SLOVENSKI STANDARD
oSIST prEN 1434-5:2020

01-november-2020

Merilniki toplote - 5. del: Preskusi prve overitve

Thermal energy meters - Part 5: Initial verification tests

Thermische Energiemessgeräte - Teil 5: Tests für Konformitätsuntersuchungen und Eichungen

Compteurs d'énergie thermique - Partie 5 : Essais de vérification initiaux

Ta slovenski standard je istoveten z: **prEN 1434-5**

ICS:

17.200.20	Instrumenti za merjenje temperature	Temperature-measuring instruments

oSIST prEN 1434-5:2020 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 1434-5

November 2020

ICS 17.200.20

Will supersede EN 1434-5:2015+A1:2019

English Version

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Thermische Energiemessgeräte - Teil 5: Tests für Konformitätsuntersuchungen und Eichungen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 176.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. prEN 1434-5:2020 E

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European foreword

This document (prEN 1434-5:2020) has been prepared by Technical Committee CEN/TC 176 “Thermal heat meters”, the secretariat of which is held by SIS.

This document is currently submitted to the CEN Enquiry.

This document supersedes EN 1434-5:2015+A1:2019.

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 to EN 1434-5:2015+A1:2019, the following changes have been made:

— the third calibration temperature Θ_3 for extrapolation error of sensor pairs was changed in Table 1.

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).

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

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

1 Scope

This document specifies initial verification 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.

Electrical safety requirements are not covered by this document.

Pressure safety requirements are not covered by this document.

Surface mounted temperature sensors are not covered by this document.

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

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.

prEN 1434-1:2020, *Thermal energy meters — Part 1: General*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 1434-1:2020 apply.

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

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

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

4 General

Initial verification of a measuring instrument is a series of tests and visual examinations carried out to determine whether an instrument manufactured to replicate a given pattern conforms to that pattern and to regulations, and that its metrological characteristics lie within the limits of the maximum permissible errors. If the instrument passes all tests and examinations, it is given legal character by its acceptance as evidenced by stamping and/or issuance of a certificate of verification.

The provisions of this standard also apply to the re-verification of thermal energy meters.

The instrument shall be tested under rated operating conditions at the extremes and midpoints of its ranges.

Initial verification is divided into metrological, technical and administrative phases.

In tests of a thermal energy meter as a combined instrument, the flow sensor, the temperature sensors and the calculator shall each be tested separately.

Unless otherwise stated in the certificate of pattern approval, the verification shall be carried out in accordance with this standard.

Modern thermal energy meters are mainly equipped with CMOS microprocessors with a very low power consumption, allowing battery operation. Testing and adjusting of this type of meter needs a completely different approach. Until now, almost every meter type needed its own test equipment to handle the manufacturer's specific requirements. This is a very complicated and expensive way for users of several types of meters and for initial verification institutes. The more different types of thermal energy meters a user has installed, the more testing equipment he may need. An economical testing of several meters should be possible and an easy adaptation to the existing test bench is of great interest.

Since this problem came up, experts have been researching an acceptable solution to it. Details of one example of an acceptable solution are given in “Normierter Wärmezähler Adapter” (Standardized heat meter adapter) Version 1.5 of September 2000, AGFW Merkblatt 6, Band 2, Frankfurt, Germany.

5 Uncertainty of test equipment

Standards, instruments and methods used in verification 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 either:

a) not exceed 1/5 of the MPE (maximum permissible error) of the EUT (equipment under test),

or, if exceeding 1/5 of the MPE,

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.

It is recommended that option a) is used.

6 Tests to be carried out

6.1 General

If the error determined lies outside the MPE, the test shall be repeated twice. The test is then declared satisfactory 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.

The meters shall not exploit the MPE or systematically favour any party. Each individual meter with electronic abilities for adjustments of their error curves, where the errors are aligned into the same sign (±) in the complete measuring range, shall only pass the verification assessment if any of the errors does not exceed half of the MPE. Mechanical meters (e.g. Woltman Turbine Meters) with no abilities by electronic adjustments shall be produced as close as possible to zero error.

For information regarding bath constructions, see prEN 1434-4:2020, Annex A. For initial verification tests for temperature sensors the recommended ambient temperature is (23 ± 2) °C.

6.2 Flow sensors

The verification of the flow sensor shall be carried out within each of the following flow rate ranges at a liquid temperature of (50 ± 5) °C for heating applications and (15 ± 5) °C for cooling applications.

a) $q_i \leq q \leq 1{,}2\, q_i$

b) $0{,}1\, q_p \leq q \leq 0{,}11\, q_p$

c) $0{,}9\, q_p \leq q \leq 1{,}1\, q_p$

If the pattern approval certificate so provides, the verification may be carried out with cold water in accordance with the procedures laid down in the certificate.

When testing the flow sensors, the guidelines in the pattern approval certificate shall be followed (e.g. requirements for water conductivity, water temperature, straight inlet/outlet tubes).

To enable rapid testing of the flow sensor, it is customary to bypass the output signal used by the calculator. However, for at least one test, this signal shall be included.

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

6.3 Temperature sensor pair

6.3.1 Error in temperature difference

The individual temperature sensors of the temperature sensor pair shall be tested, without their pockets, in the same temperature bath at temperatures within each of the three temperature ranges in Table 1.

Table 1 — Test temperature ranges

Test points	Test temperature range	
θ_1	$\theta_{\min}$ to $\left(\theta_{min} + 10K\right)$	
θ_2	$\frac{\theta_1 + \theta_3}{2} \pm 5K$	
θ_3	$\theta_{max} \leq 150°C$	$\left(\theta_{max} - 10K\right)$ to $\theta_{\max}$
	$\theta_{max} > 150°C$	$\left(\theta_{max} - 30K\right)$ to $\theta_{\max}$ but in any case more than 140 °C
NOTE If specified in the pattern approval certificate, variations in the temperature ranges and the number of temperatures are permissible.		

The immersion depth of the sensor under test shall be at least 90 % of the total length.

The determined resistance values shall be used in a system of three equations to calculate the three constants of the temperature/resistance formula of EN 60751 and a curve shall be drawn through the three test points. Thereby the characteristic curve for the temperature sensor is known.

The “ideal” curve using the standard constants of EN 60751 shall be generated. To give the error at any temperature, the “ideal” curve shall be subtracted from the characteristic curve for each temperature sensor.

As a further step, the worst case error of the temperature sensor pair shall be determined over the temperature range and over the temperature difference range specified for the sensors.

For outlet temperatures above 80 °C, only temperature differences over 10 K shall be taken into account.

The error determined as described above shall be within the limits stated in prEN 1434-1:2020, 9.2.2.2.

When measuring resistance, the current shall be such, that the power dissipation does not exceed 0,2 mW RMS.

6.3.2 Insulation resistance

The resistance between each terminal and the sheath shall be measured with a test DC-voltage between 10 V and 100 V and under ambient conditions between 15 °C and 35 °C and at a relative humidity not exceeding 80 %. The polarity of the test current shall be reversed. In all cases, the resistance shall not be less than 100 MΩ.

6.3.3 Single temperature sensor for smart metering applications

The compliance with the permissible error of the temperature sensor of ± 0,7 K compared to the performance curve according to EN 60751, including the signal cables thereof, shall be tested for each temperature sensor at three typical temperature points for field applications (e.g. 10 °C; 30 °C; 50 °C).

6.4 Calculator

The calculator shall be tested, at least within each of the following temperature difference ranges:

For heating applications:

a) $\Delta\Theta_{min} \leq \Delta\Theta \leq 1{,}2\ \Delta\Theta_{min}$

b) $10\ K \leq \Delta\Theta \leq 20\ K$

c) $\Delta\Theta_{max} - 5\ K \leq \Delta\Theta \leq \Delta\Theta_{max}$

For cooling applications:

a) $\Delta\Theta_{min} \leq \Delta\Theta \leq 1{,}2\ \Delta\Theta_{min}$

b) $0{,}8\ \Delta\Theta_{max} \leq \Delta\Theta \leq \Delta\Theta_{max}$

The simulated flow rate signal shall not exceed the maximum acceptable by the calculator.

The outlet temperature shall be in the temperature range between (50 ± 5) °C for heating applications and (15 ± 5) °C for cooling applications, if not otherwise stated in the pattern approval certificate.

To enable rapid testing of the calculator, it is customary to by-pass the indicating device of the thermal energy meter. However, for at least one test, the meter's indicating device shall be included.

Additional test for bifunctional meters for change-over systems between heating and cooling:

An example for the switching over from heating to cooling register and reversed is given in prEN 1434-1:2020, Figure 1.

It shall be tested that:

— heating energy shall only be recorded at $\Delta\Theta > \Delta\Theta_{hc}$ and at $\theta_{inlet} > \theta_{hc}$.

— cooling energy shall only be recorded at $\Delta\Theta < -\Delta\Theta_{hc}$ and at $\theta_{inlet} < \theta_{hc}$.

no heating and cooling energies shall be recorded between $-\Delta\Theta_{hc}$ and $\Delta\Theta_{hc}$. The general test in this clause shall be performed both for the heating and the cooling function using the correct heat coefficient (depending on installation of the flow sensor in higher respectively lower temperature).

6.5 Calculator and temperature sensor pair

6.5.1 Heating and cooling applications

The sub-assembly of calculator and temperature sensor pair shall be tested using temperature ranges of 6.4 and the temperature difference ranges of 6.3.

Additionally, a final test of the sub-assembly is necessary, with the temperature sensor pair immersed in two temperature regulated baths. The temperature difference of the baths shall be between 3 K and 4 K.

The simulated flow rate shall not create a signal exceeding the maximum signal acceptable by the calculator.

If the calculator and temperature sensor pair are tested as an inseparable sub-assembly, it shall be tested in accordance with 6.4.

6.5.2 Calculator with single temperature sensor for smart metering applications

The compliance with the permissible error on temperature indication of the inlet and outlet temperatures compared to the correct value of the measured temperature of ± 1,0 K shall be tested. The test shall be examined in accordance with 6.3.3 and 6.4.

6.6 Combined thermal energy meter

The flow sensor, the temperature sensor pair and the calculator shall be each tested separately, in accordance with 6.2 to 6.4.

6.7 Complete meter

The verification of the complete meter shall be carried out, at least within each of the following ranges.

For heating applications:

a)	$\Delta\Theta_{min}$	$\leq \Delta\Theta \leq$	$1{,}2\ \Delta\Theta_{min}$	and	$0{,}9\ q_p$	$\leq q \leq$	$1{,}1\ q_p$
b)	10 K	$\leq \Delta\Theta \leq$	20 K	and	$0{,}1\ q_p$	$\leq q \leq$	$0{,}11\ q_p$
c)	$\Delta\Theta_{max}$- 5 K	$\leq \Delta\Theta \leq$	$\Delta\Theta_{max}$	and	q_i	$\leq q \leq$	$1{,}2\ q_i$

For cooling applications:

a)	$\Delta\Theta_{min}$	$\leq \Delta\Theta \leq$	$1{,}2\ \Delta\Theta_{min}$	and	$0{,}9\ q_p$	$\leq q \leq$	$1{,}1\ q_p$
b)	$0{,}8\ \Delta\Theta_{max}$	$\leq \Delta\Theta \leq$	$\Delta\Theta_{max}$	and	$0{,}1\ q_p$	$\leq q \leq$	$0{,}11\ q_p$
c)	$0{,}8\ \Delta\Theta_{max}$	$\leq \Delta\Theta \leq$	$\Delta\Theta_{max}$	and	q_i	$\leq q \leq$	$1{,}2\ q_i$

The outlet temperature shall be in the temperature range of (50 ± 5) °C for heating applications and (15 ± 5) °C for cooling applications, if not otherwise stated in the pattern approval certificate.

To enable rapid testing of the complete meter, it is customary to bypass the indicating device of the thermal energy meter. However, for at least one test, the meter's indicating device shall be included.

Additional test for bifunctional meters for change-over systems between heating and cooling: