuration parameters are categorized into two groups:

- **Parameters related to and affecting measurement**, such as the flow sensor placing, pulse constant and pulse unit, energy unit and the type of temperature sensors. The data is secured with a certification jumper, which is accessible after removing the manufacturer's seal and the calculator's PCB cover, or after breaking out the jumper's guard (seal the broken cover later with the metrological seal). To activate the authorisation to metrological configuration, close the jumper's fields for longer than 1 second. The configuration is accessible for 5 minutes from closing the jumper's fields, and the access is extended by another 5 minutes after each correct configuration save. The authorisation to access the configuration is signalled on the LCD with a blinking wrench symbol . In addition, the modification of metrological parameters is secured with an HASP service hardware key.
- **Parameters not affecting measurement**, they are secured with a client jumper, which is accessible after opening the cover. The jumper is an easy-to-use button accessible through the pusher in the side panel of the PCB guard. To activate the configuration authorisation, press and hold the button for longer than 250 ms. Holding the button for longer than 1 second will automatically open the configuration menu. The access to the configuration is active for 5 minutes from the moment when the button was pressed. The access is extended by another 5 minutes after each successful configuration save or activity in the configuration menu (group 6). The authorisation to access the configuration is signalled on the LCD with a lit-up wrench symbol .

Configuration type	Save protection			
	Client jumper	Certification jumper	Client HASP key	Service HASP key
additional input configuration	+			
communications configuration	+			
additional module configuration	+			
configuration of tariff registers and cool register	+			
failures detection configuration	+			
setting date and time	+			
current and archive data display configuration	+			
<b>Archive configuration:</b>				
archive registrations period and range configuration	+			
deleting archive registrations - cyclic archives	+			
deleting archive registrations - failure archive, event archive and tariff archive	+		+	
<b>Calculator configuration:</b>				
calculator type, flow sensor placing, energy unit		+		+
operation system - enabling leak detection operation system	+			
<b>Temperature measurement configuration:</b>				
sensor type, measurement method		+		+

Configuration type	Save protection			
	Client jumper	Certification jumper	Client HASP key	Service HASP key
<b>Flow sensor configuration:</b>				
pulse constant, registers resolution		+		+
nominal flow rate and dynamic range	+			
<b>Setting the initial values or resetting of registers:</b>				
resetting the energy registers, volume registers and main mass registers		+		+
resetting the cool energy registers, cool volume registers and tariff registers	+		+	
setting the auxiliary volume registers and the auxiliary mass registers	+		+	
setting the initial values for the additional input registers	+			
resetting the operation time and the active error operation time	+		+	
resetting the tariff threshold exceeding time	+		+	
Configuration of the parameters displayed in group 6 on LCD	+			

Shown below is the location of the client jumper button (B) and the service jumper (A):

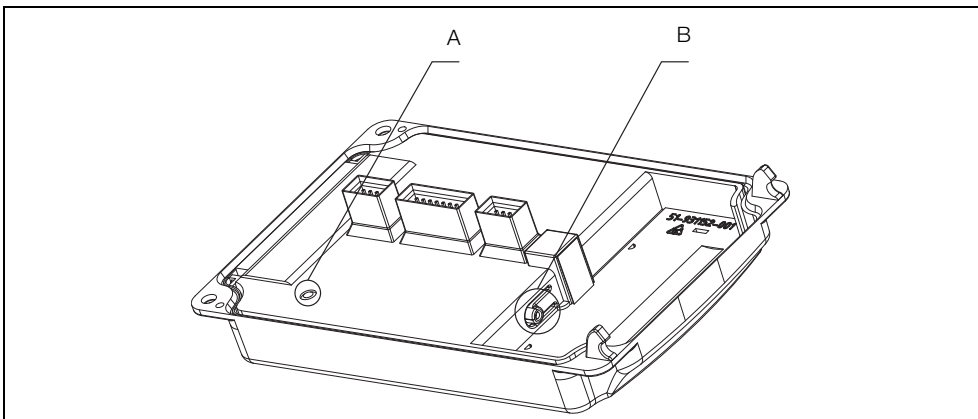


Figure 2: Location of user jumper (B) and service jumper (A)



## 5 Calculator operation: display queue and buttons

The following chapter describes the operation of the calculator, the data available on the display, the possible configuration of the display queue and parameterisation using the calculator.

### 5.1 How to operate the calculator

The LCD and two buttons are used for displaying data and operating the calculator. The data shown on the display has been categorised into six groups, with each group containing values which are logically related to each other. The type of the values displayed in a given group can be configured (see chapter 4.3). Some of the values may be omitted from the display if such values are not recorded.

#### 5.1.1 LCD and buttons

The display includes two output fields: one 8-digit field for presenting values and another field, depending on the displayed screen, for additional description of the values, error signalling or, for example, for displaying the time on the date and time screen. In addition, the display shows the units of the displayed values and their symbols.

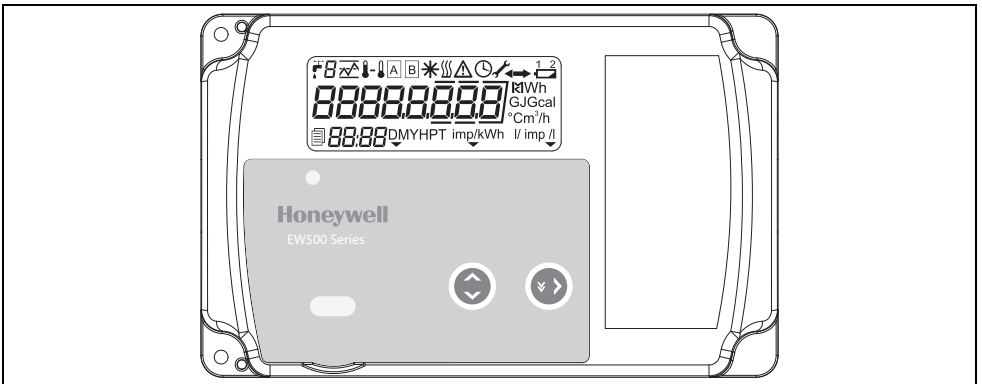
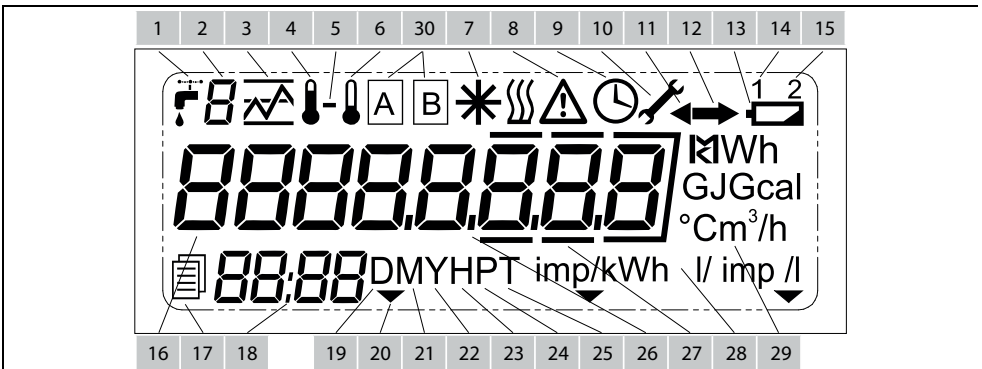


Figure 3: View of calculator's cover






The calculator is operated using two buttons (P1 and P2). Each button has two functions, which are activated by:

- pressing the button briefly (labelled with a dark arrow),
- pressing the button for a longer period of time - pressing and holding the button for approx. 2 seconds (labelled with a light arrow).

The calculator may have optional mechanical or capacitive buttons.



Below is the description of the display symbols used to present the calculator data and configuration:

1. **Symbol** indicating volume or flow. It is also shown with the symbol in field 2 for additional input values.
2. **Additional input or tariff symbol.** The symbol indicates data (register or configuration value) for an additional input, symbols: A, b, C, d, or values related to tariffs, symbols: 1, 2.
3. **Instantaneous/minimum/maximum/average or tariff value.** The symbol indicates one of the following values:
  - instantaneous value: , for flow and power,
  - minimum value: ,
  - maximum value: ,
  - average value: ,
  - tariff value: , displayed with the symbol in field 2, which indicated the tariff number.
4. **Flow temperature symbol.** It is displayed for the instantaneous, average or peak value as well as for historic flow temperature values.
5. **Temperature difference symbol.** Along with symbols 4 and 6, it indicates the temperature difference.
6. **Return temperature symbol.** It is displayed for the return temperature.
7. **Cold symbol.** It is displayed for the values of the cool registers: energy and volume. It is also displayed on the temperature difference screen if the cool calculation conditions are fulfilled.
8. **Malfunction symbol.** It signals that a malfunction has occurred. This symbol is displayed on the main screen and on the screens related to a given malfunction. In addition, there is an error type message in field 18.
9. **Time symbol.** It is displayed on the screens for the current date and time, the date and time values related to historic data, and for the operating time.
10. **Configuration access symbol.** The wrench symbol indicates the level of access to the calculator's configuration (it is displayed on all screens when access is blocked). A blinking symbol indicates access to metrological settings. A lit-up symbol indicates access to user settings.
11. **Backflow symbol.** It indicates a backflow inconsistent with the correct direction. This option is available only for flow sensors with digital communication.
12. **Flow symbol.** It indicates correct flow direction.
13. **Low battery symbol.** Displayed together with symbols 14 and 15, it indicates the type of the discharged battery (displayed on all screens during malfunction) or indicates the battery type for which voltage is displayed in the service menu.
14. **Main battery symbol.** Displayed with symbol 13, it indicates a value or signals a malfunction of the main battery.
15. **Backup battery symbol.** Displayed with symbol 13, it indicates a value or signals a malfunction of the backup battery.
16. **Main display field.** 8-digit field displaying values and the calculator's configuration data.
17. **Archive symbol.** Displayed with symbol 19, 21, 22, 23, 24 or 25, it indicates the type of historic data displayed.
18. **Additional display field.** 4-digit field for displaying additional information about the values displayed in the main field, error type, and current or historic time on selected screens.
19. **24-hour data symbol.** It indicates historic data from the 24-hour archive.
20. **Optical port activity symbol.** This symbol is displayed when the optical port is activated by button and communication is possible.
21. **Monthly data symbol.** It indicates historic data from the monthly archive.
22. **Annual data symbol.** It indicates historic data from the annual archive.
23. **Hourly data symbol.** It indicates historic data from the hourly archive.
24. **Minute data symbol.** It indicates historic data from the minute/configurable archive.
25. **Tariff data symbol.** It indicates historic data from the tariff archive.
26. **Decimal symbol.** It indicates the decimal part of a value or separates different values.
27. **Decimal symbol.** This symbol distinguishes the decimal part of a value.
28. **Pulse constant symbol.** It indicates the pulse constant unit.
29. **Unit field.** It indicates the unit of the value displayed in the main field. The available units include energy, volume, flow, power and time units.

30. **Register type symbol.** Displayed only when the calculator is configured to operate in the leak detection system, only for the values determined for both flow sensors (volume, mass, flow and error code). It specifies the flow sensor which the displayed data relates to: A - main flow sensor, B - auxiliary flow sensor.

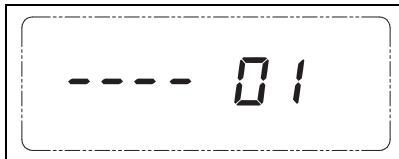
### 5.1.2 Navigating through the display queue

To navigate through the calculator's menu, use the two available buttons. The buttons' function in the main menu groups (except for the configuration menu) is presented below:

- **P1 button** – It is used mainly to navigate through the elements in a group and subgroup (vertical movement in the menu):
  - When pressing the button briefly, you can move to the next element in a group/subgroup (also after using the menu shortcut) or enter a group/subgroup if a group label is displayed. If the current screen is the last screen in the group, the short click of the button will open the first screen in the group/subgroup.
  - Pressing the button for a longer period of time allows you to exit the group/subgroup. If another group/subgroup is displayed, pressing and holding the button for a longer period of time will open the first screen of the menu, and if the first item of the group (subgroup) is displayed, the group/subgroup selection screen will open.
- **P2 button** – It is used to navigate through groups and subgroups (horizontal movement in the menu):
  - Pressing the button briefly:
    - If group selection screens are displayed, the next group/subgroup will open.
    - When the selected values are displayed the shortcut will be executed and the value from other group connected with the displayed value will be displayed. Subsequent short pressing of this button will result in displaying next values assigned to the shortcut.
  - Pressing P2 button for a longer period of time activates the optical port and serves to confirm the changes made to settings from the calculator level.

### 5.1.3 Navigating through groups

In order to go to another group, press and hold the P1 button while any values are displayed on the LCD. Hold the button until the display shows the group or subgroup selection screen. When the button is pressed, the next element in the group will be displayed, which is the reaction to a short press. For example, when leaving the main group, the following message is displayed:



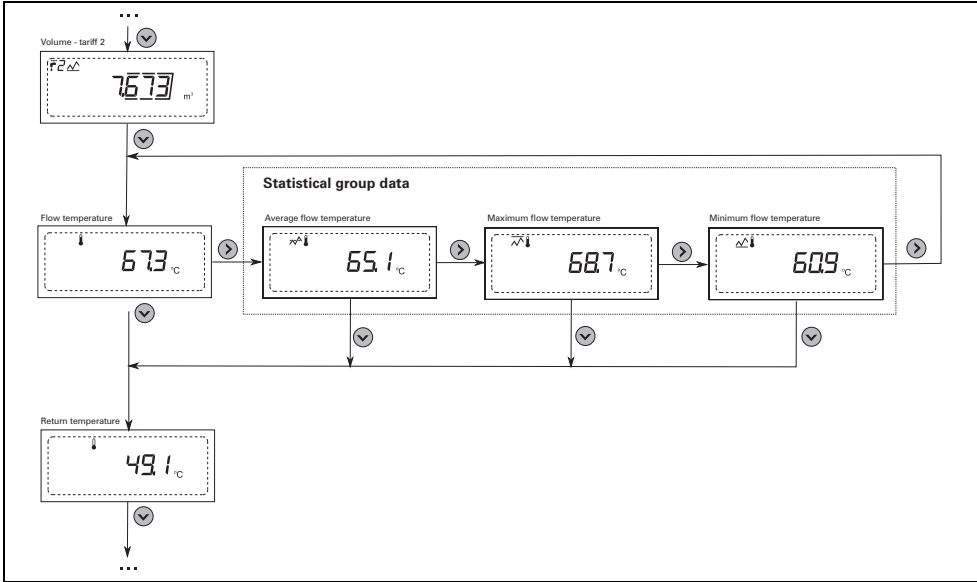
When the group or subgroup selection screen is displayed, a short press of the P2 button will change the group number or the subgroup. The calculator may omit certain groups if they are not available. These groups include:

- Statistical group (02): not displayed if the display of statistical data is deactivated,
- Tariff group (04): if no threshold is active,
- Configuration group (06): if the settings cannot be accessed – the jumper has not been used.

To display the elements of the selected group, briefly press the P2 button.

### 5.1.4 Shortcuts used to navigate between the values in the groups

As regards the values in the main group you can display the values from other group connected with the displayed value. The shortcut is executed after the short press of the P2 button, subsequent pressing of this button will result in displaying next values. However, when the P1 button is pressed in any time another value from the main group will be displayed. Please see a detailed description in chapter 5.2.1. The diagram below presents the function of shortcuts provided for the flow temperature.



### 5.1.5 Shortcuts for navigating through groups

For selected values in the main group, it is possible to directly access another group and the value related to the displayed value. The shortcut is activated by a short press of the P2 button. For a detailed description, see chapter 5.2.1.

## 5.2 Detailed description of menu groups

The following chapter discusses the individual menu groups available in the calculator. The data available on the display has been grouped as follows:

1. Main group. It allows for displaying the current status of the calculator's main registers and the measured instantaneous values.
2. Statistical group. It contains average and peak data for the averaging cycle.
3. Service group. It allows for displaying the selected configuration data of the calculator, such as primary input and additional input settings, additional module settings, current date and time, operating time, etc. The group is divided into three subgroups containing the calculator configuration data, additional inputs/outputs and the more recent energy part.
4. Tariff group. It allows for displaying the current data from the tariff registers, exceeded value time and threshold value, as well as historic tariff data and the calculator's register status when the exceeded status of the tariff threshold discontinued.
5. Archive group. It allows for displaying historic data from cyclical archives. The data for each archive type is included in separate subgroups: minute, hourly, 24-hour, monthly, annual and billing history.
6. Configuration group. It allows for configuring selected meter parameters.

### 5.2.1 Main group

The main group allows for displaying the calculator's main registers, such as: energy, volume, additional inputs, error code, as well as the measured instantaneous values: temperature, temperature difference, flow, thermal power and metrological test. The first menu screen, which is displayed in the calculator by default, displays the main energy. The calculator allows for configuring the time after which the display queue will automatically return to this menu item if other screens are displayed.



To go to subsequent screens in the group, briefly press the P1 button. The last menu screen is the display test, which allows for displaying all LCD segments. After reaching the last item in the group, a short press of the button will cause the display to return to the main energy screen. The main energy screen can also be reached from any location in the group by pressing and holding the P1 button.

#### Menu shortcuts

For selected screens, the values in another group can be reached directly using a shortcut. To do this, access the respective menu screen and briefly press the P2 button. Using this method allows you to switch:

- from the instantaneous values screen: flow temperature, return temperature, temperature difference, power and flow to the display of the average, maximum and minimum value connected with the given value (from the statistical group when the display option is enabled for these values),
- from the error code screen to the display of the operation time and the error operation time (from the service group),
- from the display test screen to the display of the serial number, customer number and the network addresses (from the service group),
- from the value for the additional input screen to the display of the pulse constant and the serial number of the device assigned to the input (from the service group).

### 5.2.2 Statistical group

The statistical group may display all available average and peak values (minimum and maximum values) for the configurable averaging cycle (1-1,440 minutes). The default setting of the averaging cycle is 60 minutes. This group does not contain any subgroups. To navigate through the group's items, use the standard P1 button.

The statistical values are identified with the following symbols:

- maximum values:  $\overline{\wedge}$
- minimum values:  $\underline{\wedge}$
- average values:  $\overline{\wedge}$

### 5.2.3 Service group

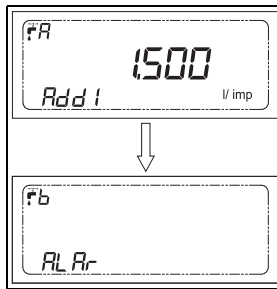
The service group is divided into two subgroups:

- **Calculator settings (labelled as Meter).** This subgroup includes the following: serial no., network address, customer ID, calculator settings, RTC time, operating time and error operating time, error detection settings and battery voltage.
- **Additional input/output settings (labelled as IO).** This subgroup includes the following: additional input settings and module settings.
- **Less significant part of energy registers (labelled as Regs).** This subgroup includes remaining, less significant digits of energy registers displayed in the main group. Each register has 4 additional digits displayed.

To access the selected subgroup, briefly press the P1 button.



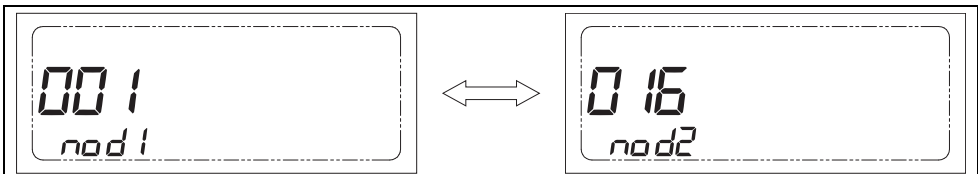
In the input/output subgroup, the first displayed item is the configuration of the first active additional input.



Short press of the P1 button displays the settings of the next additional input. The next screens display the encoded name of the additional module (in the main output field) and the module slot number (module 1: 'nod 1', module 2: 'nod 2'). To display information about the next module, briefly press button 2.

Codes of additional modules:

- communication modules:
  - 001: M-Bus module,
  - 002: LonWorks module,
  - 003: RS 232 or RS 485 module,
  - 004: radio module Wireless M-Bus,
  - 005: radio module AIUT for IMR systems,
- pulse input/output modules:
  - 016: module with 2 pulse outputs,
  - 080: module, 2 pulse inputs + 2 pulse outputs,
  - module with 2 analogue outputs: code 256.



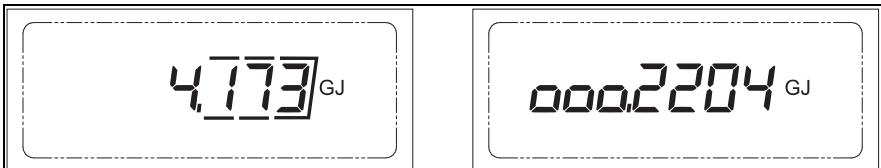
The subsequent screens display the data related to the module selected on the screen with the module code. Depending on the module type, the following information is displayed:

- For module with communication interface: configuration of serial transmission (transmission speed and parity: setting E – even, O – odd, n – no parity), type of the set communication protocol,
- Module with pulse outputs: type of data for the module's pulse outputs,
- Module with analogue outputs: type of data for the module's analogue outputs.

The final screen of the IO subgroup is the screen with the configuration of the optical port (baud rate and parity setting).



Depending on the calculator's configuration, the third subgroup includes the less significant part of the main energy register and it may also include less significant parts of the energy tariff register. The screens shown below are examples of screens for main energy (main register and register of the more recent part).

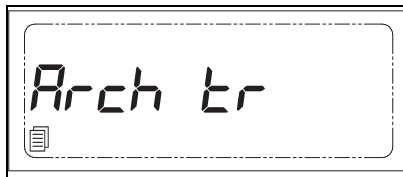


These data is interpreted to calculate the energy which equals: 4.1732204 GJ.

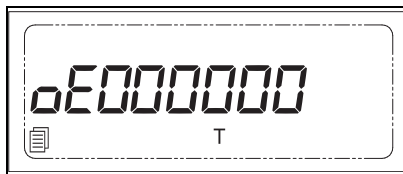
#### 5.2.4 Tariff group

The tariff group is available if at least one tariff has been configured. The following values are available in the menu for each tariff: energy, tariff volume, exceeded tariff threshold time, type and value of the set threshold. If any of the tariffs is not active, this data is omitted.

It is possible to go from the tariff group to the tariff archive subgroup by briefly pressing the P2 button while the tariff history subgroup screen is displayed.



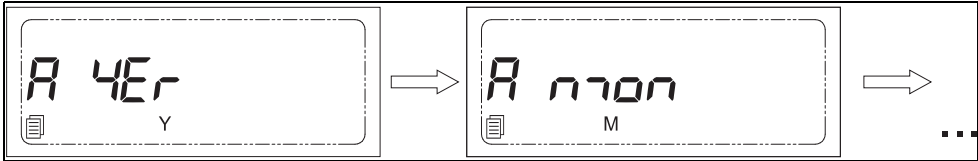
The first screen of the tariff archive is the screen where the record ID is selected.



Briefly press the P2 button to change the record ID. A brief press of the P1 button will open the screens presenting the historic data record with the selected number. To view the data stored in the data record, briefly press the P1 button. When the data of a given data record is displayed, you can switch at any time to the display of the same data from the next data record in the history. To leave the tariff archive, press and hold the P2 button until the tariff archive subgroup screen is displayed. If an entry is damaged, the tariff history displays an appropriate message – description in chapter 4.2.3.

### 5.2.5 Archive group

The archive group is available if at least one data record is saved in any cyclical archive. The group contains separate subgroups for each archive type. After accessing a group, the screen allowing for the selection of the type of archive to be viewed is displayed. Data from the following archives are available: annual, monthly, 24-hour, hourly, with varying recording cycle (minute) and billing history. Briefly press button 2 to change the history type.

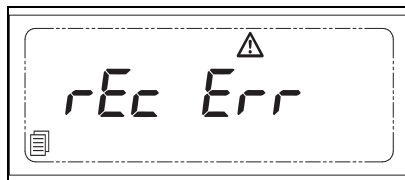


Some archives may be automatically omitted if the data recording for the archive is deactivated or if there are no data records to be displayed. To access the selected history subgroup, briefly press the P1 button. The first screen displayed after accessing selected archive is the data record number selection screen, e.g. in the annual archive:



To change the number of the displayed data record, briefly press the P2 button at any time. A brief press of the P1 button will open the screens presenting the historic data for the selected record. To view the data stored in the data record, briefly press the P1 button. When the data of a given data record is displayed, you can switch at any time to the display of the same data from the next data record in the history. To exit to the selection of another archive type, press and hold the P1 button as usual.

When the record data is corrupted (entry has been damaged), a message about the erroneous record is displayed. Briefly press P1 or P2 button to display the record number or to select another record.



A detailed list of the data displayed for the history data records is included in the annex, chapter 10.1.5.

### 5.2.6 Configuration group

The last group in the display queue is the configuration group, which is used for configuring selected parameters of the calculator. By default, this group is hidden and not available to the user. For detailed information about the configuration process, refer to chapter 5.4.



### 5.3 Configuring the display queue

The calculator allows for comprehensive configuration of the range and mode for displaying data on the LCD. For the energy and volume value (main, cool, tariff and additional inputs), it is possible to deactivate the display of the redundant zeros.



It is possible to activate or deactivate the automatic return to the display of the main energy indication. If a different menu screen is displayed, the energy display screen will open automatically once the configured time has elapsed.

There is a comprehensive configuration option for the range of the data displayed in the current and statistical data group. It is possible to activate/deactivate the display of the data for the individual values presented in the table below. In addition, the range of the displayed history data for the minute, hourly, 24-hour, monthly and annual archive can be configured. The display of any instantaneous, average or peak values can be activated/deactivated, provided that such data is recorded in the archive. You can also configure the maximum number of the data records to be displayed for the tariff, billing, minute, hourly, 24-hour, monthly and annual archive.

Display parameters	Displayed parameters activation/deactivation
Range of data displayed in main data group – 1	<ul style="list-style-type: none"> <li>• cool energy</li> <li>• cool volume</li> <li>• energy - tariff 1</li> <li>• volume - tariff 1</li> <li>• energy - tariff 2</li> <li>• volume - tariff 2</li> <li>• main and auxiliary mass</li> <li>• flow temperature</li> <li>• return temperature</li> <li>• temperature difference</li> <li>• flow</li> <li>• auxiliary flow</li> <li>• power</li> <li>• error code</li> <li>• additional input 1/2/3/4 (volume/energy)</li> <li>• metrological test</li> <li>• display test</li> </ul>

Display parameters	Displayed parameters activation/deactivation
Range of data displayed in statistical data group – 2  /  Range of data displayed for data records in archive group – 5 <sup>1</sup>	<ul style="list-style-type: none"> <li>• instantaneous values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• average values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• maximum values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> <li>• minimum values:               <ul style="list-style-type: none"> <li>- flow</li> <li>- power</li> <li>- flow temperature</li> <li>- return temperature</li> <li>- temperature difference</li> </ul> </li> </ul>

1. The range of configurable values depends on the configured range of the recorded data.

## 5.4 Configuring the calculator in the menu

The calculator allows for configuring selected parameters in the menu. Parameters such as date, time, network settings and additional input settings can be configured. The configuration option is secured by the client jumper, which can be accessed by opening the case. Detailed information about the safeguards can be found in chapter 4.7. Press and hold the jumper button for 1 second to automatically display the configuration group selection screen (06). The configuration group is available for 5 minutes from using the jumper or from the last activity in this group. After that time, the configuration group screen automatically switches back to the main energy screen. To activate the configuration group, use the jumper again. When the configuration option is accessible, you can exit and re-access this group at any time following the standard steps. After accessing the configuration menu, the calculator's current configuration is read and displayed during editing.

Follow the standard steps to navigate through the configuration group screens.

### 5.4.1 Editing numeric values

To start editing a numeric value, briefly press the P2 button while such value is displayed. The first digit of the edited value will start blinking. Briefly press the P2 button to set the desired value. To edit the next digit, briefly press the P1 button. In order to exit the value editing mode, go to the last editable digit and briefly press the P1 button again. As a result, the last digit will stop blinking and the display will return to the value screen. It is possible to select another value for editing.

The above procedure allows for configuring the following values in the calculator:

- date and time,
- network address (M-Bus, MODBUS oraz LUMBUS) and customer ID,
- pulse constant and serial number for additional inputs,
- initial value of the additional inputs registers.

**NOTE:** network address configuration for MODBUS and LUMBUS is possible only when the protocol is configured.

#### 5.4.2 Editing date and time

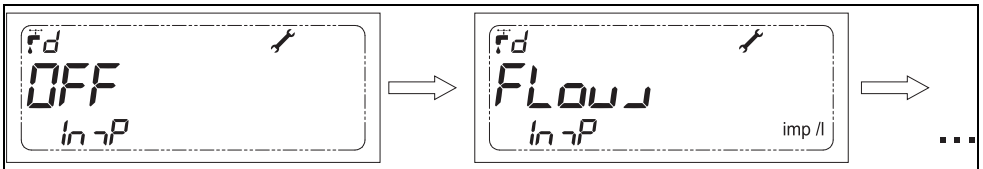
A single screen is used to edit date and time. Briefly press P2 button to start amending the date, after proceeding to the settings menu. Editing starts with the year, while subsequent pressing of P1 button changes the month, day, hour and minutes. The set date and time in the calculator is confirmed after the last digit is amended (tens of minutes).



#### 5.4.3 Editing additional input type

To change the type of an additional input, briefly press the P2 button while the pulse input type screen is displayed. As a result, the input type will change to the next available type. Depending on the input number, the following input types can be set:

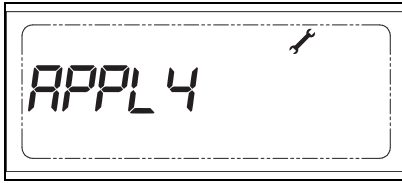
- input deactivated,
- pulse input with pulse constant: dm3/imp, imp/dm3 or imp/kWh,
- alarm input,
- input for digital communication with flow sensor.



**NOTE:** If the set input type is other than pulse input, the menu does not show the settings of the pulse constant and the serial number for a given input.

#### 5.4.4 Confirming the edited values

For date and time settings, the values in the calculator are updated immediately after their editing is finished.



To confirm other values, go to the last screen for confirming changes in the configuration group. If the current configuration has been changed, the display shows the message "APPLY". To save the new configuration, press and hold the P2 button until the display shows the message "No rConf". This means that the calculator has been configured according to the data entered in the configuration menu.



**NOTE:** If you leave the configuration group without performing the above step, the new settings will not be saved to the calculator.

## 6 Remote readout/configuration

The calculator has two ports for connecting a communication module. The modules can operate independently and use any available protocol.

### 6.1 Readout of calculator values

Four communication protocols have been implemented permanently in the calculator: MODBUS, LUMBUS, M-Bus and the protocol for the parameterisation and readout of historic data from the calculator. One of the protocols can be independently selected for a given module. Presented below is a detailed description of the data which can be read using the implemented protocols.

#### 6.1.1 M-Bus protocol

The M-Bus protocol conforms to the standards EN 13757-2:2005, EN 13757-3:2013 and OMS. The protocol can be used to read a number of data and selected historic data from the calculator.

##### 6.1.1.1 Addressing

There are three addressing methods available:

- **Primary addressing** with a user-configurable network primary address.
- **Secondary addressing** with a user-configurable 8-digit customer ID. The ID can be set from the range 00000000-99999999. During the manufacturing process, the secondary address assumes the value of the serial number, allowing for collision-free secondary addressing to be used for communication immediately after installation.
- **Extended secondary addressing** with a fixed unique 8-digit serial number assigned during the manufacturing process.

The calculator supports addressing with the masking of individual digits of the secondary address and the extended secondary address (wildcard search), making it possible to read a selected group of calculators which fulfils a specific criterion, e.g. the readout of calculators manufactured in a given period. This procedure allows for easy search of the whole M-Bus network and for detecting all connected devices.

##### 6.1.1.2 Supported commands

The implemented protocol supports the following commands:

- **REQ\_UD2**, allowing for the readout of data from the device,
- **SND\_UD**, for:
  - secondary device addressing and extended secondary device addressing,
  - configuration of the baud rate and the primary and secondary address (customer's jumper required),
- **SND\_NKE**, regarding the standardisation and deselection of the secondary addressed device.

##### 6.1.1.3 Scope of the transmitted data

The scope of the data transmitted in response to REQ\_UD2 is fixed but it can be configured by the user. Selected data can be added to or removed from the frame. In addition, if the transmission of a value is active and the calculator is configured in such a way that the value is not determined, such value is not transmitted in the frame. The configuration of the transmitted data range is configured separately for both modules and the optical port. The configuration of the transmitted data range is available only for the wired M-Bus module. The table below lists the full range of values which can be read.

Data type	Configurable readout	Depending on calculator configuration
Network primary address	-	-
Manufacturer ID („APT“)	-	-
Customer ID	-	-
Calculator type	-	-
Calculator version	-	-
Response ordinal number	-	-
Response ordinal number	-	-

Data type	Configurable readout	Depending on calculator configuration
<b>Current values</b>		
Serial number	+	-
Main error code	-	-
Additional error code	+	+
Date and time in F format	+ <sup>1</sup>	-
Date in G format		
Operating time	+	-
Error operating time	+	-
Main energy	-	-
Cool energy	+	+
Energy - tariff 1	+	+
Energy - tariff 2	+	+
Main volume	-	-
Cool volume	+	+
Volume – tariff 1	+	+
Volume – tariff 2	+	+
Auxiliary volume	+	+
Volume difference ( $V_{\text{flow}} - V_{\text{return}}$ )	+	+
Main mass	+	+
Auxiliary mass	+	+
Mass difference ( $M_{\text{flow}} - M_{\text{return}}$ )	+	+
Additional input 1 (volume/energy)	+	+
Additional input 2 (volume/energy)		+
Additional input 3 (volume/energy)		+
Additional input 4 (volume/energy)		+
Flow	+	-
Auxiliary flow	+	+
Flow difference ( $F_{\text{flow}} - F_{\text{return}}$ )	+	+
Thermal power	+	-
Flow temperature	+	-
Return temperature	+	-
Temperature difference	+	-
Metrological test (manufacturer specific)	+	-
<b>Historic values</b>		
Timestamp of 24-hour data record (format G)	- <sup>2</sup>	-
Average 24-hour flow temperature	+	-
Average 24-hour return temperature	+	-
Average 24-hour flow	+	-
Timestamp of monthly data record (format G)	- <sup>2</sup>	-
Max. flow for previous month	+	-

Data type	Configurable readout	Depending on calculator configuration
Max. power for previous month	+	-
Timestamp of billing data record (format G)	- <sup>2</sup>	-
Main energy for selected date	+	-
Auxiliary energy for selected date	+	-
Tariff energy 1 for selected date	+	-
Tariff energy 2 for selected date	+	-
Main volume for selected date	+	-
Additional input 1 for selected date	+	+
Additional input 2 for selected date		+
Additional input 3 for selected date		+
Additional input 4 for selected date		+

1. Only one value can be selected.
2. This value is transmitted always if one of the historic values is transmitted.

**NOTE:** If a measurement error (for instantaneous data) or a readout error (for historic data) occurs, the message is sent with the flag "value during error status".

### 6.1.2 MODBUS protocol

The MODBUS protocol implemented in the calculator conforms to the MODBUS RTU specification. Communicating using the MODBUS protocol requires that a correct network address is configured. It is possible to configure a MODBUS address different than the network addresses for the other protocols: M-Bus and LUMBUS. Listed below are the registers which can be read, containing current data and data from the averaging cycle.

Register address	Data size [B]	Register name	Data format
1024	4	Main value units	
1026	4	Serial number	BCD
1028	4	Customer number	BCD
1030	4	Main energy	UInt32
1032	4	RTC time (time in Unix format)	UInt32
1034	4	Operating time [h]	UInt32
1036	4	Error operating time [h]	UInt32
1038	4	Cool energy	UInt32
1040	4	Energy - tariff 1	UInt32
1042	4	Energy - tariff 2	UInt32
1044	4	Main volume	UInt32
1046	4	Cool volume	UInt32
1048	4	Volume - tariff 1	UInt32
1050	4	Volume - tariff 2	UInt32
1052	4	Units of additional input values	
1054	4	Additional input 1 (volume/energy)	UInt32
1056	4	Additional input 2 (volume/energy)	UInt32
1058	4	Additional input 3 (volume/energy)	UInt32
1060	4	Additional input 4 (volume/energy)	UInt32

Register address	Data size [B]	Register name	Data format
1062	4	Flow temperature	Uint32
1064	4	Return temperature	Uint32
1066	4	Temperature difference	Uint32
1068	4	Metrological test	Uint32
1070	4	Auxiliary volume	Uint32
1072	4	Main mass	Uint32
1074	4	Auxiliary mass	Uint32
1536	2	Main error code	Uint16
1537	2	Averaging cycle [min]	Uint16
1538	2	Instantaneous power	Uint16
1539	2	Average power	Uint16
1540	2	Maximum power	Uint16
1541	2	Minimum power	Uint16
1542	2	Instantaneous flow	Uint16
1543	2	Average flow	Uint16
1544	2	Maximum flow	Uint16
1545	2	Minimum flow	Uint16
1546	2	Average flow temperature	Uint16
1547	2	Maximum flow temperature	Uint16
1548	2	Minimum flow temperature	Uint16
1549	2	Average return temperature	Uint16
1550	2	Maximum return temperature	Uint16
1551	2	Minimum return temperature	Uint16
1552	2	Average temperature difference	Uint16
1553	2	Maximum temperature difference	Uint16
1554	2	Minimum temperature difference	Uint16
1555	2	Firmware version	BCD
1557	2	Additional error code	Uint16
1558	2	Auxiliary flow	Uint16

The decimal place is sent under address 1024 for the transmitted temperatures and instantaneous difference as well as average and peak values, flow, power, volume and energy, as well as the energy unit.

Register bit 1024	Size [b]	Field name
2:0	3	Decimal place for instantaneous temperatures and temperature difference
5:3	3	Decimal place for instantaneous flow, average flow and peak flow
8:6	3	Decimal place for instantaneous power, average power and peak power
11:9	3	Decimal place for volume
14:12	3	Decimal place for energy



Register bit 1024	Size [b]	Field name
17:15	3	Decimal place for average and peak temperatures and temperature difference
20:18	3	Energy unit
23:21	3	Power unit
31:24	3	Reserved

The decimal place and the unit of the transmitted values of additional inputs is transmitted under address 1052.

Register bit 1052	Size [b]	Field name
2:0	3	Decimal place for the value of additional input 1
5:3	3	Unit for the value of additional input 1
8:6	3	Decimal place for the value of additional input 2
11:9	3	Unit for the value of additional input 2
14:12	3	Decimal place for the value of additional input 3
17:15	3	Unit for the value of additional input 3
20:18	3	Decimal place for the value of additional input 4
23:21	3	Unit for the value of additional input 4
31:24	3	Reserved

The decimal place field may have the following values:

- 0 – resolution of the sent data equal to 1 unit,
- 1 – resolution of 0.1 of the unit,
- 2 – resolution of 0.01 of the unit,
- 3 – resolution of 0.001 of the unit.

The energy unit field has the following values:

- 0 – GJ,
- 1 – Gcal,
- 2 – kWh,
- 3 – MWh.

The power unit field has the following values:

- 0 – kW,
- 1 – MW.

The field 'Unit of additional input values' has the following values:

- 0 – m<sup>3</sup>,
- 1 – kWh,
- 2 – MWh.

When using the MODBUS protocol you can also change the baud rate and the module address and type. To change these parameters you should press the customer's jumper. The transmission parameter configuration is saved in the register with the address of 4201:

Bit register 4201	Size [b]	Name	Value
2:0	3	Baud rate	<ul style="list-style-type: none"> <li>• 0: 300b/s</li> <li>• 1: 600b/s</li> <li>• 2: 1200b/s</li> <li>• 3: 2400b/s</li> <li>• 4: 4800b/s</li> <li>• 5: 9600b/s</li> <li>• 6: 19200b/s</li> <li>• 7: 38400b/s</li> <li>• 0: 57600b/s</li> <li>• 1: 76800b/s</li> <li>• 2: 115200b/s</li> </ul>
4:3	2	Parity	<ul style="list-style-type: none"> <li>• 0: no parity</li> <li>• 1: even parity</li> <li>• 2: odd parity</li> </ul>
5	1	Transmission speed (the older part)	<ul style="list-style-type: none"> <li>• 0: 300 b/s to 38400 b/s</li> <li>• 1: 57600 b/s, 76800 b/s, 115200 b/s</li> </ul>
15:5	11	Reserved	-

The configurable MODBUS address is located in the register under address 4202. The MODBUS address should be set from the range: 1 ... 247.

The communications port configuration is saved in the register with the address of 4203:

Bit register 4201	Size [b]	Name	Value
3:0	4	Type of module	<ul style="list-style-type: none"> <li>• 0: none</li> <li>• 1: M-Bus</li> <li>• 3: RS232 / RS485</li> </ul>
8:4	5	Reserved	-
12:9	4	Type of protocol	<ul style="list-style-type: none"> <li>• 0: M-Bus / conf.</li> <li>• 1: MODBUS</li> <li>• 3: LUMBUS</li> </ul>
15:13	3	Reserved	-

### 6.1.3 LUMBUS protocol

The LUMBUS protocol implemented in the calculator conforms to LUMEL's specification. Communicating using the LUMBUS protocol requires that a correct network address is configured. It is possible to configure a LUMBUS address different than the network addresses for the other protocols: M-Bus and MODBUS. Data can be read from index 9 and 16.

### 6.2 Calculator parameterisation

FaunSerwis is a dedicated software for remote parameterisation of the calculator. The software allows to modify all settings available to the user.

### 6.3 Communication via optical port

As standard, each calculator has an optical port for communication using optical head EWA3001798. When using the optical port, you can configure and read current and historic data from the calculator. The supported protocols include M-Bus, and the configuration and readout protocol.

#### Optical port wakeup:

To save battery energy, if there is no communication, the optical port is deactivated and no communication is possible. The port is activated by pressing and holding P2 button for a longer period of time (right button on the cover) or by sending a wakeup string of characters according to PN-EN 1434-3, chapter 6.1.1. The activity of the optical port activated by pressing the button is signalled when the outer left triangle is displayed on the LCD.

If the port is activated using:

- **the button**, communication is possible for a specific time. The optical port's activity time can be configured in the communication settings within the range from 1 to 255 seconds. However, it is recommended to set the shortest time possible. After each transmission, the activity time is extended by the set value,
- **a string of wakeup characters**, the port is activated for a specific time, similarly to when it is activated by the button, but only until a query is received and a response is sent. Once the calculator has transmitted the response, the port is deactivated and another wakeup is necessary.

## 7 Calculator installation

The following chapter discusses the available versions of the calculator. The arrangement of the terminals on the main connection strip and the method for connecting temperature sensors, flow sensor and additional pulse input devices.

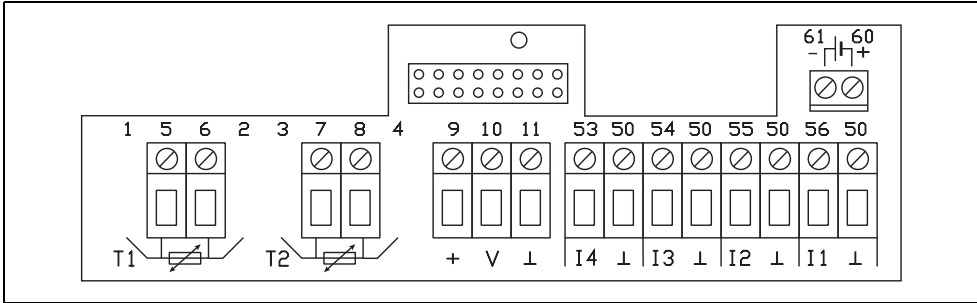


Figure 4: View of terminal strip

### 7.1 Temperature sensor types and connection method

The calculator works with PT500 type temperature sensors with two-wire connection.

Connect the T1 sensor to terminals marked with numbers 5 and 6, and the T2 sensor to terminal marked with numbers 7 and 8.

### 7.2 Flow sensor types and connection method

For connecting the main flow sensor, a 3-terminal connector marked with the following numbers is used:

- 9 – power supply output for flow sensor (from main power source),
- 10 – signal input for flow sensor,
- 11 – signal reference output for flow sensor.

You can also connect the flow sensor's communication wire to the signal input: the fourth additional input (terminal 53).

Below is the method for connecting flow sensors: with an open collector type output for a flow sensor that requires power supply from the calculator (1), with an open collector type output (2) and a closing contact type output (3):

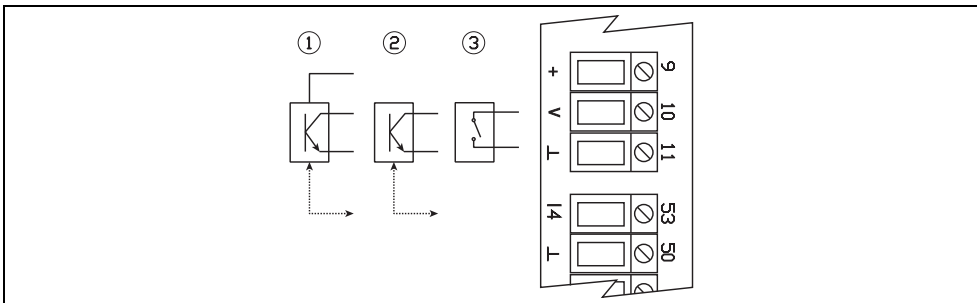


Figure 5: Method for connecting signals to flow sensor's main input

### 7.3 How to connect the auxiliary flow sensor

The auxiliary flow sensor may be used to detect leaks of systems operating in a closed system. It should be connected to additional input 3. The flow sensor should be connected with the 2 terminal connector marked with the following numbers:

- 54 - signal input for auxiliary flow sensor,
- 50 - auxiliary flow sensor signal reference output.

Moreover, you can also connect the flow sensor communications and power supply input:

- 9 - power supply output for flow sensor (from main power supply source),
- 55 - signal input to communicate with auxiliary flow sensor (additional input 2).

Please refer to the diagram below to connect the auxiliary flow sensor with the open collector output for the flow sensor with the required power supplied from the calculator (1), open collector output(2) and the normally closed contact output (3):

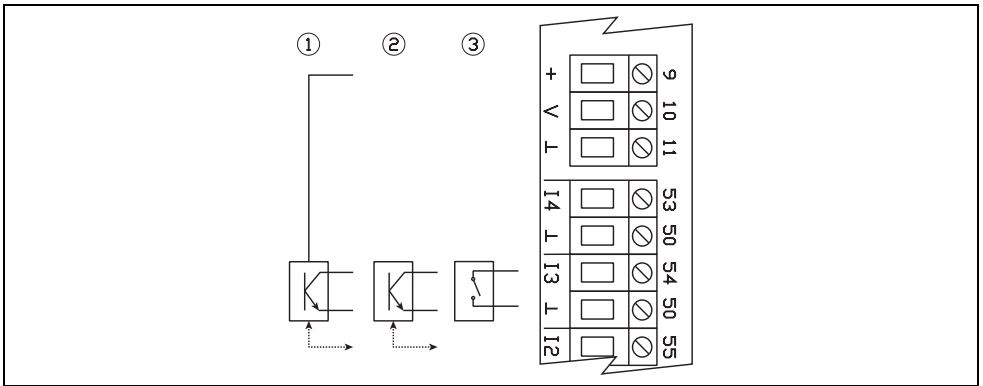


Figure 6: Connecting signals to the auxiliary flow sensor input

### 7.4 Method for connecting additional input signals

In each version of the main terminal strip, there are 4 additional inputs, and each input can work in one of 3 modes. You can learn more about the operation of the additional inputs in chapter 4.4. Each input has two terminals, which are marked as follows:

- 53/54/55/56 – signal input for additional inputs no. 4/3/2/1,
- 50 – reference input for additional input; each input has a separate terminal for connecting the reference signal.

Below is an example how to connect the signal to one of the additional inputs for a device with output type open collector (1) and closing contact (2):

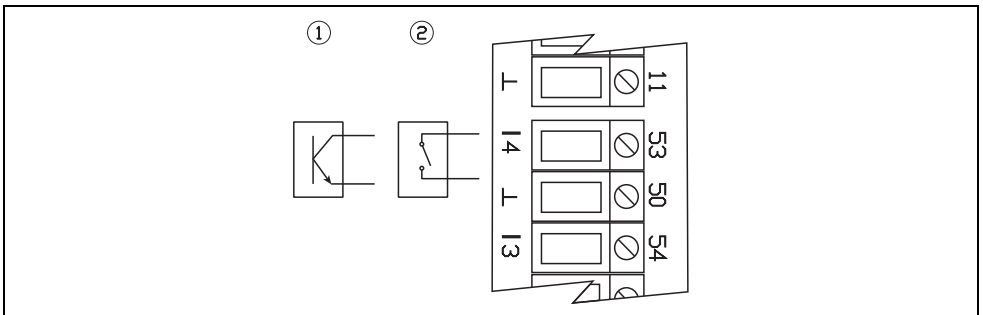


Figure 7: Example of how to connect signals to an additional input

### 7.5 Installing modules and main power supply

Presented below is the installation location and installation method for additional modules and the main power supply. Maximum two modules can be installed. The modules can be installed in any terminal, with the exception of radio modules which can only be installed in the terminal labeled with number 1.

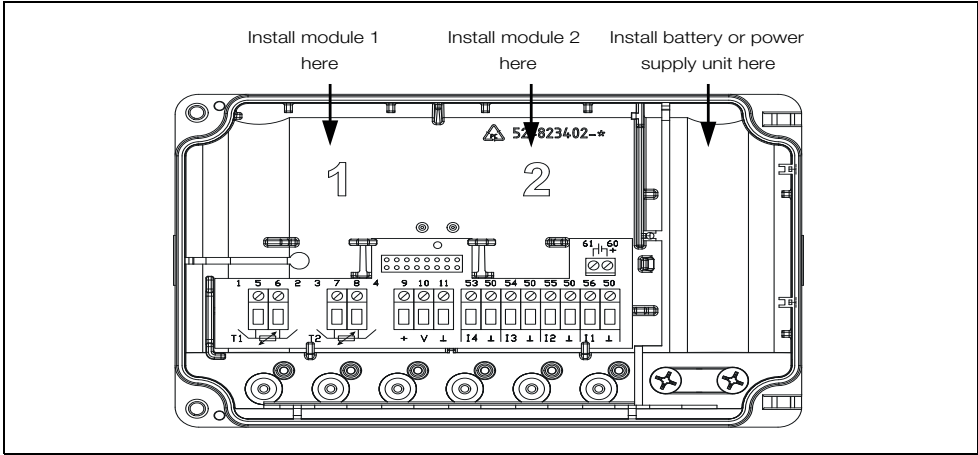


Figure 8: View of the base with terminal strip and marked places for installing modules and main power supply

### 7.6 Sealing

There are two methods to seal access to the terminals, power supply and the calculator's modules. Two wire seals (A and B) or two stickers (C and D) can be used for sealing. The sealing place is shown below.

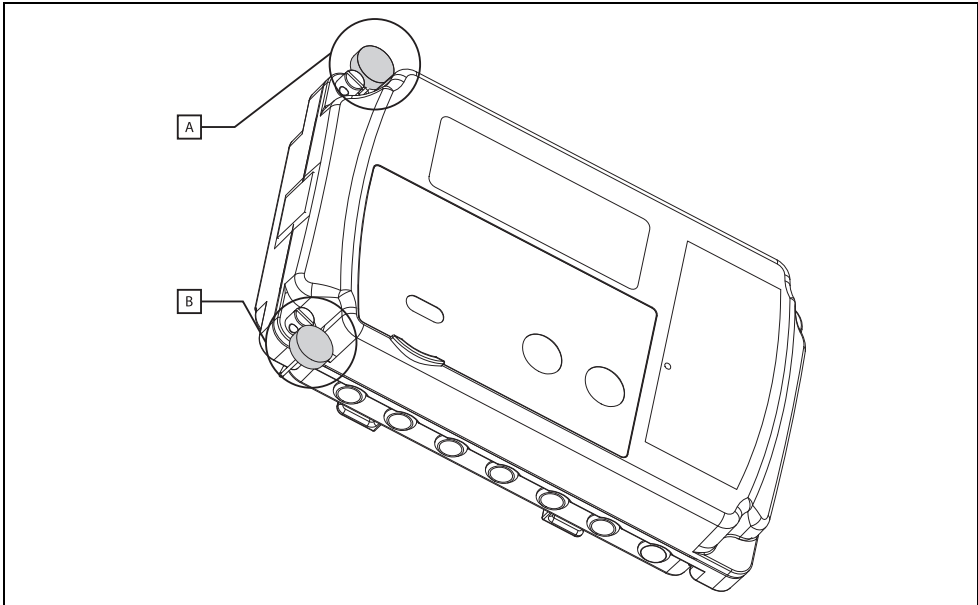


Figure 9: Sealing calculator with wire seals

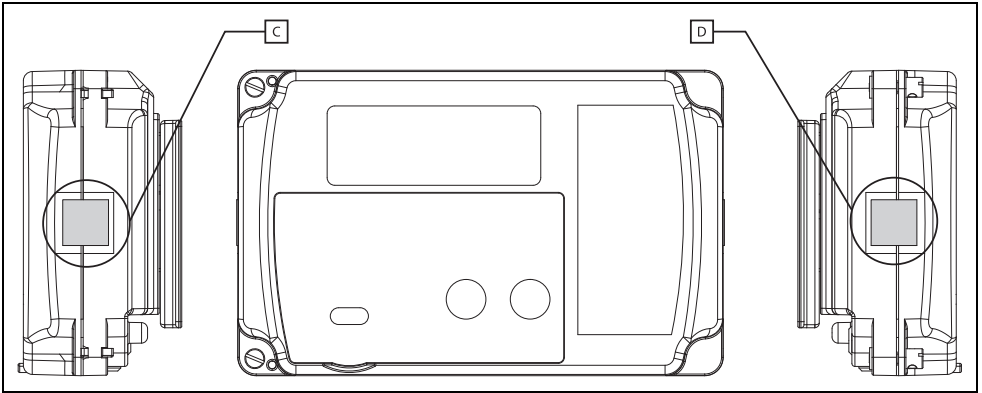


Figure 10: Sealing calculator with sticker seals

## 8 Additional modules

The calculator can work with two wired/wireless communication modules, pulse input/output modules or analogue output modules. The following chapter discusses the available modules. However RS485 module operating at a speed greater than 9600, can work simultaneously with only another RS485 module operating at speeds greater than 9600.

### 8.1 M-Bus module EWA500C-MBUS (module code: 001)

The M-Bus module is powered from the M-Bus lines and galvanically separated from the calculator with optical insulation. The module supports primary, secondary and secondary extended addressing. It allows for reading current data and selected historic data. For a detailed list of data which can be read using the M-Bus protocol, see chapter 6.1.1.3. For connecting M-Bus signals, use the inputs marked with the numbers 24 and 25.

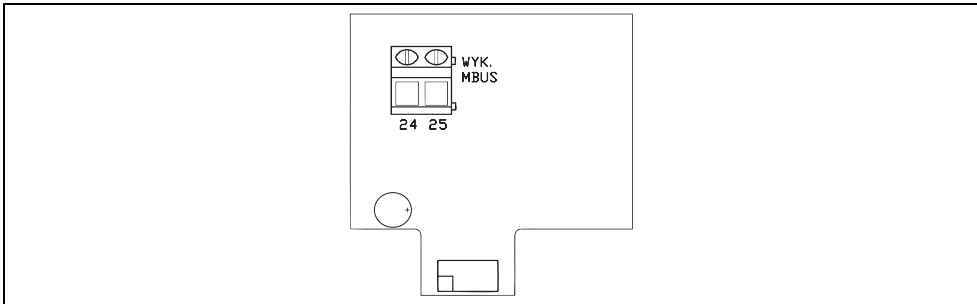


Figure 11: View of M-Bus module

M-Bus module parameters		
Maximum voltage in M-Bus network	V	42
Module's maximum current consumption	mA	1,2 <sup>1</sup> / 12,2 <sup>2</sup>
Available baud rates	Baud	300, 600, 1200, 2400, 4800, 9600
Maximum number of interfaces in the network	szt.	3
Wire isolation voltage	V	> 500
Maximum length of connection wire	m	1000 <sup>4</sup>
Maximum diameter of connection wires	mm <sup>2</sup>	2,5
Recommended M-Bus wire	-	YnTKSY 1x2x1,0 mm

1. Maximum current consumption when there is no transmission.
2. Maximum consumption during transmission.
3. The number of interfaces depends on the allowed load of the used converter.
4. Where there is strong interference, the length may be much shorter.



## 8.2 RS 485 module EWA500C-RS485 (module code: 006)

Similarly to RS 232, the RS 485 module requires an external power supply. It is galvanically separated from the calculator by means of optical insulation. The module can be supplied with direct or alternating voltage. To connect power, use terminals 97 and 98. Polarisation of power can be any. To connect communication wires, use terminals: 86 – signal ground, 85 - A+ input/output (non-inverting), 84 - input/output B (inverting).

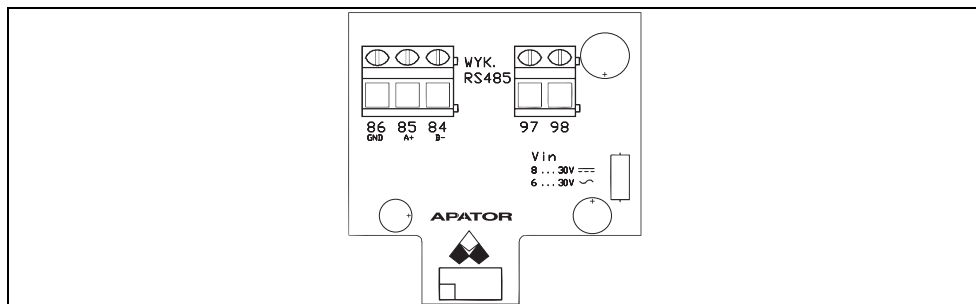


Figure 12: View of RS 485 module

RS 485 module parameters		
Module's supply voltage	Vac	6 ... 30
	Vdc	8 ... 30
Module's maximum current consumption	mA	3,6 <sup>1</sup>
Available baud rates	Baud	300, 600, 1200, 2400, 4800, 9600 19200, 38400, 57600, 76800, 115200
Wire isolation voltage	V	> 500
Maximum wire length in the network	m	500 <sup>2</sup>
Maximum number of interfaces in the network	szt.	255
Maximum cross-section of connection wires	mm <sup>2</sup>	2,5

1. Maximum current consumption during transmission with a supply voltage of 9 VDC.
2. Use terminators for lengths greater than 100 m.

**NOTE:** If a baud rate of more than 9,600 is required, it is recommended to install module in slot 2.

**NOTE:** If the first module runs at a baud rate of 300, 600, 1200, 2400, 4800 or 9600, the second module can also only operate with one of these rates. Similarly, if the first module runs at a baud rate of: 19200, 38400, 57600, 76800 or 115200, the second module can also only work with one of these rates. An RS485 module operating at a speed greater than 9600, can not be combined with any other modules.

### 8.3 LonWorks module EWA500C-LON (module code: 002)

The module requires an external power supply 9-24 V DC. The sequence of connecting wires to LON network is of no importance. Joint marking is shown in figure.

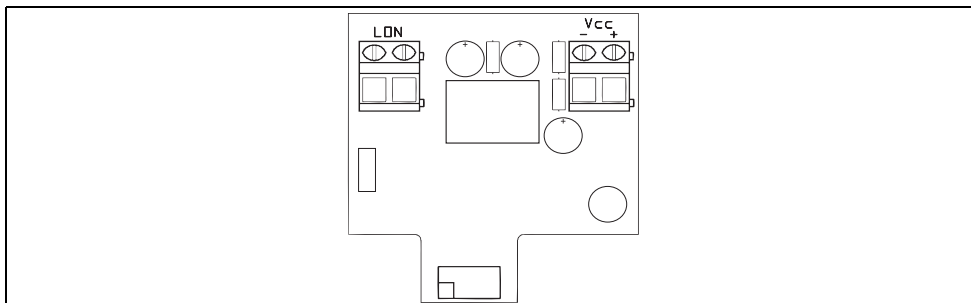


Figure 13: View of LonWorks module

Parameters of LonWorks module	
Input voltage range	9 -24V DC
Typical power consumption (with power voltage 12V)	250mW
Protection	Against invert polarity, over-current (max. current 250mA)
Processor	Neuron Chip 5000
Timing frequency	80MHz
Network interface	
Transceiver	TP/FT-10
Transmission protocol	LonTalk®
Transmission rate	78kb/s
Transmission medium	Twisted pair
Maximum distance (for wire BELDEN 8471)	Bus topology – 2700m/64 network nodes Free topology – 500m/64 network nodes
Electric service connection	Terminal strip with screwed terminals in 5.08mm raster, max. wire cross-section 2.5 mm <sup>2</sup>

#### List of network variables for appliance APT-LON

Name of network variable	Type of network variable	Description of network variable	Fault/default
nciReadingTime	SNVT_time_min	Polling frequency of the meter in minutes	1
nvoSerialNo	SNVT_count_32	Serial number	0
nvoEnergy	SNVT_elec_whr_f	Main energy	NAN
nvoEnergyT1	SNVT_elec_whr_f	Energy, tariff 1	NAN
nvoEnergyT2	SNVT_elec_whr_f	Energy tariff 2	NAN
nvoVolume	SNVT_vol_f	Main volume	NAN
nvoVolumeT1	SNVT_vol_f	Volume, tariff 1	NAN
nvoVolumeT2	SNVT_vol_f	Volume, tariff 2	NAN
nvoTempFlow	SNVT_temp_p	Flow temperature	327.67

## List of network variables for appliance APT-LON

Name of network variable	Type of network variable	Description of network variable	Fault/default
nvoTempReturn	SNVT_temp_p	Return temperature	327.67
nvoTempDiff	SNVT_temp_p	Temperature difference	327.67
nvoPower	SNVT_power_f	Instantaneous power	NAN
nvoFlow	SNVT_flow_f	Instantaneous flow	NAN
nvoErrorFlags	SNVT_count	Error code	0
nvoAddInput1	SNVT_vol_f	Additional input 1 (volume/energy)	NAN
nvoAddInput2	SNVT_vol_f	Additional input 2 (volume/energy)	NAN
nvoAddInput3	SNVT_vol_f	Additional input 3 (volume/energy)	NAN
nvoAddInput4	SNVT_vol_f	Additional input 4 (volume/energy)	NAN

### 8.4 Wireless M-Bus radio module EWA500C-RF01 (module code: 004)

Wireless M-Bus radio module that operates in frequency band 868 MHz is one of the technologically most advanced communication interfaces. As a separate, replaceable element, it is located inside the calculator housing in slot 1. It has its own battery power supply and an aerial.

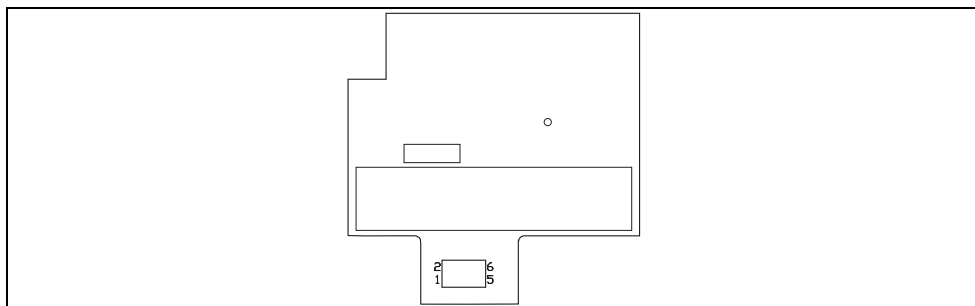


Figure 14: View of Wireless M-Bus module

Wireless M-Bus radio module	
Aerial	Inner, wire $\frac{1}{4} \lambda$
Power supply	Ion-lithium battery 3,6 V, 1200 mAh, size $\frac{1}{2}$ AA, battery installed inside radio module
Operating temperature range	0°C ÷ +55°C
Operating frequency	868.950MHz
Frequency instability	< $\pm 2,5$ kHz
Modulation type	FSK, frequency deviation $\pm 50$ kHz
Transmitter power	10 dBm
Receiver sensitivity	-105 dBm
Mode	T1, data transmission time period: 120 s
Transmitted registers	serial number, terror flags, date, heat energy, main volume, power temperature, return temperature, heat energy of recent month
Period of refreshing registers	900s (register refreshing time period is a time between queries for register contents transmitted periodically by radio module to heat meter)

## 8.5 Pulse output/input module EWA500C-PO, EWA500C-PIPO (module codes: 016/080)

There are two types of the pulse input/output modules:

- Module EWA500C-PO with 2 pulse outputs (module code 016). Module is shown on the left in the figure below.
- Module EWA500C-PIPO with 2 pulse inputs and 2 pulse outputs (module code 080). Module is shown on the right in the figure below.

The modules must be supplied from an external power source. The external power source is connected to terminals 97 and 98. Polarisation of power can be any.

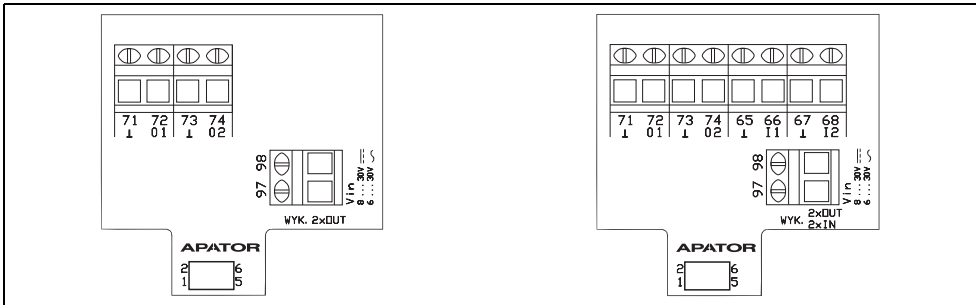


Figure 15: Module view: 2 pulse outputs (left); 2 pulse outputs + 2 pulse inputs (right)

Pulse inputs are connected to terminals 65, 66 and 67, 68. The signal from the pulse outputs is connected to terminals 71, 72 and 73, 74.

The pulse outputs operate in class OC (according to PN-EN 1434-2). Output operation class is configured during production and cannot be subsequently changed.

The pulse output generates the number of pulses which is proportional to the increase in main, cool or tariff energy or volume with the selected pulse value. The type of the pulsed data and the pulse value can be configured in any manner for each output. Please see chapter 4.6.3 for more details on the available module configurations.

Pulse output parameters		
Module's supply voltage (external power)	Vac	6 ... 24
	Vdc	8 ... 24
Output operation class (according to PN-EN 1434-2)	-	OC
Value at the output	-	<ul style="list-style-type: none"> <li>• main energy</li> <li>• main volume</li> <li>• cool energy</li> <li>• cool volume</li> <li>• energy - tariff 1</li> <li>• volume - tariff 1</li> <li>• energy - tariff 2</li> <li>• volume - tariff 2</li> </ul>
Module's average current consumption <sup>1</sup>	uA/channel	260
Maximum pulse frequency at the output	Hz	5
Minimum pulse duration	ms	100
Minimum pause duration	ms	100
Output type	-	open collector

Pulse output parameters			
Maximum voltage at the output		V	27 (according to PN-EN 1434-2 max. 6 V)
Maximum current at the output		mA	27 (according to PN-EN 1434-2 max. 0.1 mA)
Voltage drop at transistor for $I_{\max}$		V	< 0,3
Maximum wire length	m		25
Maximum wire cross-section	mm <sup>2</sup>		2,5

1. Average current consumption when pulses are generated, at maximum frequency and for a single output.

The pulse inputs allow connection of any device with a pulse output that operates according to IB or IC class (according to PN-EN 1434-2). These may include devices with a potential-free output: closing contacts, open collector, open drain, e.g. water meters, gas meters and electricity meters. The inputs at the modules operate and can be configured similarly to additional inputs on the main terminal strip. For correct operation, it is necessary to configure pulse constant, pulse unit and register resolution in the module settings. For more details, see chapter 4.4.1.

Pulse input parameters		
Module's supply voltage (external power)	Vac	6 ... 30
	Vdc	8 ... 30
Input operation class (according to PN-EN 1434-2)	-	IB, IC
Maximum pulse frequency at the input	Hz	70
Minimum pulse duration	ms	6
Minimum pause duration	ms	8
Voltage for pulse active state	V	< 0,5
Voltage for pause	V	> 2,5
Maximum wire length	m	25
Maximum cross-section of service connection wires	mm <sup>2</sup>	2

## 8.6 Analogue output module EWA500C-ANALOG (module code: 256)

The analogue output module requires an external power supply. There is a galvanic isolation between calculator and module. The module has two current outputs 0/4 ... 20 mA. The analogue outputs are freely configurable. The value present on the output can be proportional to one of the instantaneous values: flow, power, flow temperature, return temperature or temperature difference. The state of the analogue output is updated every cycle when instantaneous values are determined, i.e. every 10 seconds during normal operation with a flow other than zero. For correct operation, it is necessary to configure the outputs in the module configuration. For a detailed description of configuration, see chapter 4.6.3.

Terminals 97 and 98 are to connect power supply of the module. The output terminals are as follows:

- 2 current outputs:
  - output 1 positive terminal – 80, negative terminal – 81,
  - output 2 positive terminal – 82, negative terminal – 83.

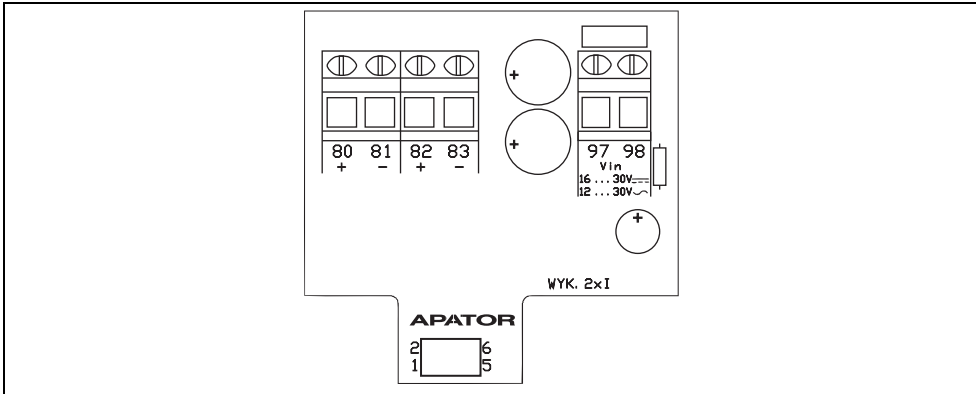


Figure 16: Module view: 2 analogue outputs for 2 current outputs

**NOTE:** When the module is powered by calculator, it is possible to install one analogue module only.

Analogue output module parameters		
Module's supply voltage (external power)	V <sub>ac</sub>	12 ... 30
	V <sub>dc</sub>	16 ... 30
Update frequency of output status	s	10
Value at the output	-	<ul style="list-style-type: none"> <li>• flow</li> <li>• thermal power</li> <li>• flow temperature</li> <li>• return temperature</li> <li>• temperature difference</li> </ul>
Value at the output	mA	0/4 ... 20
Current output load	Ω	0 ... 500
Voltage output load	Ω	> 500
Maximum consumption of module current	mA	50
Maximum wire length	m	25
Maximum cross-section of connection wires	mm <sup>2</sup>	2

## 9 Power supply mode

The calculator has two power sources:

- **Backup power** in the form of a low capacity 1/2AA cell 3.6V lithium battery installed in the cover.  
Total operation time when calculator is supplied by back-up battery (i.e. total operation time when main power supply is not available, e.g. because cover has been detached from base) is 5 years.  
The backup power sustains operation of the calculator, the RTC and saving of register values after cover is detached from base. Once base is detached, the calculator operates in a limited mode.  
The calculator's current data is saved to a non-volatile memory. LCD indications continue to be available. Data can be read using the optical port, except for historic data. It is also possible to parameterise the calculator. The optical port operates in the same way as when in normal operation.
- **Main power**, such as a power supply unit or the standard C cell battery installed in the base. After opening the cover, main battery or power supply unit can be accessed. For each battery or the power supply unit, there are wires for connection to the calculator. Connect main power to strip terminal marked with the numbers: 60 – positive pole and 61 – negative pole.

The table below shows main parameters of the 230 V power supply unit.

Power supply unit parameters		
Voltage range for power supply unit	Vac	230 V ± 15 %
Supply voltage frequency	Hz	50/60
Number of PSU outputs	-	<ul style="list-style-type: none"> <li>• 1 main output for supplying the calculator</li> <li>• 2 auxiliary outputs for supplying the modules</li> </ul>
Maximum current consumption at auxiliary outputs	mA	50
Voltage range at auxiliary output	Vac	9 ... 16
Auxiliary power supply unit's power consumption at rated voltage	W	0,6
Maximum cross-section of connection wires	mm <sup>2</sup>	2,5

The table below shows basic parameters of the 24 V power supply.

Parameters of the 24 V power supply		
Voltage range for power supply unit	Vac	24 V ± 15 %
Supply voltage frequency	Hz	50/60
Number of PSU outputs	-	<ul style="list-style-type: none"> <li>• 1 main output for supplying the calculator</li> <li>• 2 auxiliary outputs for supplying the modules</li> </ul>
Maximum current consumption at auxiliary outputs	mA	50
Voltage range at auxiliary output	Vac	16 ... 27
Auxiliary power supply unit's power consumption at rated voltage	W	0,6
Maximum cross-section of connection wires	mm <sup>2</sup>	2,5

## 9.1 Battery operating time

The table below show the calculator's operating time, including temperature measurement modes and the option to supply a flow sensor with a power consumption of 150 mAh/year.

<b>Operation time for the calculator module powered by the battery</b>			
<b>Battery type</b>	<b>Option to supply a flow sensor</b>	<b>Temperature measurement mode</b>	<b>Operating time</b>
C	yes (maximum 2)	2-wire	10 + 1 years

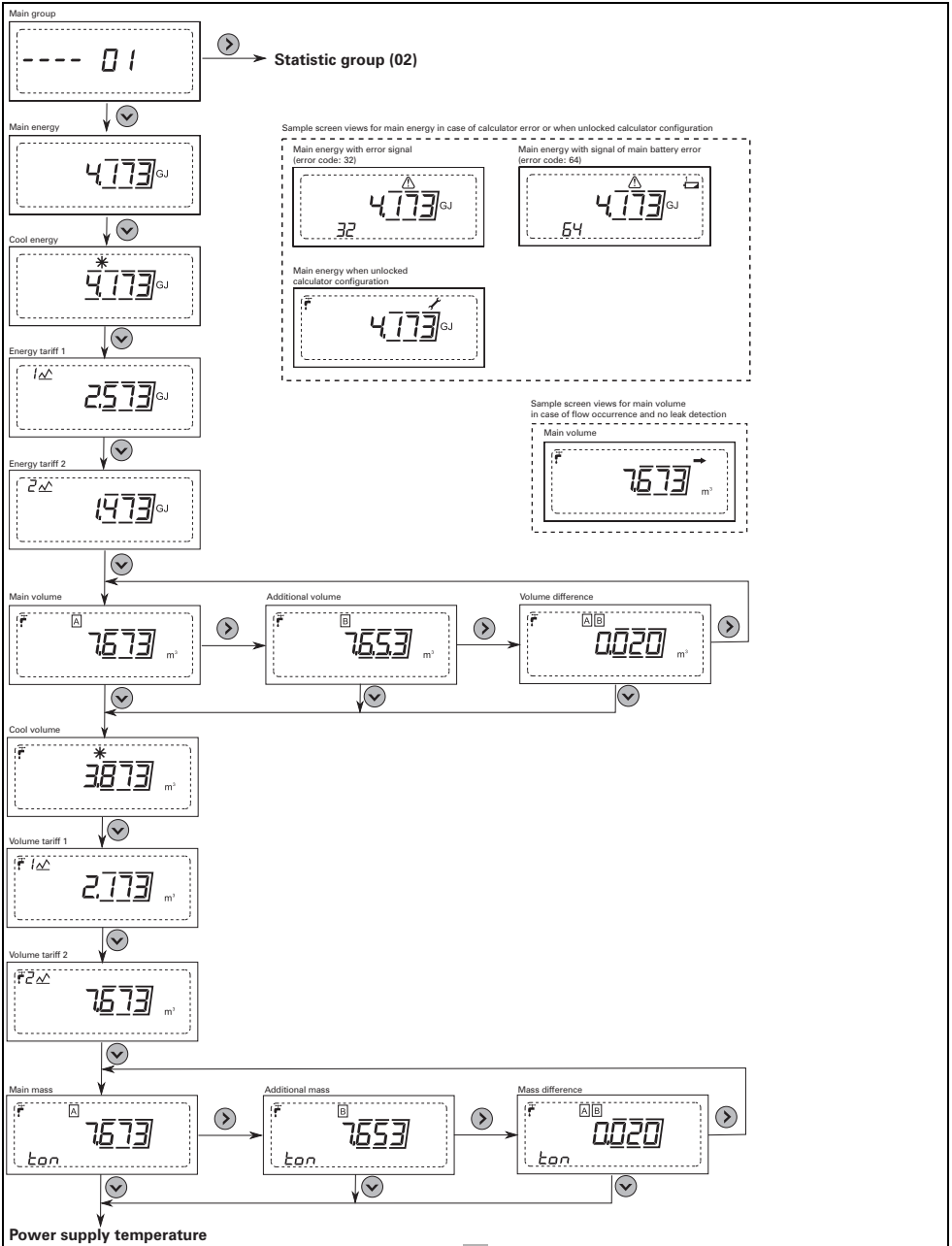
**NOTE:** Presented battery life does not include power supply I / O module generating or counting high-frequency pulses.

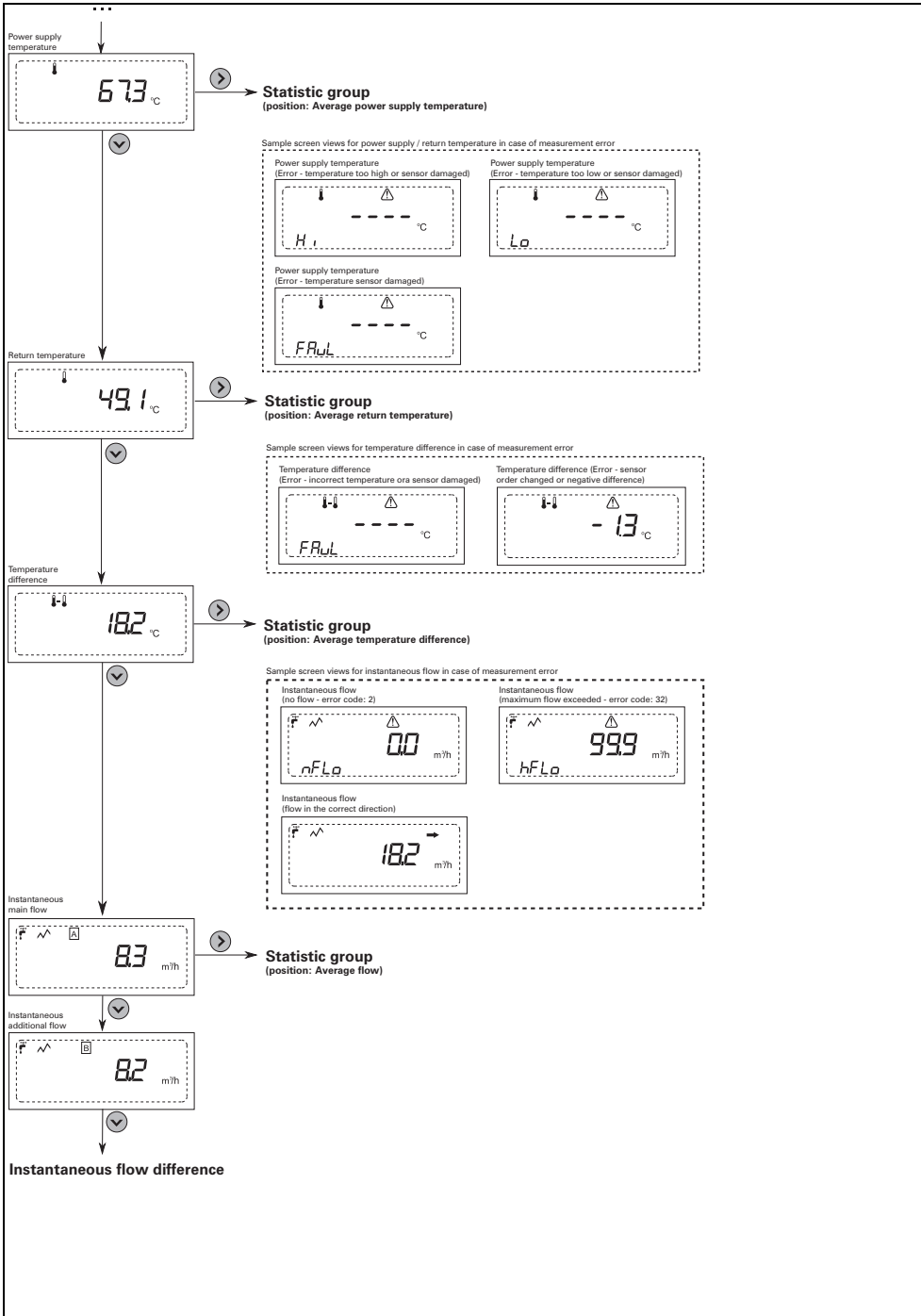


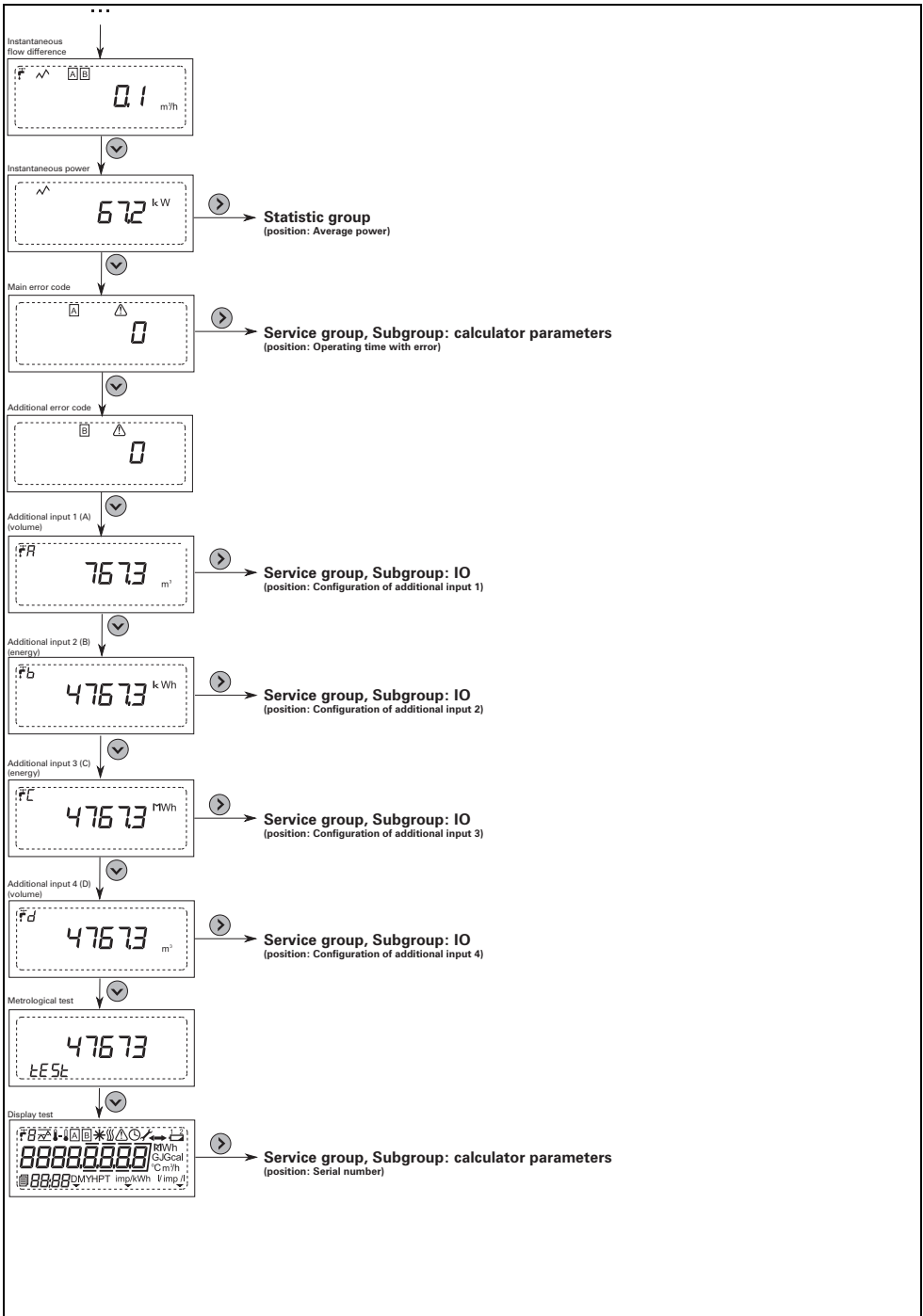
# 10 Annexes

## 10.1 Display queue

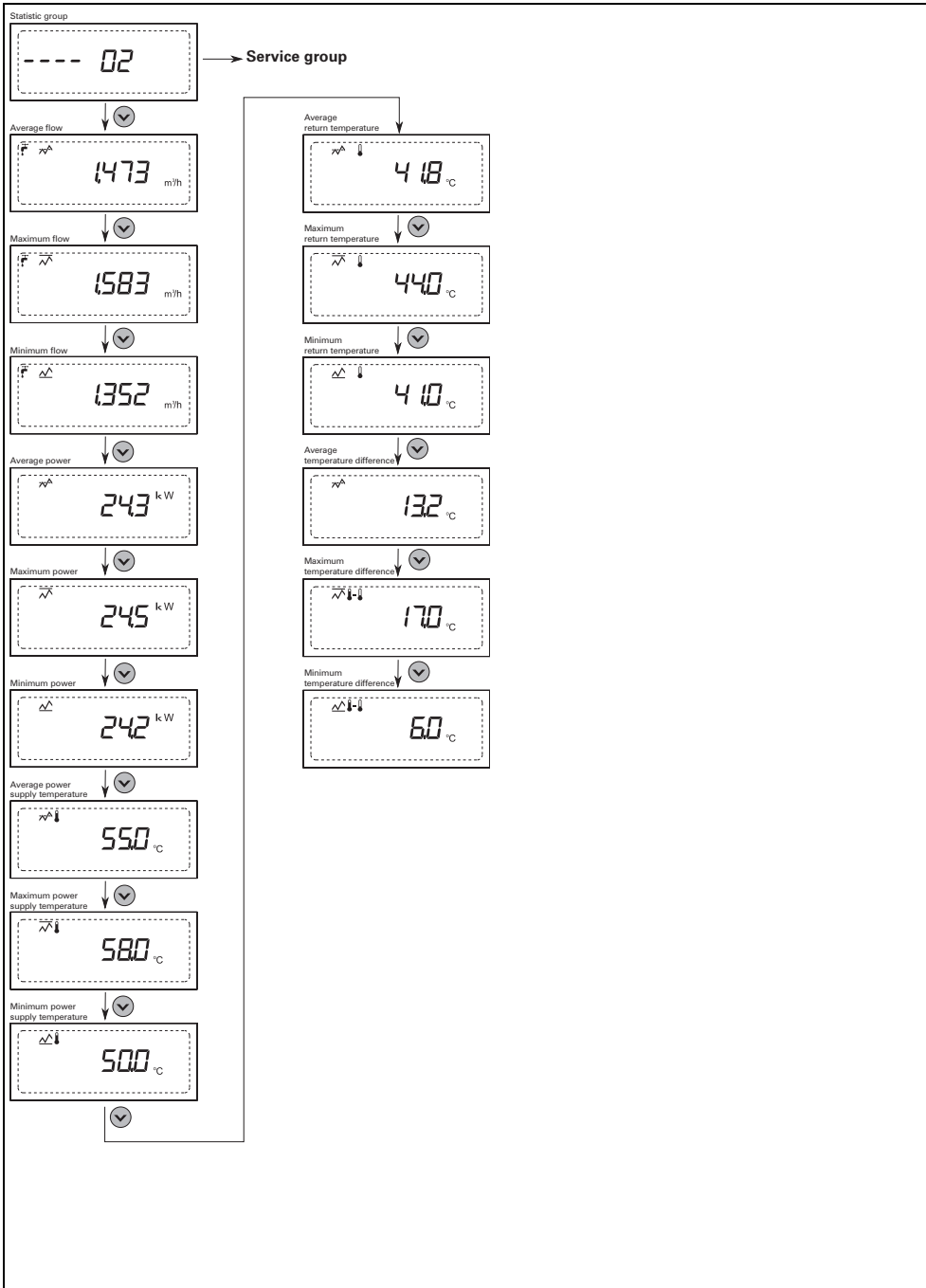
### 10.1.1 Main group (01)



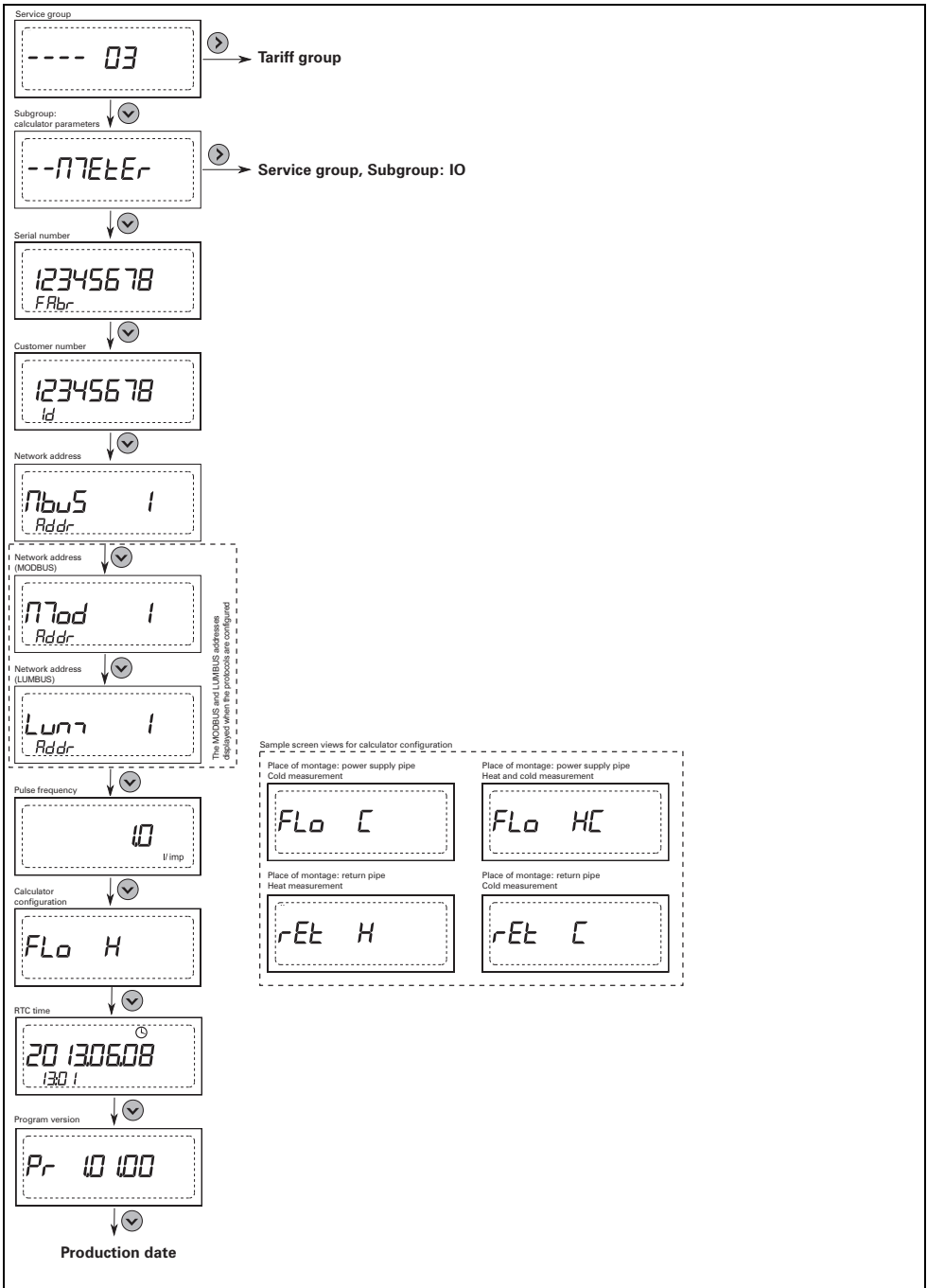


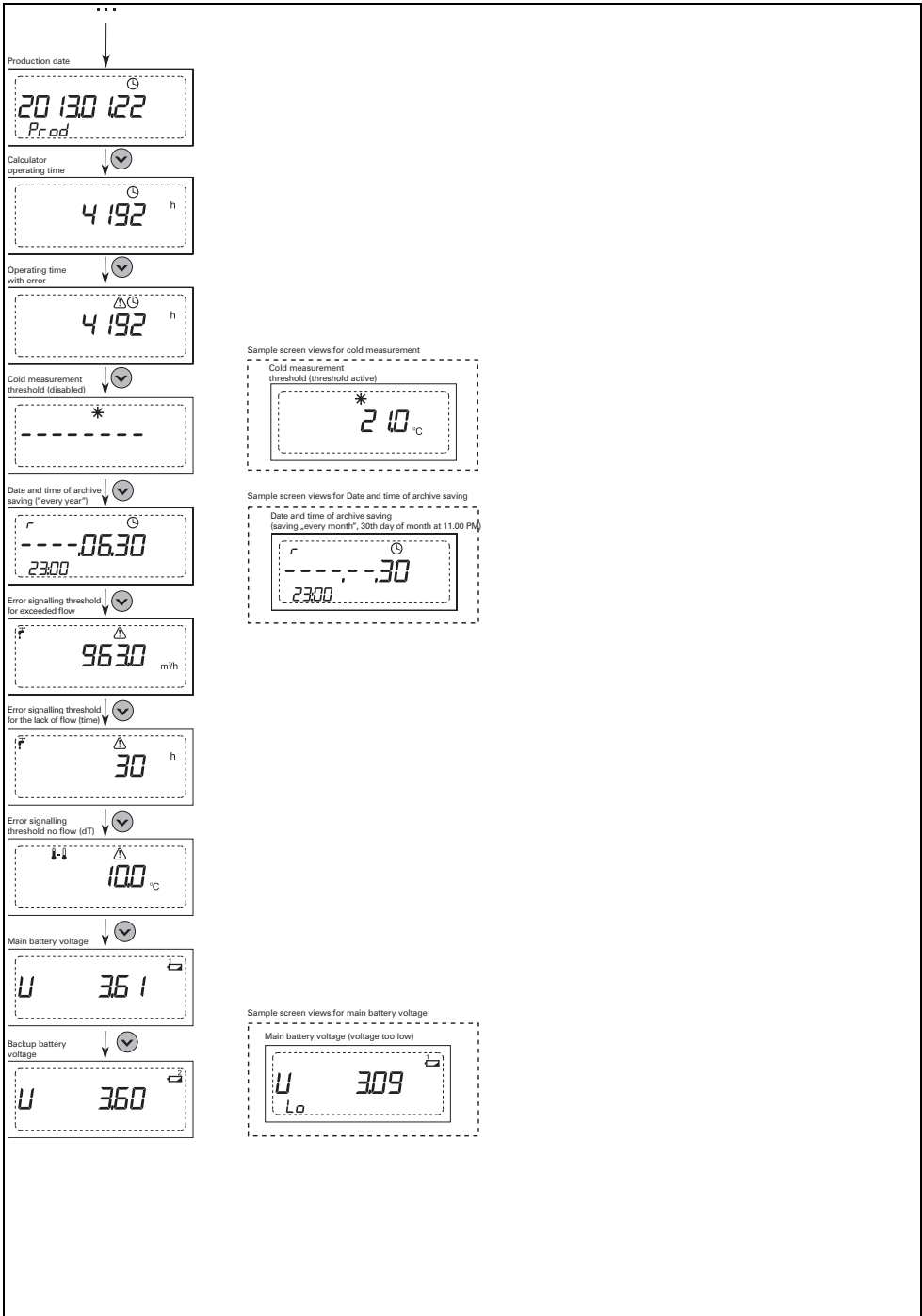


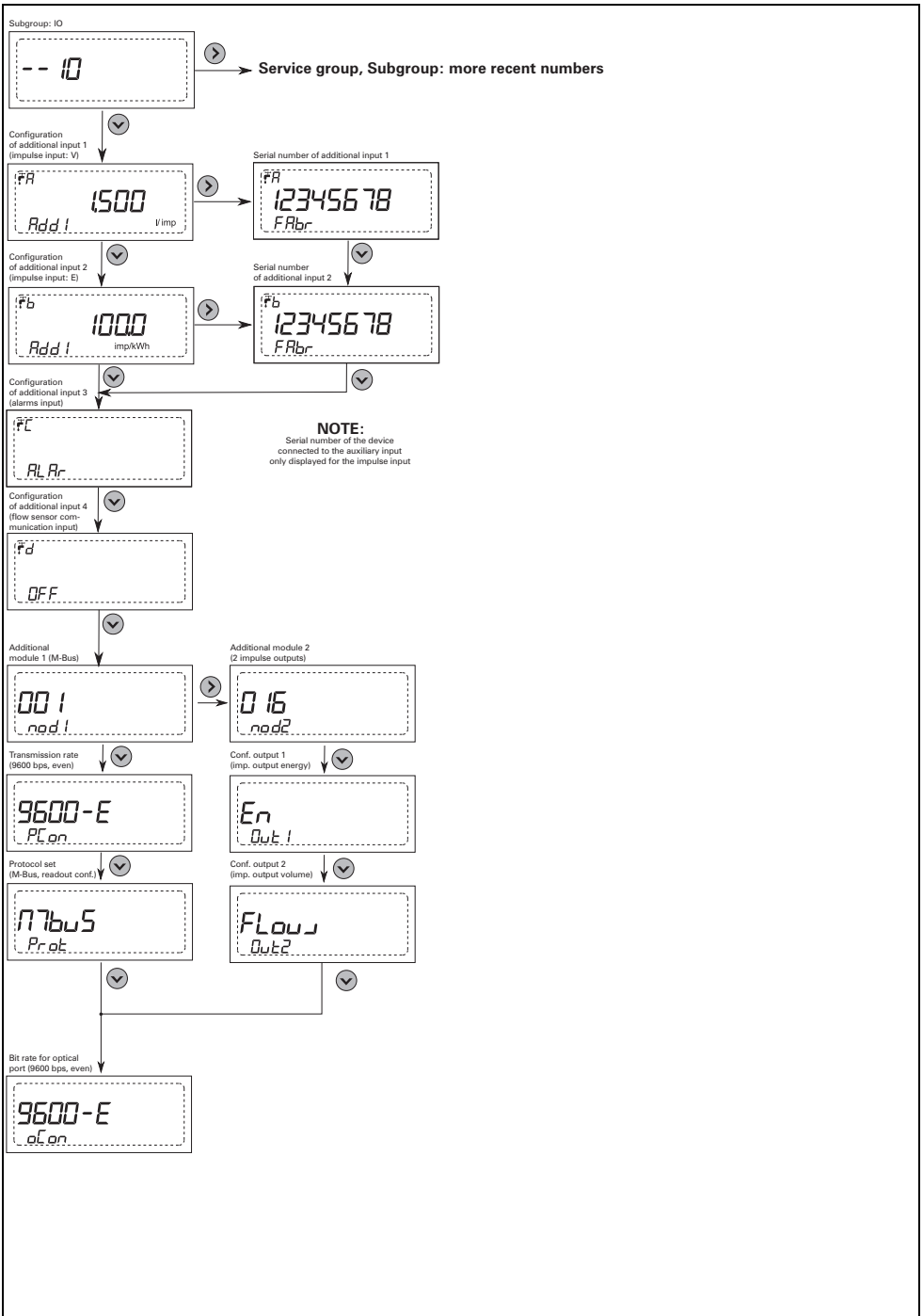
### 10.1.2 Statistical group (02)



### 10.1.3 Service group (03)







Sample screen views for configuration of additional module

Analog outputs module

Configuration output 1  
(analog output: disable)

no  
Pn.1

Configuration output 1

(analog output: instantaneous flow)

FLow  
Pn.1

Configuration output 1

(analog output: temperature difference)

dtmP  
Pn.1

Configuration output 1

(analog output: return temperature)

rtmP  
Pn.1

Configuration output 1

(analog output: power supply temperature)

FtmP  
Pn.1

Configuration output 1

(analog output: instantaneous power)

Po  
Pn.1

Sample screen views for configuration of additional module

Impulse outputs module

Configuration output 1  
(impulse output: additional energy)

EnAdd  
Out.1

Configuration output 1

(impulse output: volume)

FLow  
Out.1

Configuration output 1

(impulse output: energy tariff 2)

Entr2  
Out.1

Configuration output 1

(impulse output: energy tariff 1)

Entr.1  
Out.1

Configuration output 1

(impulse output: volume tariff 1)

FlowJtr.1  
Out.1

Configuration output 1

(impulse output: additional volume)

FlowJAdd  
Out.1

Configuration output 1

(impulse output: volume tariff 2)

FlowJtr.2  
Out.1

Configuration output 1

(impulse output: disable)

no  
Out.1

Sample screen views for module protocol setting

Protocol set

(LUMBUS)

Lunrbus  
Prot.

Protocol set

(MODBUS)

M7odbus  
Prot.



Subgroup: more recent numbers



Service group,  
Subgroup: calculator

More recent numbers:  
main energy



More recent numbers:  
energy tariff 1



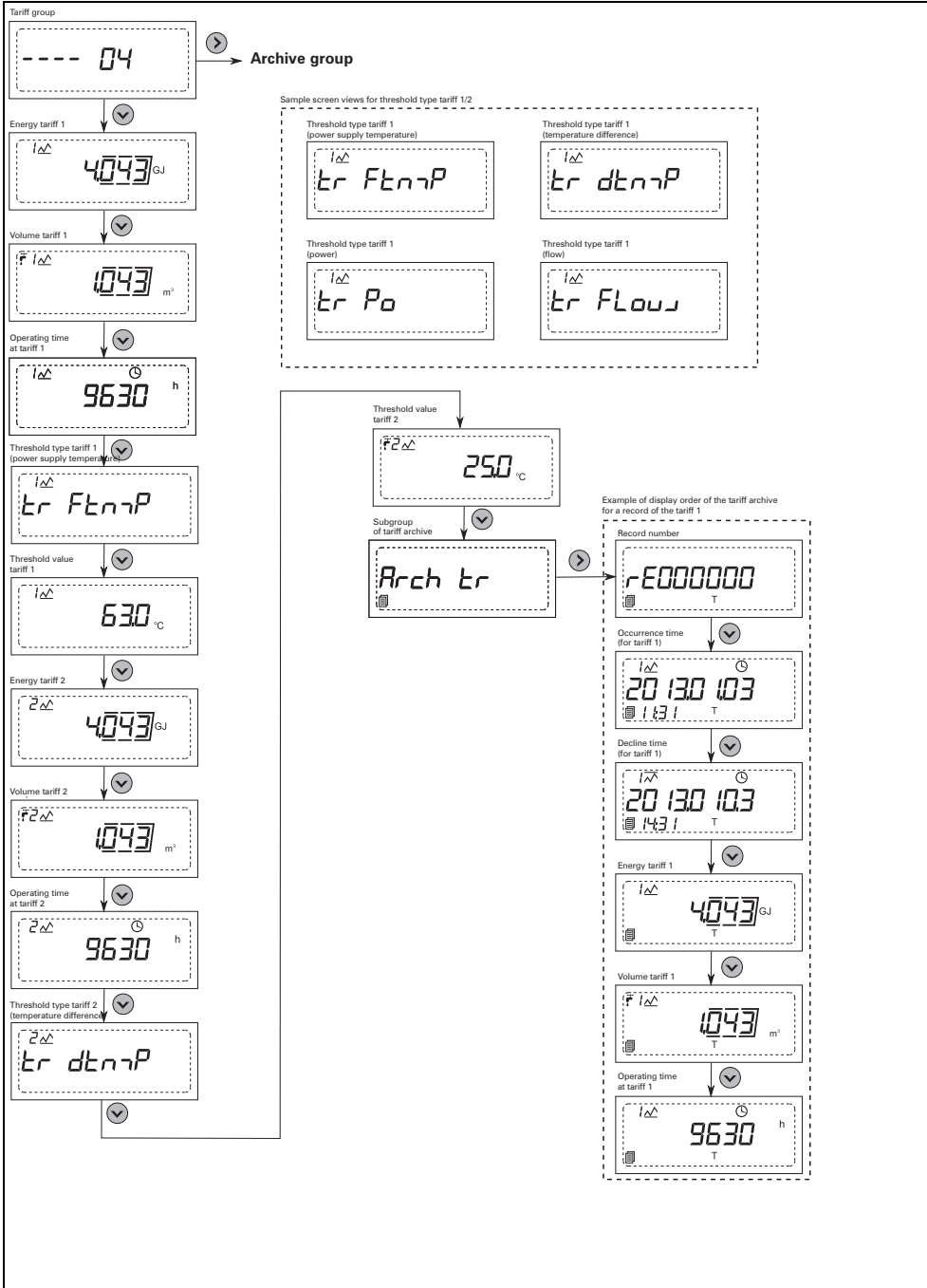
More recent numbers:  
energy tariff 2



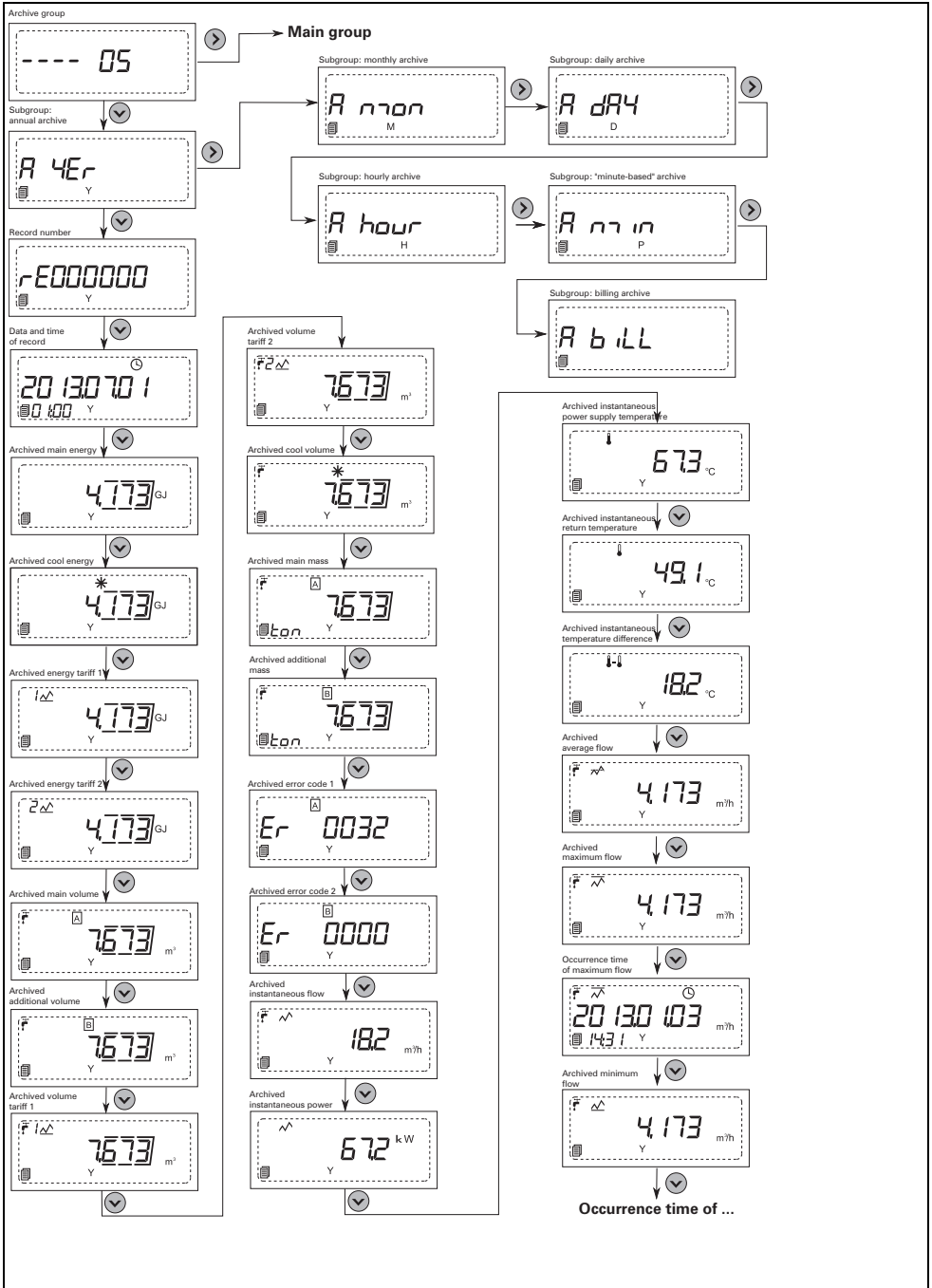
**Note:**

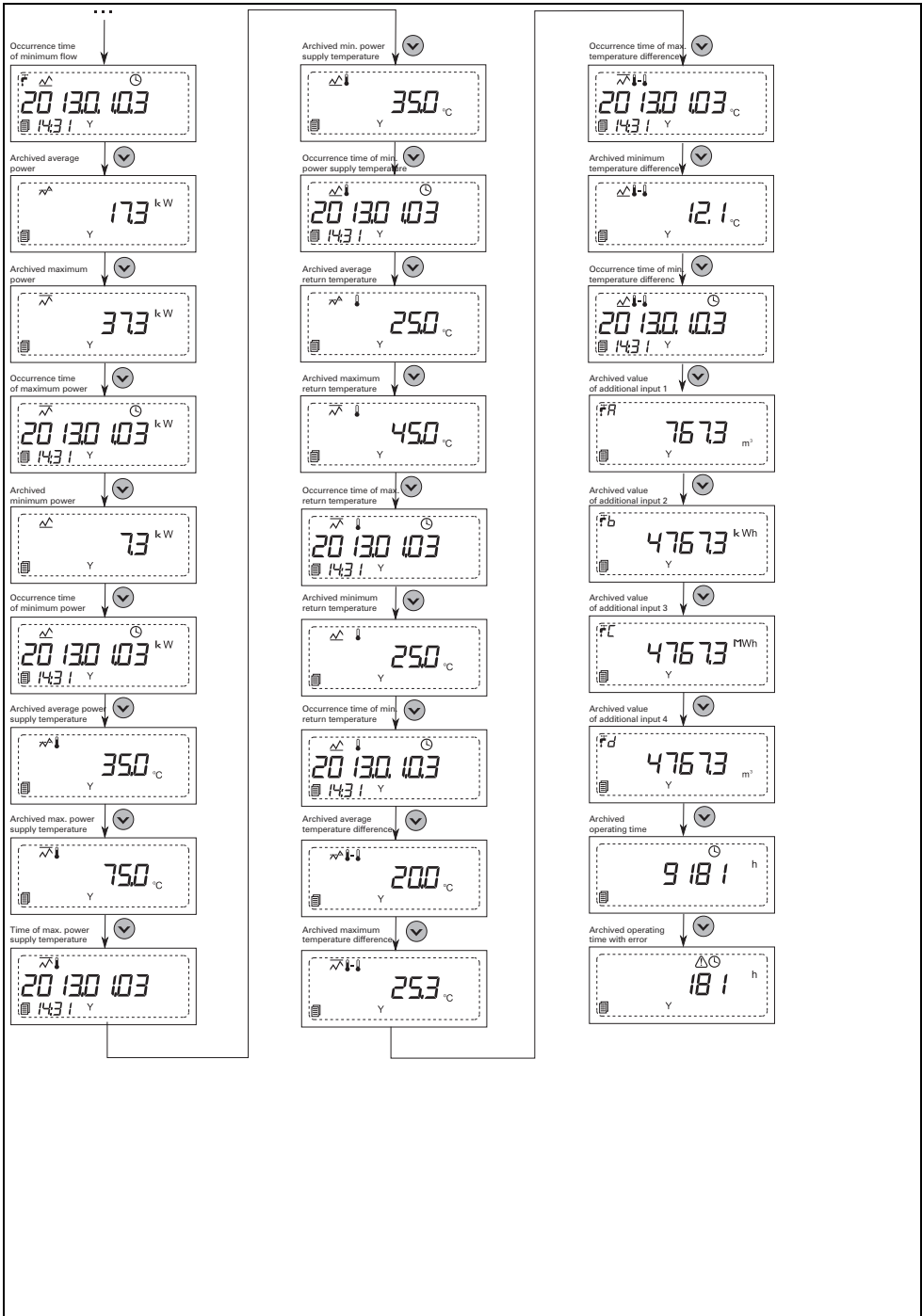
value tariff registers are not displayed  
when the tariff registers are disabled

### 10.1.4 Tariff group (04)

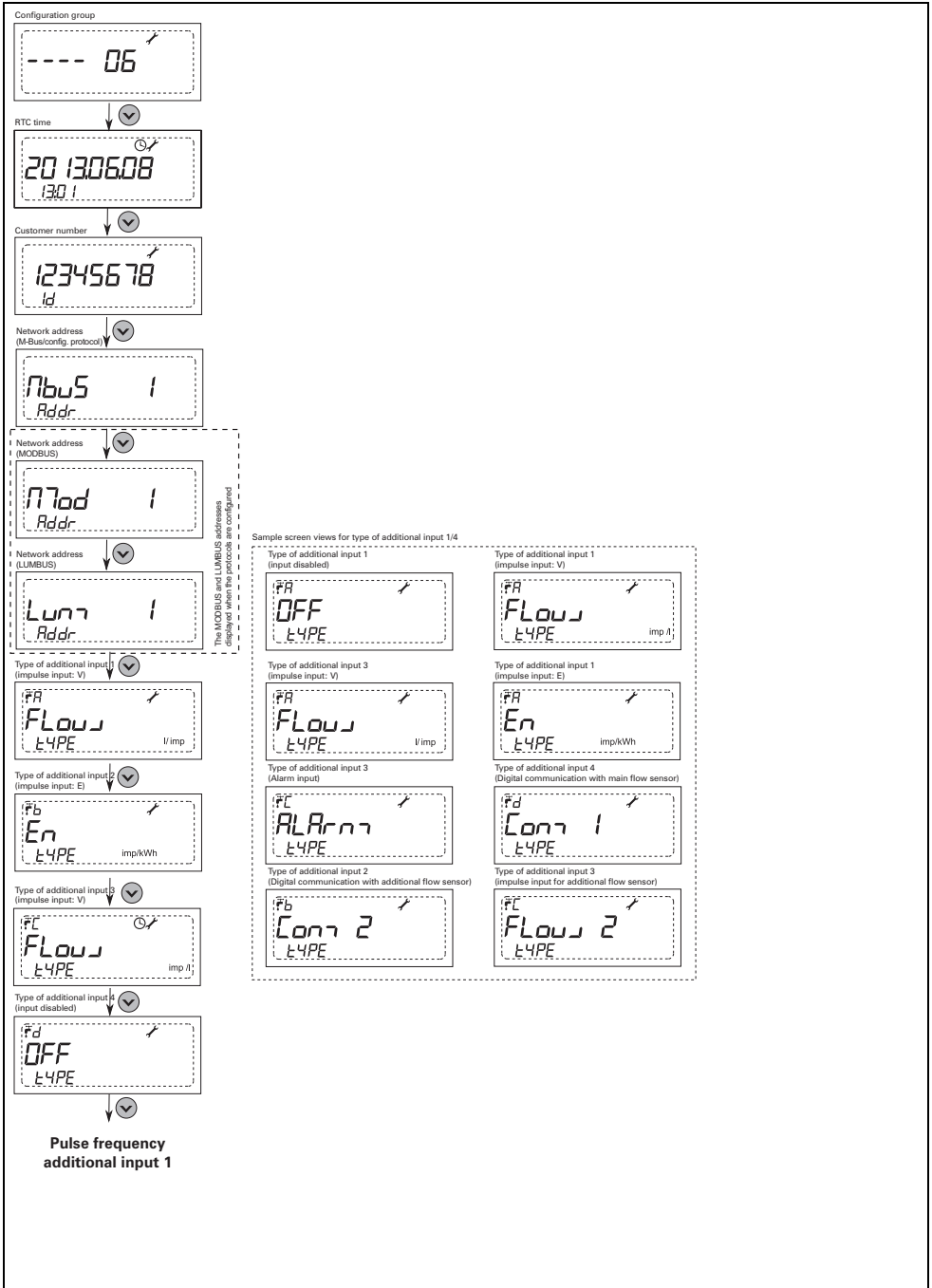


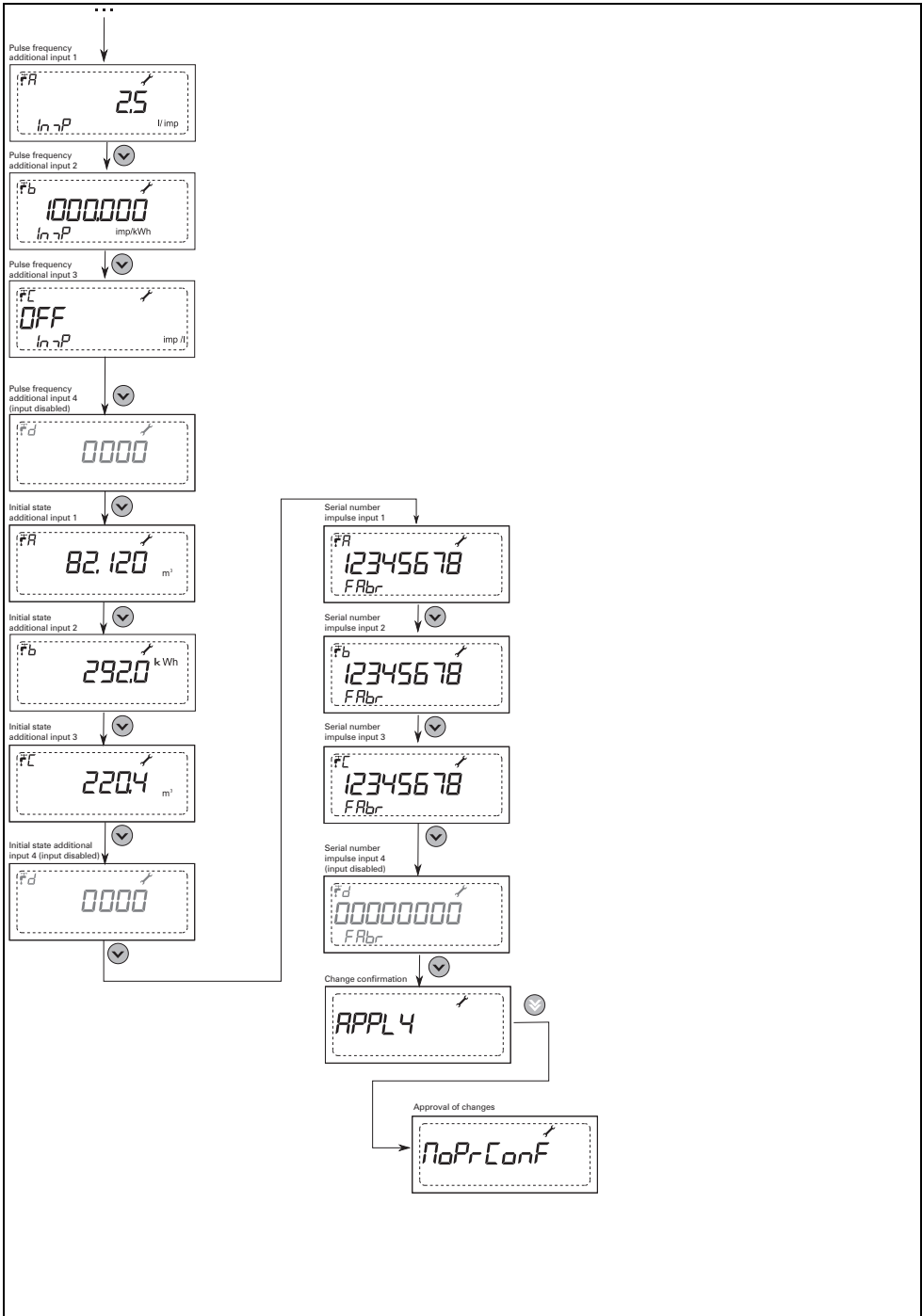
10.1.5 Grupa archiwalna (05)





### 10.1.6 Configuration group (06)









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