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Edition 1.0 2020-07

INTERNATIONAL STANDARD

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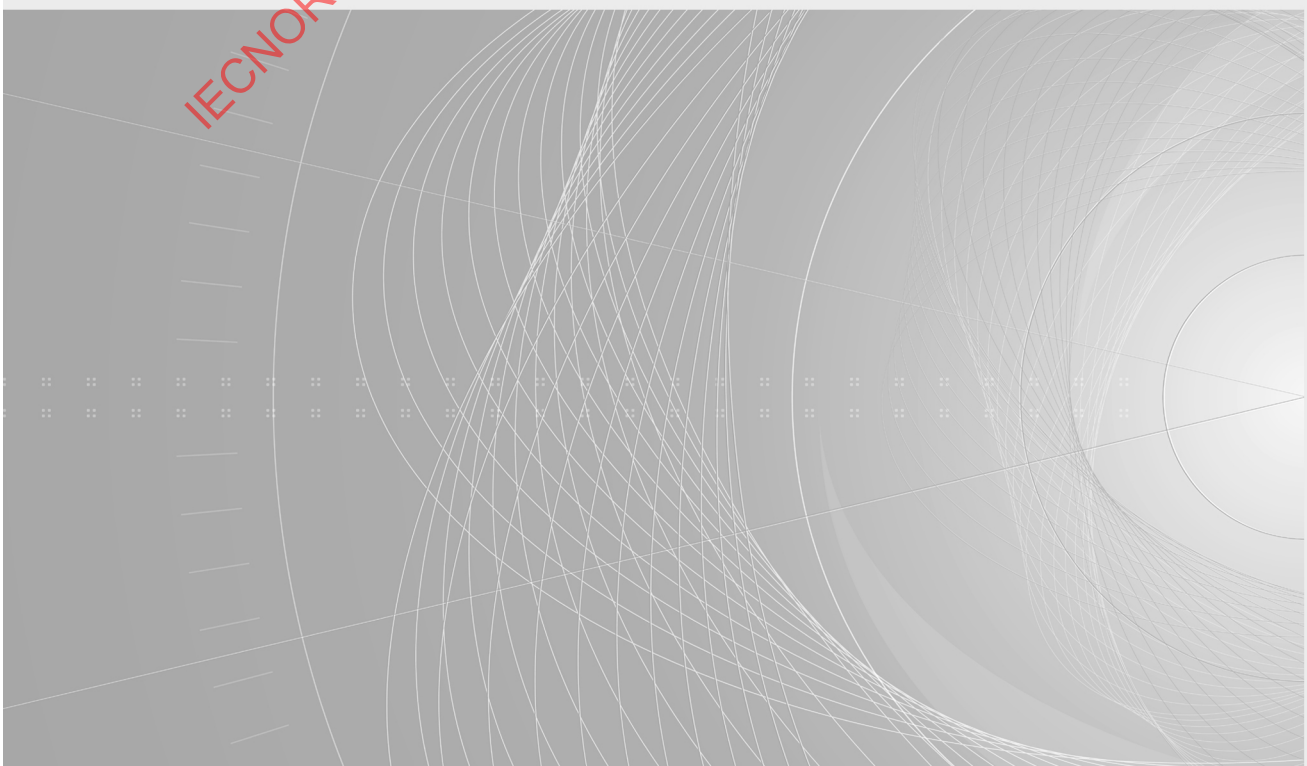
Lighting equipment – Non-active mode power measurement



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CONTENTS

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LIGHTING EQUIPMENT – NON-ACTIVE MODE POWER MEASUREMENT

FOREWORD

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International Standard IEC 63103 has been prepared by IEC technical committee 34: Lamps and related equipment.

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

FDIS	Report on voting
34/698/FDIS	34/709/RVD

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

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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- withdrawn,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

The first edition of this document specifies uniform requirements for measuring non-active mode power consumption for all lighting equipment. Present performance standards for controlgear (IEC 62442 (all parts)) and luminaires (IEC 62722-1), already include some descriptions for measuring standby power. It is expected that these standards will be amended, accordingly.

In addition to an illumination function, today's lighting equipment can execute a variety of additional non-illumination functions, for example through integrated surveillance cameras, noise detectors, occupancy counters, vehicular and pedestrian traffic detection, weather detection, smoke detection, visible light communication and proximity or location devices. During the execution of these functions, the (multi-function) lighting equipment can operate in many different (active and non-active) modes. Non-active mode power consumption of (multi-function) lighting equipment, i.e. the power consumed when the illumination function is off, is an important aspect of lighting equipment and is becoming more important with the emergence of connected lighting.

This document defines and describes methods of measurement of electrical power consumption in non-active mode(s) for lighting equipment. The document is organized into two main clauses: Clause 4 "General test conditions" and Clause 5 "Measurements".

Clause 4 contains specifications on the general conditions for making the measurements. Subclauses 4.1 through 4.4 cover conditions for setting up the laboratory, selecting a supply voltage and suitable instruments for the power measurement. Subclause 4.5 covers aspects which should be considered when the lighting equipment is connected to a network to work properly. Subclause 4.5.2 is for wired networks and 4.5.3 and 4.5.4 give setups for wireless networks using conducted or radiated connections, respectively. These setups for wireless networks are harmonized with ETSI Standard EN 300 328 and modified for lighting equipment.

Clause 5 details the procedures for making measurements of the equipment under test (EUT). Subclause 5.1 gives general instructions for setting the EUT into the possible non-active mode(s). Subclause 5.2 details the large variety of EUTs. These EUTs can be placed into two categories: illumination-only (5.2.2) and multi-function (5.2.3) lighting equipment. Traditional lighting equipment with an illumination-only function is summarized in 5.2.2, Table 1. Multi-function lighting equipment having additional non-illumination functions is addressed in 5.2.3. A standardized form for reporting the measured result according to the functions and modes of the multi-function lighting equipment under test is specified in 5.2.3, Table 2. Table 2 is a central feature of this document that will enable all users to report their non-active power results in a consistent manner.

Subclause 5.3 specifies procedures for preparing the EUT to make measurements of the input power. Instructions for EUTs containing battery charging functions are found in 5.3.2. Subclause 5.3.3 gives procedures for EUTs having no network provision and 5.3.4 covers networked EUTs whether wired or wireless.

The measurement procedure is specified in 5.4 and offers three alternative methods and the specific stability conditions required for each. These methods are adapted for lighting equipment from IEC 62301:2011. The direct meter method specified in 5.4.2 has the most limited applicability. It can only be used when the power reading is stable. In cases of discrepancy, the average reading method (5.4.3) or sampling method (5.4.4) have precedence. The average reading method is suitable only for EUTs having stable modes whereas the sampling method is suited for cyclic or unstable modes and if the mode is of limited duration.

Informative annexes are included to illustrate various measurement setups (Annex B and Annex C) and Annex D provides practical examples of controlgear, for example involving lighting equipment having a digital addressable lighting interface network in accordance with IEC 62386 (all parts), and of luminaires.

The methods defined and described in this document are not intended to be used to measure power consumption of (multi-function) lighting equipment during active mode(s) (also called "on mode(s)"), as these are generally covered by IEC standards or other product standards.

This document provides methods of measurement for lighting equipment. However, the methods specified in this document could also be used to measure lighting system models. A system model is a full-size portion of the lighting system containing specific functions and can set every mode of a portion of the system. The system models should be scalable to the entire lighting system additively. Thus, the total non-active mode power consumption of the system should equal the summation of power measured in each system model.

Using an adaptive roadway and pedestrian lighting system as an example for illustration, the following three system models could be present:

– (A) five luminaires connected to one daylight sensor; illuminate to compensate daylight;
– (B) a luminaire with a pedestrian sensor, a daylight sensor, connected to a crosswalk illumination; illuminate the crosswalk upon sensing a pedestrian when needed;
– (C) a dimmable luminaire with a vehicle detector; illuminate upon sensing a vehicle when needed.

Assume the lighting system comprises 50 A-, 10 B-, and 20 C-system models, then the total power consumption for a specified mode of the system would be Power(mode) = 50 × power(A) + 10 × power(B) + 20 × power(C). Table 2 (5.2.3) could be used to specify the measurement of a system model set in various combinations of modes. In this way, the system is evaluated in measurable pieces (system models) set to function interactively as the entire system is intended for each mode.

LIGHTING EQUIPMENT – NON-ACTIVE MODE POWER MEASUREMENT

1 Scope

This document specifies methods of measurement of electrical power consumption in non-active mode(s), as applicable for electrical lighting equipment. This includes electrical lighting equipment incorporating non-illumination components.

This document specifies neither performance requirements nor limits on power consumption.

This document applies to lighting equipment connected to a supply voltage up to 1 500 V DC or up to 1 000 V AC.

This document is intended to be referenced by lighting equipment product standards for the measurement of non-active mode power consumption. Details for the non-active mode power consumption measurement and data presentation are specified in the product standards.

NOTE Annex A provides guidance on details specified in product standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-845, *International Electrotechnical Vocabulary – Part 845: Lighting (available at http://www.electropedia.org)*

IEC 62504, *General lighting – Light emitting diode (LED) products and related equipment – Terms and definitions*

IEC TS 63105, *Lighting systems and related equipment – Vocabulary*[1]

ETSI EN 300 328 V2.1.1 (2016-11), *Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 60050-845, IEC 62504 and IEC TS 63105 and the following 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

[1] Under preparation. Stage at the time of publication IEC CDTS 63105:2020.

3.1
lighting equipment
assembly of components used for the primary function of providing illumination, or any component thereof

EXAMPLE Integrated lamp, non-integrated lamp plus controlgear, luminaire, controlgear, luminaire with camera.

Note 1 to entry: Lighting equipment can also include non-illumination components that offer non-illumination functions.

Note 2 to entry: Within the primary function of illumination, applications like horticultural, UV disinfection, etc. are included.

3.2
component
constituent part which cannot be physically divided into smaller parts without losing its function

EXAMPLE Light source, power supply, control unit.

[SOURCE: IEC 60050-151:2001, 151-11-21, modified – "of a device" and "particular" deleted.]

3.3
supply voltage
SV
<of lighting equipment> voltage applied by electric connection to provide electric energy

EXAMPLE 110 V AC, 230 V AC, 24 V DC, power over Ethernet.

[SOURCE: IEC 61347-1:2015, 3.5, modified – Definition adapted for lighting and examples added.]

3.4
network
communication infrastructure with a topology of links, an architecture, including the physical components, organizational principles, communication procedures and formats (protocols)

3.5
function
<of equipment> predetermined operating characteristic

EXAMPLE Illuminating, battery charging, wireless routing, auxiliary power output.

Note 1 to entry: Functions can be either on, off, in standby or networked standby.

Note 2 to entry: Typically, instructions for use specify which functions can be turned off and how.

3.6
mode
<of lighting equipment> distinct configuration of the status of functions

3.7
active mode
<of lighting equipment> mode with the illumination function on

3.8
non-active mode
<of lighting equipment> mode with the illumination function off

EXAMPLE Standby mode, networked standby mode, off mode, no-load mode.

3.9
off mode
<of lighting equipment> mode with all functions off

Note 1 to entry: An indicator that only shows the user that the lighting equipment is in the off state is included within the classification of off mode.

3.10
standby mode
<of lighting equipment> mode when the equipment is connected to a supply voltage with the illumination function off, while capable of being activated by an external trigger not being a trigger from a network

Note 1 to entry: Examples of external triggers are sensing or timing.

3.11
networked standby mode
<of lighting equipment> mode when the equipment is connected to a supply voltage with the illumination function off, while capable of being activated by an external trigger being a trigger from a network

3.12
no-load mode
<of lighting equipment> mode when the equipment is connected to a supply voltage where the illumination function is switched off or disconnected at the output circuit of the controlgear

3.13
charging maintenance mode
mode to maintain the battery in a fully charged condition

Note 1 to entry: Power consumption of emergency lighting equipment is called emergency lighting charging power.

3.14
instructions for use
information that is provided by the manufacturer or responsible vendor for users of the equipment

Note 1 to entry: Instructions for use would include a user manual and may be in paper or electronic form. Instructions for use do not include any special directions provided by the equipment supplier to the test laboratory especially for testing purposes.

[SOURCE: IEC 62301:2011, 3.12, modified – "by the manufacturer or responsible vendor" added and "product" replaced with "equipment".]

3.15
equipment under test
EUT
equipment as specified in the scope of this document subjected to non-active mode power consumption assessment

EXAMPLE Illumination-only lighting equipment or multi-function lighting equipment.

3.16
power boundary
perimeter surrounding the equipment under test through which all forms of energy flow and at which the sum of power is measured

3.17
packet error rate
PER
ratio of the number of packets incorrectly received to the total number of packets sent expressed as a percentage

4 General test conditions

4.1 General

Unless otherwise specified in relevant product standards or instructions for use, measurements on the equipment under test (EUT) shall be made under the test conditions and with measuring instruments specified in 4.2 to 4.5.

4.2 Laboratory and environmental conditions

The test shall be carried out at a room temperature of (25 ± 5) °C.

4.3 Supply voltage

4.3.1 Supply voltage and frequency

Tests shall be carried out at the rated voltage and at the rated frequency.

In the case where a rated voltage range is specified, tests shall be carried out at the minimum and maximum value of that specified voltage range.

In case of alternative rated voltages, tests shall be performed separately for each rated voltage.

In case of alternative rated AC frequencies or a rated frequency range, tests shall be performed at the minimum and maximum frequency.

The supply voltage and the frequency shall be maintained constant within ±1 % during the test.

4.3.2 Supply voltage waveform

In case of AC supply voltage, the total harmonic distortion (THD), up to and including the 13th harmonic, of the supply voltage when supplying the EUT in the specified mode, shall not exceed 3 %. THD is the ratio of the RMS value of the sum of the harmonic components (in this context, harmonic current components I_h of orders 2 to at least 13) to the RMS value of the fundamental component, expressed as a percentage. The power supply shall not produce inter-harmonics when operating in the power range of interest. In addition to the above, the ratio of peak value to RMS value of the AC test voltage (i.e. crest factor) when supplying the EUT shall be between 1,34 and 1,49.

In case of DC supply voltage, the ripple factor of the supply voltage shall be lower than 0,5 %.

4.4 Power measurement accuracy and uncertainty

For measurement accuracy, uncertainty and traceability see ISO/IEC Guide 98-3 and IEC Guide 115.

4.5 Network aspects

4.5.1 General

When the external trigger to change between active mode and non-active mode originates from a network connection, care shall be taken to ensure that the network in question is properly configured and connected to the EUT, to obtain an accurate measure of power consumption. Where the use of additional products/components is needed for the measurement of the EUT care shall be taken in the selection and characterization of these items such that they are fully representative to the degree that the measurement accuracy for the EUT is not adversely affected. The instructions for use shall contain information about which functions can be turned off for the measurement and how to turn them off.

Care shall be taken as several power levels can be possible (e.g. power can be affected by network connection quality, connection speed or the number and type of network connections). The power consumption can also cycle in these modes.

For non-active mode power consumption measurements, the network functionality shall be limited to setting the (non-active) mode of the EUT, such that no additional power consumption is induced to the EUT beyond the need to set and maintain the non-active mode.

To test an EUT connected to a wired network, guidance is given in 4.5.2.

For a wireless network, there can be a difference in power consumption between the wireless device looking for a connection (listening) and where the network connection is established. It is important to consider that in a network, the energy consumption of the EUT can be affected by its design, the environment and user interaction as well as network interaction.

When an EUT has the capability to connect to multiple wireless networks, non-active mode power shall be determined for all networks independently.

An EUT connected to a wireless network can be configured either with an antenna connector or an integrated antenna. In the case where the EUT has antenna connectors, the EUT can be tested either by using a cabled connection (see 4.5.3) or by using the integrated antenna (for direct radiating measurements, see 4.5.4).

NOTE In the case of a network receiver that is only waiting for trigger signal and where the power does not change due to the quality of the network, there is no need to establish networks in accordance with 4.5.3 and 4.5.4.

4.5.2 Wired networks

Wired networks can induce power consumption by the EUT which is not linked to the intended function to change modes of the lighting equipment. During measurements in non-active mode, the EUT and a suitable controller shall be the only devices being connected to the bus. Communication in such wired network shall be limited to what is needed to switch the EUT from non-active mode to active mode within the time specified. During measurements, the high voltage level of the communication bus (representing one logic state) shall be set to the rated value with a tolerance of ±2 %. If a rated voltage range is specified, the middle value of the range shall be set with a tolerance of ±2 %. The low voltage level of the bus shall be negligibly low.

4.5.3 Wireless networks: conducted connection for testing

For an EUT whose ports are equipped with antenna connectors, testing shall be performed using conducted measurements in accordance with the test setup shown in Figure 1 or in accordance with 4.5.4.

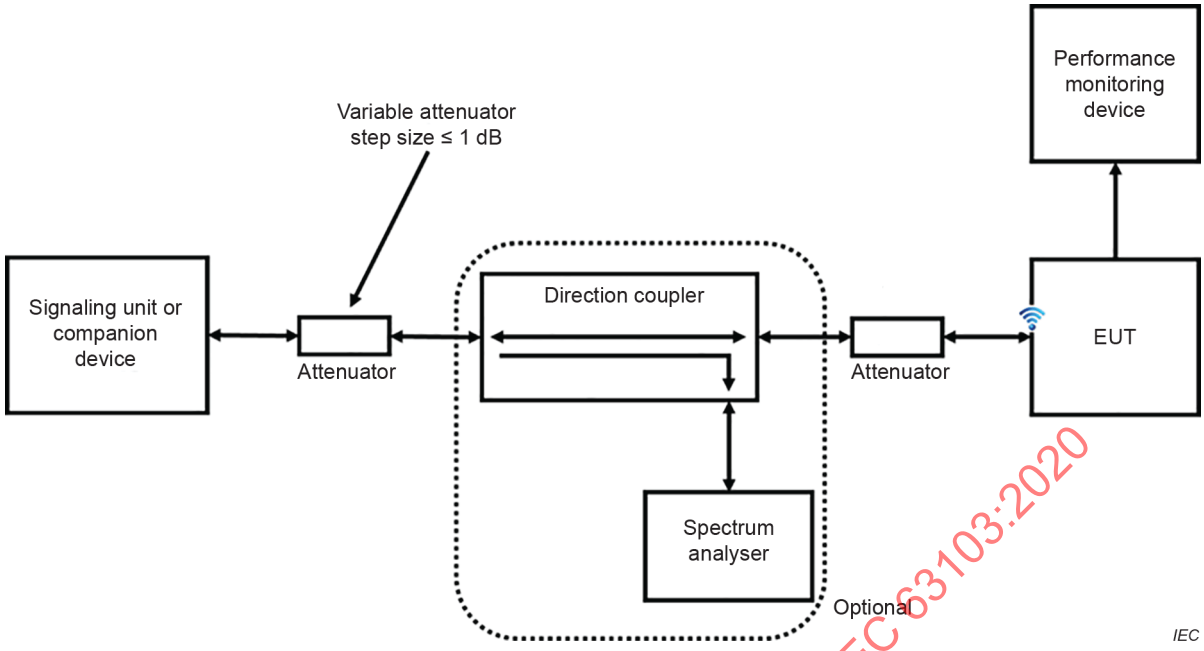


Figure 1 – Test setup for non-active mode power consumption measurement of conducted connected EUT

When this test method is selected, the following steps shall be employed to prepare the EUT for measurement:

– For a frequency hopping EUT, operating channel variation is accepted as is.

– For a non-frequency hopping EUT, the EUT shall be set to an operating channel that will be employed when the EUT is used for its intended application. The operating channel frequency shall be recorded.

– A communication link is established between the EUT and the associated companion device using the test setup shown in Figure 1. The attenuation of the variable attenuator shall be increased in 1 dB steps to the maximum value at which the packet error rate (PER) remains less than or equal to 10 %. The manufacturer may specify an alternative PER if appropriate for the intended use of the EUT. The resultant signal level at the input of the EUT is then P_{min} and shall be recorded.

– Set the wireless network command refreshment rate at 1 kHz, or at a relevant rate provided by the manufacturer.

4.5.4 Wireless networks: radiated connection for testing

For an EUT with integral antennas, i.e. without antenna connectors, testing shall be performed using radiated measurements in accordance with the test setup shown in Figure 2.

When this test method is selected, the following steps shall be employed to prepare the EUT for measurement:

– A test site as described in Annex B of ETSI standard EN 300 328 V2.1.1 (2016-11) and applicable measurement procedures as described in Annex C, Clauses C.1 to C.4 inclusive of the same standard shall be used.

– The test setup shall take the form shown in Figure 2.

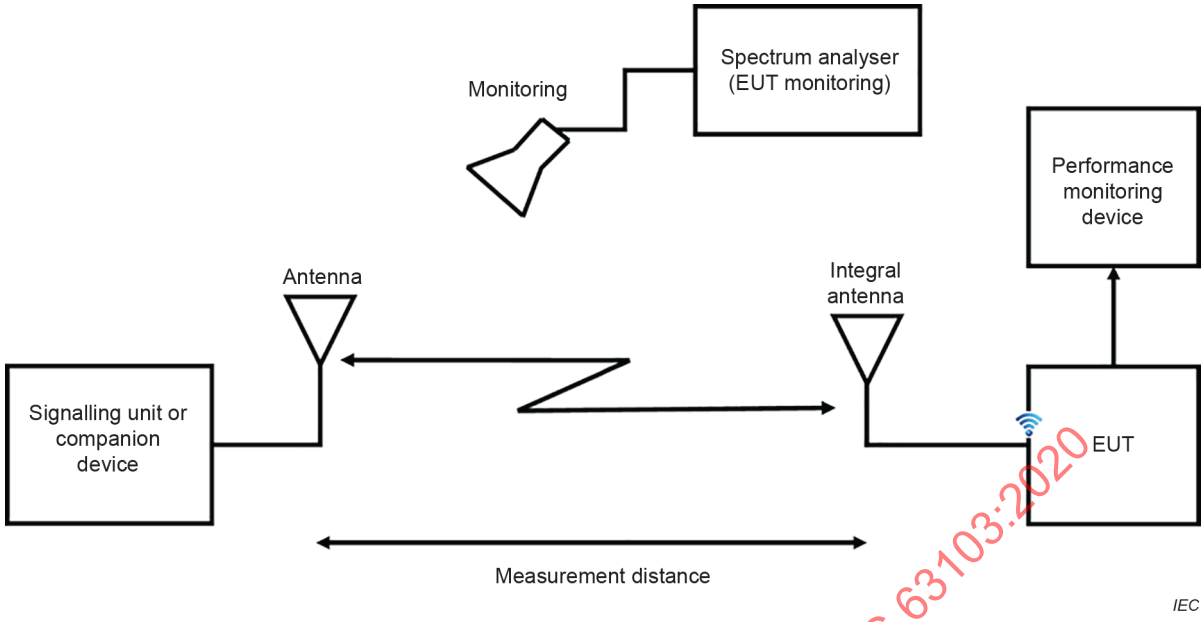


Figure 2 – Test setup for non-active mode power consumption measurement of connected EUT with integral antennas (RF path symbolically shown)

– The transmitted power level from the associated companion device and its physical separation from the EUT shall be adjusted until the packet error rate (PER) approaches but remains less than or equal to 10 %. The manufacturer may specify an alternative PER if appropriate for the intended use of the EUT.

– The resultant signal level at the input of the EUT is measured by a spectrum analyser using a substitution antenna as shown in Figure 3. The measurement distance between antennas and power setting of the signaling unit or companion device are kept fixed. The absolute signal level, P_{min}, at the EUT shall be recorded as a calibration.

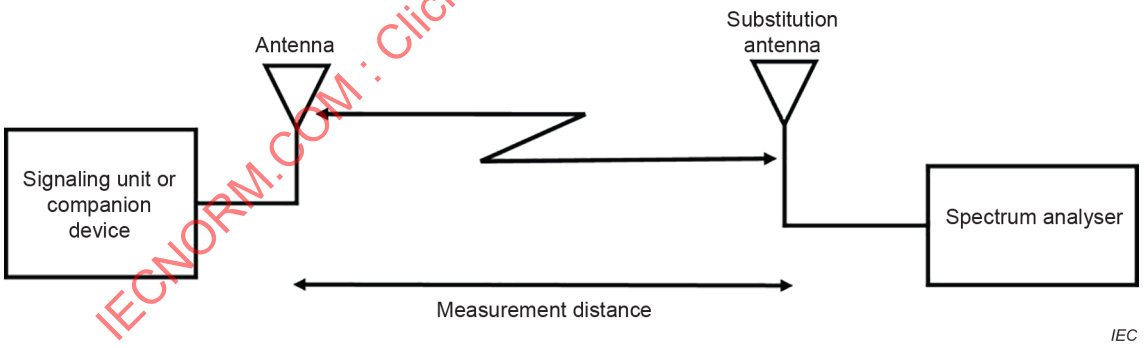


Figure 3 – Calibration setup for non-active mode power measurement of connected EUT with integral antennas

– Following calibration, the substitution antenna and the spectrum analyser shall be replaced with the EUT.

– Set the wireless network command refreshment rate at 1 kHz, or at a relevant rate provided by the manufacturer.

5 Measurements

5.1 General

The purpose of the measurements is to determine the power consumption in persistent non-active mode(s) of lighting equipment. A non-active mode is persistent when power consumption is constant or when there are several power levels that occur in a regular sequence.

NOTE 1 During transition from the active mode to the non-active mode some EUTs could be waiting in a higher power state while transition tasks are performed, or circuits are energized or de-energized, so they can take some time to enter a stable state.

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

NOTE 3 While limited duration modes can be documented using measurements in accordance with this document, the results for such modes can be reported as an energy consumption (Wh) and related time intervals.

A variety of non-active modes can be considered for assessing, for example:

– standby mode;
– networked standby mode;
– off mode;
– no-load mode.

The EUTs assessed are described in 5.2. To assess a specific mode, an EUT shall be prepared as described in 5.3. Guidance for EUTs with battery charging provisions is also given in 5.3.2. After preparation, power consumption of the EUT in the specified non-active mode is determined via the procedure described in 5.4.

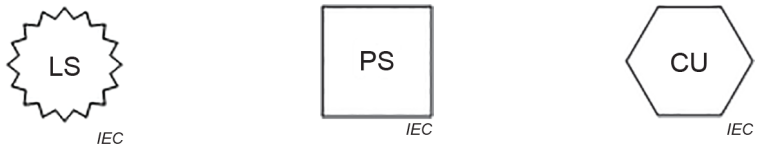
5.2 Equipment under test (EUT)

5.2.1 General

The EUT to be assessed on non-active mode power consumption can be lighting equipment for illumination-only (for example lamps, luminaires and controlgear) and multi-function lighting equipment (which include additional non-illumination function(s)). Details on illumination-only lighting equipment is given in 5.2.2 and on multi-function lighting equipment in 5.2.3.

5.2.2 Illumination-only lighting equipment

Illumination-only lighting equipment can consist of one or more components, which function as light source (LS), power supply (PS) and control unit (CU). In Figure 4 these three components are shown with their symbols used throughout this document.



a) Light source **b) Power supply** **c) Control unit**

Figure 4 – Components present within illumination-only EUT

The light source (see Figure 4 a)) is the component responsible for generating light from the energy delivered by the power supply.

NOTE For the purposes of this document, the light source is used to indicate a luminous element as defined in IEC 60050-845:2020, 845-28-001.

The power supply (see Figure 4 b)) is the component converting, in a controlled way, power from a supply voltage into power entering the light source for light generation.

The control unit (see Figure 4 c)) is the component acting as the interface between (external) communication options and the EUT. The control unit is instrumental in changing the EUT mode from active to non-active mode and vice versa, except when physical disconnections are made to control the light output. The control unit instructs the power supply to drive the light source in the requested mode (active, non-active).

Triggering the control unit to change between modes can originate from a sensor, timer or external trigger. The external trigger to change between the active mode and a non-active mode can originate from a network connection or from another source. In the case where the external trigger originates from a network, the mode is termed "networked standby mode". In other cases, the non-active EUT mode is termed "standby mode".

The power supply does not have a control unit, but its settings can be controlled via a control unit. Therefore, the power supply does not have a direct connection to an external network.

Illumination-only lighting equipment under test can be fully functional products including a light source, a power supply and a control unit (like a lamp or luminaire) or only some of these elements, like a controlgear which is composed of a power supply and a control unit.

In Table 1 combinations of the components light source, power supply and control unit are given, representing illumination-only lighting equipment. The table provides EUT configurations with examples and references to the associated measurement setup schemes for non-active mode power measurements in Annex B. Details on the preparation of the measurement setups are given in 5.3.

Table 1 – Configurations and examples of illumination-only equipment and reference to the measurement setup

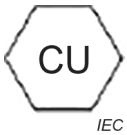
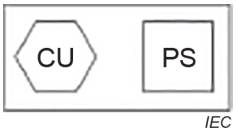
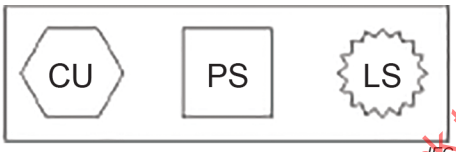
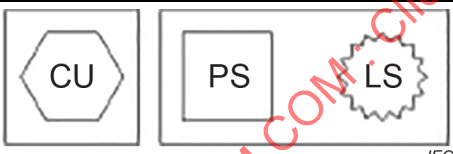
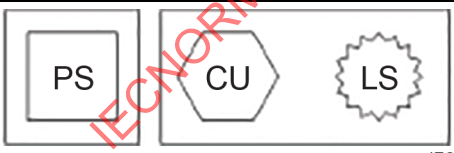
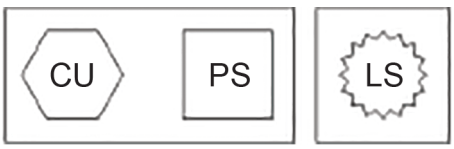
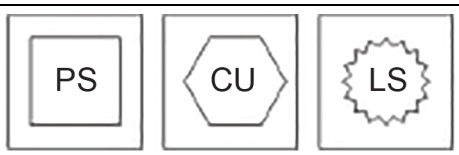
	EUT configuration	Example(s)	Measurement setup
A		Independent power supply	Figure B.2
B		Controller Digital addressable lighting interface	Figure B.3
C		Controlgear	Figure B.4
D		Mains voltage lamp	Figure B.5
E		Dimmable lamp Controllable lamp	Figure B.6
F		Integrated lamp luminaire	Figure B.7
G		Dimmable lamp with external dimmer Mains dimmable lamp	
H		Dimmable lamp with external power source	
I		Lamp with remote controlgear	
J		Lamp with independent power supply and dimmer	

Table 2 provides an overview of modes which can be present in EUTs. The template of this table can be used for reporting the assessed non-active mode configuration by ticking the corresponding cells and providing the measured value for the non-active mode power. If an EUT can be set into various non-active modes, separate templates shall be used for reporting each individual mode.

Table 2 – Template for reporting non-active mode power

	Non-active mode			
Function	**Function status**			
	Off	**Standby**	**Networked standby**	**On**
Illumination				
Sensing				
Imaging				
Energy storage				
Powering				
High network availability				
…				
…				
Measured non-active mode power	Value			
	Unit [W]			
Key: greyed cells indicate non-applicability.				

Table 3 is an example of the template of Table 2 reporting the standby power of illumination-only equipment, in this case a luminaire with an integrated presence sensor (EUT configuration F in Table 1).

Table 3 – Example of using the template of Table 2 for reporting measured standby power for an illumination-only luminaire with integrated presence sensor

	Non-active mode			
Function	**Function status**			
	Off	**Standby**	**Networked standby**	**On**
Illumination		X		
Sensing				X
Imaging				
Energy storage				
Powering				
High network availability				
…				
…				
Measured non-active mode power	Value	0,50		
	Unit [W]	W		
Key: greyed cells indicate non-applicability.				

5.2.3 Multi-function lighting equipment

Multi-function lighting equipment as EUT consists of one or more light sources, power supplies and control units for the illumination function and one or more components (see Figure 5) representing one or more additional functions to add desired features to the lighting equipment, for example people counting, noise detection.

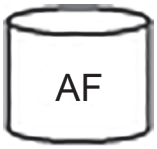


Figure 5 – Component representing an additional function (AF) of multi-function EUT

Figure 6 shows a schematic representation of an EUT configuration comprising one light source, one power supply, one control unit and one additional function. In practice, an EUT with multiple of said components can also be assessed.

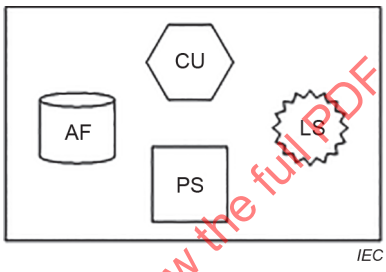


Figure 6 – Configuration of multi-function lighting equipment: example including one additional function

When non-active mode power consumption is to be assessed, the illumination function shall be set to its non-active mode. Depending on the capabilities of the multi-function EUT to set its additional functions into a non-active mode, the power consumption can be determined for all configurations of non-active modes for the additional functions available. For each configuration, the illumination function shall be set to non-active mode.

Table 2 provides a non-exhaustive overview of functions and modes which can be present in an EUT. The template of this table can be used for reporting assessed combinations of function states and modes by ticking the corresponding cells and the measured non-active mode power. This table shall be extended to include all functions and modes of the EUT under consideration. If an EUT can be set into various combinations of non-active modes, separate templates shall be used for reporting each combination.

Table 4 gives an example of the template of Table 2 used for measuring the standby power of multi-function lighting equipment, in this case a luminaire with an integrated presence sensor and an integrated camera as additional function AF (see configuration in Figure 6). In this example the camera cannot be switched into standby mode.

Table 4 – Example of using the template of Table 2 for reporting measured standby power for a (multi-function) luminaire with an integrated presence sensor and an integrated camera

	Non-active mode			
Function	**Function status**			
	Off	**Standby**	**Networked standby**	**On**
Illumination		X		
Sensing				X
Imaging				X
Energy storage				
Powering				
High network availability				
…				
…				
Measured non-active mode power	Value	7,5		
	Unit [W]	W		
Key: greyed cells indicate non-applicability.				

5.3 Preparation of EUT

5.3.1 General

The EUT can have external network provisions, which can serve to instruct the EUT to enter a mode and/or to communicate its status, including measured performance.

Beyond the above functionality, network provisions can also include other functionalities, like acting as a router. With this additional router network functionality or other network related functionality included in the EUT, such a case refers to a multi-function EUT.

In this document, instructions will be given for EUTs:

- with no network provision;
- with network provision (wired or wireless).

5.3.2 Measurement of input power

The EUT can be connected to one or more supply voltages. Multiple supply voltages are present, for example, when the control unit is powered via another supply voltage than the power supply or when the illumination lighting components and non-illumination components have a different supply voltage. In the single supply voltage case, provision for one power measurement shall be made, while in the multiple supply voltage case, provisions for multiple independent power measurements need to be made; the total power consumption during the non-active mode is the addition of multiple power consumption measurements, simultaneously executed. In the multiple supply voltage case, power can be flowing out of the EUT via one of the supply voltages.

For illumination-only lighting equipment Table 1, column 3 (Measurement setup) gives the references to the measurement setup schemes for each configuration presented in Annex B. The measurement setup scheme for a multi-function EUT is given in Figure C.2.

For practical purposes, in the schemes, the (multiple) supply voltage connections are shown as one power boundary rather than as individual power measurement points.

When assessing an individual lighting component as EUT, a substitution load or reference circuit (R_{load}) to simulate other components can be necessary. Corresponding information shall be provided by the manufacturer. In cases where a substitution load causes circuit shutdown, the intended load may be used and shall be reported accordingly.

The following gives guidance for specifying substitution loads or reference circuits:

- For a power supply or a power supply and control unit in one enclosure, the power consumption in (network) standby and off modes should be measured independent of the light source. To assess such lighting components, a substitution load (R_{load}) should be used to simulate the light source.
  - In case a resistor R_{load} is used, R_{load} is determined from the maximum rated output power (P_{rated}) and, maximum rated output voltage (U_{rated}) or maximum rated output current (I_{rated}) of the power supply, according to:

$$R_{load} = \frac{U_{rated}^2}{P_{rated}} = \frac{P_{rated}}{I_{rated}^2}$$

    The R_{load} resistor should have a power rating sufficient to maintain a resistance value within 1 % during the test.
  - Power supplies designed for LED light sources with variable impedance can malfunction when driving a pure resistance substitution load. For such power supplies, a combination of diodes and variable resistors or electronic load using semiconductor devices simulating the LED light sources should be used. The simulation load shall draw the maximum rated output power (P_{rated}) at the maximum rated output voltage or at the maximum rated output current.
- A power supply may be substituted by an applicable reference circuit and power source with output characteristics as specified by the manufacturer.
- A control unit may be substituted by a synthetic waveform generator with output characteristics as specified by the manufacturer.

In case the EUT contains a rechargeable battery and charging circuitry, the following conditions shall apply.

– For an EUT containing a charging circuit, the power consumed in non-active mode shall be measured after precautions have been taken to ensure that the battery is not being charged during the test, either by removing the battery or ensuring that the battery is kept fully charged.

– For an EUT containing a charging circuit in a charging maintenance mode the power consumed shall be measured with the batteries installed and fully charged before any measurements are undertaken.

NOTE Where regional legal provisions exist that specify different test conditions, it can be necessary for additional tests to be performed.

To prepare the EUT for assessing the power consumption, the following steps shall be taken:

– employing Table 1 and consulting the referenced figure in Annex B or Figure C.2, select and prepare the applicable EUT measurement configuration;

– read the instructions for use and configure the EUT in accordance with these instructions;

– continue the preparations of the EUT following the relevant subclause representing the network provision, being

  - 5.3.3: EUT with no network provision;
  - 5.3.4: EUT with network provision (wired or wireless).

5.3.3 EUT with no network provision

– Determine how the mode of the EUT is changed.

– Refer to the relevant EUT test procedure, external requirement (e.g. regulation) or instructions for use that specify the EUT mode(s) to test. The EUT modes tested should be consumer relevant and representative of expected normal use. Where instructions for use provide configuration options, each relevant option should be separately tested.

– Switch on the supply voltage.

– Set the EUT to the relevant non-active mode, for example standby mode, to be tested.

– Perform testing in accordance with 5.4.

5.3.4 EUT with network provision (wired or wireless)

– Determine how the mode of the EUT is changed.

– Refer to the relevant EUT test procedure, external requirement (e.g. regulation) or instructions for use that specify the EUT mode(s) to test. The EUT modes tested should be consumer relevant and representative of expected normal use. Where instructions for use provide configuration options, each relevant option should be separately tested.

– Connect the EUT to the specified external network according to the manufacturer's instructions for use.

NOTE In the case of a wireless connection, see 4.5.3 and 4.5.4.

– Switch on the supply voltage.

– Instruct the external network to set the EUT into the non-active mode to be tested (e.g. the networked standby mode).

– Perform testing in accordance with 5.4.

5.4 Measuring procedure

5.4.1 General

The non-active mode power consumption shall be determined by one or more of the following methods:

– the direct meter reading method;

– the average reading method;

– the sampling method.

The direct meter reading method is the most elementary and preferred measurement method but is limited in its applicability. Assuming a stable mode and power reading, with this method the power consumption is determined by recording the instrument power reading. Subclause 5.4.2 provides further validity and details of this method.

The average reading method assumes that the mode is stable. The power consumption is determined by averaging the instrument power readings over a specified period or, alternatively, by recording the accumulated energy consumption over a specified period and dividing by the period. Subclause 5.4.3 provides further validity and details of this method.

The sampling method uses an instrument to record power measurements at regular intervals throughout the measurement period. This method of measurement is applicable for all modes and EUTs. For modes where power varies cyclically, is unstable, or limited in duration, the sampling method shall be used. Subclause 5.4.4 provides further validity and details of this method.

5.4.2 Direct meter reading method

The direct meter reading method shall only be used where the mode does not change and, the power reading displayed on the measuring instrument is stable. Any result using the methods specified in 5.4.4 or 5.4.3 have precedence over results using this method in the case of a discrepancy.

NOTE A shorter measurement period can be possible using the sampling method – see 5.4.4.

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

– Allow the EUT to operate for at least 30 min in non-active mode. 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 50 mW/h or 3 % of the measured input power per hour, whatever is greater.
– Where the relevant criterion above is not met the direct meter reading method shall not be used.

5.4.3 Average reading method

The average reading method is suitable for EUTs having stable modes. The method shall not be used with EUTs having cyclic or limited duration modes.

After the EUT 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 shall be determined using either the average power or accumulated energy methods as follows:

– select two comparison periods, each made up of not less than 10 min duration (periods shall be approximately the same duration), noting the start time and duration of each period;
– determine the average power for each comparison period;
– stability is established where the power difference between the two comparison periods divided by the time difference of the mid-points of the comparison periods has a slope of less than 50 mW/h or 3 % of the measured input power per hour, whatever is greater.
– where the above stability criterion is not satisfied, longer periods of approximately equal duration are added until the relevant criterion 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 each, the sampling method in 5.4.4 shall be used.

Average power method: the power measuring instrument shall record a true average power over a selected period of at least 10 min.

Accumulated energy method: the power measuring instrument shall measure energy over a selected period of at least 10 min. The integrating period shall be such that the total recorded value for energy and time is more than 200 times the resolution of the meter for energy and time. Determine the average power by dividing the measured energy by the time for the monitoring period.

NOTE 1 Determination of an average power from accumulated energy over a period is equivalent to averaging power readings. Energy accumulators are more common than instrument functions that average power over a specified period.

NOTE 2 To ensure consistent units, watt-hours and hours can be used above, to give watts.

EXAMPLE 1 For an instrument with a time resolution of for example 1 s, a minimum of 200 s (3,33 min) is used for integration on such an instrument.

EXAMPLE 2 For an instrument with an energy resolution of for example 0,1 mWh, a minimum of 20 mWh is used for the accumulation of energy on such an instrument (at a load of 0,1 W this would take about 12 min, at 1 W this would take 1,2 min). Note that both the time and energy resolution requirements are satisfied by the reading, as well as the minimum recording period specified above (10 min).

5.4.4 Sampling method

This methodology shall be used where either the power or the mode is not stable (cyclic or unstable). It also provides the fastest test method when the mode is stable. It should be used if there is any doubt regarding the temporal response of the EUT or stability of the mode.

Power readings, together with other key parameters such as voltage and current, shall be recorded at equal intervals of not more than 1 s for the minimum period specified.

NOTE 1 Data collection at equal intervals of 0,25 s or faster is used 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 EUT shall be energized for not less than 15 min in non-active mode; this is the total period.
– Any data from the first one third of the total period shall be discarded. Data recorded in the second two thirds of the total period shall be used to determine stability.
– Establishment of stability depends on the average power recorded in the second two thirds of the total period. 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 or less than 1 % of the measured input power per hour, whatever is greater.
– Where a total period of 15 min does not result in the above stability criteria being satisfied, the total period shall be extended until the relevant criteria above is achieved (in the second two thirds of the total period).
– Once stability is achieved, the reported power consumption shall be the average power consumed during the second two thirds of the total period.
– If stability cannot be achieved within a total period of 3 h, the data shall be assessed for any cyclic pattern.

For modes that are known (based on instructions for use, specifications or measurements) to be non-cyclic and varying, power consumption shall be recorded for a long enough period so that the cumulative average of all data points taken during the second two thirds of the total period fall within a band of ±1 %. When testing such modes, the total period shall not be less than 60 min.

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

– The EUT shall be energized for an initial period of not less than 10 min in non-active mode. Data during this period shall not be used to assess the power consumption of the EUT.
– The EUT shall be then energized for a time sufficient to encompass two comparison periods, where each period shall include not less than two cycles and have a duration of not less than 10 min (comparison periods 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 50 mW/h or 3 % of the measured input power per hour, whatever is greater.
– Where the above stability criteria are not satisfied, additional cycles shall be added equally to each comparison period until the relevant criteria above are achieved.
– Once stability is achieved, the reported power consumption shall be the average of all readings from both comparison periods.

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

NOTE 2 In all cases power for the period of data collection is represented in graphical form to assist in the establishment of any warm-up period, cyclic pattern, instability and stability period.

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

NOTE 3 The EUT is not required to operate for a minimum initial period before data measurements are recorded when performing the above test.

For an EUT where a sequence of separate EUT non-active modes occur, the power level shall be determined for each mode of the sequence in accordance with 5.4.4. In addition, the description (including duration of each mode) of the sequence shall be reported.

Annex A
(informative)

Guidance for product standards

For non-active mode power measurement and data presentation, it is the specific product standards that will specify details such as:

– test sample size and sample selection;
– method of nomination of rated non-active power from the sample measurements;
– the handling of non-active power measurement variations caused by supply voltage range and supply frequency range variations of the product;
– marking of non-active power on the product or provision via data sheets;
– presentation of non-active power data (e.g. units and resolution of the presented data);
– the use of direct meter reading method, average meter reading method, or sampling method;
– allowed variation/tolerance between rated non-active power and measured non-active power;
– any variations to the test conditions specified in this document.

Annex B
(normative)

Measurement setup schemes for illumination-only lighting equipment

Annex B gives the schematic setups for the measurement of the power consumption during the non-active mode(s) of illumination-only lighting equipment.

Figure B.1 shows the symbols used in schematic setup schemes in this annex.

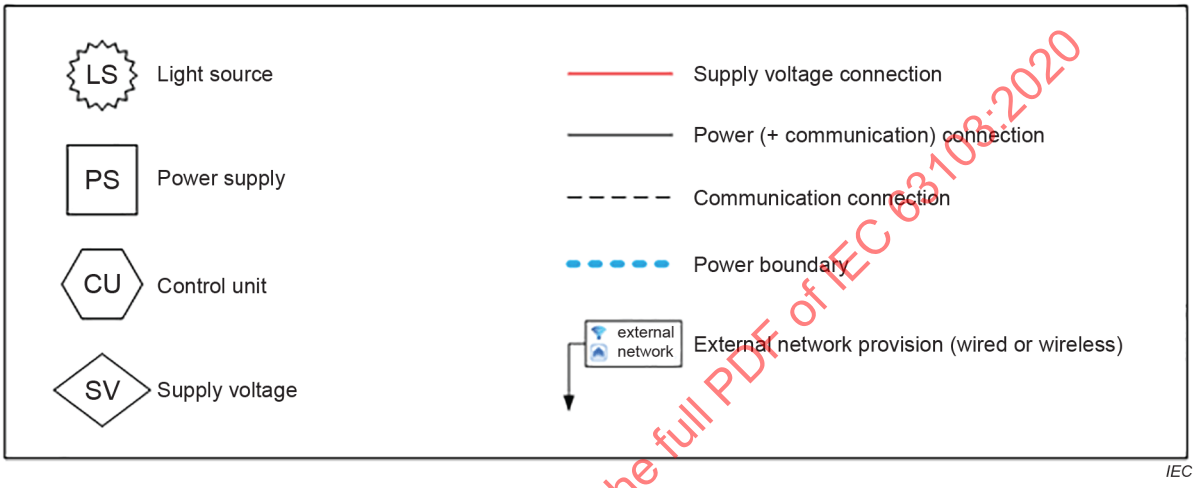


Figure B.1 – Key to symbols used in figures of Annex B

The figures in this Annex B, show the measurement setup schemes to determine the input power to the lighting equipment as EUT in accordance with the listing of Table 1:

– (A): Figure B.2: PS (Power supply),
– (B): Figure B.3: CU (Control unit),
– (C): Figure B.4: CU+PS (Control unit + Power supply),
– (D): Figure B.5: PS+LS (Power supply + Light source),
– (E); Figure B.6: CU+LS (Control unit + Light source)
– (F) – (J): Figure B.7: CU+PS+LS (Control unit + Power supply + Light source)

In these figures also the optional provision for an external network is indicated for each configuration, when applicable. Beyond the measurement setup schemes, other configurations can still be possible.

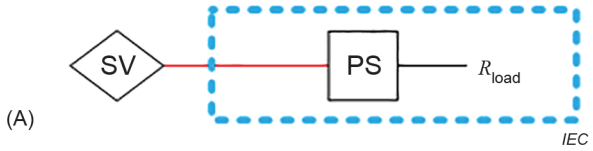


Figure B.2 – Measurement setup for determining the input power supplied to the power supply

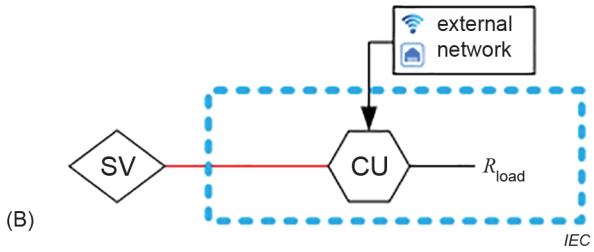
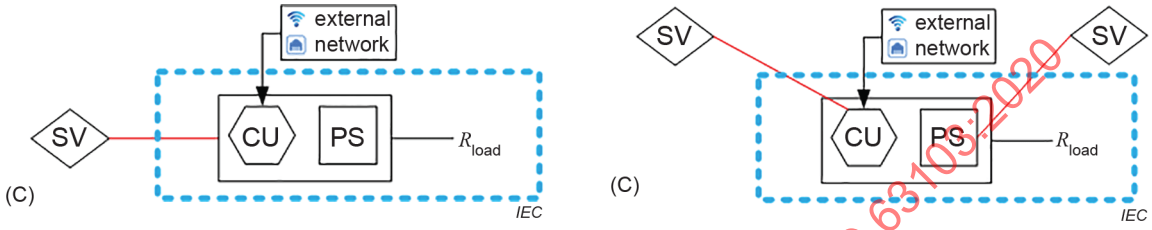


Figure B.3 – Measurement setup (with optional network provision) for determining the input power supplied to the control unit



a) Single supply voltage

b) Dual supply voltage

Figure B.4 – Measurement setup (with optional network provision) for determining the input power supplied to the combined power supply and control unit

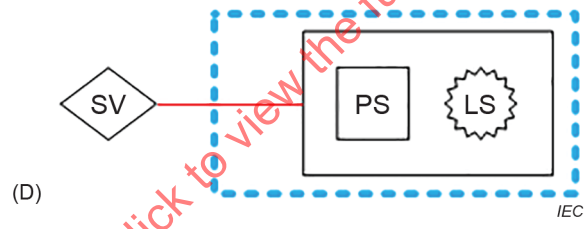


Figure B.5 – Measurement setup for determining the input power supplied to the combined light source and power supply

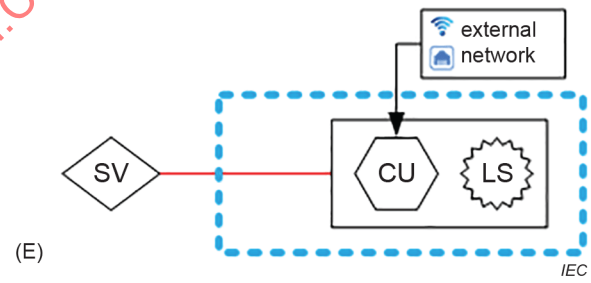


Figure B.6 – Measurement setup (with optional network provision) for determining the input power supplied to the combined light source and control unit