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Desktop and notebook computers – Measurement of energy consumption

IEC 62623:2022-04 RLV(en)

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Desktop and notebook computers – Measurement of energy consumption

INTERNATIONAL
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DESKTOP AND NOTEBOOK COMPUTERS – MEASUREMENT OF ENERGY CONSUMPTION

FOREWORD

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IEC 62623 has been prepared by technical area 19: Environmental and energy aspects for multimedia systems and equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

The first edition of this standard was originally based on ECMA-383.

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

a) Additions to terms & definitions and modification to short & long idle descriptions.
b) Test setup modifications for notebooks where battery pack cannot be removed for testing.
c) Categorisation procedure based on ECMA-389 removed.
d) Replace majority profile with new duty cycle study including new duty cycle attributes for desktop and notebook in a residential and enterprise application.
e) Removal of any reference and test methodology to ENERGY STAR V5.

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

Draft	Report on voting
100/3583/CDV	100/3669/RVC

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.

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/standardsdev/publications.

In this standard, the following print types or formats are used:

– requirements proper and normative annexes: in roman type;
– notes/explanatory matter: in smaller roman type;
– terms that are defined in 3.1: **bold**.

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,
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INTRODUCTION

This document ~~includes~~ provides definitions of energy saving modes and generic energy saving guidance for designers of desktop and notebook computers, by defining a methodology on how to measure the energy consumption of a product whilst providing key categorisation ~~criteria~~ attributes that enable energy consumption comparisons of similar products.

This document is originally based on ECMA-383 and complements the guidance given in IEC 62075.

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DESKTOP AND NOTEBOOK COMPUTERS – MEASUREMENT OF ENERGY CONSUMPTION

1 Scope

This document covers personal computing products. It applies to desktop and notebook computers as defined in 4.1 that are marketed as final products and that are hereafter referred to as the equipment under test (EUT) or product.

This document specifies:

– a test procedure to enable the measurement of the power and/or energy consumption in each of the EUT's power modes;

– formulas for calculating the **typical energy consumption** (**TEC**) for a given period (normally annual);

– a majority profile ~~that should~~ to be used with this document which enables conversion of average power into energy within the **TEC** formulas;

~~– a system of categorisation enabling like for like comparisons of energy consumption between EUTs;~~

– a pre-defined format for the presentation of results.

This document does not set any pass/fail criteria for the EUTs. Users of the test results ~~should~~ define such criteria.

2 Normative references

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

~~ECMA-389, *Procedure for the Registration of Categories for ECMA-383 2nd edition*~~

There are no normative references in this document.

3 Terms, definitions and abbreviations

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

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and definitions

3.1.1
active workload
simulated amount of productive or operative activity that the EUT performs as represented in the P_{work} (see 4.2.12) and $\boldsymbol{T}_{\textbf{work}}$ (see 3.1.11.6) attributes of the **TEC** equation (see 5.6)

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3.1.2
category
~~grouping of EUT configurations~~
classification within a product type that is based on product features and installed components

3.1.3
duty cycle
divisions of time the EUT spends in each of its individual power modes

Note 1 to entry: A duty cycle is expressed as a percentage totalling 1.

3.1.4
energy use
energy used by a product when measured from the mains power supply over a given period of time

Note 1 to entry: Energy is measured in kilowatt hour.

3.1.5
external power supply
EPS
equipment contained in a separate physical enclosure external to the computer casing and designed to convert mains power supply to lower DC voltage(s) for the purpose of powering the computer

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: The **EPS** is sometimes referred to as an AC brick.

Note 3 to entry: A reference to a document which outlines the testing procedures for measuring **EPS** efficiencies (External Power Supply Efficiency Test Method) can be found in the Bibliography.

3.1.6
internal power supply
IPS
component contained ~~in the same physical enclosure to~~ inside the computer casing and designed to convert AC voltage from the mains power supply to lower DC voltage(s) for the purpose of powering the computer components

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: A reference to a document which outlines the testing procedures for measuring **IPS** efficiencies (Generalized Internal Power Supply Efficiency Test Protocol) can be found in the Bibliography.

3.1.7
local area network
LAN
computer network located on a user's premises within a limited geographical area

[SOURCE: IEC 60050-732-01-04]

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: Currently the two primary technologies used in computers are IEEE 802.3 Ethernet or Wired **LAN**, and IEEE 802.11 WiFi or Wireless **LAN.**

3.1.8
manufacturer
organization responsible for the design, development and production of a product in view of its being placed on the market, regardless of whether these operations are carried out by that organization itself or on its behalf

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~~3.1.9~~
~~**red green blue**~~
~~**RGB**~~
~~primary colours that make up a pixel on a computer display~~

~~Note 1 to entry: The **RGB** values represent the intensity settings of each colour of that pixel to specify an exact colour.~~

3.1.9
typical energy consumption
TEC
number for the consumption of energy of a computer that is used to compare the energy performance of like computers, which focuses on the typical energy consumed by an EUT for a given profile while in normal operation during a representative period of time

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: For desktops and notebook computers, the key criterion of the **TEC** approach is a value for typical annual **energy use**, measured in kilowatt-hours (kWh), using measurements of average operational mode power levels scaled by an assumed typical **duty cycle** that represent annualized use for a profile.

3.1.10
actual energy consumption
TEC measured using P_{work}

Note 1 to entry: The **actual energy consumption** is referenced as $\mathbf{TEC}_{actual}$.

~~**3.1.12**~~
~~**estimated energy consumption**~~
~~**TEC** estimated by substituting P_{sidle} for P_{work}~~

~~Note 1 to entry: The **estimated energy consumption** is referenced as $\mathbf{TEC}_{estimated}$.~~

~~Note 2 to entry: P_{sidle} is defined in detail in 4.2.~~

~~Note 3 to entry: P_{work} is defined in detail in 4.2.~~

3.1.11
duty cycle attributes
percentage of time the EUT spends in each of its individual power modes

Note 1 to entry: Examples of **duty cycle attributes** are defined in 3.1.12.1 to 3.1.12.7.

3.1.11.1
off component of duty cycle
T_{off}
percentage of time the EUT is in the off mode

3.1.11.2
sleep component of duty cycle
T_{sleep} **and** $T_{sleepWoL}$
percentage of time the EUT is in the sleep modes

3.1.11.3
on components of duty cycle
T_{on}
percentage of time the EUT is in the on mode

Note 1 to entry: The T_{on} **duty cycle** is equal to the sum of the T_{work} + T_{sidle} + ~~T_{lidle}~~ T_{idle}.

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3.1.11.4
short idle component of duty cycle
T_{sidle}
percentage of time the EUT is in the short idle mode

3.1.11.5
long idle component of duty cycle
~~T_{lidle}~~ T_{idle}
percentage of time the EUT is in the long idle mode

3.1.11.6
alternative low power component of duty cycle
T_{alpm}
percentage of time the EUT is in the alternative low power mode

3.1.11.7
active component of duty cycle
T_{work}
percentage of time the EUT is in the active (work) mode

3.1.12
user of the test results
entity that will utilise the test results to apply to their needs

Note 1 to entry: Examples of such an entity are voluntary agreement owners, regulators, private companies, etc.

3.1.13
wake on LAN
WoL
functionality that allows a computer to wake from sleep or off to an active state when directed by a network wake request via Ethernet

Note 1 to entry: This note applies to the French language only.

3.1.14
graphics processor unit
GPU
integrated circuit, separate from the CPU, designed to accelerate the rendering of either 2D and/or 3D content to displays

Note 1 to entry: GPU may be paired with a CPU, on the system board of the computer or elsewhere to offload display capabilities from the CPU

3.1.15
discrete graphics
graphics processor (GPU) which must contain a local memory controller interface and local graphics-specific memory

3.1.16
integrated graphics
graphics solution that does not contain **discrete graphics**

3.1.17
switchable graphics
functionality that allows **discrete graphics** to be disabled when not required in favour of **integrated graphics**

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Note 1 to entry: This functionality allows lower power and lower capability integrated GPUs to render the display while on battery or when the output graphics are not overly complex while then allowing the more power consumptive but more capable discrete GPU to provide rendering capability when the user requires it.

3.1.18
system memory bandwidth
rate at which data can be read or stored into computer system's memory

Note 1 to entry: System memory bandwidth is measured in gigabytes per second (GB/s).

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

ACPI advanced configuration and power interface

NOTE 1 ACPI specification can be found here: http://www.uefi.org/acpi/specs

ALPM	alternative low power mode
CF	crest factor
CFR	crest factor ratio
CPU	central processing unit
DVI	Digital Visual Interface
EPS	external power supply
EUT	equipment under test

NOTE 2 Also referred to as product in this standard and sometimes referred to as UUT (unit under test) in other specifications.

FB_BW	frame buffer bandwidth
GPU	graphic processing unit
HDD	hard disk drive
HDMI®[1]	High Definition Multimedia Interface
IPS	internal power supply
LAN	local area network
LPM	low power mode
~~MCF~~	~~Meter Crest Factor~~
MCR	maximum current ratio
OS	operating system
PAPR	profile active power ratio
PAWR	profile active workload ratio
PCF	product crest factor
PF	power factor
RAM	random access memory
~~RGB~~	~~red green blue~~
RMS	root mean square
~~SSD~~	~~Solid State Drive~~
TEC	typical energy consumption
THD	total harmonic distortion

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[1] HDMI® and HDMI® High-Definition Multimedia Interface are trademarks of HDMI Licensing Administrator, Inc. This information is given for the convenience of users of this document 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.

ULE Ultra Low Energy
UPS uninterruptible power supply
VGA Video Graphics Array
WoL wake on LAN

4 Specifications for EUT

4.1 Computer descriptions

4.1.1 Desktop computer

A desktop computer is a computer where the main unit is intended to be located in a permanent location, often on a desk or on the floor. Desktops are not designed for portability and utilize an external computer display, keyboard, and mouse. Desktops are designed for a broad range of home and office applications.

4.1.2 Notebook computer

A notebook computer is a computer designed specifically for portability and intended to be operated for extended periods of time either with or without a direct connection to an AC mains power supply. Notebooks utilize an integrated computer display and are capable of operation from an integrated battery. In addition, most notebooks use an EPS or AC brick and have an integrated a non-detachable mechanical keyboard (using physical, moveable keys) and pointing device. Notebook computers are typically designed to provide similar functionality to desktops, including operation of software similar in functionality as that used in desktops. For the purposes of this document, docking stations are considered accessories and, therefore, should not be considered as part of the EUT. Tablet computers, which may use touch-sensitive screens along with, or instead of, other input devices, are considered notebook computers in this standard. Netbook computers which are typically identified by a smaller screen size (constrained) and base memory size are also considered notebook computers in this standard.

4.1.3 Two-in-one notebook

A computer which resembles a traditional notebook computer with a clam shell form factor, but has a detachable display which can act as an independent slate/tablet when disconnected. The keyboard and display portions of the product must be shipped as an integrated unit. Two-in-one notebooks are considered notebooks in the remainder of this standard and are therefore not referenced explicitly.

4.1.4 Multiscreen notebook

A computer which resembles a traditional notebook computer with a clam shell form factor but has a secondary display with touch and/or pen capability that can be used as a touch screen keyboard in place of a traditional mechanical keyboard. These products are considered to be notebook computers for purposes of this standard.

4.1.5 Slate/Tablet

A computing device designed for portability that meets all of the following criteria:

a) Includes an integrated display with a diagonal size greater than 6,5 inches and less than 17,4 inches;

a) lacking an integrated, physical attached keyboard in its as-shipped configuration;

b) includes and primarily relies on touchscreen input; (with optional keyboard);

c) includes and primarily relies on a wireless network connection (e.g., Wi-Fi, 3G, etc.); and

d) includes and is primarily powered by an internal battery (with connection to the mains for battery charging, not primary powering of the device).

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4.1.6 Portable all-in-one computer

A computing device designed for limited portability that meets all of the following criteria:

a) Includes an integrated display with a diagonal size greater than or equal to 17,4 inches;
b) lacking keyboard integrated into the physical housing of the product in its as-shipped configuration;
c) includes and primarily relies on touchscreen input; (with optional keyboard);
d) includes wireless network connection (e.g. Wi-Fi, 3G, etc.); and
e) includes an internal battery, but is primarily powered by connection to the ac mains.

4.1.7 Integrated desktop computer

An integrated desktop computer is a desktop computer where the computer and computer display function as a single unit ~~receiving its~~ and which is connected to AC mains power through a single mains cable. Integrated desktop computers come in one of two possible forms:

– a product where the computer display and computer are physically combined into a single unit; or
– a product packaged as a single product where the computer display is separate but is connected to the main chassis by a DC power cord and both the computer and computer display are powered from a single power supply.

As a subset of desktop computers, integrated desktop computers are typically designed to provide similar functionality as desktop computers.

NOTE 1 An integrated desktop computer can also be referred to as an all-in-one computer.

4.2 Power modes

4.2.1 Off mode

Off mode is the lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the EUT is connected to the main electricity supply and used in accordance with the **manufacturer**'s instructions. For products where ACPI standards are applicable, off mode correlates to ACPI system level S5 state.

NOTE 1 Some international regulations also refer to this mode as standby mode.

4.2.2 P_{off}

P_{off} represents the average power measured in the off mode.

4.2.3 Sleep mode

Sleep mode is ~~the lowest~~ a low power mode that the EUT is capable of entering automatically after a period of inactivity or by manual selection. An EUT with sleep capability can quickly wake to a readable display in response to a wake event from network connections or user interface devices ~~with a latency of ≤ 5 s from initiation of wake event to product becoming fully usable including rendering of display~~. For products where ACPI standards are applicable, sleep mode most commonly correlates to ACPI system level S3 (suspend to RAM) state. When the EUT is tested with the **WoL** capability disabled in the sleep state, it is referred to as sleep mode. When the EUT is tested with the **WoL** capability enabled in the sleep state, it is referred to as **WoL** sleep mode.

NOTE 1 Low power sleep modes other than ACPI S3 can be supported.

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4.2.4 P_{sleep}

P_{sleep} represents the average power measured in the sleep mode with the **WoL** capability disabled.

4.2.5 $P_{sleepWoL}$

$P_{sleepWoL}$ represents the average power measured in the sleep mode with the **WoL** capability enabled.

4.2.6 Alternative low power mode

A low power mode that the computer enters automatically after a period of inactivity or by manual selection that is defined by the display turning off and the computer entering a state of reduced functionality. A computer with alternative low power mode must maintain immediate responsiveness to network connections or user interface devices.

4.2.7 P_{alpm}

P_{alpm} represents the average power measured when in the Alternative Low Power Mode.

4.2.8 On mode

The on mode represents the mode the EUT is in when not in the sleep or off modes. The on mode has several sub-modes that include the long idle mode, the short idle mode and the active (work) mode.

4.2.9 P_{on}

P_{on} represents the average power measured when in the on mode.

4.2.10 Idle modes

4.2.10.1 General

The idle modes are modes in which the operating system and other software have completed loading, a user profile is created, the product is not in sleep mode or an alternative low power mode, and activity is limited to those basic applications that the product starts by default. There are two forms of idle that comprise the idle modes: short idle mode (see 4.2.10.2) and long idle mode (see 4.2.10.4).

4.2.10.2 Short idle mode

~~Short idle is the mode where the EUT has reached an idle condition (for example, 5 min after OS boot or after completing an **active workload** or after resuming from sleep, one can also use 15 min in order to conform to legacy testing procedures), the screen is on for at least 30 min to allow it to warm up, and set to at least a brightness level detailed in test procedure 5.3, and long idle power management features should not have engaged (for example, HDD (if available) is spinning and the EUT is prevented from entering sleep mode).~~

The short idle mode is where the EUT screen is on, and long Idle power management features have not engaged (e.g. HDD is spinning and the EUT is prevented from entering sleep mode or alternative low power mode). This condition shall be up to 5 min after:

– ceased user input or
– OS boot or
– after completing an active workload or

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– after resuming from sleep mode or alternative low power mode

4.2.10.3 P_{sidle}

P_{sidle} represents the average power measured when in the short idle mode.

4.2.10.4 Long idle mode

Long idle mode is the mode where the EUT has reached an idle condition (for example, 15 min after OS boot or after completing an **active workload** or after resuming from sleep), the screen of the primary display has just blanked but EUT remains in the working mode (ACPI G0/S0). Power management features, if configured as shipped, should have engaged (for example, primary display is on, HDD may have spun-down) but the EUT is prevented from entering sleep mode.

NOTE The screen has just blanked" refers to the main computer display (integrated panel or external display) having entered a low power state where the screen contents cannot be observed (for example, backlight has been turned off turning the screen black).

Long idle mode is where the EUT's display has entered a low-power state where display contents cannot be observed (that is backlight has been turned off) but EUT remains in the working mode (ACPI G0/S0). If power management features are enabled as-shipped, such features shall be enabled prior to evaluation of long Idle (e.g. display is in a low power state, HDD may have spun down), but the EUT is prevented from entering sleep mode or alternative low power mode.

This condition shall be between 15 to 20 min after

– ceased user input or
– OS boot or
– after completing an **active workload** or
– after resuming from sleep mode or alternative low power mode

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4.2.10.5 P_{idle} P_{lidle}

P_{idle} P_{lidle} represents the average power measured when in the long idle mode.

4.2.11 Active (work) mode

Active mode is the mode in which the EUT is carrying out user-initiated work in response to

– prior or concurrent user input; or
– prior or concurrent instruction over the network.

This mode includes active processing, seeking data from storage, memory, or cache, while awaiting further user input or acting on concurrent user input and before entering other low power modes. In this mode, the screen is on and set to as-shipped brightness.

4.2.12 P_{work}

P_{work} represents the average power measured when in the active mode.

4.3 Profile attributes

4.3.1 Profile

A profile is a combination of **duty cycle attributes** and a given use case (for example, office users, home users, gamers).

NOTE 1 Refer to Annex A, Annex B and Annex C for further information on profiles.

4.3.2 Majority profile

The majority profile is the most common profile of users for desktop and notebook computers.

The majority profile should be used with this standard and is documented in Annex B. It provides the **duty cycle attributes** and the profile **TEC** error that is used to determine the **TEC** equation to be used in 5.6.

4.3.3 Minority profile

The minority profiles represent less common profiles of users of desktop and notebook computers that are not represented in the majority profile. As an example, extreme gamers represent a very specific profile but are a very small percentage of computer users.

4.3.4 Profile study

A profile study is a study performed to create a new profile for this standard. The study shall generate, together with supporting data, the following:

– all the **duty cycle attributes**;
– the PAPR (see 4.3.6);
– the profile **TEC** error (see 4.3.9);
– the PAWR (see 4.3.7).

All data shall be derived from a statistically significant sample size that is representative of the user population as a whole. Annex C provides guidance on how to conduct a profile study.

4.3.5 Product active power ratio

The product active power ratio is the ratio of P_{on}/P_{sidle}, or the average on power divided by short idle power for an individual product within a profile study.

4.3.6 PAPR

PAPR is the average of all the product active power ratios recorded in a profile study.

4.3.7 PAWR

PAWR represents the average ratio of P_{work}/P_{sidle} conducted on profile study products and is used to validate that the **active workload** closely matches the profile study (through its PAWR).

4.3.8 Product TEC error

The product **TEC** error is the percent error calculation used in a profile study to evaluate how much error exists for an individual product when directly measuring **TEC** versus estimating **TEC** by substituting the static "short idle" power measurement for the measured P_{work} power.

4.3.9 Profile TEC error

The profile **TEC** error is the average of the product **TEC** error in a profile study.

4.4 Categorisation attributes

4.4.1 General

Below are some examples of categorisation attributes~~; additional examples should be found in the **category** registry (see 5.5)~~.

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4.4.2 Cores

The cores attribute is the number of physical CPU cores in the EUT.

~~4.4.3 Channels of memory~~

~~Channels of memory is expressed by the total number of channels the EUT is capable of supporting (they do not have to be populated). Each channel has a separate data path.~~

~~4.4.4 System memory~~

~~System memory is the amount of memory measured in gigabytes.~~

~~4.4.5 System fan~~

~~A system fan is any fan used in the EUT, excluding fans integrated into the power supply.~~

4.4.3 Expandability score (ES)

Expandability score (ES) is a result of a calculation designed to estimate a computer's power supply capacity based on the power draw, if each interface present in the system were operated at their designed maximum voltage and current.

4.4.4 Performance score

Performance score is one of the categorisation attributes and is a measure of:

(number of CPU cores x CPU Clock speed (GHz), where the number of cores represents the number of physical CPU cores and clock speed represents the maximum Thermal Design Power (TDP) core frequency (not the turbo boost frequency).

4.4.5 Graphics capability

Graphics capability is categorized based on frame buffer bandwidth

4.4.6 TEC adders

A **TEC** adder is a power allowance expressed in kilowatt hour per year that when added or configured to the EUT will increase its **TEC** by some amount. Examples could be:

- ~~graphics cards, memory, TV tuners, sound cards, hard disk drives, solid state disk drives, etc.;~~
- discrete graphics, memory including system memory bandwidth, network devices, I/O devices, power supply size, etc.;
- for computer with an integrated ~~desktop computer~~ display(s), ~~the~~ each screen shall be treated as an adder.

5 Test procedure and conditions, categorisation, TEC formula, meter specifications and results reporting

5.1 General

The following procedure shall be used when measuring the power or energy consumption of the EUT.

The user of this standard shall measure a sample of the EUT. The size of the sample shall be appropriate to demonstrate compliance to the requirements set by the **user of the test results**.

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5.2 Test setup

The EUT and test conditions shall be set up as defined below.

The automatic display luminance control should be disabled for testing. If automatic display luminance control cannot be disabled for testing, position a light source such that at least 300 lux directly enters the automatic display luminance control sensor.

a) The EUT shall be configured in accordance with the instructions provided with the product (unless otherwise stated in this test procedure) including all hardware accessories and software shipped by default. The EUT shall also be configured using the following requirements for all tests:
   1) Desktop and integrated desktop computers shipped without an input device shall be configured with a **manufacturer's** recommended input device (for example, mouse and/or keyboard). No other external peripherals shall be connected.
   2) Desktop computers shall be configured with an external computer display (the external display energy consumption is not included as part of the **TEC** calculation).
   3) Preparing external displays for desktop computers
      i) Display connections priority:
         a) If the EUT has a port that supports switchable graphics capable of automatic switching, use that port.
         b) If a discrete GPU is installed, connect to that GPU, except for where it conflicts with(a) in this list.
         c) If no discrete or automatically switchable GPU is installed, choose a connection to an integrated GPU.
         d) If multiple ports meet the requirements in(a) to (c) of this list, test with the first available interface from Table 1.

Table 1 – External display connection priority

i. DisplayPort™ [2]
ii. HDMI®
iii. DVI
iv. VGA
v. Other (i.e. Thunderbolt 3, Composite Video, etc.)

      ii) Display Resolution: An external monitor used in the testing of the EUT shall have a minimum native resolution of 1920 x 1080 pixels with progressive scanning (1080p). The EUT operating system shall be set to operate at a minimum of 1080p.
   4) Notebook computers need not include a separate keyboard or mouse when equipped with an integrated pointing device or digitizer. Slates/Tablets and Two-In-One Computers shall be configured in a manner identical to Notebooks unless otherwise specified.
   5) Notebook computers shall be connected to the mains power source using the EPS shipped with the product. Battery pack(s) shall be removed for all tests. For an EUT where operation without a battery pack is not an end-user supported configuration, the test shall be performed with fully charged battery pack(s) installed~~, making sure to report this configuration in the test results~~ and the state of the batteries as indicated by the

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[2] DisplayPort™ and the DisplayPort™ logo are trademarks of the Video Electronics Standards Association (VESA®). This information is given for the convenience of users of this document 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.

EUT's user interface shall be "fully charged" or similar state. The test configuration including any battery status indications, shall be reported in the test results.

~~5) The screen shall be configured with a "desktop background" (wallpaper) of a solid colour defined by a bitmap set to the **RGB** values of 130, 130, and 130. The screen brightness shall be set as-shipped or to a specified luminance level condition as appropriate.~~

~~NOTE 1 The as-shipped screen brightness is defined as a level the **manufacturer** deems to be appropriate for how an end user would want to use the product.~~

6) For computers with integrated display the three black and white vertical bar video signal as defined in 3.2.1.3 of IEC 60107-1:1997, "*Methods of measurement on receivers for television broadcast transmissions – Part 1: General conditions –Measurements at radio and video frequencies,*" (Edition 3) shall be displayed on the screen. The three-bar image shall be configured using the default image display application to set the display brightness for power measurements which is detailed in 5.3.6.

7) A notebook, two in one notebook, tablets/slates, portable all in one and integrated desktop computer shall include the power used by the integrated display in reported results.

NOTE 2 Additional specified luminance level conditions ~~may~~ can be measured (see 5.3.6) and disclosed in the reported results.

8) The sleep timer of the EUT shall be disabled or set to ~~30 min~~ a time to prevent the EUT from entering the sleep state during the idle or active tests.

Figure 1 illustrates a typical test setup for a notebook two-in-one notebook, slate/tablet, portable all-in-one, and a desktop computer.

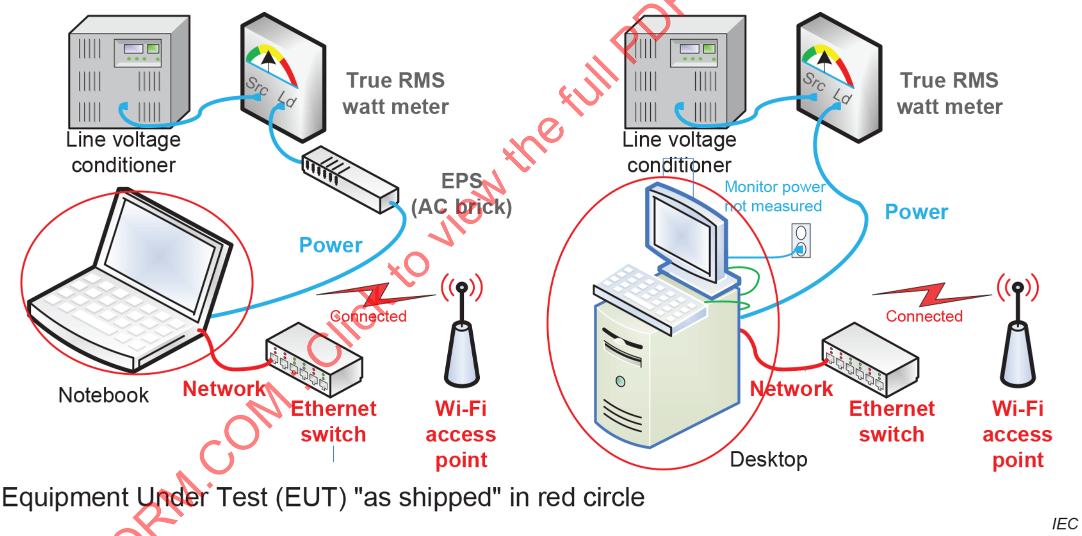

Figure 1 – Typical test setup

NOTE 3 Figure 1 shows wired and wireless connections. Only one is connected during test per 5.2c).

b) A true RMS watt meter that meets the meter requirements in 5.7 is placed between the mains power supply and the EUT power supply. No power strips or UPS units shall be connected between the meter and the EUT. The meter shall remain in place until all required power mode data is recorded. The mains power supply shall meet the requirements in 5.4.

c) For sleep, long idle, ALPM, short idle and the optional active measurements, the EUT energy consumption shall be measured with network connectivity in one of the ~~two~~ three states described below.

1) For an EUT with Ethernet port support, the EUT shall be connected to an active network switch via Ethernet that supports the highest link speed supported by the EUT (the network switch only needs to be connected to EUT but does not need to be connected to ~~a live network~~ any other device, either WAN or LAN). Only a single network connection needs to be made in the case of an EUT with multiple network connections. It shall also support the minimum requirements needed to support additional power management functions that are supported by the EUT.

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As an example, the IEEE 802.3az-2010 specification supports power management of Ethernet links that shall be supported by both the EUT and network switch.

To test this function, the switch shall also support this function. Power to alternative network devices such as wireless radios shall be turned off for all tests. This applies to wireless network adapters or device-to-device wireless protocols (for example, Bluetooth, Wi-Fi, etc). Cellular network connections shall be disabled for testing.

NOTE 4 For examples of wireless network adapters, see IEEE 802.11.

2) For an EUT with only wireless connectivity, a live wireless connection to a wireless router or network access point, which supports the highest and lowest data speeds of the client radio, shall be maintained for the duration of testing.

3) For an EUT that does not support Ethernet, but supports some other sort of wired network connectivity, that network shall be turned on and be in a connected state.

Some activities can cause variation in idle power during testing. The following is a partial list of occurrences in newly built systems that are likely to cause noticeable variations in idle power:

– Software updates
– Antivirus scans
– Drive Indexing
– Deferred activity from OS build process

d) The EUT shall be disconnected from the internet, anti-virus scans are not running and OS updates are not occurring and turn off drive indexing.

e) Record the EUT description as required in 5.10.

f) Measure the test conditions as defined in 5.4 and record as required in 5.10.

g) The ambient light conditions of the test room shall be measured using a meter that meets the requirements in 5.9 and set to the appropriate levels called for in 5.4.

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5.3 Test procedure

5.3.1 General

The test procedures are listed in order of energy consumption. The specific procedure for measuring each power mode shall be followed. However, the power measurements of each energy mode can be made in any order and, if a **TEC** result is not required, the user does not need to test all of the power modes.

5.3.2 Measuring off mode

To measure the off mode:

– place the EUT in off mode (see 4.2.1);
– WoL setting shall be in as shipped condition;
– set the meter to begin accumulating true power values at an interval of one or more readings per second; and
– accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{off}.

5.3.3 Measuring sleep mode

To measure the sleep mode:

– switch on the EUT;
– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in sleep mode (see 4.2.3);

– reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second;
– accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{sleep};
– if testing both **WoL** enabled and **WoL** disabled for sleep, wake the EUT and change the **WoL** from sleep setting through the operating system settings or by other means. Place the EUT back in sleep mode and repeat test, recording sleep power necessary for this alternate configuration as P_{sleepWoL}.
– For EUT that does not offer a Sleep Mode enabled by default, power shall be measured in the lowest-latency user-activated mode or state that preserves machine state and is enabled by default. If no such state separate from Long Idle or Off Mode exists, the measurement shall be omitted.

5.3.4 Measuring alternative low power mode

To measure alternative low power mode:

– switch on the EUT;
– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in alternative low power mode (see 4.2.10.4 or 4.2.6);
– the EUT shall be allowed no more than 20 min from the point of ceased user input before measurements must be started. If any default settings cause the EUT to enter long idle after 20 min, begin taking measurements when the EUT has reached the 20 min point;
– once the EUT has entered the alternative low power mode, reset the meter (if necessary) and begin accumulating true power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{ALPM}.

5.3.5 Measuring long idle mode

To measure long idle mode:

– switch on the EUT;
– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in long idle mode (see 4.2.10.4);
– the EUT shall be allowed no more than 20 min from the point of ceased user input before measurements must be started. If any default settings cause the EUT to enter long idle after 20 min, begin taking measurements when the EUT has reached the 20 minute point;
– once the EUT has entered the long idle mode, reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second;
– accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{idle}.

5.3.6 Measuring short idle mode

To measure short idle mode:

– switch on the EUT;
– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop background screen or equivalent ready screen is displayed, and the image has been scaled to completely fill the display area, ~~set to at least a brightness level of~~ if the EUT has an integrated display calibrate the EUT display brightness to the closest brightness setting using a luminance meter focused on one of the white bars in the three-bar black and white image detailed in 5.2a)6) to get the measurement reading that is at least 90 cd/m² for a notebook computer or at least 150 cd/m² for integrated desktop computers, slates/tablets and portable all in one computers, or if these levels are

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not attainable, set the product brightness level to the nearest achievable level, record the level and place the EUT in short idle mode (see 4.2.10.2);

- after display brightness level is set, open an image of RGB 130, 130, 130 where the image has been scaled to completely fill the display area using the default image viewing software on the EUT;
- the EUT shall be allowed no more than 5 min from the point of ceased user input before measurements must be started;
- once the EUT has entered short idle mode, reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second;
- accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{sidle}. Display sleep settings shall be disabled. Other default settings that cause the EUT to exit short idle during the measurement time shall be extended so that the EUT remains in short idle for the duration of the measurement.
- Additionally, only for notebook computers that demonstrate cyclical battery charging patterns extend the short idle test long enough to capture the energy consumption over one or more complete cycles. The extended test shall be conducted by keeping the unit in short idle through minimal user input such as moving the mouse or pressing a key that does not perform any action (e.g. shift, ctrl, tab). The EUT must remain in short idle during the entire time of the extended test.

5.3.7 Measuring active power mode (optional, see 5.6)

To measure active mode:

- switch on the EUT;
- once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in short idle mode (see 4.2.10.2);
- load the **active workload** and prepare it to run;
- reset the meter (if necessary) and start the **active workload**. Begin accumulating true power values at an interval of one or more readings per second;
- when the **active workload** indicates it has finished, record the average power as P_{work}.

NOTE 1 Criteria for the **active workload** is defined in 5.6.4.

NOTE 2 Criteria for active mode efficiency will need to be developed to account for computer performance and energy.

5.4 Test conditions

All tests carried out on the EUT shall take place under the conditions in Table 2.

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Table 2 – Test conditions

Mains power supply voltage	North America/Taiwan: Europe/Australia/New Zealand/China: Japan:	115 (±1 %) V AC, 60 Hz (±1 %) 230 (±1 %) V AC, 50 Hz (±1 %) 100 (±1 %) V AC, 50 Hz (±1 %) or 60 Hz (±1 %) For products rated > 1,5 kW maximum power, the voltage range is ±4 %
THD (voltage)	< 2 % THD (< 5 % for products which are rated for > 1,5 kW maximum power)	
Ambient temperature	(23 ±5) °C	
Relative humidity	10 % to 80 %	
Ambient light	(250 ±50) Lux	

NOTE 1 The voltage and frequency tolerances defined in Table 2 can only be achieved through the use of a line conditioner.

NOTE 2 It is recognised that the nominal voltage of some countries vary from the voltages defined above (for example, China is 220 V and India is typically 240 V), however this document has limited the number of voltages to be tested for worldwide compliance to three in order to minimise test overheads. Whilst the mains power supply voltage and frequency will have some impact on the overall **TEC** score, the variation that will be seen between 230 V, 220 V and 240 V will be minimal and well within the natural variation expected from testing to this document.

NOTE 3 Ambient light setting is only required if the display is sensitive to ambient light control and automatic display luminance control cannot be disabled for testing.

5.5 Categorisation

5.5.1 General

Categorisation is a grouping of product configurations enabling their relative **energy use** to be compared. ~~ECMA-389 includes the procedure for the registration of categories in accordance with ECMA-383.~~ A categorisation system is separate from this document as computer categories change on a much quicker timescale than standards due to changing market needs (local and international).

~~To be responsive to market and technology changes, the categories used with this standard are posted in International Registers on the following Ecma maintained, publicly available web site: http://www.ecma-international.org/publications/standards/Categories_to_be_used_with_Ecma-383.htm. This categorisation system is separate from the standard as computer categories change on a much quicker timescale than standards due to changing market needs (local and international). See Annex G for the maintenance procedures for the registration of categories.~~

~~5.5.2 ULE category~~

~~This **category** identifies products that have very low energy consumption, which are EUTs with an annualised **TEC** calculation below a certain kilowatt hour target with no other attributes or adders. Once a product qualifies as being in the ULE **category**, it does not qualify to fit within any of the other categories. If a product does not meet the ULE criteria it will fall within one of the other categories.~~

~~NOTE Refer to the **category** web site defined in 5.5 for the current annualised energy consumption target for a product to qualify as an ULE.~~

5.5.2 TEC adders

Since the configurations of base EUTs as defined in 5.6 can be altered with additional features, this standard provides for **TEC** adders. **TEC** adders are intended to increment the **TEC** limit

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(provided by the **user of the test results**) for a given **category** of EUTs that include the attribute identified by the **TEC** adder.

TEC adders may be provided for items~~ such as memory, graphics, TV tuners, additional HDD, use of an SSD, discrete sound cards, discrete network cards~~ discrete graphics , memory including system memory bandwidth, add-in cards, storage devices, network devices, I/O devices, power supply size, integrated display, etc. The **user of the test results** should provide the energy adders to be applied.

Where the discrete graphics component is treated as an adder, the FB_BW shall be used to determine the adder value.

~~In the case of an integrated desktop computer, the screen shall be treated as an adder.~~

NOTE 1 FB_BW: Is the display frame buffer bandwidth in gigabytes per second (GB/s). This is a manufacturer declared parameter and are calculated as follows: (Data Rate [MHz] × Frame Buffer Data Width [bits]) / (8 × 1 000)

To calculate the **TEC** adder energy consumption:

– determine which **TEC** adders apply and based on the allowances provided by the **user of the test results** calculate the **TEC** adder value in kilowatt hour per **TEC** adder;
– apply any appropriate weighting that the **user of the test results** provides;
– report the overall **TEC** adder energy as defined in 5.10.

NOTE ~~1~~ 2 Adders are defined in kilowatt hour/adder/year. The **user of the test results** provides the energy adder information. Annex D provides examples on how adders are included in a **TEC** calculation.

~~NOTE 2 The ULE **category** does not use adders.~~

~~NOTE 3 For notebook computers a screen adder is not applicable as the screen power is part of the base **category** power.~~

5.6 Annualised energy consumption formulas

5.6.1 General

TEC is a weighted average of measured average power in specific EUT power modes: Off, sleep/**WoL** sleep, long idle, short idle and active.

It is recommended that the majority profile found in Annex B be used with this document.

Should the user of this document choose to use a different profile, a profile study shall be completed (4.3.4) and the profile **TEC** error determined.

If the profile **TEC** error is ≤ 15 %, the user of this document shall use 5.6.2.

If the profile **TEC** error is >15 %, the user of this document shall use 5.6.3 and an **active workload** shall be created that meets the criteria in 5.6.4.

NOTE 1 Annex D provides some examples of **TEC** calculations.

5.6.2 Estimated annualised energy consumption formula (estimated active workload)

$$\text{TEC}_{\text{estimated}} = (8\,760/1\,000) \times [P_{\text{off}} \times \boldsymbol{T}_{\mathbf{off}} + P_{\text{sleep}} \times \boldsymbol{T}_{\mathbf{sleep}} + \cancel{P_{\text{idle}}}\ P_{\text{lidle}} \times \cancel{\boldsymbol{T}_{\mathbf{idle}}}\ \boldsymbol{T}_{\mathbf{lidle}} + P_{\text{sidle}} \times (\boldsymbol{T}_{\mathbf{sidle}} + \boldsymbol{T}_{\mathbf{work}})]$$

$$100\ \% = T_{\mathbf{off}} + T_{\mathbf{sleep}} + \cancel{T_{\mathbf{idle}}}\ T_{\mathbf{lidle}} + T_{\mathbf{sidle}} + T_{\mathbf{work}}$$

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Where an alternative low power mode is used in place of sleep mode and long idle mode, power in alternative low power mode (P_{alpm}) may be used in place of both the power in sleep (P_{sleep}) and the power in long idle (P_{lidle}).

$$TEC_{estimated} = (8\ 760/1\ 000) \times [P_{off} \times \boldsymbol{T}_{\mathbf{off}} + P_{alpm} \times \boldsymbol{T}_{\mathbf{alpm}} + P_{sidle} \times (\boldsymbol{T}_{\mathbf{sidle}} + \boldsymbol{T}_{\mathbf{work}})]$$

$$100\ \% = T_{\mathbf{off}} + T_{\mathbf{alpm}} + T_{\mathbf{sidle}} + T_{\mathbf{work}}$$

Where T_x are components of the **duty cycle** and represent the weighted averages of the time spent in each of the P_x power modes.

$\boldsymbol{T}_{\mathbf{off}}$ the percent time the product annually spends in the off mode;

$\boldsymbol{T}_{\mathbf{sleep}}$ the percent time the product annually spends in the sleep mode;

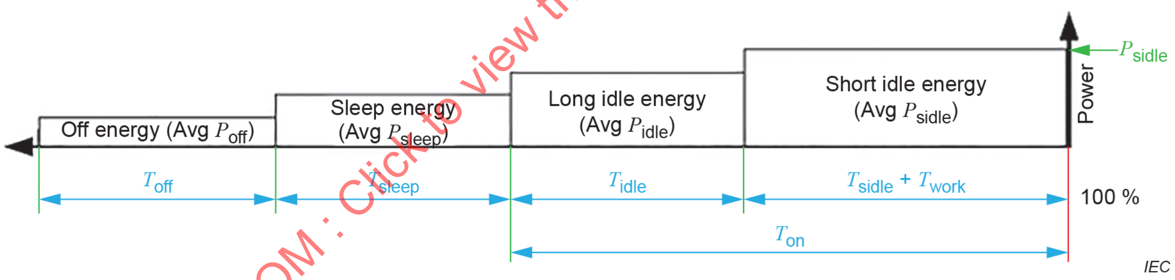
~~$\boldsymbol{T}_{\mathbf{idle}}$~~ $\boldsymbol{T}_{\mathbf{lidle}}$ the percent time the product is annually on and in the long idle mode (screen blanked);

$\boldsymbol{T}_{\mathbf{sidle}}$ the percent time the product is annually on and in the short idle mode (screen not blanked);

$\boldsymbol{T}_{\mathbf{alpm}}$ the percent time the product is annually on and in the alternative low power mode;

$\boldsymbol{T}_{\mathbf{work}}$ the percent time the product is annually on and in the active mode (screen not blanked).

This is further illustrated in Figure 2.



NOTE 1 T_{work} in the equation is used when there is computer active mode consideration, otherwise use T_{sidle} as a proxy for active mode.

NOTE 2 Figure 2 not to scale.

Figure 2 – Example of estimated annualised energy consumption formula (estimated active workload)

5.6.3 Measured annualised energy consumption formula (with an active workload)

$$TEC_{actual} = (8\ 760/1\ 000) \times (P_{off} \times \boldsymbol{T}_{\mathbf{off}} + P_{sleep} \times \boldsymbol{T}_{\mathbf{sleep}} + \sout{P_{idle}}\ P_{lidle} \times \sout{\boldsymbol{T}_{\mathbf{idle}}}\ \boldsymbol{T}_{\mathbf{lidle}} + P_{sidle} \times \boldsymbol{T}_{\mathbf{sidle}} + P_{work} \times \boldsymbol{T}_{\mathbf{work}})$$

$$100\ \% = T_{\mathbf{off}} + T_{\mathbf{sleep}} + \sout{T_{\mathbf{idle}}}\ T_{\mathbf{lidle}} + T_{\mathbf{sidle}} + T_{\mathbf{work}}$$

Where an alternative low power mode is used in place of sleep mode and long idle mode, power in alternative low power mode (P_{alpm}) may be used in place of both the power in sleep (P_{sleep}) and the power in long idle (P_{lidle}).

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$TEC_{actual} = (8\ 760/1\ 000) \times (P_{off} \times \boldsymbol{T_{off}} + P_{alpm} \times \boldsymbol{T_{alpm}} + P_{sidle} \times \boldsymbol{T_{sidle}} + P_{work} \times \boldsymbol{T_{work}})$

$100\ \% = T_{off} + T_{alpm} + T_{sidle} + T_{work}$

Where T_x are components of the **duty cycle** and represent the weighted averages of the time spent in each of the P_x power modes.

$\boldsymbol{T_{off}}$ the percent time the product annually spends in the off mode;

$\boldsymbol{T_{sleep}}$ the percent time the product annually spends in the sleep mode;

~~$\boldsymbol{T_{idle}}$~~$\boldsymbol{T_{lidle}}$ the percent time the product is annually on and in the long idle mode (screen blanked);

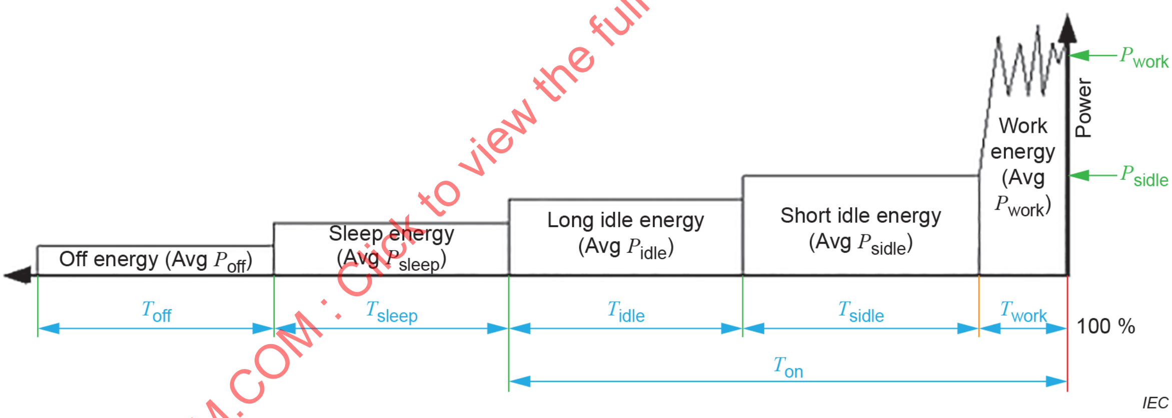
$\boldsymbol{T_{sidle}}$ the percent time the product is annually on and in the short idle mode (screen not blanked);

$\boldsymbol{T_{alpm}}$ the percent time the product is annually on and in the alternative low power mode;

$\boldsymbol{T_{work}}$ the percent time the product is annually on and in the active mode (screen not blanked).

where P_{work} is measured using an **active workload** created based on the criteria in 5.6.4.

This is further illustrated in Figure 3.



NOTE Figure 3 not to scale.

Figure 3 – Measured annualised energy consumption formula (with an active workload)

5.6.4 Criteria for an active workload

Should the profile **TEC** error be greater than the error defined in 5.6 an **active workload** shall be created and the TEC_{actual} formula in 5.6.3 used.

The workload shall be created to ensure that the PAPR, determined as a result of a profile study, comes within 15 % of the PAWR, determined by running the workload on the study computers. The **active workload** shall consist of workload fragments representative of the targeted profile:

– PAPR = P_{on}/P_{sidle}

– PAWR = P_{work}/P_{sidle}

– 15 % > **|**(PAPR - PAWR)**|**/PAPR (absolute values)

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The P_{on} formula is defined as

$$P_{on} = (P_{idle}\ P_{lidle} \times T_{idle}\ T_{lidle} + P_{sidle} \times T_{sidle} + P_{work} \times T_{work})/T_{on}$$

$$E_{onwl} - E_{onstdy}/E_{onstdy}$$

where E_{onwl} is the "on energy" calculated from the developed workload, and E_{onstdy} is the "on energy" calculated from the energy study; or

$$E_{onwl} = P_{idle}\ P_{lidle} \times T_{idle}\ T_{lidle} + P_{sidle} \times T_{sidle} + P_{work} \times T_{work}$$

$$E_{onstdy} = P_{on} \times T_{on}$$

$$T_{on} = T_{idle}\ T_{lidle} + T_{sidle} + T_{work}$$

Resulting in the equation:

$$15\ \% > |P_{idle}\ P_{lidle} \times T_{idle}\ T_{lidle} + P_{sidle} \times T_{sidle} + P_{work} \times T_{work} - P_{on} \times T_{on}|/(P_{on} \times T_{on})$$

NOTE 1 Criteria for active mode efficiency will need to be developed to account for computer performance, power and energy consumed to run the workload.

5.7 True RMS watt meter specification

Approved meters shall include the following attributes:

– An available current crest factor of 3 or more at its rated range value. For meters that do not specify the crest factor, the analyser shall be capable of measuring an amperage spike of at least three times the maximum current measured during any 1 s sample of the measurement.

– A bound on the current range of 10 mA or less.

– A minimum frequency response of 3,0 kHz or less.

– Report true RMS power (W) and at least two of the following measurement units:

  - voltage,
  - current, and
  - power factor (PF).

The power measuring instrument shall be capable of meeting the requirements of 5.8 when measuring the following:

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

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

– The following attributes in addition to those above should be considered: the meter shall be able to be calibrated by a standard traceable to International System of Units. The analyser shall have been calibrated within the past year.

– If the meter is used in an automated setup, it shall have an interface that allows its measurements to be read by the SPEC PTDaemon (see Bibliography). The reading rate supported by the analyzer shall be at least one set of measurements per second, where a set is defined as Watts and at least two of the following readings: Volts, Amperes and power factor. The data averaging interval of the analyser shall be either 1 time (preferred) or 2

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times the reading interval. "Data averaging interval" is defined as the time period over which all samples captured by the high-speed sampling electronics of the analyser are averaged to provide the measurement set.

It is also desirable for measurement instruments to be able to average power accurately over any user selected time interval (this is usually done with an internal math calculation dividing accumulated energy by time within the meter, which is the most accurate approach). As an alternative, the measurement instrument shall be capable of integrating energy over any user selected time interval with an energy resolution of less than or equal to 0,1 mWh and integrating time displayed with a resolution of 1 s or less.

5.8 True RMS watt meter accuracy

Measurements of power of ~~1,0~~ 0,5 W or greater shall be made with an accuracy of 2 % or better at the 95 % confidence level. Measurements of power of less than ~~1,0~~ 0,5 W shall be made with an accuracy of ~~0,02~~ 0,01 W or better at the 95 % confidence level. A further requirement of the power measurement instrument shall have a resolution of:

– 0,01 W or better for power measurements of 10 W or less;
– 0,1 W or better for power measurements of greater than 10 W up to 100 W; and
– 1,0 W or better for power measurements of greater than 100 W.

All power figures shall be in watts and rounded to the second decimal place. For loads greater than or equal to 10 W, three significant figures shall be reported.

For loads with a calculated effective maximum current ratio (MCR), as described below, of more than 5, the uncertainty is adjusted using the following equation:

$$\mathrm{CFR} = \frac{\mathrm{PCF}}{\mathrm{MCF}}$$

If the calculated value of CFR is less than 1,0 then the value of CFR used in subsequent calculations shall be taken to be 1,0.

$$\mathrm{MCR} = \frac{\mathrm{CFR}}{\mathrm{PF}}$$

where

– the PCF is the measured peak current drawn by the product divided by the measured RMS current drawn by the product;
– the 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 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, 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:

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

where U_{pc} is the maximum permitted relative uncertainty for cases where the MCR > 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} × measured value) at the 95 % confidence level.

For ease in making the measurements, it is recommended that the power measuring instrument detects, indicates, signals and records any "out of range" conditions.

NOTE 1 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.

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.

5.9 Ambient light meter specification

If the EUT supports an automatic display luminance control and cannot be disabled for testing, then the EUT shall be tested in an environment that meets the ambient light requirements defined in 5.4.

A meter used to measure the ambient light conditions shall measure illumination and shall meet the ~~following~~ requirements listed in Table 3.

Table 3 – Ambient light meter specifications

Resolution	Accuracy
10 Lux	± 5 %

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5.10 Reporting of results

The following minimum information shall be reported. The format is an example format only; the user of this document may use any format of choice.

1. EUT description

Manufacturer ____

EUT code / Model number __________________________________

EUT Type:

Notebook computer ☐ Desktop computer ☐ Integrated desktop computer ☐

Operating System: Windows ☐ Mac OS ☐ Chrome ☐ Other ______________________________

Operating system version details: ____

For notebook computers:

Battery pack removed during test Yes ☐ No ☐ If no then: _______

Fully charged battery pack used Yes ☐

2. EUT category (only required if a TEC result is recorded)

Category (include the date extension): ____________________________________

List any **TEC** adders applied~~ (not applicable for ULE **category**)~~:

____

____

____

3. Results

All boxes shall be completed if a **TEC** result is recorded.

Power mode	Recorded average Watts (P)
Off mode (P_{off})	
Sleep mode (P_{sleep})	
Sleep mode ($P_{sleepWoL}$)	
Long idle (~~P_{idle}~~ P_{lidle})	
Short idle (P_{sidle})	
Active mode (P_{work})*	

*If applicable

TEC (no **WoL**): ________________

TEC (with **WoL**): ________________

TEC adder allowances (if applicable) ________________

Majority profile used Yes ☐ No ☐

If No – description of profile used:

____

____

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4. Test conditions

Sample size tested: ____________

Name/model of meter used: ____________

Supply voltage (V): ____________

Supply frequency (Hz) ____________

THD (voltage) (%): ____________

Ambient temperature (°C): ____________

Relative humidity (%): ____________

Ambient light (Lux): ____________

5. Declaration

Name: __________________________

Position in company: __________________________

Signed: __________________________

Date: __________________________

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Annex A
(informative)

Overview of profile methodology

Profiles are an important concept in this document and the approach taken is to focus on a single (majority) profile for measuring **TEC** versus supporting multiple profiles. This annex outlines the reasons for this approach, and other approaches explored in the development of this document.

The computer is a general purpose device, and the **TEC** consumed by that device is very dependent on how it is used. While a computer can be described through categorisation, this only defines the attributes of the computer hardware and software. This computer (defined by a **category**) can then be used in many ways (defined by a profile) that will result in different **TEC** values (on the same computer).

For example, a computer "C1" is being purchased by users "U1" and "U2". U1 works in a large enterprise and primarily uses a suite of office applications over an office day (typically five days per week and allowing for holidays). He will get a **TEC** value of T1. U2 uses the same computer at home for Internet access and email with family members and gets a different **TEC** value of T2. The values of T1 and T2 are different, yet were generated by the same computer. Both **TEC** results are correct, but as this example demonstrates, the **TEC** value is influenced based on the usage profile.

Therefore when trying to get an accurate value of **TEC**, it is important to not only note the **category** of the computer, but to also describe the profile of how it is used.

Creating a standard which produces multiple **TEC** estimates for a single computer is confusing, and overly complicated. Therefore the approach taken by this document is to focus the **TEC** value on a single profile which represents a "typical" user and to base the profile attributes (T_{off}, T_{sleep}, ~~T_{idle}~~T_{lidle}, T_{sidle}, T_{work}) around this single typical profile called the majority profile.

For this document, a typical profile is defined as a profile that represents how a majority of users use a computer. Consider the user base as a bell curve where the majority of users fall within the majority profile and the other minority profiles fall outside this range, as shown in Figure A.1.

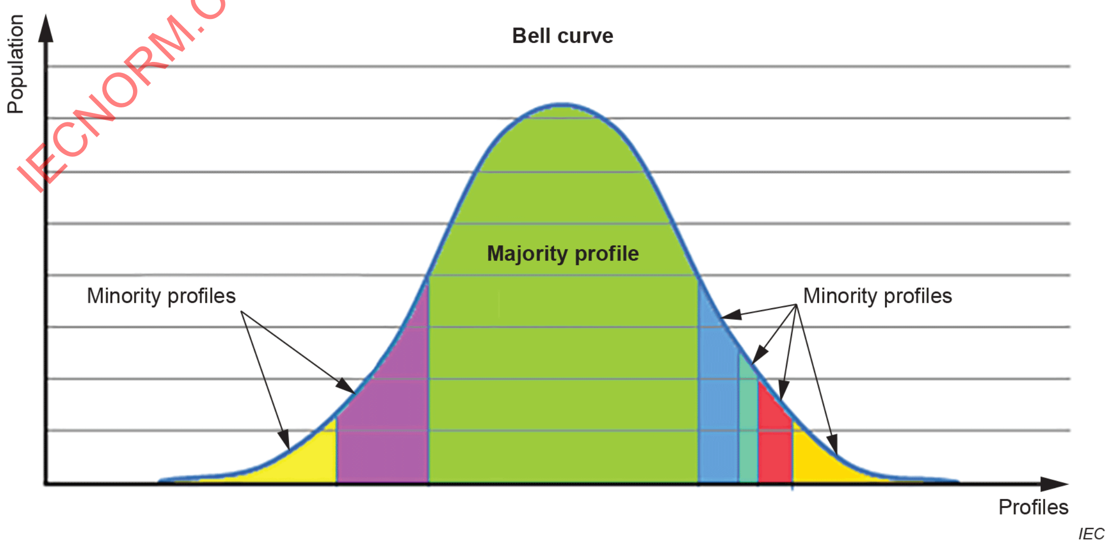

Figure A.1 – Example of a typical profile

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Statistical data for profiles is readily available to determine a majority profile (and the minority profiles). This document focuses on the majority profile and creates **duty cycle attributes** based on that profile to generate the **TEC** values. It is recognized that users of computers who do not match the majority profile will experience different TEC_{actual} values based on their usage of the computer, however the methodology makes a compromise to reduce the complexity and use of **TEC** such that a majority of users will experience accurate $TEC_{estimated}$ values based on their "majority usage".

A similar approach has been taken in other industries such as estimating kilometres per litre for automobiles. Here there are two profiles of usage (highway and city driving) that are used to describe the efficiency of cars globally. But this represents how a majority of users would use that automobile, and actual mileage will vary based on how that user actually drives. The majority of users will experience fuel mileage close to the estimates, but for a minority of users the mileage will vary.

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Annex B
(informative)

Majority profile

The first edition of IEC 62623 provided a majority profile based on a previous enterprise profile study conducted in 2010 by the ECMA-383 workgroup. In 2019 the US Environmental Protection Agency (EPA) reported at one of its ENERGY STAR stakeholder meetings the outcome of an extensive mode weightings study. The result was a change to the mode weightings in the version 8.0 Computers specification for Desktops and a proposed change for Notebooks for version 9.0.

The EPA had received over 700 000 individual desktop and integrated desktop data points across multiple manufacturers, product types, user profiles including enterprise and residential and across different geographical areas/regions. Similarly, for Notebooks the EPA had received 1,2 million individual data points with an equivalent variety and breadth as reported for Desktops.

The additional data enabled the EPA to separate long and short idle from sleep power mode and also allowing a further refinement of the non-active power mode values. The scale of breadth of the data set provided justification that these duty cycle attributes are representative of aggregate current behaviour of deployed desktops operating within enterprise and residential environments.

Duty cycle attributes of a profile are defined in 4.3.1. The use of the majority profile is recommended in 4.3.2. The recommended majority profile for use with this document is based on both enterprise and residential users ~~(people using computers in small to large businesses primarily focused on office productivity applications)~~ and is documented in Table B.1.

~~A profile study on enterprise users was conducted on over 500 computers, involving large enterprises from industry conducted geographically across China, Japan, Europe and the USA and the results are documented in Table B.1.~~

Table B.1 – Duty cycle attributes for the enterprise and residential majority profile duty cycle study

	Desktop computer	Notebook computer
~~T_{off}~~	~~45 %~~	~~25 %~~
~~$T_{sleep} + T_{sleepWoL}$~~	~~5 %~~	~~35 %~~
~~T_{idle}~~	~~15 %~~	~~10 %~~
~~T_{sidle}~~	~~35 %~~	~~30 %~~
~~T_{work}~~	~~0 %~~	~~0 %~~
T_{off}	15 %	10 %
T_{sleep} *OR* $T_{sleepWoL}$	45 %	60 %
T_{lidle}	10 %	10 %
T_{sidle}	30 %	20 %

~~The percentages provided above were created through an enterprise profile study conducted in 2010 by the ECMA-383 workgroup.~~

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Additionally the energy study was performed on 17 machines which conclusively showed that no **active workload** is needed for the enterprise profile, as the average **TEC** error across all machines averaged to be approximately 1,2 % (see Table B.2 and Figure B.1); well below the 15 % error criteria for requiring an **active workload**:

Table B.2 – Summary of the enterprise energy study

–	Measured AC power			–	–	TEC Error Calculation	–	–
Users	**Active**	**Short idle**	**Long idle**	**Sleep**	**Off**	**TECact**	**TECcalc**	**% Error**
1	45,8	42,7	36,7	1,5	0,5	160	160	0,1
2	32,1	32,0	26,0	1,5	0,5	120	120	0,3
3	33,8	33,9	23,9	1,5	0,5	123	123	0,2
4	36,2	35,7	29,7	1,5	0,5	134	134	0,5
5	21,2	21,0	15,0	1,5	0,5	79	78	0,6
6	33,2	33,2	25,6	1,5	0,5	123	123	0,1
7	35,1	35,0	26,1	1,5	0,5	128	128	0,2
8	22,2	21,9	20,5	1,5	0,5	87	87	0,7
9	40,4	39,7	33,7	1,5	0,5	149	149	0,4
10	44,4	42,6	37,7	1,5	0,5	165	161	2,5
11	28,4	27,9	17,7	1,5	0,5	101	100	1,2
12	25,3	25,3	18,6	1,5	0,5	94	94	0,0
13	22,1	22,1	10,8	1,5	0,5	77	77	0,0
14	19,9	18,6	17,8	1,5	0,5	75	75	0,4
15	30,4	29,6	21,8	1,5	0,5	111	109	1,7
16	12,0	9,0	9,0	1,5	0,5	43	39	8,7
17	72,4	35,9	29,9	1,5	0,5	139	134	3,0

Avg. Error = 1,2 %

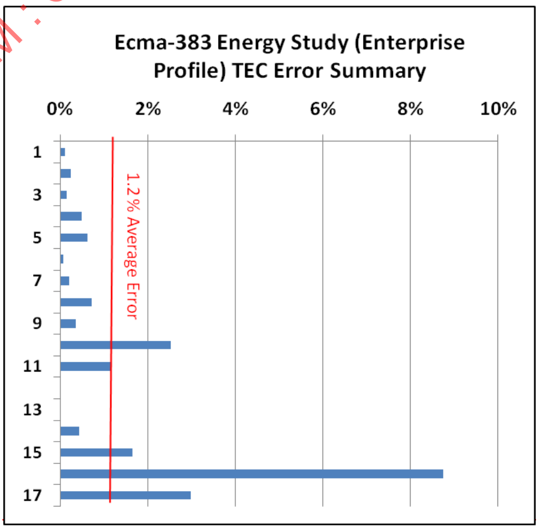

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Figure B.1 – TEC error summary chart

This results in the following **TEC** equations for the typical enterprise and residential majority profile:

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~~Desktop $TEC_{estimate}$ = 8,76 × (P_{off} × 45 % + P_{sleep} × 5 % + P_{idle} × 15 % + P_{sidle} × 35 %);~~

~~Notebook $TEC_{estimate}$ = 8,76 × (P_{off} × 25 % + P_{sleep} × 35 % + P_{idle} × 10 % + P_{sidle} × 30 %).~~

Desktop $TEC_{estimated}$ = 8,76 × (P_{off} × 15 % + P_{sleep} × 45 % + P_{lidle} × 10 % + P_{sidle} × 30 %);

Notebook $TEC_{estimated}$ = 8,76 × (P_{off} × 10 % + P_{sleep} × 60 % + P_{lidle} × 10 % + P_{sidle} × 20 %).

~~These numbers will be further validated for future editions of this standard through additional profile studies.~~

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Annex C
(informative)

Method for conducting a profile study

C.1 General

If the majority profile is not used with this document, the user should ensure that the profile used has been created through a profile study.

C.2 Profile study example

A majority of client users of computers consist of enterprise (for example, office) users, so a profile study is performed around "enterprise users" as the majority profile.

A large statistically significant number of computers are instrumented to gather utilisation data based around how the computers are used. The **duty cycle attributes** T_{off}, T_{sleep}, and T_{on} are recorded. This study is performed for a minimum of one year. The average value of T_{off}, T_{sleep} and T_{on} are then reported as part of the study along with the sample time and number of samples.

The second stage of the study requires computers to be instrumented and used by users that fit within the study profile to measure their on power and capture on utilisation (T_{idle} T_{lidle}, T_{sidle} and T_{work}). While this sample of computers cannot be as large as the first sample (cost reasons), it should be a large enough sample to draw a number of conclusions with a mix of different computers from different client computer categories:

– the average T_{idle} T_{lidle}, T_{sidle} and T_{work} ratios for this given profile;

– the PAPR;

– the profile **TEC** error.

The profile study should provide a description and attributes of the computers used in the study including how the data was collected and calculated.

The example in Table C.1 illustrates some data from a profile study and shows eight computers with measured P_{idle} P_{lidle}, P_{sidle} and P_{on}. The product active power ratio is calculated for each computer (P_{on}/P_{sidle}) and then the PAPR is calculated by taking the average of all of the product active power ratios.

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Table C.1 – Profile study 1

Measurement	NB1	NB2	NB3	DT1	DT2	DT3	DT4	DT5
P_{off}	1	1	1	1,6	1,6	1,6	1,6	1,6
P_{sleep}	1,5	1,5	1,5	2,8	2,8	2,8	2,8	2,8
~~P_{idle}~~P_{lidle}	22,7	19,3	22	39,3	55	120,9	210,5	168,1
P_{sidle}	32,8	28,2	28,1	39,3	55	120,9	210,5	168,1
P_{on}	34	28,7	30,3	40	56,5	122,8	227,3	168,7
Product active power ratio	1,03	1,02	1,08	1,02	1,03	1,02	1,08	1
PAPR	1,04							
NB = Notebook computer DT = Desktop computer								

The product active power ratio was a good way of representing the computer's active power and shows how much higher it is than when the product is in a short idle state. Because this is a ratio, it allows various products with different absolute power values to be examined together (notice the ratios for desktops which are in the 100 W range can be combined with notebook ratios which are in the 20 W to 30 W range).

The PAPR is then used as an attribute to describe what the **active workload** should look like (if needed). In the case of this profile, the **active workload** is very close to the short idle power measurement.

Additionally the profile study needs to provide **duty cycle attributes** for the profile. This can be done in two parts, the first to determine the **duty cycle attributes** of off, sleep and on modes for the computer (T_{off}, T_{sleep} and T_{on}), and the second to determine the components of the on mode **duty cycles** (~~T_{idle}~~T_{lidle}, T_{sidle} and T_{work}), as listed in Table C.2.

~~Table C.2 shows an existing study used for the ENERGY STAR® V5 specification to determine the off, sleep and on mode **duty cycle attributes**:~~

~~**Table C.2 – ENERGY STAR® V5 computer study**~~

	~~Desktop computer~~	~~Notebook computer~~
~~T_{off}~~	~~55 %~~	~~60 %~~
~~T_{sleep}~~	~~5 %~~	~~10 %~~
~~T_{on}~~	~~40 %~~	~~30 %~~

~~The T_{on} components of the **duty cycle attributes** will be created through the profile study. Continuing the example from above, the data in Table C.3 shows how the **duty cycle attributes** break down for each of the computers used in the profile study, the profile T_{idle}, T_{sidle} and T_{work} is then calculated from the averages of the sample products (in this case the profile has separated desktop and notebooks).~~

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Table C.2 – Profile study, duty cycles

Measurement	NB1	NB2	NB3	DT1	DT2	DT3	DT4	DT5
~~T_{idle}~~ T_{lidle}	1,6 %	4,6 %	1,3 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %
T_{sidle}	15,9 %	19,9 %	11,2 %	37,2 %	21,3 %	26,7 %	6,3 %	36,5 %
T_{work}	12,6 %	5,5 %	17,5 %	2,8 %	18,7 %	13,3 %	33,7 %	3,5 %
	NB			DT				
Profile ~~T_{idle}~~ T_{lidle}	2,5 %			0,0 %				
Profile T_{sidle}	15,7 %			25,6 %				
Profile T_{work}	11,9 %			14,4 %				
NB = Notebook computer DT = Desktop computer								

With this data, the TEC_{actual} and $TEC_{estimated}$ values can then be calculated. The TEC_{actual} is calculated by using the P_{on} for the average on power, while the $TEC_{estimated}$ is calculated using the measured ~~P_{idle}~~ P_{lidle}, P_{sidle}, ~~T_{idle}~~ T_{lidle}, T_{sidle}, T_{work} and using P_{sidle} as an approximation of the P_{work} power. This is summarized in Table C.3.

Table C.3 – Profile study, TEC_{actual} and $TEC_{estimated}$ calculations

Measurement	NB1	NB2	NB3	DT1	DT2	DT3	DT4	DT5
TEC_{actual}	96,0	82,1	86,3	149,1	206,9	439,2	805,4	600,1
$TEC_{estimated}$	90,7	78,8	79,2	146,6	201,7	432,6	746,5	598,0
Product **TEC** error	5,6 %	4,0 %	8,3 %	1,6 %	2,5 %	1,5 %	7,3 %	0,4 %
PAPR	3,9 %							
NB = Notebook computer DT = Desktop computer								

An example of TEC_{actual} and $TEC_{estimated}$ calculations are shown below for the NB1 data:

TEC_{actual} = 8,76 × (T_{off} × P_{off} + T_{sleep} × P_{sleep} + (~~T_{idle}~~ $T_{lidle}+T_{sidle}+T_{work}$) × P_{on})

TEC_{actual} = 8,76 × (60 % × 1 W + 10 % × 1,5 W + (2,5 % +15,7 % + 11,9 %) × 34 W)

TEC_{actual} = 96,2 KWh

The TEC_{actual} is calculated by using the measured P_{on} which is the average power of the computer measured over the time for which the computer was on (hence the weighting factor was the sum of all of the active weightings: ~~T_{idle}~~ T_{lidle}, T_{sidle} and T_{work}).

$TEC_{estimated}$ uses the measured ~~T_{idle}~~ T_{lidle} and T_{sidle} with the appropriate weighting factors, but then substituting P_{sidle}, which is statically measured, with the P_{work} value:

$TEC_{estimated}$ = 8,76 × (T_{off} × P_{off} + T_{sleep} × P_{sleep} + ~~T_{idle}~~ T_{lidle} × ~~P_{idle}~~ P_{lidle} + ($T_{sidle}+T_{work}$) × P_{sidle})

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$TEC_{estimated}$ = 8,76 × (60 % × 1 W + 10 % × 1,5 W + 2,5 % × 22,7 W + (15,7 % + 11,9 %) × 32,8 W)

$TEC_{estimated}$ = 90,8 KWh

To understand how the estimated value (which does not require the testing of an actual workload) impacts the product **TEC** error the following calculation is used:

$[TEC_{actual} - TEC_{estimated}] / (TEC_{actual})$

(96,2 – 90,8)/96,2 = 5,6 % error

NOTE 1 The mode weightings used in the above $TEC_{estimated}$ calculations were based on previous profile study and does not reflect the updated PC duty cycle (mode weightings) in the standard, based on most recent profile study (Table B.1)

These same calculations are done for all of the products, and then the product **TEC** error is averaged to give the profile **TEC** error of 3,9 %.

In this case the profile study would recommend that for this profile the **TEC** does not require an **active workload** and all submitted **TEC** values for this profile can be estimated using the short idle **TEC** estimation.

For the case where the profile study showed a much higher profile **TEC** error, then the **active workload** would have to be created to allow the P_{work} attribute to be measured. The **active workload** would have to be created from code fragments represented by the profile usages, but ~~shall~~ would also guarantee that the PAPR is within 15 % of the PAWR, as shown in 5.6.4:

– PAPR = P_{on}/P_{sidle}

– PAWR = P_{work}/P_{sidle}

– 15 % > |(PAPR - PAWR)|/PAPR (absolute values).

or

– 15 % > $TEC_{actual} - TEC_{estimated} / TEC_{actual}$

where,

TEC_{actual} = 8,76 × (P_{off} × $T_{\mathbf{off}}$ + P_{sleep} × $T_{\mathbf{sleep}}$ + ~~P_{idle}~~ P_{lidle} × ~~T_{idle}~~ $T_{\mathbf{lidle}}$ + P_{sidle} × $T_{\mathbf{sidle}}$ + P_{work} × $T_{\mathbf{work}}$)

$TEC_{estimated}$ = 8,76 × (P_{off} × $T_{\mathbf{off}}$ + P_{sleep} × $T_{\mathbf{sleep}}$ + ~~P_{idle}~~ P_{lidle} × ~~T_{idle}~~ $T_{\mathbf{lidle}}$ + P_{sidle} × ($T_{\mathbf{sidle}}$ + $T_{\mathbf{work}}$))

resulting in the following formula to qualify the Energy Study for the need of an **active workload**:

– 15 % > (P_{work} × $T_{\mathbf{work}}$ − P_{sidle} × $T_{\mathbf{work}}$)/(P_{off} × $T_{\mathbf{off}}$ + P_{sleep} × $T_{\mathbf{sleep}}$ + ~~P_{idle}~~ P_{lidle} × ~~T_{idle}~~ $T_{\mathbf{lidle}}$ + P_{sidle} × $T_{\mathbf{sidle}}$ + P_{work} × $T_{\mathbf{work}}$)

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Annex D
(informative)

Sample TEC calculations

D.1 General

This annex will go through two **TEC** calculation examples: notebook computers and desktop computers.

D.2 Notebook computer example

A notebook computer is to measure its **TEC** value, and has a configuration as follows:

– 2 core CPU;
– 15 in (38,1 cm). display;
– 2 memory channel capability;
– 4 Gbytes of memory;
– integrated graphics controller.

The user then takes the notebook computer and performs the tests outlined in Clause 5 and summarizes the results below:

P_{off} = 1,4 W

P_{sleep} = 4,3 W

P_{idle} = 8,7 W

P_{sidle} = 13,2 W

The majority profile dictates the use of the **TEC** formulae:

Notebook $TEC_{estimate}$ = 8,76 × (P_{off} × 25 % + P_{sleep} × 35 % + P_{idle} × 10 % + P_{sidle} × 30 %);

and filling in the measured values:

Notebook $TEC_{estimate}$ = 8,76 × (1,4 × 25 % + 4,3 × 35 % + 8,7 × 10 % + 13,2 × 30 %);

therefore:

Notebook $TEC_{estimate}$ = 58,6 kWh/Year.

For users who want to then compare this **TEC** value to some specified limit associated with the **category**, there might be a need to apply adders to the limit (the value of these adders is provided by the **user of the test results**).

In accessing the **category** registry (see 5.5), it shows that this product falls into the "NBX category" which, by way of an example, is defined as (note this is an example not based on an actual **category** from the registry, the real **category** registry will change over time):

≤2 CPU cores, ≥1 channel memory, ≥2 Gbytes memory, integrated graphics and a screen size ≤13,3".

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Additionally, the registry states that the **TEC** limit would have an adder of x kWh/Gbyte of memory above the base (2 Gbytes). So the user of this specification would then take the **category** limit and add this to the adder (2*x kWh/Gbyte since there were 2 Gbyte of memory over the base **category** definition).

In this case the user of the specification would determine if the **TEC** value passed or failed depending on the value of the calculated limit:

Pass: 58,6 kWh ≤ [**TEC** Limit + 2*x]

Fail: 58,6 kWh > [**TEC** Limit + 2*x]

An example notebook computer has a configuration as follows:

– 6 core CPU;
– 14,1 in (35,8 cm) display;
– 32 Gbytes of memory;
– integrated graphics controller.

For this given notebook computer example the tests outlined in Clause 5 are performed and the results are summarized below:

P_{off} = 0,30 W

P_{sleep} = 1,68 W

P_{sidle} = 6,94 W

P_{lidle} = 1,68 W

The majority profile dictates the use of the **TEC** formulae:

Notebook $TEC_{estimated} = 8{,}76 \times (P_{off} \times 10\% + P_{sleep} \times 60\% + P_{sidle} \times 20\% + P_{lidle} \times 10\%)$;

and filling in the measured values:

Notebook $TEC_{estimated} = 8{,}76 \times (0{,}3 \times 10\% + 1{,}68 \times 60\% + 6{,}94 \times 20\% + 1{,}68 \times 10\%)$;

therefore,

Notebook $TEC_{estimated}$ = 22,72 kWh/Year.

This $TEC_{estimated}$ value may require the addition of one or more TEC adders associated with the category, resulting in a final TEC value.

In this case the user of the specification would determine if the **TEC** value passed or failed depending on the value of the calculated limit:

Pass: 22,72 kWh ≤ [**TEC** Limit + 2*x]

Fail: 22,72 kWh > [**TEC** Limit + 2*x]

D.3 Desktop computer example

An all-in-one desktop computer is to measure its **TEC** value, and has a configuration as follows:

– 3 core CPU;

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~~– 20" display;~~

~~– 3 memory channel capability;~~

~~– 4 Gbytes of memory;~~

~~– integrated graphics controller.~~

~~The user then takes the all-in-one desktop computer and performs the tests outlined in Clause 5 and summarizes the results below:~~

~~P_{off} = 2,2 W~~

~~P_{sleep} = 4,1 W~~

~~P_{idle} = 25,7 W~~

~~P_{sidle} = 33,6 W~~

~~The majority profile dictates the use of the **TEC** formulae:~~

~~Desktop $TEC_{estimate}$ = 8,76 × (P_{off} × 45 % + P_{sleep} × 5 % + P_{idle} × 15 % + P_{sidle} × 35 %);~~

~~and filling in the measured values:~~

~~Desktop $TEC_{estimate}$ = 8,76 × (2,2 × 45 % + 4,1 × 5 % + 25,7 × 15 % + 33,6 × 35 %);~~

~~therefore,~~

~~Desktop $TEC_{estimate}$ = 147,3 kWh/Year.~~

~~For users who want to then compare this **TEC** value to some specified limit associated with the **category**, there might be a need to apply adders to the limit (the value of these adders is provided by the **user of the test results**).~~

~~In accessing the **category** registry (see 5.5), it shows that this product falls into the "DTX category" which, by way of example, is defined as (note this is an example not based on an actual **category** from the registry, the real **category** registry will change over time):~~

~~≥ 2 CPU cores, ≥ 2 channel memory, ≥ 2 Gbyte memory~~

~~Additionally, the registry states that the **TEC** limit would have an adder of x kWh/Gbyte of memory above the base (2 Gbyte). So the user of this specification would then take the **category** limit and add this to the adder (2*x kWh/Gbyte since there were 2 Gbytes of memory over the base **category** definition).~~

~~Additionally the registry states that the **TEC** limit would have an adder of y kWh for the integrated display. In this case the user of the specification would determine if the **TEC** value passed or failed depending on the value of the calculated limit:~~

~~– Pass: 147,3 kWh ≤ [**TEC** Limit + 2(x + y)]~~

~~– Fail: 147,3 kWh > [**TEC** Limit + 2(x + y)].~~

A desktop computer, for example a notebook computer, has a configuration as follows:

– 3 core CPU;

– 4 Gbytes of memory;

– integrated graphics controller.

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The user then takes the desktop computer and performs the tests outlined in Clause 5 and summarizes the results below:

P_{off} = 0,38 W

P_{sleep} = 1,64 W

P_{sidle} = 21,26 W

P_{lidle} = 20,23 W

The majority profile dictates the use of the **TEC** formulae:

Desktop $\text{TEC}_{\text{estimated}} = 8{,}76 \times (P_{\text{off}} \times 15\% + P_{\text{sleep}} \times 45\% + P_{\text{sidle}} \times 30\% + P_{\text{lidle}} \times 10\%)$;

and filling in the measured values:

Desktop $\text{TEC}_{\text{estimated}} = 8{,}76 \times (0{,}38 \times 15\% + 1{,}64 \times 45\% + 21{,}26 \times 30\% + 20{,}23 \times 10\%)$;

therefore,

Desktop $\text{TEC}_{\text{estimated}}$ = 80,56 kWh/Year.

This $\text{TEC}_{\text{estimated}}$ value may require the addition of one or more TEC adders associated with the category, resulting in a final TEC value.

Pass: 80,56 kWh ≤ [**TEC** Limit + 2(x + y)].

Fail: 80,56 kWh > [**TEC** Limit + 2(x + y)].

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Annex E
(informative)

ENERGY STAR V5 compliant testing methodology

E.1 General

IEC 62623 was developed to be compliant with the ENERGY STAR V6 testing methodology, however many are building regulations based around The ENERGY STAR V5/V5.2 testing methodology. In general the testing methodology is identical except in regards to the testing of short idle and long idle. This informative Annex provides ENERGY STAR V5 compliant testing methodology for the short and long idle testing. The **duty cycle attributes** for V5 compliance testing are provided in Table E.1.

In ENERGYSTAR V5 and V5.2 specification only the terminology of "Idle" is used. There are different testing methodologies for how to measure idle on systems with integrated displays versus measuring idle on systems with external displays. IEC 62623 uses terminology of "Long Idle" to refer to how ENERGYSTAR V5 and V5.2 to test systems with integrated displays (for example, notebooks, All-In-One desktops, … are tested with screen OFF or blanked) and the terminology of "Short Idle" to refer to how ENERGYSTAR V5 and V5.2 to test systems with external displays (for example, tower desktop computer, …, are tested with screen ON).

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E.2 Measuring ENERGY STAR V5.2 compliant long idle mode

– Switch the EUT on.
– Once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in long idle mode which is defined as:

  The mode where the EUT has reached an idle condition (for example, 15 min after OS boot or after completing an **active workload** or after resuming from sleep), the screen has just blanked but remains in the working mode (ACPI G0/S0). Power management features, configured as shipped, should have engaged (for example, display is on, …), but the EUT is prevented from entering sleep mode, and the HDD (where applicable) is not allowed to be power managed ("spun-down") during testing unless containing non-volatile cache integral to the drive (for example, "hybrid" hard drives). If more than one internal hard drive is installed as shipped, the non-primary, internal hard drive(s) may be tested with hard drive power management enabled as shipped. If these additional drives are not power managed when shipped to customers, they shall be tested without such features implemented.

– Once the EUT has entered the long-idle mode, reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second.
– Accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{idle}.

E.3 Measuring ENERGY STAR V5.2 short idle mode

– Switch the EUT on.
– Once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in short idle mode which is defined as:

  The mode where the EUT has reached an idle condition (for example, 15 min after OS boot or after completing an **active workload** or after resuming from sleep), the screen is on (system is re-configured to prevent the display from blanking or turning off) and set to as shipped brightness and long idle power management features should not have engaged (for example, HDD is spinning and the EUT is prevented from entering sleep mode), low brightness control by the timer should be prohibited.

– Once the EUT has entered short idle mode, reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second.

– Accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{sidle}.

Table E.1 – Duty cycle attributes for V5 compliant testing

	Desktop computer	Notebook computer
T_{off}	55 %	60 %
T_{sleep} + $T_{sleepWoL}$	5 %	10 %
T_{idle}	0 %	30 %
T_{sidle}	40 %	0 %
T_{work}	0 %	0 %

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Annex E
(informative)

Power measurement methodology

E.1 General

This annex follows current procedures outlined in CENELEC standard EN 50564:2011. It includes power measurement methods for unstable, cyclic or limited duration modes. These methods are intended to improve the repeatability and reproducibility of measurement results, particularly for low power measurements.

Within this standard, power consumption should be determined by:

– sampling method: by the use of an instrument to record power measurements at regular intervals throughout the measurement period (see E.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 which should be used under this standard, or;
– 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 E.3 for details of when this method is valid), or;
– direct meter reading method: where the power value is stable and the mode is stable, by recording the instrument power reading (see E.4 for details of when this method is valid).

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

E.2 Sampling method

This method should be used where the power is 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 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, should be recorded at equal intervals of not more than 1 s for the minimum period specified.

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 should be energized 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

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

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 should be energized for an initial operation period of not less than 10 min. Data during this period is not to be used to assess the power consumption of the product.
– The product is then energized for a time sufficient to encompass two comparison periods, where each period should include not less than two cycles and have a duration of not less than 10 min (comparison periods ~~shall~~ 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 should be measured to adequately characterise the power consumption of the mode (a minimum of 10 cycles is recommended).

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.

E.3 Average reading method

This method should not be used for cyclic loads or limited duration modes.

NOTE A shorter measurement period is possible using the sampling method (see E.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:

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Select two comparison periods, each made up of not less than 10 min duration (periods should 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 30 min duration each, the sampling method in E.2 should be used.

There are two approaches:

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

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

If an instrument has a time resolution of approximately 1 s, then a minimum of 200 s (3,33 min) is required for integration on such an instrument.

If an instrument has an energy resolution of approximately 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 approximately 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).

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E.4 Direct meter reading method

The direct meter reading method should only be used where the mode does not change and the power reading displayed on the measuring instrument is stable. This method should not be used for verification purposes. Any result using the methods specified in E.2 or E.3 should take precedence over results using this method in the case of a dispute.

NOTE 1 A shorter measurement period is possible using the sampling method (see E.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 should not be used.

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Annex G
(normative)

Procedure for the registration of categories for IEC 62623

G.1 General

This annex specifies the procedure to be followed by the Registration Authority in preparing, maintaining and publishing International Registers of desktop, notebook and ULE computer categories for use with IEC 62623.

G.2 International registers

There are three registers:

1) Notebook computer categories:

– Grouping of notebook computer configurations.

2) Desktop computer categories:

– Grouping of desktop computer configurations.

3) Ultra low energy (ULE) **category**:

– Products exhibiting annual energy consumption below a certain level.

G.3 Registration authority

G.3.1 Appointment

Ecma International is the Registration Authority for the International Registers defined in G.2.

G.3.2 Duties

G.3.2.1 Publication of public content of International Registers

The Registration Authority shall publish, at no cost, the International Registers in G.2. for public access at

http://www.ecma-international.org/publications/standards/Categories_to_be_used_with_Ecma-383.htm.

G.3.2.2 Maintenance of International Registers

The Registration Authority shall maintain the International Registers specified in items 1) and 2) of G.2 by following the change request procedure in G.4 and registration procedure in G.5.

G.3.2.3 Inform a change requestor of the decision

The Registration Authority shall inform the requestor of changes to existing categories of the decision to accept or reject such a request.

G.4 Change requests

Using the form to be found at the web link below, implementers of IEC 62623 may send comments for consideration by the registration authority for modifications to categories specified in G.2.

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Such comments shall be fit for use with IEC 62623 and comply with the following minimum criteria:

– Comments requesting the creation of a new **category** shall:
  - be able to demonstrate that the new **category** is distinguishable via attributes from other existing or requested categories within a given register;
  - be able to show a 15 % **TEC** increase from an existing lower adjacent **category**, or show 10 % **TEC** decrease from the adjacent **category** above, or 10 % decrease from lowest **TEC category**.

– Comments requesting a modification to an existing **category** shall:
  - be able to demonstrate that it does not change the ability to distinguish via attributes from other existing categories or requested new categories within a given register;
  - be able to demonstrate that a minimum of a 10 % difference in **TEC** score is maintained between categories in a given register.

Web Link:

http://www.ecma-international.org/publications/standards/Ecma-383_comments_to_categories.php.

G.5 Registration procedure

The Registration Authority shall:

1) review registration comments as specified in G.4;
2) ascertain that registration comments are in accordance with this annex;

   If required, indicate to the requestor the changes needed to meet the requirements of this Annex.
3) manage multiple comments in a manner that minimises updates to the International Register and takes into account conflicting or supporting comments from different parties;
4) approve or reject the comments;
5) in case of approval and before modification of the International Register, the registration authority shall
   a) maintain a minimum of 6 months between changes to the International Registers.
   b) take into account all comment approvals and manage the registers in a manner that minimises the number of updates.
6) inform the requestor of approval or rejection within 30 business days.

G.6 Appeal procedure

Appeals shall be filed using the form at the web link below within 30 business days of receipt of the decision from the Registration Authority.

The Registration Authority shall respond to the appeal within 30 business days after receipt of the appeal.

Web link:

http://www.ecma-international.org/publications/standards/Ecma-383_appeals_for_rejected_comments.php.

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Desktop and notebook computers – Measurement of energy consumption

Ordinateurs de bureau et ordinateurs portables – Mesurage de la consommation d'énergie

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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DESKTOP AND NOTEBOOK COMPUTERS – MEASUREMENT OF ENERGY CONSUMPTION

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IEC 62623 has been prepared by technical area 19: Environmental and energy aspects for multimedia systems and equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

The first edition of this standard was originally based on ECMA-383.

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

a) Additions to terms & definitions and modification to short & long idle descriptions.
b) Test setup modifications for notebooks where battery pack cannot be removed for testing.
c) Categorisation procedure based on ECMA-389 removed.
d) Replace majority profile with new duty cycle study including new duty cycle attributes for desktop and notebook in a residential and enterprise application.
e) Removal of any reference and test methodology to ENERGY STAR V5.

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

Draft	Report on voting
100/3583/CDV	100/3669/RVC

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.

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/standardsdev/publications.

In this standard, the following print types or formats are used:

– requirements proper and normative annexes: in roman type;
– notes/explanatory matter: in smaller roman type;
– terms that are defined in 3.1: **bold**.

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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INTRODUCTION

This document provides definitions of energy saving modes and generic energy saving guidance for designers of desktop and notebook computers, by defining a methodology on how to measure the energy consumption of a product whilst providing key categorisation attributes that enable energy consumption comparisons of similar products.

This document is originally based on ECMA-383 and complements the guidance given in IEC 62075.

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DESKTOP AND NOTEBOOK COMPUTERS – MEASUREMENT OF ENERGY CONSUMPTION

1 Scope

This document covers personal computing products. It applies to desktop and notebook computers as defined in 4.1 that are marketed as final products and that are hereafter referred to as the equipment under test (EUT) or product.

This document specifies:

– a test procedure to enable the measurement of the power and/or energy consumption in each of the EUT's power modes;

– formulas for calculating the **typical energy consumption** (**TEC**) for a given period (normally annual);

– a majority profile to be used with this document which enables conversion of average power into energy within the **TEC** formulas;

– a pre-defined format for the presentation of results.

This document does not set any pass/fail criteria for the EUTs. Users of the test results define such criteria.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviations

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

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and definitions

3.1.1
active workload
simulated amount of productive or operative activity that the EUT performs as represented in the P_{work} (see 4.2.12) and $\boldsymbol{T}_{\textbf{work}}$ (see 3.1.11.6) attributes of the **TEC** equation (see 5.6)

3.1.2
category
classification within a product type that is based on product features and installed components

3.1.3
duty cycle
divisions of time the EUT spends in each of its individual power modes

Note 1 to entry: A duty cycle is expressed as a percentage totalling 1.

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3.1.4
energy use
energy used by a product when measured from the mains power supply over a given period of time

Note 1 to entry: Energy is measured in kilowatt hour.

3.1.5
external power supply
EPS
equipment contained in a separate physical enclosure external to the computer casing and designed to convert mains power supply to lower DC voltage(s) for the purpose of powering the computer

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: The **EPS** is sometimes referred to as an AC brick.

Note 3 to entry: A reference to a document which outlines the testing procedures for measuring **EPS** efficiencies (External Power Supply Efficiency Test Method) can be found in the Bibliography.

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3.1.6
internal power supply
IPS
component contained inside the computer casing and designed to convert AC voltage from the mains power supply to lower DC voltage(s) for the purpose of powering the computer components

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: A reference to a document which outlines the testing procedures for measuring **IPS** efficiencies (Generalized Internal Power Supply Efficiency Test Protocol) can be found in the Bibliography.

3.1.7
local area network
LAN
computer network located on a user's premises within a limited geographical area

[SOURCE: IEC 60050-732-01-04]

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: Currently the two primary technologies used in computers are IEEE 802.3 Ethernet or Wired **LAN**, and IEEE 802.11 WiFi or Wireless **LAN.**

3.1.8
manufacturer
organization responsible for the design, development and production of a product in view of its being placed on the market, regardless of whether these operations are carried out by that organization itself or on its behalf

3.1.9
typical energy consumption
TEC
number for the consumption of energy of a computer that is used to compare the energy performance of like computers, which focuses on the typical energy consumed by an EUT for a given profile while in normal operation during a representative period of time

Note 1 to entry: This note applies to the French language only.

Note 2 to entry: For desktops and notebook computers, the key criterion of the **TEC** approach is a value for typical annual **energy use**, measured in kilowatt-hours (kWh), using measurements of average operational mode power levels scaled by an assumed typical **duty cycle** that represent annualized use for a profile.

3.1.10
actual energy consumption
TEC measured using P_{work}

Note 1 to entry: The **actual energy consumption** is referenced as $\mathbf{TEC}_{actual}$.

3.1.11
duty cycle attributes
percentage of time the EUT spends in each of its individual power modes

Note 1 to entry: Examples of **duty cycle attributes** are defined in 3.1.12.1 to 3.1.12.7.

3.1.11.1
off component of duty cycle
T_{off}
percentage of time the EUT is in the off mode

3.1.11.2
sleep component of duty cycle
T_{sleep} **and** $T_{sleepWoL}$
percentage of time the EUT is in the sleep modes

3.1.11.3
on components of duty cycle
T_{on}
percentage of time the EUT is in the on mode

Note 1 to entry: The T_{on} **duty cycle** is equal to the sum of the T_{work} + T_{sidle} + T_{lidle}.

3.1.11.4
short idle component of duty cycle
T_{sidle}
percentage of time the EUT is in the short idle mode

3.1.11.5
long idle component of duty cycle
T_{lidle}
percentage of time the EUT is in the long idle mode

3.1.11.6
alternative low power component of duty cycle
T_{alpm}
percentage of time the EUT is in the alternative low power mode

3.1.11.7
active component of duty cycle
T_{work}
percentage of time the EUT is in the active (work) mode

3.1.12
user of the test results
entity that will utilise the test results to apply to their needs

Note 1 to entry: Examples of such an entity are voluntary agreement owners, regulators, private companies, etc.

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3.1.13
wake on LAN
WoL
functionality that allows a computer to wake from sleep or off to an active state when directed by a network wake request via Ethernet

Note 1 to entry: This note applies to the French language only.

3.1.14
graphics processor unit
GPU
integrated circuit, separate from the CPU, designed to accelerate the rendering of either 2D and/or 3D content to displays

Note 1 to entry: GPU may be paired with a CPU, on the system board of the computer or elsewhere to offload display capabilities from the CPU

3.1.15
discrete graphics
graphics processor (GPU) which must contain a local memory controller interface and local graphics-specific memory

3.1.16
integrated graphics
graphics solution that does not contain **discrete graphics**

3.1.17
switchable graphics
functionality that allows **discrete graphics** to be disabled when not required in favour of **integrated graphics**

Note 1 to entry: This functionality allows lower power and lower capability integrated GPUs to render the display while on battery or when the output graphics are not overly complex while then allowing the more power consumptive but more capable discrete GPU to provide rendering capability when the user requires it.

3.1.18
system memory bandwidth
rate at which data can be read or stored into computer system's memory

Note 1 to entry: System memory bandwidth is measured in gigabytes per second (GB/s).

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

ACPI advanced configuration and power interface

NOTE 1 ACPI specification can be found here: http://www.uefi.org/acpi/specs

ALPM alternative low power mode

CF crest factor

CFR crest factor ratio

CPU central processing unit

DVI Digital Visual Interface

EPS external power supply

EUT equipment under test

NOTE 2 Also referred to as product in this standard and sometimes referred to as UUT (unit under test) in other specifications.

FB_BW frame buffer bandwidth

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GPU	graphic processing unit
HDD	hard disk drive
HDMI®[1]	High Definition Multimedia Interface
IPS	internal power supply
LAN	local area network
LPM	low power mode
MCR	maximum current ratio
OS	operating system
PAPR	profile active power ratio
PAWR	profile active workload ratio
PCF	product crest factor
PF	power factor
RAM	random access memory
RMS	root mean square
TEC	typical energy consumption
THD	total harmonic distortion
UPS	uninterruptible power supply
VGA	Video Graphics Array
WoL	wake on LAN

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4 Specifications for EUT

4.1 Computer descriptions

4.1.1 Desktop computer

A desktop computer is a computer where the main unit is intended to be located in a permanent location, often on a desk or on the floor. Desktops are not designed for portability and utilize an external computer display, keyboard, and mouse. Desktops are designed for a broad range of home and office applications.

4.1.2 Notebook computer

A notebook computer is a computer designed specifically for portability and intended to be operated for extended periods of time either with or without a direct connection to an AC mains power supply. Notebooks utilize an integrated computer display and are capable of operation from an integrated battery. In addition, most notebooks use an EPS or AC brick and have a non-detachable mechanical keyboard (using physical, moveable keys) and pointing device. Notebook computers are typically designed to provide similar functionality to desktops, including operation of software similar in functionality as that used in desktops. For the purposes of this document, docking stations are considered accessories and, therefore, should not be considered as part of the EUT.

4.1.3 Two-in-one notebook

A computer which resembles a traditional notebook computer with a clam shell form factor, but has a detachable display which can act as an independent slate/tablet when disconnected. The keyboard and display portions of the product must be shipped as an integrated unit. Two-in-one

[1] HDMI® and HDMI® High-Definition Multimedia Interface are trademarks of HDMI Licensing Administrator, Inc. This information is given for the convenience of users of this document 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.

notebooks are considered notebooks in the remainder of this standard and are therefore not referenced explicitly.

4.1.4 Multiscreen notebook

A computer which resembles a traditional notebook computer with a clam shell form factor but has a secondary display with touch and/or pen capability that can be used as a touch screen keyboard in place of a traditional mechanical keyboard. These products are considered to be notebook computers for purposes of this standard.

4.1.5 Slate/Tablet

A computing device designed for portability that meets all of the following criteria:

a) Includes an integrated display with a diagonal size greater than 6,5 inches and less than 17,4 inches;
b) lacking an integrated, physical attached keyboard in its as-shipped configuration;
c) includes and primarily relies on touchscreen input; (with optional keyboard);
d) includes and primarily relies on a wireless network connection (e.g., Wi-Fi, 3G, etc.); and
e) includes and is primarily powered by an internal battery (with connection to the mains for battery charging, not primary powering of the device).

4.1.6 Portable all-in-one computer

A computing device designed for limited portability that meets all of the following criteria:

a) Includes an integrated display with a diagonal size greater than or equal to 17,4 inches;
b) lacking keyboard integrated into the physical housing of the product in its as-shipped configuration;
c) includes and primarily relies on touchscreen input; (with optional keyboard);
d) includes wireless network connection (e.g. Wi-Fi, 3G, etc.); and
e) includes an internal battery, but is primarily powered by connection to the ac mains.

4.1.7 Integrated desktop computer

An integrated desktop computer is a desktop computer where the computer and computer display function as a single unit and which is connected to AC mains power through a single mains cable. Integrated desktop computers come in one of two possible forms:

– a product where the computer display and computer are physically combined into a single unit; or
– a product packaged as a single product where the computer display is separate but is connected to the main chassis by a DC power cord and both the computer and computer display are powered from a single power supply.

As a subset of desktop computers, integrated desktop computers are typically designed to provide similar functionality as desktop computers.

NOTE 1 An integrated desktop computer can also be referred to as an all-in-one computer.

4.2 Power modes

4.2.1 Off mode

Off mode is the lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the EUT is connected to the main electricity supply and used in accordance with the **manufacturer**'s instructions. For products where ACPI standards are applicable, off mode correlates to ACPI system level S5 state.

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NOTE 1 Some international regulations also refer to this mode as standby mode.

4.2.2 P_{off}

P_{off} represents the average power measured in the off mode.

4.2.3 Sleep mode

Sleep mode is a low power mode that the EUT is capable of entering automatically after a period of inactivity or by manual selection. An EUT with sleep capability can quickly wake to a readable display in response to a wake event from network connections or user interface devices. For products where ACPI standards are applicable, sleep mode most commonly correlates to ACPI system level S3 (suspend to RAM) state. When the EUT is tested with the **WoL** capability disabled in the sleep state, it is referred to as sleep mode. When the EUT is tested with the **WoL** capability enabled in the sleep state, it is referred to as **WoL** sleep mode.

NOTE 1 Low power sleep modes other than ACPI S3 can be supported.

4.2.4 P_{sleep}

P_{sleep} represents the average power measured in the sleep mode with the **WoL** capability disabled.

4.2.5 P_{sleepWoL}

P_{sleepWoL} represents the average power measured in the sleep mode with the **WoL** capability enabled.

4.2.6 Alternative low power mode

A low power mode that the computer enters automatically after a period of inactivity or by manual selection that is defined by the display turning off and the computer entering a state of reduced functionality. A computer with alternative low power mode must maintain immediate responsiveness to network connections or user interface devices.

4.2.7 P_{alpm}

P_{alpm} represents the average power measured when in the Alternative Low Power Mode.

4.2.8 On mode

The on mode represents the mode the EUT is in when not in the sleep or off modes. The on mode has several sub-modes that include the long idle mode, the short idle mode and the active (work) mode.

4.2.9 P_{on}

P_{on} represents the average power measured when in the on mode.

4.2.10 Idle modes

4.2.10.1 General

The idle modes are modes in which the operating system and other software have completed loading, a user profile is created, the product is not in sleep mode or an alternative low power mode, and activity is limited to those basic applications that the product starts by default. There are two forms of idle that comprise the idle modes: short idle mode (see 4.2.10.2) and long idle mode (see 4.2.10.4).

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4.2.10.2 Short idle mode

The short idle mode is where the EUT screen is on, and long Idle power management features have not engaged (e.g. HDD is spinning and the EUT is prevented from entering sleep mode or alternative low power mode). This condition shall be up to 5 min after:

– ceased user input or
– OS boot or
– after completing an active workload or
– after resuming from sleep mode or alternative low power mode

4.2.10.3 P_{sidle}

P_{sidle} represents the average power measured when in the short idle mode.

4.2.10.4 Long idle mode

Long idle mode is where the EUT's display has entered a low-power state where display contents cannot be observed (that is backlight has been turned off) but EUT remains in the working mode (ACPI G0/S0). If power management features are enabled as-shipped, such features shall be enabled prior to evaluation of long Idle (e.g. display is in a low power state, HDD may have spun down), but the EUT is prevented from entering sleep mode or alternative low power mode.

This condition shall be between 15 to 20 min after

– ceased user input or
– OS boot or
– after completing an **active workload** or
– after resuming from sleep mode or alternative low power mode

4.2.10.5 P_{lidle}

P_{lidle} represents the average power measured when in the long idle mode.

4.2.11 Active (work) mode

Active mode is the mode in which the EUT is carrying out user-initiated work in response to

– prior or concurrent user input; or
– prior or concurrent instruction over the network.

This mode includes active processing, seeking data from storage, memory, or cache, while awaiting further user input or acting on concurrent user input and before entering low power modes.

4.2.12 P_{work}

P_{work} represents the average power measured when in the active mode.

4.3 Profile attributes

4.3.1 Profile

A profile is a combination of **duty cycle attributes** and a given use case (for example, office users, home users, gamers).

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NOTE 1 Refer to Annex A, Annex B and Annex C for further information on profiles.

4.3.2 Majority profile

The majority profile is the most common profile of users for desktop and notebook computers.

The majority profile should be used with this standard and is documented in Annex B. It provides the **duty cycle attributes** and the profile **TEC** error that is used to determine the **TEC** equation to be used in 5.6.

4.3.3 Minority profile

The minority profiles represent less common profiles of users of desktop and notebook computers that are not represented in the majority profile. As an example, extreme gamers represent a very specific profile but are a very small percentage of computer users.

4.3.4 Profile study

A profile study is a study performed to create a new profile for this standard. The study shall generate, together with supporting data, the following:

- all the **duty cycle attributes**;
- the PAPR (see 4.3.6);
- the profile **TEC** error (see 4.3.9);
- the PAWR (see 4.3.7).

All data shall be derived from a statistically significant sample size that is representative of the user population as a whole. Annex C provides guidance on how to conduct a profile study.

4.3.5 Product active power ratio

The product active power ratio is the ratio of $P_{\text{on}}/P_{\text{sidle}}$, or the average on power divided by short idle power for an individual product within a profile study.

4.3.6 PAPR

PAPR is the average of all the product active power ratios recorded in a profile study.

4.3.7 PAWR

PAWR represents the average ratio of $P_{\text{work}}/P_{\text{sidle}}$ conducted on profile study products and is used to validate that the **active workload** closely matches the profile study (through its PAWR).

4.3.8 Product TEC error

The product **TEC** error is the percent error calculation used in a profile study to evaluate how much error exists for an individual product when directly measuring **TEC** versus estimating **TEC** by substituting the static "short idle" power measurement for the measured P_{work} power.

4.3.9 Profile TEC error

The profile **TEC** error is the average of the product **TEC** error in a profile study.

4.4 Categorisation attributes

4.4.1 General

Below are some examples of categorisation attributes.

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4.4.2 Cores

The cores attribute is the number of physical CPU cores in the EUT.

4.4.3 Expandability score (ES)

Expandability score (ES) is a result of a calculation designed to estimate a computer's power supply capacity based on the power draw, if each interface present in the system were operated at their designed maximum voltage and current.

4.4.4 Performance score

Performance score is one of the categorisation attributes and is a measure of:

(number of CPU cores x CPU Clock speed (GHz), where the number of cores represents the number of physical CPU cores and clock speed represents the maximum Thermal Design Power (TDP) core frequency (not the turbo boost frequency).

4.4.5 Graphics capability

Graphics capability is categorized based on frame buffer bandwidth

4.4.6 TEC adders

A **TEC** adder is a power allowance expressed in kilowatt hour per year that when added or configured to the EUT will increase its **TEC** by some amount. Examples could be:

– discrete graphics, memory including system memory bandwidth, network devices, I/O devices, power supply size, etc.;
– for computer with an integrated display(s), each screen shall be treated as an adder.

5 Test procedure and conditions, categorisation, TEC formula, meter specifications and results reporting

5.1 General

The following procedure shall be used when measuring the power or energy consumption of the EUT.

The user of this standard shall measure a sample of the EUT. The size of the sample shall be appropriate to demonstrate compliance to the requirements set by the **user of the test results**.

5.2 Test setup

The EUT and test conditions shall be set up as defined below.

The automatic display luminance control should be disabled for testing. If automatic display luminance control cannot be disabled for testing, position a light source such that at least 300 lux directly enters the automatic display luminance control sensor.

a) The EUT shall be configured in accordance with the instructions provided with the product (unless otherwise stated in this test procedure) including all hardware accessories and software shipped by default. The EUT shall also be configured using the following requirements for all tests:
   1) Desktop and integrated desktop computers shipped without an input device shall be configured with a **manufacturer's** recommended input device (for example, mouse and/or keyboard). No other external peripherals shall be connected.

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2) Desktop computers shall be configured with an external computer display (the external display energy consumption is not included as part of the **TEC** calculation).

3) Preparing external displays for desktop computers

   i) Display connections priority:

      a) If the EUT has a port that supports switchable graphics capable of automatic switching, use that port.

      b) If a discrete GPU is installed, connect to that GPU, except for where it conflicts with(a) in this list.

      c) If no discrete or automatically switchable GPU is installed, choose a connection to an integrated GPU.

      d) If multiple ports meet the requirements in(a) to (c) of this list, test with the first available interface from Table 1.

Table 1 – External display connection priority

i. DisplayPort™ [2]
ii. HDMI®
iii. DVI
iv. VGA
v. Other (i.e. Thunderbolt 3, Composite Video, etc.)

   ii) Display Resolution: An external monitor used in the testing of the EUT shall have a minimum native resolution of 1920 x 1080 pixels with progressive scanning (1080p). The EUT operating system shall be set to operate at a minimum of 1080p.

4) Notebook computers need not include a separate keyboard or mouse when equipped with an integrated pointing device or digitizer. Slates/Tablets and Two-In-One Computers shall be configured in a manner identical to Notebooks unless otherwise specified.

5) Notebook computers shall be connected to the mains power source using the EPS shipped with the product. Battery pack(s) shall be removed for all tests. For an EUT where operation without a battery pack is not an end-user supported configuration, the test shall be performed with fully charged battery pack(s) installed and the state of the batteries as indicated by the EUT’s user interface shall be "fully charged" or similar state. The test configuration including any battery status indications, shall be reported in the test results.

6) For computers with integrated display the three black and white vertical bar video signal as defined in 3.2.1.3 of IEC 60107-1:1997, "*Methods of measurement on receivers for television broadcast transmissions – Part 1: General conditions –Measurements at radio and video frequencies,*" (Edition 3) shall be displayed on the screen. The three-bar image shall be configured using the default image display application to set the display brightness for power measurements which is detailed in 5.3.6.

7) A notebook, two in one notebook, tablets/slates, portable all in one and integrated desktop computer shall include the power used by the integrated display in reported results.

NOTE 2 Additional specified luminance level conditions can be measured (see 5.3.6) and disclosed in the reported results.

8) The sleep timer of the EUT shall be disabled or set to a time to prevent the EUT from entering the sleep state during the idle or active tests.

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[2] DisplayPort™ and the DisplayPort™ logo are trademarks of the Video Electronics Standards Association (VESA®). This information is given for the convenience of users of this document 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.

Figure 1 illustrates a typical test setup for a notebook two-in-one notebook, slate/tablet, portable all-in-one, and a desktop computer.

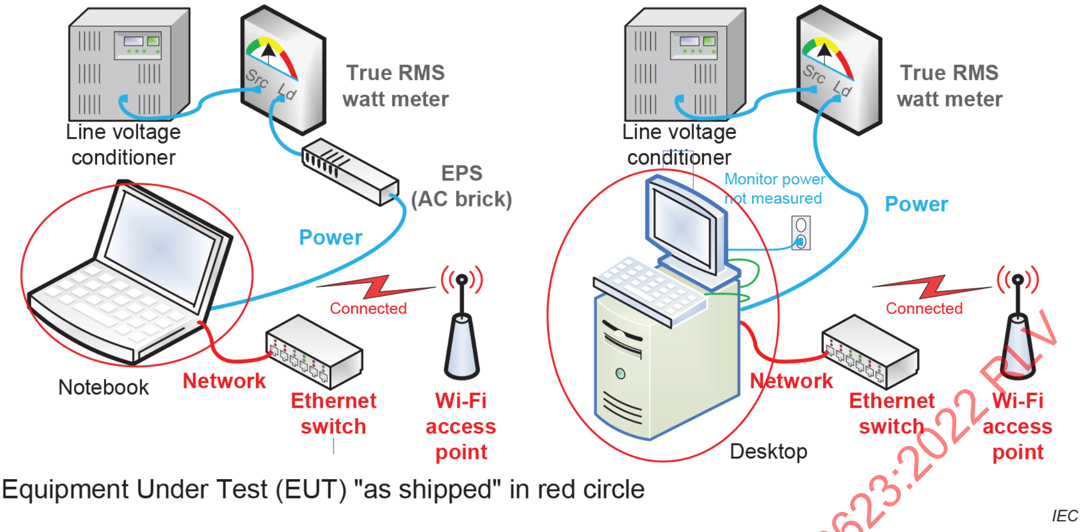

Figure 1 – Typical test setup

NOTE 3 Figure 1 shows wired and wireless connections. Only one is connected during test per 5.2c).

b) A true RMS watt meter that meets the meter requirements in 5.7 is placed between the mains power supply and the EUT power supply. No power strips or UPS units shall be connected between the meter and the EUT. The meter shall remain in place until all required power mode data is recorded. The mains power supply shall meet the requirements in 5.4.

c) For sleep, long idle, ALPM, short idle and the optional active measurements, the EUT energy consumption shall be measured with network connectivity in one of the three states described below.

1) For an EUT with Ethernet port support, the EUT shall be connected to an active network switch via Ethernet that supports the highest link speed supported by the EUT (the network switch only needs to be connected to EUT but does not need to be connected to any other device, either WAN or LAN). Only a single network connection needs to be made in the case of an EUT with multiple network connections. It shall also support the minimum requirements needed to support additional power management functions that are supported by the EUT.

As an example, the IEEE 802.3az-2010 specification supports power management of Ethernet links that shall be supported by both the EUT and network switch.

To test this function, the switch shall also support this function. Power to alternative network devices such as wireless radios shall be turned off for all tests. This applies to wireless network adapters or device-to-device wireless protocols (for example, Bluetooth, Wi-Fi, etc). Cellular network connections shall be disabled for testing.

NOTE 4 For examples of wireless network adapters, see IEEE 802.11.

2) For an EUT with only wireless connectivity, a live wireless connection to a wireless router or network access point, which supports the highest and lowest data speeds of the client radio, shall be maintained for the duration of testing.

3) For an EUT that does not support Ethernet, but supports some other sort of wired network connectivity, that network shall be turned on and be in a connected state.

Some activities can cause variation in idle power during testing. The following is a partial list of occurrences in newly built systems that are likely to cause noticeable variations in idle power:

– Software updates
– Antivirus scans
– Drive Indexing
– Deferred activity from OS build process

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d) The EUT shall be disconnected from the internet, anti-virus scans are not running and OS updates are not occurring and turn off drive indexing.

e) Record the EUT description as required in 5.10.

f) Measure the test conditions as defined in 5.4 and record as required in 5.10.

g) The ambient light conditions of the test room shall be measured using a meter that meets the requirements in 5.9 and set to the appropriate levels called for in 5.4.

5.3 Test procedure

5.3.1 General

The test procedures are listed in order of energy consumption. The specific procedure for measuring each power mode shall be followed. However, the power measurements of each energy mode can be made in any order and, if a **TEC** result is not required, the user does not need to test all of the power modes.

5.3.2 Measuring off mode

To measure the off mode:

– place the EUT in off mode (see 4.2.1);

– WoL setting shall be in as shipped condition;

– set the meter to begin accumulating true power values at an interval of one or more readings per second; and

– accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{off}.

5.3.3 Measuring sleep mode

To measure the sleep mode:

– switch on the EUT;

– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in sleep mode (see 4.2.3);

– reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second;

– accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{sleep};

– if testing both **WoL** enabled and **WoL** disabled for sleep, wake the EUT and change the **WoL** from sleep setting through the operating system settings or by other means. Place the EUT back in sleep mode and repeat test, recording sleep power necessary for this alternate configuration as $P_{sleepWoL}$.

– For EUT that does not offer a Sleep Mode enabled by default, power shall be measured in the lowest-latency user-activated mode or state that preserves machine state and is enabled by default. If no such state separate from Long Idle or Off Mode exists, the measurement shall be omitted.

5.3.4 Measuring alternative low power mode

To measure alternative low power mode:

– switch on the EUT;

– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in alternative low power mode (see 4.2.10.4 or 4.2.6);

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– the EUT shall be allowed no more than 20 min from the point of ceased user input before measurements must be started. If any default settings cause the EUT to enter long idle after 20 min, begin taking measurements when the EUT has reached the 20 min point;

– once the EUT has entered the alternative low power mode, reset the meter (if necessary) and begin accumulating true power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{ALPM}.

5.3.5 Measuring long idle mode

To measure long idle mode:

– switch on the EUT;

– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in long idle mode (see 4.2.10.4);

– the EUT shall be allowed no more than 20 min from the point of ceased user input before measurements must be started. If any default settings cause the EUT to enter long idle after 20 min, begin taking measurements when the EUT has reached the 20 minute point;

– once the EUT has entered the long idle mode, reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second;

– accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{idle}.

5.3.6 Measuring short idle mode

To measure short idle mode:

– switch on the EUT;

– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop background screen or equivalent ready screen is displayed, and the image has been scaled to completely fill the display area, if the EUT has an integrated display calibrate the EUT display brightness to the closest brightness setting using a luminance meter focused on one of the white bars in the three-bar black and white image detailed in 5.2a)6) to get the measurement reading that is at least 90 cd/m^2 for a notebook computer or at least 150 cd/m^2 for integrated desktop computers, slates/tablets and portable all in one computers, or if these levels are not attainable, set the product brightness level to the nearest achievable level, record the level and place the EUT in short idle mode (see 4.2.10.2);

– after display brightness level is set, open an image of RGB 130, 130, 130 where the image has been scaled to completely fill the display area using the default image viewing software on the EUT;

– the EUT shall be allowed no more than 5 min from the point of ceased user input before measurements must be started;

– once the EUT has entered short idle mode, reset the meter (if necessary) and begin accumulating true power values at an interval of one or more readings per second;

– accumulate power values for 5 min and record the average (arithmetic mean) value observed during that 5 min period as P_{sidle}. Display sleep settings shall be disabled. Other default settings that cause the EUT to exit short idle during the measurement time shall be extended so that the EUT remains in short idle for the duration of the measurement.

– Additionally, only for notebook computers that demonstrate cyclical battery charging patterns extend the short idle test long enough to capture the energy consumption over one or more complete cycles. The extended test shall be conducted by keeping the unit in short idle through minimal user input such as moving the mouse or pressing a key that does not perform any action (e.g. shift, ctrl, tab). The EUT must remain in short idle during the entire time of the extended test.

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5.3.7 Measuring active power mode (optional, see 5.6)

To measure active mode:

– switch on the EUT;

– once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed, and place the EUT in short idle mode (see 4.2.10.2);

– load the **active workload** and prepare it to run;

– reset the meter (if necessary) and start the **active workload**. Begin accumulating true power values at an interval of one or more readings per second;

– when the **active workload** indicates it has finished, record the average power as P_{work}.

NOTE 1 Criteria for the **active workload** is defined in 5.6.4.

NOTE 2 Criteria for active mode efficiency will need to be developed to account for computer performance and energy.

5.4 Test conditions

All tests carried out on the EUT shall take place under the conditions in Table 2.

Table 2 – Test conditions

Mains power supply voltage	North America/Taiwan:	115 (±1 %) V AC, 60 Hz (±1 %)
	Europe/Australia/New Zealand/China:	230 (±1 %) V AC, 50 Hz (±1 %)
	Japan:	100 (±1 %) V AC, 50 Hz (±1 %) or 60 Hz (±1 %)
		For products rated > 1,5 kW maximum power, the voltage range is ±4 %
THD (voltage)	< 2 % THD (< 5 % for products which are rated for > 1,5 kW maximum power)	
Ambient temperature	(23 ±5) °C	
Relative humidity	10 % to 80 %	
Ambient light	(250 ±50) Lux	

NOTE 1 The voltage and frequency tolerances defined in Table 2 can only be achieved through the use of a line conditioner.

NOTE 2 It is recognised that the nominal voltage of some countries vary from the voltages defined above (for example, China is 220 V and India is typically 240 V), however this document has limited the number of voltages to be tested for worldwide compliance to three in order to minimise test overheads. Whilst the mains power supply voltage and frequency will have some impact on the overall **TEC** score, the variation that will be seen between 230 V, 220 V and 240 V will be minimal and well within the natural variation expected from testing to this document.

NOTE 3 Ambient light setting is only required if the display is sensitive to ambient light control and automatic display luminance control cannot be disabled for testing.

5.5 Categorisation

5.5.1 General

Categorisation is a grouping of product configurations enabling their relative **energy use** to be compared. A categorisation system is separate from this document as computer categories change on a much quicker timescale than standards due to changing market needs (local and international).

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5.5.2 TEC adders

Since the configurations of base EUTs as defined in 5.6 can be altered with additional features, this standard provides for **TEC** adders. **TEC** adders are intended to increment the **TEC** limit (provided by the **user of the test results**) for a given **category** of EUTs that include the attribute identified by the **TEC** adder.

TEC adders may be provided for items **d**iscrete graphics , memory including system memory bandwidth, add-in cards, storage devices, network devices, I/O devices, power supply size, integrated display, etc The **user of the test results** should provide the energy adders to be applied.

Where the discrete graphics component is treated as an adder, the FB_BW shall be used to determine the adder value.

NOTE 1 FB_BW: Is the display frame buffer bandwidth in gigabytes per second (GB/s). This is a manufacturer declared parameter and are calculated as follows: (Data Rate [MHz] × Frame Buffer Data Width [bits]) / (8 × 1 000)

To calculate the **TEC** adder energy consumption:

– determine which **TEC** adders apply and based on the allowances provided by the **user of the test results** calculate the **TEC** adder value in kilowatt hour per **TEC** adder;
– apply any appropriate weighting that the **user of the test results** provides;
– report the overall **TEC** adder energy as defined in 5.10.

NOTE 2 Adders are defined in kilowatt hour/adder/year. The **user of the test results** provides the energy adder information. Annex D provides examples on how adders are included in a **TEC** calculation.

5.6 Annualised energy consumption formulas

5.6.1 General

TEC is a weighted average of measured average power in specific EUT power modes: Off, sleep/**WoL** sleep, long idle, short idle and active.

It is recommended that the majority profile found in Annex B be used with this document.

Should the user of this document choose to use a different profile, a profile study shall be completed (4.3.4) and the profile **TEC** error determined.

If the profile **TEC** error is ≤ 15 %, the user of this document shall use 5.6.2.

If the profile **TEC** error is >15 %, the user of this document shall use 5.6.3 and an **active workload** shall be created that meets the criteria in 5.6.4.

NOTE 1 Annex D provides some examples of **TEC** calculations.

5.6.2 Estimated annualised energy consumption formula (estimated active workload)

$$\text{TEC}_{\text{estimated}} = (8\,760/1\,000) \times [P_{\text{off}} \times \boldsymbol{T}_{\textbf{off}} + P_{\text{sleep}} \times \boldsymbol{T}_{\textbf{sleep}} + P_{\text{lidle}} \times \boldsymbol{T}_{\textbf{lidle}} + P_{\text{sidle}} \times (\boldsymbol{T}_{\textbf{sidle}} + \boldsymbol{T}_{\textbf{work}})]$$

$$100\ \% = T_{\textbf{off}} + T_{\textbf{sleep}} + T_{\textbf{lidle}} + T_{\textbf{sidle}} + T_{\textbf{work}}$$

Where an alternative low power mode is used in place of sleep mode and long idle mode, power in alternative low power mode (P_{alpm}) may be used in place of both the power in sleep (P_{sleep}) and the power in long idle (P_{lidle}).

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$$TEC_{estimated} = (8\ 760/1\ 000) \times [P_{off} \times \boldsymbol{T_{off}} + P_{alpm} \times \boldsymbol{T_{alpm}} + P_{sidle} \times (\boldsymbol{T_{sidle}} + \boldsymbol{T_{work}})]$$

$$100\ \% = T_{off} + T_{alpm} + T_{sidle} + T_{work}$$

Where T_x are components of the **duty cycle** and represent the weighted averages of the time spent in each of the P_x power modes.

$\boldsymbol{T_{off}}$ the percent time the product annually spends in the off mode;

$\boldsymbol{T_{sleep}}$ the percent time the product annually spends in the sleep mode;

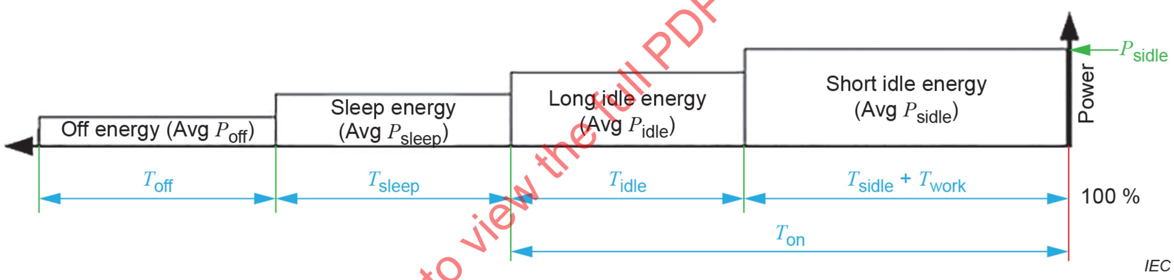
$\boldsymbol{T_{lidle}}$ the percent time the product is annually on and in the long idle mode (screen blanked);

$\boldsymbol{T_{sidle}}$ the percent time the product is annually on and in the short idle mode (screen not blanked);

$\boldsymbol{T_{alpm}}$ the percent time the product is annually on and in the alternative low power mode;

$\boldsymbol{T_{work}}$ the percent time the product is annually on and in the active mode (screen not blanked).

This is further illustrated in Figure 2.



NOTE 1 T_{work} in the equation is used when there is computer active mode consideration, otherwise use T_{sidle} as a proxy for active mode

NOTE 2 Figure 2 not to scale.

Figure 2 – Example of estimated annualised energy consumption formula (estimated active workload)

5.6.3 Measured annualised energy consumption formula (with an active workload)

$$TEC_{actual} = (8\ 760/1\ 000) \times (P_{off} \times \boldsymbol{T_{off}} + P_{sleep} \times \boldsymbol{T_{sleep}} + P_{lidle} \times \boldsymbol{T_{lidle}} + P_{sidle} \times \boldsymbol{T_{sidle}} + P_{work} \times \boldsymbol{T_{work}})$$

$$100\ \% = T_{off} + T_{sleep} + T_{lidle} + T_{sidle} + T_{work}$$

Where an alternative low power mode is used in place of sleep mode and long idle mode, power in alternative low power mode (P_{alpm}) may be used in place of both the power in sleep (P_{sleep}) and the power in long idle (P_{lidle}).

$$TEC_{actual} = (8\ 760/1\ 000) \times (P_{off} \times \boldsymbol{T_{off}} + P_{alpm} \times \boldsymbol{T_{alpm}} + P_{sidle} \times \boldsymbol{T_{sidle}} + P_{work} \times \boldsymbol{T_{work}})$$

$$100\ \% = T_{off} + T_{alpm} + T_{sidle} + T_{work}$$

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Where T_x are components of the **duty cycle** and represent the weighted averages of the time spent in each of the P_x power modes.

T_{off} the percent time the product annually spends in the off mode;

T_{sleep} the percent time the product annually spends in the sleep mode;

T_{lidle} the percent time the product is annually on and in the long idle mode (screen blanked);

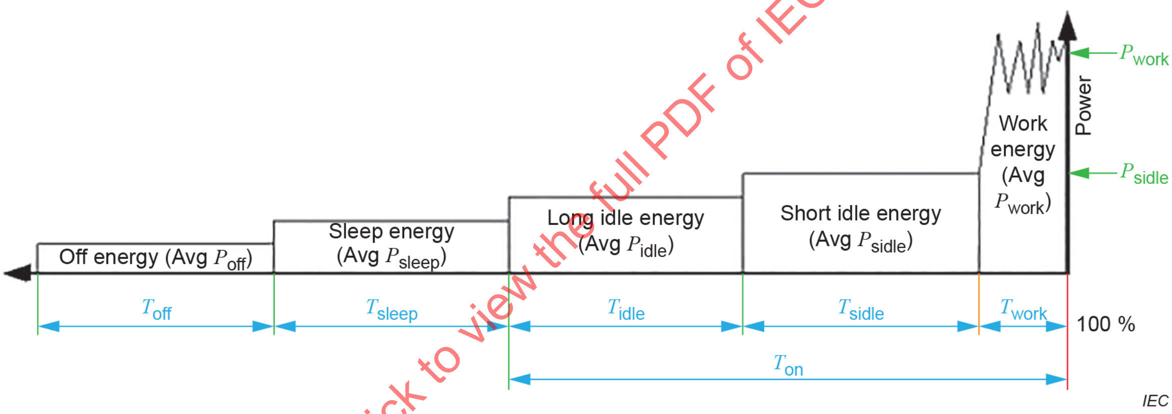
T_{sidle} the percent time the product is annually on and in the short idle mode (screen not blanked);

T_{alpm} the percent time the product is annually on and in the alternative low power mode;

T_{work} the percent time the product is annually on and in the active mode (screen not blanked).

where P_{work} is measured using an **active workload** created based on the criteria in 5.6.4.

This is further illustrated in Figure 3.



NOTE Figure 3 not to scale.

Figure 3 – Measured annualised energy consumption formula (with an active workload)

5.6.4 Criteria for an active workload

Should the profile **TEC** error be greater than the error defined in 5.6 an **active workload** shall be created and the TEC_{actual} formula in 5.6.3 used.

The workload shall be created to ensure that the PAPR, determined as a result of a profile study, comes within 15 % of the PAWR, determined by running the workload on the study computers. The **active workload** shall consist of workload fragments representative of the targeted profile:

– PAPR = P_{on}/P_{sidle}

– PAWR = P_{work}/P_{sidle}

– 15 % > |(PAPR - PAWR)|/PAPR (absolute values)

The P_{on} formula is defined as $P_{on} = (P_{lidle} \times T_{lidle} + P_{sidle} \times T_{sidle} + P_{work} \times T_{work})/T_{on}$

$E_{onwl} - E_{onstdy}/E_{onstdy}$

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where E_{onwl} is the "on energy" calculated from the developed workload, and E_{onstdy} is the "on energy" calculated from the energy study; or

$$E_{onwl} = P_{lidle} \times \boldsymbol{T}_{\mathbf{lidle}} + P_{sidle} \times \boldsymbol{T}_{\mathbf{sidle}} + P_{work} \times \boldsymbol{T}_{\mathbf{work}}$$

$$E_{onstdy} = P_{on} \times \boldsymbol{T}_{\mathbf{on}}$$

$$T_{\mathbf{on}} = T_{\mathbf{lidle}} + T_{\mathbf{sidle}} + T_{\mathbf{work}}$$

Resulting in the equation:

$$15\ \% > |P_{lidle} \times \boldsymbol{T}_{\mathbf{lidle}} + P_{sidle} \times \boldsymbol{T}_{\mathbf{sidle}} + P_{work} \times \boldsymbol{T}_{\mathbf{work}} - P_{on} \times \boldsymbol{T}_{\mathbf{on}}|/(P_{on} \times \boldsymbol{T}_{\mathbf{on}})$$

NOTE 1 Criteria for active mode efficiency will need to be developed to account for computer performance, power and energy consumed to run the workload.

5.7 True RMS watt meter specification

Approved meters shall include the following attributes:

– An available current crest factor of 3 or more at its rated range value. For meters that do not specify the crest factor, the analyser shall be capable of measuring an amperage spike of at least three times the maximum current measured during any 1 s sample of the measurement.

– A bound on the current range of 10 mA or less.

– A minimum frequency response of 3,0 kHz or less.

– Report true RMS power (W) and at least two of the following measurement units:
  - voltage,
  - current, and
  - power factor (PF).

The power measuring instrument shall be capable of meeting the requirements of 5.8 when measuring the following:

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

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

– The following attributes in addition to those above should be considered: the meter shall be able to be calibrated by a standard traceable to International System of Units. The analyser shall have been calibrated within the past year.

– If the meter is used in an automated setup, it shall have an interface that allows its measurements to be read by the SPEC PTDaemon (see Bibliography). The reading rate supported by the analyzer shall be at least one set of measurements per second, where a set is defined as Watts and at least two of the following readings: Volts, Amperes and power factor. The data averaging interval of the analyser shall be either 1 time (preferred) or 2 times the reading interval. "Data averaging interval" is defined as the time period over which all samples captured by the high-speed sampling electronics of the analyser are averaged to provide the measurement set.

It is also desirable for measurement instruments to be able to average power accurately over any user selected time interval (this is usually done with an internal math calculation dividing

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accumulated energy by time within the meter, which is the most accurate approach). As an alternative, the measurement instrument shall be capable of integrating energy over any user selected time interval with an energy resolution of less than or equal to 0,1 mWh and integrating time displayed with a resolution of 1 s or less.

5.8 True RMS watt meter accuracy

Measurements of power of 0,5 W or greater shall be made with an accuracy of 2 % or better at the 95 % confidence level. Measurements of power of less than 0,5 W shall be made with an accuracy of 0,01 W or better at the 95 % confidence level. A further requirement of the power measurement instrument shall have a resolution of:

- 0,01 W or better for power measurements of 10 W or less;
- 0,1 W or better for power measurements of greater than 10 W up to 100 W; and
- 1,0 W or better for power measurements of greater than 100 W.

All power figures shall be in watts and rounded to the second decimal place. For loads greater than or equal to 10 W, three significant figures shall be reported.

For loads with a calculated effective maximum current ratio (MCR), as described below, of more than 5, the uncertainty is adjusted using the following equation:

$$\mathrm{CFR} = \frac{\mathrm{PCF}}{\mathrm{MCF}}$$

If the calculated value of CFR is less than 1,0 then the value of CFR used in subsequent calculations shall be taken to be 1,0.

$$\mathrm{MCR} = \frac{\mathrm{CFR}}{\mathrm{PF}}$$

where

- the PCF is the measured peak current drawn by the product divided by the measured RMS current drawn by the product;
- the 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 MCR ≤ 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 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:

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

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

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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} × measured value) at the 95 % confidence level.

For ease in making the measurements, it is recommended that the power measuring instrument detects, indicates, signals and records any "out of range" conditions.

NOTE 1 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.

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.

5.9 Ambient light meter specification

If the EUT supports an automatic display luminance control and cannot be disabled for testing, then the EUT shall be tested in an environment that meets the ambient light requirements defined in 5.4.

A meter used to measure the ambient light conditions shall measure illumination and shall meet the requirements listed in Table 3.

Table 3 – Ambient light meter specifications

Resolution	Accuracy
10 Lux	± 5 %

5.10 Reporting of results

The following minimum information shall be reported. The format is an example format only; the user of this document may use any format of choice.

1. EUT description

Manufacturer ____________________

EUT code / Model number ____________________

EUT Type:

Notebook computer ☐ Desktop computer ☐ Integrated desktop computer ☐

Operating System: Windows ☐ Mac OS ☐ Chrome ☐ Other ____________________

Operating system version details: ____________________

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For notebook computers:

Battery pack removed during test Yes ▯ No ▯ If no then: ______

Fully charged battery pack used Yes ▯

2. EUT category (only required if a TEC result is recorded)

Category (include the date extension): ________________________________

List any **TEC** adders applied:

____

____

____

3. Results

All boxes shall be completed if a **TEC** result is recorded.

Power mode	Recorded average Watts (P)
Off mode (P_{off})	
Sleep mode (P_{sleep})	
Sleep mode ($P_{sleepWoL}$)	
Long idle (P_{lidle})	
Short idle (P_{sidle})	
Active mode (P_{work})*	

*If applicable

TEC (no **WoL**): ______________

TEC (with **WoL**): ______________

TEC adder allowances (if applicable) ______________

Majority profile used Yes ▯ No ▯

If No – description of profile used:

____

____

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4. Test conditions

Sample size tested: ____________

Name/model of meter used: ____________

Supply voltage (V): ____________

Supply frequency (Hz) ____________

THD (voltage) (%): ____________

Ambient temperature (°C): ____________

Relative humidity (%): ____________

Ambient light (Lux): ____________

5. Declaration

Name: __________________________

Position in company: __________________________

Signed: __________________________

Date: __________________________

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Annex A
(informative)

Overview of profile methodology

Profiles are an important concept in this document and the approach taken is to focus on a single (majority) profile for measuring **TEC** versus supporting multiple profiles. This annex outlines the reasons for this approach, and other approaches explored in the development of this document.

The computer is a general purpose device, and the **TEC** consumed by that device is very dependent on how it is used. While a computer can be described through categorisation, this only defines the attributes of the computer hardware and software. This computer (defined by a **category**) can then be used in many ways (defined by a profile) that will result in different **TEC** values (on the same computer).

For example, a computer "C1" is being purchased by users "U1" and "U2". U1 works in a large enterprise and primarily uses a suite of office applications over an office day (typically five days per week and allowing for holidays). He will get a **TEC** value of T1. U2 uses the same computer at home for Internet access and email with family members and gets a different **TEC** value of T2. The values of T1 and T2 are different, yet were generated by the same computer. Both **TEC** results are correct, but as this example demonstrates, the **TEC** value is influenced based on the usage profile.

Therefore when trying to get an accurate value of **TEC**, it is important to not only note the **category** of the computer, but to also describe the profile of how it is used.

Creating a standard which produces multiple **TEC** estimates for a single computer is confusing, and overly complicated. Therefore the approach taken by this document is to focus the **TEC** value on a single profile which represents a "typical" user and to base the profile attributes (T_{off}, T_{sleep}, T_{lidle}, T_{sidle}, T_{work}) around this single typical profile called the majority profile.

For this document, a typical profile is defined as a profile that represents how a majority of users use a computer. Consider the user base as a bell curve where the majority of users fall within the majority profile and the other minority profiles fall outside this range, as shown in Figure A.1.

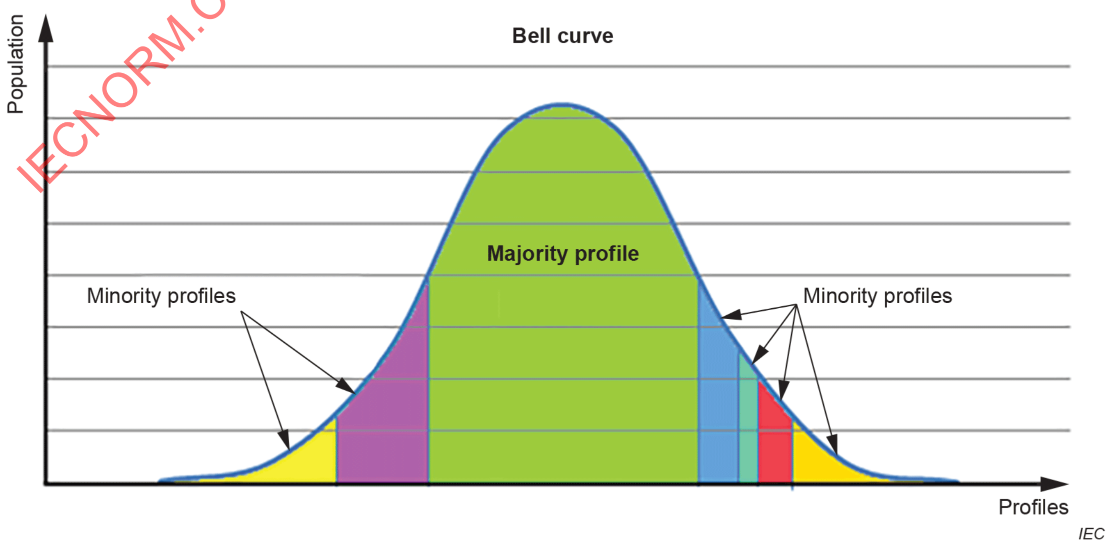

Figure A.1 – Example of a typical profile

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Statistical data for profiles is readily available to determine a majority profile (and the minority profiles). This document focuses on the majority profile and creates **duty cycle attributes** based on that profile to generate the **TEC** values. It is recognized that users of computers who do not match the majority profile will experience different TEC_{actual} values based on their usage of the computer, however the methodology makes a compromise to reduce the complexity and use of **TEC** such that a majority of users will experience accurate $TEC_{estimated}$ values based on their "majority usage".

A similar approach has been taken in other industries such as estimating kilometres per litre for automobiles. Here there are two profiles of usage (highway and city driving) that are used to describe the efficiency of cars globally. But this represents how a majority of users would use that automobile, and actual mileage will vary based on how that user actually drives. The majority of users will experience fuel mileage close to the estimates, but for a minority of users the mileage will vary.

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Annex B
(informative)

Majority profile

The first edition of IEC 62623 provided a majority profile based on a previous enterprise profile study conducted in 2010 by the ECMA-383 workgroup. In 2019 the US Environmental Protection Agency (EPA) reported at one of its ENERGY STAR stakeholder meetings the outcome of an extensive mode weightings study. The result was a change to the mode weightings in the version 8.0 Computers specification for Desktops and a proposed change for Notebooks for version 9.0.

The EPA had received over 700 000 individual desktop and integrated desktop data points across multiple manufacturers, product types, user profiles including enterprise and residential and across different geographical areas/regions. Similarly, for Notebooks the EPA had received 1,2 million individual data points with an equivalent variety and breadth as reported for Desktops.

The additional data enabled the EPA to separate long and short idle from sleep power mode and also allowing a further refinement of the non-active power mode values. The scale of breadth of the data set provided justification that these duty cycle attributes are representative of aggregate current behaviour of deployed desktops operating within enterprise and residential environments.

Duty cycle attributes of a profile are defined in 4.3.1. The use of the majority profile is recommended in 4.3.2. The recommended majority profile for use with this document is based on both enterprise and residential users and is documented in Table B.1.

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Table B.1 – Duty cycle attributes for the enterprise and residential majority profile duty cycle study

	Desktop computer	**Notebook computer**
$T_{\mathbf{off}}$	15 %	10 %
$T_{\mathbf{sleep}}$ *OR* $T_{\mathbf{sleepWoL}}$	45 %	60 %
$T_{\mathbf{lidle}}$	10 %	10 %
$T_{\mathbf{sidle}}$	30 %	20 %

This results in the following **TEC** equations for typical enterprise and residential majority profile:

Desktop $\text{TEC}_{\text{estimated}} = 8{,}76 \times (P_{\text{off}} \times 15\ \% + P_{\text{sleep}} \times 45\ \% + P_{\text{lidle}} \times 10\ \% + P_{\text{sidle}} \times 30\ \%)$;

Notebook $\text{TEC}_{\text{estimated}} = 8{,}76 \times (P_{\text{off}} \times 10\ \% + P_{\text{sleep}} \times 60\ \% + P_{\text{lidle}} \times 10\ \% + P_{\text{sidle}} \times 20\ \%)$.

Annex C
(informative)

Method for conducting a profile study

C.1 General

If the majority profile is not used with this document, the user should ensure that the profile used has been created through a profile study.

C.2 Profile study example

A majority of client users of computers consist of enterprise (for example, office) users, so a profile study is performed around "enterprise users" as the majority profile.

A statistically significant number of computers are instrumented to gather utilisation data based around how the computers are used. The **duty cycle attributes** $\boldsymbol{T}_{\mathbf{off}}$, $\boldsymbol{T}_{\mathbf{sleep}}$, and $\boldsymbol{T}_{\mathbf{on}}$ are recorded. This study is performed for a minimum of one year. The average value of $\boldsymbol{T}_{\mathbf{off}}$, $\boldsymbol{T}_{\mathbf{sleep}}$ and $\boldsymbol{T}_{\mathbf{on}}$ are then reported as part of the study along with the sample time and number of samples.

The second stage of the study requires computers to be instrumented and used by users that fit within the study profile to measure their on power and capture on utilisation ($\boldsymbol{T}_{\mathbf{lidle}}$, $\boldsymbol{T}_{\mathbf{sidle}}$ and $\boldsymbol{T}_{\mathbf{work}}$). While this sample of computers cannot be as large as the first sample (cost reasons), it should be a large enough sample to draw a number of conclusions with a mix of different computers from different client computer categories:

– the average $\boldsymbol{T}_{\mathbf{lidle}}$, $\boldsymbol{T}_{\mathbf{sidle}}$ and $\boldsymbol{T}_{\mathbf{work}}$ ratios for this given profile;

– the PAPR;

– the profile **TEC** error.

The profile study should provide a description and attributes of the computers used in the study including how the data was collected and calculated.

The example in Table C.1 illustrates some data from a profile study and shows eight computers with measured P_{lidle}, P_{sidle} and P_{on}. The product active power ratio is calculated for each computer ($P_{\mathrm{on}}/P_{\mathrm{sidle}}$) and then the PAPR is calculated by taking the average of all of the product active power ratios.

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Table C.1 – Profile study 1

Measurement	NB1	NB2	NB3	DT1	DT2	DT3	DT4	DT5
P_{off}	1	1	1	1,6	1,6	1,6	1,6	1,6
P_{sleep}	1,5	1,5	1,5	2,8	2,8	2,8	2,8	2,8
P_{lidle}	22,7	19,3	22	39,3	55	120,9	210,5	168,1
P_{sidle}	32,8	28,2	28,1	39,3	55	120,9	210,5	168,1
P_{on}	34	28,7	30,3	40	56,5	122,8	227,3	168,7
Product active power ratio	1,03	1,02	1,08	1,02	1,03	1,02	1,08	1
PAPR	1,04							
NB = Notebook computer DT = Desktop computer								

The product active power ratio was a good way of representing the computer's active power and shows how much higher it is than when the product is in a short idle state. Because this is a ratio, it allows various products with different absolute power values to be examined together (notice the ratios for desktops which are in the 100 W range can be combined with notebook ratios which are in the 20 W to 30 W range).

The PAPR is then used as an attribute to describe what the **active workload** should look like (if needed). In the case of this profile, the **active workload** is very close to the short idle power measurement.

Additionally the profile study needs to provide **duty cycle attributes** for the profile. This can be done in two parts, the first to determine the **duty cycle attributes** of off, sleep and on modes for the computer ($\boldsymbol{T}_{\mathbf{off}}$, $\boldsymbol{T}_{\mathbf{sleep}}$ and $\boldsymbol{T}_{\mathbf{on}}$), and the second to determine the components of the on mode **duty cycles** ($\boldsymbol{T}_{\mathbf{lidle}}$, $\boldsymbol{T}_{\mathbf{sidle}}$ and $\boldsymbol{T}_{\mathbf{work}}$), as listed in Table C.2.

Table C.2 – Profile study, duty cycles

Measurement	NB1	NB2	NB3	DT1	DT2	DT3	DT4	DT5
T_{lidle}	1,6 %	4,6 %	1,3 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %
T_{sidle}	15,9 %	19,9 %	11,2 %	37,2 %	21,3 %	26,7 %	6,3 %	36,5 %
T_{work}	12,6 %	5,5 %	17,5 %	2,8 %	18,7 %	13,3 %	33,7 %	3,5 %
	NB			DT				
Profile $\boldsymbol{T}_{lidle}$	2,5 %			0,0 %				
Profile $\boldsymbol{T}_{sidle}$	15,7 %			25,6 %				
Profile $\boldsymbol{T}_{work}$	11,9 %			14,4 %				
NB = Notebook computer DT = Desktop computer								

With this data, the TEC_{actual} and $TEC_{estimated}$ values can then be calculated. The TEC_{actual} is calculated by using the P_{on} for the average on power, while the $TEC_{estimated}$ is calculated using the measured P_{lidle}, P_{sidle}, $\boldsymbol{T}_{\mathbf{lidle}}$, $\boldsymbol{T}_{\mathbf{sidle}}$, $\boldsymbol{T}_{\mathbf{work}}$ and using P_{sidle} as an approximation of the P_{work} power. This is summarized in Table C.3.

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Table C.3 – Profile study, TEC_{actual} and $TEC_{estimated}$ calculations

Measurement	NB1	NB2	NB3	DT1	DT2	DT3	DT4	DT5
TEC_{actual}	96,0	82,1	86,3	149,1	206,9	439,2	805,4	600,1
$TEC_{estimated}$	90,7	78,8	79,2	146,6	201,7	432,6	746,5	598,0
Product **TEC** error	5,6 %	4,0 %	8,3 %	1,6 %	2,5 %	1,5 %	7,3 %	0,4 %
PAPR	3,9 %							
NB = Notebook computer DT = Desktop computer								

An example of TEC_{actual} and $TEC_{estimated}$ calculations are shown below for the NB1 data:

$$TEC_{actual} = 8{,}76 \times (\boldsymbol{T}_{\mathbf{off}} \times P_{off} + \boldsymbol{T}_{\mathbf{sleep}} \times P_{sleep} + (\boldsymbol{T}_{\mathbf{lidle}} + \boldsymbol{T}_{\mathbf{sidle}} + \boldsymbol{T}_{\mathbf{work}}) \times P_{on})$$

$$TEC_{actual} = 8{,}76 \times (60\ \% \times 1\ W + 10\ \% \times 1{,}5\ W + (2{,}5\ \% + 15{,}7\ \% + 11{,}9\ \%) \times 34\ W)$$

$$TEC_{actual} = 96{,}2\ KWh$$

The TEC_{actual} is calculated by using the measured P_{on} which is the average power of the computer measured over the time for which the computer was on (hence the weighting factor was the sum of all of the active weightings: $\boldsymbol{T}_{\mathbf{lidle}}$, $\boldsymbol{T}_{\mathbf{sidle}}$ and $\boldsymbol{T}_{\mathbf{work}}$).

$TEC_{estimated}$ uses the measured $\boldsymbol{T}_{\mathbf{lidle}}$ and $\boldsymbol{T}_{\mathbf{sidle}}$ with the appropriate weighting factors, but then substituting P_{sidle}, which is statically measured, with the P_{work} value:

$$TEC_{estimated} = 8{,}76 \times (\boldsymbol{T}_{\mathbf{off}} \times P_{off} + \boldsymbol{T}_{\mathbf{sleep}} \times P_{sleep} + \boldsymbol{T}_{\mathbf{lidle}} \times P_{lidle} + (\boldsymbol{T}_{\mathbf{sidle}} + \boldsymbol{T}_{\mathbf{work}}) \times P_{sidle})$$

$$TEC_{estimated} = 8{,}76 \times (60\ \% \times 1\ W + 10\ \% \times 1{,}5\ W + 2{,}5\ \% \times 22{,}7\ W + (15{,}7\ \% + 11{,}9\ \%) \times 32{,}8\ W)$$

$$TEC_{estimated} = 90{,}8\ KWh$$

To understand how the estimated value (which does not require the testing of an actual workload) impacts the product **TEC** error the following calculation is used:

$$[TEC_{actual} - TEC_{estimated}] / (TEC_{actual})$$

$$(96{,}2 - 90{,}8)/96{,}2 = 5{,}6\ \%\ error$$

NOTE 1 The mode weightings used in the above $TEC_{estimated}$ calculations were based on previous profile study and does not reflect the updated PC duty cycle (mode weightings) in the standard, based on most recent profile study (Table B.1)

These same calculations are done for all of the products, and then the product **TEC** error is averaged to give the profile **TEC** error of 3,9 %.

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In this case the profile study would recommend that for this profile the **TEC** does not require an **active workload** and all submitted **TEC** values for this profile can be estimated using the short idle **TEC** estimation.

For the case where the profile study showed a much higher profile **TEC** error, then the **active workload** would have to be created to allow the P_{work} attribute to be measured. The **active workload** would have to be created from code fragments represented by the profile usages, but would also guarantee that the PAPR is within 15 % of the PAWR, as shown in 5.6.4:

– PAPR = P_{on}/P_{sidle}

– PAWR = P_{work}/P_{sidle}

– 15 % > |(PAPR - PAWR)|/PAPR (absolute values).

or

– 15 % > $TEC_{actual} - TEC_{estimated} / TEC_{actual}$

where,

$TEC_{actual} = 8{,}76 \times (P_{off} \times T_{\mathbf{off}} + P_{sleep} \times T_{\mathbf{sleep}} + P_{lidle} \times T_{\mathbf{lidle}} + P_{sidle} \times T_{\mathbf{sidle}} + P_{work} \times T_{\mathbf{work}})$

$TEC_{estimated} = 8{,}76 \times (P_{off} \times T_{\mathbf{off}} + P_{sleep} \times T_{\mathbf{sleep}} + P_{lidle} \times T_{\mathbf{lidle}} + P_{sidle} \times (T_{\mathbf{sidle}} + T_{\mathbf{work}}))$

resulting in the following formula to qualify the Energy Study for the need of an **active workload**:

– 15 % > $(P_{work} \times T_{\mathbf{work}} - P_{sidle} \times T_{\mathbf{work}})/(P_{off} \times T_{\mathbf{off}} + P_{sleep} \times T_{\mathbf{sleep}} + P_{lidle} \times T_{\mathbf{lidle}} + P_{sidle} \times T_{\mathbf{sidle}} + P_{work} \times T_{\mathbf{work}})$

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Annex D
(informative)

Sample TEC calculations

D.1 General

This annex will go through two **TEC** calculation examples: notebook computers and desktop computers.

D.2 Notebook computer example

An example notebook computer has a configuration as follows:

- 6 core CPU;
- 14,1 in (35,8 cm) display;
- 32 Gbytes of memory;
- integrated graphics controller.

For this given notebook computer example the tests outlined in Clause 5 are performed and the results are summarized below:

P_{off} = 0,30 W

P_{sleep} = 1,68 W

P_{sidle} = 6,94 W

P_{lidle} = 1,68 W

The majority profile dictates the use of the **TEC** formulae:

$$\text{Notebook TEC}_{\text{estimated}} = 8{,}76 \times (P_{\text{off}} \times 10\% + P_{\text{sleep}} \times 60\% + P_{\text{sidle}} \times 20\% + P_{\text{lidle}} \times 10\%);$$

and filling in the measured values:

$$\text{Notebook TEC}_{\text{estimated}} = 8{,}76 \times (0{,}3 \times 10\% + 1{,}68 \times 60\% + 6{,}94 \times 20\% + 1{,}68 \times 10\%);$$

therefore,

$$\text{Notebook TEC}_{\text{estimated}} = 22{,}72 \text{ kWh/Year.}$$

This $\text{TEC}_{\text{estimated}}$ value may require the addition of one or more TEC adders associated with the category, resulting in a final TEC value.

In this case the user of the specification would determine if the **TEC** value passed or failed depending on the value of the calculated limit:

Pass: 22,72 kWh ≤ [**TEC** Limit + 2*x]

Fail: 22,72 kWh > [**TEC** Limit + 2*x]

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D.3 Desktop computer example

A desktop computer, for example a notebook computer, has a configuration as follows:

– 3 core CPU;
– 4 Gbytes of memory;
– integrated graphics controller.

The user then takes the desktop computer and performs the tests outlined in Clause 5 and summarizes the results below:

P_{off} = 0,38 W

P_{sleep} = 1,64 W

P_{sidle} = 21,26 W

P_{lidle} = 20,23 W

The majority profile dictates the use of the **TEC** formulae:

Desktop $TEC_{estimated}$ = 8,76 × (P_{off} × 15% + P_{sleep} × 45% + P_{sidle} × 30% + P_{lidle} × 10%);

and filling in the measured values:

Desktop $TEC_{estimated}$ = 8,76 × (0,38 × 15% + 1,64 ×45% + 21,26 × 30% + 20,23 × 10%);

therefore,

Desktop $TEC_{estimated}$ = 80,56 kWh/Year.

This $TEC_{estimated}$ value may require the addition of one or more TEC adders associated with the category, resulting in a final TEC value.

Pass: 80,56 kWh ≤ [**TEC** Limit + 2(x ± y)]
Fail: 80,56 kWh > [**TEC** Limit + 2(x ± y)].

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Annex E
(informative)

Power measurement methodology

E.1 General

This annex follows current procedures outlined in CENELEC standard EN 50564:2011. It includes power measurement methods for unstable, cyclic or limited duration modes. These methods are intended to improve the repeatability and reproducibility of measurement results, particularly for low power measurements.

Within this standard, power consumption should be determined by:

– sampling method: by the use of an instrument to record power measurements at regular intervals throughout the measurement period (see E.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 which should be used under this standard, or;

– 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 E.3 for details of when this method is valid), or;

– direct meter reading method: where the power value is stable and the mode is stable, by recording the instrument power reading (see E.4 for details of when this method is valid).

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

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E.2 Sampling method

This method should be used where the power is 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 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, should be recorded at equal intervals of not more than 1 s for the minimum period specified.

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

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 should be energized for an initial operation period of not less than 10 min. Data during this period is not to be used to assess the power consumption of the product.
– The product is then energized for a time sufficient to encompass two comparison periods, where each period should include not less than two cycles and have a duration of not less than 10 min (comparison periods 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 should be measured to adequately characterise the power consumption of the mode (a minimum of 10 cycles is recommended).

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.

E.3 Average reading method

This method should not be used for cyclic loads or limited duration modes.

NOTE A shorter measurement period is possible using the sampling method (see E.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:

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Select two comparison periods, each made up of not less than 10 min duration (periods should 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 30 min duration each, the sampling method in E.2 should be used.

There are two approaches:

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

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

If an instrument has a time resolution of approximately 1 s, then a minimum of 200 s (3,33 min) is required for integration on such an instrument.

If an instrument has an energy resolution of approximately 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 approximately 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).

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E.4 Direct meter reading method

The direct meter reading method should only be used where the mode does not change and the power reading displayed on the measuring instrument is stable. This method should not be used for verification purposes. Any result using the methods specified in E.2 or E.3 should take precedence over results using this method in the case of a dispute.

NOTE 1 A shorter measurement period is possible using the sampling method (see E.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 should not be used.

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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ORDINATEURS DE BUREAU ET ORDINATEURS PORTABLES – MESURAGE DE LA CONSOMMATION D'ÉNERGIE

AVANT-PROPOS

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Cette seconde édition annule et remplace la première édition parue en 2012. Cette édition constitue une révision technique.

La première édition de la présente norme a été établie sur la base de l'ECMA-383.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) des termes et définitions ont été ajoutés, et les descriptions relatives aux termes attente courte et attente longue ont été modifiées;
b) le montage d'essai a été modifié pour les ordinateurs portables dont le bloc de batteries ne peut pas être retiré pour les essais;

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c) la procédure de classification issue de l'ECMA-389 a été supprimée;

d) le profil majoritaire a été remplacé par une nouvelle étude des cycles de service; de nouveaux attributs de cycle de service ont été ajoutés pour les ordinateurs de bureau et les ordinateurs portables destinés à une application domestique et d'entreprise;

e) les références à la spécification et à la méthodologie d'essai ENERGY STAR V5 ont été supprimées.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
100/3583/CDV	100/3669/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

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– notes/explications: petits caractères romains;
– termes définis en 3.1: **caractères gras**.

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INTRODUCTION

Le présent document donne les définitions relatives aux modes d'économie d'énergie ainsi que des recommandations d'économie d'énergie générales pour les concepteurs d'ordinateurs de bureau et d'ordinateurs portables, en définissant une méthodologie de mesurage de la consommation d'énergie d'un produit et en fournissant des attributs de classification clés qui permettent de comparer la consommation d'énergie de produits analogues.

Le présent document a été établi sur la base de l'ECMA-383 et complète les recommandations fournies dans l'IEC 62075.

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ORDINATEURS DE BUREAU ET ORDINATEURS PORTABLES – MESURAGE DE LA CONSOMMATION D'ÉNERGIE

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1 Domaine d'application

Le présent document traite des produits informatiques personnels. Il s'applique aux ordinateurs de bureau et aux ordinateurs portables définis en 4.1, qui sont commercialisés en tant que produits finaux et appelés ci-après matériel à l'essai (EUT, *Equipment Under Test*) ou produit.

Le présent document spécifie:

– une procédure d'essai pour mesurer la consommation de puissance et/ou d'énergie dans chacun des modes d'alimentation de l'EUT;
– des formules pour calculer la **consommation d'énergie type** (**TEC**, *Typical Energy Consumption*) sur une période donnée (annuellement en général);
– le profil majoritaire à utiliser avec le présent document pour convertir la puissance moyenne en énergie dans les formules de **TEC**;
– un format prédéfini pour la présentation des résultats.

Le présent document n'établit aucun critère de réussite/d'échec pour les EUT. Ces critères sont définis par les utilisateurs des résultats d'essai.

2 Références normatives

Le présent document ne contient aucune référence normative.

3 Termes, définitions et abréviations

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1 Termes et définitions

3.1.1
charge de travail active
grandeur simulée d'une activité de production ou d'exploitation accomplie par l'EUT, représentée dans les attributs P_{work} (voir 4.2.12) et $\boldsymbol{T}_{\textbf{work}}$ (voir 3.1.11.6) de l'équation de la **TEC** (voir 5.6)

3.1.2
catégorie
classification au sein d'un type de produit, établie en fonction des caractéristiques du produit et des composants installés

3.1.3
cycle de service
divisions du temps qu'utilise l'EUT dans chacun de ses modes d'alimentation

Note 1 à l'article: Un cycle de service est exprimé sous forme d'un pourcentage ramené à 1.

3.1.4
utilisation d'énergie
énergie utilisée par un produit, qui est mesurée à partir du réseau d'alimentation électrique sur une période donnée

Note 1 à l'article: L'énergie est mesurée en kilowattheures.

3.1.5
alimentation externe
EPS
matériel contenu dans une enceinte physique distincte extérieure au boîtier de l'ordinateur, qui convertit la tension délivrée par le réseau d'alimentation électrique en tension(s) continue(s) inférieure(s) pour alimenter l'ordinateur

Note 1 à l'article: L'abréviation "EPS" est dérivée du terme anglais développé correspondant "external power supply".

Note 2 à l'article: L'**EPS** est parfois appelée bloc d'alimentation secteur.

Note 3 à l'article: La Bibliographie comporte une référence à un document (External Power Supply Efficiency Test Method) qui présente les procédures d'essai pour mesurer le rendement des **EPS**.

3.1.6
alimentation interne
IPS
composant contenu dans le boîtier de l'ordinateur et conçu pour convertir la tension alternative délivrée par le réseau d'alimentation électrique en tension(s) continue(s) plus basse(s) dans le but d'alimenter l'ordinateur

Note 1 à l'article: L'abréviation "IPS" est dérivée du terme anglais développé correspondant "internal power supply".

Note 2 à l'article: La Bibliographie comporte une référence à un document (Generalized Internal Power Supply Efficiency Test Protocol) qui présente les procédures d'essai pour mesurer le rendement des **IPS**.

3.1.7
réseau local
réseau local d'entreprise
LAN
réseau d'ordinateurs situé dans un domaine privé et géographiquement limité

[SOURCE: IEC 60050, 732-01-04]

Note 1 à l'article: L'abréviation "LAN" est dérivée du terme anglais développé correspondant "local area network".

Note 2 à l'article: A l'heure actuelle, les deux technologies couramment utilisées dans les ordinateurs sont l'IEEE 802.3 Ethernet ou le **LAN** câblé et l'IEEE 802.11 WiFi ou le **LAN** sans fil.

3.1.8
fabricant
organisme responsable de la conception, de l'élaboration et de la production d'un produit en vue de sa mise sur le marché, que ces opérations soient effectuées par cet organisme lui-même ou pour son compte

3.1.9
consommation d'énergie type
TEC
nombre qui représente la consommation d'énergie d'un ordinateur et qui permet de comparer la performance énergétique d'ordinateurs analogues. Ce nombre reflète l'énergie type consommée par un EUT pour un profil donné lorsqu'il est en fonctionnement normal sur une période représentative

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Note 1 à l'article: L'abréviation "TEC" est dérivée du terme anglais développé correspondant "typical energy consumption".

Note 2 à l'article: Pour les ordinateurs de bureau et les ordinateurs portables, le principal critère de l'approche de **TEC** est une valeur d'**utilisation d'énergie** annuelle type mesurée en kilowattheures (kWh), qui repose sur les niveaux moyens de puissance mesurés en mode fonctionnel et qui est mise à l'échelle selon un **cycle de service** type estimé qui représente une utilisation annualisée pour un profil donné.

3.1.10
consommation d'énergie réelle
TEC mesurée à l'aide de P_{work}

Note 1 à l'article: La **consommation d'énergie réelle** est notée $\mathbf{TEC}_{\text{actual}}$.

3.1.11
attributs de cycle de service
pourcentage de temps qu'utilise l'EUT dans chacun de ses modes d'alimentation

Note 1 à l'article: Des exemples d'**attributs de cycle de service** sont définis en 3.1.12.1 à 3.1.12.7.

3.1.11.1
composante arrêt du cycle de service
T_{off}
pourcentage de temps pendant lequel l'EUT est en mode arrêt

3.1.11.2
composante sommeil du cycle de service
T_{sleep} **et** T_{sleepWoL}
pourcentage de temps pendant lequel l'EUT est en modes sommeil

3.1.11.3
composantes marche du cycle de service
T_{on}
pourcentage de temps pendant lequel l'EUT est en mode marche

Note 1 à l'article: Le **cycle de service** T_{on} est égal à la somme $T_{\text{work}} + T_{\text{sidle}} + T_{\text{lidle}}$.

3.1.11.4
composante attente courte du cycle de service
T_{sidle}
pourcentage de temps pendant lequel l'EUT est en mode attente courte

3.1.11.5
composante attente longue du cycle de service
T_{lidle}
pourcentage de temps pendant lequel l'EUT est en mode attente longue

3.1.11.6
composante basse puissance alternative du cycle de service
T_{alpm}
pourcentage de temps pendant lequel l'EUT est en mode basse alimentation alternative

3.1.11.7
composante active du cycle de service
T_{work}
pourcentage de temps pendant lequel l'EUT est en mode actif (travail)

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3.1.12
utilisateur des résultats d'essai
entité qui utilise les résultats d'essai pour répondre à ses besoins

Note 1 à l'article: Les détenteurs d'accords volontaires, les organismes de régulation, les entreprises privées, etc. sont des exemples d'une telle.

3.1.13
wake on LAN
WoL
fonctionnalité qui permet à un ordinateur de se réveiller ou d'entrer dans un état actif lorsqu'il reçoit une demande de réveil du réseau par Ethernet

Note 1 à l'article: L'abréviation "WoL" est dérivée du terme anglais développé correspondant "wake on LAN".

3.1.14
processeur graphique
GPU
circuit intégré distinct de l'unité centrale de traitement (UCT), dont la fonction est d'accélérer le rendu d'un contenu 2D et/ou 3D à des fins d'affichage

Note 1 à l'article: Le processeur graphique peut être associé à une unité centrale de traitement (UCT), sur la carte système de l'ordinateur ou à un autre emplacement afin de décharger les capacités d'affichage de l'UCT.

Note 2 à l'article: L'abréviation "GPU" est dérivée du terme anglais développé correspondant "graphics processor unit".

3.1.15
carte graphique discrète
processeur graphique (GPU) qui doit contenir une interface de gestionnaire de mémoire locale et une mémoire spécifique à la carte graphique locale

3.1.16
carte graphique intégrée
solution graphique qui ne comporte pas de **carte graphique discrète**

3.1.17
carte graphique commutable
fonctionnalité qui permet de désactiver la **carte graphique discrète**, lorsque celle-ci n'est pas exigée, afin d'utiliser la **carte graphique intégrée**

Note 1 à l'article: Cette fonctionnalité permet aux GPU intégrés de puissance et capacité inférieures d'assurer l'affichage graphique lorsque le dispositif fonctionne sur batterie ou lorsque les graphiques de sortie ne sont pas trop complexes, tout en permettant aux GPU discrets dont la consommation d'énergie et les capacités sont supérieures d'assurer le rendu graphique lorsque l'utilisateur en a besoin.

3.1.18
bande passante de mémoire système
débit auquel les données peuvent être lues ou stockées dans la mémoire système d'un ordinateur

Note 1 à l'article: La bande passante de mémoire système est mesurée en gigabits par seconde (Gbits/s).

3.2 Abréviations

Pour les besoins du présent document, les abréviations suivantes s'appliquent.

ACPI (Advanced Configuration and Power Interface)	Interface de configuration et d'alimentation avancée

NOTE 1 La spécification ACPI est disponible à l'adresse: http://www.uefi.org/acpi/specs

ALPM (Alternative Low Power Mode)	Mode basse alimentation alternative

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CF (Crest Factor)	Facteur de crête
CFR (Crest Factor Ratio)	Rapport de facteur de crête
UCT	Unité centrale de traitement
DVI (Digital Visual Interface)	Interface visuelle numérique
EPS (External Power Supply)	Alimentation externe
EUT (Equipment Under Test)	Matériel à l'essai

NOTE 2 Egalement appelé produit dans la présente norme et parfois appelé unité à l'essai (UUT, *Unit Under Test*) dans d'autres spécifications.

FB_BW (Frame Buffer Bandwidth)	Bande passante du tampon de trames
GPU (Graphic Processing Unit)	Processeur graphique
HDD (Hard Disk Drive)	Disque dur
HDMI®[1] (High Definition Multimedia Interface)	Interface multimédia haute définition
IPS (Internal Power Supply)	Alimentation interne
LAN (Local Area Network)	Réseau local
LPM (Low Power Mode)	Mode basse alimentation
MCR (Maximum Current Ratio)	Rapport de courant maximal
OS (Operating System)	Système d'exploitation
PAPR (Profile Active Power Ratio)	Rapport de puissance active du profil
PAWR (Profile Active Workload Ratio)	Rapport de charge de travail active du profil
PCF (Product Crest Factor)	Facteur de crête du produit
PF (Power Factor)	Facteur de puissance
RAM (Random Access Memory)	Mémoire à accès direct ou mémoire vive
efficace	valeur efficace
TEC (Typical Energy Consumption)	Consommation d'énergie type
THD (Total Harmonic Distortion)	Taux de distorsion harmonique
ASI	Alimentation sans interruption
VGA (Video Graphics Array)	Carte vidéographique
WoL	Wake on LAN

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4 Spécifications relatives à l'EUT

4.1 Descriptions des ordinateurs

4.1.1 Ordinateur de bureau

Un ordinateur de bureau est un ordinateur dont l'unité centrale est destinée à être installée à un emplacement permanent, souvent sur un bureau ou sur le sol. Les ordinateurs de bureau ne sont pas conçus pour être portables; ils comportent un écran, un clavier et une souris externes. Les ordinateurs de bureau sont conçus pour une vaste gamme d'applications domestiques et de bureau.

[1] HDMI® et HDMI® (High-Definition Multimedia Interface) sont des marques déposées de HDMI Licensing Administrator, Inc. Cette information est donnée à l'intention des utilisateurs du présent document et ne signifie nullement que l'IEC approuve l'emploi du produit ainsi désigné. Des produits équivalents peuvent être utilisés s'il est démontré qu'ils aboutissent aux mêmes résultats.

4.1.2 Ordinateur portable

Un ordinateur portable est un ordinateur conçu de façon spécifique pour être portable et destiné à être utilisé pendant des périodes prolongées avec ou sans connexion directe à un réseau d'alimentation en courant alternatif. Les ordinateurs portables comportent un écran intégré et peuvent fonctionner sur une batterie intégrée. En outre, la plupart des ordinateurs portables utilisent une EPS – ou bloc d'alimentation secteur – et possèdent un clavier mécanique non amovible (équipé de touches) ainsi qu'un dispositif de pointage. Les ordinateurs portables sont généralement conçus pour fournir des fonctionnalités analogues à celles des ordinateurs de bureau, notamment l'exécution de logiciels qui proposent des fonctionnalités analogues à celles utilisées sur les ordinateurs de bureau. Pour les besoins du présent document, les stations d'accueil sont considérées comme étant des accessoires et il convient donc de considérer qu'elles ne font pas partie de l'EUT.

4.1.3 Ordinateur portable deux-en-un

Ordinateur qui ressemble à un ordinateur portable classique rabattable, mais qui possède un écran amovible qui peut être utilisé comme une ardoise/tablette indépendante lorsque celui-ci est détaché de l'ordinateur. Les parties clavier et écran du produit doivent être livrées sous forme d'une unité intégrée. Les ordinateurs portables deux-en-un sont considérés comme des ordinateurs portables dans le reste de la présente norme et ne sont donc pas désignés de manière explicite.

4.1.4 Ordinateur portable à plusieurs écrans

Ordinateur qui ressemble à un ordinateur portable classique rabattable, mais qui possède un écran secondaire avec fonction tactile et/ou stylet qui peut être utilisé comme un clavier tactile à la place d'un clavier mécanique classique. Ces produits sont considérés comme étant des ordinateurs portables dans le cadre de la présente norme.

4.1.5 Ardoise/tablette

Dispositif informatique conçu pour être portable et qui respecte l'ensemble des critères suivants:

a) il comporte un écran intégré dont la diagonale est comprise entre 6,5 pouces et 17,4 pouces;
b) il ne comporte pas de clavier physique intégré dans sa configuration d'usine;
c) il comporte un écran tactile dont il est tributaire (clavier en option);
d) il permet de se connecter à des réseaux sans fil (WiFi, 3G, etc.) dont il est tributaire; et
e) il comprend une batterie interne rechargeable qui constitue sa principale source d'alimentation (la connexion au réseau d'alimentation est destinée à la recharge de la batterie et non à l'alimentation électrique principale du dispositif).

4.1.6 Ordinateur portable tout-en-un

Dispositif informatique conçu pour procurer une portabilité limitée et qui respecte l'ensemble des critères suivants:

a) il comporte un écran intégré dont la diagonale est supérieure ou égale à 17,4 pouces;
b) aucun clavier n'est intégré à son boîtier dans sa configuration d'usine;
c) il comporte un écran tactile dont il est tributaire (clavier en option);
d) il permet de se connecter à des réseaux sans fil (WiFi, 3G, etc.); et
e) il possède une batterie interne, mais qui est principalement destinée à être connectée au réseau d'alimentation en courant alternatif.

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4.1.7 Ordinateur de bureau intégré

Un ordinateur de bureau intégré est un ordinateur de bureau dans lequel l'ordinateur et l'écran fonctionnent comme une seule unité et qui est raccordé au réseau d'alimentation en courant alternatif par un câble d'alimentation unique. Les ordinateurs de bureau intégrés peuvent se présenter sous deux formes:

– un produit dans lequel l'écran et l'ordinateur sont physiquement réunis dans une seule unité; ou
– un produit conditionné comme un seul produit dans lequel l'écran est séparé, mais qui est relié au châssis principal par un cordon d'alimentation en courant continu, où l'ordinateur et l'écran sont deux alimentés par une alimentation unique.

Les ordinateurs de bureau intégrés constituent un sous-ensemble des ordinateurs de bureau et sont généralement conçus pour fournir des fonctionnalités analogues à celles des ordinateurs de bureau.

NOTE 1 Un ordinateur de bureau intégré peut également être appelé ordinateur tout-en-un.

4.2 Modes d'alimentation

4.2.1 Mode arrêt

Le mode arrêt est le mode d'alimentation minimal qui ne peut pas être désactivé (influencé) par l'utilisateur et qui peut persister pendant une durée indéfinie lorsque l'EUT est connecté au réseau d'alimentation électrique et qu'il est utilisé conformément aux instructions du **fabricant**. Pour les produits qui relèvent des normes ACPI, le mode arrêt se réfère à l'état S5 au niveau système ACPI.

NOTE 1 Certains règlements internationaux font également référence à ce mode sous l'appellation mode de veille.

4.2.2 P_{off}

P_{off} représente la puissance moyenne mesurée en mode arrêt.

4.2.3 Mode sommeil

Le mode sommeil est le mode basse alimentation dans lequel l'EUT peut passer automatiquement après une période d'inactivité ou par une sélection manuelle. Un EUT avec fonction de sommeil peut se réveiller rapidement en réponse à des connexions réseau ou à des dispositifs d'interface utilisateur; le réveil correspond à l'intervalle de temps entre le déclenchement d'un événement de réveil et la restitution d'un écran lisible. Pour les produits qui relèvent des normes ACPI, le mode sommeil se réfère le plus couramment à l'état S3 au niveau système ACPI (suspension de la RAM). Lorsque l'EUT est soumis à l'essai et que la fonction **WoL** est désactivée à l'état de sommeil, ce mode est appelé mode sommeil. Lorsque l'EUT est soumis à l'essai et que la fonction **WoL** est activée à l'état de sommeil, ce mode est appelé mode sommeil **WoL**.

NOTE 1 Les modes sommeil basse alimentation autres que l'état ACPI S3 peuvent être pris en charge.

4.2.4 P_{sleep}

P_{sleep} représente la puissance moyenne mesurée en mode sommeil lorsque la fonction **WoL** est désactivée.

4.2.5 P_{sleepWoL}

P_{sleepWoL} représente la puissance moyenne mesurée en mode sommeil lorsque la fonction **WoL** est activée.

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4.2.6 Mode basse alimentation alternative

Mode basse alimentation dans lequel l'ordinateur passe automatiquement après une période d'inactivité ou par une sélection manuelle; ce mode est défini par la désactivation de l'écran et le passage de l'ordinateur dans un état de fonctionnalité réduite. Un ordinateur en mode basse alimentation alternative doit répondre immédiatement aux connexions réseau ou aux dispositifs d'interface utilisateur.

4.2.7 P_{alpm}

P_{alpm} représente la puissance moyenne mesurée en mode basse alimentation alternative.

4.2.8 Mode marche

Le mode marche représente le mode dans lequel se trouve l'EUT lorsqu'il n'est pas en mode sommeil ou en mode arrêt. Le mode marche comporte plusieurs sous-modes: le mode attente longue, le mode attente courte et le mode actif (travail).

4.2.9 P_{on}

P_{on} représente la puissance moyenne mesurée en mode marche.

4.2.10 Modes d'attente

4.2.10.1 Généralités

Les modes d'attente désignent les modes, où le système d'exploitation et les autres logiciels sont complètement chargés, un profil utilisateur est créé, le produit n'est pas en mode sommeil ou en mode basse alimentation alternative et où l'activité est limitée aux applications de base que le produit lance par défaut. Les modes d'attente sont définis selon deux types: le mode attente courte (voir 4.2.10.2) et le mode attente longue (voir 4.2.10.4).

4.2.10.2 Mode attente courte

En mode attente courte, l'écran de l'EUT est allumé et les fonctionnalités de gestion de l'alimentation du mode attente longue sont désactivées (par exemple, le disque dur tourne et l'EUT ne peut pas passer en mode sommeil ou en mode basse alimentation alternative). Cette condition doit être inférieure ou égale à 5 min après les événements suivants:

- aucune action de l'utilisateur n'est enregistrée; ou
- démarrage du système d'exploitation; ou
- après avoir accompli une charge de travail active; ou
- après la sortie du mode sommeil ou du mode basse alimentation alternative.

4.2.10.3 P_{sidle}

P_{sidle} représente la puissance moyenne mesurée en mode attente courte.

4.2.10.4 Mode attente longue

En mode attente longue, l'écran de l'EUT passe à l'état basse alimentation, où le contenu de l'écran ne peut pas être observé (le rétroéclairage est désactivé), mais où l'EUT reste en mode travail (état ACPI G0/S0). Si les fonctions de gestion de l'alimentation sont activées dans la configuration d'usine, celles-ci doivent être activées avant d'évaluer l'attente longue (par exemple, l'écran est à l'état basse alimentation, le disque dur peut avoir arrêté de tourner), mais l'EUT ne peut pas passer en mode sommeil ou en mode basse alimentation alternative.

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Cette condition doit être comprise entre 15 min et 20 min après les événements suivants:

- aucune action de l'utilisateur n'est enregistrée; ou
- démarrage du système d'exploitation; ou
- après avoir accompli une **charge de travail active**; ou
- après la sortie du mode sommeil ou du mode basse alimentation alternative.

4.2.10.5 $P_{\mathbf{lidle}}$

P_{lidle} représente la puissance moyenne mesurée en mode attente longue.

4.2.11 Mode actif (travail)

Le mode actif est le mode, où l'EUT accomplit un travail demandé par l'utilisateur en réponse à:

- une action antérieure ou simultanée de l'utilisateur; ou
- une instruction antérieure ou simultanée sur le réseau.

Ce mode inclut le traitement actif, la recherche de données sur un dispositif de stockage, dans une mémoire ou un cache, en attendant une nouvelle action ou une action simultanée de l'utilisateur; avant de passer dans l'un des modes basse alimentation.

4.2.12 $P_{\mathbf{work}}$

P_{work} représente la puissance moyenne mesurée en mode actif.

4.3 Attributs de profil

4.3.1 Profil

Un profil est une combinaison d'**attributs de cycle de service** et d'un cas d'utilisation donné (par exemple, utilisateurs dans un bureau, utilisateurs domestiques, joueurs).

NOTE 1 Pour plus d'informations sur les profils, se reporter à l'Annexe A, l'Annexe B et l'Annexe C.

4.3.2 Profil majoritaire

Le profil majoritaire est le profil d'utilisateurs d'ordinateurs de bureau et d'ordinateurs portables le plus courant.

Avec la présente norme, il convient d'utiliser le profil majoritaire décrit à l'Annexe B. Celle-ci fournit les **attributs de cycle de service** et l'erreur de **TEC** de profil utilisée pour déterminer l'équation de **TEC** à utiliser en 5.6.

4.3.3 Profil minoritaire

Les profils minoritaires représentent les profils d'utilisateurs d'ordinateurs de bureau et d'ordinateurs portables les moins courants, qui ne sont pas représentés dans le profil majoritaire. Par exemple, les joueurs intensifs constituent un profil très spécifique, mais représentent un très faible pourcentage des utilisateurs d'ordinateurs.

4.3.4 Etude de profil

Une étude de profil est une étude effectuée pour créer un nouveau profil selon la présente norme. En plus des données justificatives, l'étude doit permettre d'établir:

- l'ensemble des **attributs de cycle de service**;

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– le PAPR (voir 4.3.6);
– l'erreur de **TEC** de profil (voir 4.3.9);
– le PAWR (voir 4.3.7).

Toutes les données doivent être déterminées à partir d'un nombre d'échantillons statistiquement significatif et représentatif de la population d'utilisateurs dans son ensemble. L'Annexe C fournit des recommandations pour réaliser une étude de profil.

4.3.5 Rapport de puissance active du produit

Le rapport de puissance active du produit est le rapport P_{on}/P_{sidle}, ou la puissance moyenne divisée par la puissance d'attente courte pour un produit donné dans le cadre d'une étude de profil.

4.3.6 PAPR

Le PAPR est la moyenne de tous les rapports de puissance active du produit enregistrés dans une étude de profil.

4.3.7 PAWR

Le PAWR est le rapport moyen P_{work}/P_{sidle} mesuré sur les produits de l'étude de profil; il permet de déterminer si la **charge de travail active** reflète correctement les résultats de l'étude de profil (au niveau du PAWR).

4.3.8 Erreur de TEC de produit

L'erreur de **TEC** de produit est le calcul du pourcentage d'erreur utilisé dans une étude de profil pour évaluer la quantité d'erreurs existante pour un produit donné lorsque la **TEC** est mesurée en fonction de la **TEC** estimée en remplaçant la puissance P_{work} mesurée par la puissance statique mesurée en mode "attente courte".

4.3.9 Erreur de TEC de profil

L'erreur de **TEC** de profil est la moyenne de l'erreur de **TEC** de produit dans une étude de profil.

4.4 Attributs de classification

4.4.1 Généralités

Les paragraphes suivants présentent quelques exemples d'attributs de classification.

4.4.2 Cœurs

L'attribut cœurs est le nombre de cœurs UCT physiques présents dans l'EUT.

4.4.3 Score d'extensibilité (ES)

Le score d'extensibilité (ES) est le résultat d'un calcul qui vise à estimer la capacité d'alimentation d'un ordinateur en fonction de sa consommation d'énergie, si chaque interface présente dans le système a été exploitée à la tension et au courant maximaux prévus.

4.4.4 Score de performance

Le score de performance est l'un des attributs de classification et est une mesure de:

(nombre de cœurs UCT x fréquence d'horloge UCT (GHz), où le nombre de cœurs et la fréquence d'horloge représentent respectivement le nombre de cœurs UCT physiques et la

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fréquence de cœur maximale de l'enveloppe thermique (TDP, *Thermal Design Power*) (et non la fréquence turbo).

4.4.5 Fonction graphique

La fonction graphique est classée en fonction de la bande passante du tampon de trames.

4.4.6 Additionneurs de TEC

Un additionneur de **TEC** est une marge de puissance exprimée en kilowattheures par année qui, lorsqu'elle est ajoutée ou configurée dans l'EUT, augmente sa **TEC** d'une certaine valeur. Des exemples peuvent inclure:

– une carte graphique discrète, la mémoire y compris la bande passante de mémoire système, les dispositifs réseau, les dispositifs d'E/S, la capacité d'alimentation, etc.;
– lorsque l'ordinateur est équipé d'un ou de plusieurs écrans intégrés, chaque écran doit être considéré comme un additionneur.

5 Procédure et conditions d'essai, classification, formules de TEC, spécifications des appareils de mesurage et compte-rendu des résultats

5.1 Généralités

La procédure suivante doit être utilisée pour mesurer la consommation de puissance ou d'énergie de l'EUT.

L'utilisateur de la présente norme doit mesurer un échantillon de l'EUT. Les dimensions de l'échantillon doivent être appropriées pour démontrer la conformité aux exigences établies par l'**utilisateur des résultats d'essai**.

5.2 Montage d'essai

L'EUT et les conditions d'essai doivent être définis comme ci-dessous.

Il convient de désactiver la commande de réglage automatique de la luminance d'affichage pour les essais. Si la commande de réglage automatique de la luminance d'affichage ne peut pas être désactivée pour les essais, positionner une source lumineuse de telle sorte qu'un éclairement d'au moins 300 lux pénètre directement dans le capteur de commande de réglage automatique de la luminance d'affichage.

a) L'EUT doit être configuré conformément aux instructions fournies avec le produit (sauf indication contraire dans cette procédure d'essai) avec l'ensemble des accessoires matériels et des logiciels livrés par défaut. L'EUT doit également être configuré en appliquant les exigences suivantes pour l'ensemble des essais:
   1) Les ordinateurs de bureau et les ordinateurs de bureau intégrés livrés sans dispositif d'entrée doivent être configurés avec un dispositif d'entrée recommandé par le **fabricant** (par exemple, souris et/ou clavier). Aucun autre périphérique externe ne doit être connecté.
   2) Les ordinateurs de bureau doivent être configurés avec un écran externe (la consommation d'énergie de l'écran externe n'est pas incluse dans le calcul de **TEC**).
   3) Préparation des écrans externes pour les ordinateurs de bureau:
      i) Afficher la priorité des connexions:
         a) Si l'EUT possède un port qui prend en charge les cartes graphiques commutables capables d'effectuer une commutation automatique, utiliser ce port.
         b) Si un GPU discret est installé, connecter celui-ci sauf si l'exigence a) de cette liste est remplie.

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