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Semiconductor devices – Part 5-6: Optoelectronic devices – Light emitting diodes

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SEMICONDUCTOR DEVICES –

Part 5-6: Optoelectronic devices – Light emitting diodes

FOREWORD

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IEC 60747-5-6 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

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

a) ultraviolet-emitting diodes (UV LED) and their related technical contents were added;
b) power efficiency (η_{PE}) as part of electrical and optical characteristics were added;
c) new measuring methods related to thermal resistance were added;
d) hydrogen sulphide corrosion test was added to quality evaluation;
e) some standards were added to the bibliography.

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

FDIS	Report on voting
47E/745/FDIS	47E/752/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/standardsdev/publications.

A list of all parts in the IEC 60747 series, published under the general title *Semiconductor devices*, can be found on the IEC website.

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- withdrawn,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.

SEMICONDUCTOR DEVICES –

Part 5-6: Optoelectronic devices – Light emitting diodes

1 Scope

This part of IEC 60747 specifies the terminology, the essential ratings and characteristics, the measuring methods and the quality evaluations of light emitting diodes (LEDs) for general industrial applications such as signals, controllers, sensors, etc.

LEDs for lighting applications are out of the scope of this part of IEC 60747.

LEDs are classified as follows:

a) LED package;
b) LED flat illuminator;
c) LED numeric display and alpha-numeric display;
d) LED dot-matrix display;
e) infrared-emitting diode (IR LED);
f) ultraviolet-emitting diode (UV LED).

LEDs with a heat spreader or having a terminal geometry that performs the function of a heat spreader are within the scope of this part of IEC 60747.

An integration of LEDs and controlgears, integrated LED modules, semi-integrated LED modules, integrated LED lamps or semi-integrated LED lamps, are out of the scope of this part of IEC 60747.

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 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60068-2-17, *Basic environmental testing procedures – Part 2-17: Tests – Test Q: Sealing*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60747-5-13, *Semiconductor devices – Part 5-13: Optoelectronic devices – Hydrogen sulphide corrosion test for LED packages*

IEC 60749-6, *Semiconductor devices – Mechanical and climatic test methods – Part 6: Storage at high temperature*

IEC 60749-10, *Semiconductor devices – Mechanical and climatic test methods – Part 10: Mechanical shock*

IEC 60749-12, *Semiconductor devices – Mechanical and climatic test methods – Part 12: Vibration, variable frequency*

IEC 60749-14, *Semiconductor devices – Mechanical and climatic test methods – Part 14: Robustness of terminations (lead integrity)*

IEC 60749-15, *Semiconductor devices – Mechanical and climatic test methods – Part 15: Resistance to soldering temperature for through-hole mounted devices*

IEC 60749-20, *Semiconductor devices – Mechanical and climatic test methods – Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat*

IEC 60749-21, *Semiconductor devices – Mechanical and climatic test methods – Part 21: Solderability*

IEC 60749-24, *Semiconductor devices – Mechanical and climatic test methods – Part 24: Accelerated moisture resistance – Unbiased HAST*

IEC 60749-25, *Semiconductor devices – Mechanical and climatic test methods – Part 25: Temperature cycling*

IEC 60749-36, *Semiconductor devices – Mechanical and climatic test methods – Part 36: Acceleration, steady state*

ISO 2859-1, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

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 General terms and definitions

3.1.1
integrating sphere
hollow sphere, the interior of which is formed from, or coated with, a diffusely-reflecting material that is as spectrally neutral and as spatially uniform as possible

Note 1 to entry: Owing to the internal reflections within the sphere, the illuminance on any part of the inside surface of the sphere for which the direct flux is hidden is theoretically proportional to the luminous flux entering the sphere or produced inside the sphere. The illuminance of the internal sphere wall can be measured via a small window.

Note 2 to entry: The window of an integrating sphere is often used in radiometric measurement systems to provide a source with good spatial uniformity and with an angular distribution of radiance or luminance that is close to Lambert's cosine law.

[SOURCE: IEC 60050-845:2020, 845-25-028]

3.1.2
diffuse reflector
reflector composed of a surface with diffuse reflection

3.1.3
diffuse reflection
scattering by reflection in which, on the macroscopic scale, there is no regular reflection

[SOURCE: IEC 60050-845:2020, 845-24-054]

3.1.4
diffuse transmission
scattering by transmission in which, on the macroscopic scale, there is no regular transmission

[SOURCE: IEC 60050-845:2020, 845-24-055]

3.1.5
diffuse reflectance
ρ_d
quotient of the diffusely reflected part of the (whole) reflected flux and the incident flux

Note 1 to entry: Reflectance, ρ, is the sum of regular reflectance, ρ_r, and diffuse reflectance, ρ_d: $\rho = \rho_r + \rho_d$

Note 2 to entry: The diffuse reflectance has unit one.

[SOURCE: IEC 60050-845:2020, 845-24-068]

3.1.6
diffuse transmittance
τ_d
quotient of the diffusely transmitted part of the (whole) transmitted flux and the incident flux

Note 1 to entry: Transmittance, τ, is the sum of regular transmittance, τ_r, and diffuse transmittance, τ_d: $\tau = \tau_r + \tau_d$.

Note 2 to entry: The diffuse transmittance has unit one.

[SOURCE: IEC 60050-845:2020, 845-24-069]

3.1.7
lambertian surface
ideal surface for which the radiation coming from that surface is distributed angularly according to Lambert's cosine law

Note 1 to entry: For a lambertian surface, $M = \pi L$, where M is the radiant exitance or luminous exitance, and L the radiance or luminance.

[SOURCE: IEC 60050-845:2020, 845-24-063]

3.1.8
spectral reflectance
$R(\lambda)$
ratio of reflected radiant flux to incident radiant flux for a wavelength λ

Note 1 to entry: Spectral reflectance is also known as the "spectral reflection factor".

3.1.9
spectral transmittance
$T(\lambda)$
ratio of transmitted radiant flux to incident radiant flux for a wavelength λ

Note 1 to entry: Spectral transmittance is also known as the "spectral transmittance factor".

3.1.10
spectral distribution
proportion of the quantum of radiation per unit wavelength included in the micro wavelength interval centre on wavelength λ, which is expressed as a function of wavelength λ

Note 1 to entry: Spectral distribution is also known as the "spectrum distribution".

3.1.11
spectral sensitivity
$S(\lambda)$
light sensitivity as a function of wavelength

Note 1 to entry: The response output of the optical receiver for the radiant flux (or luminous flux) input of wavelength λ is expressed as a function of wavelength λ.

3.1.12
distribution temperature
T_D
temperature of the Planckian radiator whose relative spectral distribution $S(\lambda)$ is the same or nearly the same as that of the radiation considered in the spectral range of interest for which the following integral is minimized by adjustment of a and T:

$$\int_{\lambda_1}^{\lambda_2}\left[1-\frac{S_t(\lambda)}{a\,S_b(\lambda,T)}\right]^2 d\lambda$$

where λ is the wavelength, $S_t(\lambda)$ is the relative spectral distribution of the radiation being considered, $S_b(\lambda, T)$ is the relative spectral distribution of the Planckian radiator at temperature T, and a is a scaling factor

Note 1 to entry: The scaling factor a is chosen to make the quotient $\frac{S_t(\lambda)}{S_b(\lambda,T)}$ equal to unity at a convenient wavelength which, in photometry and colorimetry is typically 560 nm.

$$S_b(\lambda,T)=\frac{P(\lambda,T)}{P(560\,\text{nm},T)} \text{ with } P(\lambda,T)=\lambda^{-5}\left(e^{\frac{c_2}{\lambda T}}-1\right)^{-1}$$ where c_2 is the second radiation constant.

Note 2 to entry: Distribution temperature is a meaningful characteristic for radiators having a relative spectral distribution similar to that of a Planckian radiator, but only if calculated for an expanded wavelength range and for radiation whose spectral distribution of radiant flux is a continuous function of wavelength in that range.

Note 3 to entry: In photometry and colorimetry the wavelength range set by λ_1 and λ_2 is the visible spectral range, and in these cases the range from at least λ_1 = 400 nm to λ_2 = 750 nm is recommended.

Note 4 to entry: In practice, the integral is replaced by a summation. For incandescent lamps, equally spaced wavelength intervals of 10 nm will usually suffice. All values in the summation are treated with equal weight.

Note 5 to entry: The distribution temperature is expressed in kelvin (K).

Note 6 to entry: For further information, see CIE 114-1994, CIE Collection in Photometry and Radiometry – 114/4 Distribution Temperature and Ratio Temperature.

[SOURCE: IEC 60050-845:2020, 845-24-017]

3.1.13
infrared-emitting diode
IR LED
light emitting diode that emits infrared radiation