

INTERNATIONAL STANDARD

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

FOREWORD	8
1 Scope	10
2 Normative references	10
3 Terms, definitions and abbreviations	11
3.1 General terms and definitions	11
3.2 Terms and definitions relating to the measurement of the quantity of radiation	14
3.3 Terms and definitions relating to the measurement of the photometric quantity	17
3.4 Terms and definitions relating to the measurement of the thermal quantity	21
3.5 Abbreviations	22
4 Absolute maximum ratings	22
5 Electrical and optical characteristics	23
6 Measuring method	24
6.1 Basic requirements	24
6.1.1 Measuring conditions	24
6.1.2 Measuring instruments and equipment	25
6.1.3 Essential requirements	26
6.1.4 General precautions	27
6.2 Forward voltage (V_F) measurement	27
6.2.1 Purpose	27
6.2.2 Circuit diagram	27
6.2.3 Requirements	27
6.2.4 Measurement procedure	29
6.2.5 Precautions to be observed	29
6.2.6 Specified conditions	29
6.3 Reverse voltage (V_R) measurement	29
6.3.1 Purpose	29
6.3.2 Circuit diagram	29
6.3.3 Measurement procedure	29
6.3.4 Precautions to be observed	30
6.3.5 Specified conditions	30
6.4 Differential resistance (r_f) measurement	30
6.4.1 Purpose	30
6.4.2 Circuit diagram	30
6.4.3 Requirements	30
6.4.4 Measurement procedure	30
6.4.5 Precautions to be observed	31
6.4.6 Specified conditions	31
6.5 Reverse current (I_R) measurement	31
6.5.1 Purpose	31
6.5.2 Circuit diagram	31
6.5.3 Provisions	32
6.5.4 Measurement procedure	32
6.5.5 Precautions to be observed	32

6.5.6	Specified conditions.....	32
6.6	Measurement of capacitance between terminals (C_t).....	32
6.6.1	General	32
6.6.2	Measurement using LCR meter.....	33
6.6.3	Measurement using AC bridge.....	33
6.7	Measurement of junction temperature (T_j) and thermal resistance ($R_{th(j-X)}$) e) $R_{th(j-X)real}$	35
6.7.1	Purpose.....	35
6.7.2	Measurement principle.....	35
6.7.3	Measurement procedure	37
6.7.4	Precautions to be observed	42
6.7.5	Specified conditions.....	42
6.8	Response time measurement.....	42
6.8.1	Purpose.....	42
6.8.2	Circuit diagram	42
6.8.3	Provisions.....	43
6.8.4	Measurement procedure	43
6.8.5	Precautions to be observed	43
6.8.6	Specified conditions.....	44
6.9	Frequency response and cut-off frequency (f_c) measurement	44
6.9.1	Purpose.....	44
6.9.2	Circuit diagram	44
6.9.3	Provisions.....	45
6.9.4	Measurement procedure.....	45
6.9.5	Precautions to be observed	46
6.9.6	Specified conditions.....	46
6.10	Luminous flux (Φ_v) measurement.....	46
6.10.1	Purpose.....	46
6.10.2	Measurement principle.....	46
6.10.3	Measuring circuit	46
6.10.4	Measurement procedure	47
6.10.5	Precautions to be observed	47
6.10.6	Measurement conditions to be defined.....	48
6.11	Radiant flux (Φ_e) measurement.....	48
6.11.1	Purpose.....	48
6.11.2	Measurement principle.....	48
6.11.3	Measuring circuit	49
6.11.4	Measurement procedure	49
6.11.5	Precautions to be observed	49
6.11.6	Measurement conditions to be defined.....	50
6.12	Luminous intensity (I_v) measurement	50
6.12.1	Purpose.....	50
6.12.2	Measurement principle.....	50
6.12.3	Measuring circuit	51
6.12.4	Measurement procedure	52
6.12.5	Precautions to be observed	52
6.12.6	Measurement conditions to be defined.....	52
6.13	Radiant intensity (I_e) measurement	52

6.13.1	Purpose.....	52
6.13.2	Measurement principle.....	52
6.13.3	Measuring circuit.....	53
6.13.4	Measurement procedure.....	53
6.13.5	Measurement conditions to be defined.....	53
6.14	Luminance (L_V) measurement.....	53
6.14.1	Purpose.....	53
6.14.2	Measuring circuit.....	54
6.14.3	Measurement procedure.....	54
6.14.4	Measurement conditions to be defined.....	54
6.15	Emission spectrum distribution, peak emission wavelength (λ_p), and spectral half bandwidth ($\Delta\lambda$) measurement.....	55
6.15.1	Purpose.....	55
6.15.2	Measuring circuit.....	55
6.15.3	Measurement procedure.....	56
6.15.4	Measurement conditions to be defined.....	57
6.16	Chromaticity measurement.....	57
6.16.1	Purpose.....	57
6.16.2	Measurement principle.....	57
6.16.3	Measuring circuit.....	60
6.16.4	Measurement procedure.....	60
6.16.5	Measuring conditions to be defined.....	60
6.17	Directional characteristics and full width half maximum of an intensity measurement.....	60
6.17.1	Purpose.....	60
6.17.2	Measuring circuit.....	61
6.17.3	Measurement procedure.....	61
6.17.4	Measuring conditions to be defined.....	62
6.18	Illuminance (E_V) measurement.....	63
6.18.1	Purpose.....	63
6.18.2	Measuring circuit.....	63
6.18.3	Measurement procedure.....	63
6.18.4	Measuring conditions to be defined.....	63
7	Items to be indicated on the package.....	63
8	Quality evaluation.....	64
8.1	General.....	64
8.2	Classification of quality evaluations.....	64
8.2.1	General.....	64
8.2.2	Classification I.....	64
8.2.3	Classification II.....	64
8.2.4	Classification III.....	64
8.2.5	Precautions to be observed.....	64
8.3	Quality evaluation test.....	70
8.3.1	General.....	70
8.3.2	Specimens.....	71
8.4	Lot quality inspection.....	71
8.4.1	General.....	71
8.4.2	Specimens.....	71

8.5	Periodical quality inspection.....	71
8.5.1	General	71
8.5.2	Specimens.....	71
8.5.3	Inspection period	71
8.6	Easing of the lot quality inspection standards.....	71
8.7	Periodical evaluation maintenance tests	72
8.7.1	Test items and specimens	72
8.7.2	Test period	72
8.8	Long-term storage products	72
8.9	Continuous current test.....	72
8.9.1	General	72
8.9.2	Initial measurement	72
8.9.3	Test circuits.....	72
8.9.4	Test conditions	73
8.9.5	Post-treatment.....	73
8.9.6	Final measurement	73
Annex A	(normative) Standard luminous efficiency.....	74
Annex B	(normative) How to obtain the self-absorption correction factor	77
B.1	Purpose	77
B.2	LED light sources for self-absorption measurement	77
B.3	Method	77
Annex C	(normative) How to obtain the colour correction factor	79
C.1	Purpose	79
C.2	Method	79
C.2.1	Luminous flux and luminous intensity measurement.....	79
C.2.2	Radiant flux and radiant intensity measurement.....	80
Annex D	(normative) Calibration of the luminance meter.....	81
D.1	Purpose	81
D.2	How to perform the calibration	81
Annex E	(normative) Colour-matching function of the XYZ colour system	83
Annex F	(normative) Spectral chromaticity coordinates	88
Annex G	(normative) Illuminance meter calibration	93
G.1	Purpose	93
G.2	How to perform the calibration	93
Bibliography	94
Figure 1	– Radiant intensity	15
Figure 2	– Radiance.....	16
Figure 3	– Radiant exitance	16
Figure 4	– Irradiance.....	17
Figure 5	– Spectral luminous efficiency.....	18
Figure 6	– Circuit diagram for V_F measurement	27
Figure 7	– Circuit diagram for V_F measurement with a constant voltage source and a current-limiting resistor	28
Figure 8	– Circuit diagram for V_F measurement using an SMU.....	28
Figure 9	– Circuit diagram for V_R measurement.....	29

Figure 10 – Circuit diagram for r_f measurement	30
Figure 11 – Circuit diagram for I_R measurement	32
Figure 12 – Circuit diagram for C_t measurement	33
Figure 13 – Circuit diagram for C_t measurement	34
Figure 14 – An example of the temperature dependence of η_{PE}	35
Figure 15 – Heating time duration dependence of the measured thermal resistance	36
Figure 16 – Cumulative thermal capacitance versus cumulative thermal resistance characteristics (structural function)	37
Figure 17 – Circuit diagram for measurement of change in V_F	38
Figure 18 – Change in V_F during the measurement	39
Figure 19 – Example of the time variation in V_F	40
Figure 20 – Transient vibration waveform immediately after the heating is off	40
Figure 21 – Circuit diagram for response time measurement	42
Figure 22 – Waveform of response time measurement	44
Figure 23 – Circuit diagram for f_c measurement	45
Figure 24 – Circuit diagram for Φ_V measurement	47
Figure 25 – Circuit diagram for Φ_e measurement	49
Figure 26 – Schematic diagram for I_V measurement	51
Figure 27 – Circuit diagram for I_V measurement	51
Figure 28 – Circuit diagram for I_e measurement	53
Figure 29 – Circuit diagram for L_V measurement	54
Figure 30 – Circuit diagram for λ_p measurement	55
Figure 31 – Circuit diagram for λ_p measurement	56
Figure 32 – Schematic diagram of $\Delta\lambda$ measurement	57
Figure 33 – Chromaticity	59
Figure 34 – Circuit diagram for chromaticity measurement	61
Figure 35 – Directional characteristics (example 1)	62
Figure 36 – Directional characteristics (example 2)	62
Figure 37 – Circuit diagram for E_V measurement	63
Figure 38 – Circuit diagram for continuous current test	73
Figure B.1 – Schematic diagram for self-absorption measurement	77
Figure D.1 – Schematic diagrams for calibration	82
Figure G.1 – Schematic diagram for calibration	93
Table 1 – Absolute maximum ratings	22
Table 2 – Electrical and optical characteristics	23
Table 3 – CIE averaged LED intensity measurements	51
Table 4 – Items for the screening test and their conditions(reference)	64
Table 5 – Quality evaluation tests	65
Table 6 – Lot quality inspection	67

Table 7 – Periodical quality inspection	70
Table A.1 – Definitive values of the spectral luminous efficiency function for photopic vision $V(\lambda)$	74
Table E.1 – Colour-matching function of the XYZ colour system	83
Table F.1 – Spectral chromaticity coordinates	88

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SEMICONDUCTOR DEVICES –

Part 5-6: Optoelectronic devices – Light emitting diodes

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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

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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 control gears, 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*

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3 Terms, definitions and abbreviations

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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

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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 :

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

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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

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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.

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

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 $\lambda_1 = 400 \text{ nm}$ to $\lambda_2 = 750 \text{ nm}$ 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