SLOVENSKI STANDARD
SIST EN 1434-4:2016+A1:2019

01-marec-2019

Nadomešča:
SIST EN 1434-4:2016

Merilniki toplote - 4. del: Preskusi za odobritev tipa (vključno z dopolnilom A1)

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

Ta slovenski standard je istoveten z: EN 1434-4:2015+A1:2018

ICS:

17.200.10 Toplota. Kalorimetrija Heat. Calorimetry

SIST EN 1434-4:2016+A1:2019 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1434-4:2015+A1

November 2018

ICS 17.200.10

English Version

Thermal energy meters - Part 4: Pattern approval tests

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

Wärmezähler - Teil 4: Prüfungen für die Bauartzulassung

This European Standard was approved by CEN on 5 September 2015 and includes Amendment 1 approved by CEN on 18 July 2018.

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Ref. No. EN 1434-4:2015+A1:2018 E

Contents

Page

European foreword

This document (EN 1434-4:2015+A1:2018) 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of an identical text or by endorsement, at the latest by May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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 includes Amendment 1, approved by CEN on 2018-07-18.

This document supersedes ▌A1⟩ EN 1434-4:2015 ⟨A1▌.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ▌A1⟩ ⟨A1▌.

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

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

EN 1434, ▌A1⟩ *Thermal energy meters* ⟨A1▌ 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 to EN 1434-4:2007, the following changes have been made:

— metrological requirements for smart metering applications are added;

— additional functionalities for smart metering applications are added;

— cooling meters are added;

— influences of sensors are added;

— tests for cooling applications and for fast response meters are added;

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

— test for additional functionalities for smart metering applications, e.g. internal clock, external digital signal, absolute temperature are added;

— calculator with single temperature sensor are added;

— test for communication interfaces, endurance test for flow sensors and accelerated durability test are added;

— electromagnetic field caused by digital radio equipment;

— static magnetic field;

— test procedure for temperature sensor pairs with pockets and without pockets.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies pattern approval tests for [A1] thermal energy meters [A1]. [A1] Thermal energy meters [A1] 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 [A1] thermal energy meter [A1] indicates the quantity of heat in legal units.

Electrical safety requirements are not covered by this European Standard.

Pressure safety requirements are not covered by this European Standard.

Surface mounted temperature sensors are not covered by this European Standard.

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[A1] EN 1434-1:2015+A1:2018, *Thermal energy meters — Part 1: General requirements* [A1]

EN 55022, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement (CISPR 22:2008)*

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

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

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

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

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

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

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

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

EN 61000-4-6:2014, *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, *Electromagnetic compatibility (EMC) — Part 4-8: Testing and measurement techniques — Power frequency magnetic field immunity test (IEC 61000-4-8)*

EN 61000-4-11, *Electromagnetic compatibility (EMC) — Part 4-11: Testing and measurement techniques — Voltage dips, short interruptions and voltage variations immunity tests (IEC 61000-4-11)*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ⟦A1⟩ EN 1434-1:2015+A1:2018 ⟨A1⟧ apply.

4 General

The procedure shall ascertain that the pattern conforms to the metrological requirements of this European Standard. In addition to the checking of the documentation (Clause 7) and the comparison of the pattern with the metrological requirements of this European Standard, the tests in Clause 6 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 European Standard.

5 Requirements

Under normal operating conditions, the error of ⟦A1⟩ thermal energy meters ⟨A1⟧ or their sub-assemblies shall not exceed the maximum permissible error, MPE specified in EN 1434-1.

When ⟦A1⟩ thermal energy meters ⟨A1⟧ or their sub-assemblies are exposed to disturbances, significant faults shall not occur.

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 [A1] thermal energy meter [A1].

6.3 Reference values for the measurand, RVM

6.3.1 General

For [A1] bifunctional thermal energy meters [A1] the RVM shall be based on the values for the heating range.

6.3.2 Reference values for the measurand, RVM

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 m³/h	(0,7 to 0,75) q_p in m³/h
Outlet temperature:	(50 ± 5) °C	(15 ± 5) °C

The conditions, mentioned in Table 2, are reference values for a complete [A1] thermal energy meter [A1]. 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 [A1] thermal energy meter's [A1] environmental class. See [A1] EN 1434-1:2015+A1:2018, Clause 10 [A1].

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 ▌A1⟩ EN 1434-1:2015+A1:2018, 5.10 ⟨A1▌. It shall be tested that the specific MPE according to ▌A1⟩ EN 1434-1:2015+A1:2018, 5.10.5 ⟨A1▌ 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 ▌A1⟩ thermal energy meter ⟨A1▌, 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.

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 [A1] thermal energy meters [A1] 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					
NSFa	7.8	Durability	X	X		X	4
NSF	7.9.1	Damp heat, cyclic	X	X[a]	X	X	1
	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
NSFa	7.11	Electrical transients		X[a,b]	X[b]	X	3
NSFd	7.12	Electromagnetic field		X[a,b]	X[b]	X	3
NSFd	7.13	Electromagnetic field – digital radio equipment		X[a,b]	X[b]	X	3
NSFd	7.14	Radio frequency, amplitude modulated		X[a,b]	X[b]	X	3
NSFa	7.15	Electrostatic discharge		X[a]	X	X	3
NSFd	7.16	Static magnetic field		X	X	X	3
NSFd	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
NSFa	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
NSFd	7.22	Flow disturbances		X		X	1
NSFa	7.23	Vibration/ mechanical shock	X	X	X	X	2

MPE Maximum permissible error according to [A1] EN 1434-1:2015+A1:2018, Clause 9 [A1].

NSFd No signification fault shall occur during the test.

NSFa 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 for meters / sub-assemblies with at least IP 65.

For [A1] bifunctional thermal energy meters [A1] 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 [A1] thermal energy meter [A1] 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:

$q_{1\,-10}^{\;0}\,\%$, $q_2 \pm 5\%$, $q_3 \pm 5\%$, $q_4 \pm 5\%$ and $q_5\,^{+10}_{0}\,\%$

where

$q_1 = q_s$ 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.

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		

The water temperature at the [A1] thermal energy meter [A1] shall not vary by more than 2 K during a measurement.

For flow sensors larger than DN 250, testing at water temperature a) only, is considered sufficient if the following conditions are satisfied:

— the test results for smaller flow sensors of the same model are inside MPE for all water temperatures;

— documentary evidence is given that technological similarity exists between the models tested and the larger sizes applied for.

7.4.2.3 Electromagnetic type flow sensors

Electromagnetic type flow sensors shall be tested with water having an electrical conductivity higher than 200 µS/cm.

If the manufacturer has stated a lower permitted conductivity, tests shall also be performed at that conductivity at the flow rates q_1 and q_5, and at the water temperature a). The conductivity shall be noted in the certificate.

If the electronic part of the flow sensor is separated from the sensor head, the type and the maximum length of the connecting cable to the electrodes shall be stated by the manufacturer, be used for the above mentioned low conductivity test and noted in the certificate.

7.4.2.4 Fast response meters

For fast response meters the transient behaviour of the flow sensors of size $q_p \leq 2{,}5\ m^3/h$ shall be investigated by measuring the total quantity of water delivered in 10 to 15 cycles, consisting of 10 s period at a flow rate of q_s and 30 s period at zero flow rate.

The duration of start and stop shall be (1 ± 0,2) s.

The water temperature shall be as a) in 7.4.2.2.

The error shall not exceed the MPE.

For a complete or combined meter, the water temperature specified above is the outlet temperature. The temperature difference shall be the maximum obtainable, but shall not exceed 42 K.

7.4.3 Calculator

7.4.3.1 Heating and cooling applications

The calculator shall be tested at the following simulated temperatures:

Table 5 — Testing temperatures for heating applications

Temperature °C	Temperature difference K
a) $\theta_{outlet} = \left(\theta_{\min}{}^{+5}_{0}\right)$	$\Delta\Theta_{\min}$, 5, 20, $\Delta\Theta_{RVM}$
b) $\theta_{outlet} = \left(\theta_{RVM} \pm 5\right)$	$\Delta\Theta_{\min}$, 5, 20, $\Delta\Theta_{RVM}$, $\Delta\Theta_{\max}$ [a]
c) $\theta_{inlet} = \left(\theta_{\max}{}^{0}_{-5}\right)$	20, $\Delta\Theta_{RVM}$, $\Delta\Theta_{\max}$
[a] The level corresponding to $\Delta\Theta_{\max}$ shall be reduced if needed to be within $\theta_{\max}$.	