IEC 60747-5-3

Edition 1.1 2009-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Discrete semiconductor devices and integrated circuits – Part 5-3: Optoelectronic devices – Measuring methods

Dispositifs discrets à semiconducteurs et circuits intégrés – Partie 5-3: Dispositifs optoélectroniques – Méthodes de mesure

IEC 60747-5-3:1997+A1:2002

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX **CN**

ICS 31.080.99

ISBN 978-2-88910-275-4

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

DISCRETE SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS –

Part 5-3: Optoelectronic devices – Measuring methods

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60747-5-3 has been prepared by subcommittee 47C: Optoelectronic, display and imaging devices, of IEC technical committee 47: Semiconductor devices.

This consolidated version of IEC 60747-5-3 consists of the first edition (1997) [documents 47C/173/FDIS and 47C/186/RVD] and its amendment 1 (2002) [documents 47E/210/FDIS and 47E/215/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

It should be read jointly with IEC 60747-1, IEC 62007-1 and IEC 62007-2.

Annex A is for information only.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
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- amended.

DISCRETE SEMICONDUCTOR DEVICES AND INTEGRATED CIRCUITS –

Part 5-3: Optoelectronic devices – Measuring methods

1 Scope

This part of IEC 60747 describes the measuring methods applicable to the optoelectronic devices which are not intended to be used in the fibre optic systems or subsystems.

2 Normative references

The following referenced documents are indispensable for the application 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 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60270:1981, *Partial discharge measurements*

3 Measuring methods for photoemitters

3.1 Luminous intensity of light-emitting diodes (I_V)

a) *Purpose*

To measure the luminous intensity of semiconductor light-emitting diodes.

The method can be applied to three possible measurement variants:

Variant 1

Rotation of the diode around its mechanical axis for an accurate location of the minimum and/or maximum value.

Variant 2

Alignment of the diode optical axis with that of the optical bench.

Variant 3

Positioning according to a reference corresponding to the type of the diode envelope and allowing a reproducible mechanical orientation.

b) *Circuit diagram*

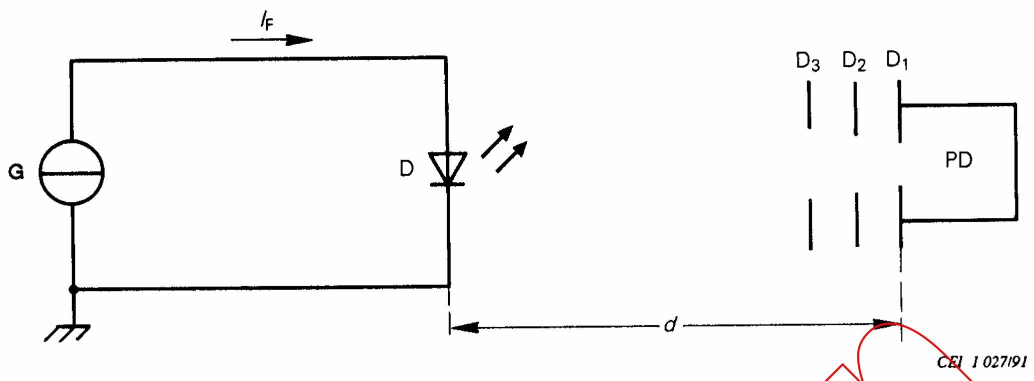


Figure 1

c) *Circuit description and requirements*

G = current source

D = light-emitting diode being measured

PD = photodetector including the diaphragm D_1 of area *A*

D_2, D_3 = Diaphragms intended to suppress parasitic radiations. D_2 and D_3 shall not limit the solid angle

d = distance between the diode being measured and D_1.

The spectral sensitivity of the photometer shall be adjusted to the CIE (International Commission on Illumination) standard observers curve in the wavelength region of the light emitted by the diode. The photometer shall be calibrated in candelas at the distance *d*, with diaphragm D_1 in place.

The distance *d* shall be such that the solid angle viewed by the light source at the diaphragm D_1 ($= A/d^2$) is less than 0,01 sr.

For pulse measurements, the current generator should provide current pulses of the required amplitude, duration and repetition rate. The photodetector should have a rise time sufficiently small in comparison with the pulse duration; it should be a peak-reading instrument.

d) *Measurement procedure*

The diode being measured is positioned according to the variant chosen.

The specified current is applied and the luminous intensity is measured on the photodetector.

e) *Specified conditions*

- Ambient temperature and, where appropriate, the atmospheric conditions.
- Forward current in the diode and, where applicable, duration and repetition rate.
- Variant: 1, 2 or 3.

3.2 Radiant intensity of infrared-emitting diodes (I_e)

a) *Purpose*

To measure the radiant intensity of semiconductor infrared-emitting diodes.

The method can apply to three possible measurement variants:

Variant 1

Rotation of the diode around its mechanical axis for an accurate location of the minimum and/or maximum value.

Variant 2

Alignment of the diode optical axis with that of the optical bench.

Variant 3

Positioning according to a reference corresponding to the type of the diode envelope and allowing a reproducible mechanical orientation.

b) *Circuit diagram*

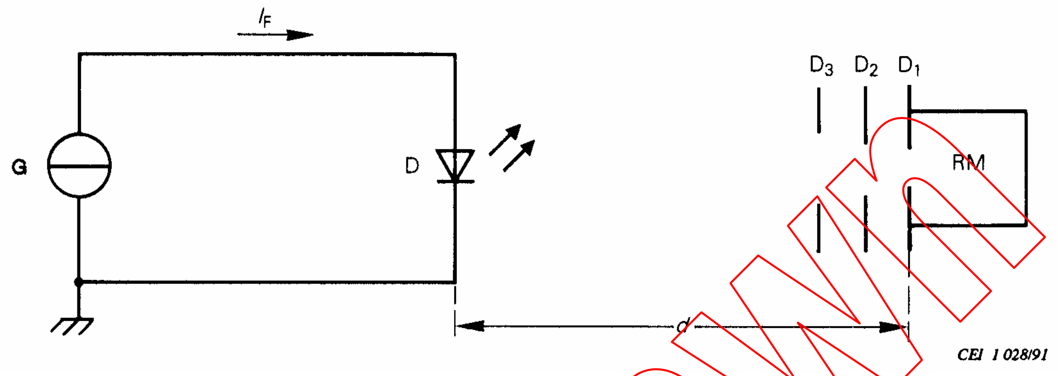


Figure 2

c) *Circuit description and requirements*

G = current source

D = infrared-emitting diode being measured

RM = radiometer including the diaphragm D_1 of area *A*

D_2, D_3 = diaphragms intended to suppress parasitic radiations. D_2 and D_3 shall not limit the solid angle

d = distance between the diode being measured and D_1.

The radiant intensity I_e in the direction of the case axis should be measured by a wavelength-independent detector (for example, a thermocouple element) and the radiometer shall be calibrated in W/sr at the distance *d* with diaphragm D_1 in place.

The distance *d* shall be such that the solid angle viewed by the infrared source at the diaphragm D_1 ($= A/d^2$) is less than 0,01 sr.

For pulse measurements, the current generator shall provide current pulses of the required amplitude, duration and repetition rate. The radiometer shall have a rise time sufficiently small in comparison with the pulse duration; it shall be a peak-reading instrument.

d) *Measurement procedure*

The diode being measured is positioned according to the variant chosen.

The specified current is applied to the diode and the radiant intensity is measured on the radiometer.

e) *Specified conditions*

- Ambient temperature and, where appropriate, the atmospheric conditions.
- Forward current in the diode and, where applicable, duration and repetition rate.
- Variant: 1, 2 or 3.

3.3 Peak-emission wavelength (λ_p) spectral radiation bandwidth ($\Delta\lambda$) and number of longitudinal modes (n_m)

a) *Purpose*

To measure the peak-emission wavelength and the spectral radiation bandwidth of emitting devices and to determine the number of longitudinal modes of laser diodes.

b) *Circuit diagram*

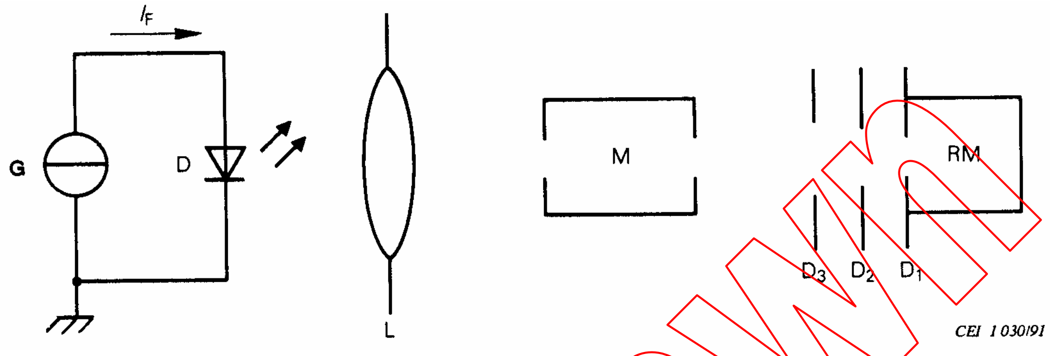


Figure 3 – Basic circuit

c) *Circuit description and requirements*

D = device being measured
L = focusing lens systems
G = generator (pulsed or d.c.)
M = monochromator
D_2, D_3 = diaphragms intended to suppress parasitic radiations, where appropriate.
RM = radiometer (including diaphragm D_1).

The wavelength resolution and the bandwidth of the monochromator shall be such that the measurement is carried out with adequate accuracy.

The spectral response of the radiometer shall be calibrated. For convenience of measurement, the peak of the curve may represent 100 %.

d) *Precautions to be observed*

If the transmission factor of the monochromator and the radiometer sensitivity are not constant over the required range of wavelength, the recorded values should be corrected.

For measurement of the laser diode, radiant power reflected into the laser diode shall be minimized to ensure that the spectral response is not significantly affected.

e) *Measurement procedure*

1) Peak emission wavelength and spectral radiation bandwidth of a light-emitting diode, or an infrared-emitting diode, or a single-mode laser diode

   The specified current is applied to the device being measured.

   The wavelength of the monochromator is adjusted within the required range until the maximum reading on the radiometer has been achieved. The wavelength corresponding to this peak value is recorded. This is the peak-emission wavelength (λ_p) (see Figure 4).

The wavelength of the monochromator is then adjusted on either side of □p until the maximum reading is halved. These two wavelengths (λ_1 and λ_2 on Figure 4) are recorded. Their difference is the spectral radiation bandwidth of the infrared-emitting or light-emitting device (see Figure 4).

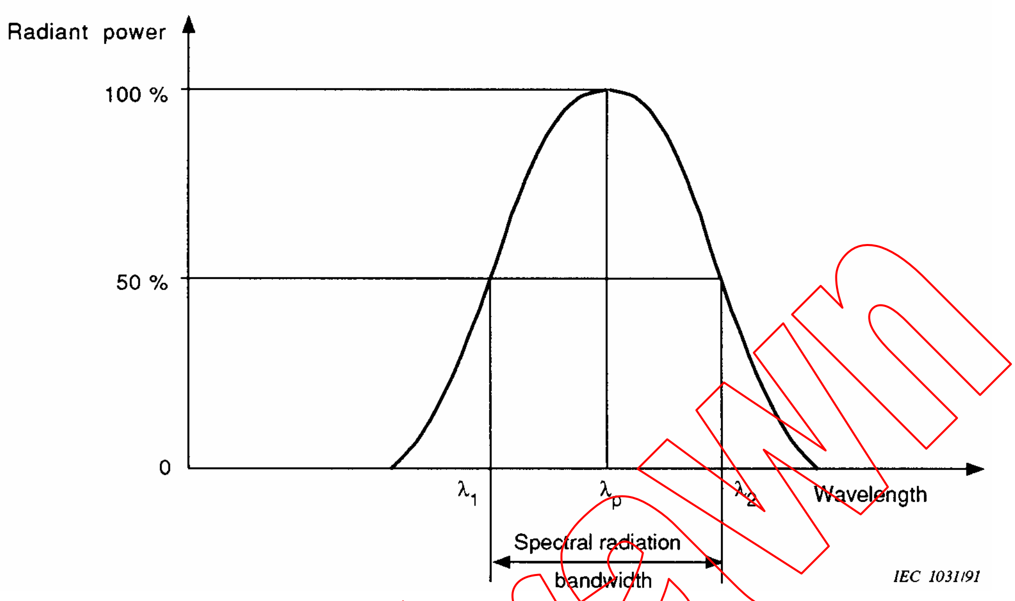


Figure 4 – Radiant power as function of wavelength

2) *Peak-emission wavelength, spectral radiation bandwidth and number of longitudinal modes of a multimode laser diode*

2.1) *Peak-emission wavelength of a multimode laser diode*

A current corresponding to the specified optical power output is applied to the device being measured.

The wavelength of the monochromator is adjusted within the required range until the highest of the various maxima is indicated.

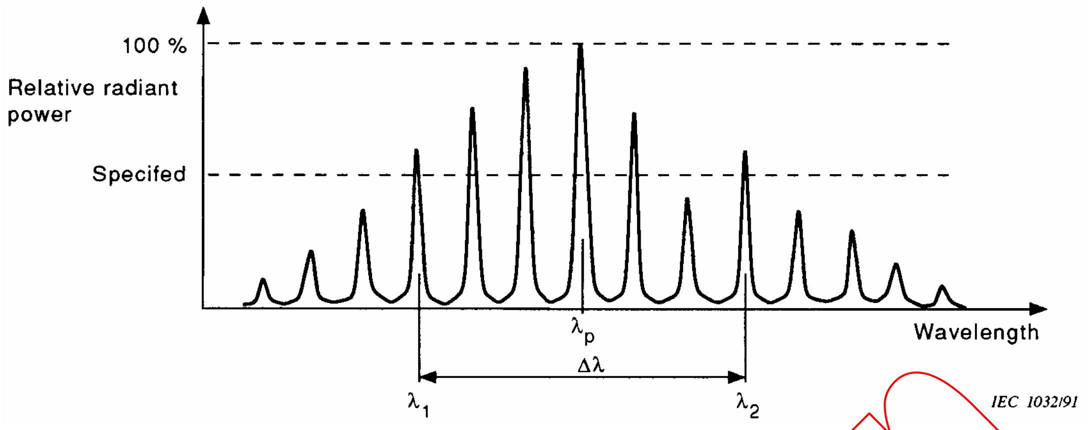
The wavelength corresponding to this value is recorded. This is the peak-emission wavelength (λ_p) (see Figure 5).

2.2) *Spectral radiation bandwidth of a multimode laser diode*

The monochromator is set to a long wavelength and then adjusted progressively to shorter wavelengths. Record the first wavelength at which the specified percentage of the highest reading recorded under e) 2.1) is obtained or exceeded. The monochromator is set to a short wavelength and thus adjusted progressively to longer wavelengths. Record the first wavelength at which the specified percentage of the highest reading recorded under e) 2.1) is obtained or exceeded. The difference between the two recorded values is the spectral radiation bandwidth of the laser diode ($\Delta\lambda$) (see Figure 5).

2.3) *Number of longitudinal modes of a multimode laser diode*

The spectral radiation bandwidth as in e) 2.2) above is measured and then the number of modes (n_m) within that bandwidth including the two modes that define the limit of the bandwidth is counted (see Figure 5).



Δλ = spectral radiation bandwidth

Figure 5

f) *Specified conditions*

– For LED and IRED:

- ambient or case temperature;
- forward current (d.c. or pulse), as specified.

– For laser diodes:

- ambient, case or submount temperature;
- radiant power or forward current;
- percentage of peak emission if other than 50 %.

3.4 Emission source length and width and astigmatism of a laser diode without pigtail

a) *Purpose*

To measure the emission source size on the facet of the laser diode with respect to a defined axis and the astigmatism of the optical beam emitted from the laser diode.

b) *Measuring equipment*

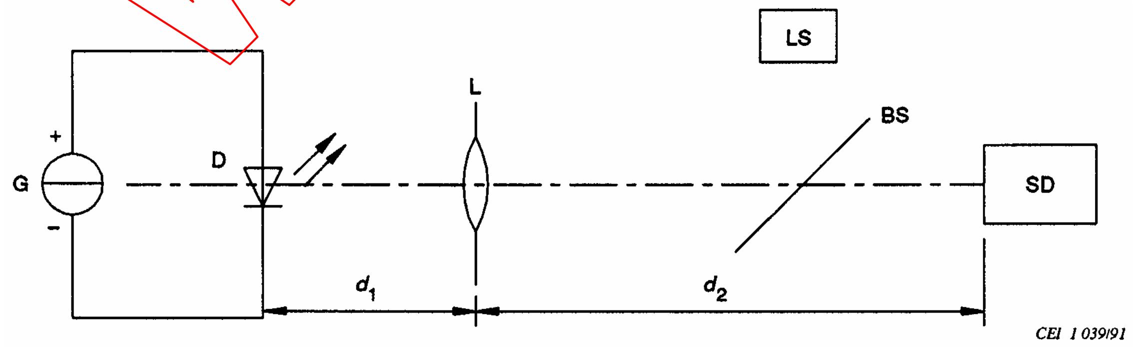


Figure 6

c) *Equipment description and requirements*

G = current source
D = device being measured
L = lens system
SD = scanning photodetector with a narrow slit
LS = light source with filter or LED the emission wavelength of which is close to that of the device being measured
BS = beam splitter

$d_2 \gg d_1$

d) *Precautions to be observed*

The lens system L shall be substantially achromatic over the range of wavelengths encompassed by the light source LS and the device D.

e) *Measurement procedure*

Emission source size

The light source LS is turned on and the lens system L adjusted to obtain a focused image of the front face of the device D on the photodetector SD. Distances d_1 and d_2 are then read.

The specified d.c. current or the d.c. current corresponding to the specified radiant power ϕ_e is applied to the device being measured D.

The scanning direction of the photodetector SD is aligned with the major and minor axes of the focused image.

The photodetector SD is scanned along the major and the minor axes. The length and width of the emission source are given by the distance between the 3 dB power points along the major and minor axes multiplied by d_1/d_2.

Astigmatism d_A

The light source LS is turned on and the lens system L adjusted to obtain a focused image of the front facet of the device D on the photodetector SD. Distances d_1 and d_2 are read.

The scanning direction of the photodetectors align with SD the major and the minor axes of the focused image.

The lens system L is moved along the optical axis toward the device D until the emission source length along the major axis is minimized.

The distance d_3 traversed by the lens system L is measured.

The lens system is returned to the original position. The procedure is repeated for the minor axis. The distance d_4 traversed by the lens system L is measured.

The difference between d_3 and d_4, multiplied by $(1 - d_1^2/d_2^2)$, is the astigmatism.

f) *Specified conditions*

- Ambient, case or submount temperature.
- Direct forward current or radiant power.
- Reference axes (major and minor axes).