

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Household electrical appliances – Measurement of standby power

Appareils électrodomestiques – Mesure de la consommation en veille



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2011 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00



IEC 62301

Edition 2.0 2011-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Household electrical appliances – Measurement of standby power

Appareils électrodomestiques – Mesure de la consommation en veille

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX



ICS 17.220.20; 97.030

ISBN 978-2-88912-329-2

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 General conditions for measurements.....	10
4.1 General.....	10
4.2 Test room.....	10
4.3 Power supply.....	10
4.3.1 Supply voltage and frequency.....	10
4.3.2 Supply voltage waveform.....	11
4.4 Power measuring instruments	11
4.4.1 Power measurement uncertainty.....	11
4.4.2 Power measurement frequency response	12
4.4.3 Power measurement long term averaging requirement	12
5 Measurements.....	13
5.1 General.....	13
5.2 Preparation of product.....	13
5.3 Procedure	14
5.3.1 General	14
5.3.2 Sampling method.....	14
5.3.3 Average reading method.....	16
5.3.4 Direct meter reading method	16
6 Test report.....	17
6.1 Product details	17
6.2 Test parameters	17
6.3 Measured data, for each product mode as applicable	17
6.4 Test and laboratory details	18
Annex A (informative) Guidance on modes and functions for selected product types.....	19
Annex B (informative) Notes on the measurement of low power modes.....	26
Annex C (informative) Converting power values to energy	34
Annex D (informative) Determination of uncertainty of measurement	36
Bibliography.....	41
Figure A.1 – Circuit diagram images by type	25
Figure B.1 – Connection arrangement for products powered directly from an a.c. power supply for lower power loads.....	32
Figure B.2 – Connection arrangement for a product powered via an external power supply for lower power loads.....	32
Figure B.3 – Connection arrangement for a product powered directly from the a.c. main supply for higher power loads	33
Figure B.4 – Connection arrangement for a product powered via an external power supply for higher power loads	33

Table 1 – Typical nominal electricity supply details for some regions	11
Table A.1 – Table of devices, their functions and their associated modes – for guidance only	22

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HOUSEHOLD ELECTRICAL APPLIANCES –
MEASUREMENT OF STANDBY POWER**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62301 has been prepared by IEC technical committee 59: Performance of household and similar electrical appliances.

This second edition cancels and replaces the first edition published in 2005 and constitutes a technical revision. The main changes from the previous edition are as follows:

- greater detail in set-up procedures and introduction of stability requirements for all measurement methods to ensure that results are as representative as possible;
- refinement of measurement uncertainty requirements for power measuring instruments, especially for more difficult loads with high crest factor and/or low power factor;
- updated guidance on product configuration, instrumentation and calculation of measurement uncertainty;
- inclusion of definitions for low power modes as requested by TC59 and use of these new definitions and more rigorous terminology throughout the standard;
- inclusion of specific test conditions where power consumption is affected by ambient illumination.

The text of this standard is based on the following documents:

FDIS	Report on voting
59/555/FDIS	59/561/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

Words in **bold** in the text are defined in Clause 3 Terms and definitions.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

INTRODUCTION

The methods defined in this standard are intended to cover **low power modes**. They are not intended to be used to measure power consumption of products during **active mode** (also called “on **mode**”), as these are generally covered by IEC or other product standards (see Bibliography for some examples), although the measuring techniques, measurement uncertainty determination and test equipment specifications could be adapted for such measurements with careful review.

HOUSEHOLD ELECTRICAL APPLIANCES – MEASUREMENT OF STANDBY POWER

1 Scope

This International Standard specifies methods of measurement of electrical power consumption in **standby mode(s)** and other **low power modes (off mode and network mode)**, as applicable. It is applicable to electrical products with a rated input voltage or voltage range that lies wholly or partly in the range 100 V a.c. to 250 V a.c. for single phase products and 130 V a.c. to 480 V a.c. for other products.

The objective of this standard is to provide a method of test to determine the power consumption of a range of products in relevant **low power modes** (see 3.4), generally where the product is not in **active mode** (i.e. not performing a primary function).

NOTE 1 The measurement of energy consumption and performance of products during intended use are generally specified in the relevant product standards and are not covered by this standard.

NOTE 2 The term “products” in this standard means energy using products such as household appliances or other equipment within the scope of TC 59. However, the measurement methodology could be applied to other products.

NOTE 3 Where this International standard is referenced by performance standards or procedures, these should define and name the relevant **low power modes** (see 3.4) to which this test procedure is applied.

NOTE 4 The inclusion of DC powered products within the scope of this standard is under consideration.

This standard does not specify safety requirements. It does not specify minimum performance requirements nor does it set maximum limits on power or energy consumption.

2 Normative references

The following referenced documents are indispensable for the application 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 60050-131, *International Electrotechnical Vocabulary (IEV) – Part 131: Circuit theory*

IEC 60050-300, *International Electrotechnical Vocabulary (IEV) – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050-131 and IEC 60050-300 as well as the following definitions apply.

3.1

function

a predetermined operation undertaken by the energy using product. **Functions** may be controlled by an interaction of the user, of other technical systems, of the system itself, from measurable inputs from the environment and/or time

In this standard, **functions** are grouped into 4 main types:

- user oriented secondary **functions** (see 3.6 - **standby mode**)
- network related secondary **functions** (see 3.7 - **network mode**)
- primary **functions** (see 3.8 - **active mode**, which is not the focus of this standard)
- other **functions** (these **functions** do not affect the **mode** classification).

NOTE A list of typical **functions** that may be found in products is included in Annex A. Accurate recording and documentation of **functions** in the relevant **product mode** is a key element of documentation in this standard (see 6.3). **Function** types are generally classified as primary or secondary (remote, network, sensing and protective).

3.2

mode

a state that has no **function**, one **function** or a combination of **functions** present

NOTE 1 The **low power mode** categories in this standard are intended to provide guidance for the development of specific **mode** definitions for TC59 products by the relevant subcommittees.

NOTE 2 Annex A provides guidance on expected **modes** found in various product configurations and designs based on their circuitry and layout, but it does not define these **modes**. Annex A also provides background and guidance to users of this International standard regarding the development of **mode** definitions for specific products.

NOTE 3 See Annex C for examples of how to calculate total energy consumption from power measurements where the duration of each relevant **mode** is known.

3.3

product mode

mode where the **functions** present, if any, and whether these are activated, depend on the particular product configuration

NOTE The issue of devising appropriate names for **product modes** is a matter for the relevant product committees. While a **product mode** name should generally reflect the **functions** that are activated, they need not contain the terms “standby” or “network” even where the **product mode** falls within these **mode** categories.

3.4

low power mode

a **product mode** that falls into one of the following broad **mode** categories:

- **off mode(s)**
- **standby mode(s)**
- **network mode(s)**

NOTE 1 **Low power modes** are classified into one of the **mode** categories above (where applicable) on the basis of the **functions** that are present and activated in each relevant **mode**. Where other **functions** are present in a **product mode** (in addition to the ones required for the **mode** categories specified above), these **functions** do not affect the **mode** classification.

NOTE 2 **Low power mode** categories are defined in order to provide guidance to users of this international standard and to provide a consistent framework for the development of **low power modes**.

NOTE 3 Any transition that occurs between **modes**, either through user intervention or automatically, is not considered to be a **mode**.

NOTE 4 Not all **low power mode** categories are present on all products. Some products may have more than one **product mode** in each of the **low power mode** categories with different combination of **functions** activated. The power consumption in each **low power mode** depends on the product design and the **functions** which are activated in the particular **product mode**.

3.5

off mode(s)

any **product modes** where the energy using product is connected to a mains power source and is not providing any **standby mode**, **network mode** or **active mode function** and where the **mode** usually persists. An indicator that only shows the user that the product is in the off position is included within the classification of **off mode**.

NOTE Guidance on **modes** and **functions** may be found in Annex A.

3.6

standby mode(s)

any **product modes** where the energy using product is connected to a mains power source and offers one or more of the following user oriented or protective **functions** which usually persist

- to facilitate the activation of other **modes** (including activation or deactivation of **active mode**) by remote switch (including remote control), internal sensor, timer;
- continuous **function**: information or status displays including clocks;
- continuous **function**: sensor-based functions

NOTE Guidance on **modes** and **functions** may be found in Annex A. A timer is a continuous clock **function** (which may or may not be associated with a display) that provides regular scheduled tasks (e.g. switching) and that operates on a continuous basis.

3.7

network mode(s)

any **product modes** where the energy using product is connected to a mains power source and at least one network **function** is activated (such as reactivation via network command or network integrity communication) but where the primary **function** is not active

NOTE Where a network **function** is provided but is not active and/or not connected to a network, then this **mode** is not applicable. A network **function** could become active intermittently according to a fixed schedule or in response to a network requirement. A "network" in this context includes communication between two or more separate independently powered devices or products. A network does not include one or more controls which are dedicated to a single product. **Network mode** may include one or more standby **functions**.

3.8

active mode(s)

a **product mode** where the energy using product is connected to a mains power source and at least one primary **function** is activated

NOTE The common terms "on", "in-use" and "normal operation" also describe this **mode**.

3.9

disconnected mode

the state where all connections to mains power sources of the energy using product are removed or interrupted

NOTE Common terms "unplugged" or "cut off from mains" also describe this **mode**. This **mode** is not part of the **low power mode** category.

3.10

rated voltage

supply voltage (range) designated by the manufacturer

3.11

rated frequency

supply frequency (range) designated by the manufacturer

3.12

instructions for use

information that is provided for users of the product

NOTE **Instructions for use** would include a user manual and may be in paper or electronic form. **Instructions for use** do not include any special directions provided by the product supplier to the test laboratory especially for testing purposes.

4 General conditions for measurements

4.1 General

Unless otherwise specified, measurements shall be made under the test conditions and with measuring instruments specified in 4.2 to 4.4.

4.2 Test room

The tests shall be carried out in a room that has an air speed close to the product under test of $\leq 0,5$ m/s. The ambient temperature shall be maintained at (23 ± 5) °C throughout the test.

Where the product has an ambient light sensor that affects the power consumption, the test shall be carried out with controlled ambient light conditions. Where the illuminance levels are externally defined (in a test procedure or in the **instructions for use**), these values shall be used. Where no illuminance levels are stated or defined, reference illuminance levels of >300 lx and <10 lx shall be used.

Information on the method used to achieve the above illuminance levels, where relevant, shall be recorded in the test report (see 6.3). Where values of illuminance are given, they shall be measured as close to the product's light sensor as practical.

NOTE The measured power for some products and **modes** could be affected by the ambient conditions (e.g. illuminance, temperature).

4.3 Power supply

4.3.1 Supply voltage and frequency

Where this standard is referenced by an external standard or regulation that specifies a test voltage and frequency, the test voltage and frequency so defined shall be used for all tests.

Where the test voltage and frequency are not defined by an external standard, the test voltage and the test frequency shall be the nominal voltage and the nominal frequency of the country for which the measurement is being determined ± 1 % (see Table 1).

NOTE A stabilised power supply may be required to meet these requirements.

Table 1 – Typical nominal electricity supply details for some regions

Country/Region	Nominal voltage and frequency ^a
Europe	230 V, 50 Hz
North America	115 V, 60 Hz
Japan ^b	100 V, 50/60 Hz
China	220 V, 50 Hz
Australia and New Zealand	230 V, 50 Hz
^a Values are for single phase only. Some single phase supply voltages can be double the nominal voltage above (centre transformer tap). The voltage between two phases of a three-phase system is 1,73 times single phase values (e.g. 400 V for Europe). Thus these multiples of the listed nominal voltage are also the nominal voltage for some products (e.g. ovens and clothes dryers) in some markets. ^b “50 Hz” is applicable for the Eastern part and “60 Hz” for the Western part, respectively.	

4.3.2 Supply voltage waveform

The total harmonic content of the supply voltage when supplying the product under test in the specified **mode** shall not exceed 2 % (up to and including the 13th harmonic); harmonic content is defined as the root-mean-square (r.m.s.) summation of the individual components using the fundamental as 100 %. The value of the harmonic content of the voltage supply shall be recorded during the test and reported (see 6.3).

In addition to the above, the ratio of peak value to r.m.s. value of the test voltage (i.e. crest factor) when supplying the product under test shall be between 1,34 and 1,49.

NOTE Power supplies meeting IEC 61000-3-2 are likely to meet the above requirements.

4.4 Power measuring instruments

NOTE Many power meters can also record harmonic content, as required by 4.3.2.

4.4.1 Power measurement uncertainty

This section covers the requirements for uncertainty introduced by the instrument that measures the input power to the product under test, including any external shunts.

The maximum permitted uncertainty of measurement depends on the size of the load and the characteristics of the load. The key characteristic of the load used to determine the maximum permitted uncertainty is the Maximum Current Ratio (MCR), which is calculated as follows:

$$\text{Maximum Current Ratio (MCR)} = \frac{\text{Crest Factor (CF)}}{\text{Power Factor (PF)}}$$

where

- the Crest Factor (CF) is the measured peak current drawn by the product divided by the measured r.m.s. current drawn by the product;
- the Power Factor (PF) is a characteristic of the power consumed by the product. It is the ratio of the measured real power to the measured apparent power.

a) Permitted uncertainty for values of $\text{MCR} \leq 10$

For measured power values of greater than or equal to 1,0 W, the maximum permitted relative uncertainty introduced by the power measurement equipment, U_{mr} , shall be equal to or less than 2 % of the measured power value at the 95 % confidence level.

For measured power values of less than 1,0 W, the maximum permitted absolute uncertainty introduced by the power measurement equipment, U_{ma} , shall be equal to or less than 0,02 W at the 95 % confidence level.

b) Permitted uncertainty for values of MCR > 10

The value of U_{pc} shall be determined using the following equation:

$$U_{pc} = 0,02 \times [1 + (0,08 \times \{MCR - 10\})]$$

where U_{pc} is the maximum permitted relative uncertainty for cases where the MCR is > 10.

For measured power values of greater than or equal to 1,0 W, the maximum permitted relative uncertainty introduced by the power measurement equipment shall be equal to or less than U_{pc} at the 95 % confidence level.

For measured power values of less than 1,0 W, the permitted absolute uncertainty shall be the greater of U_{ma} (0,02 W) or U_{pc} when expressed as an absolute uncertainty in W ($U_{pc} \times$ measured value) at the 95 % confidence level.

NOTE 1 It is preferred that the power measuring instrument detects, indicates, signals and records any “out of range” conditions.

NOTE 2 See Annex D and the *Guide to the Expression of Uncertainty in Measurement (GUM)* for further details.

NOTE 3 Although a specification for the power meter in terms of allowable crest factor is not included here, it is important that the peak current of the measured waveform does not exceed the permitted measurable peak current for the range selected, otherwise the uncertainty requirements above will not be achieved. See B.1.2 for an example calculation for U_{pc} and for more information.

For products connected to more than one phase, the power measuring instrument shall be capable of measuring the total power of all phases connected.

Where the power is measured using the accumulated energy method (see 5.3.3) the calculated power measurement uncertainty shall meet the above requirements.

4.4.2 Power measurement frequency response

The power measuring instrument shall be capable of meeting the requirements of 4.4.1 when measuring the following:

- DC
- AC with a frequency from 10 Hz to 2 000 Hz.

NOTE If the power meter contains a bandwidth limiting filter, it should be capable of being taken out of the measurement circuit.

4.4.3 Power measurement long term averaging requirement

Where it is necessary to perform measurements in accordance with 5.3.3, the power measuring instrument shall either be capable of

- measuring the average power over any operated selected time interval, or;
- integrating energy over any operator selected time interval.

NOTE A data recording capability (sampling) or output to a computer or data recorder is the most desirable capability as required by 5.3.2 – see B.2.5 for further information.

5 Measurements

5.1 General

The purpose of this test method is to determine the power consumption in the relevant **product mode**, which is either persistent or of a limited duration. A **mode** is considered to be persistent where the power level is constant or where there are several power levels that occur in a regular sequence for an indefinite period of time.

NOTE 1 During transition from one **mode** to another (either automatic or user initiated) some products could wait in a higher power state while transition tasks are performed or circuits are energized or de-energized, so they can take some time to enter a stable state.

NOTE 2 Where the **product mode** changes automatically it can sometimes be necessary to operate a product through the automatic sequence several times on a trial basis to ensure that sequence is fully understood and documented before test results are recorded and reported. A sequence of separate **product modes** could also exhibit a regular ongoing pattern of power levels. See Annex B for further guidance.

NOTE 3 While limited duration **modes** may be documented using measurements to this standard, the results for such **modes** should be reported as an energy consumption (Wh) and duration. A **product mode** that is stable should persist without any user intervention.

5.2 Preparation of product

Tests in this standard are to be performed on a single product.

The product shall be prepared and set up in accordance with the **instructions for use**, except where these conflict with the requirements of this standard and / or the relevant product performance standard. If no **instructions for use** are available, then factory or “default” settings shall be used, or where there are no indications for such settings, the product is tested as supplied.

NOTE An appropriate product standard would be, for example, IEC 60436 (dishwashers) or IEC 60456 (washing machines).

Once a product has been selected and is ready for testing, the following steps shall be followed and documented in the test report as applicable:

- remove the product from packaging (where applicable);
- read the **instructions for use** and configure the product in accordance with these instructions;
- determine if the product contains a sensor affecting the measurement result, e.g. an ambient light sensor;
- determine if the product contains a battery and whether the product contains circuitry for recharging a rechargeable battery. Reference shall be made to determine whether there is a legal provision which specifies the conditions to be applied, otherwise the following shall apply. For products containing a recharging circuit, the power consumed in
 - **off mode** and **standby mode** shall be measured after precautions have been taken to ensure that the battery is not being charged during the test, e.g. by removing the battery where this is possible, or ensuring that the battery is kept fully charged if the battery is not removable;
 - a maintenance **mode** shall be measured with the batteries installed and fully charged before any measurements are undertaken.
- refer to the relevant product test procedure, external requirement (e.g. regulation) or **instructions for use** that specifies the **product mode(s)** to test (where applicable). The **product modes** tested should be consumer relevant and representative of expected

normal use. Where **instructions for use** provide configuration options, each relevant option should be separately tested. **Active mode(s)** should be measured in accordance with the relevant performance standard for the product;

- undertake testing on relevant **product modes** in accordance with Subclause 5.3;
- classify each of the **product modes** tested into one of the **low power mode** categories (see Subclause 3.4) or other **mode** as applicable.

5.3 Procedure

5.3.1 General

Within this standard, power consumption shall be determined by

- the sampling method: by the use of an instrument to record power measurements at regular intervals throughout the measurement period (see 5.3.2). Sampling is the preferred method of measurement for all **modes** and product types under this standard. For **modes** where power varies in a cyclic fashion or is unstable, or for limited duration **modes**, sampling is the only measurement method permitted under this standard; or
- the average reading method: where the power value is stable and the **mode** is stable, by averaging the instrument power readings over a specified period or, alternatively by recording the energy consumption over a specified period and dividing by the time (see 5.3.3 for details of when this method is valid); or
- the direct meter reading method: where the power value is stable and the **mode** is stable, by recording the instrument power reading (see 5.3.4 for details of when this method is valid).

NOTE Determination of an average power from accumulated energy over a time period is equivalent. Energy accumulators are more common than **functions** to average power over an operator specified period.

5.3.2 Sampling method

This methodology shall be used where either the power is not stable (cyclic or unstable) or the **mode** is of limited duration. It also provides the fastest test method when the **mode** is stable. However, it may also be used for all **modes** and is the recommended approach for all measurements under this International standard. It should be used if there is any doubt regarding the behaviour of the product or stability of the **mode**.

Connect the product to the power supply and power measuring instrument. Select the **product mode** to be measured (this could require a sequence of operations, including waiting for the product to automatically enter the desired **mode**) and commence recording the power. Power readings, together with other key parameters such as voltage and current, shall be recorded at equal intervals of not more than 1 s for the minimum period specified.

NOTE 1 Data collection at equal intervals of 0,25 s or faster is recommended for loads that are unsteady or where there are any regular or irregular power fluctuations.

Where the power consumption within a **mode** is not cyclic, the average power is assessed as follows:

- the product shall be energised for not less than 15 min; this is the total period;
- any data from the first one third of the total period is always discarded. Data recorded in the second two thirds of the total period is used to determine stability;
- establishment of stability depends on the average power recorded in the second two thirds of the total period. For input powers less than or equal to 1 W, stability is established when a linear regression through all power readings for the second two thirds of the total period has a slope of less than 10 mW/h. For input powers of more than 1 W, stability is established when a linear regression through all power readings for the second two thirds of the total period has a slope of less than 1 % of the measured input power per hour.

- where a total period of 15 min does not result in the above stability criteria being satisfied, the total period is continuously extended until the relevant criteria above is achieved (in the second two thirds of the total period).
- once stability is achieved, the result is taken to be the average power consumed during the second two thirds of the total period.

NOTE 2 If stability cannot be achieved within a total period of 3 h, the raw data should be assessed to see whether there is any periodic or cyclic pattern present.

Modes that are known (based on **instructions for use**, specifications or measurements) to be non-cyclic and of varying power consumption shall be recorded for a long enough period so that the cumulative average of all data points taken during the second two thirds of the total period fall within a band of $\pm 0,2$ %. When testing such **modes**, the total period shall not be less than 60 min.

Where the power consumption within a **mode** is cyclic (i.e. a regular sequence of power states that occur over several minutes or hours), the average power over a minimum of four complete cycles is assessed as follows:

- the product shall be energised for an initial operation period of not less than 10 min. Data during this period is not used to assess the power consumption of the product;
- the product is then energised for a time sufficient to encompass two comparison periods, where each period shall include not less than two cycles and have a duration of not less than 10 min (comparison periods must contain the same number of cycles);
- calculate the average power for each comparison period;
- calculate the mid-point in time of each comparison period in hours;
- stability is established where the power difference between the two comparison periods divided by the time difference of the mid-points of the comparison periods has a slope of less than
 - 10 mW/h, for products where the input powers is less than or equal to 1 W; or
 - 1 % of the measured input power per hour, for products where the input powers is greater than 1 W.
- where the above stability criteria is not satisfied, additional cycles are added equally to each comparison period until the relevant criteria above is achieved;
- once stability is achieved, the power is determined as the average of all readings from both comparison periods.

Where cycles are not stable or are irregular, sufficient data shall be measured to adequately characterise the power consumption of the **mode** (a minimum of 10 cycles is recommended).

NOTE 3 In all cases it is recommended that power for the period where data is recorded be represented in graphical form to assist in the establishment of any warm up period, cyclic pattern, instability and stability period.

Modes that are known (based on **instructions for use**, specifications or measurements) to be of limited duration shall be recorded for their whole duration. The results for such **modes** shall be reported as an energy consumption (Wh) and duration together with a statement that the **mode** is of limited duration.

NOTE 4 The product is not required to operate for a minimum initial period before data measurements are recorded when performing the above test.

For products where a series of separate **product modes** occur in a regular pattern, the power level for each **mode** shall be determined in accordance with this clause and the known sequence and duration of each **mode** in the pattern documented. See Annex B for further guidance.

5.3.3 Average reading method

This method is not permitted for cyclic loads or limited duration **modes**.

NOTE 1 A shorter measurement period may be possible using the sampling method – see 5.3.2.

Connect the product to the power supply and power measuring instrument. Select the **mode** to be measured (this may require a sequence of operations and it could be necessary to wait for the product to automatically enter the desired **mode**) and monitor the power. After the product has been allowed to stabilize for at least 30 min, assess the stability of two adjacent measurement periods. The average power over the measurement periods is determined using either the **average power** or **accumulated energy** methods as follows:

- select two comparison periods, each made up of not less than 10 min duration (periods shall be approximately the same duration), noting the start time and duration of each period;
- determine the average power for each comparison period;
- stability is established where the power difference between the two comparison periods divided by the time difference of the mid-points of the comparison periods has a slope of less than
 - 10 mW/h, for products where the input powers is less than or equal to 1 W; or
 - 1 % of the measured input power per hour, for products where the input powers is greater than 1 W.
- where the above stability criteria is not satisfied, longer periods of approximately equal duration are added until the relevant criteria above is achieved;
- once stability is achieved, the power is determined as the average of readings from both comparison periods;
- where stability cannot be achieved with comparison periods of a 30 min duration each, the sampling method in 5.3.2 shall be used.

Average power approach: where the power measuring instrument can record a true average power over an operator selected period, the period selected shall not be less than 10 min.

Accumulated energy approach: where the power measuring instrument can measure energy over an operator selected period, the period selected shall not be less than 10 min. The integrating period shall be such that the total recorded value for energy and time is more than 200 times the resolution of the meter for energy and time. Determine the average power by dividing the measured energy by the time for the monitoring period.

NOTE 2 To ensure consistent units, it is recommended that watt-hours and hours be used above, to give watts.

NOTE 3 Example 1 – if an instrument has a time resolution of for example 1 s, then a minimum of 200 s (3,33 min) is required for integration on such an instrument.

NOTE 4 Example 2 – if an instrument has an energy resolution of for example 0,1 mWh, then a minimum of 20 mWh is required for the accumulation of energy on such an instrument (at a load of 0,1 W this would take about 12 min, at 1 W this would take 1,2 min). Note that both the time and energy resolution requirements should be satisfied by the reading, as well as the minimum recording period specified above (10 min).

5.3.4 Direct meter reading method

The direct meter reading method may only be used where the **mode** does not change and the power reading displayed on the measuring instrument is stable. This method shall not be used for verification purposes. Any result using the methods specified in 5.3.2 or 5.3.3 have precedence over results using this method in the case of a dispute.

NOTE A shorter measurement period may be possible using the sampling method – see 5.3.2.

Power consumption using the direct reading method is assessed as follows:

- connect the product to be tested to the power supply and measuring instrument, and select the **mode** to be measured;
- allow the product to operate for at least 30 min. If the power appears to be stable, take a power measurement reading from the instrument. If the reading still appears to be varying the 30 min period is extended until stability appears to have occurred;
- after a period of not less than 10 min, take an additional power measurement reading and note the time between the power measurement readings in hours;
- the result is the average of the two readings, providing that the difference in power between the two readings divided by the time interval between readings is less than
 - 10 mW/h, for products where the input powers is less than or equal to 1 W, or;
 - 1 % of the measured input power per hour, for products where the input powers is greater than 1 W.
- where the relevant criterion above is not met the direct meter reading method shall not be used.

6 Test report

6.1 Product details

The following information shall be recorded in the test report.

- Brand, model, type, and serial number
- Product description, *as appropriate*
- **Rated voltage(s)** and **frequency** (frequencies)
- Details of manufacturer marked on the product (if any)
- Source of information used to establish **product modes (instructions for use)** and a technical justification, where applicable, regarding the selection of the **modes** measured and any **modes** excluded.

In the case of products with multiple **functions** or with options to include additional modules or attachments, the configuration of the product as tested shall be noted in the report.

6.2 Test parameters

The following values shall be achieved and recorded during the test. If the values change during the test, the minimum and maximum values shall be recorded.

- Ambient temperature (°C)
- **Test voltage(s)** (V) and **frequency** (frequencies) (Hz)
- Total harmonic distortion of the electricity supply system
- Information and documentation on the instrumentation, set-up and circuits used for electrical testing.

6.3 Measured data, for each product mode as applicable

The following information shall be recorded in the test report:

- description of the **product mode** and documentation on the user oriented and other **functions** that are active and provide a description of how the **mode** was activated;
- sequence of events to reach the **mode** where the product automatically changes **modes**;
- average power in watts rounded to the second decimal place. For loads greater than or equal to 10 W, at least three significant figures shall be reported;

- calculated uncertainty of the result due to the measuring instrument (U_e)(see Annex D) and whether the result complies with 4.4.1;
- measurement method used (see 5.3.2, 5.3.3 or 5.3.4). In the case of 5.3.3, indicate whether average power or accumulated energy approach was used;
- sampling interval, total duration of measurements and stability period (5.3.2 if applicable);
- accumulated energy and period of measurement (seconds/minutes/hours) (5.3.3 if applicable);
- energy and duration of any **modes** of limited duration. Documentation describing the pattern (or patterns) for **modes** that automatically repeat sequentially;
- any notes regarding the operation of the product;
- record ambient conditions such as illuminance levels during the measurement where these affect the power reading;
- classification of the measured **product mode** into one of the relevant **mode** categories in Clause 3, or other **mode** as applicable.

NOTE 1 Apparent power (VA), real power factor and crest factor are also useful parameters and are recommended for inclusion in the test report. Presentation of data collected by sampling in graphical format is recommended.

NOTE 2 It is recommended that total uncertainty of the result (U_{total}) also be calculated and reported (see Annex D).

6.4 Test and laboratory details

The following information shall be recorded in the test report:

- test report number/reference
- date of test
- laboratory name and address
- test officer(s)

Annex A (informative)

Guidance on modes and functions for selected product types

A.1 General

It is important for subcommittees and other groups that reference this international standard to devise names for **product modes**, within the broad categories defined, that reflect the relevant **functions** that are present and working.

IEC 62301 is a measurement procedure for **low power modes** and is not sufficient to provide an estimate for total energy consumption. Issues like user behaviour, as well as considerations concerning frequency and duration of each possible **low power mode** in addition to **active mode** and **disconnected mode**, are required to determine energy consumption and are not subjects of this standard.

A.2 Product modes

A product may or may not have each of the **modes** defined and it may have more than one of each of the relevant **modes**. Information on **functions** is included in A.3.

Disconnected mode is included in definitions as many products are removed by users from the source of mains power for substantial periods of time. The energy consumption (from the mains) in this state is of course zero and no measurements under this standard are specified. However, the prevalence of this **mode** is user dependent (habits and practices) and is only included as this will have some impact on total product energy consumption in cases where this is of interest.

A product may have several **off modes** or it may have no **off mode**. Switches on products that are labelled as power, on / off or standby may not reflect the **mode** classification based on the actual **functions** active in that **mode**.

The existence of a switch (of whichever technology) which is located on the product is not considered a (user oriented) **function** under **standby modes**. A remote switch (not located on the product) (e.g. remote control, low voltage remote switch) should be considered a remote operation **function** and would therefore normally be part of **standby mode**. The exception is where a remote switch operates at mains voltage by controlling the mains power supply to a product; in this case it should be considered as **disconnected mode**. The existence of components to facilitate electromagnetic compatibility (EMC) is not considered a user orientated **function** and is not relevant to the determination of **product mode**.

Functions regarding memory retention and history of use, user preferences etc are not considered as a **function** under **standby mode** as these should be retained in **off mode**, during power outages and in **disconnected mode** (e.g. stored in non volatile memory).

Functions that are not protective and/or which cannot be verified (e.g. in the **instructions for use** or information) should not be considered a **function** under **standby mode**.

In **network mode**, care is required to ensure that a properly configured network is available and connected to the product when testing to obtain an accurate measure of power consumption in this **mode**. Care is required in these **modes** as several power levels may be possible (e.g. power may be affected by network connection speed or the number and type of network connections). The power consumption may also cycle in these **modes**. For a wireless network, there may be a difference in power consumption between the wireless device locking

for a connection (listening) and where the network connection is actually established. It is important to consider that in a network environment, the energy consumption of the energy using product may be affected by the product design and user interaction as well as network interaction.

In most cases, **active mode** energy consumption is complex and requires a detailed analysis of the duty cycle of the product together with the influence of any user interaction and the range of common tasks. In many cases there are specific product standards that cover the **active mode** energy consumption and these should be referenced where they are available. However, product committees may decide that the measurement methodologies defined in Clause 5 of this standard could be applicable to **active modes** which have relatively low power and steady power consumption.

For portable products with rechargeable batteries, the relevant **low power modes** would be

- with the charger or docking / base station connected to mains power but with the product detached (battery disconnected); and
- with the charger or docking / base station connected to mains power with the product attached and fully charged (also called float or maintenance).

Modes where batteries are being charged (apart from float or maintenance **modes**) are not defined in this standard.

The **low power mode** with the minimum power level (lowest power **mode**) for an individual product may be a useful benchmark for products with comparable functionality.

In Edition 1 of this standard, **standby mode** was defined as follows:

lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions

In the present Edition 2, this definition is no longer used as **standby mode**. This definition above has no defined level of functionality and if used should be applied with great caution, as compared products may have different levels of functionality. The minimum power consumption **mode** is not a **mode** in this standard and does not relate to any one of the **low power mode** categories as defined in Edition 2.

A.3 Functions

A **function** is defined in Subclause 3.1.

Functions can be generally classified as either primary **functions** or secondary **functions**. Secondary **functions** can include remote switching, network, sensing and protective type **functions**. Primary **functions** relate to the primary purpose of the product. For some products network **functions** or sensing **functions** can be a primary **function**. There may be more than one primary **function**.

The operating load (as illustrated in Figure A.1) is the primary **function** of the product. Thermostats or temperature control devices which control the operating load in order to maintain a constant condition are usually considered as part of the operating load (primary **function**) and not as a power switch or a secondary **function**.

Examples of secondary **functions** are as follows:

- remote control of power to the operating load (effectively a remote power switch) – typically wireless or low voltage (dedicated to a product);

- secondary control of the load (auto off, delay start or delay off);
- sensors such as light, occupancy, heat, smoke, temperature, water flow (note that a thermostat which controls an operating load is not considered to be a sensor in this context);
- display (could be **mode**, status, program, state or clock etc.);
- memory and timer functions;
- electronic controls, locks and switches;
- network **functions** (wired, wireless, infrared);
- battery charging (where this is not a primary **function** of the device);
- electromagnetic compatibility (EMC) filters;
- sensors for protection of products and / or users.

Some examples of **functions** and their respective **mode** classifications are set out in Table A.1.

It is useful to consider secondary **function(s)** as separate modules to the primary load (or primary **function**) in order to understand why power consumption may occur in some **low power modes**. Secondary **functions** will consume small amounts of power under some design configurations. Some secondary **functions** may have a separate switch to disconnect them from the mains power supply under some **product modes**. A range of possible configurations for secondary **function** modules are shown in Figure A.1.

A.4 Power switch

A power switch allows the user to activate or deactivate a primary **function**. A power switch is usually located on the product. Some secondary **functions** may remain active or become activated once the primary **function** is deactivated. Some products may have more than one power switch (some switches may operate on secondary **functions** alone). Some products may not have a power switch. A power switch is not classified as a **function** in this standard. There are a number of possible variations of a power switch, such as the following:

- mains power switch: power supply to the primary **function** is controlled by a user activated mains voltage switch. Some secondary **functions** may remain active or become activated when the primary **function** is deactivated;
- low voltage or “soft” power switch: power supply to the primary **function** is controlled via a user activated secondary low voltage switch. Some secondary **functions** may remain active or become activated when the primary **function** is deactivated;
- timer or automatic switch: a variation of a switch where the primary **function** is controlled within the product rather than by the user directly (can be automatic (e.g. at completion of a task) or user programmed to turn on or turn off at specified times or selected periods and can include power management);
- remote control switch: a variation of a switch where the primary **function** is controlled remotely by the user or by another device;
- power control switch: a power switch that incorporates some sort of power control device such as a dimmer or thyristor.

Table A.1 – Table of devices, their functions and their associated modes – for guidance only

Device	Description	Secondary function type	Associated mode	Comments/issues
Remote switch	Remote switch that uses low voltage (wired) or radio or IR signals (wireless)	User oriented	Standby	Remote function has to be active. Does not include mains voltage switch that may be mounted remote from the product. Includes normal remote controls that are common on consumer products and some appliances (e.g. heaters).
Local switch	Switch that places the product into a mode with no apparent user oriented function active	Other	Off	Switch located on the product. Overrides remote switches and network functions . Some switches do not deactivate all functions (e.g. clocks, remotes etc.) – these would be standby mode .
Child lock	Device to stop accidental activation of a product by a child	User oriented	Off (see NOTE 1)	Typically an electrical lock (can also be mechanical) to ensure the product stays in off mode. Often associated with a LED. Variant of off but may require some power.
LED to signal Off-Mode	Light emitting diode (LED) to show the user that the product is off	Other	Off	A special case which should be considered as off mode (see Subclause 3.5). Does not include cases where remote switch is still active (see remote switch above).
Safety switches	Earth leakage, residual current devices or Ground Fault Circuit Interrupter or Arc Fault Circuit Interrupters	Other	See NOTE 3	Protective device which disconnects power in case of an electrical fault to protect the user or product – user not aware of presence.
EMC filters	Electromagnetic compatibility filters	Other	Off	EMC filters are required to limit interference with other devices. May or may not be connected when product is off.
Flood protector	Detection systems to ensure that flooding does not occur from faulty solenoids (e.g. washing products)	Other	Off (see NOTE 2)	Once solenoids are properly closed, they are unlikely to open again – should be required to ensure solenoids are closed and not leaking at end of cycle (designs vary).
Back-siphonage protector	Stops backflow of water into the mains water supply from a product (e.g. washing products)	Other	Off	Many products are required to have this and almost always this is a mechanical device (no power). Protects other users connected to the water supply.
No movement deactivation switch	Turns the product off if there is no movement in a defined period of time (e.g. iron)	Other	Active	An automatic change of mode from active to off or standby mode – not a normal operating state, protects property in case of (accidental) misuse of the product, not common in normal use. This function is by definition associated with use in active mode . Should not be relevant to energy consumption. Device protects property.
Delayed off switch	After a certain (user selectable) period the product is switched to a lower state	User oriented	Standby	Once powered to a lower state, the resulting mode would depend on the functions that are active (e.g. is remote control active or not). Relevant to energy consumption.
The final product mode will depend on the combination of functions (devices) that are present and activated. NOTE 1 Should be off mode as the product is clearly off and is considered to be off by the user. However, power may be required to keep electronic locks active so may need to be considered as a special kind of off mode. Some options for this function are mechanical and may not require power consumption. NOTE 2 Some designs provide additional protection by detecting leakages ahead of the solenoid, e.g. leakage of tube & connections. However, all of these functions are not obvious to users and it can be argued that the user could not differentiate this from normal off mode. However, these are real functions and may require some power. This is an area where there are different views and product committees need to consider specific cases. This device protects property. NOTE 3 Safety switches should be ignored when determining the mode category, but if it was noted in the user manual, it could be classified as standby mode. This device protects users.				

A.5 Product types

This clause sets out in diagrammatic form some common product configurations and whether these are likely to have some power consumption in **low power modes**. The major components in the product that affect power consumption are described below together with some examples and descriptions for each type (A to G) (see Figure A.1) A brief description of each type and some examples are given below. The example products listed are to illustrate those typical products that are configured in a particular way and their inclusion is not necessarily an accurate classification for possible product variations.

NOTE Letters allocated to each type are arbitrary.

Type A: The product has no secondary **function** load and no power switch. The product operates whenever plugged in. There may be some internal regulation of the load (e.g. thermostat or temperature control device). There is no **low power mode**.

Examples of Type A products: electric kettles (with no cut-out), some small kitchen products, electric storage water heaters, room heaters, refrigerators and freezers.

Type B: The product has a power switch. The primary **function** of the product operates when it is manually turned on by the power switch and stops when turned off. Power switches can be the auto-off type (automatically turns off at the completion of the operation). As there is no secondary **function**, the **low power mode** usually takes little or no power.

Examples of Type B products: electric heaters (with no thermostat), hair dryers, toasters, electric kettles (with boil cut-out), some major appliances (some dishwashers, clothes washers and clothes dryers), many small kitchen appliances, cooktops, some ovens.

Type C: The product has no mains power switch but has a secondary **function** that controls the primary **function** or performs some related **function**. There may be a remote control or low voltage power switch. **Low power mode** energy may be associated with the secondary **function**.

Examples of Type C products: bread makers, some small kitchen appliances, some major appliances (some dishwashers, clothes washers and clothes dryers), some microwave ovens, any product with a remote control and no hard off switch, any product with a “soft” (electronic) power switch.

Type D: The product has a power switch that disconnects the primary **function** and has a secondary **function** that is permanently connected to the power. **Low power mode** energy may be associated with the secondary **function**.

Examples of Type D products: conventional ovens, some types of heaters, microwave oven, any product that requires some power for a secondary **function** (clock, display, timer etc.).

Type E: The product has a power switch that disconnects the primary **function**. It may have a secondary **function** that is permanently connected to the power and/or one that is disconnected with the power switch. **Low power mode** energy may be associated with the permanently connected secondary **function**. Other **low power modes** may be associated with the switched secondary **function**.

Examples of Type E products: some microwave ovens, some major appliances (some dishwashers, clothes washers and clothes dryers), some types of heaters, any product that requires some power for a secondary **function** (clock, display, timer etc.), any product with permanently connected electronics or EMC filters, low voltage switches and controls or wired remote controls.

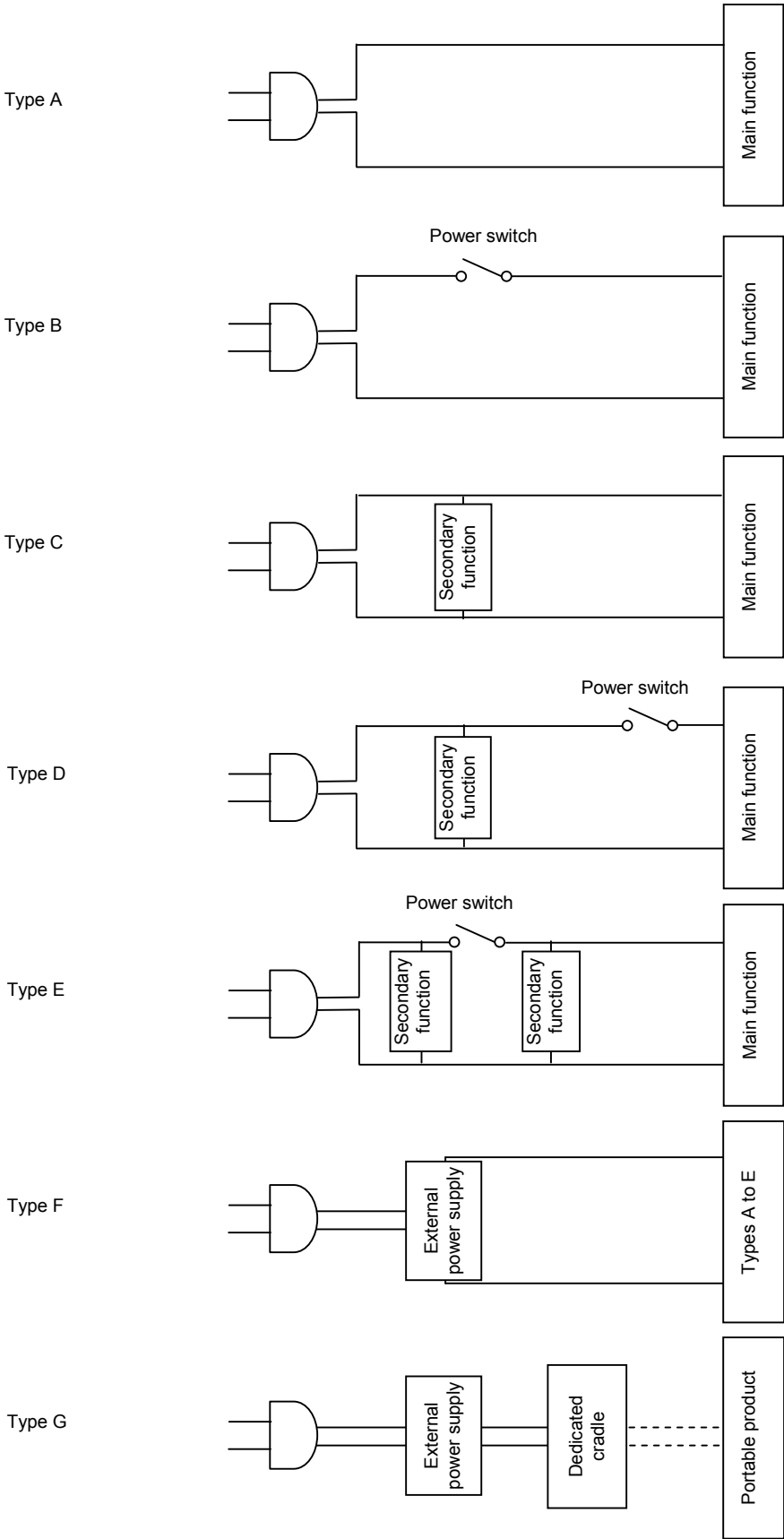
Type F: The product has an external power supply that provides the product with power. Supply is usually extra low voltage (<50 V), may be a.c. or d.c. and may be connected to a

plug. Internal product configurations may be A to E above. All **functions** require the external power supply to be connected to mains power. Energy consumption is associated with the power supply and there may be numerous **low power modes**.

Examples of Type F products: some small personal care products, some small kitchen appliances, any product that is normally connected to mains power via an external power supply.

Type G: The product has an external power supply that provides the product with power, mainly for battery charging. The product's primary **function** is normally performed with key part of the product disconnected from the power supply (battery operated and portable products), but some products may be used with the power supply connected. Supply is usually extra low voltage (<50 V) and may be a.c. or d.c. and is usually connected via a detachable plug. For these types of products the battery may be either charged while remaining inside or connected to the product (in this case the power supply may be attached to the product itself via a plug, or the product may sit in a dedicated cradle which charges the product when placed in the cradle while not in use) or the battery may be disconnected from the product for charging purposes (may require a dedicated or generic battery charging device). Energy consumption is usually associated with the power supply (even when the product is disconnected) and there can be **low power modes** and/or **active modes** associated with battery charging and product use (see Clause A.2).

Examples of Type G products: portable battery operated products such as battery shavers, electric toothbrushes, portable vacuum cleaners.



IEC 175/11

NOTE Dedicated charging cradle only provided in some product configurations

Figure A.1 – Circuit diagram images by type

Annex B (informative)

Notes on the measurement of low power modes

B.1 Low power measurement issues

B.1.1 General

There are a number of problems associated with power measurement of very small loads that are typically found in **low power modes** (typically less than 10 W). These mostly relate to the ability of the power measuring instrument to respond correctly to non sinusoidal current waveforms that are often presented in **low power modes**. Key points for consideration are discussed briefly below.

The intent of this standard is to measure power of the device in each relevant **product mode**. However in many **low power modes**, the current waveform is unlikely to be sinusoidal, so it is necessary to ensure that the meter has a scanning frequency that is sufficiently fast to capture the unusual current waveforms that are common (such as pulses or spikes). To determine the power, the meter has to multiply the instantaneous current and voltage values several hundred times per cycle (roughly 15 ms). Most digital instruments accumulate these values and display an average power once or twice a second. It is important to note that the power of many products in **low power modes** will be less than 10 W (some will be very small). This is partly due to low current levels, but also, in some cases, due to the current waveform being significantly different from the voltage waveform.

B.1.2 Effect of crest factor

The crest factor is defined as the ratio of peak current to r.m.s. current (or peak voltage to r.m.s. voltage). For a pure sinusoidal waveshape the crest factor is 1,414, while for a pure constant d.c. load the crest factor is 1,0. For power supplies meeting the requirements of 4.3.2, the voltage waveform will be generally sinusoidal and so the parameter of particular concern is the current waveform.

During the measurement, it is critical that the crest factor capability of the meter is greater than the actual crest factor of the load, otherwise the peak value of the current will be “lopped off” and the integration for power will be incorrect. Most meters will have a stated meter crest factor (or an allowable peak current) associated with each “current range”. Usually, the meter crest factor will increase as the actual load becomes smaller relative to the rated input range selected. However, if the range selected is too large, the accuracy resolution of the measurement will become poor and the uncertainty introduced from the (necessary) use of the larger range will have increased substantially. A meter that is able to handle higher peak currents within a given current range (i.e. no “out of range” signalled) will generally achieve a better overall uncertainty when measuring loads with a high crest factor and/or a low power factor, as it will be possible to select a smaller current range.

In order to make measurements in accordance with this standard it is important to use a power meter that gives an “out of range” reading if the peak current for that range is exceeded. For **low power modes** it is typical for the current waveform to have a crest factor in the range 3 to 10, sometimes even more and therefore it is important to verify that any “out of range” indicator has not operated.

For loads with a very high crest factor and / or very low power factor, Subclause 4.4.1 modifies the required uncertainty of measurement in recognition of the technical difficulty in reading these types of loads, even with highly accurate meters. An example calculation of the determination of uncertainty U_{pc} in Subclause 4.4.1 is set out below: