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LED modules - Safety requirements

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LED modules - Safety requirements

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IEC 62031 has been prepared by subcommittee 34A: Electric light sources, of IEC technical committee 34: Lighting. It is an International Standard.

This third edition cancels and replaces the second edition published in 2018. This edition constitutes a technical revision.

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

a) Complete review of the document structure, detailed technical requirements and tests, including but not limited to what is individually described under items b) to i);
b) Clarification of the scope and revision of the applicability of this document to independent and integral LED modules;
c) Updated terms and definitions;
d) Clearer specification for clause general requirements and clause general test requirements;
e) Update of the marking clause, such as marking of control terminals;

f) A full review and update of the electrical safety, thermal safety, and mechanical safety requirements preventing misinterpretation and ambiguity;

g) Updated photobiological safety requirements;

h) Revised and updated fault conditions and abnormal conditions requirements;

i) Removal of the annex relating to conformity testing during manufacture.

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

Draft	Report on voting
34A/2464/FDIS	34A/2467/RVD

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

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

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

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

– reconfirmed,
– withdrawn, or
– revised.

1 Scope

This document specifies safety requirements for LED modules for operation on DC supplies up to 1 500 V or on AC supplies up to 1 000 V. This document does not include requirements for performance characteristics of LED modules.

This document does not apply to:

– LED packages;
– LED modules for automotive lighting;
– OLED modules;
– LED lamps.

NOTE 1 Products that were designated as "independent LED modules" in the previous edition of IEC 62031 are considered luminaires which comprise LED module(s) as an integral component.

NOTE 2 Requirements for LED modules that are an integral component of the luminaire are specified in IEC 60598-1:2024. IEC 60598-1:2024, 4.3.1, makes reference back to this document as far as reasonable.

NOTE 3 Where the word "LED module" is used in this document, it is understood to be "built-in LED module".

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 60384-14:2023, *Fixed capacitors for use in electronic equipment - Part 14: Sectional specification - Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*
IEC 60384-14:2023/AMD1:2025

IEC 60417, *Graphical symbols for use on equipment*, available at http://www.graphical-symbols.info/equipment

IEC 60598-1:2024, *Luminaires - Part 1: General requirements and tests*

IEC 60695-2-10:2021, *Fire hazard testing - Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2021, *Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end products (GWEPT)*

IEC 60695-11-5:2016, *Fire hazard testing - Part 11-5: Test flames - Needle-flame test method - Apparatus, confirmatory test arrangement and guidance*

IEC 60990:2016, *Methods of measurement of touch current and protective conductor current*

IEC 61032:1997, *Protection of persons and equipment by enclosures - Probes for verification*

IEC 61347-1:2024, *Controlgear for electric light sources - Safety - Part 1: General requirements*

IEC 61189-2:2006, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies - Part 2: Test methods for materials for interconnection structures*

IEC 61249-2 (all parts), *Materials for printed boards and other interconnecting structures - Part 2: Reinforced base materials, clad and unclad*

IEC 62368-1:2023, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*

IEC 62471-7:2023, *Photobiological safety of lamps and lamp systems - Part 7: Light sources and luminaires primarily emitting visible radiation*

ISO 4046-4:2016, *Paper, board, pulp and related terms - Vocabulary - Part 4: Paper and board grades and converted products*

ISO 7089:2000, *Plain washers - Normal series - Product grade A*

3 Terms and definitions

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

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

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

3.1
ultraviolet hazard efficacy of luminous radiation
$K_{S,v}$
quotient of an ultraviolet hazard quantity by the corresponding photometric quantity

$$K_{S,v} = \frac{E_S}{E_v}$$

where

E_S is the effective actinic irradiance in W · m^{-2} and

E_v is the illuminance in lx = lm · m^{-2}

EXAMPLE With E_S = 10^{-3} W · m^{-2} and E_v = 500 lx follows $K_{S,v}$ = 2 · 10^{-6} W · lm^{-1} = 2 mW · klm^{-1}.

Note 1 to entry: Ultraviolet hazard efficacy of luminous radiation is expressed in watt per lumen (W · lm^{-1}), possibly with a metric prefix (here mW · klm^{-1}).

Note 2 to entry: The ultraviolet hazard efficacy of luminous radiation is obtained by weighting the spectral power distribution of the lamp or LED module with the UV hazard function $S_{UV}(\lambda)$. Information about the relevant UV hazard function is given in IEC 62471:2006. It only relates to possible hazards regarding UV exposure of human beings. It does not deal with the possible influence of optical radiation on materials, such as mechanical damage or discoloration.

[SOURCE: IEC 62471-7:2023, 3.17]

3.2
replaceable LED module
LED module designed to be replaced by an ordinary person or a skilled person

Note 1 to entry: When incorporated into a luminaire, a replaceable LED module can be classified as replaceable, non-user replaceable or non-replaceable depending on the luminaire design.

3.3
non-user replaceable LED module
LED module designed to be replaced only by the manufacturer, its service agent, or similar skilled person

Note 1 to entry: When incorporated into a luminaire a non-user replaceable LED module can become classified as non-replaceable due to the luminaire design.

3.4
integrated LED module
LEDi module
LED module, incorporating controlgear and any additional elements necessary for stable operation of the light source, designed for direct connection to the mains

[SOURCE: IEC 60050-845:2020, 845-27-059, modified – "supply voltage" replaced by "mains".]

3.5
semi-integrated LED module
LEDsi module
LED module that carries the control unit of the controlgear, and is operated by the separated power supply of the controlgear

Note 1 to entry: The term control unit is specified in IEC 60050-845:2020, 845-28-057.

[SOURCE: IEC 60050-845:2020, 845-27-060, modified – the term “control gear” spelled as one word, “controlgear” and Note 1 to entry added.]

3.6
non-integrated LED module
LEDni module
LED module which needs a separate control circuitry or controlgear to operate

[SOURCE: IEC 60050-845:2020, 845-27-061 – the term “control gear” spelled as one word, “controlgear”, and Note 1 to entry deleted.]

3.7
rated value
<of LED modules> declared value of a quantity, used for specification purposes and established under standard test conditions

Note 1 to entry: To express the "rated value" of a particular quantity, the term "value" is replaced by the quantity name; for example, rated power, rated voltage, rated current, and rated temperature.

Note 2 to entry: The standard test conditions are given in this document.

[SOURCE: IEC 60050-845:2020, 845-27-100, modified – The specific use <light sources and related equipment> changed to <of LED modules> and the wording “declared by the manufacturer or responsible vendor” deleted from the definition.]

3.8
type test
test or series of tests for the purpose of checking compliance of the design of a given product with the requirements of the relevant standard

3.9
type test sample
sample consisting of one or more similar units being representative of the production for the purpose of the type test

3.10
t_c-point
designated location on the surface of the LED module for measuring t_c

3.11
rated surface temperature
t_c
<of an LED module> declared highest permissible temperature at the t_c-point

3.12
thermal power
P_d
power to be transferred from an LED module to the luminaire by means of heat conduction

Note 1 to entry: Thermal power is expressed in Watt (W).

Note 2 to entry: P_d is below the rated power of an LED module.

Note 3 to entry: For LED modules which do not require heat conduction to the luminaire, P_d is equal to zero.

3.13
terminal
conductive part of an LED module, provided for connecting that LED module to one or more external conductors

[SOURCE: IEC 60050-151:2001, 151-12-12, modified – "device, electric circuit or electric network" has been replaced by "LED module" and the Note has been deleted.]

3.14
mains
AC or DC power distribution system that supplies operating power to electrical equipment

Note 1 to entry: Mains include public or private utilities and, unless otherwise specified in this document, equivalent sources such as motor-driven generators and uninterruptible power supplies.

3.15
interrupted DC
DC signal changing between zero and a certain level with a certain frequency, where the time of the signal being at the certain level can vary within one period

Note 1 to entry: The abbreviated form of direct current "DC" is used to avoid confusion when used in combination with "voltage" and "current" signal (e.g. interrupted DC voltage).

[SOURCE: IEC 61347-1:2024, 3.39]

3.16
live part
conductive part intended to be energized under normal operating conditions, including the neutral conductor and mid-point conductor, but excluding the PEN conductor, PEM conductor and PEL conductor

Note 1 to entry: PEN conductor, PEM conductor and PEL conductor are defined in IEC 60050-195:2021, 195-02-12, 195-02-13 and 195-02-14.

Note 2 to entry: This concept does not necessarily imply a risk of electric shock.

[SOURCE: IEC 60050-195:2021, 195-02-19, modified – The domain has been omitted, and Note 1 and Note 2 to entry added.]

3.17
hazardous-live-part
live part that, under certain conditions, can give a harmful electric shock

Note 1 to entry: The neutral conductor is always regarded as a hazardous live part.

[SOURCE: IEC 60050-195:2021, 195-06-05, modified – Note 1 to entry has been replaced with the new Note 1 to entry.]

3.18
pulse width modulation control
PWM control
pulse control in which the pulse width or frequency or both are modulated within each fundamental period to produce a certain output waveform

[SOURCE: IEC 60050-551:1998, 551-16-30]

3.19
working voltage
highest RMS voltage across any insulation at any rated electrical supply conditions, transients being neglected, under normal and under abnormal conditions

Note 1 to entry: The rated electrical supply conditions can be the rated voltage, the rated current or a rated supply voltage range or rated supply current range.

3.20
extra-low voltage
ELV
voltage which does not exceed 50 V AC or 120 V ripple-free DC between conductors or between any conductor and earth

Note 1 to entry: Ripple-free is conventionally defined as an RMS ripple voltage of not more than 10 % of the DC component.

Note 2 to entry: Extra-low voltage (ELV) is part of the low-voltage (LV) band, see IEC 61140:2016, 4.2 and IEC 61140:2016, Table 1.

3.21
SELV circuit
electric circuit in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions
– under abnormal operating conditions and
– under single fault conditions, including earth faults in other electric circuits

Note 1 to entry: SELV is the abbreviation for safety extra-low voltage.

[SOURCE: IEC 61140:2016, 3.26.1, modified – "system" replaced by "circuit"; added "under abnormal operating conditions".]

3.22
PELV circuit
electric circuit in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions
– under abnormal operating conditions and
– under single fault conditions, except earth faults in other electric circuits

Note 1 to entry: PELV is the abbreviation for protective extra-low voltage.

[SOURCE: IEC 61140:2016, 3.26.2, modified – "system" replaced by "circuit"; added "under abnormal operating conditions".]

3.23
FELV circuit
ELV circuit having the ELV voltage for functional reasons and not fulfilling the requirements for SELV or PELV

Note 1 to entry: FELV is the abbreviation for functional extra-low voltage.

Note 2 to entry: A FELV circuit is not safe to touch and may be connected to protective earth.

[SOURCE: IEC 61558-1:2017, 3.7.19, modified – Note 1 to entry and Note 2 to entry added, alternative term "functional extra low voltage-circuit" deleted.]

3.24
sample
one or more sampling items intended to provide information on the population or on the material

[SOURCE: IEC 60050-151:2001, 151-16-19]

3.25
sample item
one of the individual items in a population of similar items, or a portion of material forming a cohesive entity and taken from one place and at one time

[SOURCE: IEC 60050-151:2001, 151-16-18]

4 Classification

LED modules are classified, according to the level of controlgear integration, as:

– integrated LED modules, LEDi module,
– semi-integrated LED modules, LEDsi module, or
– non-integrated LED modules, LEDni module.

5 General requirements

LED modules shall be so designed and constructed that, for their intended use, they cause no danger to the users or surroundings.

Parts of LED modules providing hazard protection shall not become loose during normal operation and handling.

Requirements, tests and compliances are provided in this document to reduce the risk of harm to a tolerable level under normal operating conditions, abnormal operating conditions and single fault conditions.

Where the terms "voltage" and "current" are used in this document, they imply the RMS values unless otherwise stated.

Annex B and Annex C provide information for luminaire design and information for controlgear design, respectively.

6 General notes on tests

6.1 General

6.1.1 Type test

Tests according to this document are type tests.

NOTE The requirements and tolerances specified in this document are related to testing of a type test sample submitted by e.g. the manufacturer for that purpose. Compliance of type test samples does not ensure compliance of the whole production of a manufacturer with this document. Conformity of production is the responsibility of the manufacturer, and routine tests and quality insurance in addition to the type test can be necessary.

6.1.2 Test samples

Tests shall be carried out with type test samples.

NOTE 1 For example, damage to marking as a result of the marking test has no impact on electrical testing, thus the LED module is still considered to be representative of production for other tests.

Unless otherwise specified in this document, the type test shall be carried out on one sample consisting of one or more sample items submitted for the purpose of the type test.

All tests shall be carried out on each type of the LED module. Where there is a range of similar LED modules for testing, samples representing the most onerous case within the range shall be selected as relevant to the test criteria.

NOTE 2 As an example, it is not necessary to carry out overload condition tests separately on LED modules of one type having different colour temperatures.

NOTE 3 It can be helpful to contact the manufacturer for information on a range of similar LED modules.

LED modules shall not be altered for the purposes of testing where the results of the tests could be affected. Specially prepared sample items may be used, where necessary.

6.1.3 Compliance by inspection of relevant data

Where in this document compliance of materials, components or subassemblies is checked by inspection or by testing of properties, compliance may be confirmed by reviewing any relevant data or previous test results that are available.

6.2 Default test conditions

6.2.1 General

Unless otherwise specified in this document, the tests shall be conducted under the most onerous operating conditions within the specified operating range. In addition to 6.2.2 and 6.2.3 the following parameters shall be taken into account:

– operating mode, including loading by external connected equipment;
– control settings and dimming conditions;
– position of movable parts;
– orientation.

NOTE It can be helpful to contact the manufacturer for information on the most onerous test conditions.

6.2.2 Electrical supply conditions

6.2.2.1 General

The supply voltage, current and frequency shall be stabilized within ± 1 % of the specified test value. The peak-to-peak ripple of the DC test current or voltage shall not exceed 10 % of the average value of the test current or voltage.

6.2.2.2 LED modules supplied by voltage sources

LED modules supplied by voltage sources usually comprise means to adjust their operating current so they can be supplied by a voltage source that, ideally, has no impedance.

EXAMPLE 1 Mains supplied integrated LED modules (LEDi modules) and semi-integrated LED modules (LEDsi modules).

Tests shall be carried out at the rated voltage, or at the most onerous value within the boundary of rated voltage range, if not otherwise specified in this document.

For LED modules having alternative rated voltages or voltage ranges, tests shall be carried out separately for each rated voltage or voltage range.

For AC rated LED modules, tests shall be carried out at the most onerous rated frequency.

For LED modules rated for both AC and DC, each test shall be carried out with the most onerous voltage source condition.

Where LED modules are intended for operation on a battery supply, a DC power source may supply the LED module under test, provided that the source impedance is equivalent to that of a battery.

EXAMPLE 2 A non-inductive capacitor of appropriate rated voltage and with a capacitance of at least 50 µF connected across the supply terminals of the units under test normally provides a source impedance simulating that of a battery.

6.2.2.3 LED modules supplied by current sources

LED modules supplied by current sources usually do not comprise means to adjust their operating current, the operating voltage of such LED modules results from the design and the operating current.

EXAMPLE Non-integrated LED module (LEDni module).

Tests shall be carried out at the maximum rated current.

6.2.3 Ambient test conditions

Tests shall be carried out at an ambient temperature within the range of 10 °C to 30 °C unless otherwise specified in this document.

7 Marking

7.1 Overview

The requirements of 7.2, 7.3, 7.4 and 7.5 apply. Table 1 gives an overview for information.