maddalena®
www.maddalena.it

Compact Thermal Energy Meter (Heat Meter, Combined Heat/Cooling Energy Meter)

microCLIMA U/SENSOSTAR®2U

DE-13-MI004-PTB001 (MID heat)

1 Application and Function

Thermal energy meter (heat meter or combined heat/cooling meter) designed for the measurement of the consumed thermal energy in a closed heating or heating/cooling system.

2 Contents of the Package

- Thermal energy meter (heat meter or combined heat/cooling meter) consisting of a detachable calculator, a flow sensor and two temperature sensors, all permanently connected to each other.
- Installation kit
- Installation and Operating Instructions

3 General Information

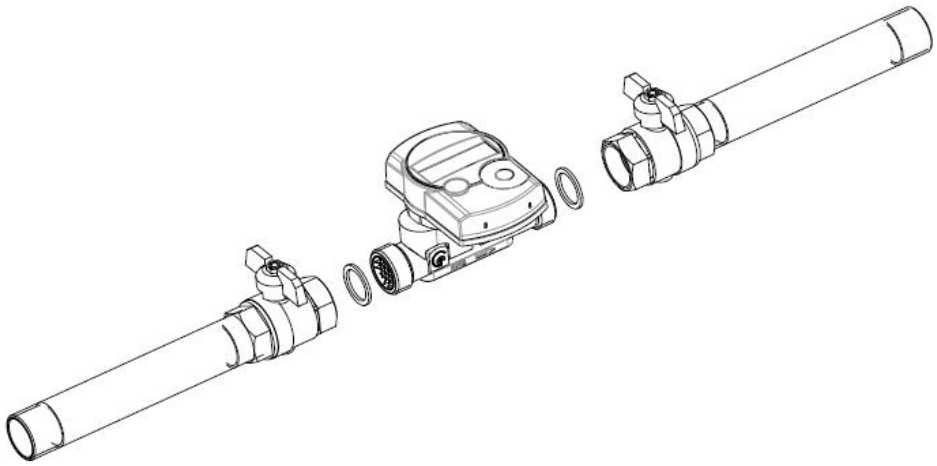
- Valid standards for the application of heat meters: EN 1434, parts 1 – 6; the Measuring Instrument Directive 2004/22/EC, Annexes I and MI-004; and the relevant national verification regulations.
- For the selection, installation, commissioning, monitoring and maintenance of the instrument observe the standard EN 1434 part 6 as well as Annex 22 of the verification regulations (for Germany).
- National regulations for the consumption measurement of cooling must be observed.
- The technical regulations for electrical installations must be observed.
- This product fulfils the requirements of the European Council Directive on Electromagnetic Compatibility (EMC Directive) 2004/108/EC.
- The identification plate of the instrument and the seals must not be removed or damaged – otherwise the guarantee and the approved application of the instrument are no longer valid!
- To achieve measurement stability of the meter is it necessary that the water quality meet the requirements of the AGFW-recommendation FW-510 and the document VDI (Association of German Engineers) VDI 2035.
- The heat meter left the factory in conformance with all applicable safety regulations. All maintenance and repair work is to be carried out only by qualified and authorized technical personnel.
- The instrument must be stored and transported at temperatures above-freezing.
- Instruments with activated radio function are not allowed on air freight.
- The correct installation point in the system must be chosen: forward or return flow, as stated on the type identification label.
- The temperature sensor cables and the cable between the calculator and flow sensor must not be kinked, rolled up, lengthened or shortened.
- To clean the heat meter (only if necessary) use a slightly moist cloth.
- To protect against damage and dirt the heat meter should only be removed from the packaging directly before installation.
- If more than one heat meter is installed in one unit, care must be taken to ensure that all the meters have the same installation conditions.
- All specifications and instructions listed on the data sheet and in the Application Notes must be adhered to.
- Further information can be obtained at **www.engelmann.de**.
- Instruments which have been replaced or exchanged must be disposed of according to relevant environmental regulations.
- The display is deactivated and can be activate for one minute by pushing the button (except calculator without additional interfaces).

3.1 Definition of pictograms on type identification label

	Installation in return flow
	Installation in forward flow

4 Mounting the Flow Sensor

- Flush the pipes according the generally acknowledged rules of technology. Then close all the shut-off valves. Open the nearest draining valve for pressure release.
- Drain the closed-off pipe section.
- Loosen the coupling rings and remove the old heat meter.
- Remove all old gaskets.
- Clean the sealing surfaces.
- Insert new gaskets.
- Position the flow sensor correctly, taking into account the direction of flow (arrow on the side of the flow sensor)!
- Tighten the coupling rings.
- Detach the calculator and mount it, or rotate it to the best position for read-out.



Note

In order to simplify mounting in narrow installation spaces the calculator can be detached from the flow sensor.

To release the calculator pull it carefully up off the flow sensor.

For heat meter versions it is recommended to detach the calculator.

For heat/cooling meters the calculator must be detached from the flow sensor.

5 Mounting the Temperature Sensors

For pipes of sizes < DN25 in new installations (whether new construction or refurbishment) it is required to install the temperature sensors directly immersed in the flow (without temperature pockets).

Note

During installation of the meter make sure that the temperature sensors are mounted according to their marking.

5.1 Direct mounting (ball valve and T-piece)

- Remove the blind plug/old temperature sensor and gasket/old O-ring. Clean connection surfaces.
- Slide the O-ring off the temperature sensor and insert it to the bottom of the threaded opening of the ball valve or the T-piece.
- Insert the temperature sensor to at least 15 mm, preferably the middle of the ball valve or T-piece (or a little further) and screw tightly. It is important to pay attention that the tip of the temperature sensor does not touch the bottom (the other side) of the ball valve or T-piece.

6 Start of Operation

- Slowly open the shut-off valves.
- Check that there are no leaks.

Check the following points:

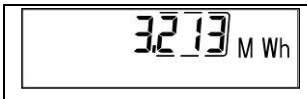
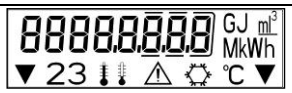
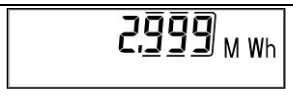
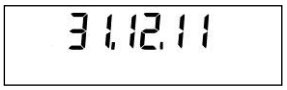
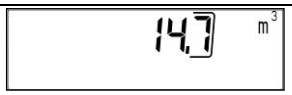
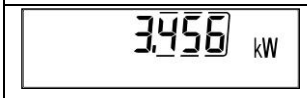
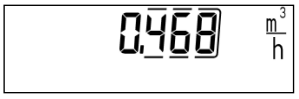
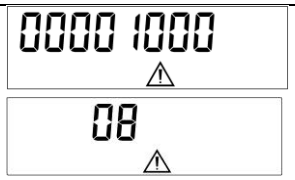
- Are all shut-off valves open?
- Is the meter of the right size?
- Is the heating (heating/cooling) system clear (dirt filters not clogged)?
- Is the temperature sensor installed in the flow sensor correctly sealed to the flow sensor?
- Does the directional arrow on the flow sensor match the actual direction of flow?
- Is a flow volume displayed?
- Is a plausible temperature difference displayed?

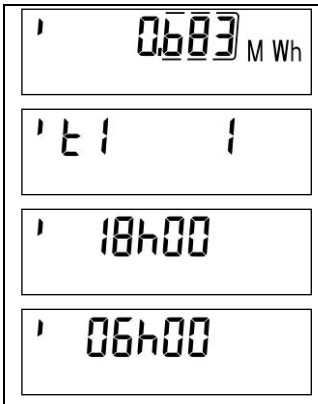
When the meter is functioning properly, attach the seals to the temperature sensors and the flow sensor (required to protect against manipulation).

7 Display

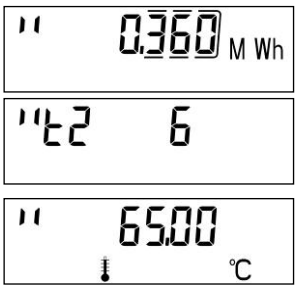
The calculator has a liquid crystal display with 8 digits and special characters. The values that can be shown are divided into three display loops. All data is retrieved using the push button next to the display. At the start you are automatically in the main loop (1st level). By pressing the push-button longer than 4 seconds you change to the next display loop. Keep the push-button pressed until you reach the desired information loop. By pressing the push-button briefly you can scan all the information within a loop. After 1 minute of non-use of the push-button, the display automatically returns to the main loop.

Level 1/Main loop

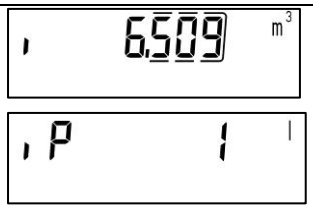
<table>
<tr>
<td> 
 
 
1) Standard display: total heat energy; alternating display: cooling energy (for heating/cooling meter) and when negative flow</td>
<td> 
2) Segment test, all segments triggered simultaneously</td>
<td> 
 
3) Heat energy at last reading date alternating with last reading date[1]</td>
<td> 
4) Total flow volume in m³</td>
</tr>
<tr>
<td> 
5) Current power in kW</td>
<td> 
6) Current flow in m³/h</td>
<td> 
7) Current date</td>
<td> 
8) Information message (alternating binary and hexadecimal display)</td>
</tr>
</table>



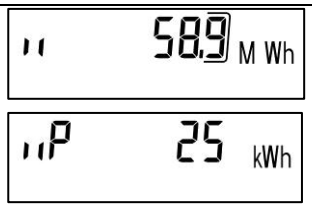
9) Tariff register 1: values alternating with tariff register number and criteria[2]



10) Tariff register 2: values alternating with tariff register number and criteria[2]



11) Momentary reading of the pulse counter 1 alternating with the pulse value[2]



12) Momentary reading of the pulse counter 2 alternating with the pulse value[2]

Level 2/Technician's loop

1) Maximum power in kW

2) Maximum flow in m³/h

3) Forward flow temperature in °C

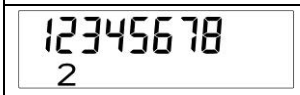
4) Return flow temperature in °C

5) Temperature difference

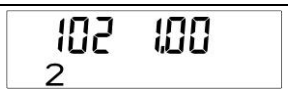
6) Days in operation since calibration

7) Sensor type/installation point

8) M-Bus address

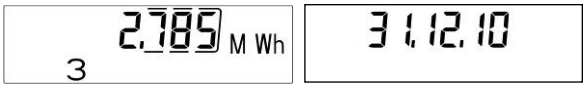


9) Serial number



10) Firmware version

Level 3/Statistics loop



1) Previous reading date alternating with its value. Alternatively, the total volume or tariff values can be displayed[1].

2 -16) Monthly values: dates alternating with their values. Alternatively, the total volume or tariff values can be displayed[1].

[1] Up to the end of the month the consumption and reading date for that month will be shown as 0.

[2] It can be set using the software "Device Monitor". A dedicated meter password is necessary. The password is available from the manufacturer.

8 Technical Data

Approval Data								
Nominal flow qp	m³/h	0.6	1.5	2.5	3.5	3.5	6.0	6.0
Accuracy class		EN 1434-1:2007; class 2/3						
Dynamic range; Minimum flow qi/qp		1:50	1:50 1:100 1:125	1:100	1:100 1:125 1:150	1:100 1:125 1:150	1:100	1:100
Maximum flow qs/qp		2:1						
Mechanical class		M1						
Electromagnetic class		E1						
Protection class of flow sensor		IP65						
Flow disturbance class		U0						
Flow Sensor								
Nominal diameter DN	mm	15	15	20	20	25	25	25

Maximum flow qs	m³/h	1.2	3.0	5.0	7.0	7.0	12.0	12.0
Pressure drop Δp at qp	mbar	40	215	110	210	210	200	200
Nominal pressure PN	bar	16						
Maximum pressure MAP	bar	16						
Low flow threshold	l/h	6	6	12	14	14	30	30
Installation length	mm	110	110	130	130	150	150	260
Connection thread	inch	G3/4B	G3/4B	G1B	G1B	G1 1/4B	G1 1/4B	G1 1/4B
Temperature range	°C	15 – 90						
Mounting position		horizontal; vertical						
Point of installation	standard	return flow (standard version) forward flow (optional version)						
Calculator								
Ambient temperature	°C	5 - 55; see 'Influencing_factors_battery_lifetime'						
Temperature range	°C	0 - 105						
Temperature difference	K	3 – 100						
Measuring cycle temperature	sec	4/60; dynamic						
Measuring cycle flow	sec	2						
Protection class		IP54						
Power supply		3 V lithium battery						
Battery lifetime, estimated	years	Standard: 10 years; 6 years + 1 with pulse output: see "Influencing_factors_battery_lifetime".						
Data storage		E^2PROM; daily						
Display		8 digits + special characters						
Interfaces	standard	infrared						
	optional	M-Bus galvanically isolated; M-Bus galvanically isolated + 2 pulse inputs; wireless M-Bus; wireless M-Bus + 2 pulse inputs; pulse output						
Temperature Sensors								
Sensor type		Platinum precision resistor Pt1000						
Connection type		2-wire technique						
Diameter	mm	5.0; 5.2; 6						
Length of cables	m	1.5; 3						
Type of installation		asymmetric; symmetric						

9 Additional Interfaces

9.1 Optical (infrared) interface

For the communication with the optical interface an optocoupler and the Device Monitor is necessary. The optocoupler and the, Device Monitor' software are available as accessory equipment.

Baud rate: 2400 baud

The optical infrared interface is activated by pressing the push-button. If within 60 seconds neither a valid telegram is received nor the push-button pressed again, the interface is deactivated. The number of read-outs via the optical interface is limited to 300 times per day.

9.2 M-Bus (optional)

The M-Bus is a galvanically isolated interface for the transmission of meter data (absolute values).

9.3 General information about the M-Bus interface

It is important to note that the acknowledged state of the art technology rules and the relevant legal restraints (international and local; see 9.3.1 “Relevant Norms, Standards an Literature on the M-Bus”) are to be observed.

The installation has to be performed by authorized, skilled persons.

If the regulations and the information in the installation and operating instruction manuals are not strictly followed, or if the installation is shown to be faulty, any resulting expenses will be charged to the company responsible for the installation.

Recommended type of cable: Telephone cable J-Y(ST)Y 2x2x0.8mm².

It is important to make sure that the topology of the M-Bus network (cable lengths and cross-sections) is suitable for the **baud rate (2400 Bd)** of the end instruments.

Further information can be found in the detailed ‘Application Note M-Bus’.

9.3.1 Relevant norms, standards and literature on the M-Bus

IEC 60364-4-41 (2005-12)	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock
IEC 60364-4-44 (2007-08)	Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances
IEC 60364-5-51 (2005-04)	Electrical installations of buildings - Part 5-51: Selection and erection of electrical equipment - Common rules
IEC 60364-5-54 (2011-03)	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors
EN 50310 (2010)	Application of equipotential bonding and earthing in buildings with information technology equipment
EN 13757-1:2002, 2:2004, 3:2004	Communication systems for meters and remote reading of meters
The M-Bus	A Documentation, Version 4.8, M-Bus User group
TI Technical Journal	Texas Instruments Technical Journal Vol. 8, 1991 M-Bus

9.3.2 Additional technical specifications

The installation has to fulfil the requirements of the relevant norms, standards and literature (see paragraph 9.3.1) and the specifications as follows.

Maximum voltage M-Bus	42 V
Minimum voltage M-Bus	21 V
Maximum ripple voltage	200 mV; EN 13757-2:2004; 4.3.3.6
Maximum voltage potential differences	2 V

9.3.3 Technical data M-Bus

Primary address	0 (factory setting); 1 – 250 (configurable)
Baud rate	2400; 300 (configurable)
Connecting cable length	1 m

9.3.4 Number of possible read-outs

The number of possible read-outs depends on the number of instruments in the M-Bus network.

Number of instruments in network	**Read-outs per day primary address**	**Read-outs per day secondary address (without using SND NKE)**
3	655	275
20	485	170
60	300	90
120	190	52
250	105	27

If fewer read-outs are carried out, the unused “credit” is stored in the instrument and can be used later.

During M-Bus communication with an end instrument the other interfaces (push-button, optical interface) of this instrument cannot be used.

9.4 Radio interface wireless M-Bus EN 13757-3, EN 13757-4 (optional)

The radio interface is for the transmission of meter data (absolute values).

General information about the radio interface

Installation of radio components between or behind heating pipes, or the presence of other bulky obstacles directly over or in front of the housing must be avoided.

The transmission quality (range, telegram processing) of radio components can be negatively influenced by instruments or equipment with electromagnetic emissions, such as telephones (particularly LTE mobile radio standard), Wi-Fi routers, baby monitors, remote control units, electric motors, etc.

In addition, the construction of the building has a strong influence on the transmission range and coverage. Furthermore, when using installation boxes (substations) they must be equipped with non-metallic covers or doors.

The factory-setting of the clock in the meter is standard (winter) Central European Time (GMT +1). There is no automatic changeover to daylight savings (summer) time.

The radio function is deactivated upon delivery (factory-setting). See section 9.4.3 “Activation of the radio interface”.

9.4.1 Technical data radio

Frequency	868 MHz
Transmission power	up to 12 dBm
Protocol	wireless M-Bus based on EN 13757-3
Selectable modes	S1/T1/C1
Telegrams	- Short telegram in conformity to AMR (OMS-Spec_Vol2_Primary_v301): energy (heat/cooling energy, pulse input 1, pulse input 2), total volume, flow, power, information message, return flow temperature, temperature difference - Long telegram for *walk-by* read-out: energy (heat/cooling energy, pulse input 1, pulse input 2), total volume, information message, 15 monthly values
Encryption	AES: Advanced Encryption Standard; key length: 128 bits

9.4.2 Radio configuration*

Parameter	**Possible settings**	**Factory settings** (Battery lifetime, estimated: 6 + 1 years)
Mode	S1/T1/C1; unidirectional	T1; unidirectional
Transmission period	00:00 – 24:00; any time period in the day	7:00 am – 7:00 pm
Transmission interval	120 seconds - 240 minutes	120 seconds (heat meters)
Weekdays	Monday – Sunday (any weekday)	Monday - Friday
Weeks in a month	1 – 4 (4: uninterrupted, incl. a possible 5th week)	1 – 4 (4: uninterrupted, incl. a possible 5th week)
Months	1 – 12	1 – 12
Radio activation date	01.01 - 31.12. (day.month)	not set

AES-128 Encryption	- Not encrypted
	- Encrypted:
	  - Engelmann Master Key
	  - random key per instrument
	  - activated/not activated
		Master Key; not activated

Type of telegram	- Short telegram AMR (OMS-Spec_Vol2_Primary_v301) - Long telegram *walk-by*	Short telegram AMR

*Factory settings may vary from the above.

9.4.3 Activation of the radio interface

The radio interface **leaves the factory deactivated**. It can be activated as follows:

a. Without using additional software the radio function can be activated by pressing the push-button for over 3 seconds while at the display item 'M-Bus address', second level, item 8 (see section 7 Display, Level 2/Technician's Loop). The standard factory-settings will be activated.

b. The radio function can also be activated using the software 'Device Monitor'. This software can be ordered separately as an option. The exact procedure for activating the radio function using this software is described in the accompanying handbook.

After successful activation of the radio function a triangle will appear permanently in the lower left corner of the display.

If using the compact mode, for one hour after activation the meter transmits in installation mode. This means that format telegrams and compact telegrams are sent alternately.

During installation mode at least one meter of the version being installed (forward or return flow, heat or heat/cooling, pulse inputs, display units) must be read out with the Engelmann Read-out Software. The format of the telegram will be stored locally in the PC in an .xml file.

After completion of the installation mode only compact telegrams will be transmitted.

9.5 Two additional pulse inputs (optional; only in conjunction with M-Bus or radio)

With this option, additional instruments with pulse outputs can be read out via M-Bus or radio.

General information about pulse inputs

It is important to note that the acknowledged state of the art technology rules and the relevant legal restraints (international and local; see 9.5.1 "Relevant norms, standards and literature on the pulse inputs") are to be observed.

The installation has to be performed by authorized, skilled persons.

If the regulations and the information in the installation and operating instruction manuals are not strictly followed, or if the installation is shown to be faulty, any resulting expenses will be charged to the company responsible for the installation.

9.5.1 Relevant norms, standards and literature on the pulse inputs

IEC 60364-4-41 (2005-12)	Low-voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock
IEC 60364-4-44 (2007-08)	Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances
IEC 60364-5-51 (2005-04)	Electrical installations of buildings - Part 5-51: Selection and erection of electrical equipment - Common rules
IEC 60364-5-54 (2011-03)	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors
EN 50310 (2010)	Application of equipotential bonding and earthing in buildings with information technology equipment
EN 1434-2:2007	Heat Meters - Part 2: Constructional requirements

9.5.2 Technical data pulse inputs

Pulse input class	CMOS; IB according to EN 1434-2:2007
Internal pull-up voltage	+ 3 V DC
Internal pull-up resistance	2 MΩ
Current	= 1.5 µA
High-level threshold	U ≥ 2 V
Low-level threshold	U ≤ 0.5 V
Length of connecting cable	1 m

9.5.3 Electrical requirements on the pulse output of the instrument to be connected (e.g. flow meter)

Pulse output class	(passive) output OA (reed contact/electronic switch) or OC (open collector) according to EN 1434-2:2007
Pulse length "on"	≥ 100 ms
Pulse length "off"	≥ 100 ms
Current	= 1.5 µA
Resistance "contact open"	≥ 6 MΩ
Resistance "contact closed"	≤ 3 kΩ

9.5.4 Setting up the two additional pulse inputs

The optional pulse inputs 1 + 2 for external meters can be set up using the “Device Monitor” configuration software.

The input pulse value, the units and the starting values of the external meters can be configured.

9.5.5 Set-up possibilities

Pulse value	**Units**
1	litres/kWh/pulse without unit
2,5	litres/kWh/pulse without unit
10	litres/kWh/pulse without unit
25	litres/kWh/pulse without unit
100	litres/kWh/pulse without unit
250	litres/kWh/pulse without unit
1000	litres/kWh/pulse without unit

Installation notes for pulse inputs

It is important that the pulse cables not be affected by (or exposed to) the M-Bus voltage!

Check the polarity of pulse generators with ‘open collector’ outputs.

The cable wires must not touch each other during installation, otherwise pulses will be counted in the instrument.

When setting up the meter it may be necessary to adjust the meter reading of the instruments connected and the pulse value using the Device Monitor software.

9.5.6 Pin assignments 6-wire cable (only in conjunction with M-Bus)

Pin	**Colour**	**Connection**
1	White	IE1+
2	Brown	IE1⊥
3	Green	IE2⊥
4	Yellow	IE2+
5	Grey	M-Bus
6	Pink	M-Bus

9.5.7 Pin assignments 4-wire cable (only in conjunction with radio)

Pin	**Colour**	**Connection**
1	Yellow	IE1+
2	Green	IE1⊥
3	Brown	IE2⊥
4	White	IE2+

9.6 Potential-free pulse output (optional)

The potential-free pulse output is an electronic switch that outputs counting pulses of the meter which can be used for any purpose.

The pulse output closes, corresponding to the pulse value shown on the type identification label on the instrument.

9.6.1 Technical data pulse output

Pulse output class	OA (electronic switch) according to EN 1434-2:2007
Pulse value heat energy	1 kWh/pulse
Pulse value volume (optional)	100 l/pulse
Peak switching current	300 mA ~/-
Switching voltage, maximum	35 V ~/-
Switching power, maximum	300 mW
Contact isolation	> 10^9 Ohm
Contact resistance (on)	max. 25 Ohm
Contact capacity	1.5 pF
Maximum current	120 mA
Withstand voltage (open contact)	350 V ~/-
Closure time	125 ms
Interval between pulses	125 ms

10 Information Messages

When the instrument has detected an information message, the message symbol is displayed: ⚠

The specific message can be found at the menu item 8 'Information message' in Level 1/Main loop (see section 7 "Display"). The instrument recognizes eight message causes, which can also occur in combination with each other. The messages are shown on the display. The message code is displayed alternately in binary and hexadecimal form.

Binary display	**Description**	**Hexadecimal display**
1 at first place	Low battery	H 80
1 at second place	Check sum error	H 40
1 at third place	E^2PROM defective	H 20
1 at fourth place	Instrument has been reset	H 10
1 at fifth place	Time-out TDC (Time-to-digital converter)	H 08
1 at sixth place	Internal calibration defective	H 04
1 at seventh place	Return flow sensor defective	H 02
1 at eighth place	Forward flow sensor defective	H 01

Example: Time-out TDC (Time-to-digital converter)

Message	Low battery	Check sum error	E^2PROM fault	Reset	Time-out TDC	Internal calibration error	Return flow sensor fault	Forward flow sensor fault	
Bit	7	6	5	4	3	2	1	0	Alternating hexadecimal message displayed (LCD)
Display location	1	2	3	4	5	6	7	8	
Alternating binary message displayed (LCD)	0000 1000 ⚠								08 ⚠

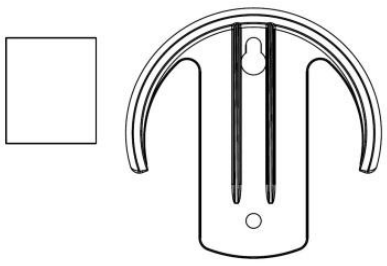
When a message appears in the standard display (total heat, or alternating total heat and cooling energy), with the exception of the messages 'Reset' (10) and 'Time-out TDC' (08) in the case of air in the measuring tube, the instrument must be exchanged and sent to the supplier for examination.

10.1 Message description

Message	Effect	Possible cause
Low battery	No influence to the calculation	Adverse environmental conditions; Long operating time
Check sum error	No calculations are carried out. The registers of flow and energy are not being updated.	Defective component.
E^2PROM fault	After a reset, the instrument is without function.	Defective component.
Reset	The measurements since the last storage of data in the E^2PROM are lost (max. one day)	EMC
Time-out TDC; no measurement of volume	No calculations are carried out. The registers for volume and energy are not being updated (no new data is being stored).	Air in the system; Volume scanning defective; Connecting cable between the calculator housing and the flow sensor damaged.
Internal calibration error	There is no energy calculation. The registers for flow and energy are not being updated (no new data is being stored).	A defect on the calculator circuit board.
Rf-sensor fault	No calculations are carried out. The registers for flow and energy are not being updated (no new data is being stored).	Sensor cable severed; sensor cable shorted circuited t.
Ff-sensor fault	No calculations are carried out. The registers for flow and energy are not being updated (no new data is being stored).	Sensor cable severed; sensor cable shorted circuited.

11 Mounting with Wall Support

For mounting the calculator on the wall, a sticker pad and a wall mounting support are available. They must be ordered separately. The adhesive surfaces must be clean and free of grease.



12 MID Declaration of Conformity

For the product described in this document we confirm, as the manufacturer, that it meets the fundamental requirements of the following directives:

- Directive 2004/22/EC of 31 March 2004 on measuring instruments, in particular those in Annex MI-004
- Directive 2004/108/EC on EMC
- Directive 2006/95/EC on low voltage
- Directive 1999/5/EC (R&TTE)

The complete signed declaration can be found at www.engelmann.de.

13 Manufacturer

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Subject to technical change