

Semiconductor devices —

Part 1: Discrete devices —

Section 1.5 Recommendations for optoelectronic devices

ICS 31.260

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Components Standards Policy Committee (ECL/-) to Technical Committee ECL/24, upon which the following bodies were represented:

EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)

Electronic Components Industry Federation

GAMBICA (BEAMA Ltd.)

Ministry of Defence

National Supervising Inspectorate

Society of British Aerospace Companies Limited

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Telecommunications plc

Engineering Equipment and Materials Users' Association

This British Standard, having been prepared under the direction of the Electronic Components Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 September 1992

© BSI 27 March 2003

First published August 1985
Second edition September 1992

The following BSI references relate to the work on this standard:
Committee reference ECL/24
Draft for comment 87/31843 DC

ISBN 0 580 21005 7

Amendments issued since publication

Amd. No.	Date	Comments
8704	November 1995	
8957	May 1996	Indicated by a sideline in the margin
14242 Corr. No. 1	27 March 2003	Addition of supersession details to national foreword

Contents

	Page
Committees responsible	Inside front cover
National foreword	vi
Chapter I. General	1
1 Introductory note	1
2 Scope	1
Chapter II. Terminology and letter symbols	3
1 Physical concepts	3
2 Types of devices	5
3 General terms	6
4 Terms related to ratings and characteristics	11
5 Letter symbols	22
Chapter III. Essential ratings and characteristics	23
Section 1. Light-emitting diodes	23
1 Type	23
2 Semiconductor material	23
3 Colour	23
4 Details of outline and encapsulation	23
5 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	23
6 Electrical characteristics	24
7 Supplementary information	24
Section 2. Infrared-emitting diodes	25
1 Type	25
2 Semiconductor material	25
3 Details of outline and encapsulation	25
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	25
5 Electrical characteristics	25
6 Supplementary information	26
Section 3. Photodiodes	27
1 Type	27
2 Semiconductor material	27
3 Details of outline and encapsulation	27
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	27
5 Electrical characteristics	27
6 Supplementary information	28
Section 4. Phototransistors	29
1 Type	29
2 Semiconductor material	29
3 Polarity	29
4 Details of outline and encapsulation	29
5 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	29
6 Electrical characteristics	30
7 Supplementary information	30

	Page
Section 5. Photocouplers, optocouplers (with output transistor)	31
1 Type	31
2 Semiconductor material	31
3 Polarity of the output resistor	31
4 Details of outline and encapsulation	31
5 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	31
6 Electrical characteristics	33
7 Supplementary information	33
Section 6. Laser diodes	35
1 Type	35
2 Semiconductor	35
3 Details of outline and encapsulation	35
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	35
5 Electrical and optical characteristics	35
6 Supplementary information	37
Section 7. Light-emitting diodes and infrared-emitting diodes for fibre optic systems or subsystems	39
1 Type	39
2 Semiconductor material	39
3 Details of outline and encapsulation	39
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	39
5 Electrical and optical characteristics	40
6 Supplementary information	41
Section 8. Laser module with pigtails	43
1 Type	43
2 Semiconductor	43
3 Details of outline and encapsulation	43
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	43
5 Electrical and optical characteristics	45
Section 9. Pin photodiodes for fibre optic systems or subsystems	47
1 Type	47
2 Semiconductor material	47
3 Details of outline and encapsulation	47
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	47
5 Electrical and optical characteristics	48
6 Supplementary information	48

	Page
Section 10. Avalanche photodiodes (APDs) with or without pigtails	49
1 Type	49
2 Semiconductor	49
3 Details of outline and encapsulation	49
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	49
5 Electrical and optical characteristics	50
6 Supplementary information	50
Section 11. Visual inspection of monochrome matrix liquid crystal display modules	51
1 General	51
2 Visual inspection of displays	51
Section 12. Liquid crystal display cells (LCD cells) (Excluding active matrix LCD and multicolour cells)	55
1 Type	55
2 Principle and material used	55
3 Mode of operation	55
4 Details of outline	55
5 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated	55
6 Electrical and optical characteristics	56
7 Supplementary information	56
Section X. Visual inspection of monochrome liquid crystal display cells ¹⁾	57
1 Scope	57
2 General	57
3 Visual inspection of displays	57
4 Seal inspections	59
5 Visual inspection of contact pad areas	59
6 Visual inspection for chipped material at the borders and edges of the support plates of cells	59
Chapter IV. Measuring methods	63
1 Measuring methods for photoemitters	63
2 Measuring methods for photosensitive devices	91
3 Measuring methods for photocouplers	110
4 Measuring methods for liquid crystal display devices	122

¹⁾ See national foreword for details of textual error.

National foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Policy Committee. It is identical with IEC Publication 747-5:1993 *Semiconductor devices. Discrete devices and integrated circuits — Part 5: Optoelectronic devices* as amended by Amendment 1:1994 and Amendment 2:1995, published by the International Electrotechnical Commission (IEC).

When preparing IEC Amendment 2 for incorporation into this document, an error was discovered in the Section numbering of the new material that it introduced. Pending the publication of a new edition of IEC 747-5, this material has been termed “Section X” and introduced at the end of Chapter 3.

This British Standard constitutes Section 1.5 of the British Standard for semiconductor devices (BS 6493). (See national foreword of BS 6493-1.1:1984.) It supersedes BS 6493-1.5:1985 which is withdrawn. It is partially superseded by BS EN 62007-1:2000 and BS EN 62007-2:2000.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

The Technical Committee has reviewed the provisions of IEC 306-1:1969, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 129 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Chapter I. General

1 Introductory note

As a rule, it will be necessary to use Publication 747-1 together with the present standard. In 747-1, the user will find all basic information on:

- terminology;
- letter symbols;
- essential ratings and characteristics;
- measuring methods;
- acceptance and reliability.

2 Scope

This standard applies to the following categories or sub-categories of devices:

- Semiconductor photoemitters, including:
 - light-emitting diodes (LEDs);
 - infrared-emitting diodes (IREDs);
 - laser diodes and laser-diode modules;
 - optoelectronic displays (under consideration).
- Semiconductor photoelectric detectors, including:
 - photodiodes;
 - phototransistors.
- Semiconductor photosensitive devices, including:
 - photoresistors, photoconductive cells;
 - photothyristors (under consideration).
- Semiconductor devices utilizing optical radiation for internal operation, including:
 - photocouplers, optocouplers.

The sequence of the different chapters is in accordance with Publication 747-1, Chapter III, subclause 2.1.

Chapter II. Terminology and letter symbols

NOTE A number of additional terms of interest for optoelectronic devices, e.g. for radiometric, photometric and spectrophotometric quantities, appear in chapter 845 of the IEV, which supersedes chapter 45.

1 Physical concepts

1.1 (Electromagnetic) radiation (IEV 845-01-01)

- 1) Emission or transfer of energy in the form of electromagnetic waves with the associated photons.
- 2) These electromagnetic waves or these photons.

1.2 Optical radiation (IEV 845-01-02)

Electromagnetic radiation of wavelengths lying between the region of transition to X-rays (≈ 1 nm) and the region of transition to radio waves (≈ 1 nm).

1.3 Visible radiation (IEV 845-01-03)

Any optical radiation capable of causing a visual sensation directly.

NOTE There are no precise limits for the spectral range of visible radiation since they depend upon the amount of radiant power available and the responsiveness of the observer. The lower limit is generally taken between 360 nm and 400 nm and the upper limit between 760 nm and 830 nm.

1.4 Infrared radiation (IEV 845-01-04, specialized)

Optical radiation for which the wavelengths are longer than those for visible radiation.

1.5 Ultraviolet radiation (IEV 845-01-05, specialized)

Optical radiation for which the wavelengths are shorter than those for visible radiation.

1.6 Light (IEV 845-01-06, without note 2 which is not relevant)

1.6.1 *Perceived light* (see IEV 845-02-17)

1.6.2 *Visible radiation* (see IEV 845-01-03)

NOTE Concept 2 is sometimes used for optical radiation extending outside the visible range, but this usage is not recommended.

1.7 Photoelectric effect (from IEV 845-05-33: photoelectric detector)

Interaction between optical radiation and matter resulting in the absorption of photons and the consequent generation of mobile charge carriers, thereby generating an electric potential or current, or a change in electrical resistance, excluding electrical phenomena caused by temperature changes.

1.8 Liquid crystal display devices

1.8.1 *Alignment layer*

A thin layer deposited over the patterned electrodes that determines the direction of the director at the surface. This layer produces the desired ordering. Alignment such as homeotropic alignment (1.8.14) or planar alignment (1.8.15) are achieved by the co-operative ordering of the liquid crystal molecules locally affected by the surface forces. The alignment layer is generating the pretilt angle (1.8.20).

1.8.2 *Chiral phase*

A liquid crystal phase exhibiting a spontaneous twist.

1.8.3 *Cholesteric phase*

A liquid crystal phase that exhibits planar nematic ordering in which the directors form a helix that has its axis perpendicular to the plane.

1.8.4 *Clearing point*

The phase transition temperature of a liquid crystal for transition toward the isotropic phase.

1.8.5 *Dichroic liquid crystal*

A liquid crystal exhibiting dichroism, i.e. the property of anisotropic absorption of light.

1.8.6 *Director*

The axial unit vector describing the local axis of symmetry for the orientational distribution function of any chosen molecular axis of a liquid crystal. The director co-ordinates define the local alignment of the liquid crystal.

1.8.7 *Disclination*

A localized alignment defect (appearing generally under the form of closed or open lines) forming the border between areas exhibiting different alignment states.

1.8.8 *Discotic mesophase*

A liquid crystal phase of disc-like shaped molecules exhibiting a long range ordering with respect to the short molecular axis.

1.8.9 *Dynamic scattering*

An electro-optical effect showing a light scattering caused by turbulent motion in a liquid crystal layer induced by an electro-hydrodynamic effect.

1.8.10 *Electrically controlled birefringence*

An electro-optical effect caused by the birefringence of a liquid crystal layer which can be modulated (varied) by an electric field. It is also called “tunable birefringence”.

1.8.11 *Electrode layer*

An electrically conductive layer, usually transparent (e.g. made of indium tin oxide, “ITO”), covering the support plates and patterned to establish the display and electrical contact configuration.

1.8.12 *Ferroelectric liquid crystal*

A liquid crystal phase exhibiting a spontaneous electric polarization.

NOTE This effect is commonly exhibited in chiral smectic liquid crystal.

1.8.13 *Guest-host effect*

An anisotropic optical absorption effect occurring in a dichroic liquid crystal layer containing a dissolved dye.

1.8.14 *Homeotropic alignment*

The alignment state of a liquid crystal layer for which the director is everywhere nominally perpendicular to a support plate surface.

1.8.15 *Planar alignment*

The alignment state of a liquid crystal layer for which the director is everywhere nominally parallel to a support plate surface. This alignment is also referred to as homogeneous.

1.8.16 *Liquid crystal*

A liquid crystal is a material that exhibits a mesophase consisting of elongated (rod-like) or disc-like (discotic) molecules and that possesses at least one long range orientational ordering with respect to one molecular axis.

1.8.17 *Liquid crystal cell*

A flat structure consisting of a minimum of two support plates with liquid crystal contained in the space between them. These plates are usually separated by a distance of several micrometers.

1.8.18 *Mesophase (mesomorphic phase)*

An ordered state of matter between the crystalline and isotropic liquid phases, exhibiting some of the properties of the neighbouring phases, as for example fluidity and birefringence.

1.8.19 *Nematic phase*

Molecules in this liquid-crystalline phase possess a long range orientational ordering of one molecular axis (uniaxial nematic LC) or two molecular axes (biaxial nematic LC).

1.8.20 Pretilt angle

The angle between the plane of a support plate and the adjacent liquid crystal director.

1.8.21 Sealing layer

A layer situated between the support plates and surrounding the liquid crystal to ensure the hermeticity and integrity of the liquid crystal cell.

1.8.22 Smectic phase

A liquid crystalline phase characterized by at least a one-dimensional long range transitional ordering of the molecules and a long range orientational ordering for one molecular axis.

1.8.23 Spacer

A material incorporated into a liquid crystal cell (e.g. calibrated spheres or cylinders) to ensure a constant distance between the support plates.

1.8.24 Support plate

Plate, generally transparent, made of e.g. glass or plastic sheet, covered with several layers (electrodes, sealing and surface alignment layers), forming the mechanical structure of a liquid crystal cell.

1.8.25 Twist angle

The oriented angle between the projections of the respective surface directors at the support plates on to one of the support plates of a twisted nematic cell.

1.8.26 Twisted nematic structure

A nematic liquid crystal state characterized by a twisted structure.

2 Type of devices**2.1 Semiconductor optoelectronic device**

- 1) A semiconductor device that emits or detects or that is responsive to coherent or non-coherent optical radiation.
- 2) A semiconductor device that utilizes such radiation for its internal purposes.

2.2 Semiconductor photoemitter

A semiconductor optoelectronic device that directly converts electric energy into optical radiant energy.

2.3 Semiconductor optoelectronic display

A semiconductor photoemitter designed for the presentation of visual information.

2.4 Semiconductor laser**2.4.1 (Semiconductor) laser diode**

A semiconductor diode that emits coherent optical radiation through stimulated emission resulting from the recombination of free electrons and holes when excited by an electric current that exceeds the threshold current of the diode.

NOTE The laser diode is mounted on a submount or in a package with or without coupling means (e.g. lens, pigtail).

2.4.2 Laser-diode module

A module containing, together with the laser diode, means for an automatic optical and/or thermal stabilization of the radiant output power.

2.5 Light-emitting diode (LED)

A semiconductor diode, other than a semiconductor laser, capable of emitting visible radiation when excited by an electric current.

2.6 Infrared-emitting diode (IRED)

A semiconductor diode other than a semiconductor laser capable of emitting infrared radiation when excited by an electric current.

2.7 (Semiconductor) photosensitive device

A semiconductor device that utilizes the photoelectric effect for detection of optical radiation.

2.8 (Semiconductor) photoelectric detector

A semiconductor device that utilizes the photoelectric effect for detection of optical radiation.

2.9 (Semiconductor) photoresistor, photoconductive cell (IEV 845-05-37, specialized)

A semiconductor photoelectric detector that utilizes the change of electric conductivity produced by the absorption of optical radiation.

2.10 Photoelement, photovoltaic cell (IEV 845-05-38)

A photoelectric detector that utilizes the electromotive force produced by the absorption of optical radiation.

2.11 Photodiode (IEV 845-05-39)

A photoelectric detector in which a photocurrent is generated by absorption of optical radiation in the neighbourhood of a PN junction between the semiconductors, or of a junction between a semiconductor and a metal.

2.12 Avalanche photodiode (IEV 845-05-40, specialized)

A photodiode operating with a reverse bias such that the primary photocurrent undergoes amplification within the diode.

2.13 Phototransistor

A transistor in which the current produced by the photoelectric effect in the neighbourhood of the emitter-base junction acts as base current, which is amplified.

2.14 Photothyristor

A thyristor that is designed to be triggered by optical radiation.

2.15 Photocoupler, optocoupler

A semiconductor optoelectronic device designed for the transfer of electrical signals by utilizing optical radiation to provide coupling with electrical isolation between the input and the output.

3 General terms

3.1 Optical axis

A line about which the principal radiation or sensitivity pattern is centered.

NOTE Unless otherwise stated, the optical axis coincides with the direction of maximum radiation or sensitivity.

3.2 Optical port (of a semiconductor optoelectronic device)

A geometrical configuration, referenced to an external plane or surface of the device, that is used to specify the optical radiation emitted from an emitting device or accepted by a detecting device.

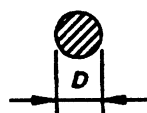
NOTE The geometrical configuration shall be specified by the manufacturer by means of geometrical information, e.g.:

- location, shape and size of the area of emission or acceptance;
- angle of emission or acceptance;
- other parameters, e.g. numerical aperture of optical fibre;
- orientation of optical axis.

Examples:

Signification of annotations in the figures:

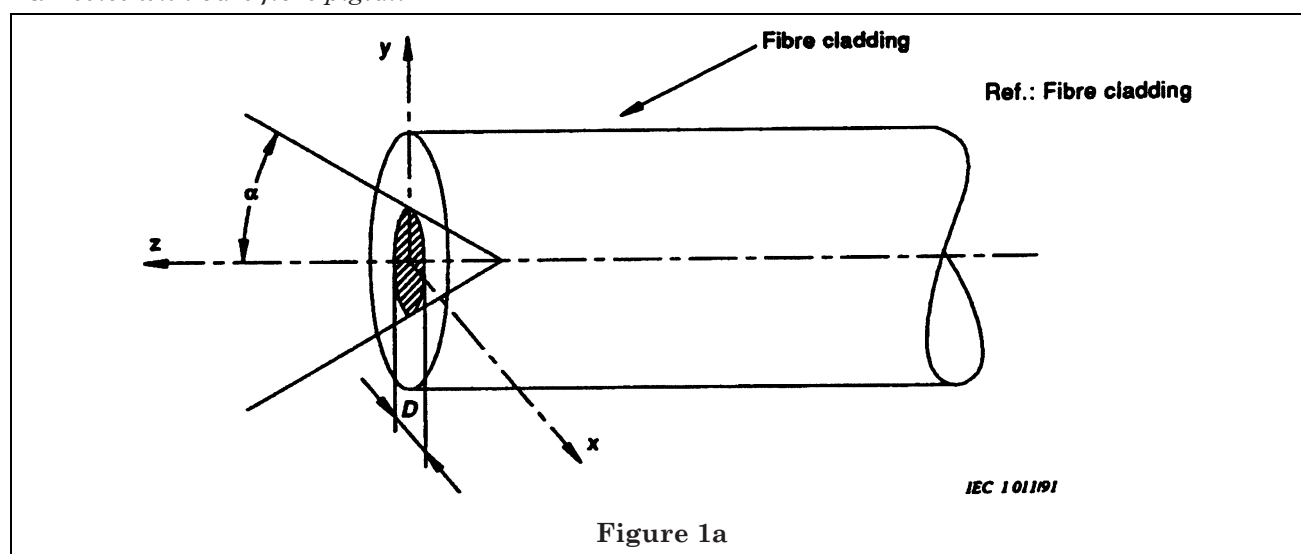
α = emission of acceptance angle

 = optical port with diameter D

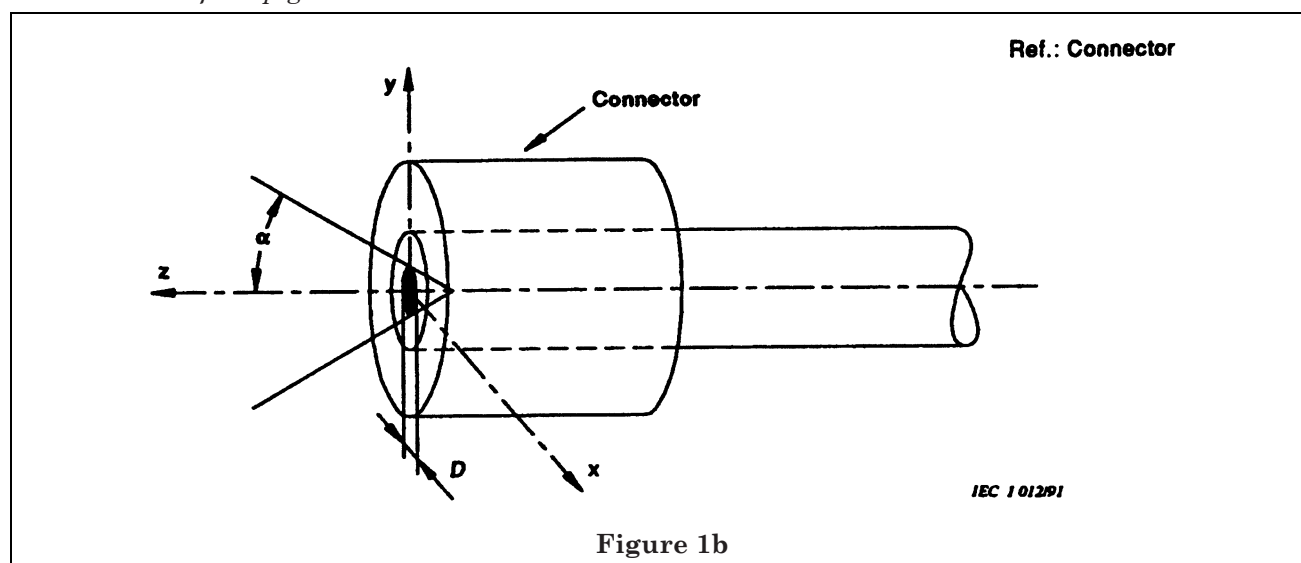
Ref. = reference locus for the definition of the optical port.

Example I: *Devices with pigtail (emitter or detector)*

Ia *Device with bare fibre pigtail*

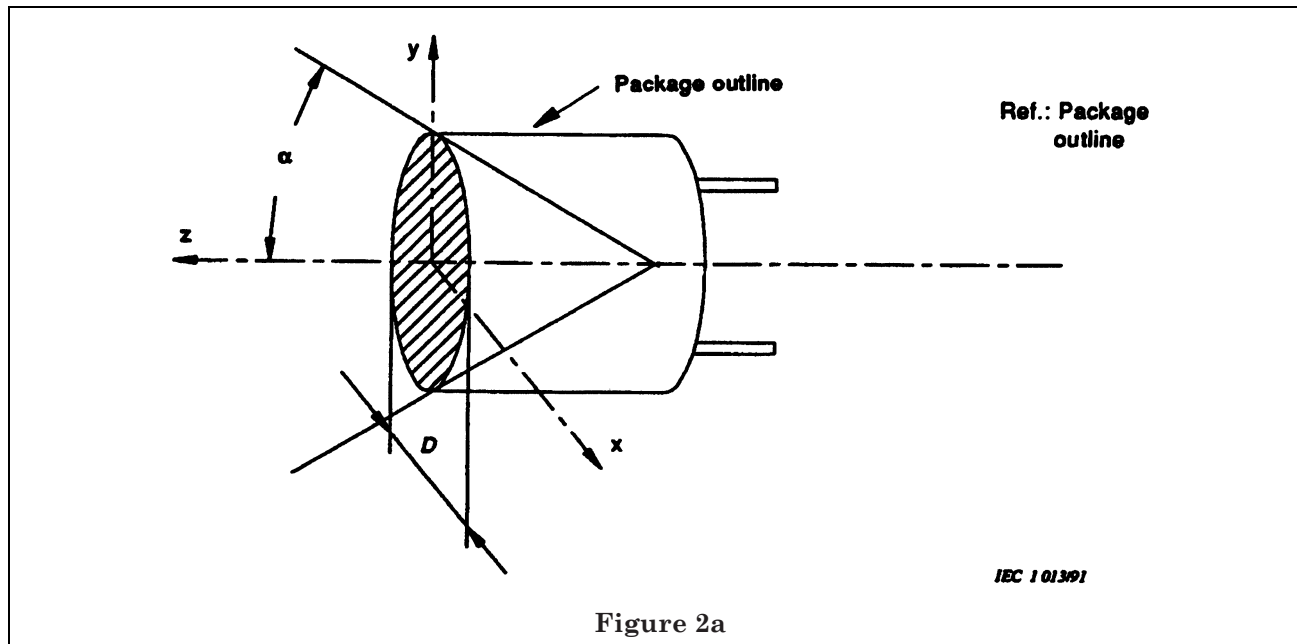


Ib *Device with fibre pigtail connector attached*

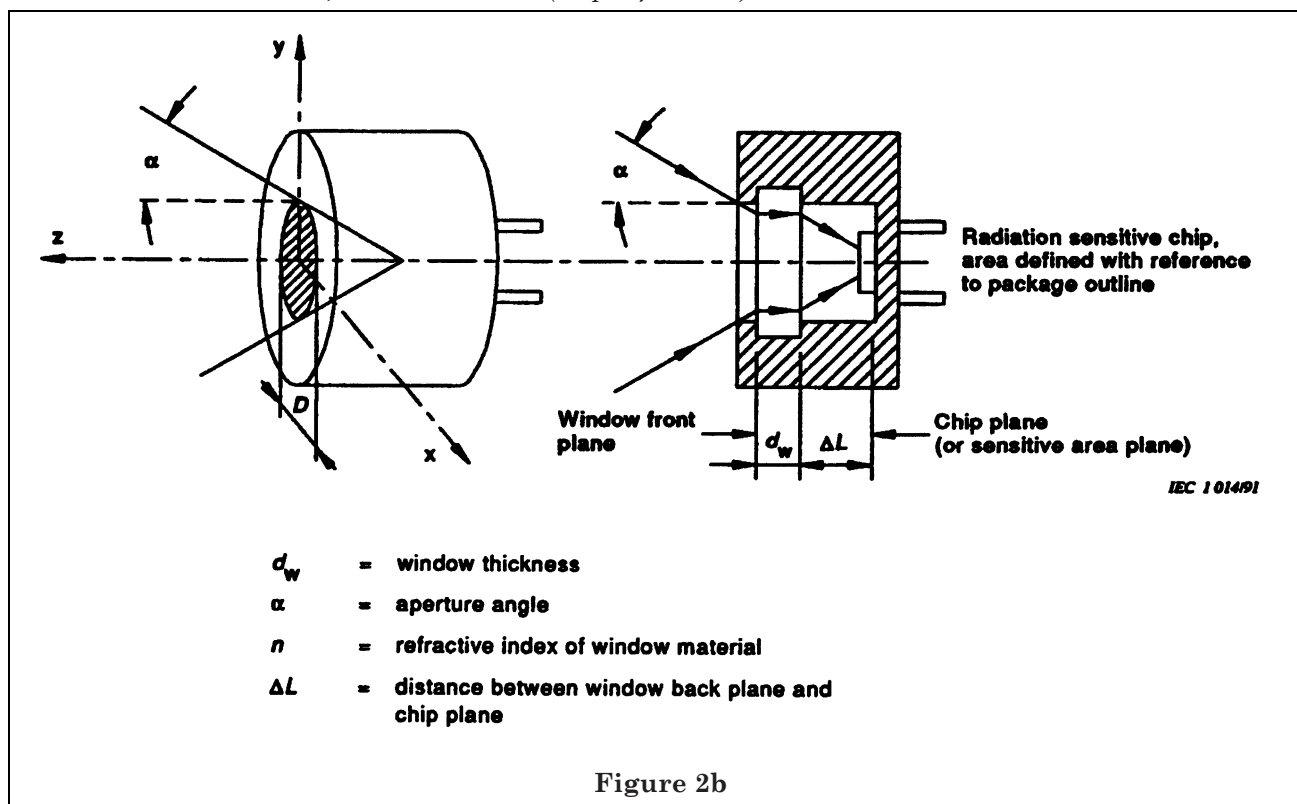


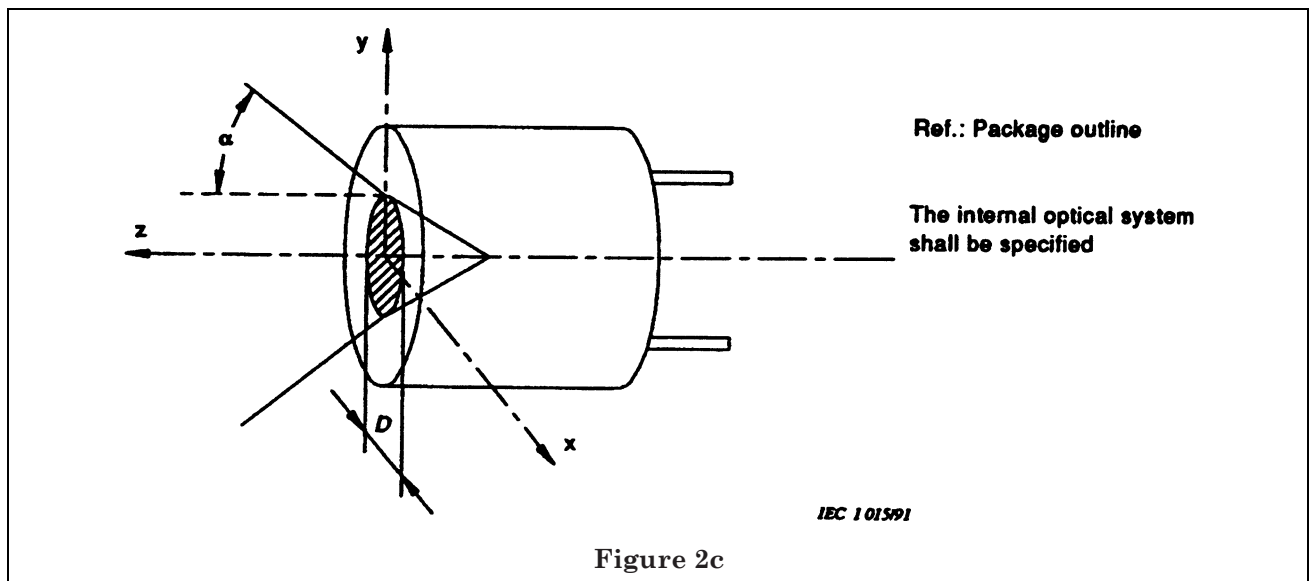
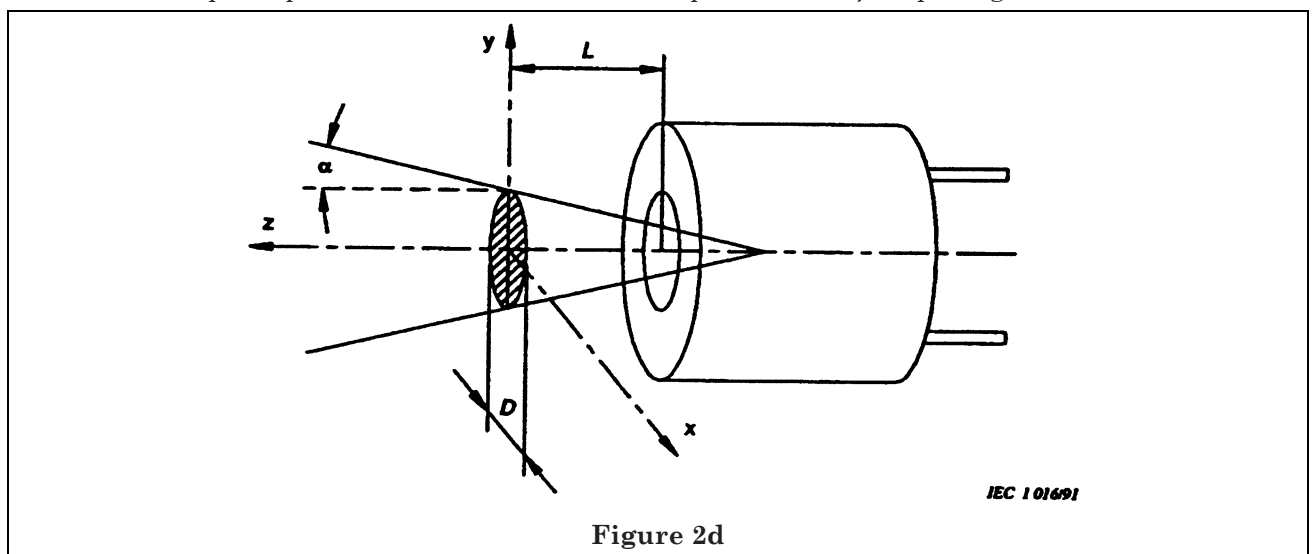
Example II: *Packaged devices (emitter or detector), without pigtail*

IIa *Device with window, but without lens*

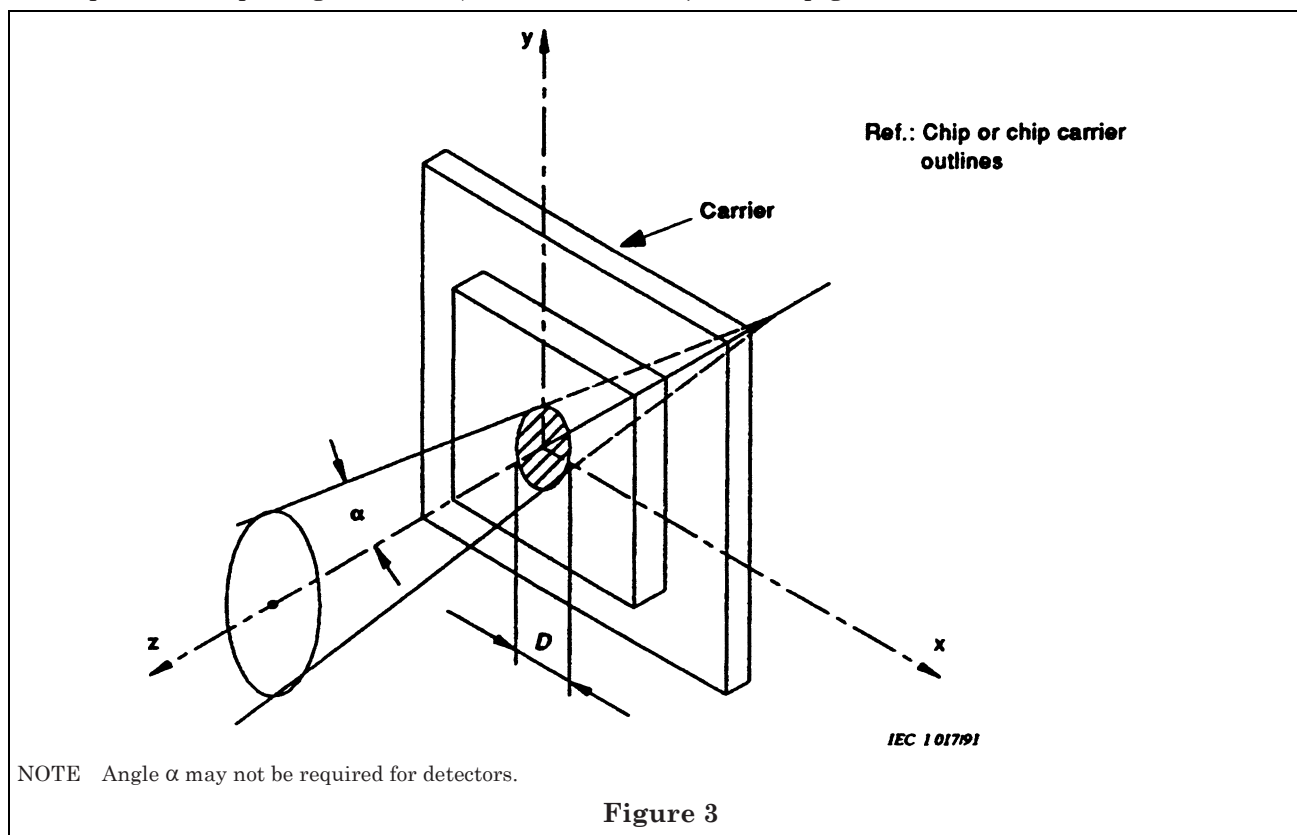


IIb *Detector with window, but without lens (chip referenced)*



IIc *Detector with lens*IIId *IRED with optical port that is not located on the output window of the package*

Example III: *Non-packaged devices (emitter or detector) without pigtail*



3.3 (Optical) cladding (IEV 731-02-05)

That dielectric material of an optical fibre surrounding the core.

3.4 Liquid crystal display devices

3.4.1 Active area

Part of a display screen area delimited by picture elements.

3.4.2 Active matrix-addressed display

A matrix-addressed display device in which each picture element has at least one switching element (e.g. diode or transistor).

3.4.3 Alphanumeric display

A display device that is able to present a limited set of characters including at least letters and numerals.

3.4.4 Emissive display

A display that contains its own source(s) of light. This light can be produced by the transducer itself or provided by one or more internal light source(s) modulated by the transducer.

3.4.5 Grey scale

Display is said to have grey scale capability if it can display images providing more than two luminance levels.

3.4.6 Liquid crystal display cell

Liquid crystal cell that is used to modulate light to present information.

3.4.7 Liquid crystal display module

A display unit combining a liquid crystal display cell with drive electronics. Additional options are possible such as backlight, mounting brackets, etc.

3.4.8 Matrix display

A display device consisting of regularly distributed pixels arranged in rows and columns.

3.4.9 Monochrome display

A display using only one colour or black and white contrast.

3.4.10 Pixel

Smallest element that is capable of generating full functionality of a display.

3.4.11 Reflective display

A display device that modulates light from an external source by reflection.

3.4.12 Segment

A segment is a special purpose dedicated pixel, e.g. a specific portion of an alphanumeric symbol, or a sign by itself.

3.4.13 Storage effect

The property of a picture element in which the visual information is retained after the activation has been removed.

3.4.14 Transflective display

A display device that modulates light from an external source by reflection or from another source by transmission through a semitransmissive reflector.

3.4.15 Transmissive display

A display device that modulates light from an external source by transmission.

3.4.16 Viewing angle range

The viewing angular direction range over which the visual specification is satisfied.

3.4.17 Viewing area

The active area (3.4.1) plus any contiguous areas that display permanent visual information or a display background.

4 Terms related to ratings and characteristics**4.1 General****4.1.1 Switching times**

NOTE The specified lower and upper limit values referred to in concepts 4.1.1.1 to 4.1.1.6 are usually 10 % and 90 % of the amplitude of the pulses (see Figure 4).

4.1.1.1 Turn-on delay time $t_{d(on)}$

The time interval between the lower specified value on the leading edge of the applied input pulse and the lower specified value on the leading edge of the output pulse.

4.1.1.2 Rise time t_r

The time interval between the lower specified value and the upper specified value on the leading edge of the output pulse.

4.1.1.3 Turn-on time t_{on}

The time interval between the lower specified value on the leading edge of the applied input pulse and the upper specified value on the leading edge of the output pulse.

$$t_{on} = t_{d(on)} + t_r$$

4.1.1.4 Turn-off delay time $t_{d(off)}$

The time interval between the upper specified value on the trailing edge of the applied input pulse and the upper specified value on the trailing edge of the output pulse.

NOTE If the turn off delay time is mainly due to carrier storage (e.g. in the output transistor of a photocoupler), the term “(carrier) storage time” and the letter symbol t_s are in use.

4.1.1.5 Fall time t_f

NOTE The time interval between the upper specified value and the lower specified value on the trailing edge of the output pulse.

4.1.1.6 Turn-off time t_{off}

The time interval between the upper specified value on the trailing edge of the applied input pulse and the lower specified value on the trailing edge of the output pulse.

$$t_{off} = t_{d(off)} + t_f$$

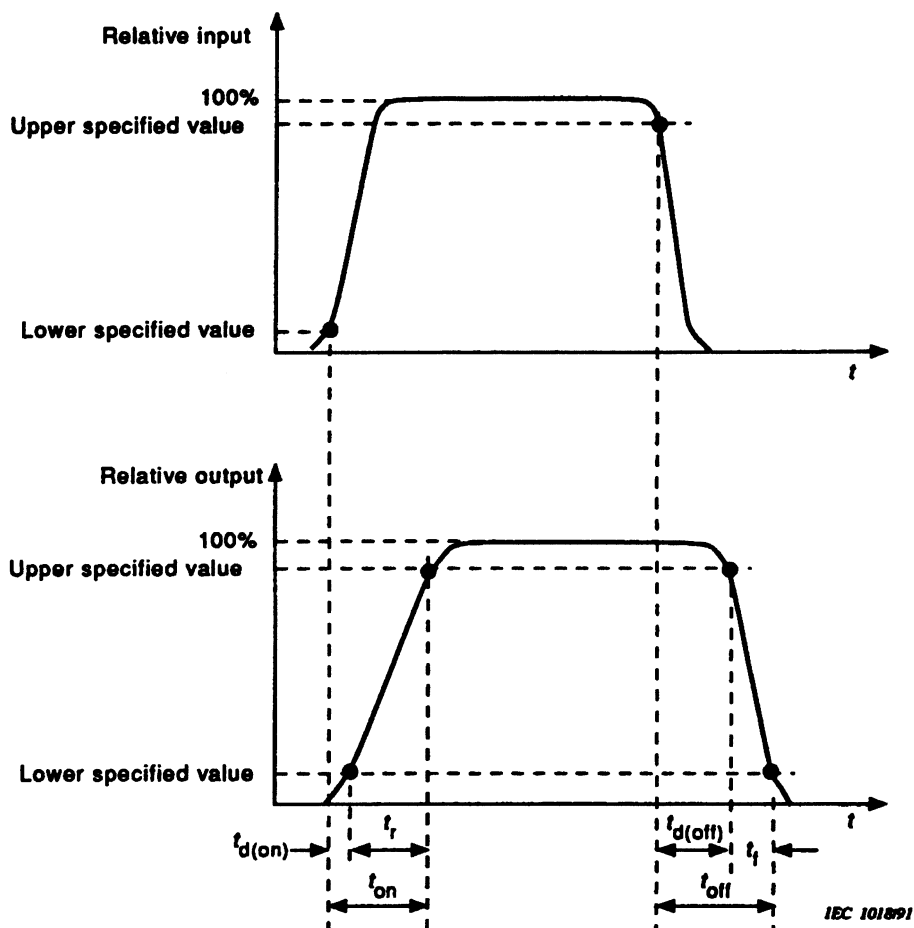


Figure 4 — Switching times

4.2 Photoemitters

4.2.1 Radiant power, luminous flux

4.2.1.1 Radiant power (of a photoemitter) ϕ_e

The radiant power emitted from the optical port of the device.

4.2.1.2 Luminous flux (of a photoemitter) ϕ_v

The luminous flux emitted from the optical port of the device.

4.2.2 Efficacies

4.2.2.1 Radiant power efficacy η_e , η radiant efficacy (of an infrared-emitting diode or a laser diode)

The quotient of the emitted radiant power ϕ_e , by the forward current I_F :

$$\eta_e = \phi_e / I_F$$

NOTE If no ambiguity is likely to occur, particularly with the term IEV 845-01-54: “radiant efficiency” $\eta_e = \phi_e / (I_F \cdot V_F)$, the term may be shortened to “radiant efficacy” or “efficacy”. This is nearly always possible.

4.2.2.2 Radiant intensity efficacy η_{ei} (of an infrared-emitting diode or a laser diode)

The quotient of the emitted radiant intensity I_e , by the forward current I_F :

$$\eta_{ei} = I_e / I_F$$

4.2.2.3 Luminous flux efficacy η_v luminous efficacy (of a light-emitting diode)

The quotient of the emitted luminous flux ϕ_v , by the forward current I_F :

$$\eta_v = \phi_v / I_F$$

NOTE If no ambiguity is likely to occur, particularly with the terms IEV 845-01-55: “luminous efficacy of a source” $\eta_v = \phi_v / (I_F \cdot V_F)$, or IEV 845-01-56: “luminous efficacy of a radiation” $K = \phi_v / \phi_e$, the term may be shortened to “luminous efficacy” or “efficacy”. This is nearly always, possible.

4.2.2.4 Luminous intensity efficacy η_{vi} (of a light-emitting diode)

The quotient of the emitted luminous intensity I_v , by the forward current I_F :

$$\eta_{vi} = I_v / I_F$$

4.2.2.5 Differential radiant power efficacy η_{ed} , η_d differential radiant efficacy (of an infrared-emitting diode or a laser diode)

The radiant power efficacy for small-signal modulation:

$$\eta_{ed} = d\phi_e / dI_F$$

NOTE 1 If no ambiguity is likely to occur, the shorter term and letter symbol may be used.

NOTE 2 The term “small-signal modulation efficacy” is in use as synonym.

4.2.2.6 Differential radiant intensity efficacy η_{eid} (of an infrared-emitted diode or a laser diode)

The radiant intensity efficacy for small-signal modulation:

$$\eta_{eid} = dI_e / dI_F$$

4.2.2.7 Differential luminous flux efficacy η_{vd} , η_d differential luminous efficacy (of a light-emitting diode)

The luminous flux efficacy for small-signal modulation:

$$\eta_{vd} = d\phi_v / dI_F$$

NOTE 1 If no ambiguity is likely to occur, the shorter term and letter symbol may be used.

NOTE 2 The term “small-signal modulation efficacy” is in use as synonym.

4.2.2.8 Differential luminous intensity efficacy η_{vid} (of a light-emitting diode)

The luminous intensity efficacy for small-signal modulation:

$$\eta_{vid} = dI_v / dI_F$$

4.2.2.9 Large-signal radiant power efficacy η_{EL} , η_L large-signal radiant efficacy (of an infrared-emitting diode or a laser diode)

The radiant power efficacy for large-signal modulation:

$$\eta_{EL} = \Delta\phi_e / \Delta I_F$$

NOTE If no ambiguity is likely to occur, the shorter term and letter symbol may be used.

4.2.2.10 Large-signal radiant intensity efficacy η_{EIL} (of an infrared-emitting diode or a laser diode)

The radiant intensity efficacy for large-signal modulation:

$$\eta_{EIL} = \Delta I_e / \Delta I_F$$

4.2.2.11 Large-signal luminous flux efficacy η_{VL} , η_L large-signal luminous efficacy (of a light-emitting diode)

The luminous flux efficacy for large-signal modulation:

$$\eta_{VL} = \Delta\phi_v / \Delta I_F$$

NOTE If no ambiguity is likely to occur, the shorter term and letter symbol may be used.

4.2.2.12 Large-signal luminous intensity efficacy η_{VIL} (of a light-emitting diode)

The luminous intensity efficacy for large-signal modulation:

$$\eta_{VIL} = \Delta I_v / \Delta I_F$$

4.2.3 Cut-off frequency

4.2.3.1 Small-signal (modulation) cut-off frequency f_{cd} , f_c (of a photoemitting diode)

The frequency at which, for constant modulation depth of the forward current, the demodulated a.c. optical radiant power has decreased to 1/2 of its low-frequency value.

4.2.3.2 Large-signal (modulation) cut-off frequency f_{CL} , f_C (of a photoemitting diode)

Under consideration.

4.2.4 Threshold current (of a laser diode) I_{TH}

The forward current at which the second derivative of the curve showing radiant power ϕ_e versus forward current I_F has its first maximum (see Figure 5).

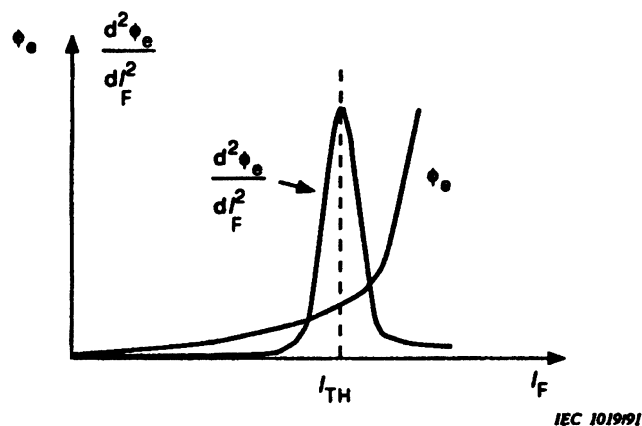


Figure 5 — Threshold current of a laser diode

4.2.5 Spatial radiation diagram and related characteristics (of a photoemitter)

4.2.5.1 Radiation diagram

A diagram that characterizes the distribution of radiant (or luminous) intensity:

$$I_e \text{ (or } I_v) = f(\theta) \text{ (see Figure 6a and Figure 6b)}$$

NOTE 1 Unless otherwise stated, the distribution of the radiant (or luminous) intensity should be specified in a plane. This plane includes the mechanical axis z .

NOTE 2 If the radiation pattern has a rotational symmetry of the z axis, the radiation diagram shall be specified for one plane only.

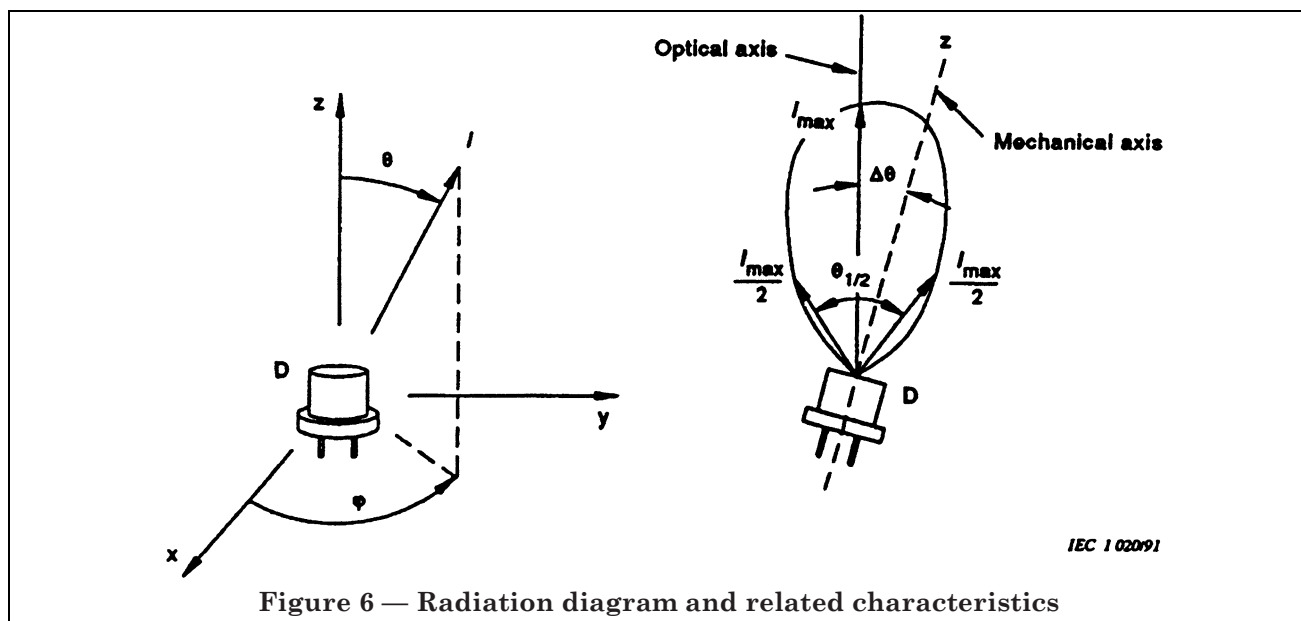
NOTE 3 If the radiation pattern has no rotational symmetry to the z axis, radiation diagrams for various angles ϕ shall be specified. Then the x , y and z directions shall be defined by a drawing in the detail specification.

4.2.5.2 Half-intensity angle $\theta_{1/2}$

In a radiation diagram, the angle within which the radiant (or luminous) intensity is greater than or equal to half of the maximum intensity (see Figure 6b).

4.2.5.3 Misalignment angle $\Delta\theta$

In a radiation diagram, the angle between the direction for maximum radiant (or luminous) intensity (optical axis) and the mechanical axis z (see Figure 6b).



4.2.6 Spectral characteristics (of light-emitting diodes and infrared-emitting diodes) (see Figure 7)

4.2.6.1 Peak-emission wavelength λ_p

The wavelength at which the spectral radiant power is a maximum.

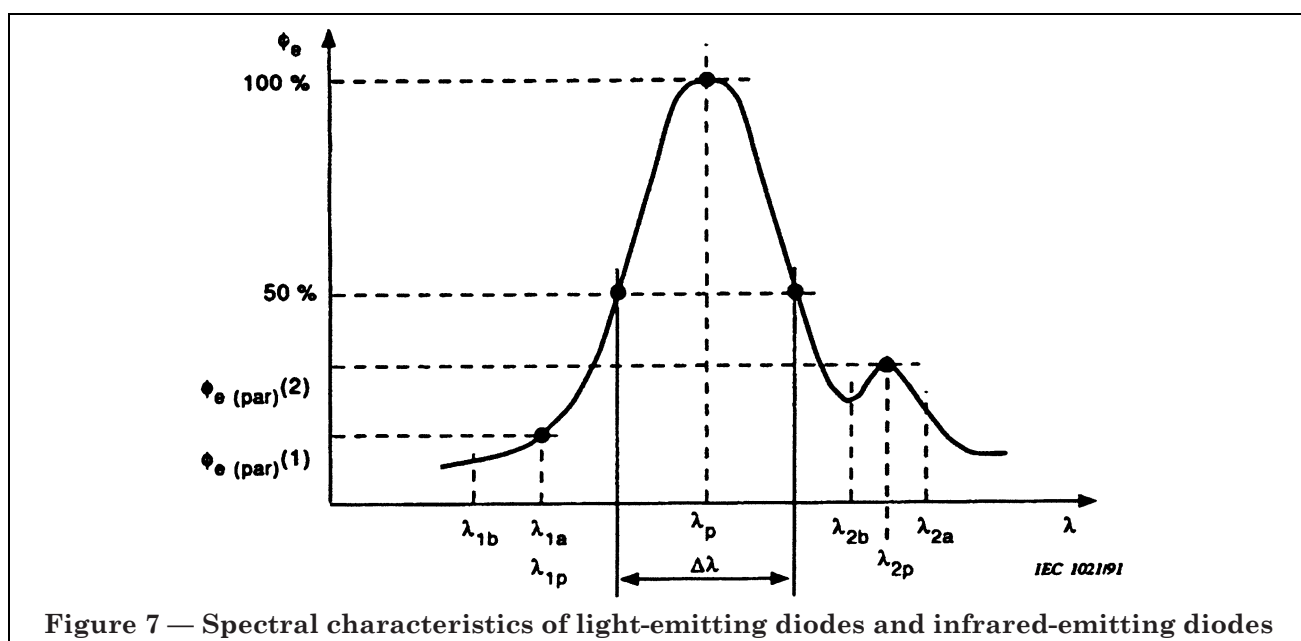
4.2.6.2 Spectral bandwidth $\Delta\lambda$

The wavelength interval in which the spectral radiant power is greater or equal to half of its maximum value.

4.2.6.3 (Relative) parasitic radiant power $\phi_{e(par)}$ or luminous flux $\phi_{v(par)}$

The value of undesired spectral radiant power (or luminous flux) in two specified wavelength ranges that lie below and above the peak-emission wavelength, expressed as a percentage of the radiant power (or luminous flux) at peak-emission wavelength.

NOTE Specified values refer to the maximum value within each of the specified wavelength ranges.



4.2.7 Spectral characteristics (of laser diodes and laser-diode modules) (see Figure 8)

4.2.7.1 Peak-emission wavelength λ_p

The wavelength at the peak value of the mode with the maximum spectral radiant power.

4.2.7.2 Spectral radiation bandwidth $\Delta\lambda$

The bandwidth that includes all wavelengths at which the radiant power is equal to or greater than a specified percentage of the power at the peak-emission wavelength.

NOTE 1 Unless otherwise stated, the specified percentage is 50 %.

NOTE 2 The definition allows peak values lower than the specified percentage to be present within this bandwidth.

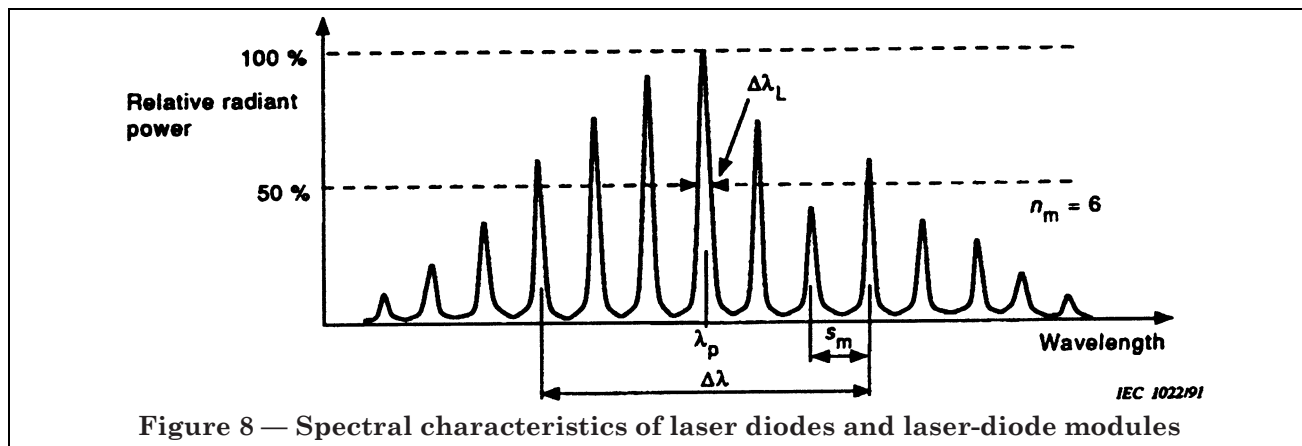


Figure 8 — Spectral characteristics of laser diodes and laser-diode modules

4.2.7.3 Line width $\Delta\lambda_L$

The wavelength interval between those points of an emission line at which the spectral radiant power is half of its maximum value.

4.2.7.4 Central wavelength $\bar{\lambda}$

The weighted average of the mode wavelengths:

$$\bar{\lambda} = \frac{\sum_{i=-\infty}^{i=+\infty} a_i \times \lambda_i}{\sum_{i=-\infty}^{i=+\infty} a_i}$$

where

λ_i is the wavelength
 a_i is the amplitude

of the i -th spectral line with $i = 0$ for λ_p

4.2.7.5 RMS bandwidth $\Delta\lambda_{\text{rms}}$

The RMS bandwidth is defined by the expression:

$$\Delta\lambda_{\text{rms}} = \sqrt{\frac{\sum_{i=-\infty}^{i=+\infty} a_i \times (\lambda_i - \bar{\lambda})^2}{\sum_{i=-\infty}^{i=+\infty} a_i}}$$

where

λ_i is the wavelength
 a_i is the amplitude
 $\bar{\lambda}$ is the central wavelength

of the i -th spectral line, with $i = 0$ for λ_p

4.2.7.6 Number of longitudinal modes n_m

The number of longitudinal modes within spectrum bandwidth, including the modes at the band limits.

4.2.7.7 Mode spacing s_m

The difference in wavelength for two neighbouring longitudinal modes.

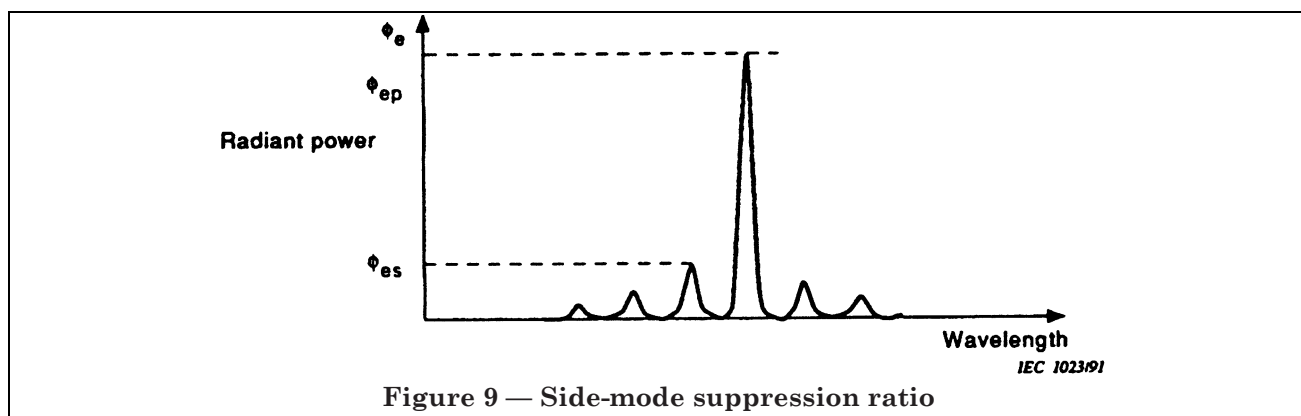
4.2.7.8 Side-mode suppression ratio SMS

The ratio of:

- the radiant power at the peak-emission wavelength ϕ_{ep} ; to
- the radiant power of the next most intense mode ϕ_{es} (see Figure 9).

NOTE Side-mode suppression ratio is normally expressed as:

$$SMS = 10 \cdot \log \left(\frac{\phi_{ep}}{\phi_{es}} \right) \quad [\text{dB}]$$



4.2.7.9 Spectral shift (versus current or temperature) $\Delta\lambda_c$

Under consideration.

4.2.7.10 Input reflection coefficient s_{11}

Under consideration.

4.2.7.11 Radiant power (of a laser chip or submount) ϕ_{e00}

See Chapter III, Section 8, subclause 6.1.

4.2.8 Emission source (of a laser diode)

4.2.8.1 Emission source width s_w

On the facet of the laser diode, in the direction of the major axis, the width within which the radiant intensity is larger than or equal to a specified percentage of the maximum value (see Figure 10).

NOTE 1 The direction of the major axis is the direction parallel to the PN junction plane.

NOTE 2 Unless otherwise stated, the specified percentage is 50 %.

4.2.8.2 Emission source height s_h

On the facet of the laser diode, in the direction of the minor axis, the height within which the radiant intensity is larger than or equal to a specified percentage of the maximum value (see Figure 10).

NOTE 1 The direction of the minor axis is the direction perpendicular to the PN junction plane.

NOTE 2 Unless otherwise stated, the specified percentage is 50 %.

4.2.8.3 Astigmatism d_A

An astigmatism of the emitted radiation that comes from a difference in curvature of the wave front in the directions of the major and minor axis, respectively, whereby usually the centre of the curvature in the direction of the major axis is farther behind the facet than in the other direction.

NOTE 1 The astigmatism can be represented by the curvature $d_A = a - b$ of a convex virtual emission source (see Figure 10).

NOTE 2 The value of d_A is calculated from the difference in position of the focussing lens when the focussed beam diameter is minimum in each of the two directions.

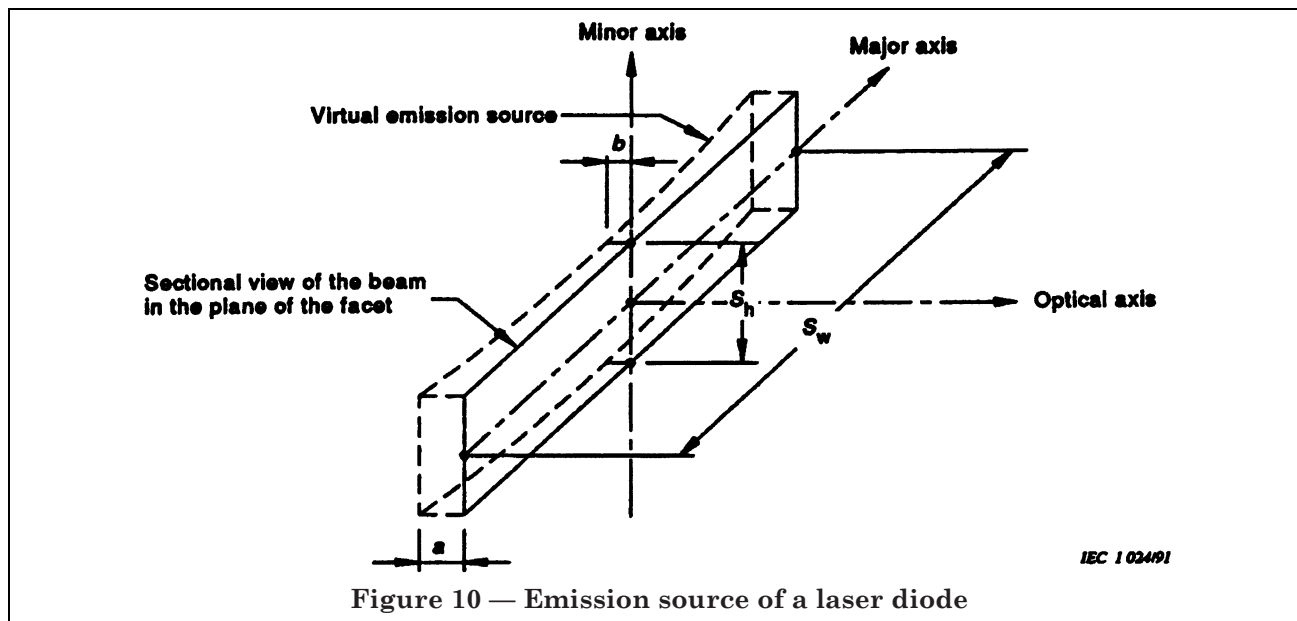


Figure 10 — Emission source of a laser diode

4.2.9 Noise characteristics (of laser diodes)

4.2.9.1 Relative intensity noise RIN

Under consideration.

4.2.9.2 Carrier-to-noise ratio C/N

The quotient of:

- the mean square radiant power at the specified frequency; to
- the mean square radiant power fluctuations normalized to a frequency band of unit width centered on the carrier frequency.

4.2.9.3 K -factor; mode partition noise

Under consideration.

4.2.10 Additional characteristics (of laser-diode modules)

4.2.10.1 Tracking error

Under consideration.

4.3 Photosensitive devices

4.3.1 Output currents (of a photodiode)

NOTE The subscripts D for dark and P for photo are still under consideration.

4.3.1.1 Reverse current (under optical radiation) $I_{R(H)}$ or $I_{R(e)}$, I_R

The total reverse current when the photodiode is exposed to incident optical radiation.

4.3.1.2 Dark current $I_{R(D)}$

The reverse current in the absence of incident optical radiation.

4.3.1.3 Photocurrent I_p

That part of the reverse current that is caused by incident optical radiation:

$$I_p = I_{R(H)} - I_{R(D)}$$

4.3.2 Output currents (of a phototransistor)

4.3.2.1 Collector current (under optical radiation) $I_{C(H)}$ or $I_{C(e)}$, I_c

The total collector current when the phototransistor is exposed to incident optical radiation.

4.3.2.2 Collector-emitter dark current I_{CEO}

The collector current in the absence of incident optical radiation.

4.3.3 Sensitivity

4.3.3.1 (Diode) sensitivity S_D , S (of a photodiode)

The quotient of

- the photocurrent I_p , by
- the irradiance E_e (or illuminance E_v) at the optical port of the photodiode.

$$S_D = \frac{I_p}{E_e} \quad \text{or} \quad S_D = \frac{I_p}{E_v}$$

NOTE If no ambiguity is likely to occur, the shorter term and letter symbol may be used.

4.3.3.2 (Fibre-input) sensitivity S_{FD} , S (of a photodiode irradiated [illuminated] from the front end of an optical fibre) (see Figure 11)

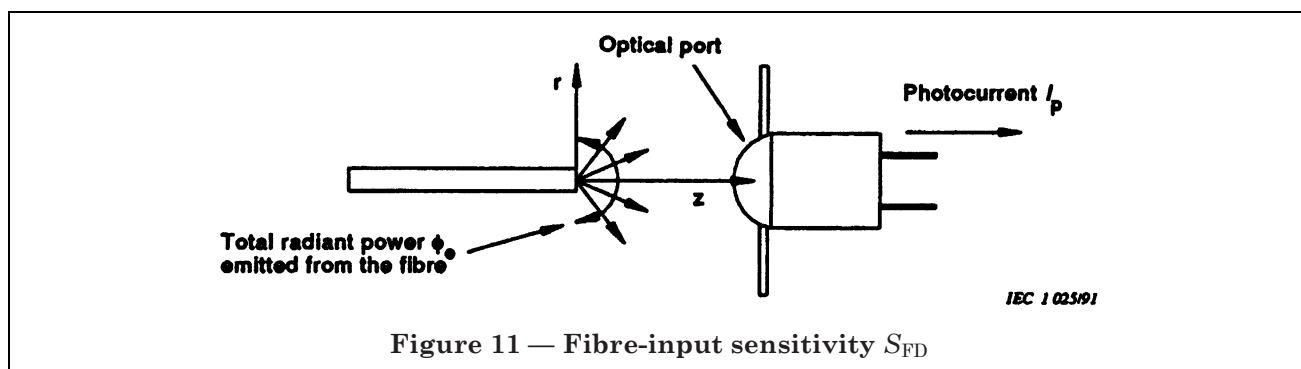
The quotient of

- the photocurrent I_p , by
- the radiant power ϕ_e (or luminous flux ϕ_v) emitted from the optical fibre, for specified values of the radial displacement r and the distance z of the front end of the optical fibre, relative to the optical port of the photodiode.

$$S_{FD} = \frac{I_p}{\phi_e} \quad \text{or} \quad S_{FD} = \frac{I_p}{\phi_v}$$

NOTE 1 If no ambiguity is likely to occur, the shorter term and letter symbol may be used.

NOTE 2 In specifications, usually curves are given showing S_{FD} as a function of r and z .



4.3.4 Cut-off frequency (of a photodiode)

4.3.4.1 Small-signal cut-off frequency f_{cd} , f_c

The frequency at which, for constant small signal modulation depth of the input radiant power, the demodulated signal power has decreased to 1/2 of its low-frequency value.

NOTE When, for the measurement of f_c , the photocurrent of the photodiode is observed, a 1-to-2 decrease in radiant power corresponds to a 1-to-2 decrease in photocurrent. Therefore, when the latter is measured as a voltage drop across a load resistance, the criterion of a 1-to-2 decrease applies also to the voltage, provided the load resistance is small compared with the output resistance of the photodiode.

4.3.4.2 Large-signal cut-off frequency f_{CL} , f_C

The frequency at which, for constant large signal modulation depth of the input radiant power, the demodulated signal power has decreased to 1/2 of its low-frequency value.

NOTE The note to subclause 4.3.4.1 applies accordingly.

4.3.5 Spatial sensitivity diagram and related characteristics (of photosensitive devices)

4.3.5.1 Sensitivity diagram

As diagram that characterizes the distribution of sensitivity:

$S = f(\theta)$ (see Figure 12a and Figure 12b)

NOTE 1 Unless otherwise stated, the distribution of sensitivity should be specified in a plane. This plane includes the mechanical axis z .

NOTE 2 If the sensitivity pattern has a rotational symmetry to the z axis, the sensitivity diagram shall be specified for one plane only.

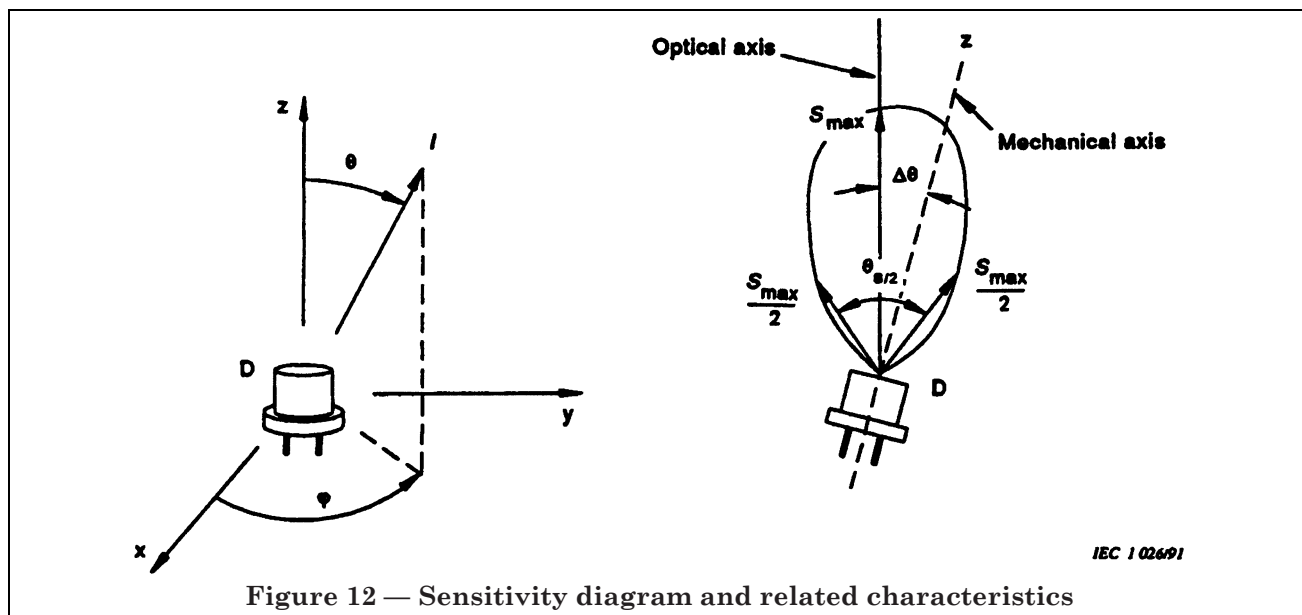
NOTE 3 If the sensitivity pattern has no rotational symmetry to the z axis, sensitivity diagrams for various angles θ shall be specified. Then the x , y and z directions shall be defined by a drawing in the detail specification.

4.3.5.2 Half-sensitivity angle $\theta_{S/2}$

In a sensitivity diagram, the angle within which the sensitivity is greater than or equal to half of the maximum sensitivity (see Figure 12b).

4.3.5.3 Misalignment angle $\Delta\theta$

In a sensitivity diagram, the angle between the direction for maximum sensitivity (optical axis) and the mechanical axis z (see Figure 12b).



4.3.6 Spectral characteristics (of photosensitive devices)

4.3.6.1 Peak-sensitivity wavelength λ_p

The wavelength at which the spectral sensitivity is a maximum.

4.3.7 Multiplication factor M (of an avalanche photodiode)

The ratio of:

- the photocurrent under a condition at which carrier multiplication takes place (I_{R1} at V_{R1}); to
- the photocurrent under a condition at which no carrier multiplication takes place (I_{R2} at V_{R2});

$$M = \frac{I_{R1}}{I_{R2}} \text{ (see Figure 13)}$$

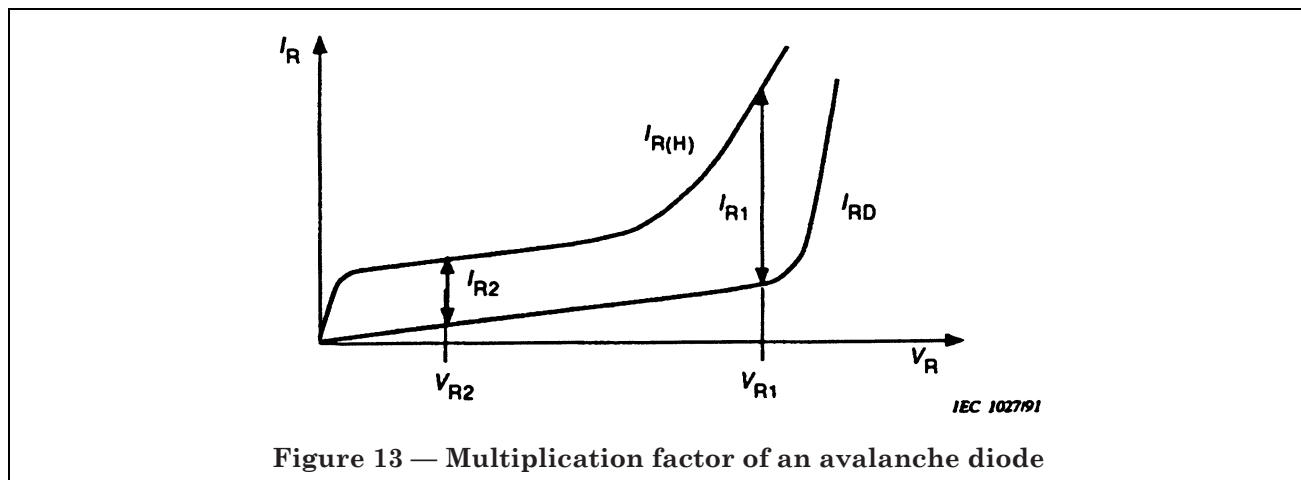


Figure 13 — Multiplication factor of an avalanche diode

4.3.8 Excess noise factor (of an avalanche photodiode)

Under consideration.

4.4 Photocouplers, optocouplers

4.4.1 Current transfer ratio

4.4.1.1 Static value of the (forward) current transfer ratio $h_{F(ctr)}$, h_F

The ratio of the d.c. output current to the d.c. input current, the output voltage being held constant.

NOTE The abbreviation CTR(d.c.) is sometimes used instead of a symbol.

4.4.1.2 Small-signal short-circuit (forward) current transfer ratio $h_{f(ctr)}$, h_f

The ratio of the a.c. output current to the a.c. input current, the output being short-circuited to a.c.

NOTE The abbreviation CTR(a.c.) is sometimes used instead of a symbol.

4.4.2 Cut-off frequency f_{ctr}

The frequency at which the modulus of the small-signal current transfer ratio has decreased to $1/\sqrt{2}$ of its low-frequency value.

4.4.3 Input-to-output capacitance C_{IO}

The total capacitance between all input terminals connected together and all output terminals connected together.

4.4.4 Isolation resistance R_{IO}

The resistance between all input terminals connected together and all output terminals connected together.

4.4.5 Isolation voltage

The voltage between any specified input terminal and any specified output terminal.

4.4.5.1 D.C. isolation voltage V_{IO}

The value of the constant isolation voltage.

4.4.5.2 Repetitive peak isolation voltage V_{IORM}

The highest instantaneous value of the isolation voltage including all repetitive transient voltages, but excluding all non-repetitive transient voltages.

NOTE A repetitive transient voltage is usually a function of the circuit. A non-repetitive transient voltage is usually due to an external cause and it is assumed that its effect has completely disappeared before the next non-repetitive voltage transient arrives.

4.4.5.3 Surge isolation voltage V_{IOSM}

The highest instantaneous value of an isolation voltage pulse of short time duration and of specified waveshape.

4.5 Liquid crystal display devices

4.5.1 Addressing

Selecting the pixels in space and/or time for activation or deactivation.

4.5.2 Contrast [IEV 45-25-265]

Subjective assessment of the difference in appearance of two parts of a field of view seen simultaneously or successively.

4.5.3 Contrast ratio

The ratio between the higher, L_H and lower, L_L luminances that define the feature to be detected, measured by contrast ratio (CR), defined as:

$$CR = \frac{L_H}{L_L}$$

(see 2.22 of ISO 9241-3).

4.5.4 Direct addressing

A method of addressing by applying a signal to a terminal that corresponds to one pixel only. Hence, all pixels can be addressed individually, in groups or simultaneously.

4.5.5 Driver

A device that transforms the address information into driving signals suitable for selecting a pixel. The same signals may also activate the pixel.

4.5.6 Duty ratio

The reciprocal value of the number of pixel groups which are addressed in a multiplex addressing scheme (e.g. the reciprocal of the number of rows for a row-at-a-time matrix addressing scheme).

4.5.7 Electro-optic characteristic

The variation of a photometric property (e.g. luminance or contrast) as a function of electrical drive quantities (voltage or current).

4.5.8 Image polarity

The relationship between background brightness and image brightness.

The presentation of brighter images on a darker background is designated by negative polarity, and darker images on a brighter background is designated by positive polarity.

4.5.9 Matrix addressing

A method of addressing in which a pixel is selected by applying signals to the terminals that correspond to its row and column. Hence, an individual pixel is addressed by selecting groups in space and time.

NOTE A typical example is a panel with row and intersecting column electrodes.

4.5.10 Multiplex driving

A method of temporal driving in which a first set of pixel groups is selected in a sequence once in a time frame and a second set of intersecting pixel groups is selected according to the pattern to be displayed.

NOTE A typical example is a cell with row and intersecting column electrodes in which one row is selected at a time.

4.5.11 Static driving

A method of driving in which all pixels are addressed simultaneously and constantly.

5 Letter symbols

Under consideration.

Chapter III. Essential ratings and characteristics

Section 1. Light-emitting diodes

(Excluding devices for fibre optic systems or subsystems dealt with in Section 7)

1 Type

Ambient-rated or case-rated light-emitting diode.

2 Semiconductor material

Gallium arsenide-phosphide, etc.

3 Colour

4 Details of outline and encapsulation

4.1 IEC and/or national reference number of the outline drawing.

4.2 Method of encapsulation: glass/metal/plastic/other.

4.3 Terminal identification and indication of any connection between a terminal and the case.

5 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated

5.1 Minimum and maximum storage temperatures (T_{stg}).

5.2 Minimum and maximum operating ambient or case temperature (T_{amb} or T_{case}).

5.3 Maximum reverse voltage (V_{R}).

NOTE Not applicable to dual-diode devices connected anode-to-cathode and cathode-to-anode.

5.4 Maximum continuous forward current (I_{F}) at an ambient or case temperature of 25 °C and derating curve or derating factor.

5.5 Where appropriate, maximum peak forward current (I_{FM}) at an ambient or case temperature of 25 °C, under specified pulse conditions.

6 Electrical characteristics

For multiple diodes, the characteristics should be given for each diode. For special applications, additional characteristics may be required.

Ref.	Characteristics	Conditions at T_{amb} or $T_{\text{case}} = 25\text{ }^{\circ}\text{C}$, unless otherwise stated	Notes	Symbols	Requirements	
6.1	Forward voltage	I_F specified (d.c. or pulse)		V_F		Max.
6.2	Reverse current	V_R specified	1	I_R		Max.
6.3	luminous intensity along the defined mechanical axis	I_F specified (d.c. or pulse)	2, 3	I_v	Min.	
6.4	Peak emission wavelength	I_F specified (d.c. or pulse)		λ_p	Min.	Max.
6.5	Spectral radiation bandwidth (where appropriate)	Half value of peak emission, with I_F as specified in subclause 6.4		$\Delta\lambda$		Max.
6.6	Switching times (where appropriate)					Max.
6.7	Half-intensity angle (where appropriate)					Max.

NOTE 1 Not applicable to dual-diode devices connected anode-to-cathode and cathode-to-anode.

NOTE 2 If the included solid angle over which the intensity is measured is not negligible, it should be specified.

NOTE 3 For diodes intended for use in multi-diode arrays, maximum luminous intensity is also required.

7 Supplementary information

7.1 Radiation diagram

A diagram graphically expressing typical luminous intensity versus viewing angle, and using either polar or rectangular co-ordinates.

7.2 Spectral diagram (where appropriate)

A diagram graphically expressing typical luminous intensity versus wavelength.

7.3 Mechanical information

Mounting and soldering conditions, where appropriate.

Section 2. Infrared-emitting diodes

(Excluding devices for fibre optic systems or subsystems dealt with in Section 7)

1 Type

Ambient-rated or case-rated infrared-emitting diode.

2 Semiconductor material

Gallium arsenide, etc.

3 Details of outline and encapsulation

3.1 IEC and/or national reference number of the outline drawing.

3.2 Method of encapsulation: glass/metal/plastic/other.

3.3 Terminal identification and indication of any connection between a terminal and the case.

4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated

4.1 Minimum and maximum storage temperature (T_{stg}).

4.2 Minimum and maximum operating ambient or case temperature (T_{amb} or T_{case}).

4.3 Maximum reverse voltage (V_{R}).

4.4 Maximum continuous forward current (I_{F}) at an ambient or case temperature of 25 °C and derating curve or derating factor.

4.5 Where appropriate, maximum peak forward current (I_{PM}) at an ambient or case temperature of 25 °C, under specified pulse conditions.

5 Electrical characteristics

For special applications, additional characteristics may be required.

Ref.	Characteristics	Conditions at T_{amb} or $T_{\text{case}} = 25\text{ }^{\circ}\text{C}$, unless otherwise stated	Notes	Symbols	Requirements	
5.1	Foreward voltage	I_{F} specified (d.c. or pulse)	1	V_{F}		Max.
5.2	Reverse current	V_{R} specified		I_{R}		Max.
5.3	Radiant power output or radiant intensity along the defined mechanical axis	I_{F} specified (d.c. or pulse)		Φ_{e} I_{e}	Min. Min.	
5.4	Peak emission wavelength	I_{F} specified (d.c. or pulse)		λ_{p}	Min.	Max.
5.5	Spectral radiation bandwidth (where appropriate)	Half value of peak emission, with I_{F} as specified in subclause 5.4		$\Delta\lambda$		Max.
5.6	Switching times (where appropriate)					Max.
5.7	Half-intensity angle (where appropriate)					Max.
5.8	Capacitance (where appropriate)					Max.
NOTE If the included solid angle over which the intensity is measured is not negligible, it should be specified.						

6 Supplementary information

6.1 Radiation diagram

A diagram graphically expressing typical radiant power output or radiant intensity versus angle with respect to the defined mechanical axis, and using either polar or rectangular coordinates.

6.2 Spectral diagram (where appropriate)

A diagram graphically expressing typical radiant power output or radiant intensity versus wavelength.

6.3 Mechanical information

Mounting and soldering conditions, where appropriate.

Section 3. Photodiodes

(Excluding devices for fibre optic systems or subsystems)

1 Type

Ambient-rated or case-rated photodiode intended for small-signal and switching applications.

2 Semiconductor material

Silicon, etc.

3 Details of outline and encapsulation

3.1 IEC and/or national reference number of the outline drawing.

3.2 Method of encapsulation: glass/metal/plastic/other.

3.3 Terminal identification and indication of any connection between a terminal and the case.

4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated

4.1 Minimum and maximum storage temperatures (T_{stg}).

4.2 Minimum and maximum operating ambient or case temperature (T_{amb} or T_{case}).

4.3 Maximum reverse voltage (V_{R}).

4.4 Where appropriate:

- maximum total power dissipation (P_{tot}) up to ambient or case temperature of 25 °C; and
- derating factor above 25 °C (K_{t}) or derating curve.

5 Electrical characteristics

Ref.	Characteristics	Conditions at T_{amb} or $T_{\text{case}} = 25\text{ °C}$, unless otherwise stated	Notes	Symbols	Requirements	
5.1	Reverse current under irradiation	V_{R} specified E_{v} or E_{e} specified	1	$I_{\text{R(H)}}$ or $I_{\text{R(e)}}$	Min.	
5.2	Dark current	V_{R} specified, $E_{\text{e}} = 0$		I_{R}		Max.
5.3	Dark current	V_{R} specified, $E_{\text{e}} = 0$ at a specified high temperature T_{amb} or T_{case}		I_{R}		Max.
5.4	Where appropriate, spectral sensitivity	V_{R} specified, E_{e} specified, at a short wavelength λ_1 specified		S	Min.	
		and at a longer wavelength λ_2 specified		S	Min.	
5.5	Switching times (where appropriate): rise time and fall time or: turn-on time and turn-off time	Specified circuit specified value of V_{R} , E_{v} or E_{e} specified Specified circuit, specified value of V_{R} , E_{v} or E_{e} specified		t_{r} t_{f} t_{on} t_{off}		Max. Max. Max. Max.

NOTE Illumination by standard illuminant A (according to IEC Publication 306-1) emitted from a filament tungsten lamp with a colour temperature $T = 2\,855,6\text{ K}$ or with radiation from a defined monochromatic source.

6 Supplementary information

6.1 Diagram of typical sensitivity

6.2 Typical spectral diagram

A diagram graphically expressing relative spectral sensitivity versus wavelength.

Section 4. Phototransistors

(Excluding devices for fibre optic systems or subsystems)

1 Type

Ambient-rated or case-rated phototransistor intended for small-signal and switching applications.

2 Semiconductor material

Silicon, etc.

3 Polarity

NPN/PNP.

4 Details of outline and encapsulation

4.1 IEC and/or national reference number of the outline drawing.

4.2 Method of encapsulation: glass/metal/plastic/other.

4.3 Terminal identification and indication of any connection between a terminal and the case.

5 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated

5.1 Minimum and maximum storage temperature (T_{stg}).

5.2 Minimum and maximum operating ambient or case temperatures (T_{amb} or T_{case}).

5.3 Maximum collector-emitter voltage with zero base current (V_{CEO}).

5.4 Where an external base connection is present:

5.4.1 Maximum collector-base voltage with zero emitter current (V_{CBO}).

5.4.2 Maximum emitter-base voltage with zero collector current (V_{EBO}).

5.5 Where no external base connection is present:

Maximum emitter-collector voltage (V_{ECO}).

5.6 Maximum continuous collector current (I_{C}).

5.7 Where appropriate:

- maximum total power dissipation (P_{tot}) up to ambient or case temperature of 25 °C; and
- derating factor above 25 °C (K_{t}) or derating curve.

6 Electrical characteristics

Ref.	Characteristics	Conditions at T_{amb} or $T_{case} = 25\text{ }^{\circ}\text{C}$, unless otherwise stated	Notes	Symbols	Requirements	
6.1	Collector current under irradiation	V_{CE} specified, $I_B = 0$ E_V or E_e specified	1	$I_{C(H)}$ or $I_{C(e)}$	Min.	Max. ^a
6.2	Collector-emitter dark current	V_{CE} specified, $I_B = 0$ $E_e = 0$		I_{CEO}		Max.
6.3	Collector-emitter dark current	V_{CE} specified, $I_B = 0$ $E_e = 0$, at a specified high temperature T_{amb} or T_{case}		I_{CEO}		Max.
6.4	Collector-emitter breakdown voltage	I_c specified, $I_B = 0$, $E_e = 0$		$V_{(BR)CEO}$	Min.	
6.5	Emitter-base breakdown voltage or, where no base connection is present, emitter-collector breakdown voltage	I_E specified, $E_e = 0$		$V_{(BR)EBO}$ $V_{(BR)ECO}$	Min. Min.	
6.6	Collector-emitter saturation voltage	I_c specified, $I_B = 0$, E_V or E_e specified, preferably as in subclause 6.1	1	V_{CEsat}		Max.
6.7	Where appropriate, spectral sensibility	$I_B = 0$, E_e specified, at a short wavelength λ_1 specified and at a longer wavelength λ_2 specified		S S	Min. Min.	
6.8	Switching times (where appropriate): rise time and fall time	Specified circuit, specified values of V_{CE} and I_C , E_V or E_e specified		t_r t_f		Max. Max.
	or turn-on time and turn-off time	Specified circuit, specified values of V_{CE} and I_C , E_V or E_e specified		t_{on} t_{off}		Max. Max.
NOTE Illumination at standard illuminant A (according to IEC Publication 306-1) emitted from a tungsten filament lamp with a colour temperature $T = 2\,855,6\text{ K}$ or with radiation from a defined monochromatic source.						
^a Where appropriate.						

7 Supplementary information

7.1 Diagram of typical sensitivity

7.2 Typical spectral diagram

A diagram graphically expressing relative spectral sensitivity versus wavelength.

Section 5. Photocouplers, optocouplers

(with output transistor)

1 Type

Ambient-rated or case-rated photocouplers, optocouplers, with transistor output, for signal-isolation applications.

2 Semiconductor material

input diode: gallium arsenide, aluminium arsenide, etc.

output transistor: silicon, etc.

3 Polarity of the output resistor

4 Details of outline and encapsulation

4.1 IEC and/or national reference number of the outline drawing.

4.2 Method of encapsulation: glass/metal/plastic/other.

4.3 Terminal identification and indication of any connection between a terminal and the case.

5 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated

Indicate any qualifications such as time, frequency, pulse duration, humidity, etc.

5.1 Minimum and maximum storage temperatures (T_{stg}).

5.2 Minimum and maximum ambient or reference-point operating temperatures (T_{amb} or T_{ref}).

5.3 Maximum soldering temperature (T_{sld}).

Maximum soldering time and minimum distance to case should be specified.

5.4 Maximum continuous (direct) reverse input voltage (V_{R}).

5.5 Maximum collector-emitter voltage, with the base open-circuited (V_{CEO}).

5.6 Maximum collector-base voltage, where an external base connection is present, with the emitter open-circuited (V_{CBO}).

5.7 Maximum emitter-base voltage, where an external base connection is present, with the collector open-circuited (V_{EBO}).

or:

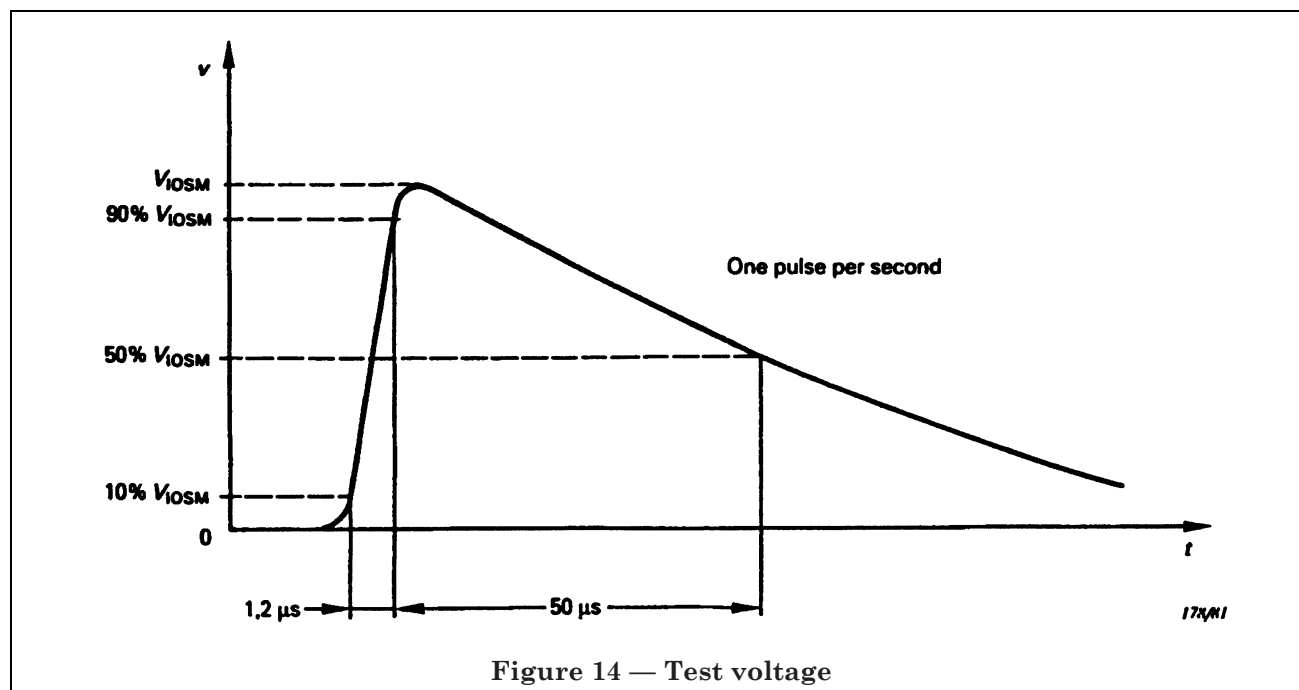
5.8 Maximum emitter-collector voltage, where no external base connection is present (V_{ECO}).

5.9 Maximum continuous (direct) or repetitive peak isolation voltage (V_{IO} or V_{IORM}).

The waveshape and repetition rate should be specified.

5.10 Where appropriate, maximum surge isolation voltage (V_{IOSM}).

This should be specified for pulses of both polarities having the waveshape shown in Figure 14.



5.11 Maximum continuous collector current (I_C).

5.12 Maximum continuous forward input current (I_F) at an ambient or reference-point temperature of 25 °C and derating curve or derating factor.

5.13 Maximum peak forward input current (I_{FRM}) at an ambient or reference-point temperature of 25 °C and under specified pulse conditions.

5.14 Maximum power dissipation (P_{trn}) of the output transistor at an ambient or reference-point temperature of 25 °C and a derating curve or derating factor.

5.15 Maximum total power dissipation of the package (P_{tot}) at an ambient or reference-point temperature of 25 °C and derating curve or derating factor.

6 Electrical characteristics

Ref.	Characteristics	Conditions at T_{amb} or $T_{case} = 25\text{ }^{\circ}\text{C}$, unless otherwise stated	Notes	Symbols	Requirements	
6.1	Input diode forward voltage	I_F specified		V_F		Max.
6.2	Input diode reverse current	V_R specified		I_R		Max.
6.3	Collector-emitter dark current	V_{CE} specified, $I_F = 0$ $I_B = 0$ (base open circuit)		I_{CEO}		Max.
	or, where appropriate ^a , collector-base dark current	V_{CB} specified, $I_F = 0$, $I_E = 0$		I_{CBO}		Max.
6.4	Collector-emitter dark current	V_{CE} specified, I_F and $I_B = 0$, T_{amb} or T_{ref} specified		I_{CEO}		Max.
	or, where appropriate ^a , collector-base dark current	V_{CB} specified, $I_F = 0$, $I_E = 0$ T_{amb} or T_{ref} specified		I_{CBO}		Max.
6.5	Collector-emitter saturation voltage	I_F and I_C specified, $I_B = 0$		V_{CEsat}		Max.
	or, where appropriate ^a , collector-base voltage	I_F and I_C specified, $I_B = 0$		V_{CB}		Max.
6.6	Current transfer ratio	I_F or I_C and V_{CE} specified, $I_B = 0$		h_F or CTR (d.c.)	Min.	Max.
6.7	Where appropriate, differential current transfer ratio	I_F or I_C and V_{CE} specified, $I_B = 0$, frequency specified		h_f or CTR (a.c.)	Min.	Max.
6.8	Isolation resistance between input and output	V_{IO} specified	1	r_{IO}	Min.	
6.9	Where appropriate, input-to-output capacitance	$f = 1\text{ MHz}$, $I_F = 0$, $I_C = 0$	1	C_{io}		Max.
6.10	Where appropriate, switching times: turn-on time and turn-off time	Specified V_{CC} , I_F and R_L , and nominal I_c , test circuit specified		t_{on} t_{off}		Max. Max.
	or: rise time and fall time	Specified V_{CC} , I_F and R_L , nominal I_C test circuit specified		t_r t_f		Max. Max.
6.11	Where appropriate, cut-off frequency	I_f or I_C et V_{CE} specified, $I_B = 0$	2	F_{ctr}	Min.	
NOTE 1 All input terminals should be connected together and all output terminals should be connected together.						
NOTE 2 The cut-off frequency is the lowest frequency at which the magnitude of the a.c. current transfer ratio is 0,707 times its value at very low frequency.						
^a For operation in the diode mode.						

7 Supplementary information

Under consideration.

Section 6. Laser diodes

1 Type

Ambient-rated or case-rated laser diodes for the following applications:

- Type A: general
- Type B: focussed laser beam
- Type C: optical digital transmission
- Type D: optical analogue transmission

2 Semiconductor

2.1 Material

Material such as GaAs, GaAlAs, InGaAsP.

2.2 Structure

Structure such as gain guiding, index guiding, distributed feed-back.

3 Details of outline and encapsulation

3.1 IEC and/or national reference number of the outline drawing.

3.2 Method of encapsulation: glass/metal/plastic/other.

3.3 Terminal identification and indication of any electrical connection between a terminal and the case.

3.4 Characteristics of the optical port: orientation relative to mechanical axes, position relative to mechanical axes, area, numerical aperture.

3.5 Information on the pigtail fibre (where appropriate): type of fibre, kind of protection, connector, length.

4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise stated

4.1 Minimum bend radius of the pigtail, where appropriate.

4.2 Maximum pull force pigtail (fibre or cable), where appropriate, in the direction of the axis of the input pigtail (fibre or cable).

4.3 Minimum and maximum storage temperatures (T_{stg})

4.4 Minimum and maximum operating temperatures.

4.4.1 Ambient or case temperature (T_{amb} or T_{case}).

4.4.2 Submount temperature, where appropriate (T_{sub}).

4.5 Maximum soldering temperature (soldering time and minimum distance to case) (T_{slid}).

4.6 Maximum reverse voltage (V_{R}).

4.7 One or more of the following at an ambient or case temperature of 25 °C together with a derating curve or derating factor with temperature:

- Maximum continuous forward current (I_{FM}).
- Maximum continuous radiant power (Φ_{eM}).
- Maximum pulsed forward current at stated frequency and pulse duration (I_{FM}).
- Maximum pulsed radiant power at stated frequency and pulse duration (Φ_{eM}).

5 Electrical and optical characteristics

Radiant power shall be specified as continuous or pulsed as appropriate to the device. ΔI_{F} indicates a forward current above the measured threshold current $I_{\text{(TH)}}$ of the device being measured.