

INTERNATIONAL STANDARD



**Household electric cooking appliances –
Part 1: Ranges, ovens, steam ovens and grills – Methods for measuring
performance**



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INTERNATIONAL STANDARD



**Household electric cooking appliances –
Part 1: Ranges, ovens, steam ovens and grills – Methods for measuring
performance**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD ELECTRIC COOKING APPLIANCES –

**Part 1: Ranges, ovens, steam ovens and grills –
Methods for measuring performance**

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60350-1:2016+AMD1:2021 CSV. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60350-1 has been prepared by subcommittee 59K: Performance of household and similar electrical cooking appliances, of IEC technical committee 59: Performance of household and similar electrical appliances. It is an International Standard.

This third edition cancels and replaces the second edition published in 2016 and Interpretation Sheet 1:2021. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) new definitions for heating function, eco function and definitions relevant for low power mode considerations are amended in Clause 3;
- b) order of clauses is changed;
- c) revision of 5.3;
- d) update of 6.2 in order to improve the reliability of volume measurement;
- e) removal of 6.7, Level of shelf;
- f) revision of Clause 7 concerning the accuracy of **eco functions** with residual heat use;
- g) revision of Clause 8 in order to improve the reliability of the method for measuring the energy consumption, especially regarding anti-circumvention;
- h) unique energy consumption measurement for all **heating functions** and **eco functions** with an indication of the energy consumption for a temperature increase of 165 K (compared to 155 K currently for forced air circulation function, for example), which results in higher energy consumption values compared to the previous edition;
- i) R_y replaced by L^* in Clause 9 and reference to IEC TS 63350;
- j) cooking time for reference measurement introduced for broccoli in Clause 10;
- k) yellow part replaced by hue angle value in Clause 10;
- l) requirements for digital assessment (see former 7.5.3.6.3) are obsolete as specified in IEC TS 63350;
- m) revision of Clause 14 (Consumption measurement of low power modes, previous Clause 12);
- n) former Annex G (informative) is cancelled due to the fact that this method for measuring an associated activity has been not applied;
- o) former Annexes B and F are obsolete, up-to-date shade charts are specified in IEC TS 63350;
- p) former Annex E will be substituted by a supporting document located on the IEC's website.

The document contains supplementary material highlighted by notes indicating the link.

The text of this International Standard is based on the following documents:

Draft	Report on voting
59K/365/FDIS	59K/370/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

Words in **bold** in the text are specifically defined in Clause 3.

A list of all parts in the IEC 60350 series, published under the general title *Household electric cooking appliances*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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HOUSEHOLD ELECTRIC COOKING APPLIANCES –

Part 1: Ranges, ovens, steam ovens and grills – Methods for measuring performance

1 Scope

This part of IEC 60350 specifies methods for measuring the performance of electric **cooking ranges, ovens, steam ovens, and grills** for household use.

NOTE 1 This document is also applicable to portable appliances with similar functionalities that were previously covered by the withdrawn IEC 61817.

The **ovens** covered by this document ~~may~~ can be with or without microwave function.

Manufacturers ~~should~~ are expected to define the primary cooking function of the appliance – microwave function or thermal heat. The primary cooking function ~~should be~~ is measured with an existing method according to energy consumption. If the primary cooking function is declared in the instruction manual as a microwave function, IEC 60705 is applied for energy consumption measurement. If the primary cooking function is declared as a thermal heat, then IEC 60350-1 is applied for energy consumption measurement.

If the primary function is not declared by the manufacturer, the performance of the microwave function and thermal heat ~~should be~~ is measured as far as it is possible.

NOTE 2 For measurement of energy consumption and time for heating a load (see Clause 8), this document is furthermore not applicable to:

- microwave combination function;
- **ovens** with reciprocating trays or turntable;
- **small cavity ovens** (see 3.16);
- **ovens** without adjustable temperature control;
- **heating functions and eco functions** other than defined in this document;
- appliances with only solo **steam function**.

NOTE 3 This document does not apply to

- microwave ovens (IEC 60705).

This document defines the main performance characteristics of these appliances that are of interest to the user and specifies methods for measuring these characteristics.

This document does not specify a classification or ranking for performance.

~~NOTE 3 Some of the tests which are specified in this standard are not considered to be reproducible since the results may vary between laboratories. They are therefore intended for comparative testing purposes only.~~

NOTE 4 This document does not deal with safety requirements (IEC 60335-2-6 and IEC 60335-2-9).

NOTE 5 Appliances covered by this document ~~may~~ can be built-in or for placing on a working surface or the floor.

NOTE 6 There is no measurement method for the energy consumption for grilling and **steam functions** available.

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.

~~IEC 60584-2, Thermocouples – Part 2: Tolerances~~

IEC 60584-1, *Thermocouples – Part 1: EMF specifications and tolerances*

IEC 62301:2011, *Household electrical appliances – Measurement of standby power*

IEC TS 63350:2022, *Household electrical appliances – Specification of the properties of a digital system for measuring the performance*

IEC 63474¹, *Electrical and electronic household and office equipment – Measurement of networked standby power consumption of edge equipment*

ISO 80000-1:2009, *Quantities and units – Part 1: General*

~~CIE 15, Colorimetry~~

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology 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>

3.1

active mode

mode in which the appliance is connected to a mains power source, has been activated, and is performing any of the intended functions

EXAMPLE Producing heat transfer by thermal heat, electromagnetic energy or condensation

Note 1 to entry: Examples of recognised associated functions include displaying recipes, running an egg timer, software download, running a cooling fan and the like.

3.2

combi steam oven

appliance or compartment of a **cooking range** in which food is cooked by a combination of **oven** and **steam oven**

Note 1 to entry: Appliances with only a steam assist function also exist. For these **ovens**, the **steam function** can only be tested if this function is described in the instruction manual or if the appliance provides a setting for **steam function**.

Note 2 to entry: The term "steam" does not refer to the evaporated water from the food.

3.3

cooking range

appliance having a **hob** and at least one **oven** and which ~~may~~ can incorporate a **grill**

¹ Under preparation. Stage at the time of publication: IEC CDV 63474:2022.

3.4

delay start

condition where the user has selected a specified delay to the beginning of any **active mode**

Note 1 to entry: This mode is only applicable if the appliance provides a delay start function for the user.

3.5

eco function

heat transmission by natural air circulation, forced air circulation or radiation for certain applications using efficient technical solutions

EXAMPLE Technical solutions:

- residual heat usage;
- low-power heating;
- or a combination of both.

3.6

grill

appliance or part of an appliance in which food is cooked by radiant heating

3.7

heating function

heat transmission by natural or forced air circulation, or radiation for baking and roasting

EXAMPLE

- Forced air circulation function which heats food mainly by circulating the air with the aid of a fan;
- conventional **heating function** which heats food mainly by natural convection of the air;
- or a combination of both functions.

Note 1 to entry: Heat transmission by steam or by microwave power, also in combination with any **heating function**, is excluded.

3.8

hob

cooktop

appliance or part of an appliance which incorporates one or more **cooking zones** and/or **cooking areas** including a **control** unit

Note 1 to entry: The **control** unit can be included in the **hob** itself or integrated in a **cooking range**.

3.9

hot steam function

heat transmission to the food by generated steam in combination with radiation ~~and/or~~ convection, ~~or a combination of both~~, at ambient pressure (approximately ~~1 bar~~ 100 kPa) and with a temperature > 100 °C

3.10

multiple cavity appliance

appliance that has more than one separate cavity in which food is cooked and which can be controlled independently, but cannot be installed separately

3.11

network

communication infrastructure with a topology of links, an architecture, including the physical components, organizational principles, communication procedures and formats (protocols)

3.12**off mode**

condition in which the appliance is connected to the mains and is not providing any **active mode** or **standby mode** and where the mode can persist for an indefinite time

Note 1 to entry: The following shall also be considered as **off mode**:

- a) conditions providing only an indication of **off mode**;
- b) conditions providing only functionalities intended to ensure electromagnetic compatibility.

3.13**oven**

appliance or compartment of a **cooking range** in which food is cooked by radiation, by natural convection, by forced-air circulation or by a combination of these heating methods

3.14**oven thermostat**

device or sensor that detects the temperature inside the cavity in order to control the set temperature

3.15**oven with catalytic cleaning**

oven in which cooking deposits are removed by breaking them down on a special coating

3.16**small cavity oven**

oven with the following dimensions:

- both ~~usable~~ internal width and ~~usable~~ internal depth are < 250 mm, or
- either one of internal width and internal depth is < 120 mm. or
- ~~usable~~ internal height is < 120 mm

Note 1 to entry: The defined maximum size of small cavity **ovens** in this document is ~~due~~ adapted to the size of the test load used in Clause 8.

3.17**standby mode**

condition where the appliance is connected to the mains and provides only the following functions, which can persist for an indefinite duration:

- (a) reactivation function, or reactivation function and a mere indication of enabled reactivation function;
- (b) information or status display;
- (c) detection function for emergency measures.

3.18**standby mode in condition of networked standby**

condition where the appliance is connected to the mains and provides only the reactivation function through a connection to a **network**, which can persist for an indefinite duration

Note 1 to entry: This mode is only applicable to appliances that provide a connection function to a **network**.

3.19**pyrolytic self-cleaning oven**

oven in which cooking deposits are removed by heating the **oven** to a sufficiently high temperature

3.20

steam oven

appliance or compartment of a **cooking range** in which food is cooked mainly by steam condensation at ambient pressure

Note 1 to entry: Appliances are fitted with their own steam generator.

Note 2 to entry: The term "steam" does not refer to the evaporated water from the food.

3.21

steam function

heat transmission to the food mainly by condensation of steam at ambient pressure (approximately ~~1 bar~~ 100 kPa) and with a temperature ≤ 100 °C

3.22

warming compartment

separate compartment in which dishes are placed in order to preheat them prior to serving, or in which food is maintained at serving temperature

~~3.12~~

~~**conventional heating function**~~

~~heat transmission to the food by radiation and natural convection only~~

~~Note 1 to entry: This does not include **conventional heating functions** which operate a top heating element only (i.e. **grill element**).~~

~~3.13~~

~~**forced air circulation function**~~

~~heat transmission to the food by forced air convection, i.e. by circulating the air with the help of a fan~~

~~Note 1 to entry: This does not include circulated air functions which operate a top heating element only (i.e. **grill element**).~~

~~3.16~~

~~**cooling down period**~~

~~unstable condition persisting after completion of the active mode and the appliance is **set to off mode** where the power consumption may change without any intervention by the user~~

~~3.17~~

~~**set to off mode**~~

~~action where the product is switched off using appliance controls or switches that are accessible and intended for operation by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a main power source and used in accordance with the manufacturer's instructions~~

~~Note 1 to entry: All actions required to **set to off mode** such as empty the water tank, remove the food, close the door, etc., have to be taken.~~

~~Note 2 to entry: For the definition of off mode IEC 62301 is relevant.~~

~~3.18~~

~~**set to standby mode**~~

~~action where the product is switched to standby using appliance controls or switches that are accessible and intended for operation by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a main power source and used in accordance with the manufacturer's instructions~~

~~Note 1 to entry: For the definition of standby mode IEC 62301 is relevant.~~

4 List of measurements

4.1 Dimensions and mass

The following measurements are carried out:

- overall dimensions (see 6.1);
- internal dimensions (see 6.2);
- dimensions of shelves and steaming accessories (see 6.4);
- dimensions of grill grids (see 6.5);
- dimensions of **warming compartments** (see 6.6);
- ~~level of the shelf (see 6.7);~~
- mass of the appliance (see 6.7).

4.2 Oven and combi steam oven

The following measurements are carried out:

- preheating the empty **oven** (see 7.3);
- accuracy of the control (see 7.4);
- energy consumption and time for heating a load (see Clause 8);
- heat distribution (see 9.2);
- ability to supply heat (see 9.3).

4.3 Steam oven and combi steam oven

The following measurements are carried out:

- ability to supply steam (see 10.1);
- distribution of steam (see 10.2);
- determination of the capacity (see 10.3).

4.4 Grill

The following measurements are carried out:

- grilling area (see Clause 11);
- ~~grilling (see 9.3).~~

4.5 Warming compartments

The following measurements are carried out:

- temperature control and energy consumption (see Clause 12).

4.6 Cleaning

The following measurements are carried out:

- cleaning of pyrolytic self-cleaning **ovens** (see 13.1);
- cleaning of **ovens** with catalytic cleaning (see 13.2).

5 General conditions for the measurement

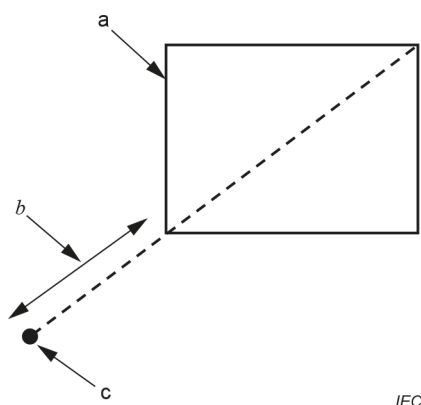
5.1 Test room

The tests are carried out in a substantially draught-free room in which the ambient temperature is maintained at $(20 \pm 5 \text{ } 23 \pm 2) \text{ }^{\circ}\text{C}$.

~~For tests 7.2, 7.4 and 7.5.3, $(23 \pm 2) \text{ }^{\circ}\text{C}$ shall be maintained during the complete test.~~

For the tests specified in 9.2.1, 9.3.1, 9.3.2, Clause 10 and Clause 11, maintaining the ambient temperature at $(25 \pm 5) \text{ }^{\circ}\text{C}$ is sufficient.

This ambient temperature is measured at a point that is at the same height as the centre of the calculated volume of the **oven** cavity under test and at a distance of 0,5 m diagonally from one of the front edges of the appliance (see Figure 1).



IEC

Key

- a **oven** (top view)
- b 0,5 m
- c thermocouple

Figure 1 – Position of the thermocouple for measuring ambient temperature

The measurement of the ambient temperature shall not be influenced by the appliance itself or by any other appliance.

5.2 Electricity supply

The appliance is supplied at rated voltage $\pm 1 \text{ } \%$.

~~For tests 7.2, 7.4 and 7.5.3:~~

- the supply voltage shall be maintained at the main terminal at the rated voltage $\pm 1 \text{ } \%$, while the heating elements are switched on;
- the supply frequency shall be at the rated frequency $\pm 1 \text{ } \%$ throughout the test. If a frequency range is indicated, then the test frequency shall be the nominal frequency of the country in which the appliance is intended to be used.

If the appliance has a rated voltage range, the tests are carried out at the nominal voltage of the country where the appliance is intended to be used.

NOTE In the case of a fixed cable, the plug (or the end of the cable) is the reference point to maintain the voltage.

~~For Clause 12 and Annex G, the power measurement requirements shall be in accordance with IEC 62301.~~

5.3 Instrumentation

~~The temperature measuring instrument including thermocouples shall have an accuracy of $\pm 0,5$ K within the temperature range of 0°C to 100°C and an accuracy of ± 2 K within the temperature range 100°C to 300°C .~~

~~The energy measuring meter shall have an accuracy of $\pm 1\%$ of the reading.~~

~~For tests 7.2 and 7.4:~~

- ~~— air temperature measurements in the empty oven are made with a thermocouple with a welded point (not with a black copper plate);~~
- ~~— temperature measurements in the brick (see 7.4) are made with two thermocouples with a 1 mm steel tube diameter, class 1 according to IEC 60584-2. The thermocouple shall be accurate to $\pm 1,5$ K;~~

~~NOTE The steel tube of the thermocouple eases the insertion of the thermocouple into the brick. Other types of thermocouples can be used provided they are shown to give the same results. The measuring point is the first contact point of the two thermo-wires.~~

- ~~— the temperature measurement system excluding the thermocouple shall be accurate to $\pm 1,0$ K;~~
- ~~— the energy measurements shall be accurate to $\pm 1.5\%$ of the reading or ± 10 Wh whatever is the greater;~~
- ~~— the measurement of the voltage shall be accurate to $\pm 0,5\%$ of the reading;~~
- ~~— the measurements of mass shall be accurate to ± 3 g;~~
- ~~— the measurements of time shall be accurate to ± 5 s;~~
- ~~— the scale for weighing the ingredients shall be accurate to $\pm 0,1$ g.~~

~~For tests according to Clause 8 the temperature measurements in the load are made with a 0,5 mm steel tube diameter, class 1 according to IEC 60584-2. The thermocouple shall be accurate to $\pm 1,5$ K.~~

~~For Clause 12 and Annex G, the measurement requirements shall be in accordance with IEC 62301.~~

Instruments used and measurements made for this document shall comply with the specifications in Table 1 and Table 2.

Table 1 – Instruments

Parameter	Unit	Minimum resolution	Maximum permissible error	Details / Additional requirements
Mass	g			
≤ 3 000 g		0,1 g	± 0,1 g	
> 3 000 g		0,5 g	± 3 g	
Temperature (thermocouples)				
• ambient temperature	°C	0,1 °C	± 0,5 K	Thermocouple with welded point
• temperature in the cavity in a range of 0 °C to 100 °C	°C	0,1 °C	± 0,5 K	Thermocouple with welded point (suitable to measurements inside of ovens with wet-steam functions)
• temperature in the cavity in a range of 100 °C to 300 °C	°C	0,1 °C	± 2,5 K	Thermocouple with welded point.
• centre temperature of the brick	°C	0,1 °C	± 1,5 K	1 mm steel tube thermocouple, class 1 in accordance with IEC 60584-1.
Dimensions	mm	1 mm	1 mm	≤ 1 mm or 0,5 % whatever is the greater
Time	s	1 s	± 1 s per hour	

Table 2 – Measurements

Parameter	Unit	Maximum permissible error	Additional requirements
Voltage	V	± 0,5 %	Measured value.
Energy consumption measurement	Wh	± 1,5 % or ± 10 Wh	Whichever is greater
Temperature measurement	°C	± 1,0 K	Excluding the thermocouples Sampling rate ≤ 1 s
For Clause 14, the power measurement requirements shall be in accordance with IEC 62301		-	In accordance with IEC 62301

5.4 Positioning the appliance

Built-in appliances are installed in accordance with the instructions for installation. Other appliances are placed with their back against a wall, unless otherwise specified in the instructions.

Floor-standing appliances are positioned between kitchen cabinets. Table-top appliances are positioned away from side walls.

For installation of the appliance ~~it should be ensured that~~, the surface ~~is~~ shall be horizontal.

~~For tests 7.2 and 7.4 on **ovens** with integrated air extraction by a fan (or similar device) to the outside of the building, the air outlet is discharged into a flue which has a pressure drop of 50 Pa when there is an airflow of 200 m³/h.~~

~~NOTE — The condition of measurement for **ovens** with integrated air extraction is similar to that in IEC 61591.~~

When the appliance is connected to the mains for the first time, it shall be operated once on any setting for at least 1 h before the energy consumption is measured in order to avoid changes in the appliance's performance or consumption values when tested 'out-of-the-box' compared to some time later at the same settings.

If the appliance is disconnected from the mains, it shall be ensured that required basic settings, like the time, are set and finalized before starting the measurement.

5.5 Preheating

The appliance is initially at room temperature. However, if preheating is specified, the appliance is preheated in accordance with the instructions for use. If no instructions are given, the appliance is considered to be preheated after the thermostat has switched off the first time.

5.6 Setting of controls

The control is set to give the temperature specified for the test. However, if the temperature cannot be attained due to the construction of the control, the nearest setting related to the specified temperature is chosen.

~~The appliance is operated for all tests in the delivery status with unchanged default settings. Ensure that no network is connected to the appliance for the duration of the measurement.~~

All tests, except the measurements for low-power modes (see Clause 14), shall be carried out:

- with the default factory settings;
- ensuring that no **network** is connected to the appliance for the duration of the measurement.

Using any modes and controls, resulting in measurements that are unrepresentative of the appliance's true characteristics that can occur during baking and roasting under comparable conditions are not allowed.

EXAMPLE A camera used to detect that the appliance is under test is not allowed.

5.7 Rounding

~~If it is required that~~ numbers ~~are~~ shall be rounded, they shall be rounded in accordance with ISO 80000-1:2009, Clause B.3, rule B.

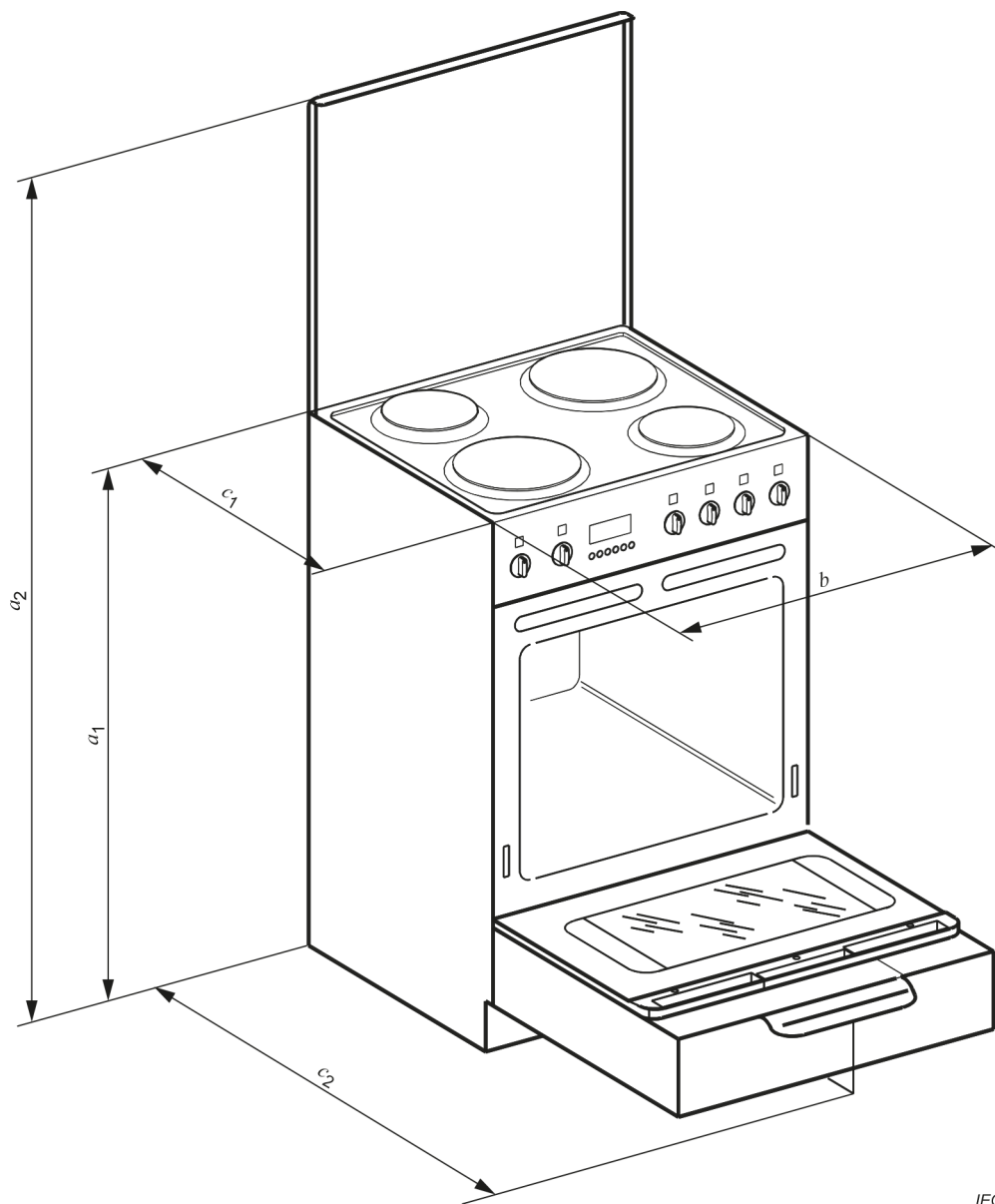
6 Dimensions and mass

6.1 Overall dimensions

The overall dimensions of the appliance are measured and stated in millimetres as follows:

Cooking ranges and other appliances placed on a surface are measured as shown in Figure 2.

Built-in **ovens** are measured as shown in Figure 3.



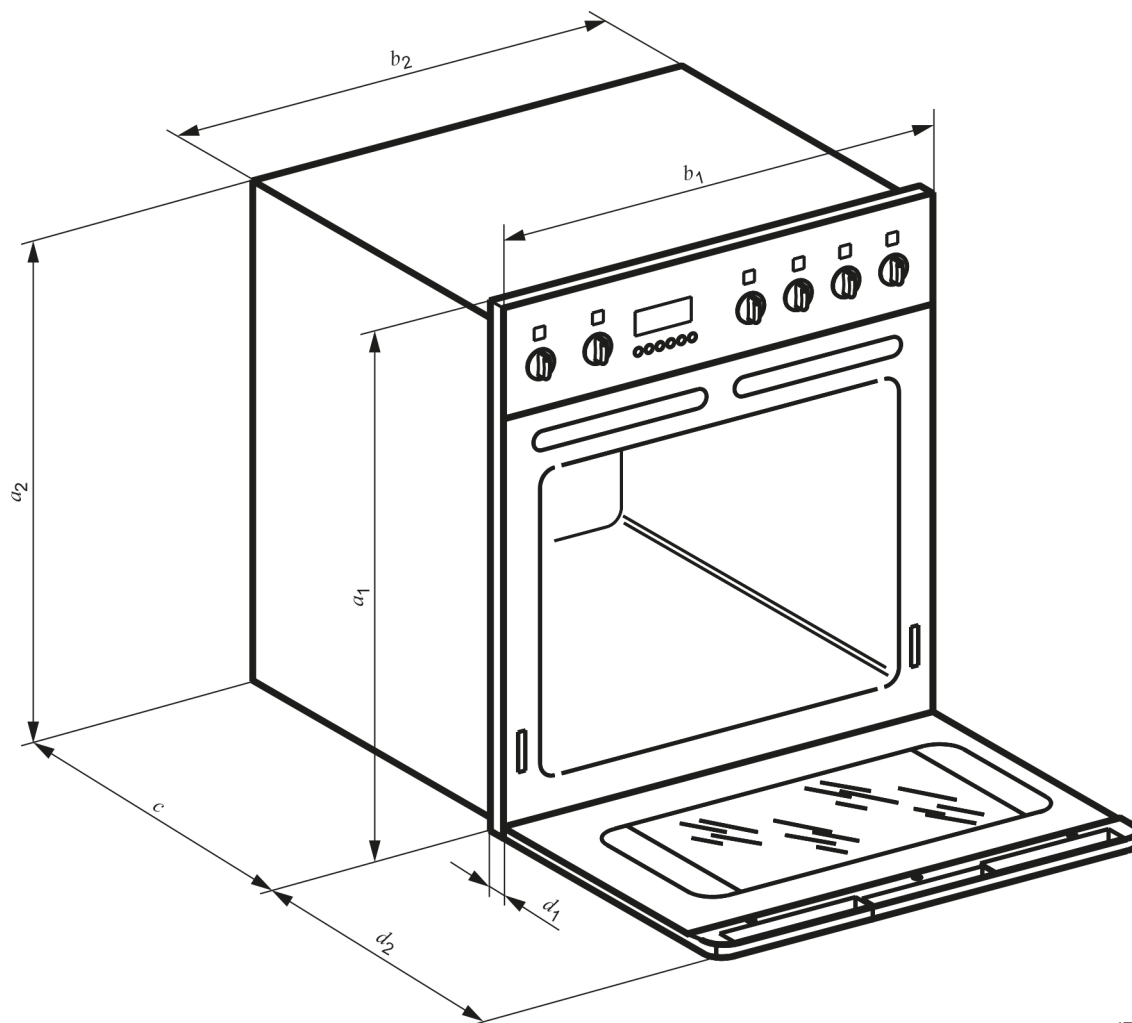
IEC

NOTE—If adjustable feet are provided, the height is measured with the feet in both extreme positions.

Key

- a_1 height from the supporting surface to the **hob** surface
- b overall width of the appliance
- a_2 maximum height from the supporting surface to the uppermost part of the appliance, with any lid in the open position
- c_1 depth of the appliance, ignoring any knobs, etc.
- c_2 maximum depth of the appliance, with any doors and drawers fully open

Figure 2 – Dimensions of appliances



IEC

Key a_1 front height of the appliance b_1 front width of the appliance c maximum depth of the appliance within the kitchen furniture a_2 maximum height of the appliance within the kitchen furniture b_2 maximum width of the appliance within the kitchen furniture d_1 depth of the appliance outside the kitchen furniture, ignoring any knobs, etc. d_2 depth of the appliance outside the kitchen furniture, with any doors and drawers fully open**Figure 3 – Dimensions of built-in appliances****6.2 Usable Internal dimensions and calculated volume****6.2.1 General**

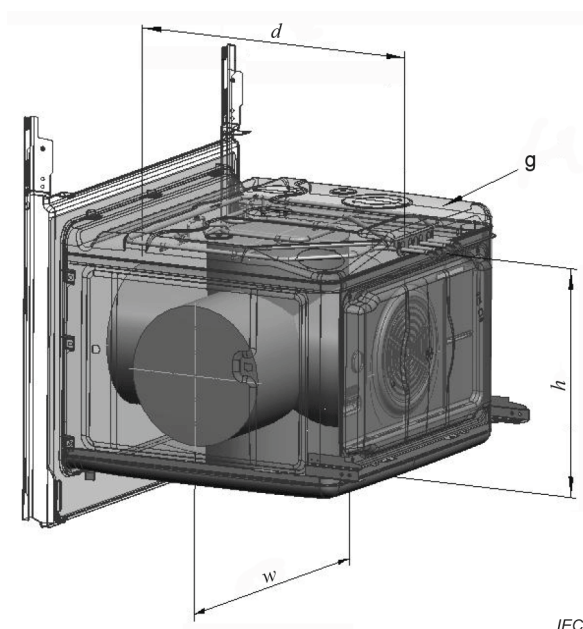
~~Removable items specified in the user instructions to be not essential for the operation of the appliance in the manner for which it is intended shall be removed before measurement is carried out.~~

~~Safety of the operation should be guaranteed. Therefore necessary parts cannot be removed for measuring the calculated volume.~~

The measurement of the calculated volume is to be carried out at ambient temperature.

The height, width and depth of the calculated volume in the cavity shall be measured in accordance with 6.2.2 to 6.2.4. The measurements are shown in Figure 4.

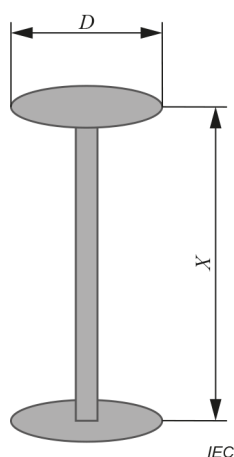
For verification purposes, the gauge shown in Figure 5, shall be used to determine all three dimensions. The gauge shall be used without appreciable force. Dimensions are stated in millimetres.



Key

- d ~~usable~~ depth
- g heating element
- h ~~usable~~ height
- w ~~usable~~ width

Figure 4 – ~~Usable~~ Internal dimensions



Key

- $D = 200 \text{ mm or } 120 \text{ mm}$
- $X = \text{dimension to be measured}$

Figure 5 – Gauge for measuring these dimensions

6.2.2 Usable Internal height

The ~~usable~~ height is the maximum length of a cylinder with a diameter of 200 mm reaching vertically from the centre of the cavity floor to the lowest point on the ceiling. ~~The lowest point of the ceiling can be constituted by a lamp, a heating element or similar object in the area of the cylinder.~~ No accessories, such as a grill grid, are inserted.

A lamp, a heating element or similar object in the area of the cylinder can constitute the lowest point of the ceiling. Protruding parts such as lamp covers, heating elements and fixing hooks shall not be removed or folded away.

If either the width or the depth of the cavity is less than 250 mm, the diameter of the cylinder to be measured shall be reduced to 120 mm.

NOTE The centre of the cavity bottom is defined by the middle of the ~~usable~~ internal depth and the middle of the ~~usable~~ internal width.

6.2.3 Usable Internal width

The ~~usable~~ internal width is the maximum length of a cylinder with a diameter of 200 mm reaching horizontally from the left-hand side wall to the right-hand side wall of the cavity.

Side racks shall be removed if they can be removed without a tool. If parts are fixed to or by the side racks, they shall be removed as well.

NOTE 1 A coin or a spoon is not considered as a tool.

If either the height or the depth of the cavity is less than 250 mm, the diameter of the cylinder to be measured shall be reduced to 120 mm.

NOTE 2 The centre of the side wall of the cavity is defined by the middle of the ~~usable~~ depth and the middle of the ~~usable~~ height.

6.2.4 Usable Internal depth

The ~~usable~~ depth is the maximum length of a cylinder with a diameter of 200 mm reaching horizontally from the centre of the rear wall to the inner face of the closed door.

Protruding parts such as the baffle or components of the door shall not be removed.

If either the width or the height of the cavity is less than 250 mm, the diameter of the cylinder to be measured shall be reduced to 120 mm.

For measuring the ~~usable~~ depth, the gauge is placed on a support in such a way that the axis lies horizontally in the centre of the cavity, the axis being extended slightly over the expected ~~usable~~ depth. The door is closed carefully so that the gauge is compressed to give the ~~usable~~ internal depth.

NOTE The centre of the rear wall of the cavity is defined by the middle of the ~~usable~~ height and the middle of the ~~usable~~ width.

6.2.5 Calculated volume

The calculated volume is determined from these three dimensions and is stated in litres, rounded to ~~full~~ the nearest litre.

6.3 Overall internal dimensions and overall volume

6.3.1 General

Where the surfaces forming the boundaries of the cavity incorporate protrusions or depressions, the planes used for measurement shall be those comprising the largest percentages of the total areas of the surfaces. Holes in surfaces shall be disregarded when calculating areas for this determination.

The following volumes or spaces shall be disregarded:

- those occupied by removable items specified by the manufacturer as not essential for the operation of the appliance, such as shelves, racks or temperature probes;
- those occupied by heating elements;
- those occupied by minor irregularities in the cooking compartment walls, including covers over temperature sensors and lamps;
- those occupied by the convection baffle;
- corner radii smaller than 50 mm at the intersections of the interior surfaces of the cooking cavity.

Dimensions are stated in millimetres.

6.3.2 Overall height (H)

The maximum vertical distance, in mm, between the plane of the cooking cavity bottom and the plane of the cavity ceiling.

6.3.3 Overall width (W)

The maximum horizontal distance, in mm, between the planes of the cavity side walls.

6.3.4 Overall depth (D)

The maximum horizontal distance, in mm, from the plane of the inside surface of the door when closed to the plane of the rear cavity wall.

6.3.5 Overall volume of rectangular cavities

The overall volume is the total internal volume of the cavity in which cooking takes place, expressed as the product of H , W and D determined as above, divided by 10^6 and rounded to the nearest litre.

6.3.6 Overall volume of non-rectangular cavities

Non-rectangular cavities shall have the volume of any non-conforming section such as a curved door or cavity wall determined by direct measurement and the application of conventional geometrical calculations. The remainder of the cavity shall be treated as a rectangular cavity and the individual volumes added together. The volume is expressed to the nearest litre.

6.4 Dimensions of shelves and steaming accessories

The usable width and usable depth of the shelf are measured. The dimensions are determined 5 mm above the surface of the shelf.

The surface area is calculated and stated in square centimetres, rounded to the nearest 10 cm².

NOTE The shelf can be a baking ~~sheet~~ tray or a steaming accessory.

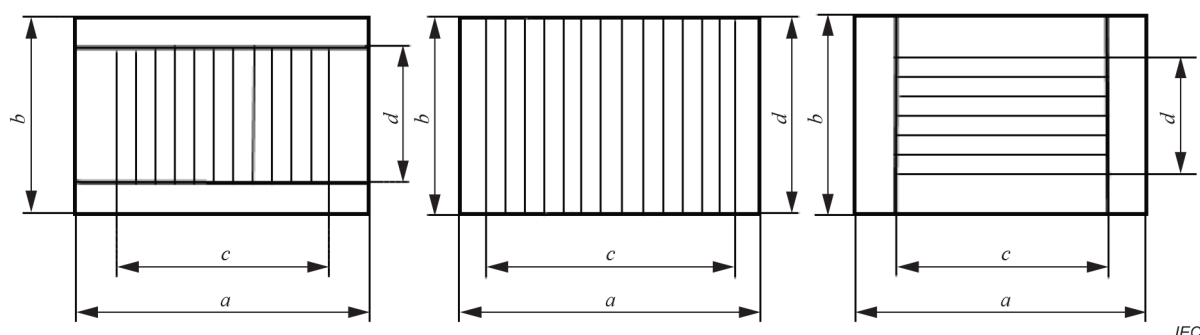
6.5 Dimensions of grill grids

6.5.1 Entire area

The entire area of the grill grid is determined by measuring the maximum width and the maximum depth of the outer rods. This entire area of the grill grid is calculated and stated in square centimetres, rounded to 10 cm².

6.5.2 Usable area

The usable width and usable depth of the grill grid are measured, by considering only the inner grid, which is suitable for placing food. The usable area of the grill grid is calculated and stated in square centimetres, rounded to 10 cm². See Figure 6.



Key

- a is the maximum width of the grill grid
- b is the maximum depth of the grill grid
- c is the usable width of the grill grid
- d is the usable depth of the grill grid

Figure 6 – Examples for determining the entire area and usable area of a grill grid

6.6 Dimensions of warming compartments

The height, width and depth of the calculated volume within the **warming compartment** are measured and indicated in millimetres.

NOTE When a heating element is located inside the **warming compartment**, the dimensions are measured up to its most protruding part.

6.7 Level of shelf

~~The shelf is placed in a central position in the oven.~~

NOTE 1 ~~The shelf can be a grid or a baking sheet.~~

~~A device consisting of a disc and an annular ring is placed centrally on the shelf. A spirit level is placed centrally on the ring as shown in Figure 6. The spirit level is rotated to the position where it shows the maximum inclination from the horizontal. Its lower side is then lifted to the horizontal by inserting a feeler gauge between the level and the ring.~~

~~For the measurement of the level of shelves the same devices as for hotplates are used (see IEC 60350-2).~~

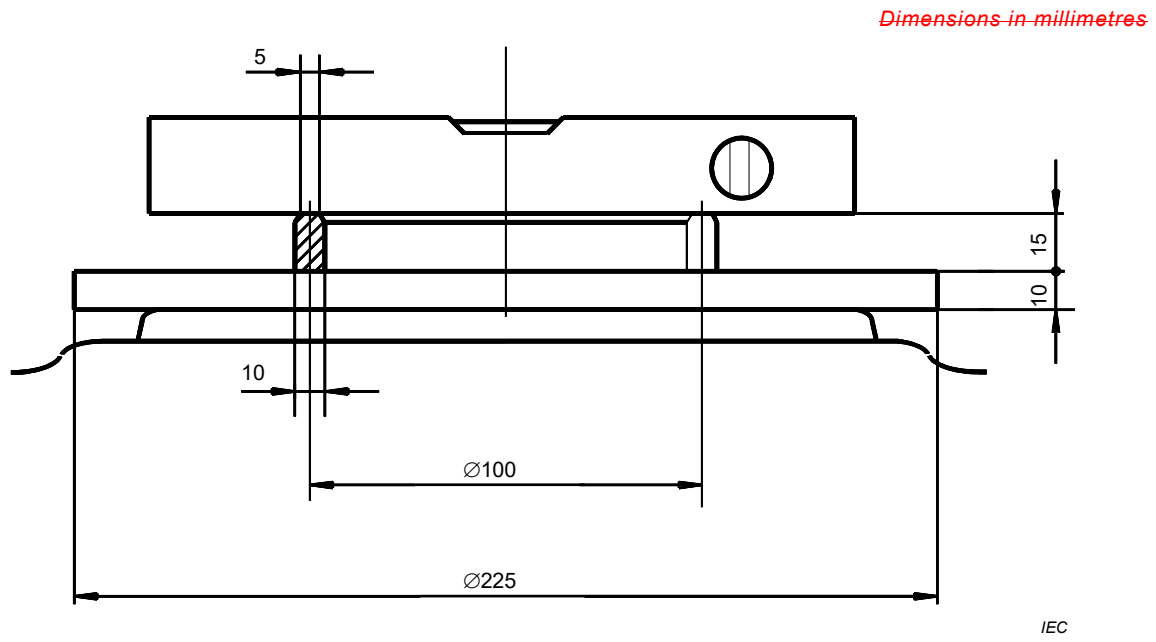


Figure 6 – Device for checking the level of shelves

~~The deviation from the horizontal is given by the thickness of the gauge, in millimetres, to two decimal places. It is expressed as a percentage, rounded to the nearest 0,1 %.~~

~~NOTE 2—The direct conversion from millimetres to percentage is possible due to the ring having a diameter of 100 mm.~~

6.7 Mass of the appliance

The mass of the appliance ~~including only the accessory which is used to perform the test of 7.4~~ is determined and expressed in kilogrammes, rounded to the nearest kilogramme. ~~To determine the mass, only the accessory described in the test in Clause 8 shall be considered.~~

7 ~~Ovens and combi steam ovens~~ Preheating and accuracy

7.1 ~~General Purpose~~

The purpose of the tests in Clause 7 is to assess the performance of the **oven** and **combi steam oven** in relation to preheating, ~~and functioning of the control, and energy consumption.~~ ~~The performance is also assessed by means of cooking tests.~~

7.2 Test setup

The air temperature in the empty **oven** and **combi steam oven** is measured with a thermocouple ~~according that conforms to the criteria specified in 5.3~~ fixed to the grid that is delivered with the appliance. It is placed in the **oven** and **combi steam oven** in a way that the welding point of the thermocouple is located at the centre of the calculated volume of the **oven** and **combi steam oven** with a distance of at least 30 mm from the grid.

If no grid can be purchased from the manufacturer of the appliance, the thermocouple ~~should~~ ~~shall~~ be positioned in the centre in a suitable way.

Thermocouples are led through the door gap in a way that the door is completely closed without applying additional force.

~~It is essential that~~ The door ~~is~~ shall be completely closed.

~~The baking tests of Clause 7 are carried out using corrected control settings according to the differences determined by the test of 7.3.~~

~~NOTE The tests of 7.2, 7.3 and 7.4 are considered to give reproducible results. The tests of 7.5 and 7.6 are applicable for comparative testing only.~~

7.3 Preheating the empty oven

The purpose of this test is to measure the energy consumption and time it takes to preheat an empty **oven** or **combi steam oven** from room temperature by a given temperature rise.

Prior to the measurement, the whole appliance (this includes the material and the insulation) shall be at ambient temperature of $(23 \pm 2) ^\circ\text{C}$. In **multiple cavity appliances**, each **oven** cavity ~~has to~~ shall be measured separately. Only the cavity measured shall be switched on.

A **heating function**, **eco function** or **hot steam function** shall be selected. The temperature control is set ~~at~~ to the maximum position ~~for each function~~. The appliance is heated until the rise ~~is~~ reaches 165 K.

~~—180 K for conventional heating function,~~

~~—155 K for forced air circulation function,~~

~~—155 K for hot steam function.~~

The temperature rise is the difference of the **oven** temperatures measured at the beginning and at the end of the test.

The time t_{ph} (t_{ph} means preheating) in minutes and seconds and the energy consumption E_{ph} in kWh shall be measured.

The time for preheating of the empty **oven**, t_{ph} , shall be reported and rounded to the nearest half minute.

The energy consumption for preheating the empty **oven**, E_{ph} , shall be reported in kWh and rounded to ~~the nearest kWh to~~ two decimal ~~s~~ spaces.

If the **oven** has an additional preheating setting, the test ~~is~~ shall be repeated with this setting.

NOTE The energy consumption of components, such as lamps and fans that are automatically switched on with the appliance, is included in the measurement.

7.4 Accuracy of the control

7.4.1 Purpose

The purpose of this test is to determine the accuracy of the temperature control and to calculate the corrected temperature setting used for tests for Clause 9.

7.4.2 Measurements

Prior to the measurements, the whole appliance shall be at ambient temperature of $(23 \pm 2) ^\circ\text{C}$.

The temperature control element is set to the position marked $150 ^\circ\text{C}$ and the appliance is heated for $t_{\text{check}, 150} = 60 \text{ min}$. Then the temperature control element is set to the position marked $200 ^\circ\text{C}$ and the appliance is heated for further $t_{\text{check}, 200} = 60 \text{ min}$. Then the temperature control element is set to the position marked $250 ^\circ\text{C}$ and the appliance is heated for a further $t_{\text{check}, 250} = 60 \text{ min}$.

Markings of the control element for grilling are ignored. If 250 °C is not marked, the next higher marked setting is taken into account. If the highest marked setting is below 250 °C, the highest possible marked setting ~~has to~~ shall be chosen. If the control element is not marked in degrees Celsius, the control element is set at appropriate markings taking into account the instructions for use.

Measurements ~~are~~ shall be performed without fast preheating function.

The **oven** temperature is recorded continuously in line with 7.2.

~~The oven temperature is respectively determined as the arithmetic mean of the minimum and maximum temperature reached during the last 20 min of t_{check} .~~

~~The arithmetic mean of the oven temperature and the minimum and maximum temperatures are noted for each setting.~~

7.4.3 Assessment

For assessing the accuracy of control, the deviations from each set temperature (V_{150} , V_{200} , V_{250}) to the **oven** temperatures are determined where the **oven** temperature is the arithmetic mean during the last 20 min of t_{check} .

Regarding the corrected temperature setting used for the tests in Clause 9, the level of the deviations V_{150} , V_{200} and V_{250} are decisive. The temperature setting used for tests in Clause 9 shall only be corrected if all deviations V_{150} , V_{200} and V_{250} are < 20 K.

NOTE Deviations equal to or more than 20 K are not corrected because the device is assumed to have an **eco function** that uses residual heat.

To calculate the corrected temperature setting for the tests in Clause 9, the **oven** temperatures T_{150} and T_{200} are used and linear regression is applied.

8 Energy consumption and time for heating a load

8.1 Purpose

The purpose of this test is to measure the energy consumption and the time for heating a load for a given **heating function** or an **eco function** in an **oven**, **combi steam oven** and combi microwave oven. The load is a water-saturated brick ~~which simulates both the thermal properties and the water content of food (e.g. meat)~~ that is representative of any food, e.g. a roast dinner.

~~Prior to the measurement, the whole appliance (this includes the material and the insulation) shall be at ambient temperature of (23 ± 2) °C. In multiple cavity appliances, each oven cavity has to be measured separately. Only the cavity measured shall be switched on.~~

8.2 Symbols and abbreviations

Table 3 shows the main symbols used in Clause 8.

Table 3 – Symbols

$T_{s,k}$	temperature setting displayed by a knob or by the control display, s is the setting and $k = 1, 2, 3$ (summing index)
$T_{o1,k} / T_{o2,k}$	measured observer temperature in phase 1 or phase 2

$T_{a1,k} / T_{a2,k}$	measured ambient temperature in phase 1 or phase 2
$T_{c2,k}$	measured temperature in the cavity centre in phase 2
$\Delta \bar{T}_{c2,1}$	average temperature rise as difference between the average ambient temperature and the cavity temperature measured in phase 2
$\bar{T}_{c2,k}$	measured temperature in the cavity centre in phase 2, smoothed
$\bar{T}_{c2,k}$	average temperature in the cavity centre in phase 2
E_k	measured energy consumption in phase 1, when the last of the two thermocouples in the brick reaches a temperature rise of 55 K
t_k	measured time in phase 1, when the last of the two thermocouples in the brick reaches a temperature rise of 55 K, also applied for phase 2
t_0	start time of phase 1 or phase 2
i_s	start index determined to calculate $\Delta \bar{T}_{c2,1}$ and $\bar{T}_{c2,k}$; i_s depends on the oven function and the temperature profile
c_k	ratio between the observer temperatures measured in phase 1 and in phase 2 in the whole phase (t_0 to t_k)
s_k	ratio between the observer temperatures measured in phase 1 and in phase 2 in the last 20 min of the whole phase (t_0 to t_k)
$\Delta T_{s,k}$	difference between temperature setting T_s and average temperature $\bar{T}_{c2,k}$ in the cavity centre in phase 2
$E_{\Delta T_0}$	calculated nominal energy consumption in kWh for heating a load at ΔT_0
ΔT_0	nominal temperature rise; 165 K for all heating functions and eco functions
$t_{\Delta T_0}$	calculated nominal time in s for heating a load at $\Delta T_0 = 165$ K for all heating functions or eco functions

8.3 Test load

8.3.1 General

The test load shall be a brick with two holes for temperature measurements, as shown in Annex C.

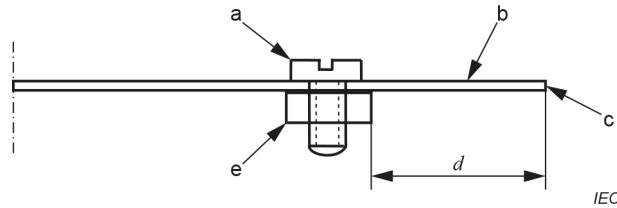
8.3.2 Pre-treatment

A new brick shall be dried before using it for the first time in an **oven** ~~of about 50 l volume~~ with a forced air circulation function at ≥ 175 °C for 3 h. No more than two bricks shall be dried at the same time in the same **oven**.

NOTE 1 A brick that is still damp due to a previous test needs at least 8 h to be dried as described above. However, see Note 1 in 8.3.3.

The weight m_d ($_d$ means dry) of the completely dry brick without thermocouples shall be measured within 5 min after removal from the **oven** and shall be noted in grams. The dry weight m_d shall be in accordance with the dry weight specified in Clause C.1. The brick shall be identified for accurate calculation of the water absorption in accordance with 8.3.3.

Place markings 32 mm from the measuring point of the two thermocouples in accordance with 5.3, and insert the thermocouples into the holes until the marking matches with the surface of the brick. The thermocouples shall be fixed to ensure that the measuring points remain at a depth of 32 mm during the whole test procedure. See the example in Figure 7.



Key

- a screw with a hole of 1 mm
- b steel tube
- c measuring point
- d 32 mm
- e nut

Figure 7 – Example of a thermocouple ~~for the test of 7.4~~

The thermocouples may be fixed by means of a droplet of silicon glue at the surface of the brick or by other suitable means.

Owing to the porosity of the brick, ~~care should be taken~~ ensure that the holes of the brick are not enlarged if the thermocouples are removed and reinserted.

NOTE 2 A brick can be used for about twenty tests when handled with normal care.

8.3.3 Preparation

The brick, pre-treated in accordance with 8.3.2, shall be prepared for energy measurement as follows.

NOTE 1 It is not necessary to pre-treat the brick between uses. It gets approximately the same water content each time it is soaked in water.

The brick shall be put into a water container so that it is completely covered with water at less than 20 °C. The water container with the brick is placed for at least 8 h into a refrigerator and cooled down to a centre temperature (both thermocouples) of $(5 \pm 2) ^\circ\text{C}$.

A hot brick shall be cooled down in air to a centre temperature below 25 °C before putting it into the cold water.

NOTE 2 A hot brick put directly into cold water would absorb substantially more water due to the capillary effect and different water viscosity at different temperatures.

Between test series, the brick should be stored in a refrigerator and preferably not soaked with water. The water used for soaking the brick ~~soaking water~~ should be kept (to reduce dissolving processes), i.e. the brick's storage water can be reused.

After the brick has been taken out of the water container, excessive water is allowed to drip off for 1 min. Then the weight of the wet brick m_w shall be measured and the absorbed amount of water is determined in g taking into account the weight of the thermocouples, if appropriate, by calculating $\Delta m = m_w - m_d$ (w means wet or water; m_d is measured according to 8.3.2). The amount of absorbed water shall be as specified in Clause D.1.

The temperature of the brick is measured. Both thermocouples shall read $(5 \pm 2) ^\circ\text{C}$.

8.4 Measurement

7.4.3.1 Procedure

~~Three tests are performed for each heating function, as appropriate (see 3.12 to 3.14 and Table 1).~~

~~In case an oven has several variants of the functions as described in 3.12 to 3.14, the manufacturer can choose the variant to be tested. This should be reported (see 7.4.4). Make sure that the function used is not combined with a microwave.~~

~~With the appliance at ambient temperature, according to 7.4.1, the brick, prepared according to 7.4.1, is placed in the geometric centre of the calculated cavity with its largest surface centrally on the grid delivered with the appliance, with the thermocouples on the upper side. The grid is inserted into a shelf support level of the appliance so that the centre of the brick comes as close as possible to the centre but not higher than the centre of the calculated cavity. The longest axis of the brick shall be parallel with the appliance front.~~

~~If no grid can be purchased from the manufacturer of the appliance, any suitable grid should be used, however not a baking sheet, tin or similar.~~

~~Where the grid can be inserted in two different positions (e.g. upside down gives a different height), the position should be taken that brings the brick centre closest to the cavity centre, but not higher.~~

~~The thermocouple shall be lead through the door gap in a way that the door is completely closed without applying additional force.~~

~~If the appliance is prepared with the thermocouples it should not be operated with a function combined with microwave energy. Out-coupled microwave power through the thermocouples can damage instruments.~~

~~The measurement shall be started by switching on the appliance within 3 min from the removal of the brick from the refrigerator. The temperature control is set to positions where the mean oven temperature rises $\frac{\Delta T_k^i}{k}$ as defined in Table 1 can be expected. $\frac{\Delta T_k^i}{k}$ is the difference between the average ambient temperature and the actual oven temperature (measured in 7.4.3.2); $k = 1, 2, 3$ (k is the summing index, i is the heating function).~~

~~The temperature setting T_{ks}^i shall be noted, where T_{ks}^i is the temperature setting of the thermostat and / or the control display (s is the setting).~~

~~If the temperature steps are not clearly marked, the setting temperature should be determined by the angle considering the visible marks on the knob using polar coordinate paper (see Annex I).~~

~~If the temperature is set by a knob, the knob should always be turned from zero to the required setting.~~

~~The average ambient temperature during the test is determined by the arithmetic mean of the ambient temperatures at the beginning of the test (i.e. when switching on the appliance) and when the last of the two thermocouples in the brick has reached a centre temperature rise of 55 K.~~

Table 1 — settings

temperature rise	Heating functions		
	Conventional (ie)	Forced air circulation (if)	Hot steam (ih)
ΔT_1^i	(140 ± 10) K	(135 ± 10) K	(135 ± 10) K
ΔT_2^i	(180 ± 10) K	(155 ± 10) K	(155 ± 10) K
ΔT_3^i	(220 ± 10) K ^a	(175 ± 10) K ^a	(175 ± 10) K ^a
^a —or the maximum temperature rise if this value cannot be reached.			

The following data is measured:

- the energy consumption(s) E_k^i in kWh and the time(s) t_k^i in min and s, as appropriate, when the last of the two thermocouples in the brick reaches a temperature rise of 55 K, $k = 1, 2, 3$;
- centre temperatures of the brick in °C;
- ambient temperature at the start of the test (when the appliance is switched on) and at the end of the test (i.e. when the last of the two thermocouples in the brick has reached 55 K temperature rise) in °C.

NOTE The energy consumption of components such as lamps and fans, which are automatically switched on with the appliance, is included in the measurement.

7.4.3.2 — Checking the oven temperature

After the test according to 7.4.3.1, the brick is removed from the appliance and the appliance is run without changing the setting for for $t_{\text{check}} = 60$ min. The oven temperature $T_{k,\text{measured}}^i$ is determined in line with 7.1 as the arithmetic mean between the maximum and minimum temperatures reached during the last 20 min of t_{check} .

The measured oven temperature $T_{k,\text{measured}}^i$ is stated.

The difference between T_{ks}^i and $T_{k,\text{measured}}^i$ is calculated according to equations (1) and (2), where $n = 3$.

$$\Delta T_{k,\text{setting}}^i = T_{ks}^i - T_{k,\text{measured}}^i \quad (1)$$

$$\Delta T_{k,\text{setting}}^i = \frac{1}{n} \sum_{k=1}^n \Delta T_{k,\text{setting}}^i \quad (2)$$

$\Delta T_{k,\text{setting}}^i$ shall be ≤ 20 K.

If ~~is $\frac{\Delta T_{k,\text{setting}}^i}{E_k^{i,\dots}} > 20$ K~~ the test shall be carried out on further three appliances, which shall be randomly selected from the market. The arithmetical mean of the values of these three appliances shall not be greater than 20 K.

Note The tolerance of 20 K is needed due to the long chain of tolerances (e.g. thermostat, connection, power of heating elements, control element and printing) and the fact that the temperature scale covers different heating functions.

7.4.3.3 ~~Acceptance verification of the test results~~

Results of the tests according to 7.4.3.1 shall only be accepted if

- a) ~~the mean temperature rises $\frac{\Delta T_k^{i,\dots}}{E_k^{i,\dots}}$ are within the temperatures specified in Table 1, and~~
- b) ~~the standard deviation $\sigma^{i,\dots}$ as defined in equation (1) is below 0,050 kWh.~~

Otherwise, for the appropriate function, all measurements according to 7.4.2 shall be repeated.

The standard deviation $\sigma^{i,\dots}$ is calculated from the data pairs ~~$\frac{\Delta T_k^{i,\dots}}{E_k^{i,\dots}}$~~ measured according to 7.3.2.1 and calculated according to equation (1) for each tested function, $k = 1, 2, 3$ (see Sachs²⁾).

$$\sigma^{i,\dots} = 1,2 \sqrt{\frac{Q_y^{i,\dots} - (Q_{xy}^{i,\dots})^2 / Q_x^{i,\dots}}{n - 2}} \quad (3)$$

where

n is the number of measuring points (for the purposes of this standard, $n = 3$);

1,2 is an approximation factor for f .

NOTE For the purpose of this standard, ~~$\frac{\Delta T_k^{i,\dots}}{E_k^{i,\dots}}$~~ can only vary between 125 K and 185 K for **forced air circulation** and **hot steam functions** resulting in factor f between 1,16 and 1,21, and between 130 K and 230 K for **conventional heating function** resulting in factor f between 1,155 and 1,168.

$$f^{i,\dots} = \sqrt{1 + \frac{1}{n} + \frac{(T_0^{i,\dots} - \Delta T^{i,\dots})^2}{Q_x^{i,\dots}}} \quad (4)$$

$$Q_y^{i,\dots} = \sum_{k=1}^n (E_k^{i,\dots})^2 - \frac{\left(\sum_{k=1}^n E_k^{i,\dots} \right)^2}{n} \quad (5)$$

$$Q_{xy}^{i,\dots} = \sum_{k=1}^n \Delta T_k^{i,\dots} E_k^{i,\dots} - \frac{\sum_{k=1}^n \Delta T_k^{i,\dots}}{n} \sum_{k=1}^n E_k^{i,\dots} \quad (6)$$

²⁾ ~~Applied statistics, equations 5.29a and 5.69, modified. See the Bibliography.~~

$$Q_x^{i...} = \sum_{k=1}^n (\Delta T_k^{i...})^2 - \frac{\left(\sum_{k=1}^n \Delta T_k^{i...} \right)^2}{n} \quad (7)$$

$$\overline{\Delta T^{i...}} = \frac{1}{n} \sum_{k=1}^n \Delta T_k^{i...} \quad (8)$$

$$\overline{E^{i...}} = \frac{1}{n} \sum_{k=1}^n E_k^{i...} \quad (9)$$

7.4.4 Evaluation and calculation

7.4.4.1 Electric energy consumption

The energy consumption $\overline{E_{\Delta T_0}^{i...}}$ for the reference temperature rise $\overline{\Delta T_0^{i...}}$ is calculated using the linear regression based on the measured data points $\overline{\Delta T_k^{i...}} / \overline{E_k^{i...}}$, according to the equation:

$$\overline{E_{\Delta T_0}^{i...}} = \overline{S^{i...}} \cdot \overline{\Delta T_0^{i...}} + \overline{B^{i...}} \quad (10)$$

where

$\overline{E_{\Delta T_0}^{i...}}$ is the calculated nominal energy consumption in kW·h for heating a load for the different heating functions *ie*, *if* or *ih* at $\overline{\Delta T_0^{i...}}$;

$\overline{\Delta T_0^{i...}}$ = 180 K for **conventional heating function**,
= 155 K for both **forced air circulation** and **hot steam functions**;

$\overline{S^{i...}}$ is the slope related to the different heating functions *ie*, *if* or *ih*, which is calculated according to equation (2);

$\overline{B^{i...}}$ is the intercept which is calculated according to equation (3):

$$\overline{S^{i...}} = \frac{n \sum_{k=1}^n (\Delta T_k^{i...} \cdot E_k^{i...}) - \left(\sum_{k=1}^n \Delta T_k^{i...} \right) \left(\sum_{k=1}^n E_k^{i...} \right)}{n \sum_{k=1}^n (\Delta T_k^{i...})^2 - \left(\sum_{k=1}^n \Delta T_k^{i...} \right)^2} \quad (11)$$

$$\overline{B^{i...}} = \frac{\sum_{k=1}^n E_k^{i...} - \overline{S^{i...}} \sum_{k=1}^n \Delta T_k^{i...}}{n} \quad (12)$$

where

$\overline{\Delta T_k^{i...}}$ is the actual temperature difference for the different heating functions *ie*, *if* or *ih*, as defined in Table 1;

~~$\frac{E_k^{i...}}{n}$ is the energy consumption in kW·h measured according to 7.4.3.1 at the different $\Delta T_k^{i...}$ for the different heating functions *ic*, *if* or *ih*;~~
 ~~n is the number of measuring points; for the purpose of this standard, $n = 3$.~~

~~As an example for data and calculation sheets, see Annex E. An Excel 97-2003³ evaluation program, which corresponds directly to Annex E, is available with this document for the automatic calculation of the energy consumption (see 7.4). These calculations may be made in any other spreadsheet programs that lead to equal results.~~

7.4.4.2 Time for heating the load

~~The time for heating the load shall be calculated and determined in the same way as the energy consumption is calculated and determined according to 7.4.4.1.~~

~~Replace in the equations (10) to (12) the E values by the appropriate t values, i.e. replace~~

~~— in equation (10) $\frac{E_{\Delta T_0}^{i...}}{n}$ by $\frac{t_{\Delta T_0}^{i...}}{n}$ and~~

~~— in equations (12) and (10) $\frac{E_k^{i...}}{n}$ by $\frac{t_k^{i...}}{n}$~~

~~where~~

~~$\frac{t_k^{i...}}{n}$ is the time measured in min and s according to 7.4.3.1 at the different $\Delta T_k^{i...}$ for the different heating functions *ic*, *if* or *ih*;~~

~~$\frac{t_{\Delta T_0}^{i...}}{n}$ is the calculated nominal time in min and s for heating a load for the different heating functions *ic*, *if* or *ih* at $\Delta T_0^{i...}$.~~

7.4.5 Reporting of test results

~~The following data shall be reported for all heating functions:~~

- ~~a) type of the appliance, available heating function(s) according to 3.12 to 3.14;~~
- ~~b) supply voltage at which the measurements were made;~~
- ~~c) tested functions or variant;~~
- ~~d) energy consumption(s) in kW·h to two decimals, according to 7.4.4.1;~~
- ~~e) time(s) in min according to 7.4.4.2, rounded to the nearest half minute;~~
- ~~f) water absorption of the brick according to 7.4.2.3.~~

~~This data shall be reported for the heating functions according to 3.12 to 3.14 as appropriate. For multiple cavity appliances, the values shall be reported separately for each cavity.~~

8.4.1 Test Procedure

Prior to all measurements, the whole appliance (this includes the material and the insulation) shall be at an ambient temperature of $(23 \pm 2) ^\circ\text{C}$. In **multiple cavity appliances**, measure each **oven** cavity separately and switch on only the cavity measured.

³ ~~Microsoft Excel is the trade name of a product supplied by Microsoft Corporation.~~

~~This information is given for the convenience of users of this standard and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.~~

Remove all accessories delivered with the appliance, such as baking trays, side racks that are not used for placing the load.

Measure the cavity temperature $T_{c,k}$ in the empty appliance with a thermocouple that conforms to 5.3 fixed to the grid delivered with the appliance. Place this grid in the appliance in a way that the welding point of the thermocouple is located at the centre of the calculated volume of the **oven** and **combi steam oven** with a distance of at least 30 mm from the grid. If no grid can be purchased from the manufacturer of the appliance, the thermocouple should be positioned in the centre in a suitable way.

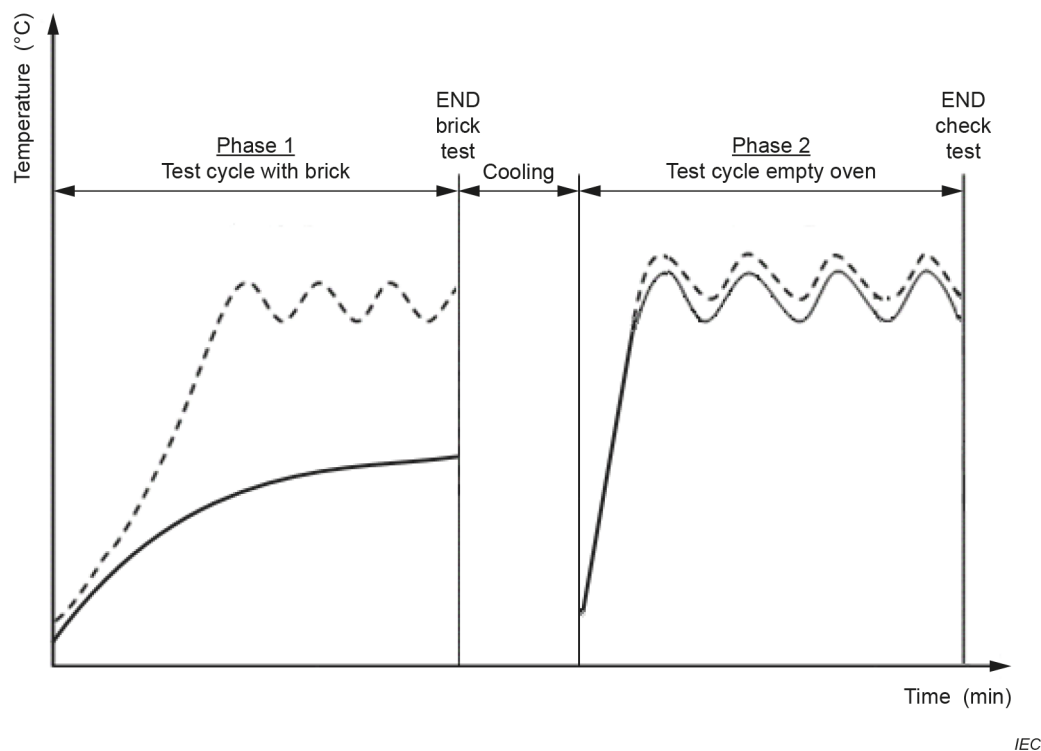
Additionally record the temperature $T_{o,k}$ close to the **oven thermostat** continuously. For this, fix a second thermocouple close to the **oven thermostat** inside the cavity as described in Figure 9, Figure 10 and Figure 11. This thermocouple is the "observer thermocouple".

Lead the thermocouples through the door gap in a way that the door is completely closed without applying additional force.

To determine the energy consumption of a **heating function** or an **eco function**, three measurements with different temperature settings are necessary. Each measurement consists of two phases:

- phase 1: energy measurement while the brick is in the **oven**;
- phase 2: determination of the reference temperature and the c -factor (empty **oven**).

The diagram in Figure 8 shows the entire process of measurement.



Phase 1		Cooling	Phase 2	
---	observer temperature $T_{o1,k}$		----	observer temperature $T_{o2,k}$
—	centre temperature brick		—	cavity temperature $T_{c2,k}$

Figure 8 – Entire process of measurement

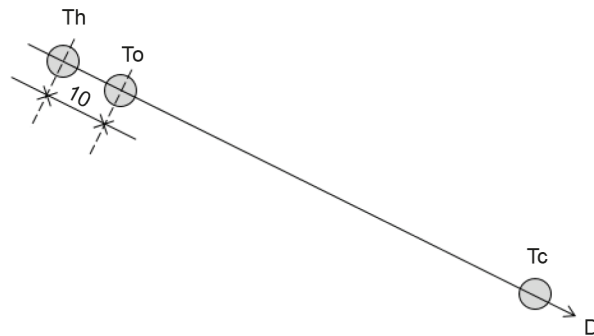
For both phases, the temperature $T_{o,k}$ is recorded continuously with a thermocouple fixed with a distance ≤ 10 mm to the **oven thermostat** inside the cavity without contact. This thermocouple is the observer thermocouple; it is fixed symmetrically in both x and y axes, on the direction of the z axis (see Figure 10 and Figure 11). The D axis is oriented toward the centre of the cavity (see Figure 9). Mount the observer thermocouple on the closest wall of the cavity with a heat resistant tape.

If the **oven thermostat** is not accessible, take into account the manufacturer's instructions regarding the position of the thermocouple.

If more than one **oven thermostat** is available, the information about the **oven thermostat** relevant for the temperature control of the considered cavity can be obtained from the manufacturer's instructions.

Keep the position of the observer thermocouple unchanged during phase 1 and phase 2.

Dimensions in millimetres



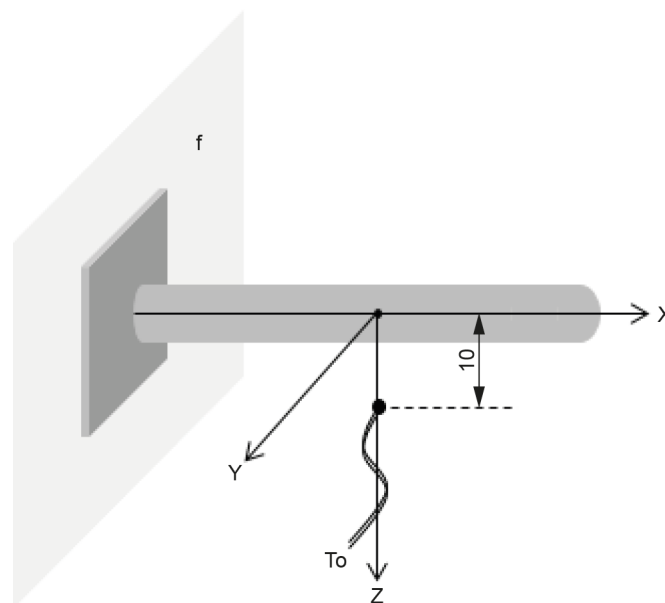
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Key

- Th oven thermostat
- To observer thermocouple
- Tc oven centre thermocouple
- D direction toward the oven centre

Figure 9 – Installation observer thermocouple

Dimensions in millimetres



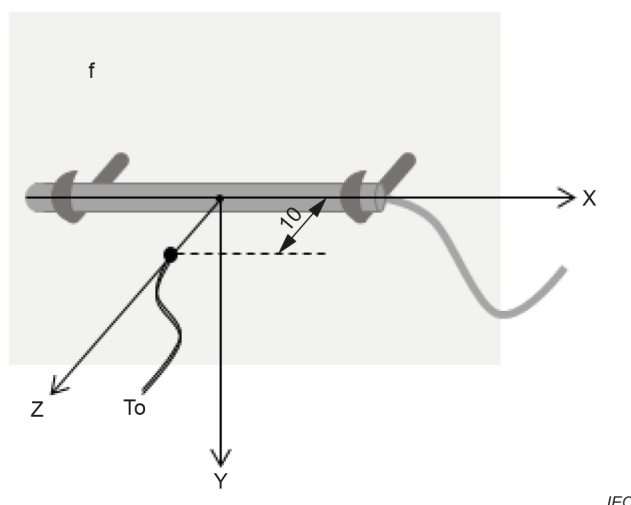
IEC

Key

- f fixation wall - position of the thermostat to the fixation wall (the thermostat body shows a perpendicular position to the surface of the fixation wall)
- To observer thermocouple
- Z direction – under thermostat

Figure 10 – Vertical installation of the observer thermocouple

Dimensions in millimetres



IEC

Key

f fixation wall - position of the thermostat to the fixation wall where the thermostat body shows a parallel position to the surface of the fixation wall

To observer thermocouple

Z direction – in front of thermostat

Figure 11 – Horizontal installation of the observer thermocouple

8.4.2 Oven settings

For measuring the energy consumption, a **heating function** or **eco function** shall be used. If more than one **heating function** or **eco function** is available, the recommendation in the manufacturer's instructions is taken into account.

The temperature control is set to a position where the average temperature rises $\Delta \bar{T}_{c2,k}$ as defined in Table 4 can be expected. $\Delta \bar{T}_{c2,k}$ is the difference between the average ambient temperature and the average cavity temperature measured in phase 2; $k = 1, 2, 3$ (k is the summing index).

The temperature setting T_s , which is the displayed setting of the knob or the control display (s is the setting), shall be noted. If the temperature steps are not clearly marked, the temperature setting should be determined by the angle according to the visible marks on the knob using polar coordinate paper (see Annex E).

If the temperature is set by a knob, the knob shall always be turned from zero to the required setting.

Table 4 – Temperature rise for three settings

Temperature rise	
$\Delta \bar{T}_{c2,1}$	$(135 \pm 15) \text{ K}$
$\Delta \bar{T}_{c2,2}$	$(165 \pm 15) \text{ K}$
$\Delta \bar{T}_{c2,3}$	$(195 \pm 15) \text{ K}^a$
^a Or the maximum temperature rise if this value cannot be reached.	

Report the used **heating function** or **eco function** and the temperature setting $T_{s,k}$ for each measurement.

8.4.3 Phase 1

- Remove all accessories delivered with the appliance, such as baking trays and side racks, which are not used for placing the brick.
- Place the brick, prepared in accordance with 8.3.3, in the geometric centre of the calculated cavity with its largest surface centrally on the grid delivered with the appliance, with the thermocouples on the upper side. If no grid can be purchased from the manufacturer of the appliance, any suitable grid should be used, however not a baking tray, tin or similar.
- Insert the grid into a shelf support level of the appliance so that the centre of the brick comes as close as possible to the centre, but not higher than the centre, of the calculated cavity. The longest axis of the brick shall be parallel with the appliance front. Where the grid can be inserted in two different positions (e.g. upside down gives a different height), the position should be taken that brings the brick's centre closest to the cavity's centre, but not higher. Only if the grid is already placed on the lowest level may the centre of the brick be higher than the centre of the cavity.
- If the appliance is prepared with the thermocouples, do not operate it with a function combined with microwave energy. Out-coupled microwave power through the thermocouples can damage instruments.

NOTE 1 See Annex D.

- Start the measurement within 3 min from the removal of the brick from the refrigerator by switching on the appliance following the requirements for setting.

The following data are measured:

- the measured energy consumption(s) E_k in kWh and the time(s) t_k in min and s, when the last of the two thermocouples in the brick reaches a temperature rise of 55 K, $k = 1, 2$ and 3;
- centre temperatures of the brick in °C;
- $T_{o1,k}$ continuously measured by the observer thermocouple in °C;
- ambient temperature $T_{a1,k}$ from the beginning of the test (when the appliance is switched on) to the end of the test (i.e. when the last of the two thermocouples in the brick has reached 55 K temperature rise) in °C.

NOTE 2 The energy consumption of components such as lamps and fans that are automatically switched on with the appliance, is included in the measurement.

8.4.4 Phase 2

In phase 2, the measurement of phase 1 is repeated in an empty **oven**.

For this, remove the brick and cool the appliance as long as it is ensured that the whole appliance (this includes the material and the insulation) is at ambient temperature of $(23 \pm 2) ^\circ\text{C}$. Forced cooling by a fan can be applied.

After cooling, verify that the setting is strictly identical to that used in phase 1 (see 8.4.3). This includes:

- unchanged position of the observer thermocouple;
- same temperature setting $T_{s,k}$;
- same **heating function**.

Switch on the appliance and operate for the same duration of t_k (measured in 8.4.3).

Measure the following data continuously:

- $T_{o2,k}$ from t_0 to t_k by the observer thermocouple during phase 2 in $^\circ\text{C}$;
- $T_{c2,k}$ from t_0 to t_k by the centre thermocouple during phase 2 in $^\circ\text{C}$;
- $T_{a2,k}$ from t_0 to t_k by the thermocouple positioned in accordance with 5.1 for measuring the ambient temperature in $^\circ\text{C}$.

8.5 Calculation

8.5.1 Smoothing the measured values

For further calculation, the measured data $T_{c2,k}$ are smoothed by a moving average applying Formula (1) in order to exclude possible measurement noise.

$$\tilde{T}_{c2,k,i} = \frac{1}{2n+1} \sum_{j=-n}^n T_{c2,k,i+j} \quad (1)$$

Where:

$\tilde{T}_{c2,k,i}$ is the smoothed temperature in the cavity centre in phase 2 in $^\circ\text{C}$;

$T_{c2,k,i+j}$ is the measured temperature in the cavity centre in phase 2 in $^\circ\text{C}$;

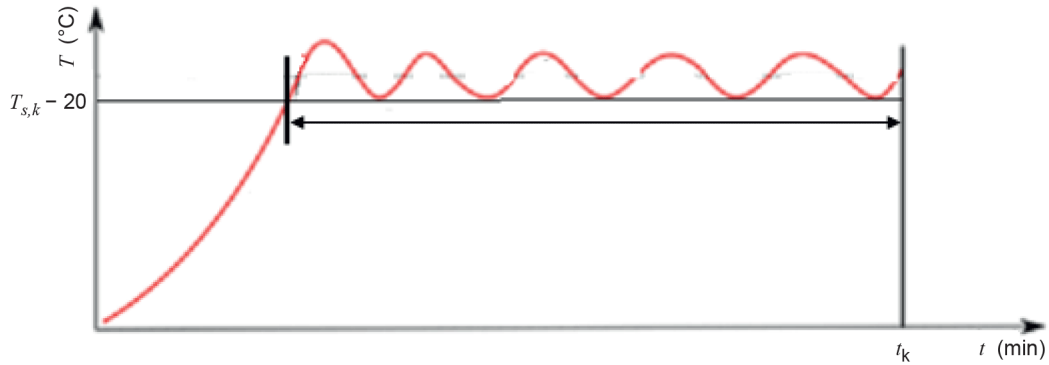
i is the sample index;

n is defined by $n = \left\lfloor \frac{f_s \times t_{\text{mov}} - 1}{2} \right\rfloor$ and where $t_{\text{mov}} = 30 \text{ s}$;

f_s is the sampling rate in 1/s.

8.5.2 Determining the average temperature rise for a heating function (phase 2)

If the manufacturer classifies the function under test as a **heating function**, this clause shall be applied to determine the average temperature rise.



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Figure 12 – Example – average temperature rise for a heating function

The average temperature rise for a **heating function** shall be calculated in the following period:

The start of this period shall be the point where $\tilde{T}_{c2,k}$ reaches $T_s - 20$ K. Hence, the start index i_s shall be defined as:

$$\tilde{T}_{c2,k}(i_s) = T_s - 20 \quad (2)$$

If the time period between $T_{s,k} - 20$ and end of measurement is less than 60 % of whole time t_k , the time period is prolonged to 60 % of t_k . In this case, the start index i_s shall be defined as:

$$i_s = i_k - 0,6i_k \quad (3)$$

The average temperature rise $\Delta\bar{T}_{c2,k}$ shall be calculated by averaging the difference of $T_{c2,k,i}$ and $T_{a2,k,i}$ for i_s until the end of the measurement (see Figure 12) by applying Formula (4):

$$\Delta\bar{T}_{c2,k} = \frac{\sum_{j=i_s}^{i_k} (\tilde{T}_{c2,k,j} - T_{a2,k,j})}{i_k - i_s + 1} \quad (4)$$

Where:

$\Delta\bar{T}_{c2,k}$ is the average temperature rise in phase 2 in K;

$\tilde{T}_{c2,k,j}$ is the measured temperature in the cavity centre in phase 2, smoothed, in °C;

$T_{a2,k,j}$ is the measured ambient temperature in phase 2 in °C;

i_s is the sample index representing the starting point;

i_k is determined by $i_k = \lfloor t_k \times f_s \rfloor$.

The average temperature $\bar{T}_{c2,k}$ shall be calculated accordingly to Formula (5).

$$\bar{T}_{c2,k} = \frac{\sum_{j=i_s}^{i_k} \tilde{T}_{c2,k,j}}{i_k - i_s + 1} \quad (5)$$

Where:

$\bar{T}_{c2,k}$ is the average temperature in the cavity centre in phase 2 in °C.

8.5.3 Determining the average temperature rise for an eco function (phase 2)

If the manufacturer classifies the function under test as an **eco function**, this clause shall be applied to determine the average temperature rise. For an **eco function**, the temperature shall be averaged within a 20 min period depending on the technical solution used for saving energy. See examples in Figure 13 and Figure 14.

– Technical solution A (See Figure 13)

The average temperature rise $\Delta\bar{T}_{c2,k}$ is calculated by averaging the difference of $T_{c2,k,i}$ and $T_{c2,k,i}$ for 1 200 s starting when the temperature setting is reached. Formulae (6) and (7) shall be applied.

$$\tilde{T}_{c2,k}(i_s) \equiv T_{ks} \quad (6)$$

$$\Delta\bar{T}_{c2,k} = \frac{\sum_{j=i_s}^{i_{1200}+i_s-1} (\tilde{T}_{c2,k,j} - T_{a2,k,j})}{i_{1200}} \quad (7)$$

Where:

$\Delta\bar{T}_{c2,k}$ is the average temperature rise in phase 2 in K;

$\tilde{T}_{c2,k,j}$ is the measured temperature in the cavity centre in phase 2, smoothened in °C;

$T_{a2,k,j}$ is the measured ambient temperature in phase 2 in °C;

i_s the sample index representing the starting point;

i_{1200} is defined by $\lfloor 1\,200 \times f_s \rfloor$.

The average temperature $\bar{T}_{c2,k}$ shall be calculated with Formula (8).

$$\bar{T}_{c2,k} = \frac{\sum_{j=i_s}^{i_{1200+i_s}-1} \tilde{T}_{c2,k,j}}{i_{1200}} \quad (8)$$

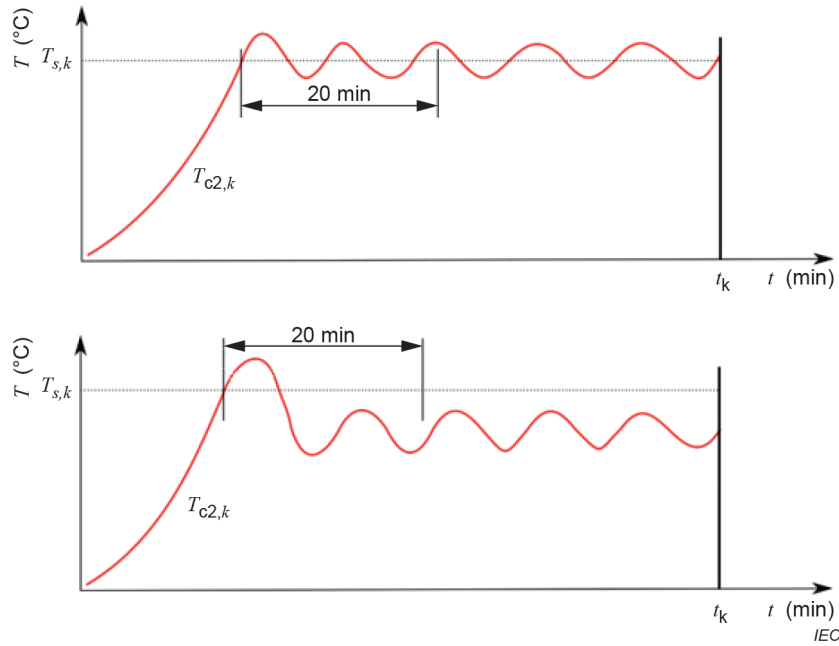


Figure 13 – Examples – set temperature reached

– Technical solution B (See Figure 14)

If the temperature setting is not reached before the last 20 min of phase 2 start, the average temperature rise $\Delta \bar{T}_{c2,k}$ is calculated by averaging the difference of $T_{c2,k,i}$ and $T_{a2,k,i}$ for the last 20 min of phase 2; see Formula (9).

$$\Delta \bar{T}_{c2,k} = \frac{\sum_{j=i_k+1-i_{1200}}^{i_k} (\tilde{T}_{c2,k,j} - T_{a2,k,j})}{i_{1200}} \quad (9)$$

Where:

$\Delta \bar{T}_{c2,k}$ is the average temperature rise in phase 2 in K;

$\tilde{T}_{c2,k,j}$ is the measured temperature in the cavity centre in phase 2, smoothed in °C;

$T_{a2,k,j}$ is the measured ambient temperature in phase 2 in °C;

i_{1200} is defined by $\lfloor 1200 \times f_s \rfloor$;

i_k is the index determined by $i_k = \lfloor t_k \times f_s \rfloor$.

The average temperature $\bar{T}_{c2,k}$ in °C is calculated with Formula (10).

$$\bar{T}_{c2,k} = \frac{\sum_{j=i_k+1-i_{1200}}^{i_k} \tilde{T}_{c2,k,j}}{i_{1200}} \quad (10)$$

Where:

$\bar{T}_{c2,k}$ is the average temperature in phase 2 in °C;

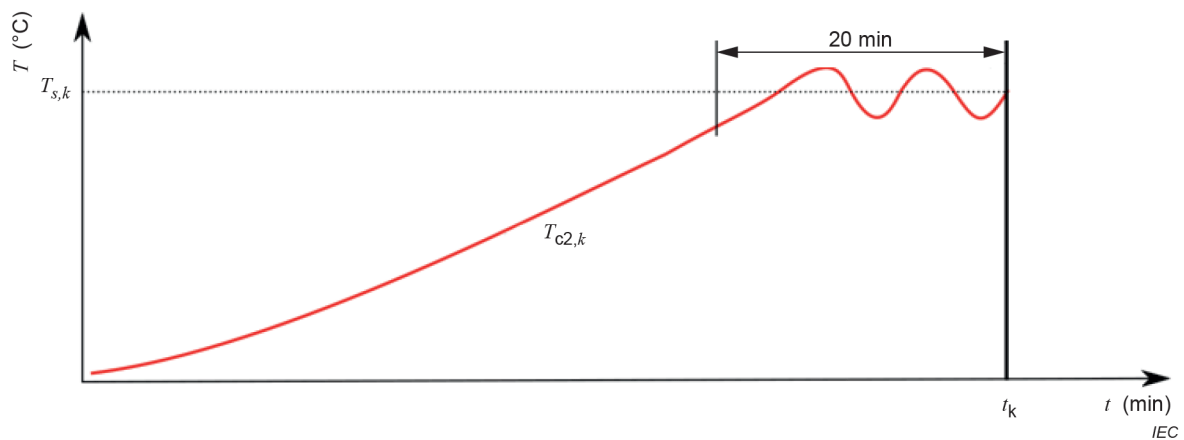


Figure 14 – Example – set temperature not reached

Calculate and note the average temperature rise $\Delta \bar{T}_{c2,k}$ in K for each measurement (each measured heating mode and temperature setting, see Table 4).

Calculate and note the average temperature $\bar{T}_{c2,k}$ in °C for each measurement (each measured heating mode and temperature setting, see Table 4).

8.5.4 Calculation of average ambient temperature

The average ambient temperature in phase 1 and phase 2 is calculated with Formulae (11) and (12):

$$\bar{T}_{a1,k} = \frac{\sum_{j=1}^{i_k} T_{a1,k,j}}{i_k} \quad (11)$$

$$\bar{T}_{a2,k} = \frac{\sum_{j=1}^{i_k} T_{a2,k,j}}{i_k} \quad (12)$$

The average ambient temperature in phase 1 and phase 2 is rounded to one decimal space and reported.

8.5.5 Determining the c -factor

Determine the c_k -factor for each measurement. The c_k -factor is the ratio between the observer temperatures measured in phase 1 and in phase 2 in the whole phase, t_o until t_k , calculated as shown in Formula (13):

$$c_k = \frac{\bar{T}_{o1,k}}{\bar{T}_{o2,k}} \quad (13)$$

Where:

$$\bar{T}_{o1,k} = \frac{\sum_{j=1}^{i_k} T_{o1,k,j}}{i_k} \quad (14)$$

$$\bar{T}_{o2,k} = \frac{\sum_{j=1}^{i_k} T_{o2,k,j}}{i_k} \quad (15)$$

j runs from 1 to i_k , where i_k is determined by $i_k = \lfloor t_k \times f_s \rfloor$.

The c_1 , c_2 and c_3 per **heating function** or **eco function** is rounded to two decimal places and reported.

8.5.6 Determining the s -factor

In the case that the heating mode is designated as a **heating function**, the s -factor shall be determined in addition to the c -factor.

Determine the s_k -factor for each measurement. The s_k -factor is the ratio between the observer temperatures measured in phase 1 and in phase 2 in the last 20 min of the whole phase, $t_k - 20$, calculated as shown in Formulae (16), (17) and (18):

$$s_k = \frac{\bar{T}_{o1,k,20}}{\bar{T}_{o2,k,20}} \quad (16)$$

Where:

$$\bar{T}_{o1,k,20} = \frac{\sum_{j=i_k+1-i_{1200}}^{i_k} T_{o1,k,j}}{i_k} \quad (17)$$

$$\bar{T}_{o2,k,20} = \frac{\sum_{j=i_k+1-i_{1200}}^{i_k} T_{o2,k,j}}{i_k} \quad (18)$$

i_{1200} is defined by $\lfloor 1200 \times f_s \rfloor$

j runs from 1 to i_{1200} , where i_k is determined by $i_k = \lfloor t_k \times f_s \rfloor$.

The s_1 , s_2 and s_3 for the **heating function** is rounded to two decimal places and reported.

8.6 Acceptance verification of the test results

8.6.1 Average temperature rise and standard deviation

Results of the tests in accordance with 8.5 shall only be accepted if

- a) the average temperature rises $\Delta \bar{T}_{c2,k}$ are within the temperatures specified in Table 4, and
- a) the standard deviation σ as defined in Formula (11) is below 0,050 kWh.

Otherwise, for the appropriate function, all measurements shall be repeated in accordance with 8.4.

The standard deviation σ is calculated, from the data pairs $\Delta \bar{T}_{c2,k}$ and E_k measured in accordance with 8.4, according to Formula (19) for each **heating function** or **eco function**, $k = 1, 2, 3$ (see Sachs ⁴).

$$\sigma = f \sqrt{\frac{Q_y - \frac{Q_{xy}^2}{Q_x}}{n-2}} \quad (19)$$

where

n is the number of measuring points (for the purposes of this standard, $n = 3$);

f is an approximation factor, $f = 1, 2$.

For calculating the standard deviation, the f -factor of 1,2 shall be used.

⁴ Applied statistics, formulas 5.29a and 5.69, modified. See the Bibliography.

NOTE 1 For the purpose of this standard, $\Delta \bar{T}_{c2,k}$ can only vary between 120 K and 210 K resulting in an f -factor of between 1,15 and 1,21. The approach to calculate the f -factor is given in Annex F for information only.

NOTE 2 The terms Q are described in Annex F.

8.6.2 Temperature setting and average temperature rise

The difference $\Delta T_{s,k}$ between $T_{s,k}$ and $\bar{T}_{c2,k}$ shall be calculated with Formula (20):

$$\Delta T_{s,k} = T_s - \bar{T}_{c2,k} \quad (20)$$

Where

$\Delta T_{s,k}$ is the difference between the set temperature and the average temperature;

$T_{s,k}$ is the set temperature;

$\bar{T}_{c2,k}$ is the average temperature in the cavity centre in phase 2.

The difference $\Delta T_{s,k}$ shall be ≤ 20 K.

If any of the difference $\Delta T_{s,k}$ is > 20 K, the measurement shall be repeated in accordance with 8.4 with an appropriate function.

NOTE The tolerance of 20 K is needed due to the long chain of tolerances (e.g. thermostat, connection, power of heating elements, control element and printing) and the fact that the temperature scale covers different **heating functions** and **eco functions**.

8.6.3 c -factor

The c -factor is used to show that the thermal behaviour of the **oven** in phase 1 and phase 2 is similar.

NOTE The c -factor is less than one, since each load, i.e. the brick in the case of energy measurement, influences the thermal behaviour.

The c_k -factors calculated in 8.5.5 for a function designated as a **heating function** shall be $c_k \geq 0,92$.

The c_k -factors calculated in 8.5.5 for a function designated as an **eco function** shall be $c_k \geq 0,82$.

8.6.4 s -factor

The s_k -factors are used to show that a function designated as a **heating function** does not use residual heat.

The s_k -factors calculated in 8.5.6 for a function designated as a **heating function** shall be $s_k \geq 0,92$.

8.7 Final electric energy consumption

If the acceptance criteria requested in 8.6 are fulfilled, the final energy consumption is calculated for the nominal temperature rise using the linear regression based on the calculated data point ΔT_k (see 8.5) and the measured data point E_k (see 8.4.3); see Formula (2).