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# Ultrasonic heat and cooling meter

## INVONIC H

Installation & operating manual

**ISO 9001** **PN-N-18001** **ISO 14001**

## Contents

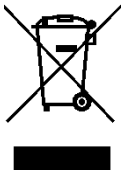
**EC DECLARATION OF CONFORMITY**

Apator Powogaz S.A. hereby declares that this product meets the requirements of the following directives:
– 2014/32/EU Measuring Instruments Directive (MID)
– 2014/30/EU EMC Directive
– 2014/35/EU Low voltage Directive
– 2014/53/EU Radio Equipment Directive (RED)

EC type examination certificate no. LT-1621-MI004-029 revision 1

**FOR EU CUSTOMERS: WEEE MARKING**

Marking of electrical and electronic equipment per Article 14(2) of Directive 2012/19/EU



When this symbol is placed on a product, the product cannot be disposed of with household waste. The product must be processed under a proper waste electrical and electronic equipment collection and disposal program. Contact your local authorities for more information about how this product should be recycled.

**SAFETY GUIDELINES**

Before installing this product, read this Manual and follow all information and guidance provided herein.
Caution: If the product is used otherwise than intended by its manufacturer, its safety level might be compromised.

1. The meter is powered with a battery (rated at 3.6 V), and the risk factor of its installation and servicing is the working medium flowing at a maximum pressure of 2.5 MPa and a maximum temperature of 180°C.
2. Only qualified technical professionals may install and service the meters. Qualified technical professionals must know and understand the technical manuals of this product and applicable general safety rules. Follow all applicable general safety rules when installing and servicing this product.
3. This product meets Safety Class II requirements. The product does not require a protective earth bonding; its enclosure is made of plastic, and all electrically conductive components are contained within it.
4. The safety of installation and servicing of the meter is guaranteed by:
   - proper insulation of electrical wiring;
   - leak-proof connections of the flow sensor and temperature sensors on the service pipeline;
   - reliable fitting of the meter components in the service installation.
5. Safety requirements for the temperature sensors, see the applicable technical manuals.
6. Operating environment:
   - Ambient temperature:
     - Calculator: from +5ºC to +55ºC
     - Flow sensor: from -30ºC to +55ºC
   - Relative humidity: < 93%

**CAUTION!** Assemble and disassemble the components of the meter only when you have verified that its pipeline contains no working medium (liquid).

## 1. Application

The INVONIC H ultrasonic heat and cooling meter has been designed for measuring heating and cooling energy and recording the metered values in two separate registers. It is intended for billing the consumption of heating/cooling energy in district or industrial heating/cooling systems which serve residential houses, office buildings, energy plants and the like.

The microprocessor compact ultrasonic heat and cooling meter can be mounted either on the supply pipeline or the return pipeline.

The meter is available with a pair of factory-installed temperature sensors and as well in version where user can install his own pair of type approved temperature sensors compliant with Directive 2014/32/EU of 26 February 2014 on measuring instruments (the MID, or the Measuring Instruments Directive).`

Meter complies to essential requirements of the Technical Regulations For Measuring Instruments, dated 30 October 2015 (transposing in the NB's country law Directive 2014/32/EU of 26 February 2014 on measuring instruments:
- Annex I (Essential requirements)
- Annex MI-004 (Heat meters)

The INVONIC H complies with the European standard EN 1434 "Heat meters", Parts 1+6.
The INVONIC H complies with Class C of environmental protection requirements according to EN 1434-1:2016

| | |
|---|---|
| Ambient temperature range: | from +5°C to +55°C |
| Humidity: | condensing |
| Location: | indoor |
| Mechanical environment class: | M1 |
| Electromagnetic environment class: | E2 |

**Type number coding of the INVONIC H heat/cooling meter:**

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|

| Flow rate measuring range $q_i/q_p$ | Code |
|---|---|
| 1:100 | H |
| 1:250* | I |

| Mounting place and nominal pressure | Code |
|---|---|
| supply pipe, PN16 | 1 |
| supply pipe, PN25 | 2 |
| return pipe, PN16 | 3 |
| return pipe, PN25 | 4 |

| Meter type, calculator IP rating, flow sensor IP rating, working medium, compliance with directive | Code |
|---|---|
| heat meter, IP65, IP65, water, MID | A |
| heat meter, IP65, IP67, water, MID | B |
| heat and cooling meter, IP65, IP67, water, MID | C |
| heat and cooling meter, IP65, IP67, 16% propylene glycol | D |
| heat and cooling meter, IP65, IP67, 25% propylene glycol | E |
| heat and cooling meter, IP65, IP67, 38% propylene glycol | F |
| heat and cooling meter, IP65, IP67, 47% propylene glycol | G |
| heat and cooling meter, IP65, IP67, 20% ethylene glycol | H |
| heat and cooling meter, IP65, IP67, 34% ethylene glycol | I |
| heat and cooling meter, IP65, IP67, 44% ethylene glycol | J |
| heat and cooling meter, IP65, IP67, 52% ethylene glycol | K |

| Energy unit | Code |
|---|---|
| GJ | 1 |
| kWh | 2 |
| MWh | 3 |
| Gcal | 4 |

| Flow sensor (nominal flow rate, body length, connection type and size) | Code |
|---|---|
| 0.6 $m^3/h$, 110 mm, threaded, DN15 / G¾" | A |
| 0.6 $m^3/h$, 190 mm, threaded, DN20 / G1" | B |
| 0.6 $m^3/h$, 190 mm, flanged, DN20 | C |
| 1 $m^3/h$, 110 mm, threaded, DN15 / G¾" | D |
| 1 $m^3/h$, 190 mm, threaded, DN20 / G1" | E |
| 1 $m^3/h$, 190 mm, flanged, DN20 | F |
| 1.5 $m^3/h$, 110 mm, threaded, DN15 / G¾" | G |
| 1.5 $m^3/h$, 130 mm, threaded, DN20 / G1" | H |
| 1.5 $m^3/h$, 190 mm, threaded, DN20 / G1" | I |
| 1.5 $m^3/h$, 190 mm, flanged, DN20 | J |
| 2.5 $m^3/h$, 130 mm, threaded, DN20 / G1" | K |
| 2.5 $m^3/h$, 190 mm, threaded, DN20 / G1" | L |
| 2.5 $m^3/h$, 190 mm, flanged, DN20 | M |
| 3.5 $m^3/h$, 260 mm, threaded, DN25 / G1¼" | N |
| 3.5 $m^3/h$, 260 mm, flanged, DN25 | O |
| 6 $m^3/h$, 260 mm, threaded, DN25 / G1¼" | P |
| 6 $m^3/h$, 260 mm, flanged, DN25 | Q |
| 10 $m^3/h$, 300 mm, threaded, DN40 / G2" | R |
| 10 $m^3/h$, 300 mm, flanged, DN40 | S |
| 15 $m^3/h$, 270 mm, flanged, DN50 | T |
| 25 $m^3/h$, 300 mm, flanged, DN65 | U |
| 40 $m^3/h$, 300 mm, flanged, DN80 | V |
| 60 $m^3/h$, 360 mm, flanged, DN100 | W |

| Power supply | Code |
|---|---|
| battery power (battery not included) | 0 |
| battery power (1 × AA; 3.6 V; 2.7 Ah) | 1 |
| battery power (2 × AA; 3.6 V; 2.7 Ah) | 2 |
| external power supply module 12-36 V AC / 12-42 V DC + battery power (1 × $AA_2$; 3.6 V; 2.7 Ah) | 3 |
| external power supply module 12-36 V AC / 12-42 V DC + 230 V power adapter + battery power (1 × AA; 3.6 V; 2.7 Ah) | 4 |
| 230 V power adapter + battery power (1 × AA; 3.6 V; 2.7 Ah) | 5 |
| 230 V power adapter + battery power (2 × AA; 3.6 V; 2.7 Ah) | 6 |

| G | H | I | J |
|---|---|---|---|

**Type number coding of the INVONIC H heat/cooling meter:**

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|

| Communication modules | Code |
|---|---|
| none | A |
| M-Bus module | B |
| current loop (CL) module | C |
| radio wM-Bus S1 module (868 MHz) | D |
| Modbus RTU RS-485 module | E |
| radio wM-Bus T1 OMS module (868 MHz), individual password per module | F |
| radio wM-Bus T1 OMS module (868 MHz), common password for all modules | G |
| BACnet MS/TP RS-485 module | H |

| Flow sensor to calculator wiring length | Code |
|---|---|
| 1.2 m | 1 |
| 2.5 m | 2 |
| 5.0 m | 5 |

| Configuration profiles settings applies only to wM-Bus radio module (in the case of other modules default profile name is "A") | Code |
|---|---|
| walk-by system: radio module transmits the following registers every 30 s, from Monday to Friday, from 6 to 18 (6 AM to 6 PM): serial number; date; heat energy; cooling energy**; volume; actual flow and power; volume from pulse input 1 and 2; energy and volume of last month with write date; energy and volume of last year with write date; active errors with timestamp; operating time without energy calculation error; supply and return temperature | A |
| drive-by system: radio module transmits the following registers every 20 s, from Monday to Friday, from 6 to 16 (6 AM to 4 PM): serial number; date; heat energy; cooling energy**; volume; volume from pulse input 1 and 2; energy and volume of last month with write date; energy and volume of last year with write date; active errors with timestamp | B |
| stationary system: radio module transmits the following registers every 180 s, 24/7: serial number; date; heat energy; cooling energy**; volume; actual flow and power; volume from pulse input 1 and 2; energy and volume of last month with write date; energy and volume of last year with write date; active errors with timestamp; operating time without energy calculation error; supply and return temperature; maximum temperatures, flow and power during last month | C |

| Temperature sensors | Code |
|---|---|
| none (without bolt protecting temperature sensor sleeve in the meter body) | 0 |
| none (with bolt protecting temperature sensor sleeve in the meter body) | 1 |
| pair of Pt500 M10x1 sensors for direct installation with 1.5 m long wiring and a brass fixing screw (Ø 5.2 mm, 0-150°C) | 2 |
| pair of Pt500 M10x1 sensors for direct installation with 1.5 m long wiring and a plastic fixing screw (Ø 5.2 mm, 0-150°C) | 3 |
| pair of Pt500 M10x1 sensors for direct installation with 2 m long wiring and a plastic fixing screw (Ø 5.2 mm, 0-150°C) | 4 |
| pair of Pt500 M10x1 sensors for direct installation with 2 m long wiring and a brass fixing screw (Ø 5.2 mm, 0-150°C) | 5 |
| pair of Pt500 M10x1 sensors for direct installation with 3 m long wiring and a plastic fixing screw (Ø 5.2 mm, 0-150°C) | 6 |
| pair of Pt500 M10x1 sensors for direct installation with 3 m long wiring and a brass fixing screw (Ø 5.2 mm, 0-150°C) | 7 |
| pair of Pt500 M10x1 sensors for direct installation with 5 m long wiring and a plastic fixing screw (Ø 5.2 mm, 0-150°C) | 8 |
| pair of Pt500 M10x1 sensors for direct installation with 5 m long wiring and a brass fixing screw (Ø 5.2 mm, 0-150°C) | 9 |
| pair of Pt500 sensors for installation in pockets with 3 m long wiring (Ø 6 mm, 0-150°C) | A |
| pair of Pt500 sensors for installation in pockets with 5 m long wiring (Ø 6 mm, 0-150°C) | B |

* with the exception of flow sensors with a nominal flow $q_p$ = 0.6 $m^3/h$; 1 $m^3/h$; 1.5 $m^3/h$ (130 mm); 3.5 $m^3/h$
** register available only in heat and cooling meters

## 2. Specification

Accuracy class: 2 by EN1434-1:2007
Energy units: GJ, Gcal, kWh, MWh
Maximum value of thermal power: 5.28 MW

### Flow measurement

Nominal flow rate to minimum flow rate ratio (should be specified when ordering):

$q_p/q_i$ = 100 or $q_p/q_i$ = 250 [available only for meters with $q_p$ = 1.5 $m^3/h$ (110 mm and 190 mm); 2.5 $m^3/h$; 6 $m^3/h$; 10 $m^3/h$; 15 $m^3/h$; 25 $m^3/h$; 40 $m^3/h$; 60 $m^3/h$]

The flow sensor can either be threaded (max $q_p$ = 10 $m^3/h$) or flanged.

Table 2.1. Flow sensor technical specifications

| Nominal flow $q_p$, $m^3/h$ | Maximum flow $q_s$, $m^3/h$ | Minimum flow $q_i$, $m^3/h$ | Starting flow, $m^3/h$ | Overall length L, mm | Pressure loss at $q_p$, kPa | Pipeline connection (G – threaded, DN – flanged) |
|---|---|---|---|---|---|---|
| 0.6 | 1.2 | 0.006 | 0.003 | 110 | 7.0 | G¾“ |
| 0.6 | 1.2 | 0.006 | 0.003 | 190 | 0.9 | G1“ or DN20 |
| 1.0 | 2.0 | 0.010 | 0.005 | 110 | 11.3 | G¾“ |
| 1.0 | 2.0 | 0.010 | 0.005 | 190 | 2.5 | G1“ or DN20 |
| 1.5 | 3.0 | 0.006 | 0.003 | 110 | 17.1 | G3/4“ |
| 1.5 | 3.0 | 0.006 | 0.003 | 190 | 5.8 | G1“ or DN20 |
| 1.5 | 3.0 | 0.015 | 0.003 | 110 | 17.1 | G3/4“ |
| 1.5 | 3.0 | 0.015 | 0.003 | 190 | 5.8 | G1“ or DN20 |
| 1.5 | 3.0 | 0.015 | 0.005 | 130 | 7.2 | G1“ |
| 2.5 | 5.0 | 0.010 | 0.005 | 130 | 19.8 | G1“ |
| 2.5 | 5.0 | 0.010 | 0.005 | 190 | 9.4 | G1“ or DN20 |
| 2.5 | 5.0 | 0.025 | 0.005 | 130 | 19.8 | G1“ |
| 2.5 | 5.0 | 0.025 | 0.005 | 190 | 9.4 | G1“ or DN20 |
| 3.5 | 7.0 | 0.035 | 0.017 | 260 | 4.0 | G1¼“ or DN25 |
| 6.0 | 12.0 | 0.024 | 0.012 | 260 | 10.0 | G1¼“ or DN25 |
| 6.0 | 12.0 | 0.060 | 0.012 | 260 | 10.0 | G1¼“ or DN25 |
| 10.0 | 20.0 | 0.040 | 0.020 | 300 | 18.0 | G2“ or DN40 |
| 10.0 | 20.0 | 0.100 | 0.020 | 300 | 18.0 | G2“ or DN40 |
| 15.0 | 30.0 | 0.060 | 0.030 | 270 | 12.0 | DN50 |
| 15.0 | 30.0 | 0.150 | 0.030 | 270 | 12.0 | DN50 |
| 25.0 | 50.0 | 0.100 | 0.050 | 300 | 20.0 | DN65 |
| 25.0 | 50.0 | 0.250 | 0.050 | 300 | 20.0 | DN65 |
| 40.0 | 80.0 | 0.160 | 0.080 | 300 | 18.0 | DN80 |
| 40.0 | 80.0 | 0.400 | 0.080 | 300 | 18.0 | DN80 |
| 60.0 | 120.0 | 0.240 | 0.120 | 360 | 18.0 | DN100 |
| 60.0 | 120.0 | 0.600 | 0.120 | 360 | 18.0 | DN100 |

Working medium (liquid) temperature range: from +5°C to +130°C.

**Important:** If the working medium temperature is equal to 90°C or lower, the calculator can be installed directly on the flow sensor or on a wall. If the working medium temperature exceeds 90°C, the calculator must be physically separated from the flow sensor and installed on a wall.

Flow sensor to calculator cable length: 1.2 m (2.5 m and 5.0 m available on custom order)
Maximum operating pressure: 16 bars (25 bars available on custom order)

Behaviour of the meter, when the flow rate exceeds the maximum flow $q_s$:

- for flow rate $q < 1.2 \times q_s$ – linear;
- for flow rate $q > 1.2 \times q_s$ – constant (the formula $q = 1.2 \times q_s$ is used to calculate the heat energy). The error "Maximum allowable value of flow rate is exceeded " is registered with duration of this error state.

### Pulse inputs

Number of pulse inputs: 2
Measurement unit: $m^3$
Pulse value: programmable
Type of pulses: IB by EN 1434-2
Min. pulse width: 100 ms
Maximum permissible frequency of input pulses: 3 Hz
Maximum permissible voltage of input pulses: 3.6 V
Condition of maintenance of high level: 3.6 V via 3.3 MΩ resistor

### Temperature measurement

Temperature measuring range (for the calculator): 0-180°C
Temperature difference measuring range (for temperature inputs): 3-150 K* or 2-150 K*
Temperature difference below which the energy is not totalled 0.15 K
Temperature sensor type: platinum, Pt500, resistive, compliant with EN 60751 and paired according with

EN 1434 and Directive 2014/32/EU Annex MI-004

Sensor installation to meters with threaded connection: short, directly mounted (type DS) in accordance with EN 1434-2
Sensor installation to meters with flanged connection: short or long, pocket mounted (type PS & PL) in accordance with EN 1434-2
Connection method and maximum cable length: 2-wire; up to 5 m

* the lower temperature measuring limit depends on the parameters of connected temperature sensors

### LCD display

The meter features an 8-digit LCD display with special icons for displaying parameters, units, and operating modes. The LCD can display the following indications: total and instantaneous measured parameter values, archived data and meter configuration data. See p. 6.3.1 for details.

Display resolution for energy: 00000001 kWh; 00000.001 GJ / Gcal / MWh
Display resolution for volume: 00000.001 $m^3$

### Data registration and storage

Every hour, day and month values of the measured parameters are stored in the meter's memory. All archived data can be accessed only with a remote reading interface (see p. 6.5). The monthly values of the parameters stored in the data logger can be read from LCD display (see p. 6.3.1).

Table 2.2. Parameter values recorded by meter hourly, daily and monthly

| No. | Parameter |
|---|---|
| 1 | Total heat energy |
| 2 | Total cooling energy |
| 3 | Tariff 1 total energy |
| 4 | Tariff 2 total energy |
| 5 | Total working medium volume |
| 6 | Pulse input 1 total volume |
| 7 | Pulse input 2 total volume |
| 8 | Maximum thermal power value for heating & measurement date |
| 9 | Maximum thermal power value for cooling & measurement date |
| 10 | Maximum flow rate value & measurement date |
| 11 | Maximum working medium supply temperature & measurement date |
| 12 | Maximum working medium return temperature & measurement date |
| 13 | Minimum working medium supply temperature & measurement date |
| 14 | Minimum working medium return temperature & measurement date |
| 15 | Minimum working medium temperature difference & measurement date |
| 16 | Average working medium supply temperature |
| 17 | Average working medium return temperature |
| 18 | Meter running time without energy calculation errors |
| 19 | Total error code |
| 20 | Total time when flow rate exceeded the maximum flow ($1.2 \times q_s$) |
| 21 | Total time when flow rate was less than the minimum flow ($q_i$) |

Data logger capacity:

- up to 1480 h of hourly records
- up to 1130 days of daily records
- up to 36 last months of monthly records

Storage time of measured total parameter values even if device is disconnected from power supply - not less than 15 years.

### External communication modules and interfaces

### Optical interface

The integrated optical interface port is located on the calculator's enclosure front. It is designed for data reading and parametrization of meter via M-Bus protocol. The optical interface is enabled (activated) only after single press of the button on the meter front panel and automatically disabled when 5 minutes have passed either from last press of the button or since last data transmission.

### Pulse outputs

The standard heat meter includes pulse outputs through which information about heat energy consumption, cooling energy consumption, or working medium volume could be send.

Number and class of pulse outputs: 2 (OB – in normal mode, OD – in test mode)
Pulse output type: open collector (max permissible current up to 20 mA; max voltage up to 50 V)
Pulse time width: 125 ms – in normal mode; 1.2 ms – in test mode

Table 2.3. Energy pulse values at the pulse output in normal mode

| Energy unit | kWh / MWh | GJ | Gcal |
|---|---|---|---|
| Pulse value | 1 kWh/pulse | 0.005 GJ/pulse | 0.001 Gcal/pulse |

Table 2.4. Volume pulse values at the pulse output in normal mode

| Flow sensor nominal flow $q_p$ | 0.6; 1; 1.5; 2.5; 3.5; 6 $m^3/h$ | 10; 15; 25; 40; 60 $m^3/h$ |
|---|---|---|
| Pulse value | 1 l/pulse | 10 l/pulse |

### Optional plug-in modules

- M-Bus module
- Radio wM-Bus module (868 MHz)
- Modbus RTU module (RS-485)
- BACnet module (RS-485)

### M-Bus module

Designed for data reading and programming the meter via M-Bus protocol. The total working time of the serial communication interface is limited to 200 minutes a month (for protection of the battery against premature discharge). Unused communication time limit is summarized. Once the communication time limit has been spent, the interface is locked out till new time limit for communication will be given (16 seconds for each next hour).

### Power supply

The standard version of meter has one AA-size battery (3.6 V; 2.7 Ah; Li-$SOCl_2$) installed inside the calculator. The minimum battery life is 11 years, including the voltage required for operation of the pulse outputs. The meter can be equipped with up to two batteries.

As an option meter could be equipped with external power supply module (12-42 V DC or 12-36 V AC 50/60 Hz,10 mA max). The power supply module is installed inside the calculator in place designated for second battery. In such case meter has one AA-size battery (3.6 V; 2.7 Ah; Li-SOCl2) inside with a minimum battery life of 11 years (not including the voltage drain by reading of optional communications modules) and powers the meter whenever the external power source is turned off.

An optional power adapter (230 V 50/60 Hz / 12 V AC) is available separately with a cable which total length is 2.5 m to feed the external power supply module.

### Mechanical specification

Calculator dimensions: 117 × 44 × 89.5 mm
Flow sensor dimensions: see Appendix B
Total meter weight: see Table 2.5.

Table 2.5. Weight of meters

| Connection type and size; flow sensor length | Max. meter weight (kg) |
|---|---|
| G3/4" (110 mm) | 0.8 |
| G1" (130 mm) | 0.9 |
| G1" (190 mm) | 1.1 |
| G1 ¼" (260 mm) | 3.6 |
| G2" (300 mm) | 7.4 |
| DN20 (190 mm) | 2.9 |
| DN25 (260 mm) | 6.1 |
| DN40 (300 mm) | 9.2 |
| DN50 (270 mm) | 8.5 |
| DN65 (300 mm) | 13.0 |
| DN80 (300 mm) | 15.0 |
| DN100 (360 mm) | 18.0 |

Environmental class: C according to EN 1434

Ambient temperature:

- calculator: from +5°C to +55°C (condensing, indoor installation)
- flow sensor: from -30°C to +55°C

Relative humidity: < 93%
Mechanical environment class: M1
Electromagnetic environment class: E2
Calculator enclosure ingress protection rating: IP65
Flow sensor enclosure ingress protection rating: IP65 (IP67 available on custom order)

# 3. Operating principle

The flow measuring principle is based on ultrasonic measurement method. The ultrasonic signal is transmitted alternately in either of the two directions along the measurement part. The flow value is calculated from the transition time difference between the ultrasonic waves with identical wavelength that was send in the right and opposite direction.

The working medium temperature is measured with standard Pt500 platinum resistive temperature sensors. Pairs of temperature sensors with 2-wire connection method for measurement temperatures on flow and return pipelines are used. Flow and return temperature sensors can only be replaced on the factory-made pairs.

In normal mode the flow volume measurement is done every 1 second, and the temperature measurement, energy value calculation and refresh of the values indicated on LCD are done every 16 seconds.

Energy calculation formulas:

- flow sensor in supply pipe: $Q = V_1 \times \rho_1 \times (h_{T1} - h_{T2})$
- flow sensor in return pipe: $Q = V_1 \times \rho_2 \times (h_{T1} - h_{T2})$

where:

Q – thermal energy
$V_1$ – water volume ($m^3$)
$\Theta_1$ – supply temperature
$\Theta_2$ – return temperature
$\rho_1$ / $\rho_2$ – water density at supply temperature $\Theta_1$ / return temperature $\Theta_2$
$h_{T1}$ / $h_{T2}$ – enthalpy at supply temperature $\Theta_1$ / return temperature $\Theta_2$

When cooling energy measurement is enabled and the temperature difference is negative (supply temperature < return temperature) with the value above 0.15 K then the cooling energy values will be written in the additional register:

$\sum Q = Q_1 + Q_2$

$Q_1$ – heat energy

$Q_2$ – cooling energy

- flow sensor in supply pipe:

  when $\Theta_1 > \Theta_2$: $Q_1 = V_1 \times \rho_1 \times (h_{T1} - h_{T2})$, $Q_2 = 0$

  when $\Theta_1 < \Theta_2$: $Q_2 = V_1 \times \rho_1 \times (h_{T2} - h_{T1})$, $Q_1 = 0$

- flow sensor in return pipe:

  when $\Theta_1 > \Theta_2$: $Q_1 = V_1 \times \rho_2 \times (h_{T1} - h_{T2})$, $Q_2 = 0$

  when $\Theta_1 < \Theta_2$: $Q_2 = V_1 \times \rho_2 \times (h_{T2} - h_{T1})$, $Q_1 = 0$

The meter's calculator provides all the necessary measurement and data storage functions.

# 4. Marking and sealing

## 4.1. Marking

### 4.1.1. Calculator

There are following information on the front panel of calculator: manufacturer's trade mark, meter type, temperature sensors type, calculator temperature measuring range, calculator temperature difference measuring range, flow sensor temperature range, nominal/maximum/minimum flow rate ($q_p$/$q_s$/$q_i$), year of manufacture, connection type and size, nominal and maximum admissible working pressure, device ingress protection rating, accuracy class, environmental class according EN1434-1, electromagnetic and mechanical environmental class, EC-type examination certificate number, flow sensor mounting place (supply or return pipe), type of working medium and concentration (if other than water), serial number and distributor's logo (if applicable).

The terminal pins numbers are marked close to the terminal which is inside the calculator.

### 4.1.2. Flow sensor

The flow sensor is marked with the following information: connection type to the pipeline (threaded connection – G, flanged connection – DN) and size, the arrow for indication of a proper flow direction of working medium.

## 4.2. Security seals

The manufacturer provides the following security measures for the calculator:
- the manufacturer's warranty seal preventing access to the adjustment activation jumper (see Fig. 12.1.);
- the manufacturer's warranty seal on the fastener of the cover protecting electronic module (see Fig. 12.1.).

The manufacturer provides the following security measures for the flow sensor:
- the seals on the screws of protective cover of flow sensor (see Fig. 12.2. - Fig. 12.4.).

After installation of the meter the installer shall mount following seals:
- butterfly, wire or lead seals to bind the lid and bottom part of the calculator enclosure (see Fig. 12.1.);

- seals on the pockets and mounting socket of the temperature sensors (see Fig. 12.6. and Fig. 12.7.);
- additionally flow sensor's connection with the pipeline should be sealed as well (for example with couplings)

The meter must be sealed once it has been installed to prevent unauthorized dismantle, removal, or altering of device without evident damage on the meter or its seals.

# 5. Installation

## 5.1. Basic requirements

The meter has been designed for operation in heating or heating and cooling systems. Pre-installation checks:
- check if all parts listed in the meter's documentation are available,
- check if there are no visible mechanical defects on device,
- check if there are valid rating plate, undamaged manufacturer's warranty seals and required by certification authority labelling.

The flow direction shown by the arrow on the flow sensor body must match the actual flow in metering circuit. The heat meter must be installed on the correct pipe (supply or return), as indicated by the icon (see Fig. 5.1.) placed on the rating plate on the meter enclosure


Fig. 5.1 Icons representing flow sensor installation place.

If the meter is designed for the supply-side installation, install the supply temperature sensor in the flow sensor body (for sizes DN15 to DN20) or in a tee / ball valve mounted next to the flow sensor body (for sizes DN25 to DN100) and the return temperature sensor should be mounted on the return pipe. If the meter is designed for the return-side installation, install the return temperature sensor in the flow sensor body (for sizes DN15 to DN20) or in a tee / ball valve mounted next to the flow sensor body (for sizes DN25 to DN100) and the supply temperature sensor should be mounted on the supply pipe.

Only qualified personnel may install the meter, following the requirements listed in this document, in technical documentation of other system components and in meter installation project.

Do not place the meter's wiring / cables less than 5 cm away from power cables of other equipment. Do not change length of provided with the meter cables in order to extend or reduce they lengths.

## 5.2. Electrical wiring

### 5.2.1. Temperature sensors connection

#### 5.2.1.1. Factory-installed sensors

Do not reduce or extend the length of the wiring of the factory-installed temperature sensors. If the connection terminals inside the calculator are accessible, installation cables can be temporarily disconnected from terminals and reconnected afterwards in exactly same order.

Before installation of the temperature sensor in a tee or ball valve, verify that accessories installation socket match the temperature sensor depth and diameter (see the dimensions in Fig. 5.2.).

**Caution:** Using installation accessories that do not meet these requirements may damage the temperature sensor!

Installation of the directly mounted temperature sensor should be started from placing the o-ring on the tool tip of mounting aid and after that with a rotary movement of the mounting aid insert o-ring in the installation socket of temperature sensor. Next adjust the o-ring into its final positon by using the other end of the mounting aid. If the temperature sensors are delivered with plastic bolt then position the inner bar of the half shell screwing into the surrounding crimp of the sensor enclosure and press two half shells firmly together. Thread the temperature sensor into the seat with a wrench and tighten to 3-5 Nm (see Fig. 5.2.). When installation is finished seal the temperature sensor by passing the seal wire through the drilling of the half shelf screwing and the installation fitting.

**Caution:** If the temperature sensor has been removed, always reinstall it with a new o-ring!

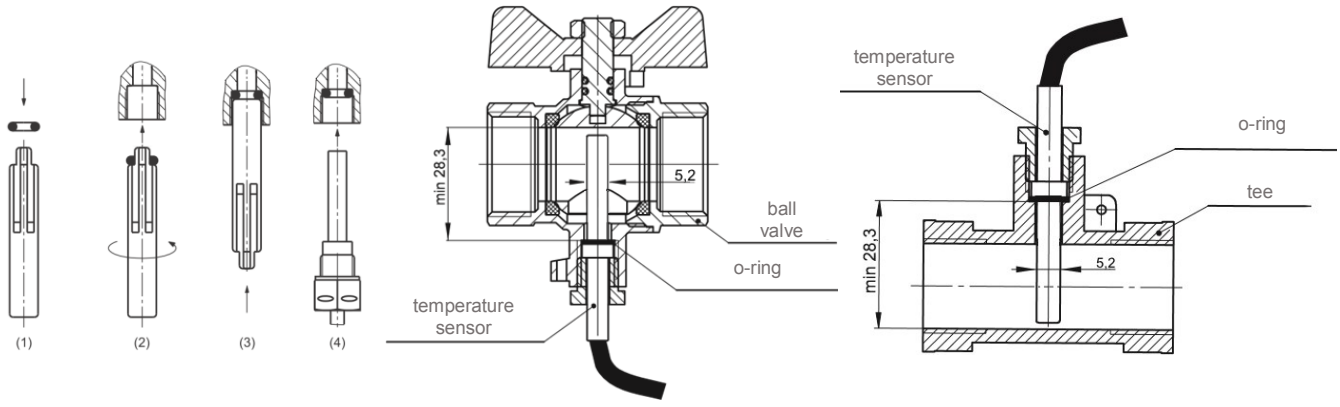



Fig. 5.2 Installation of the o-ring and the temperature sensor in a ball valve or a tee.

#### 5.2.1.2. Customer temperature sensors

Only approved and matching pairs of temperature sensors with 2-wire connection method could be used. Customer temperature sensor connection procedure:

1. Before installation check that the temperature sensors are paired with each other (T1 with T2).
2. By means of pliers remove the protective caps from the two leftmost sealant holes in the bottom part of calculator enclosure (hole 1 and 2).
3. Insert the wire of supply temperature sensor T1 wire through the hole 1 and the return temperature sensor T2 wire through the hole 2.
4. Use 2-wire connection method of temperature sensor connection and connect the supply temperature sensor T1 to terminals 5 & 6, and the return temperature sensor T2 to terminals 7 & 8 (see Fig. 10.1.).

### 5.2.2. Installation of expansion modules in the calculator

The expansion modules for the heat and cooling meter are supplied in form of PCBA (printed circuit boards) packed in anti-static protective foil. Handle the devices carefully after taking them out of the protective foil. The circuit boards may only be touched on the edges and should be mounted in the meter immediately after removing them from the anti-static foil.

Do not recharge or short-circuit additional batteries supplied with the M-Bus and wM-Bus communication modules (to extend operating life of the meter with communication module to 11 years) and factory-installed in the calculator. Keep the batteries away from contact with water and do not exposed them to temperatures above 80°C.

### 5.2.3. Installation of the M-Bus module

Module installation procedure:

1. Remove the installer's security seals from the calculator enclosure.
2. Open the calculator's lid by releasing the black latches on the left and right side of the enclosure.
3. Put the module into designated contact socket (see Fig. 5.3.). The contact pins of module must not be bent.
4. Fix the board of the module to the calculator body with two fixing screws supplied with the module.
5. Install the additional battery in the second battery holder and connect the module plug to the second battery connector.
6. By means of pliers remove the protective cap from the rightmost sealant hole in the bottom part of calculator enclosure.
7. Insert the data communication cable in sealant hole and route the cable through an available cable fittings and make a strain relief protecting wire against being pulled out from the outside.
8. Connect the data communication cable wires to the screw terminals on the M-Bus module (bipolar connection). For full description of screw terminal assignment used in communication modules see Table 10.2.
9. Close the lid of the calculator, fasten the latches on the sides of the calculator enclosure and mount again the installer's security seals.

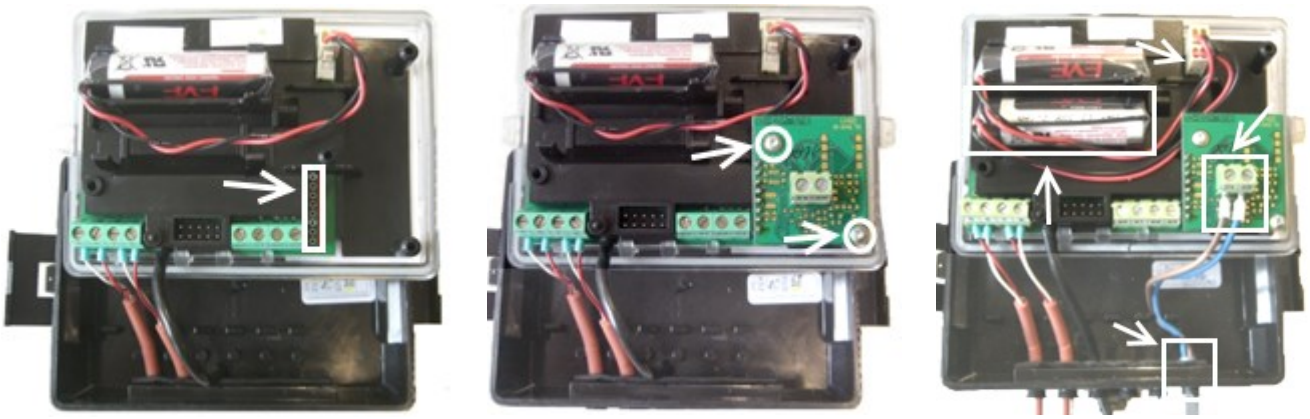


Fig. 5.3. Installation the M-Bus module in the meter’s calculator.

M-Bus module enables reading the heat and cooling meter via its primary address (default: 0) or secondary address (default: meter serial number) over a wired M-Bus network. Default baud rate: 2400 bps, data format: 8E1 (8 data bits, even parity, 1 stop bit).

### 5.2.4. Installation of the radio wM-Bus module

Module installation procedure:

1. Follow steps from 1 to 5 described in "Installation of the M-Bus module" procedure.
2. Remove the jumper from the pins of the radio wM-Bus module, if jumper is installed (see Fig. 5.4.).
3. Close the lid of the calculator, fasten the latches on the sides of the calculator enclosure and mount again the installer's security seals.

The data can be read by the radio module using the radio number (stored in the calculator and by default set to meter serial number) and the decryption key that could be found on label affixed under the flap of the meter unit packaging (if device was purchased with factory installed

module) or under the flap of the radio module unit packaging (if module was purchased separately). The radio module starts sending data telegrams only after the meter has recorded a minimum 20 liters of volume by the flow transducer.

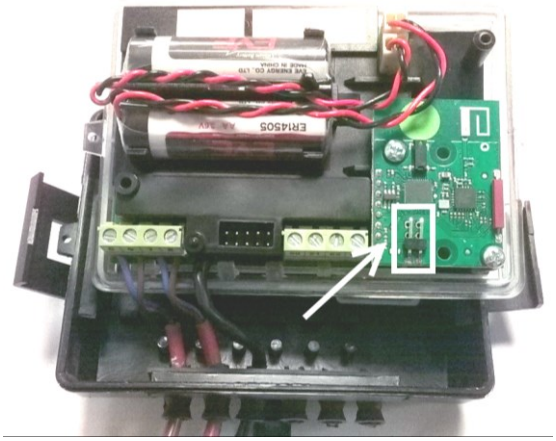


Fig. 5.4. Installation the Radio wM-Bus module in the meter's calculator.

### 5.2.5. Installation of the Modbus/BACnet module

Module installation procedure:

1. Follow steps from 1 to 4 described in "Installing the M-Bus module" procedure.
2. By means of pliers remove the protective cap from the rightmost sealant hole in the bottom part of calculator enclosure.
3. Insert the data communication cable in sealant hole and route the cable through an available cable fittings and make a strain relief protecting wire against being pulled out from the outside.
4. Connect wires of data communication cable to the screw terminals of the Modbus/BACnet module according assignment from Table 10.2.
5. Install the external power supply module according to procedure in p. 5.2.6. and connect additional power cable from external power supply module terminals to the power supply terminals on the Modbus/BACnet module (see Fig. 5.5). The connection is bipolar. For full terminal assignment of the external power supply module see Table 10.2.
6. Follow steps from 11 to 13 described in p. 5.2.6. concerning Installation of the external power supply module.
7. Close the lid of the calculator, fasten the latches on the sides of the calculator enclosure and mount again the installer's security seals.

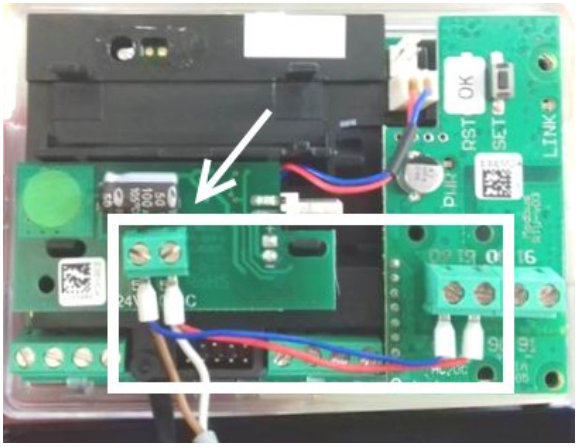



Fig. 5.5 Conencting Modbus/BACnet module to external power supply module.

The Modbus/BACnet module enables reading the data from the heat and cooling meter with an EIA-485 (RS-485) interface over a wired Modbus/BACnet network. Default settings: baud rate: 2400 bps, data format: 8E1 (8 data bits, 1 stop bit, parity bit), device address: 1 (slave ID), transmission data update time: 10 minutes. A single network can include a maximum of 256 devices.

The module has a "PWR" LED indicating the power supply of the module and "LINK" LED which is flashing when a query is received or a response is transmitted to indicate communication with the Modbus/BACnet network. Module is equipped as well with „SET" button that could reset module to factory settings (transmission baud rate, data format, device address and transmission data update time). To restore default settings in module you should disconnect it from the power supply source, press the "SET" button and turn on power supply again without releasing the button, which should be hold for at least 15 seconds until the "LINK" LED start to blink steadily.

The module has a factory reset button which, when pressed and held for more than 15 seconds, restores all default settings (transmission baud rate, data format, device address and transmission data update time).

**Power supply for the Modbus/BACnet module**

- Voltage: 12-24 V DC
- Typical supply current: 50 mA
- Maximum power consumption: 2 W
- Terminal numbering: 60 and 61 (bipolar connection)

**Communication interface**

- Modbus protocol type: RTU
- BACnet protocol type: MS/TP (ANSI/ASHRAE standard 135, version 1, revision 9; ISO 16484-5)
- Modbus data transmission baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 56000, 57600, 115200
- BACnet data transmission baud rate: 9600, 19200, 38400, 57600, 115200
- Available data formats: 8E1, 8O1, 8N2
- Terminal numbering: 90 (+), 91 (-)

### 5.2.6. Installation of the external power supply module

Module installation procedure:

1. Remove the installer's security seals from the calculator enclosure.
2. Open the calculator's lid by releasing the black latches on the left and right-hand side of the enclosure.
3. Install the module in place of the second battery holder (see Fig. 5.6.).
4. Fix the board of the module to the calculator body with one fixing screw supplied with the module
5. Disconnect the connector plug of the battery installed in the meter from the battery connector and connect it directly to the module (see Fig. 5.6.).
6. Use a metal tool to short-circuit (for 1-2 seconds) both pins of the battery connector which you have just disconnected from the battery connector plug. This will unload the internal capacity of the meter bus.
7. Connect power connector plug of module to the meter's battery connector. The LCD display should start indicating.
8. By means of pliers remove the protective cap from the spare sealant hole in the bottom part of calculator enclosure.
9. Insert the power cable (use a flexible two-wired cable 0.14-0.5 $mm^2$, with outer diameter 4-6 mm) in sealant hole and route the cable through an available cable fittings and make a strain relief protecting wire against being pulled out from the outside (see Fig. 10.3.).
10. Connect wires of the power cable to the screw terminals of external power supply module (bipolar connection). Full terminal assignment of the external power supply module, see Table 10.3.
11. Install the configuration pin connector jumper in the test mode (see Fig. 6.7).
12. Use an optical interface to connect with the optical interface port on the meter's calculator front panel. Press the button on the calculator front panel and connect with the meter with a dedicated service software suite to set the date and time (Current Readings tab) and disable the M-Bus data communication limit (Meter Configuration tab).
13. Remove the configuration pin jumper to disable the test mode and restore the normal operating mode of the heat and cooling meter.
14. Close the lid of the calculator, secure the side clasps of the calculator enclosure, and install the installer's security seals in place.
15. Connect the power cable to the external power supply source. The green LED on the calculator front panel should be on – this indicates that the meter runs on external power.

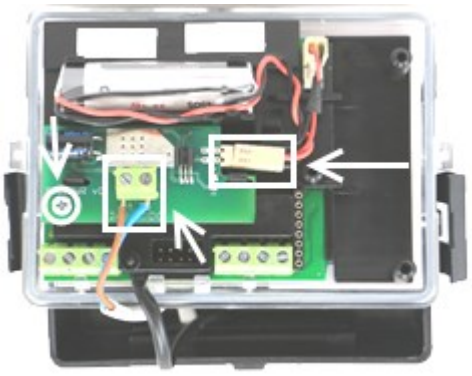


Fig. 5.6. Installation of external power supply module in the meter's calculator.

The external power supply module provides possibility of powering meter with 12-42 V DC 12-36 V AC 50/60 Hz,10 mA max. When device is power supplied from an external source, the meter does not use the internal battery power. The internal battery power in such case is used only to keep the meter running when the external power supply source is turned off.

The external power supply module can be powered by e.g. the optional 230 V 50/60 Hz / 12 V AC power adapter (see Fig. 5.7.). If you want to use it, connect the grey cable of the power adapter to the external power supply module terminals by passing it through a cable gland of the calculator, and connect the black cable marked with label (230 V AC) to the 230 V 50/60Hz power mains. As the power adapter is powered by

life-dangerous voltage value, so installation of the calculator in such configuration could be done only by qualified professionals when power supply is switched off.

Fig. 5.7. Power adapter (230 V 50/60 Hz / 12 V AC).

## 5.3. Mounting

### 5.3.1. Mounting of calculator

The meter calculator must be installed in heated premises where the ambient temperature does not exceed 55°C. Keep the calculator away from direct sunlight.

There calculator could mounted in several different ways:

- Installation of the calculator directly on the flow sensor enclosure with possibility to rotate calculator 180° or 90° if special bracket is used (Note: it is possible to install the calculator directly on the flow sensor enclosure if the working medium temperature does not exceed 90°C)
- wall-mounted installation without possibility of mounting sealing
- wall-mounted installation with possibility of mounting sealing
- standard DIN-rail installation
- panel mounting

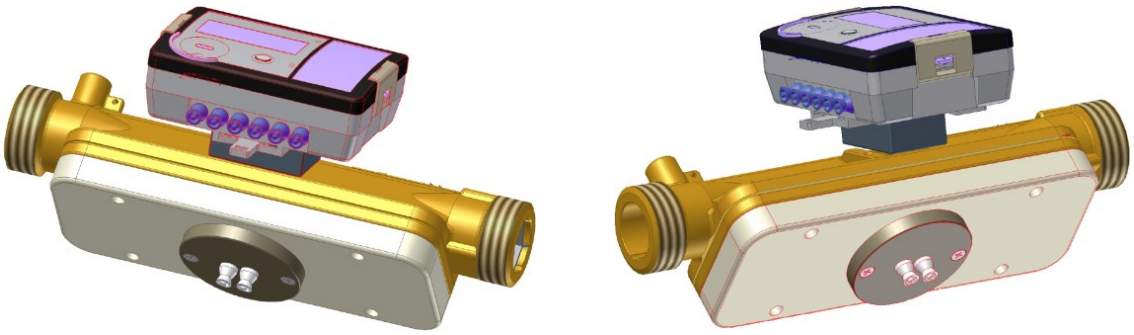


Fig. 5.8. Installation of calculator directly on the flow sensor with threaded connection.

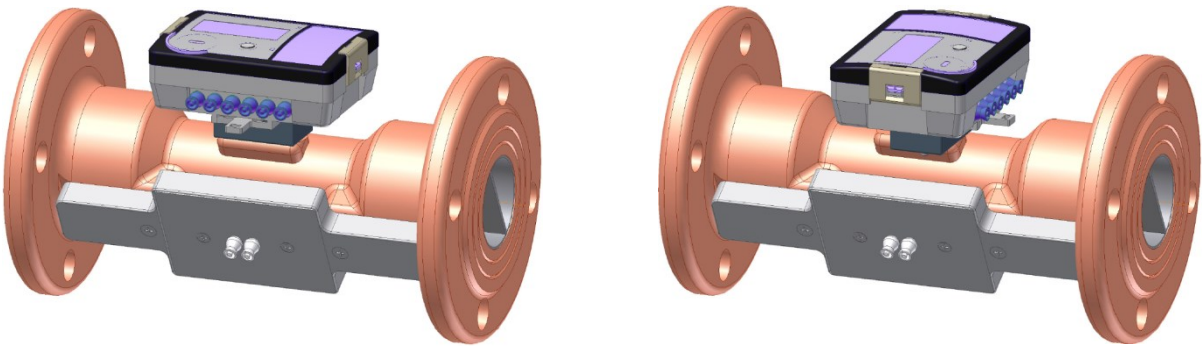


Fig. 5.9. Installation of calculator directly on the flow sensor with flanged connection.

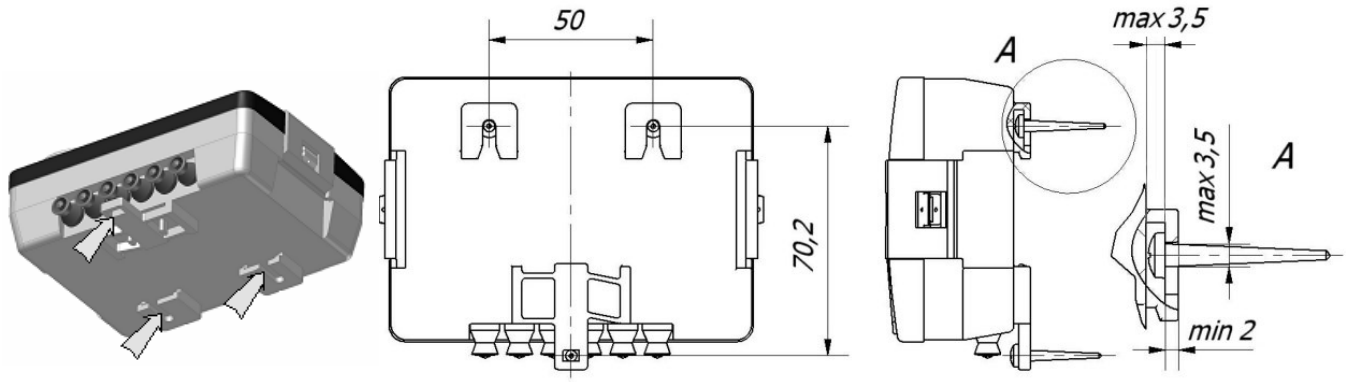



Fig. 5.10. Wall-mounted calculator installation.

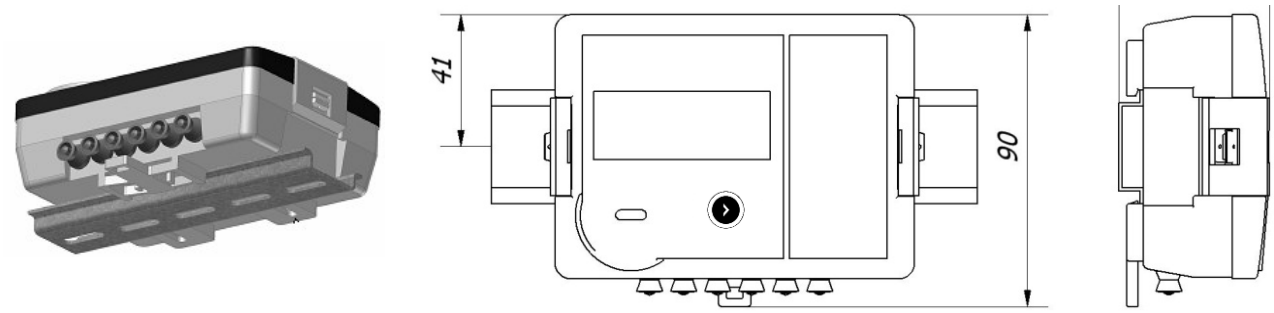



Fig. 5.11. DIN rail-mounted calculator installation.

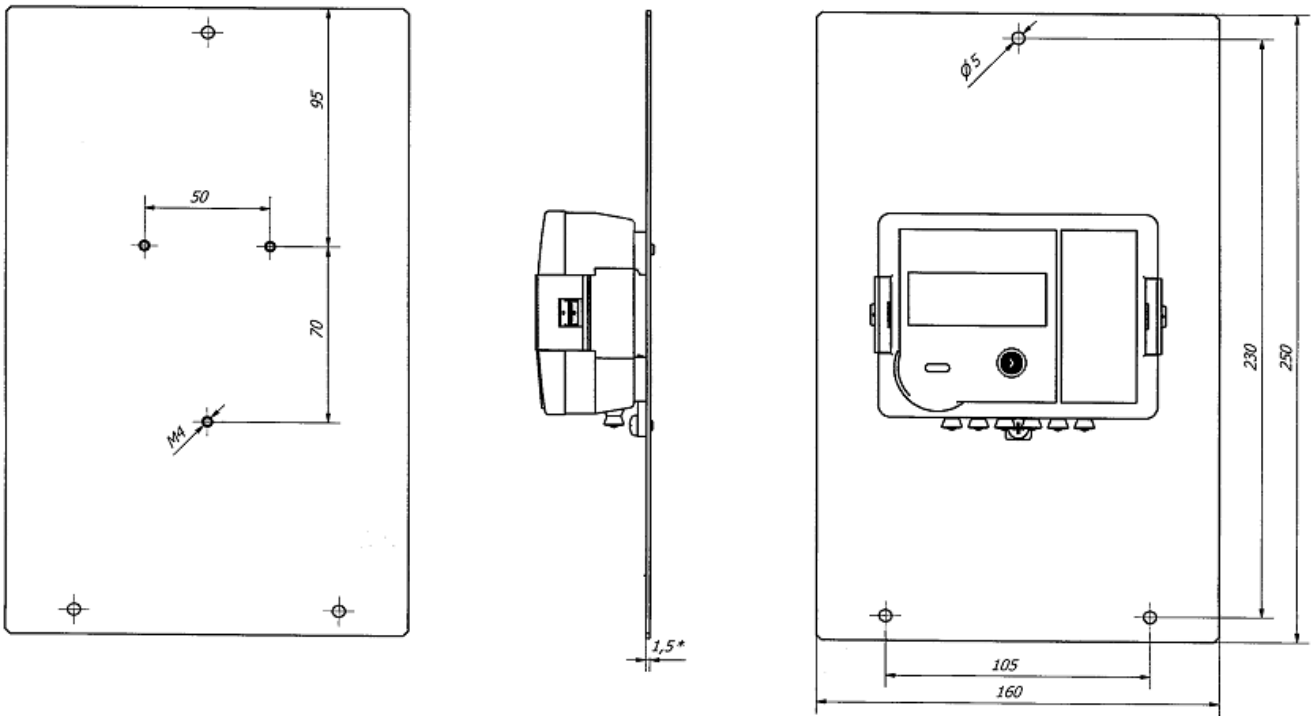



Fig. 5.12. Adapter plate as shown in Fig. 8 of EN 1434-2:2007 for a wall-mounted installation of calculator.

**Important!** Do not mount the calculator directly on a wall if there is a risk of humidity condensation on the wall or the wall surface temperature might fall below 5°C. In such case, it is recommended to install calculator with a minimum gap of 5 cm from the wall.

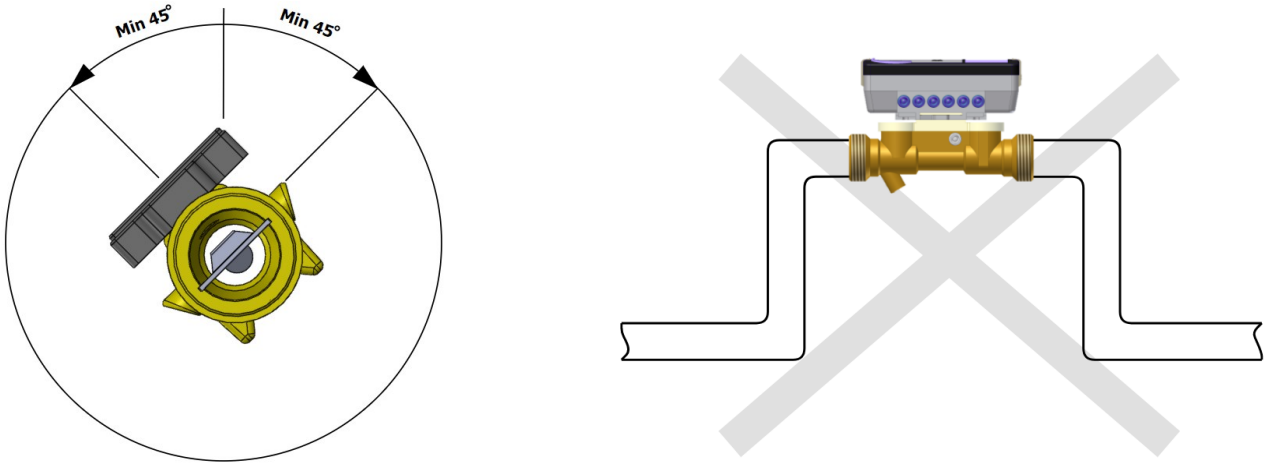
### 5.3.2. Mounting of flow sensor

Flow sensor sizes and mounting dimensions are provided in Appendix B.

For flow sensors of the meter with nominal diameter DN65 to DN100 necessary straight pipeline length in upstream direction are ≥ 5 x DN and

in downstream direction ≥ 3 x DN. For flow sensors DN50 and smaller the straight pipelines installation in upstream and downstream are not necessary.

Avoid installation of the flow sensor near the pumps due to the risk of cavitation. The flow sensor can be mounted horizontal, vertical or inclined position on a supply or return pipeline. However the horizontal or inclined installation is allowed only when the working medium flows from bottom to top. The location and position of the flow sensor from DN25 to DN100 must be selected in way that is reducing the risk of air bubbles accumulation in the zone of ultrasonic flow sensor (see Fig. 5.13).




a) Permissible installation position. b) The prohibited installation position (air bubbles may gather).

Fig. 5.13 Mounting position of DN25-DN100 flow sensors.

Flanged connections require proper sizing of the gaskets matching the piping diameter. During installation gaskets must exactly align with the centre of the pipe cross-section to avoid gasket protrusion into the piping passage that could obstruct the flow.

Before installing the flow sensor, rinse the pipeline well mounting spacer instead of flow sensor for the time of flushing.

Proper performance of the meter requires that the pipeline was pressurized, completely filled with the working medium and the flow direction shown by the arrow on the flow sensor body (see Fig. 5.14.) must match the actual flow in the metering circuit.

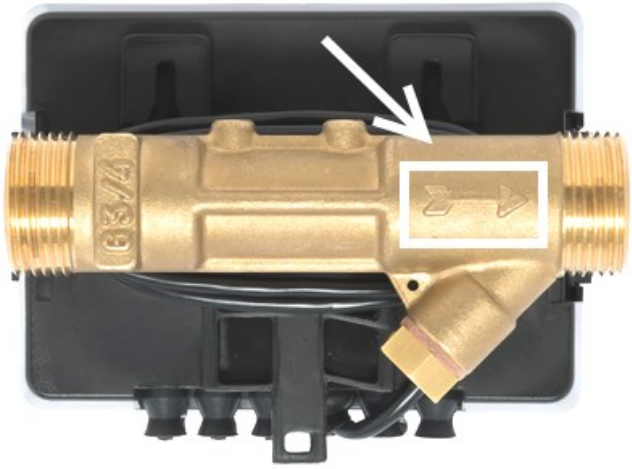


Fig. 5.14. The flow direction marking according to which flow sensor must be mounted.

It is forbidden to wire flow sensor signal cables less than 5 cm away from wires or power cables of other devices.

### 5.3.3. Mounting of temperature sensors

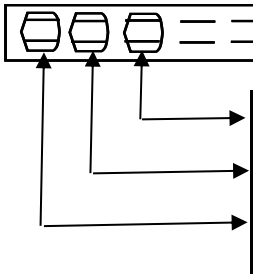
The temperature sensors are mounted by head upwards, in perpendicularly to the pipe axis or inclined by 45° angle to the pipe position, so the temperature sensor tip reaches or crosses beyond the pipe axis (see Fig. 12.6.).

For meters with G¾" and G1" connections it is possible to mount one temperature sensor directly in the flow sensor body.

## 5.4. Setting up the jumper

The jumper pin connector is on the calculator PCB, between the temperature sensor screw terminals and the pulse input/output screw terminals (see Fig. 10.1.). Joining and opening the appropriate connector pins with the jumper lets you switch between the normal operating mode and the test mode of the meter, or transform pulse outputs into pulse inputs (see

Fig. 5.15).



| Jumper removed (pins open) | Jumper installed (pins closed) |
|---|---|
| Normal mode | Test (verification) mode |
| Pulse output 1 (terminals 52 and 53) | Pulse input 1 (terminals 52 and 53)<br>jumper must be removed when operating in test mode |
| Pulse output 2 (terminals 50 and 51) | Pulse input 2 (terminals 50 and 51)<br>jumper must be removed when operating in test mode |

Fig. 5.15. Possible jumper settings.

### 5.5. Verifying the installation and configuration

After installation of the meter, let the measured working medium flow through the flow sensor. The heat meter's LCD should display the measured parameter values on the calculator display, if the heat have been properly installed (calculator, flow sensor and the temperature sensors). If the measured parameter values are not displayed correctly, it is necessary to verify the installation.

### 5.6. Sealing after the installation

The meter must be sealed once it has been installed as explained in p. 4.2 to prevent unauthorized dismantle, removal or altering the device without evident damage on the meter or its seals.

Installer's security seals:

- butterfly, wire or lead seals to bind the top and bottom parts of the calculator enclosure (see Fig. 12.1.);
- seals on the protective pockets and the mounting bolts of the temperature sensors (see Fig. 12.2. to Fig. 12.7.);
- seal also the flow sensor's connection with the pipeline ends (for example couplings).

## 6. Operation

### 6.1. Operating the LCD display

You can cycle through indications displayed on the meter LCD by pressing the control button in the lower part of the calculator front panel.

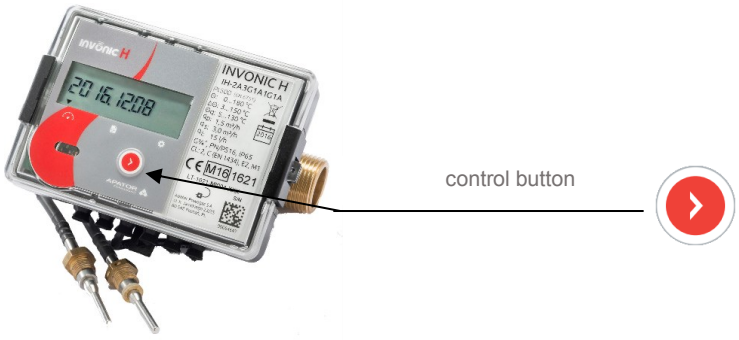



Fig. 6.1. Operating the heat and cooling meter with the control button.

### 6.2. Display functions

The meter's calculator has an 8-digit LCD display with icons of parameters, measurement units and operating modes.

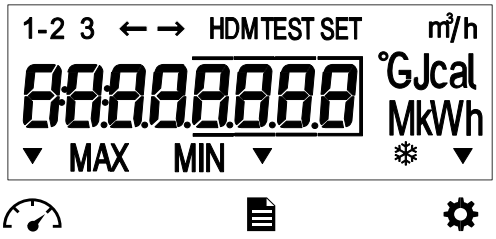



Fig. 6.2. Heat and cooling meter LCD display.

Designation of icons:

| | |
|---|---|
| → | forward (right direction) flow |
| ← | backward flow |
| arrow not displayed | no flow |

Designation of other icons, see p. 6.3.1. to 6.3.3.

The following information can be presented on the LCD display:

- total values and instantaneous measured parameters,
- archived data with data write date stamps,
- device configuration.

If the meter control button is not pressed for over 60 seconds, the LCD display will return to the heat energy consumption indications (1.2), unless there is a problem with meter. In such case LCD indicates error code screen (1.1).

## 6.3. Menu structure

### 6.3.1. Viewing the readings in normal mode (user's menu)

The menu structure in a normal operating mode is presented in Fig. 6.3.

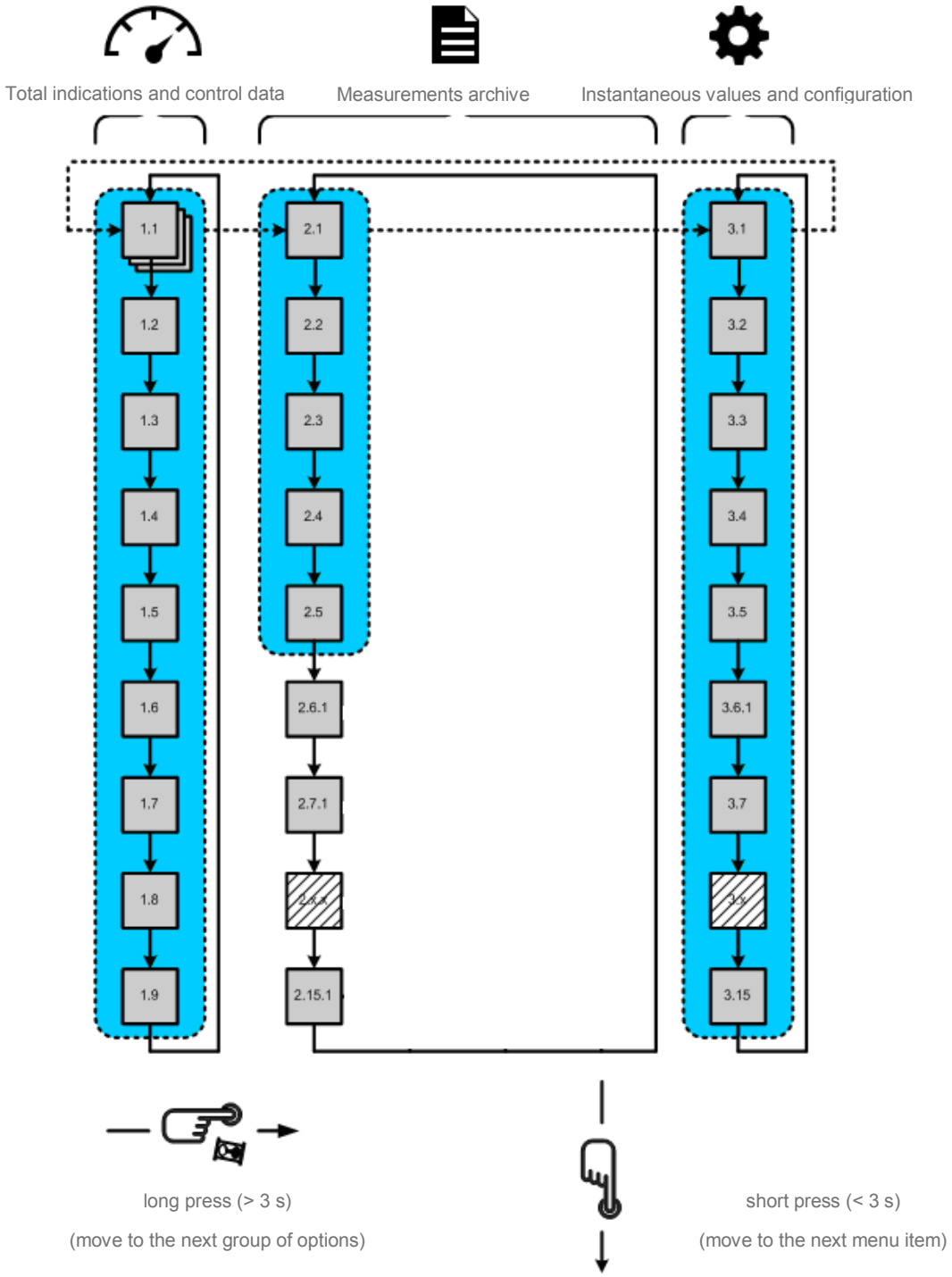
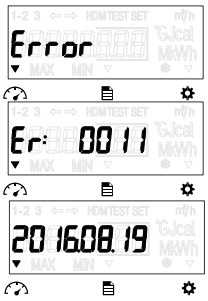
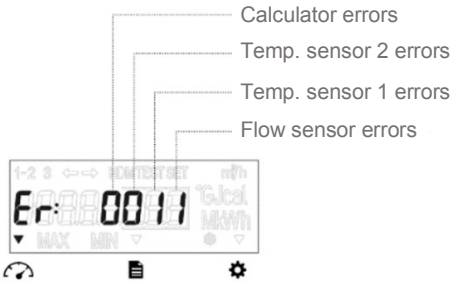
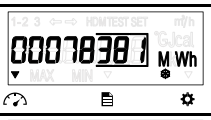
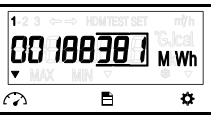
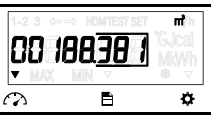
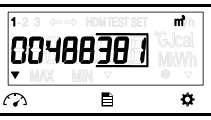
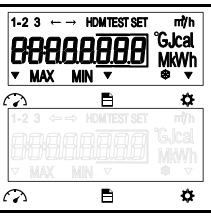
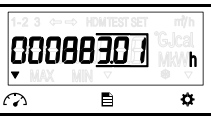
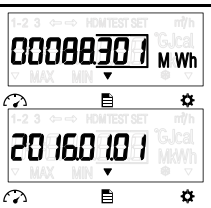
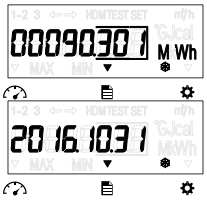
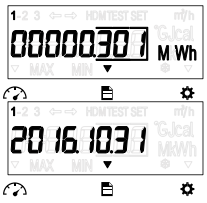
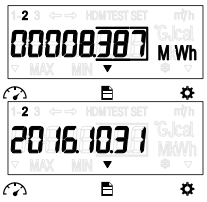
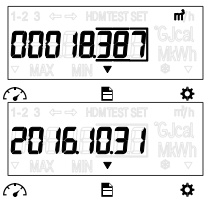
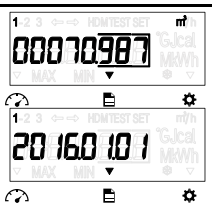
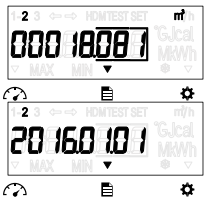
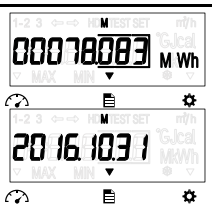
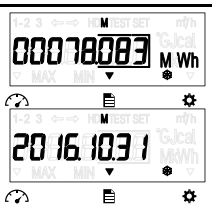
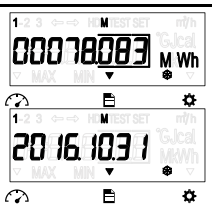


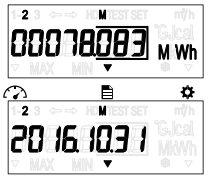
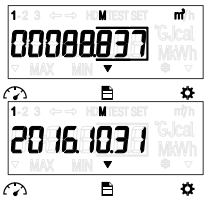
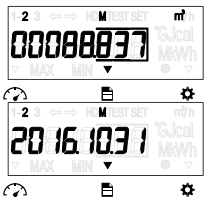
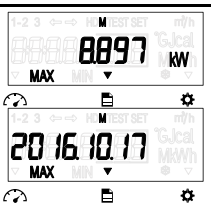
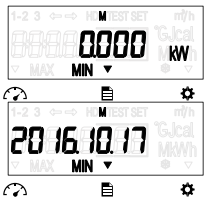
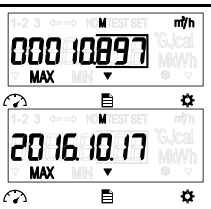
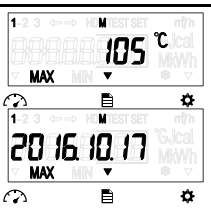
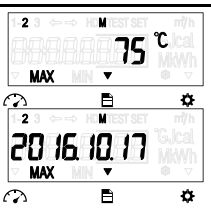

Fig. 6.3. Viewing the readings in the normal mode.

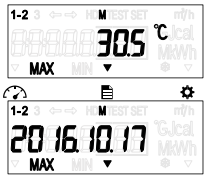
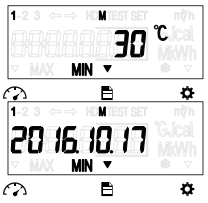
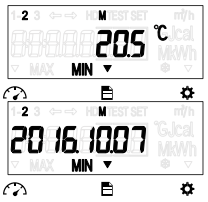
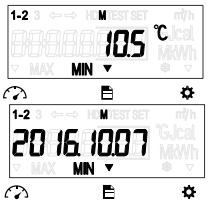
Remark: The following (Table 6.1) shows the full list of the parameters that can be displayed on the meter's LCD. The menu structure of your device might be reduced, depending on the meter configuration and type.

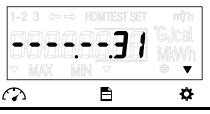
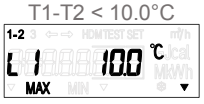
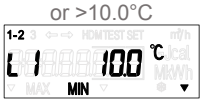
Table 6.1. Parameters available on the heat and cooling meter LCD display

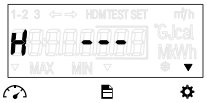
| No. | Parameter | Display indication** | Parameter notes |
|---|---|---|---|
| 1.1 | Error code with date stamp of occurrence (displayed only if there is a fault in operation of the meter) |   | Detailed description of error codes in p. 6.3.3.   |
| 1.2 | Total heat energy consumption |   | |
| 1.3 | Total cooling energy consumption |   | Displayed only in heat and cooling meters. |
| 1.4 | Total heat/cooling energy consumption in tariff 1 |   | Displayed only when the tariffs have been previously activated in the meter by the software. The snowflake symbol ❄ is displayed for the tariff linked to cooling energy. |
| 1.5 | Total heat/cooling energy consumption in tariff 2 |   | Displayed only when the tariffs have been previously activated in the meter by the software. The snowflake symbol ❄ is displayed for the tariff linked to cooling energy. |
| 1.6 | Total volume of working medium |   | |
| 1.7 | Total volume from 1st pulse input |   | Displayed only when pulse input 1 has been previously activated in the meter by the software. |
| 1.8 | Total volume from 2nd pulse input |   | Displayed only when pulse input 2 has been previously activated in the meter by the software. |
| 1.9 | LCD display test |   | |
| 1.10 | Meter operating time in hours without energy calculation error |   | |
| 1.11 | Client number (by default equal to serial number of meter) |   | Corresponds to the last 7 digits of 8 digit secondary M-Bus address or radio number, depending which communication modules is currently mounted in calculator. |
| 1.12 | Control number |   | Value calculated on the base of energy consumption value used for verification if indications of meter are valid. |
| 2.1 | Quantity of thermal energy for heat in previous billing year an date stamp |   | The day and month of writing the annual data can be configured with the service software. The data write time is always 23:59:59. |

| No. | Parameter | Display indication** | Parameter notes |
|---|---|---|---|
| 2.2 | Quantity of thermal energy for cooling in previous billing year an date stamp |  | Displayed only in heat and cooling meters. |
| 2.3 | Energy consumption in tariff 1 in previous billing year and date stamp |  | Displayed only when the tariffs have been previously activated in the meter by the software. |
| 2.4 | Energy consumption in tariff 2 in previous billing year and date stamp |  | Displayed only when the tariffs have been previously activated in the meter by the software. |
| 2.5 | Volume of the working medium in previous billing year and date stamp |  | |
| 2.6 | Volume from 1st pulse input in previous billing year and date stamp |  | Displayed only when pulse input 1 has been previously activated in the meter by the software. |
| 2.7 | Volume from 2nd pulse input in previous billing year and date stamp |  | Displayed only when pulse input 2 has been previously activated in the meter by the software. |
| 2.8 | Quantity of thermal energy for heat in previous month an date stamp |  | The day of writing the monthly data can be configured with the service software. When set to “31”, the data will always be written on the last calendar day of each month, at 23:59:59. |
| 2.9 | Quantity of thermal energy for cooling in previous month an date stamp |  | Displayed only in heat and cooling meters. |
| 2.10 | Energy consumption in tariff 1 in previous billing month and date stamp |  | Displayed only when the tariffs have been previously activated in the meter by the software. |

| No. | Parameter | Display indication** | Parameter notes |
|---|---|---|---|
| 2.11 | Energy consumption in tariff 2 in previous billing month and date stamp |  | Displayed only when the tariffs have been previously activated in the meter by the software. |
| 2.12 | Volume of the working medium in previous billing month and date stamp |  | |
| 2.13 | Volume from 1st pulse input in previous billing month and date stamp |  | Displayed only when pulse input 1 has been previously activated in the meter by the software. |
| 2.14 | Volume from 2nd pulse input in previous billing month and date stamp |  | Displayed only when pulse input 2 has been previously activated in the meter by the software. |
| 2.15 | Maximum power in previous billing month and date stamp |  | |
| 2.16 | Minimum power (or max power for cooling) in previous billing month and date stamp |  | |
| 2.17 | Maximum flow rate in previous billing month and date stamp |  | |
| 2.18 | Maximum temperature of working medium in supply pipe in previous billing month and date stamp |  | |
| 2.19 | Maximum temperature of working medium in return pipe in previous billing month and date stamp |  | |

| No. | Parameter | Display indication** | Parameter notes |
|---|---|---|---|
| 2.20 | Maximum temperature difference between working medium on supply and return pipe in previous billing month and date stamp |  | |
| 2.21 | Minimum temperature of working medium in supply pipe in previous billing month and date stamp |  | |
| 2.22 | Minimum temperature of working medium in return pipe in previous billing month and date stamp |  | |
| 2.23 | Minimum temperature difference between working medium on supply and return pipe in previous billing month and date stamp |  | |
| 2.24 - 2.583 | Data from the past months with the date stamp (up to last 36 months) | By analogy to 2.8 to 2.23 | With the service software it is possible to define if the monthly archived data will be displayed for the past 1, 2 or 36 months*. |
| 3.1 | Current thermal power |  | |
| 3.2 | Current flow rate |  | |
| 3.3 | Actual working medium temperature in supply pipe |  | |
| 3.4 | Actual working medium temperature in return pipe |  | |
| 3.5 | Actual difference between supply and return temperature |  | |
| 3.6 | Next replacement date of the battery |  | |
| 3.7* | Current date |  | |
| 3.8* | Real time clock |  | |
| 3.9* | Day and month of annual data writing |  | |

| No. | Parameter | Display indication** | Parameter notes |
|---|---|---|---|
| 3.10* | Day of monthly data writing |  | When set to "31", the data saving will be done in the last calendar day of the month. |
| 3.11* | Tariff 1 settings | Tariff 1 when:<br>T1-T2 < 10.0°C<br>  <br>or >10.0°C<br>  <br>or from 10.0 to 40.0°C<br>(changes every 1 s)<br>  <br>  <br>or a time interval in hours<br>(00-24h)<br>  <br>or the tariff is activated<br>directly by pulse input:<br>  | It is possible to choose: one of the measured parameters, 1st or 2nd pulse input (if pulse inputs are enabled), one of the temperature (supply or return) or temperature difference. |
| 3.12* | Tariff 2 settings | As in menu 3.11; only "L1" change to "L2" | See parameter 3.11 notes. |
| 3.13* | 1st pulse input/output configuration | Input:<br>  <br>input (tariff activation):<br>  <br>Output:<br>energy or volume of<br>working medium<br>  <br>Tariff<br>  <br>  <br>Tariff status:<br>  | Input: configurable for water volume indication only. Minimum pulse indication resolution: 0.00001 $m^3$.<br><br>Output: configurable for working medium volume ($m^3$), heat energy (as shown on the example), cooling energy (displayed with the snowflake symbol ❄), or to one of the tariffs. |
| 3.14* | 2nd pulse input/output configuration | As in menu 3.13; only "1" change to "2" in the top left corner of LCD | See parameter 3.13 notes. |

| No. | Parameter | Display indication** | Parameter notes |
|---|---|---|---|
| 3.15 | Working medium type |  | Working medium type:<br>--- (dashes) = water,<br>AF L16 = 16% propylene glycol,<br>AF L25 = 25% propylene glycol,<br>AF L38 = 38% propylene glycol,<br>AF L47 = 47% propylene glycol,<br>AF N20 = 20% ethylene glycol,<br>AF N34 = 34% ethylene glycol,<br>AF N44 = 44% ethylene glycol,<br>AF N52 = 52% ethylene glycol. |
| 3.16 | Pressure value for energy calculation |  | "160E4" corresponds to pressure 1.6 MPa (16 bar)<br>"250E4" corresponds to pressure 2.5 MPa (25 bar) |
| 3.17* | Customer number (by default equal to serial number of meter) |  | Corresponds to the last 7 digits of 8 digit secondary M-Bus address or radio number, depending which communication modules is currently mounted in calculator. |
| 3.18 | Software version number |  | |
| 3.19 | Serial number of meter |  | |
| 3.20* | Primary M-Bus address |  | |
| 3.21 | Meter operating time in hours without energy calculation error |  | |
| 3.22 | Battery operation time in hours |  | |

**Note:** The values of parameter marked with "*" can be modified during installation of the meter. Modification of them is possible via optical interface in conjunction with the dedicated service software when test mode is activated in the meter (see the applicable jumper setting in p. 6.4). You can also disable in the very same manner indication on LCD of irrelevant parameters to the user.

** If "Display indication" column shows more than one screen for selected parameter, that means that screens will be presented every second.

### 6.3.2. Test mode reading display (service menu)

The test mode menu structure is presented in Fig. 6.4.

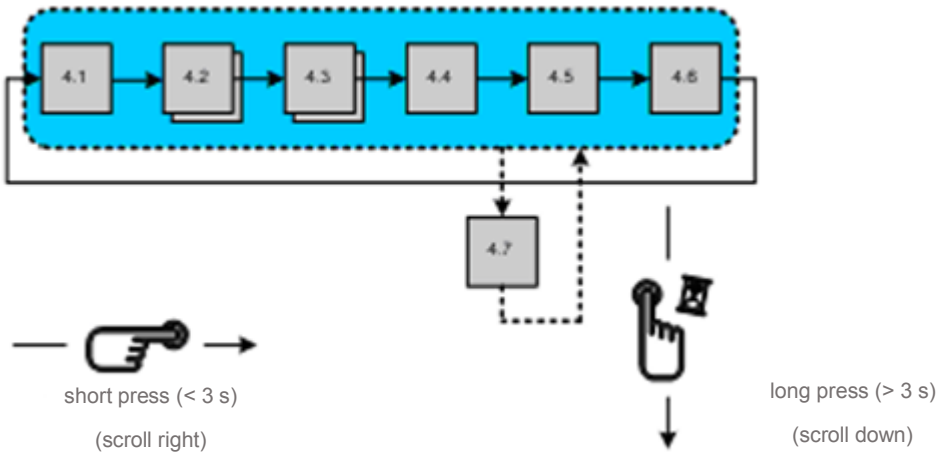
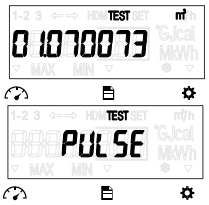



Fig. 6.4. Test mode menu structure (service menu).

Table 6.2. Test mode reading display (service menu)

| No. | Parameter | Display indication** | Parameter notes |
|---|---|---|---|
| 4.1 | Energy consumption |  | The indication resolution is higher in the test mode and updated every second. |
| 4.2 | Working medium volume |  | The indication resolution is higher in the test mode and updated every second. |
| 4.3 | Actual working medium supply temperature |  | |
| 4.4 | Actual working medium return temperature |  | |
| 4.5 | Actual working medium supply/return temperature difference |  | |
| 4.6 | Instantaneous flow rate |  | The indication resolution is higher in the test mode. |
| 4.7 | Starting simulation of nominal flow |  | During test value of nominal flow is constantly displayed. After the test, the energy and volume of the working medium are stored in the memory until the next simulation is started. |

### 6.3.3. Error codes

An error code can have up to 4 characters. Each character is a hexadecimal value from 0 to F.

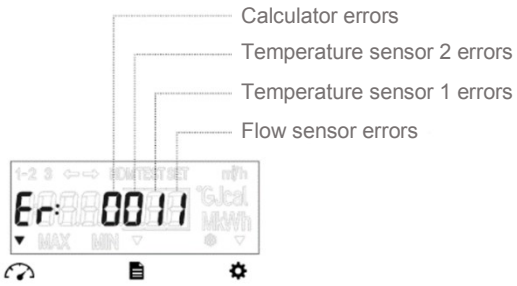



Fig. 6.5. Displaying errors for specific meter components.

Table 6.3. Description of heat/cooling meter errors

| Error character position on the LCD | Error descriptions |
|---|---|
| Calculator status  | 0 – no errors (normal operation)<br>1 – ending battery life (warning)<br>2 – temperature difference is above permitted limit<br>4 – temperature difference is below permitted limit<br>8 – electronics failure |

| Error character position on the LCD | Error descriptions |
|---|---|
| Temperature sensor 2 (return) status  | 0 – no errors (normal operation)<br>8 – sensor failure (open circuit)<br>C (8+4) – sensor failure (short circuit) |
| Temperature sensor 1 (supply) status  | 0 – no errors (normal operation)<br>8 – sensor failure (open circuit)<br>C (8+4) – sensor failure (short circuit) |
| Flow sensor status  | 0 – no errors (normal operation)<br>1 – no signal (flow sensor is empty or air bubbles are present)<br>2 – flow flows in an reverse direction<br>4 – flow rate above 1.2 × $q_s$ (indication: q = 1.2 × $q_s$)<br>8 – electronics failure |

If more than one error has been detected in meter, the error codes are summed according hexadecimal system and displayed:

3 = correspond to sum of errors: 2 + 1

5 = correspond to sum of errors: 4 + 1

7 = correspond to sum of errors: 4 + 2 + 1

9 = correspond to sum of errors: 8 + 1

A = correspond to sum of errors: 8 + 2

B = correspond to sum of errors: 8 + 2 + 1

C = correspond to sum of errors: 8 + 4

D = correspond to sum of errors: 8 + 4 + 1

E = correspond to sum of errors: 8 + 4 + 2

F = correspond to sum of errors: 8 + 4 + 2 + 1

In a case when value of at least one digit of error code is ≥ 8, the thermal energy calculation and summation of the working medium volume and operation time without errors are stopping. In a case when value of the flow sensor error is equal 4, duration of time when the flow rate exceeds 1.2 × $q_s$ is registered additionally.

### 6.4. Test mode

#### 6.4.1. Destination of connector configuration pins

The 2-line 10-pole configuration connector is on the calculator PCB, located between the temperature sensor screw terminals and the pulse input/output screw terminals (see Fig. 10.1.). The configuration pins destination is presented in Fig. 6.6.

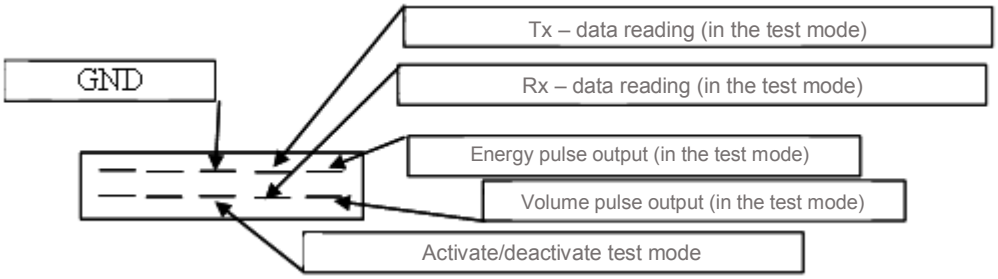



Fig. 6.6. Configuration pin connector designations.

#### 6.4.2. Activating test mode (verification)

In the test mode it is possible to achieve precise results within short measuring time. For activation of the test mode open the meter, remove all jumpers from the configuration pin connector and set up one jumper as shown in Fig. 6.7.

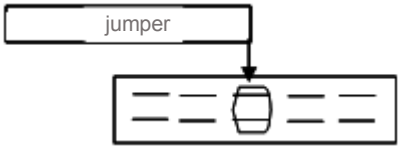



Fig. 6.7. Activating the test mode.

When the jumper is set the meter enters the test mode, which is indicated by the word "TEST" on the LCD display. The meter stops calculation process and all integral parameter values are saved in the memory. When the test mode is deactivated and the normal operating mode is restored the meter displays the original values saved in the memory of device before the test mode activation.

The meter readings in the test mode are shown in p. 6.3.2.

Table 6.1. LCD resolution in the test mode

| Energy measurement units | kWh / MWh | GJ | Gcal |
|---|---|---|---|
| Display resolution of energy | 000000.01 Wh | 0000000.1 kJ | 0000000.1 kcal |
| Display resolution of volume | 00.000001 $m^3$ | | |

Table 6.2. Energy and volume pulse values in the test mode

| Nominal flow $q_p$ | Volume (pulse value) | Energy (pulse value) | | |
|---|---|---|---|---|
| | | kWh / MWh | GJ | Gcal |
| 0.6 $m^3/h$ | 0.002 l/pulse | 0.1 Wh/pulse | 0.5 kJ/pulse | 0.1 kcal/pulse |
| 1.0 $m^3/h$ | 0.002 l/pulse | 0.2 Wh/pulse | 1.0 kJ/pulse | 0.2 kcal/pulse |
| 1.5 $m^3/h$ | 0.004 l/pulse | 0.2 Wh/pulse | 1.0 kJ/pulse | 0.2 kcal/pulse |
| 2.5 $m^3/h$ | 0.005 l/pulse | 0.5 Wh/pulse | 2.0 kJ/pulse | 0.5 kcal/pulse |
| 3.5 $m^3/h$ | 0.020 l/pulse | 1.0 Wh/pulse | 5.0 kJ/pulse | 1.0 kcal/pulse |
| 6.0 $m^3/h$ | 0.020 l/pulse | 1.0 Wh/pulse | 5.0 kJ/pulse | 1.0 kcal/pulse |
| 10.0 $m^3/h$ | 0.050 l/pulse | 2.0 Wh/pulse | 10.0 kJ/pulse | 2.0 kcal/pulse |
| 15.0 $m^3/h$ | 0.050 l/pulse | 5.0 Wh/pulse | 20.0 kJ/pulse | 5.0 kcal/pulse |
| 25.0 $m^3/h$ | 0.050 l/pulse | 5.0 Wh/pulse | 20.0 kJ/pulse | 5.0 kcal/pulse |
| 40.0 $m^3/h$ | 0.200 l/pulse | 10.0 Wh/pulse | 50.0 kJ/pulse | 10.0 kcal/pulse |
| 60.0 $m^3/h$ | 0.200 l/pulse | 10.0 Wh/pulse | 50.0 kJ/pulse | 10.0 kcal/pulse |

### 6.4.3. Deactivating test mode

Removing the jumper from the configuration pin connector disables the test mode and restores the normal mode. Once the test mode has been disabled, the meter displays previously recorded integral parameter values.

### 6.5. Remote data reading

The data can be read from meter directly with an optical interface. The optical head is placed on the optical port located on the front panel of calculator and cable of interface is connected to a PC.

For remote reading of data from meter two integrated pulse outputs can be used or one of the following optional communication modules: M-Bus module, radio wM-Bus 868 MHz module, Modbus RTU module (RS-485), BACnet MS/TP module (RS-485), current loop (CL) module.

**Pulse outputs**

The pulse outputs are activated when the corresponding configuration pins are open (see.

Fig. 5.15).

All communication interfaces do not affect the measured parameters and calculations, therefore can be installed and replaced with other type of module without removing meter's verification seals.

The data can be collected from meter via PC, telephone modem, GSM modem, the Internet and so on.

## 7. Metrological verification

The metrological control of the meter is performed according to requirements defined in EN 1434-5.

## 8. Storage and transport requirements

Check the relevant technical documentation for the requirements of safe transport and storage of temperature sensors.

Packed devices may be transported by any type of covered vehicle. Devices should be anchored reliably to avoid shocks and shifting inside the vehicle during transport.

Devices should be protected against mechanical damage and shock.

Keep the devices in dry, heated premises, where an ambient temperature is not lower than +5°C. Do not store the meters with aggressive chemicals due to a risk of corrosion.

## 9. Warranty

The manufacturer guarantees that the meter parameters will meet the technical requirements listed in the paragraph 2 of this document, if transport, storage and operating conditions will be followed.

Manufacturer's address:
Apator Powogaz S.A., ul. Klemensa Janickiego 23/25, 60-542 Poznań, Poland
tel. +48 (61) 84 18 101; fax +48 (61) 84 70 192

## 10. Appendix A

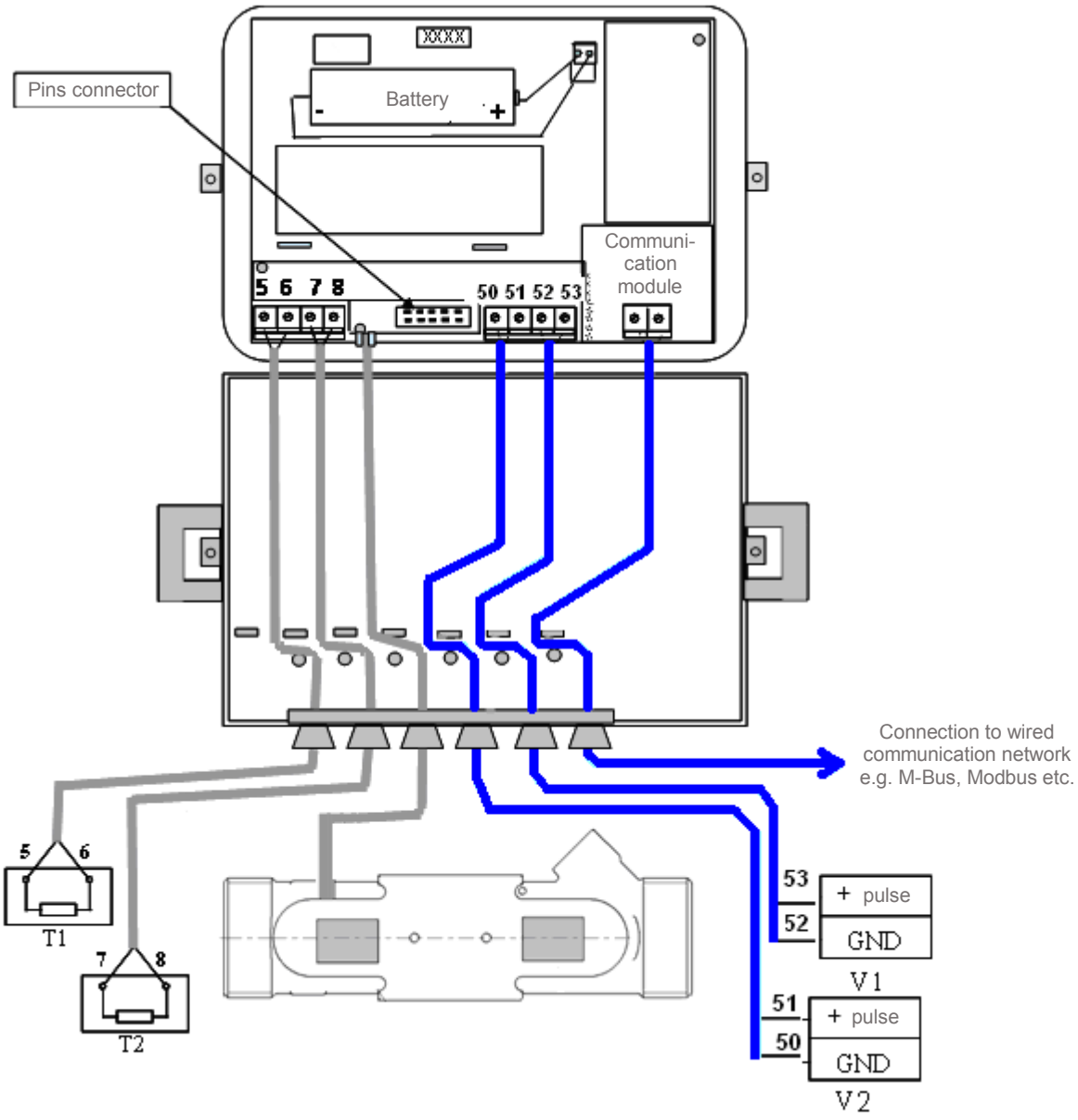



Fig. 10.1. Electrical wiring diagram.

T1 – supply temperature sensor, T2 – return temperature sensor,

V1 – pulse input/output 1, V2 – pulse input/output 2

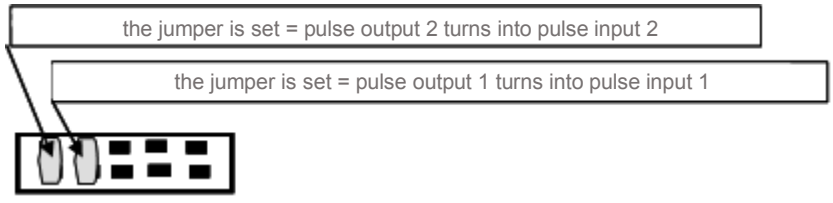



Fig. 10.2. Activating the pulse input/output by mean of configuration pins connector.

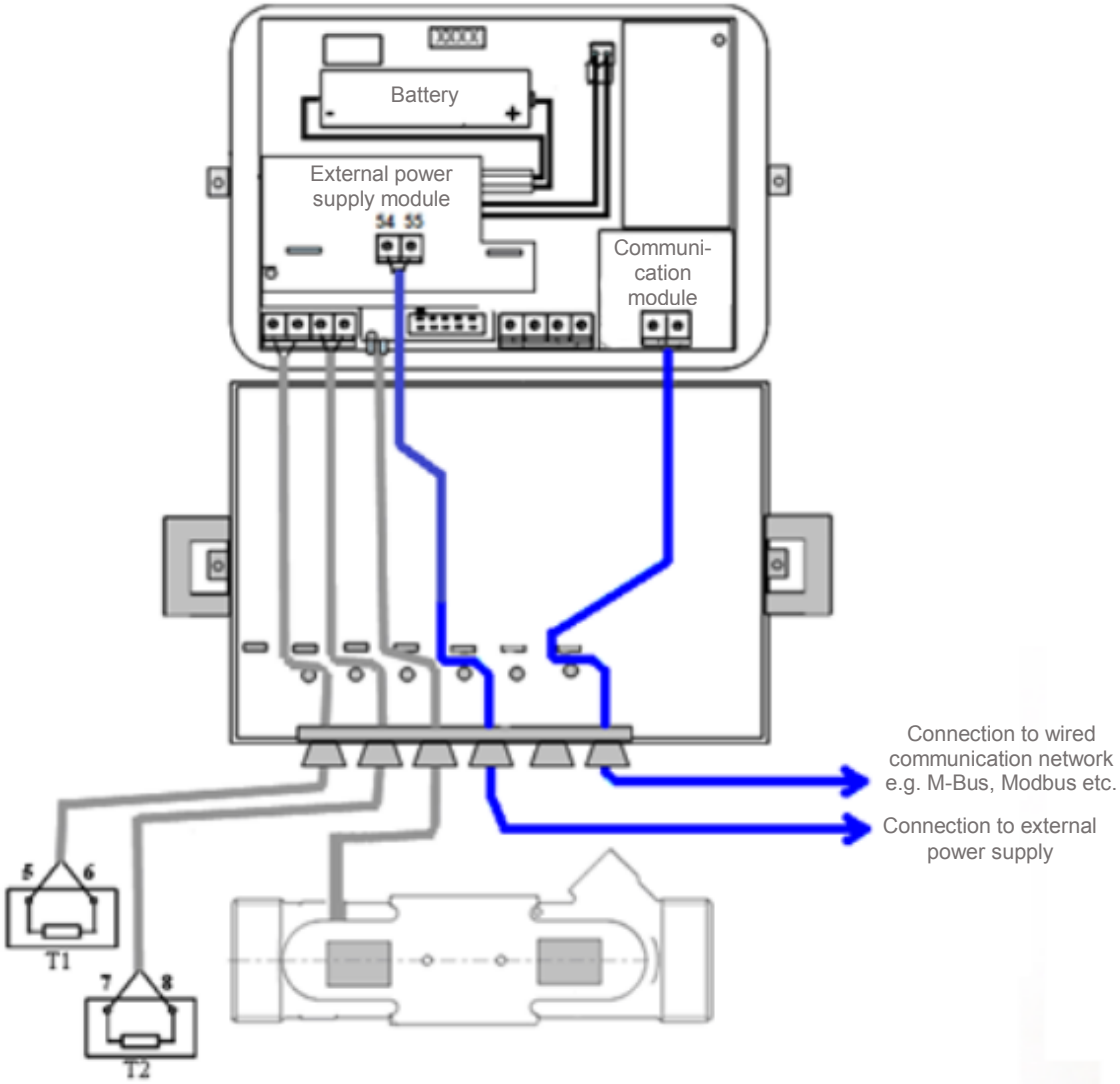



Fig. 10.3. Electrical wiring diagram for connecting the meter to an external power supply source.

Table 10.1. Numbering of the calculator screw terminals

| Terminal no. | Destination |
|---|---|
| 5, 6 | Supply temperature sensor T1 (bipolar) |
| 7, 8 | Return temperature sensor T2 (bipolar) |
| 50 | Pulse input/output 2 (GND) |
| 51 | Pulse input/output 2 (IN/OUT 2)<br>(volume value output in the test mode) |
| 52 | Pulse input/output 1 (GND) |
| 53 | Pulse input/output 1 (IN/OUT 1)<br>(energy value output in the test mode) |

Table 10.2. Numbering of the screw terminals for the optional communication modules

| Terminal no. | Destination |
|---|---|
| 20 | current loop module (+) |
| 21 | current loop module (-) |
| 24, 25 | M-Bus module (bipolar) |
| 60, 61 | 12-24 V DC power for the Modbus module (bipolar) |
| 90 | Modbus module (+) |
| 91 | Modbus module (-) |

Table 10.3. Numbering of the screw terminals for the optional external power supply module

| Terminal no. | Destination |
|---|---|
| 54, 55 | external power supply connector (bipolar) |

# 11. Appendix B

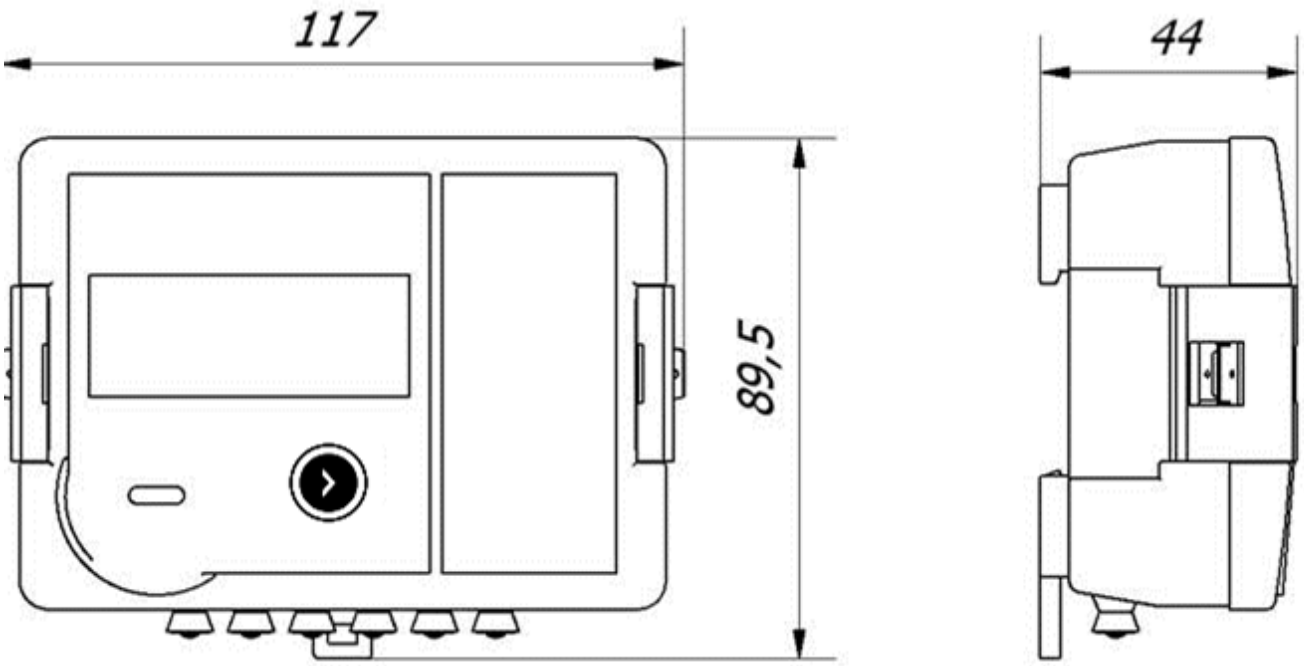



Fig. 11.1. INVONIC H meter's calculator dimensions.

**INVONIC H meter dimensions**

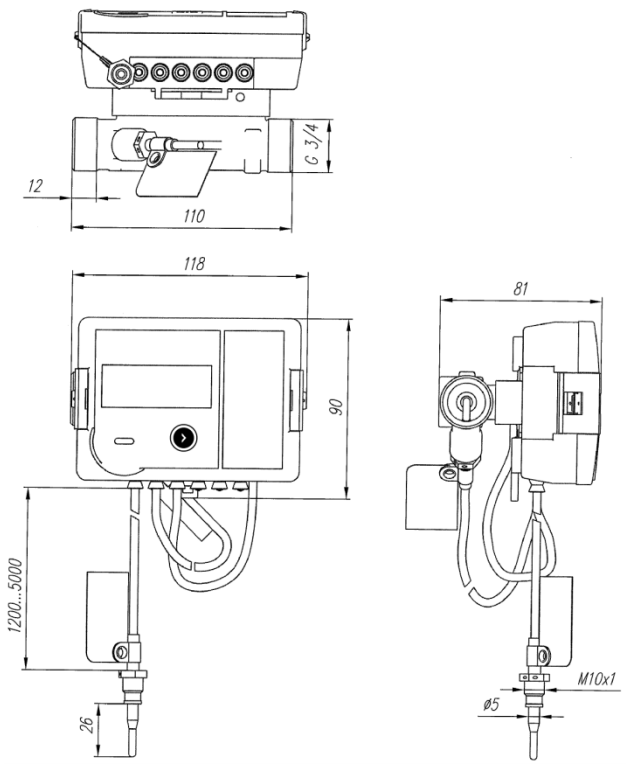



Fig. 11.2. Flow sensor $q_p$ = 0.6; 1.0; 1.5 m³/h

G¾" threaded connection

installation length L = 110 mm

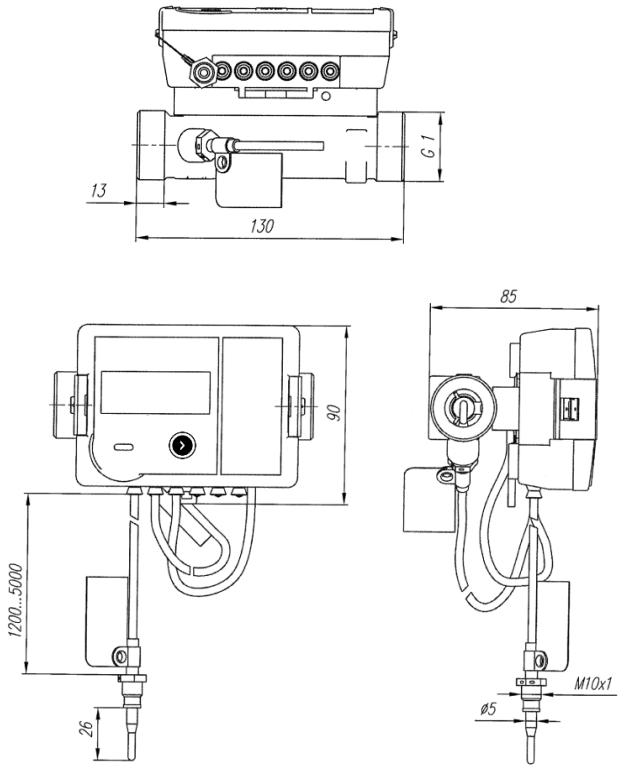



Fig. 11.3. Flow sensor $q_p$ = 1.5; 2.5 m³/h

G1" threaded connection

installation length L = 130 mm

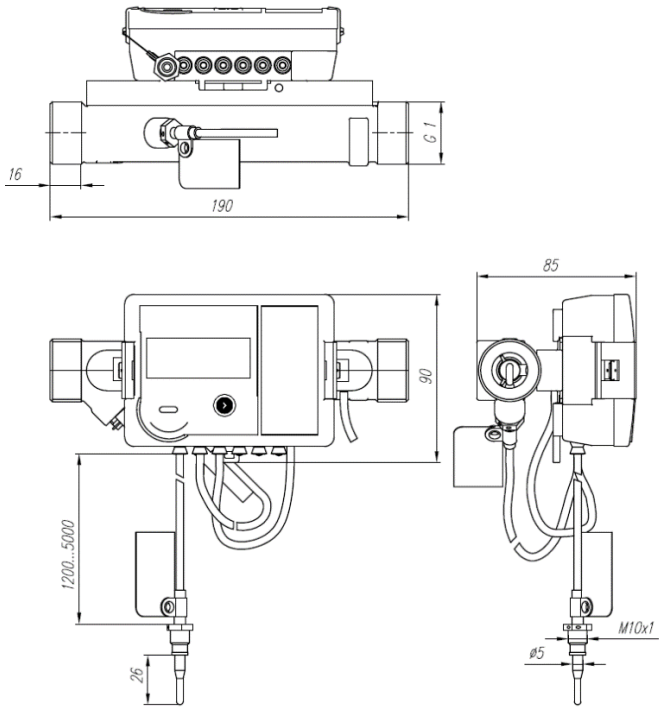



Fig. 11.4. Flow sensor $q_p$ = 0.6; 1.0; 1.5; 2.5 m³/h

G1“ threaded connection

installation length L = 190 mm

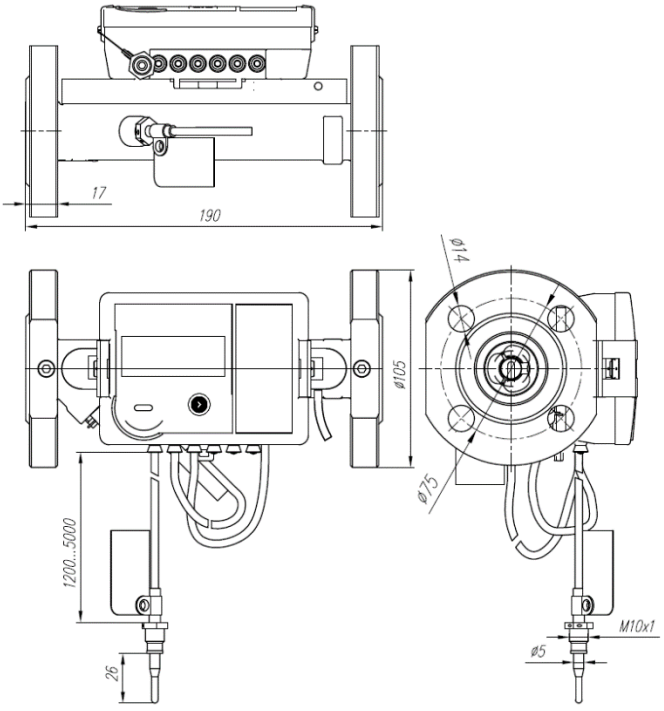



Fig. 11.5. Flow sensor $q_p$ = 0.6; 1.0; 1.5; 2.5 m³/h

DN20 flanged connection

installation length L = 190 mm

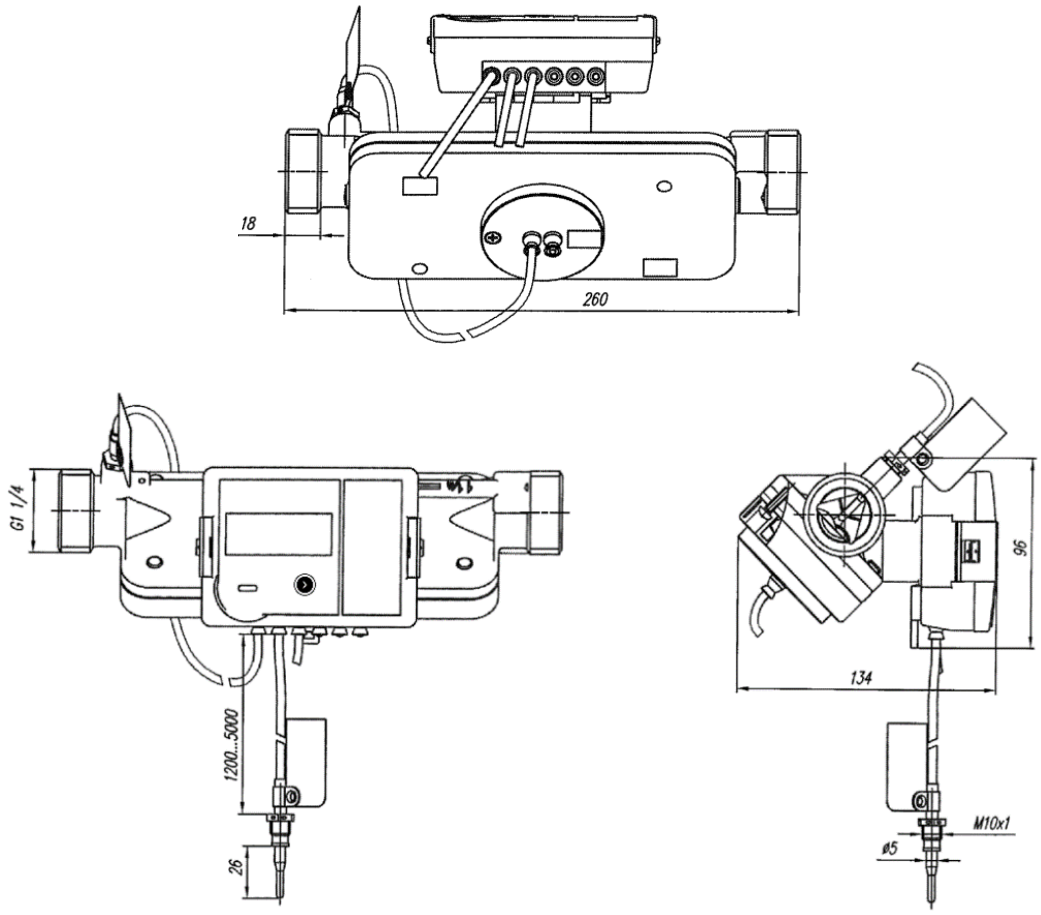



Fig. 11.6. Flow sensor $q_p$ = 3.5; 6.0 m³/h

G1¼“ threaded connection

installation length L = 260 mm

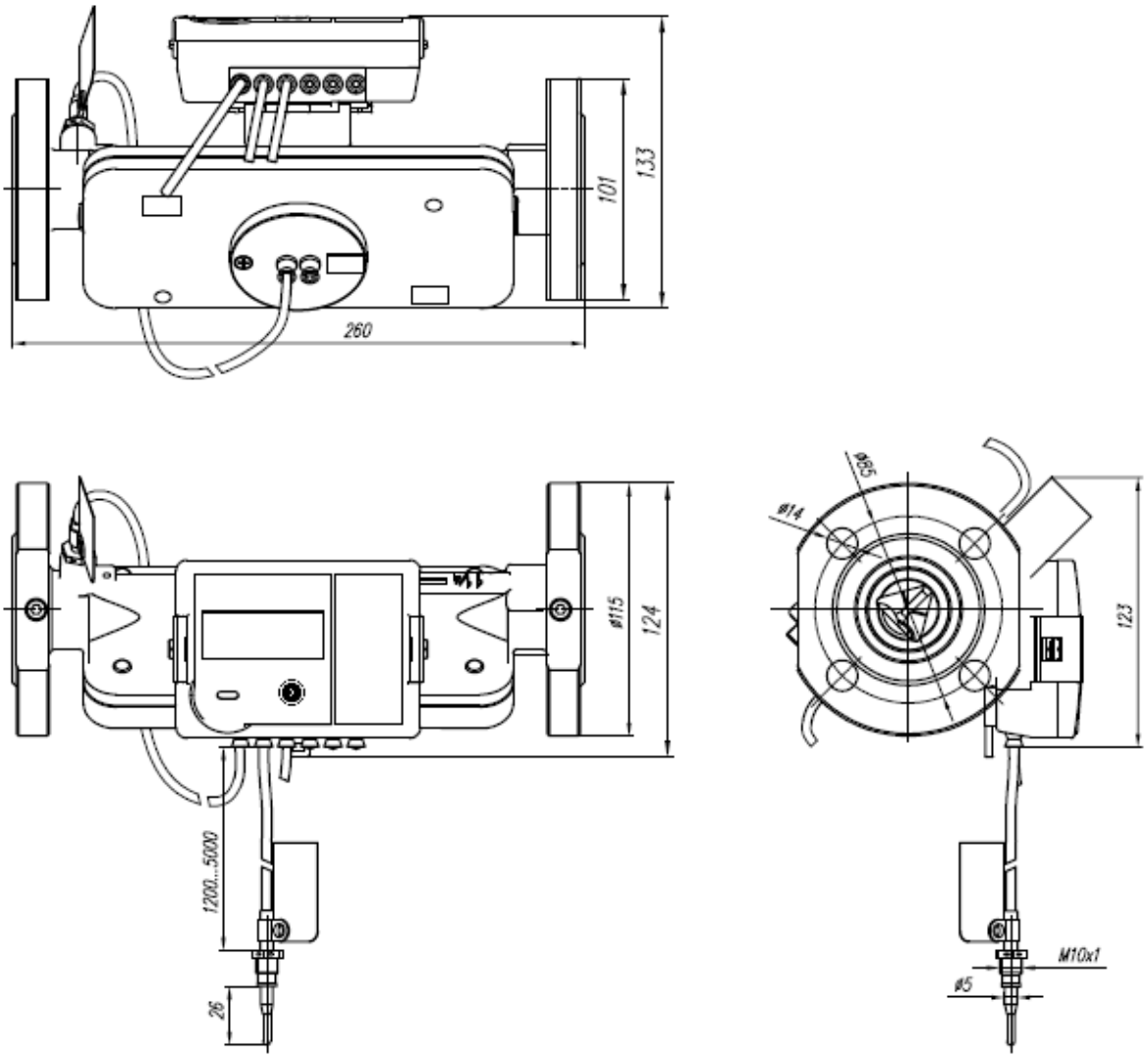



Fig. 11.7. Flow sensor $q_p$ = 3.5; 6.0 $m^3/h$

DN25 flanged connection

installation length L = 260 mm

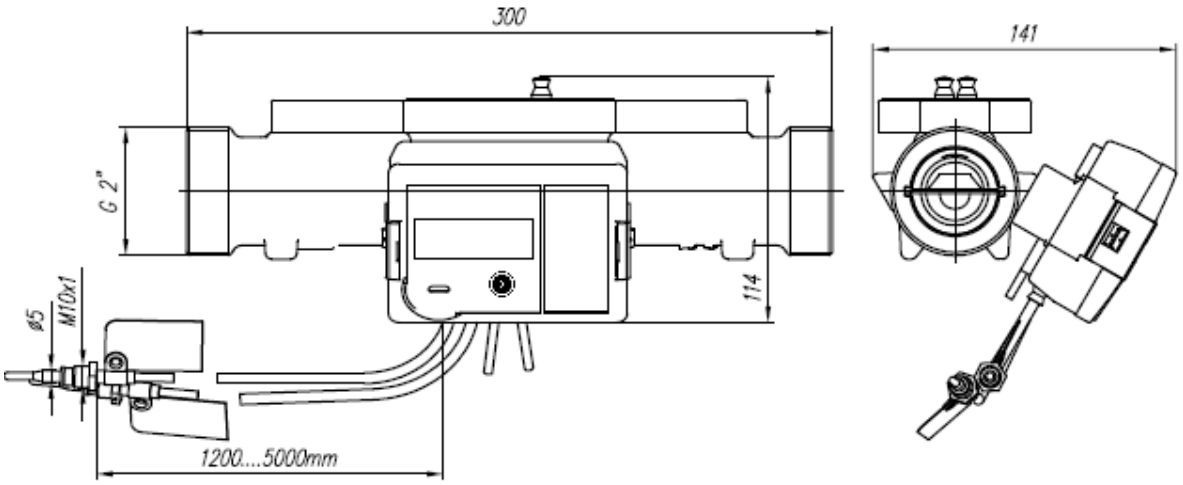



Fig. 11.8. Flow sensor $q_p$ = 10.0 $m^3/h$

G2“ threaded connection

installation length L = 300 mm

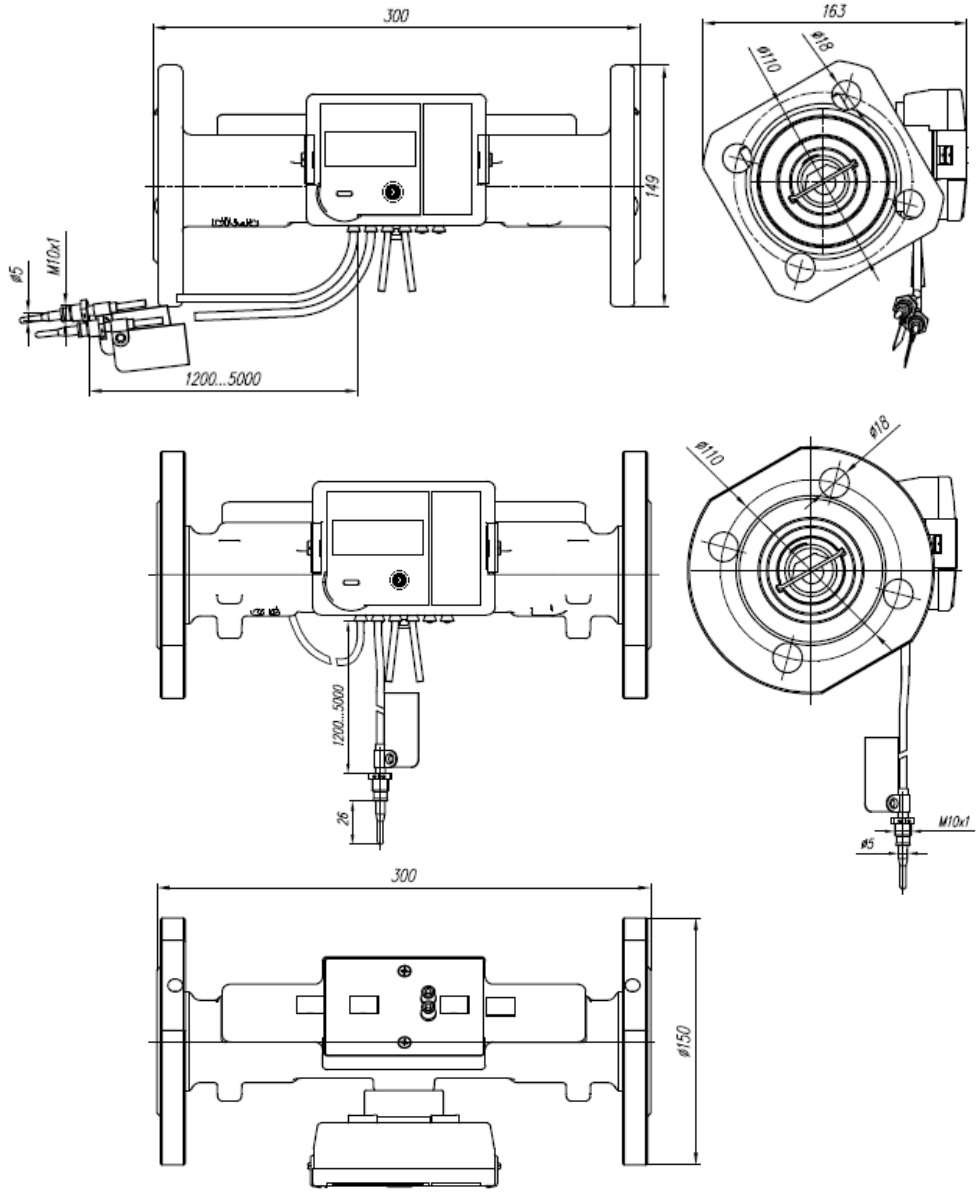



Fig. 11.9. Flow sensor $q_p$ = 10.0 $m^3/h$

DN40 flanged connection (two flange types)

installation length L = 300 mm

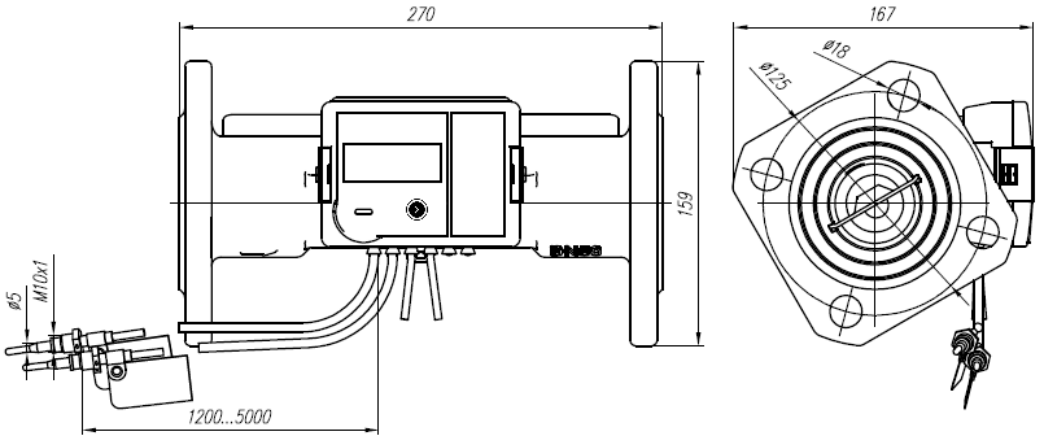



Fig. 11.10. Flow sensor $q_p$ = 15.0 $m^3/h$

DN50 flanged connection

installation length L = 270 mm

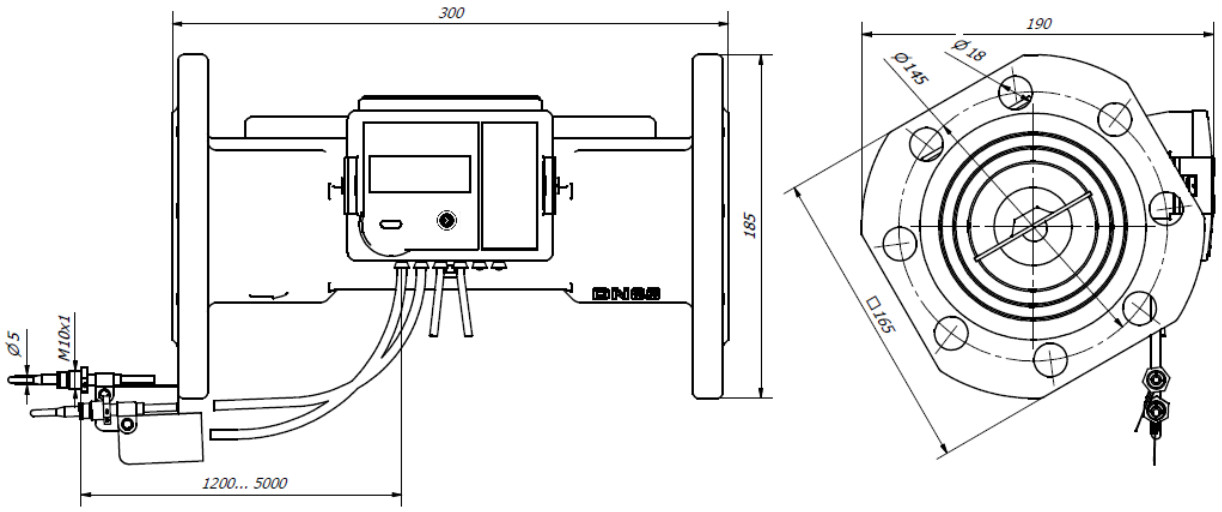



Fig. 11.11 Flow sensor $q_p$ = 25.0 $m^3/h$

DN65 flanged connection

installation length L = 300 mm

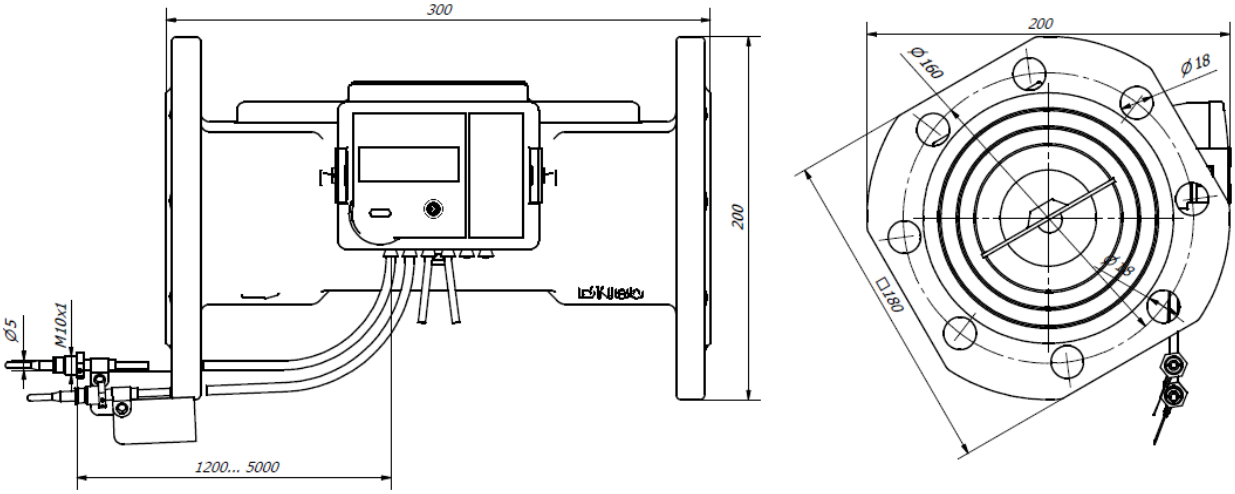



Fig. 11.12. Flow sensor $q_p$ = 40.0 $m^3/h$

DN80 flanged connection

installation length L = 300 mm

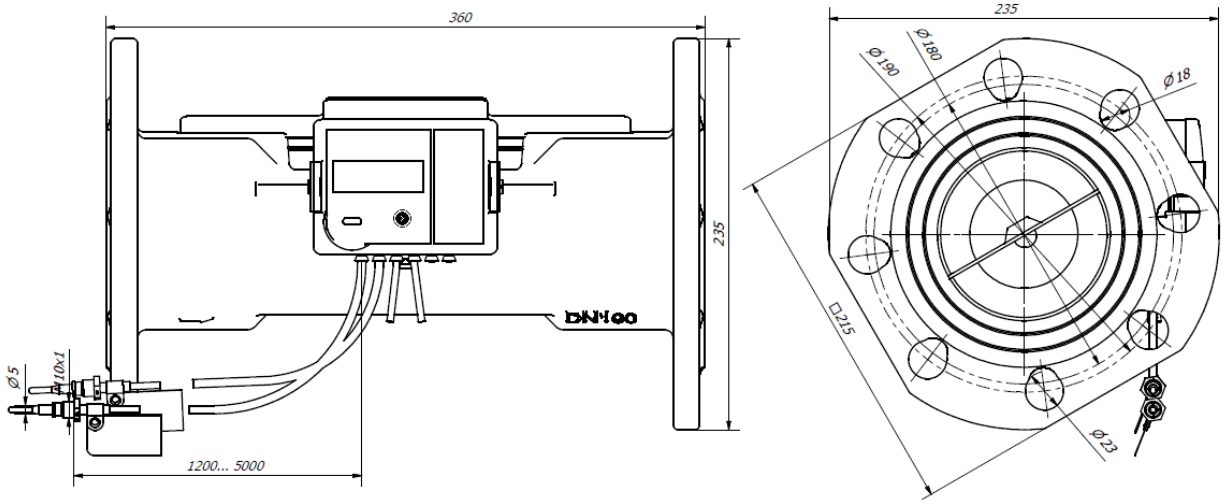



Fig. 11.13. Flow sensor $q_p$ = 60.0 $m^3/h$

DN100 flanged connection

installation length L = 360 mm

## 12. Appendix C

Locations of security seals

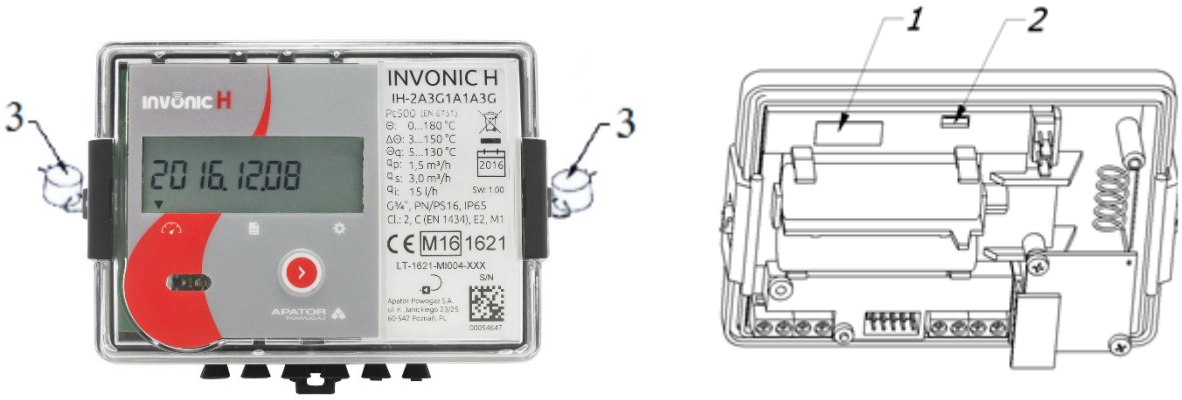



Fig. 12.1. Sealing the calculator (calculator view: with the lid closed and open).

1 – manufacturer's approval seal: a sticker on the adjustment activation jumper

2 – manufacturer's warranty seal: a sticker on the fastener of cover protecting electronic module

3 – installer's security seals: butterfly, cable or lead seals to bind the lid and bottom part of the calculator enclosure

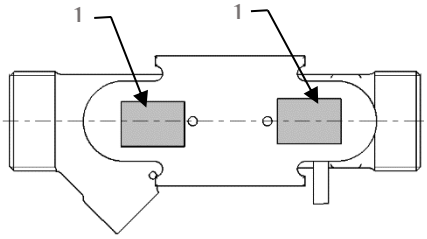



Fig. 12.2. Sealing the flow sensor $q_p$ = 0.6; 1; 1.5; 2.5 m³/h
threaded / flanged connection
installation length L = 110 mm; 130 mm; 190 mm

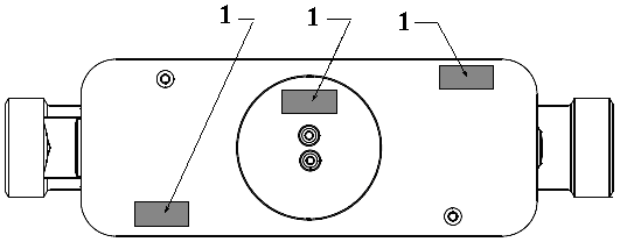



Fig. 12.3. Sealing the flow sensor $q_p$ = 3.5; 6 m³/h
threaded / flanged connection
installation length L = 260 mm

1 – manufacturer's approval seal: stickers on the flow sensor protective cover screws

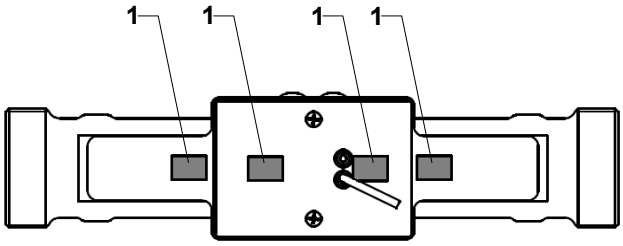



Fig. 12.4. Sealing the flow sensor $q_p$ = 10 m³/h
threaded / flanged connection
installation length L = 300 mm

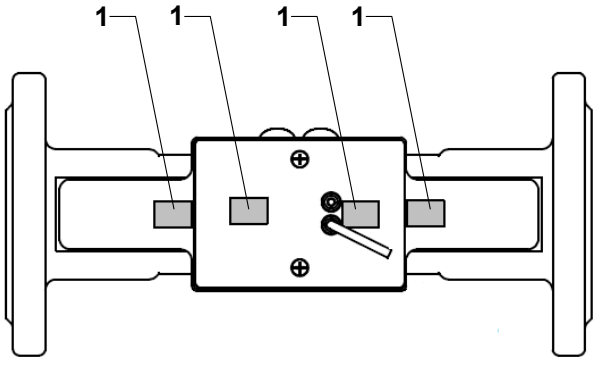
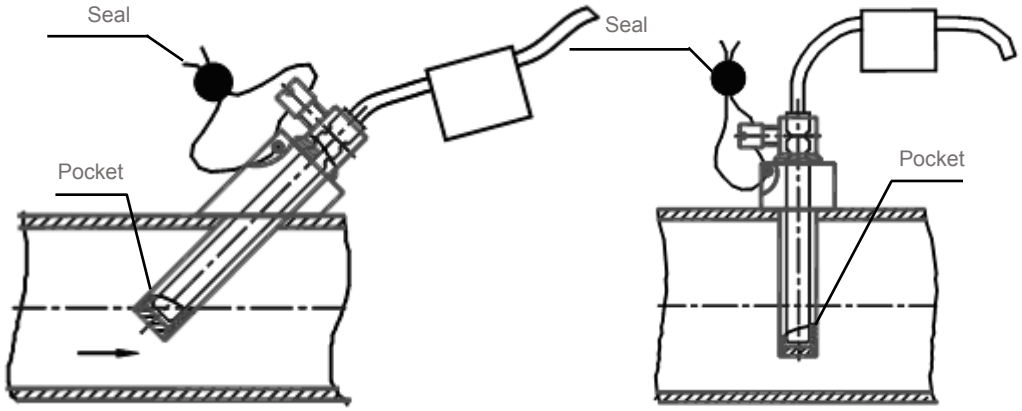



Fig. 12.5. Sealing the flow sensor $q_p$ = 15; 25; 40; 60 m³/h
flanged connection
installation length L = 270 mm; 300 mm; 360 mm

1 – manufacturer's approval seal: stickers on the flow sensor protective cover screws




a) 45° angle installation

b) perpendicular installation

Fig. 12.6. Sealing the pocket mounted temperature sensors (PS and PL type) with permanently connected signal leads

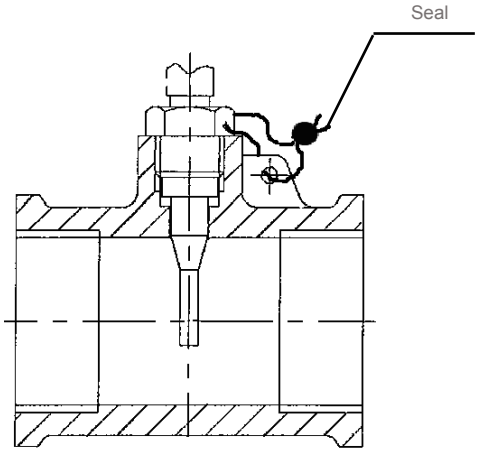



Fig. 12.7. Sealing the directly mounted temperature sensors (DS and DL type).

## Environmental protection

Do not dispose of with regular waste/trash. Take the product to a WEEE collection point for disposal. You will help protect the natural environment.

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