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Thermal energy meters - Part 4: Pattern approval tests

Thermische Energiemessgeräte - Teil 4: Prüfungen für die Bauartzulassung

Compteurs d'énergie thermique - Partie 4 : Essais en vue de l'approbation de modèle

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ICS:

17.200.20	Instrumenti za merjenje temperature	Temperature-measuring instruments

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This European Standard was approved by CEN on 17 July 2022.

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European foreword

This document (EN 1434-4:2022) has been prepared by Technical Committee CEN/TC 176 “Thermal energy meters”, the secretariat of which is held by SIS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2023, and conflicting national standards shall be withdrawn at the latest by March 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1434-4:2015+A1:2018.

EN 1434, *Thermal energy meters*, consists of the following parts:

— *Part 1: General requirements*;

— *Part 2: Constructional requirements*;

— *Part 3: Data exchange and interfaces*[1];

— *Part 4: Pattern approval tests*;

— *Part 5: Initial verification tests*;

— *Part 6: Installation, commissioning, operational monitoring and maintenance*.

In comparison with EN 1434-4:2015+A1:2018, the following changes have been made:

— addition of fluids other than water as well as electromagnetic field frequency groups and electromagnetic field distance groups on the test programme in 7.2;

— addition of performance test with fluids other than water, tapping profile test for fast response meters and general testing of temperature sensors in 7.4;

— addition of durability test for bifunctional thermal energy meters, durability test for fluids other than water and accelerated durability test for temperature sensors in 7.8;

— addition of information on supply voltage and output impedance for surge transients in 7.11;

— addition of 7.12.1 “Low frequency fields” and 7.12.2 “High frequency fields”;

— addition of 7.13.1 “Electromagnetic field in distant proximity” and 7.13.2 “Electromagnetic field in close proximity”;

— addition of pressure loss with fluids other than water in 7.19;

— reference for electromagnetic emission has been updated in 7.20;

[1] EN 1434-3 is maintained by CEN/TC 294.

— addition of asymmetric swirl generator and performing flow disturbance test with liquids other than water in 7.22;

— checklist for type approvals has been updated in Annex B;

— addition of Annex D including dimensions of asymmetric swirl generator;

— Annex ZA has been updated.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s) / Regulation(s).

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This document specifies pattern approval tests for thermal energy meters. Thermal energy meters are instruments intended for measuring the energy which in a heat-exchange circuit is absorbed (cooling) or given up (heating) by a liquid called the heat-conveying liquid. The thermal energy meter indicates the quantity of thermal energy in legal units.

This document covers meters for closed systems only, where the differential pressure over the thermal load is limited.

This document is not applicable to:

— electrical safety requirements;

— pressure safety requirements; and

— surface mounted temperature sensors.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1434-1:2022, *Thermal energy meters — Part 1: General requirements*

EN 60068-2-1:2007, *Environmental testing — Part 2-1: Tests — Test A: Cold (IEC 60068-2-1:2007)*

EN 60068-2-2:2007, *Environmental testing — Part 2-2: Tests — Test B: Dry heat (IEC 60068-2-2:2007)*

EN 60068-2-30:2005, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle (IEC 60068-2-30:2005)*

EN 60068-2-78:2013, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state (IEC 60068-2-78:2012)*

EN 60751:2008, *Industrial platinum resistance thermometers and platinum temperature sensors (IEC 60751:2008)*

EN 61000-4-2:2009, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test (IEC 61000-4-2:2008)*

EN 61000-4-3:2006,[2] *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3:2006)*

EN 61000-4-4:2012, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test (IEC 61000-4-4:2012)*

EN 61000-4-5:2014,[3] *Electromagnetic compatibility (EMC) — Part 4-5: Testing and measurement techniques — Surge immunity test (IEC 61000-4-5:2014)*

[2] Document is impacted by /A1:2008 and /A2:2010.
[3] Document is impacted by /A1:2007.

EN 61000-4-6:2014,[4] *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:2013)*

EN 61000-4-8:2010, *Electromagnetic compatibility (EMC) — Part 4-8: Testing and measurement techniques — Power frequency magnetic field immunity test (IEC 61000-4-8:2009)*

EN IEC 61000-4-11:2020,[5] *Electromagnetic compatibility (EMC) — Part 4-11: Testing and measurement techniques — Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase (IEC 61000-4-11:2020)*

EN 61000-4-39:2017, *Electromagnetic Compatibility (EMC) — Part 4-39: Testing and measurement techniques — Radiated fields in close proximity — Immunity test (IEC 61000-4-39:2017)*

EN 61000-6-3:2007,[6] *Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3:2006)*

EN 61326-1:2013, *Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 1: General requirements (IEC 61326-1:2012)*

EN ISO 4064-2:2017, *Water meters for cold potable water and hot water — Part 2: Test methods (ISO 4064-2:2014)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1434-1:2022 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

4 General

The procedure shall ascertain that the pattern conforms to the metrological requirements of this document. In addition to the checking of the documentation (Clause 8) and the comparison of the pattern with the metrological requirements of this European Standard, the tests in Clause 7 shall be performed.

It is recommended to use a checklist as in Annex B to report in a standardized way the result of the comparison between the patterns under approval with the essential requirements of this document.

5 Requirements

Under normal operating conditions, the error of thermal energy meters or their sub-assemblies shall not exceed the maximum permissible error, MPE specified in EN 1434-1:2022.

When thermal energy meters or their sub-assemblies are exposed to disturbances, significant faults shall not occur.

[4] Document is impacted by AC:2015.
[5] Document is impacted by /AC:2020.
[6] Document is impacted by /A1:2011 and /A1:2011/AC:2012.

6 Specification of operating conditions

6.1 Rated operating conditions

The rated operating conditions are those given in Table 1.

Table 1 — Rated operating conditions

Environmental class	A	B	C
Ambient temperature in °C	+5 to +55	−25 to +55	+5 to +55
Relative humidity in %	< 93		
Mains supply voltage in V	195 V to 253 V		
Mains frequency	f_{nom} ± 2 %		
Battery voltage	The voltage of a battery in service under normal conditions		
Remote AC supply voltage	12 V to 36 V		
Remote DC supply voltage	12 V to 42 V		
Local external DC supply voltage	As specified by manufacturer		

6.2 Reference conditions

Range of ambient temperature: +15 °C to +35 °C

Range of relative humidity: 25 % to 75 %

Range of ambient air pressure: 86 kPa to 106 kPa

Basic mounting orientation

The actual temperature and relative humidity within the specified range shall not vary by more than ± 2,5 K and ± 5 percentage points respectively during the period of one measurement.

The reference conditions for a sub-assembly shall be the conditions under which it would operate if it was a part of a combined thermal energy meter.

6.3 Reference values for the measurand (RVM)

6.3.1 General

For bifunctional thermal energy meters, the RVM shall be based on the values for the heating range.

6.3.2 Reference values for the measurand

Table 2 — Reference values for heating and cooling

	Heating applications	Cooling applications
Range of temperature difference:	(40 ± 2) K	(10 ± 2) K
Range of flow rate:	(0,7 to 0,75) q_p in m^3/h	(0,7 to 0,75) q_p in m^3/h
Outlet temperature:	(50 ± 5) °C	(15 ± 5) °C

The conditions, mentioned in Table 2, are reference values for a complete thermal energy meter. Reference values for sub-assemblies are the relevant parts of the conditions mentioned in Table 2.

Flow rate simulation for the flow sensor electronics is allowed, but testing with water is always preferred. The temperature of the liquid in the flow sensor shall be kept at (50 ± 5) °C or at ambient temperature. The power and signal wires shall be connected. The flow sensor including flow sensor electronics shall be operated at zero flow rate (without low flow cut off device).

7 Tests and measurements

7.1 General

Unless otherwise stated in the test specification, the test requirements apply irrespective of the thermal energy meter's environmental class. See EN 1434-1:2022, Clause 10.

All measurements shall be carried out under the installation conditions stipulated by the manufacturer for his type of meter (e.g. straight sections of piping upstream and downstream of the meter). For all tests the heat conveying liquid shall be water, unless otherwise specified. The performance test shall be carried out with the specified liquid and the type approval certificate shall include the specification of the liquid to be used for initial verification.

If a temperature sensor can be installed in the flow sensor, this shall be done during the performance tests of the flow sensor. Where a filter or strainer is an integral part of the flow sensor, it shall be included at all tests.

If the error determined lies outside the MPE, the test shall be repeated twice unless otherwise stated. The test is satisfactory declared if both the arithmetic mean of the result of the three tests and at least two of the test results are within or at the MPE.

Depending on the flow sensor size the tests and measurements to be carried out are described below:

For each meter model the test in 7.4, 7.18 and 7.19 can be carried out on a limited number of sizes according to an evaluation by the testing laboratory. This evaluation shall be included in the type testing report.

The test in 7.8 shall be carried out only for those sizes of a type for which the highest wear is expected.

For dimensions > DN 200, 7.19 shall be carried out at θ_{min}.

For each meter model the following tests shall be carried out on one size only: 7.5, 7.6, 7.7, 7.9, 7.10, 7.11, 7.12, 7.13, 7.14, 7.15, 7.16, 7.17, 7.20, 7.21 and 7.23.

Tests of additional energy registers for smart metering functionalities:

The accuracy of thermal energy accumulation into the additionally and independently energy registers shall be tested by energy performance tests according to 7.4.

NOTE In applications of smart metering, one or both single sensors of the pair are used as additional single sensor.

Additional tests for control quantities, the internal clock, external digital signal, single temperature sensors, calculators and calculators with single sensors shall be done according to requirements in EN 1434-1:2022, 5.10. It shall be tested that the specific MPE according to EN 1434-1:2022, 5.10.5 for tolerance quantities, used for threshold activation of additional energy accumulations will be met.

The absence of software-interaction between all energy registers shall be proved in accordance with the WELMEC Guide “7.2 Software”, respective latest edition. This shall be done for both directions of energy flow, in cases of delivered and absorbed energy (heat and cooling meter).

Each additional register under test shall be activated by the corresponding control quantity. It shall be ascertained that the specific activated register content on display is corresponding to the changes of control quantity, as expected and by at least one totalizer energy increment.

By metrological tests the accuracy of generating and processing, the accumulated energy values in dependency on the parameterisation of the corresponding control parameters shall be tested. By checking of the switch-on/off parameters, it shall be ascertained that the control quantity and the values thereof are indicated on display properly. The information on the display shall not deviate from the real measurement with respect to measurement conditions.

7.2 Test programme

Samples of a thermal energy meter, or its sub-assemblies, submitted for pattern approval, shall be subject to tests to verify their conformity with Clause 4. Unless otherwise stated, the tests shall be carried out at reference conditions and the samples shall be exposed to the influence factors or disturbances specified for the respective tests, as stated in Table 3.

Meters for the use with heat-conveying liquids other than water have to perform the following tests with liquids other than water:

— Performance test (7.4); the test shall be performed with the specified liquid and concentration. For meters for multiple specified liquids and/or multiple specified concentrations the manufacturer shall prove (preferably by experiment which may be supported by calculation and simulation) that the meter is capable to adapt to the physical properties of the liquid. The number of tests can then be reduced by sample testing e.g. for some of the specified liquids and/or specified concentrations. Minimum is one fluid for each liquid category.

— Flow disturbance test (7.22); the effect of flow disturbances is changing for liquids other than water because the viscosity of the liquid is an additional influence on the flow profile. Therefore, this test shall be carried out at the limits of the foreseen field of operation with regard to viscosity and density- so at the highest and lowest viscosity and density expected with the stated liquids, temperatures and concentrations.

— Durability test (7.8); the effect of abrasion and deposition is changing for liquids other than water because the viscosity and density of the liquid is an additional factor on the flow behaviour. Therefore, this test shall be carried out at the limits of the foreseen field of operation with regard to viscosity and density- so at the highest and lowest viscosity and density expected with the stated liquids, temperatures and concentrations.

As a further test, an ageing test of all parts in contact with the medium, including all seals, shall be carried out over 2 months. The test shall be performed with the heat conveying liquid to be approved. During the test, the medium may be at zero flow. Before and after this test the meter shall comply with the MPE. The parts in contact with the medium shall be visually inspected after the test. This test is used to investigate chemical interactions or swelling of the materials in direct contact with the liquid e.g. plastics/seals.

The test sequence and the number of items used shall be either as described in Table 3 or as agreed between the manufacturer and the testing laboratory (assuming four samples, numbered by the testing laboratory).

Only one influence quantity shall be applied at a time.

If the meter under test (complete, combined or sub-assemblies) has test outputs for quantity of water, temperature difference and/or energy, these outputs can be used to test such parameters.

Table 3 — Test programme for thermal energy meters and their sub-assemblies

Test	Subclause	Exposure	Temperature sensor pair	Flow sensor	Calculating device	Complete meter	Item number
		Influence factors					
MPE	7.4	Performance test	X	X	X	X	2
MPE	7.5	Dry heat		X [a]	X	X	2
MPE	7.6	Cold		X [a]	X	X	2
MPE	7.7	Static deviations in supply voltage		X [a]	X	X	2
		Disturbances					
NSF [a]	7.8	Durability	X [d]	X		X	4
NSF	7.9.1	Damp heat, cyclic	X	X [a]	X	X	1
NSF	7.9.2	Damp heat, steady-state	X [c]	X [c]		X	1
NSF	7.10	Short time reduction in supply voltage		X	X	X	3
NSF [a]	7.11	Electrical transients		X [a b]	X [b]	X	3
NSF [d]	7.12.1	Low frequency electromagnetic field		X [a b]	X [b]	X	3
NSF [d]	7.12.2	High frequency electromagnetic field		X [a b]	X [b]	X	3
NSF [d]	7.13.1	Electromagnetic field – distant proximity		X [a b]	X [b]	X	3
NSF [a]	7.13.2	Electromagnetic field – close proximity					
NSF [d]	7.14	Radio frequency, amplitude modulated		X [a b]	X [b]	X	3
NSF [a]	7.15	Electrostatic discharge		X [a]	X	X	3
NSF [d]	7.16	Static magnetic field		X	X	X	3
NSF [d]	7.17	Mains frequency magnetic field		X [a]	X	X	3

Test	Subclause	Exposure	Temperature sensor pair	Flow sensor	Calculating device	Complete meter	Item number
NSF [a]	7.18	Internal pressure		X		X	1
	7.19	Pressure loss		X		X	1
	7.20	Electromagnetic emission		X [a]	X [b]	X	3
	7.21	24 hrs interruption			X	X	3
NSF [d]	7.22	Flow disturbances		X		X	1
NSF [a]	7.23	Vibration/ mechanical shock	X	X	X	X	2

MPE Maximum permissible error according to EN 1434-1:2022, Clause 9.

NSF [d] No signification fault shall occur during the test.

NSF [a] No signification fault shall occur after the test.

X Test to be performed.

[a] Only for flow sensors with electronic devices.

[b] This test shall be done with connected cables.

[c] For cooling meters / sub-assemblies with at least IP 65.

[d] This test shall be done with 12 temperature sensor pairs in total.

For bifunctional thermal energy meters, the tests in 7.4 shall cover both functions, the tests in 7.6 and 7.9 shall be carried out using the cooling function, but all other tests shall be carried out using the heating function. (For RVM values see 6.3.)

7.3 Uncertainty of test equipment and influences of EUT

Standards, instruments and methods used in pattern approval tests shall suit the purpose, be traceable to more precise standards and be part of a reliable calibration programme.

The uncertainties associated with these standards, methods and measuring instruments shall always be known. They shall be calculated with a coverage factor of 2 corresponding to a coverage probability of 95 %.

The expanded uncertainties shall either:

a) not exceed 1/5 of the maximum permissible errors of the thermal energy meter or the sub-assemblies,

or

b) if the uncertainty is higher than 1/5 of MPE, the value of the difference between uncertainty and 1/5 MPE shall be subtracted from MPE, to calculate a new reduced MPE.

The use of a) is recommended.

Uncertainty influences (combination of resolution and repeatability) coming from equipment under test shall not be more than 30 % for the flow sensor, 20 % for the calculator and 60 % for the temperature sensor pair of the MPE of each sub-assembly.

7.4 Performance tests

7.4.1 General

The initial intrinsic error shall be determined at least at the conditions stated in 7.4.2, 7.4.3, 7.4.4 and 7.4.5.

7.4.2 Flow sensor

7.4.2.1 General

All performance tests shall be carried out three times.

For a meter model with more than one specified mounting orientation, the performance testing shall be performed in the orientation, where the higher influences are expected.

Tests of flow sensors shall be done above minimum operation pressure specified by the manufacturer with examination of absence of cavitation.

It shall be tested, that the volume and energy registers for billing purposes will not decrement in the case of reverse flow rate.

7.4.2.2 Flow rates

Flow rates:

$$q_1\,{}^{0}_{-10}\,\%,\ q_2 \pm 5\%,\ q_3 \pm 5\%,\ q_4 \pm 5\%,\ \text{and}\ q_5\,{}^{+10}_{0}\,\%$$

where

$$q_1 = q_s \ \text{and}\ q_5 = q_i,\ q_1 / q_2 = q_2 / q_3 = q_3 / q_4 = q_4 / q_5 = K$$

where

$$K = \sqrt[4]{\frac{q_s}{q_i}}$$

The test flow rate nearest to 0,7 q_p to 0,75 q_p shall be changed to be within 0,7 q_p to 0,75 q_p in order to obtain one point within RVM conditions. The water temperatures for this test are shown in Table 4.

Table 4 — Water temperatures

	Applications	
	Heating	**Cooling**
Test points	All	All
a	(θ_{min} to θ_{min} + 5) °C (but not less than 10 °C)	(15 ± 5) °C
b	(50 ± 5) °C	(5 ± 1) °C
c	(85 ± 5) °C	