DESCRIPTION

EM403

Ultrasonic thermal energy meter for heating and cooling applications certified according to MID directive (Measurement Instruments Directive 2014/32/EU). Composed by:

- ***An ultrasonic flow meter (flow sensor):*** it allows to measure with high accuracy and reliability the flow rate circulating through the device. Rated PN25 and proved up to temperature of 130°C. Available only in the threaded version (from ¾" to 2");
- ***An electronic display unit (calculator):*** it allows to set a series of characteristic parameters of the device and view and consult the data logs saved by the instrument. It houses the working and calculating electronic of the device, including the communication module and the power supply module. It can be positioned on the wall, by using the dedicated support included with the product, or on the flow sensor;
- ***A set of PT500 temperature probes:*** they allow to measure the temperature differential between flow and return and thus determine the thermal energy consumption. Available in the direct immersion version or in the pocket version (pockets for inserting the probes included with the product).

Based on the requirements, the device can be equipped with one communication protocol selectable between ***M-bus***, ***M-bus Wireless***, ***Modbus RTU***, ***Modbus TCP/IP***, ***BACnet® MS/TP***, ***BACnet® IP*** or ***LoRaWan*** and with ***integrated battery*** power supply (16 years lifetime) or ***24V AC/DC*** or ***230V AC*** external power supply. The availability of a given type of power supply may vary depending on the type of protocol selected. Equipped with an optical interface for local reading and additional pulse inputs for connecting other measuring devices such as drinking water meters (two inputs per selected protocol).

SIZES AND SELECTION

The size of the meter is distinguished by the nominal flow rate of the device q_P. In addition to this value, each meter is characterized by three other characteristic flow rate values q_c, q_i and q_s (cut-off flow rate, minimum flow rate and maximum flow rate respectively). Once the design flow rate q has been defined, the most suitable size of meter must be selected in such a way that this value is between the minimum and the nominal one ($q_i < q < q_P$). The different available sizes of EM403 thermal energy meter with their respective characteristic flow values are collected in the following table:

Article*	Flow rate				Dynamic range	Flow sensor length	Flow sensor connection**
	Cut-off q_c [l/h]	Minimum q_i [l/h]	Nominal q_p [m³/h]	Maximum q_s [m³/h]			
EM403	3	6	0,6	1,2	100:1	110 mm	¾"
EM403	3	15	1,5	3	100:1	110 mm	¾"
EM403	5	25	2,5	5	100:1	130 mm	1"
EM403	7	35	3,5	7	100:1	260 mm	1 ¼"
EM403	12	60	6	12	100:1	260 mm	1 ¼"
EM403	20	100	10	20	100:1	300 mm	2"

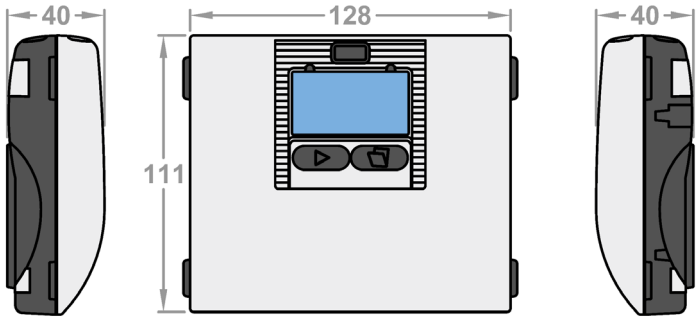
*For models with a nominal flow rate of up to 6 m³/h, the temperature probes are of the direct immersion type. For the 10 m³/h models, however, they are of the pocket type. **Thread according to EN ISO 228-1.

STE0522 rev.03 24/10/2025

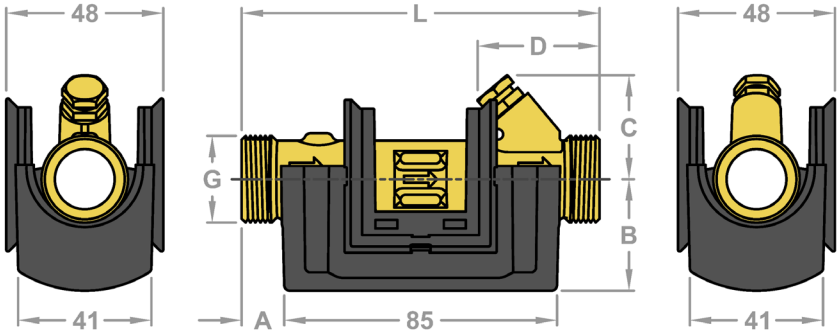
DIMENSIONS

The characteristic dimensions of the different elements making up the EM403 thermal energy meter are shown below (unit of measurement **mm**):

CALCULATOR



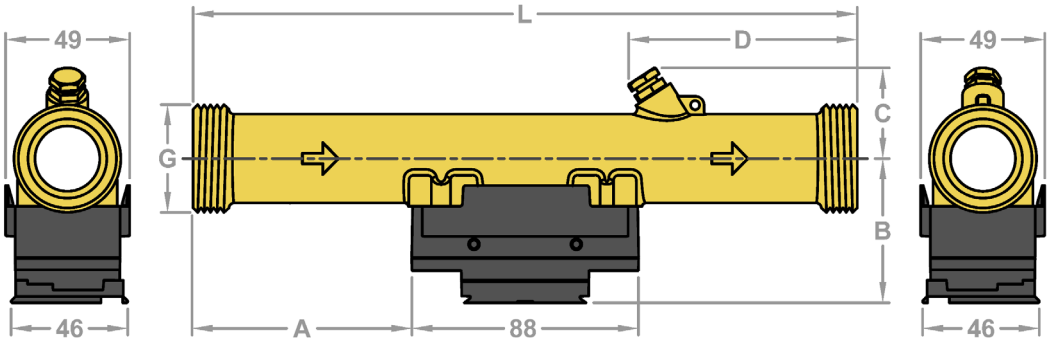
FLOW SENSOR: ¾" → 1"



Article	Size	G*	L	A	B	C	D	Weight [g]
EM403	0,6 m³/h	¾"	110	13	34	31	37	~450
EM403	1,5 m³/h	¾"	110	13	34	31	37	~450
EM403	2,5 m³/h	1"	130	22	38	34	47	~550

*Thread according to EN ISO 228-1.

SFLOW SENSOR: 1 ¼" → 2"



Article	Size	G*	L	A	B	C	D	Weight [g]
EM403	3,5 m³/h	1 ¼"	260	86	58	35	90	~1650
EM403	6 m³/h	1 ¼"	260	86	58	35	90	~1650
EM403	10 m³/h	2"	300	106	62	38	94	~2550

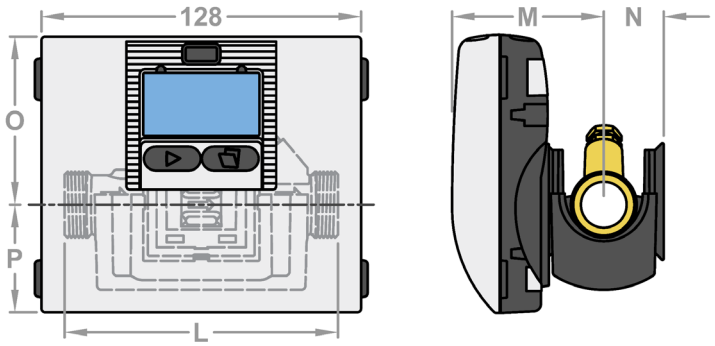
*Thread according to EN ISO 228-1.

STE0522 rev.03 24/10/2025

DIMENSIONS

The characteristic dimensions of the different elements making up the EM403 thermal energy meter are shown below (unit of measurement **mm**):

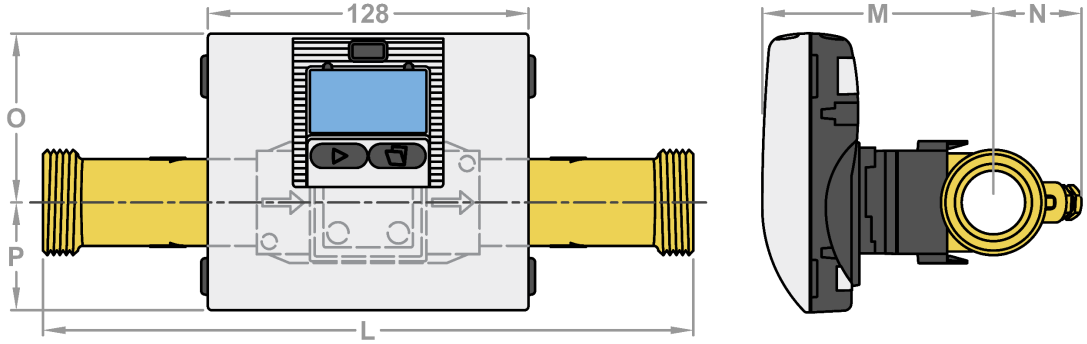
MOUNTING ON THE FLOW SENSOR: ¾" → 1"



Article	Size	L	M	N	O	P	Weight [g]*
EM403	0,6 m³/h	110	60	24	65	46	~800
EM403	1,5 m³/h	110	60	24	65	46	~800
EM403	2,5 m³/h	130	60	24	65	46	~900

*The weight indicated includes the flow sensor, the calculator and the temperature probes.

MOUNTING ON THE FLOW SENSOR: 1 ¼" → 2"



Article	Size	L	M	N	O	P	Weight [g]*
EM403	3,5 m³/h	260	93	35	69	42	~2000
EM403	6 m³/h	260	93	35	69	42	~2000
EM403	10 m³/h	300	98	38	69	42	~2900

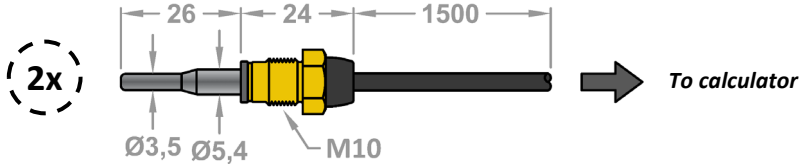
*The weight indicated includes the flow sensor, the calculator and the temperature probes.

STE0522 rev.03 24/10/2025

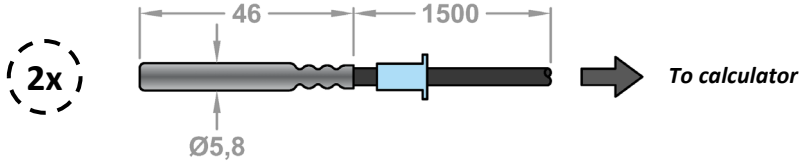
DIMENSIONS

The characteristic dimensions of the different elements making up the EM403 thermal energy meter are shown below (unit of measurement **mm**):

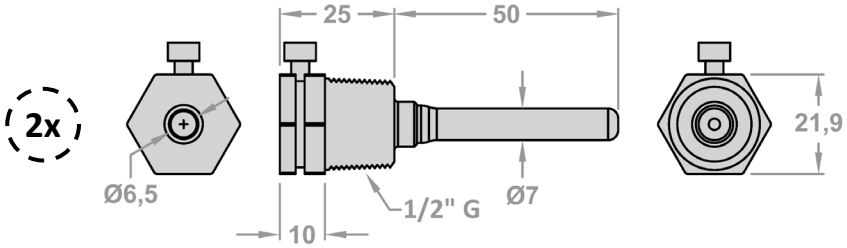
DIRECT IMMERSION TEMPERATURE PROBE



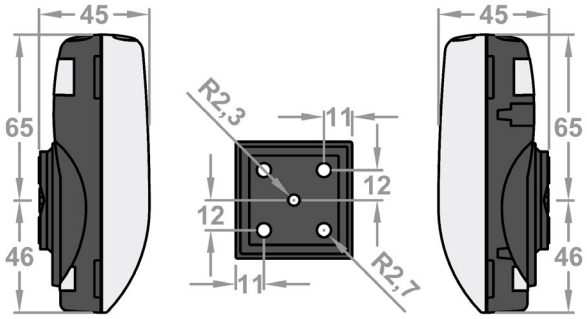
POCKET TEMPERATURE PROBE



POCKET HOUSING



SUPPORT FOR WALL MOUNTING



STE0522 rev.03 24/10/2025

MATERIALS

The materials of the different elements making up the EM403 thermal energy meter are shown below:

CALCULATOR

- Front shell — Polycarbonate filled with 10% glass fiber (PC 10% GF) with thermoplastic elastomers (TPE)
- Rear shell — Polycarbonate filled with 10% glass fiber (PC 10% GF) with thermoplastic elastomers (TPE)

CABLES

- Flow sensor - Calculator — Silicon cable 3 x 0,25 mm^2
- Temperature probes — Silicon cable 2 x 0,22 mm^2

SUPPORTS FOR MOUNTING

- Wall support — Polycarbonate filled with 20% glass fiber (PC 20% GF)

TEMPERATURE PROBES

- Immersion type — Stainless steel W. nr. 1-4404
- Pocket type — Stainless steel W. nr. 1-4404

FLOW SENSOR

- Flow sensor casing — Antidezincification brass CW602N
- Transducer — Stainless steel W. nr. 1-4404
- O-rings — EPDM
- Measuring tube — Polyethersulfone filled with 30% glass fiber (PES 30% GF)
- Reflectors — Stainless steel W. nr. 1-4436 or 1-4350
- Reflectors base — Polyethersulfone filled with 30% glass fiber (PES 30% GF)
- Protection cover — Polycarbonate filled with 20% glass fiber (PC 20% GF)

STE0522 rev.03 24/10/2025

OPERATING CONDITIONS

The EM403 thermal energy meter is suitable for indoors installation without the possibility of condensation forming. Outdoor installation is not permitted. It must be used in closed hydronic systems and is supplied by default for installation on the return pipe. If installation on the supply pipe is necessary, it is possible to change the setting on the meter.

The main characteristics and operating conditions of the device are collected in the following table:

TECHNICAL FEATURES	
IP protection (calculator)	IP54
IP protection (flow sensor)	IP68
Type of medium	Acqua
Nominal pressure (flow sensor)	25 bar
Room temperature range	5÷55 °C
Medium temperature range	2÷130 °C
Storage temperature range	-25÷60 °C
Calculator mounting	On the flow sensor or on the wall

APPROVALS

The different directives and regulations according to which the EM403 thermal energy meter is certified, with the related certificates where present, are shown below:

CERTIFICATIONS

- MID directive (Measurement Instruments Directive 2014/23/EU) ➔ Certificate DK-0200-MI004-037
- DK-BEK 1178 regulation (Danish cooling regulation) ➔ Certificate TS 27.02.009

Heating (MID)		Cooling (DK-BEK 1178)	
Temperature range θ	**Differential range $\Delta\theta$**	**Temperature range θ**	**Differential range $\Delta\theta$**
2 °C…180 °C	3 K…178 K	2 °C…180 °C	3 K…178 K
Mechanical environment: class M1 and M2 – *Electromagnetic environment:* class E1 and E2			

EUROPEAN DIRECTIVES AND REGULATIONS

- MID directive (Measurement Instruments Directive 2014/23/EU)
- EMCD directive (ElectroMagnetic Compatibility Directive)
- LVD directive (Low Voltage Directive)
- RED directive (Radio Equipment Directive)
- PED directive (Pressure Equipment Directive)
- RoHS directive (Restriction of Hazardous Substances)
- EN 1434:2007/AC:2007 regulation
- EN 1434:2015 + A1:2018 regulation
- EN 1434:2022 regulation

STE0522 rev.03 24/10/2025

CALCULATOR DATA

The calculator of the EM403 thermal energy meter is equipped with an LCD display through which it is possible to view the different recordings made by the device and the settings with which it is configured. Navigation between the different menus and modification of the related parameters can be achieved through the use of the two central buttons.

The main characteristics of the calculator of the EM403 thermal energy meter are collected in the following table:

TECHNICAL FEATURES	
Type of display	LCD with 7 or 8 digits
Display resolution	Depending on the data, up to a maximum of 3 decimal digits
Energy measurement units	Can be set between MWh, kwh or GJ
Type of memory	EEPROM (data stored are never lost)
Data logging frequency*	Yearly, monthly, daily, hourly, minute 1 (15'), minute 2 (1')
Data logging depth**	20 year, 36 months, 460 days, 72 hours, 1440 minutes, 360 minutes
Daylight saving time (DST)	Programmable
Clock accuracy (without external adjustment)	Less than 15 min/year
Clock accuracy (with external adjustment)	Less than 7 sec from daylight saving time
Data communication	Through optical head and communication module/s
Length of connection cable to flow sensor	1,5 m (can't be removed)
Length of connection cable to the temperature probes	1,5 m (can be removed but not shortened)

*In the case of yearly and monthly frequencies, the yearly and monthly date on which the EM403 thermal energy meter records the parameter can be directly set by the end user. **The logging depth, namely the number of years, months, days, hours or minutes for which it is possible to navigate within the device's memory, varies according to the logging frequency considered and increases as this latter decreases.

MOUNTING OF THE CALCULATOR

Depending on the installation needs, positioning of the calculator box can be carried out in two different ways:

- *Mounting on the flow sensor* (the calculator can be installed with any possible orientation);
- *Mounting on the wall* (in this case it is necessary to consider the maximum length of the connection cable between the calculator and the flow sensor of 1,5 m. In particular, for models with nominal flow rate up to 2,5 m^3/h, the support for wall mounting is supplied loose. For models with nominal flow rate from 3,5 to 10 m^3/h instead, it is supplied screwed on the flow sensor and must be removed from it).

If the installation takes place in humid environments or environments subject to the formation of condensation, it is recommended to position the calculator on the wall in a way that it stays above the flow sensor and not below.

STE0522 rev.03 24/10/2025

INSTALLING POSITION

In order to guarantee correct functioning, it is necessary to take into account some installation constraints regarding the positioning of the device within the system such as:

1. Do not place the flow sensor at the highest point of the pipe (***Fig.1***);
2. Do not place the flow sensor immediately after a butterfly valve or a regulating control valve. However, previous installation is permitted (***Fig.2***);
3. Do not place the flow sensor immediately before or after a circulation pump (***Fig.3***);
4. Do not place the flow sensor immediately after a double curve oriented on two different planes (***Fig.4***);

For cases 2, 3 and 4, if you want to proceed with the installation, provide a straight section of pipe between the two elements with a minimum length equal to ten times the nominal diameter of the device. For any other cases not listed, straight pipe sections are not necessary either before or after the installation point.

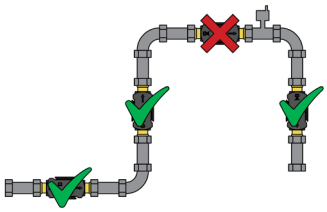


Fig.1

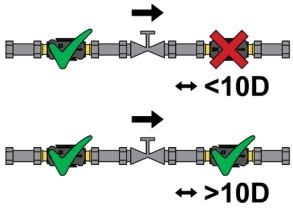


Fig.2

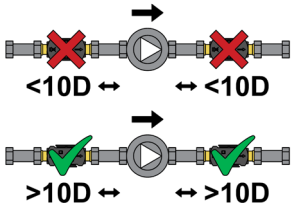


Fig.3

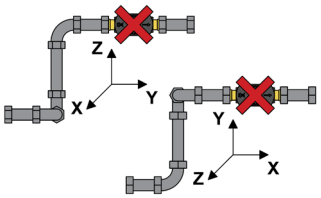


Fig.4

MOUNTING OF THE FLOW SENSOR

The mounting of the flow sensor of the EM403 thermal energy meter must be carried out in accordance with the following two conditions:

1. The direction of flow must agree with the direction of the arrows shown on the device's body;
2. The installation position inside the circuit must agree with the one set on the calculator (supply or return).

The EM403 thermal energy meter is equipped with an advanced integrated diagnostic system. If the installation direction is not consistent with the set flow direction, the meter generates a specific alarm message.

FLOW SENSOR ORIENTATION

The flow sensor can be oriented in any position: horizontal, vertical or inclined (***Fig.5***). In particular, if the installation is vertical, compatibly with the available space, the flow sensor can be rotated 360° around its axis. If the installation is of the horizontal type, however, the orientation that can be achieved varies depending on the size considered:

- **Models with nominal flow rate up to 2,5 m³/h:** the flow sensor can be oriented with inclinations between 0° and -90°. In particular, orientation with an angle between -45° and -90° is permitted if the absence of impurities and dirt inside the heat transfer fluid has been verified (***Fig.6***);
- **Models with nominal flow rate from 3,5 to 10 m³/h:** the flow sensor can be oriented with inclinations between 45° and -90°. In particular, orientation with an angle between -45° and -90° is permitted if the absence of impurities and dirt inside the heat transfer fluid has been verified. Orientation with an angle between 45° and 0° is permitted if the absence e of air inside the heat transfer fluid has been verified (***Fig.7***).

What has been analyzed so far is to be applied in the case of heating systems. In the case of cooling or mixed applications, it is recommended to orient the flow sensor with an angle equal to 0°, for models with a nominal flow rate of up to 2,5 m³/h, and with an angle equal to 45°, for models with nominal flow rate from 3,5 to 10 m³/h (***Fig.8***).

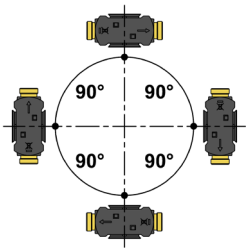


Fig.5

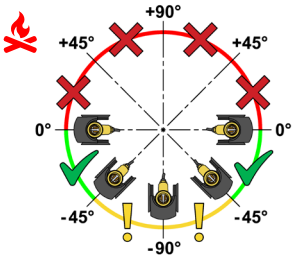


Fig.6

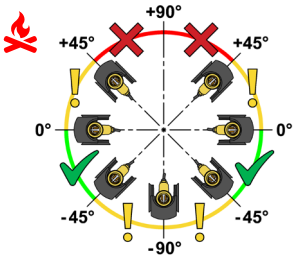


Fig.7

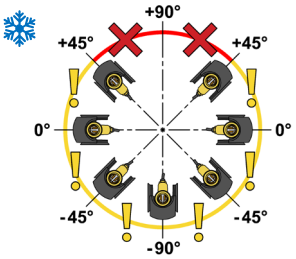


Fig.8

STE0522 rev.03 24/10/2025

TEMPERATURE PROBES

The EM403 thermal energy meter is equipped with two PT500 temperature probes, one for the supply (T1 probe) and one for the return (T2 probe).Devices equipped with direct immersion probes (sizes 0,6÷6 m³/h) have got the T2 probe directly inserted into the flow sensor while the T1 probe is loose and must be installed in a dedicated probe holder (***Fig.9***). Hydraulic sealing is provided by compression of the end gasket (the probe does not need to be fully tightened against the stop). Devices equipped with pocket probes (size 10 m³/h) instead have got both sensors loose. In this case the installation must be done by inserting the probes into the dedicated pockets included with the device. These pockets in turn must be installed on the pipelines thanks to the help of dedicated fittings (***Fig.10***). In the case of heating applications, the probe can be oriented in any position: horizontal, vertical or inclined (***Fig.11***). In the case of cooling or mixed applications, however, orienting the probe with an angle between 0° and -90° is recommended (***Fig.12***). Installation at angles greater than 0° requires the probe to be suitably thermally insulated.

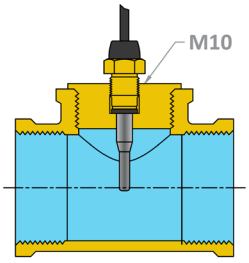


Fig.9

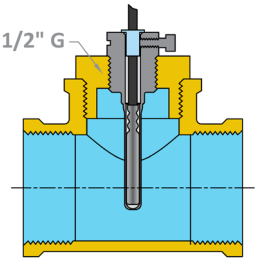


Fig.10

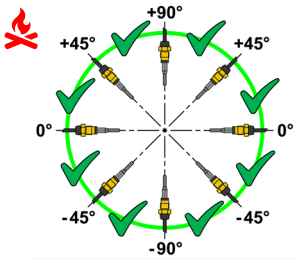


Fig.11

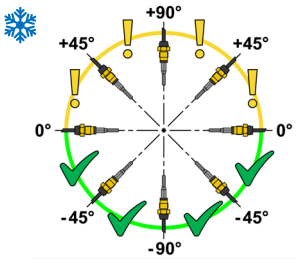
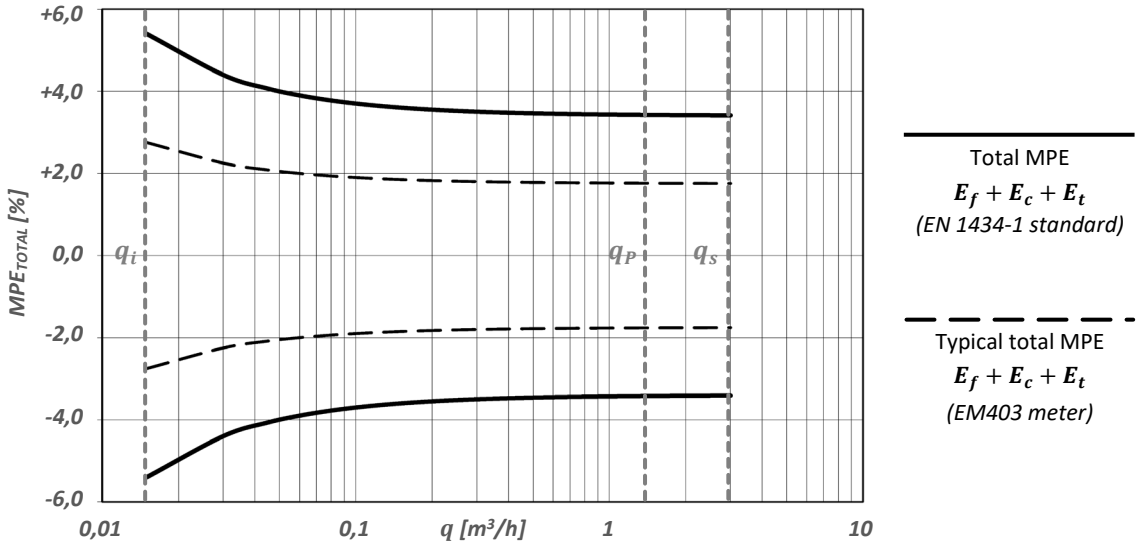


Fig.12

MEASURING ACCURACY

The measurement accuracy of the EM403 thermal energy meter complies with the minimum requirements indicated in the EN 1434-1 standard. As an example, consider the graph below which represents the typical measurement accuracy (MPE) of the EM403 thermal energy meter ($q_p = 1{,}5\ m^3/h$, $\Delta\Theta = 30\ K$) compared to the limits imposed by EN 1343-1 standard.



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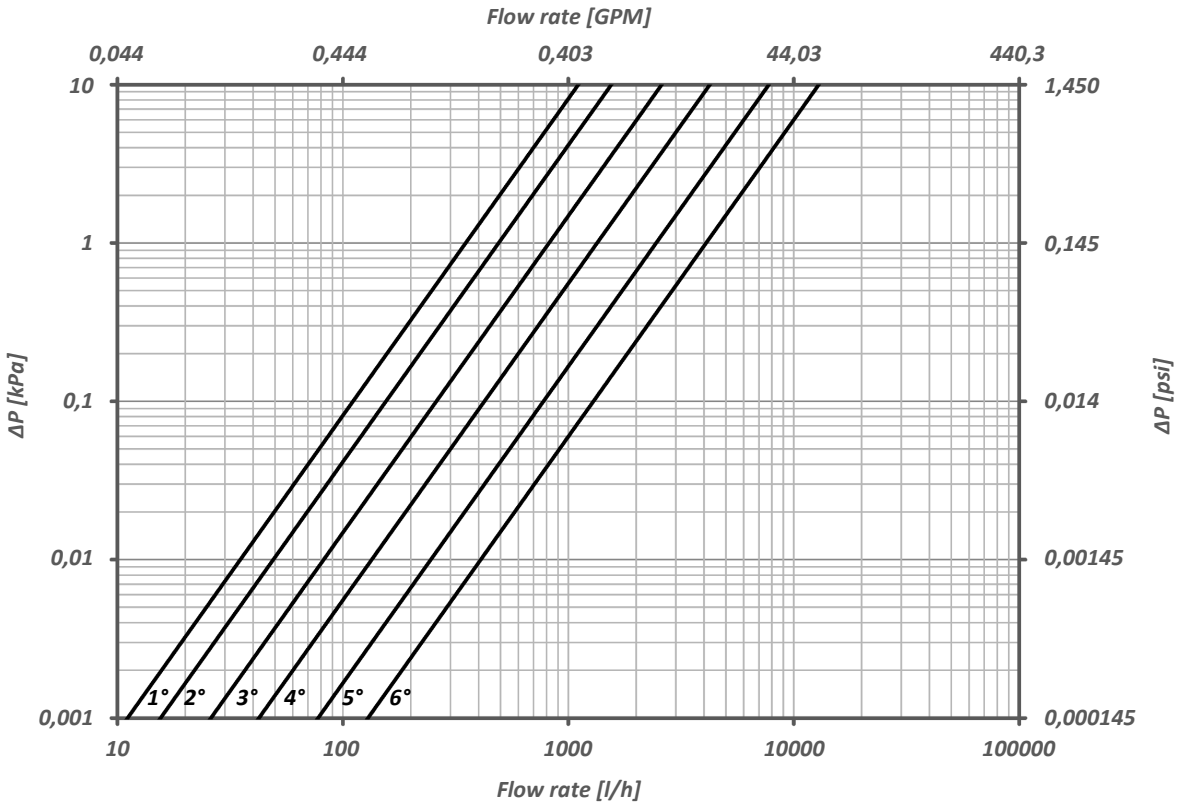
PRESSURE DROP DIAGRAM

The flow coefficients of the different meter sizes available are shown below:



Size [m³/h]	0,6	1,5	2,5	3,5	6	10
Kv	3,5	4,9	8,2	13,4	24,5	40,8
Cv	4	5,7	9,5	15,5	28,3	47,2
PN	25	25	25	25	25	25
Curve	*1°*	*2°*	*3°*	*4°*	*5°*	*6°*

FLOW RATE MEASUREMENT

The flow sensor inside the EM403 thermal energy meter is of the ultrasonic type. Thanks to the absence of moving parts, this technology minimizes the need for maintenance of the device, thus maximizing its reliability and measurement precision over time.

STE0522 rev.03 24/10/2025

COMMUNICATION PROTOCOL

The EM403 thermal energy meter has an optical interface on the front body that can be used for local reading of the device using an appropriate optical probe. At the same time, based on communication needs, the device can be equipped with one communication protocol. The different communication protocols with which the EM403 thermal energy meter can be supplied are collected in the following table:

Protocol*	Communication standard	Transmission speed / Transmission frequency
M-Bus	EN13757:2013	300, 2400, 9600 e 19200 baud (automatic detection)
M-Bus Wireless	EN13757:2019	912,5/915/918,5 MHz
Modbus RTU*	MODBUS RTU RS-485	300, 2400, 9600, 19200, 38400, 57600, 76800 e 115200 baud
Modbus TCP/IP	MODBUS TCP/IP	10/100 Mbit/s
BACnet® MS/TP	ASHRAE 135.1-2016 e ISO 16484-5	9600, 19200, 38400, 57600, 76800 e 115200 baud (automatic detection)
BACnet® IP	ASHRAE 135.1-2016 e ISO 16484-5	10/100 Mbit/s
LoRaWan	LoRa Alliance®	868 MHz

*Each protocol is also equipped with two pulse inputs for connecting other measuring devices such as drinking water meters (3,6V, max. 5µ A). **Factory settings: *Speed* → 9600 baud, *Parity* → even, *Stop bits*→ 1 stop bit. These parameters can be changed by the end user using a specific additional accessory. For further information, contact Pettinaroli technical service directly.

POWER SUPPLY

The EM403 thermal energy meter can be supplied with one of the following power supplies:

- Lithium integrated battery 3,65V DC (lifetime up to 16 years in conditions of $T_{BATTERY}$ < 30°C)
- External power supply module 230V AC;
- External power supply module 24V AC/DC.

Availability of a given type of power supply may vary depending on the type of communication protocol selected, as shown in the following table:

Power supply	*M-bus*	*M-bus Wireless*	*Modbus RTU*	*Modbus TCP/IP*	*BACnet® MS/TP*	*BACnet® IP*	*LoRaWan*
Battery	✓	✓	NO	NO	NO	NO	✓
230V AC	✓	On request	✓	✓	✓	✓	On request
24V AC/DC	✓	On request	✓	✓	✓	✓	On request

Devices equipped with external power supply are supplied without the connecting cable.

COMPONENTS REPLACEMENT

The EM403 thermal energy meter is modular, meaning that if it is needed to replace one of the internal components of the device, it is not necessary to renew the entire device. The replaceable elements are:

- Power module
- Communication module
- Temperature probes

Regarding the temperature probes, the replacement must be done for both components (T1 probe and T2 probe). Replacement of the single probe is not allowed.

GENERAL NOTES

For further technical and installation information, please refer to the dedicated literature or directly contact Pettinaroli technical support.

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