

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Semiconductor optoelectronic devices for fibre optic system applications –
Part 1: Specification template for essential ratings and characteristics**

**Dispositifs optoélectroniques à semi-conducteurs pour application dans les
systèmes à fibres optiques –
Partie 1: Modèle de spécification relatif aux valeurs et caractéristiques
essentielles**



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**Dispositifs optoélectroniques à semiconducteurs pour application dans les
systèmes à fibres optiques –
Partie 1: Modèle de spécification relatif aux valeurs et caractéristiques
essentielles**

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**SEMICONDUCTOR OPTOELECTRONIC DEVICES
FOR FIBRE OPTIC SYSTEM APPLICATIONS –****Part 1: Specification template for essential ratings and characteristics**

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International Standard IEC 62007-1 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

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

- 1) The definitions of some symbols and terms are revised in order to harmonize them with those in other SC 86C documents.
- 2) A clause on APD-TIA has been added.

The text of this standard is based on the following documents:

| CDV | Report on voting |
|--------------|------------------|
| 86C/1256/CDV | 86C/1283/RVC |

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62007 series, published under the general title *Semiconductor optoelectronic devices for fibre optic system applications*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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

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SEMICONDUCTOR OPTOELECTRONIC DEVICES FOR FIBRE OPTIC SYSTEM APPLICATIONS –

Part 1: Specification template for essential ratings and characteristics

1 Scope

This part of IEC 62007 is a specification template for essential ratings and characteristics of the following categories of semiconductor optoelectronic devices to be used in the field of fibre optic systems and subsystems:

- semiconductor photoemitters;
- semiconductor photoelectric detectors;
- monolithic or hybrid integrated optoelectronic devices and their modules.

This part of IEC 62007 provides a frame for the preparation of detail specifications for the essential ratings and characteristics.

In using this part of IEC 62007, detail specification writers add but do not delete specification parameters and/or groups of specification parameters for particular applications.

2 Normative references (standards.iteh.ai)

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60825 (all parts), *Safety of laser products*

IEC 60747-5-1, *Discrete semiconductor devices and integrated circuits – Part 5-1: Optoelectronic devices – General*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions concerning physical concepts, types of devices, general terms, and ratings and characteristics given in IEC 60747-5-1 and the following apply.

3.1.1

PIN photodiode

photodiode with a large intrinsic region sandwiched between P- and N-doped semiconducting regions used for the detection of optical radiation

[SOURCE: IEC 60050-731-06-29, modified — The note has been deleted.]

3.1.2 avalanche photodiode APD

photodiode operating with a bias voltage such that the primary photocurrent undergoes amplification by cumulative multiplication of charge carriers

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60050-731-06-30, modified — The note has been deleted.]

3.1.3 *RIN* relative intensity noise

quotient of the radiant power mean square fluctuations $\langle \Delta \Phi_e^2 \rangle$ to the mean square radiant power $\langle \Phi_e \rangle^2$, normalized to a frequency band of unit width

Note 1 to entry: *RIN* is usually expressed in dB/Hz.

$$RIN = 10 \log_{10} \left\{ \frac{\langle \Delta \Phi_e^2 \rangle}{\langle \Phi_e \rangle^2 \times \Delta f} \right\}$$

Note 2 to entry: This note applies to the French language only.

3.1.4 $\Delta \lambda_c$ spectral shift

deviation of the peak-emission wavelength at a particular case temperature or a particular forward current from its value at a specified reference case temperature or a specified reference forward current, respectively

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Note 1 to entry: The specific reference temperature is typically 25 °C.
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3.1.5 S_{11} input reflection coefficient

quotient of the high frequency reflected voltage to the high frequency incident voltage

3.1.6 E_{tr} tracking error

deviation of the radiant power at a particular case temperature from its value at a specified reference case temperature

Note 1 to entry: The specific reference temperature is typically 25 °C.

Note 2 to entry: Specifications usually refer to the maximum deviation (absolute value) in two specified temperature ranges below and above the specified reference case temperature.

Note 3 to entry: The tracking error is usually expressed as a percentage of the radiant power at the reference case temperature.

3.1.7 R_D R diode responsivity

responsivity
<photodiode> quotient of the photocurrent I_p by the radiant power Φ_e at the optical port of the photodiode

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

Note 2 to entry: Photodiode means a complete device such as:

- chip itself;
- packaged component with window or pigtail.

3.1.8

 F_e

excess noise factor

noise resulting from the spatial and timing fluctuations of the avalanche carrier multiplication, defined as the ratio of the noise power at a specified reverse bias to the amplified shot noise of the photocurrent at a reference reverse bias

Note 1 to entry: The reference reverse voltage should be sufficiently low that no carrier multiplication takes place but sufficiently large that the device is fully depleted and has achieved its rated speed and responsivity.

3.1.9

 P_o

overload

maximum received power of a photodiode for obtaining a given bit error rate

3.2 Abbreviations

| | |
|------|---|
| APD | avalanche photodiode |
| BH | buried heterostructure |
| CMOS | complementary metal-oxide semiconductor |
| CW | continuous wave |
| FWHM | full width at half maximum |
| HBT | heterojunction bipolar transistor |
| LD | laser diode |
| LED | light emitting diode |
| MQW | multi-quantum well |
| RIN | relative intensity noise |
| TEC | thermo-electric cooler |
| TIA | transimpedance amplifier |

4 LEDs for fibre optic systems or subsystems

4.1 Type

Ambient-rated or case-rated LED with or without optical fibre pigtail for fibre optic systems or subsystems

4.2 Semiconductor materials

GaAs, GaAlAs, InGaAs, InP, etc.

4.3 Details of outline and encapsulation

4.3.1 IEC and/or national reference number of outline drawing

4.3.2 Method of encapsulation: glass/metal/plastic/other

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

4.3.4 Characteristics of the optical port: relative orientation to mechanical axis, relative position to mechanical axis, area, numerical aperture

4.3.5 For devices with a fibre pigtail: information on the pigtail fibre, kind of protection, connector, length

4.3.6 Information on the heat sink of the package

4.4 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated

See Table 1.

Table 1 – Limiting values for LEDs

| Characteristics | Symbol | Requirements ^a | | Unit |
|--|-------------------------|---------------------------|-------------|-----------------------|
| | | Min. | Max. | |
| Storage temperature | T_{stg} | x | x | °C |
| Temperature: either ambient temperature or case temperature | T_{amb} T_{case} | x x | x x | °C °C |
| Soldering temperature at maximum soldering time and minimum distance to case specified | T_{sld} | | x | °C |
| Reverse voltage | V_R | | x | V |
| Continuous forward current Derating curve or derating factor | I_F | | x | mA |
| Repetitive peak forward current at specified pulse conditions (where appropriate) Derating curve or derating factor (where appropriate) | I_{FRM} | | x | mA |
| Power dissipation Derating curve or derating factor (where appropriate) | P_{tot} | | x | W |
| For case-rated devices: Virtual junction temperature (where appropriate) | T_{vj} | | x | °C |
| For devices with pigtail: Bend radius of pigtail (at specified distance from the case) | r | x | | mm(cm) |
| Shock | | | x | m/s ² , s |
| Vibration | | | x | m/s ² , Hz |
| Tensile force on devices with pigtail: Untight structure: – Tensile force on fibre along its axis – Tensile force on cladding along its axis Tight structure: – Tensile force on pigtail along its axis | F F F | | x x x | N N N |

^a x represents the value to be specified.

4.5 Electrical and optical characteristics

See Table 2.

Table 2 – Electrical and optical characteristics for LEDs

| Characteristics | Conditions at T_{amb} or $T_{case} = 25\text{ °C}$ unless otherwise stated | Symbol | Requirements ^b | | Unit |
|---|---|---|---------------------------|------------------|------------------------------|
| | | | Min. | Max. | |
| Forward voltage | I_F or Φ_e specified | V_F | | x | V |
| Reverse current | V_R specified | I_R | | x | mA |
| Differential resistance | I_F or Φ_e specified | r_d | | x | Ω |
| Total capacitance | V_R, f specified | C_{tot} | | x | μF |
| Noise parameter either relative intensity noise ^a or carrier-to-noise ratio ^a | I_F or $\Phi_e, f_o, \Delta f_N$ specified I_F or $\Phi_e, f_c, \Delta f_N, f_m, m$ specified | RIN C/N | | x | dB/Hz dB |
| Output parameter either radiant output power or forward current | I_F specified (d.c. or pulse, or both) Φ_e specified | Φ_e I_F | x x^a | x^a x | mW mA |
| For devices without pigtail: Half-intensity angle ^a | I_F or Φ_e , angle ϕ specified | $\theta_{1/2}$ | | x | $^\circ$ |
| For devices without pigtail: Misalignment angle ^a | I_F or Φ_e , angle ϕ specified | $\Delta\theta$ | | x | $^\circ$ |
| Spectral radiation bandwidth | I_F or Φ_e specified | $\Delta\lambda$ | | x | nm |
| Bandwidth either switching times: – rise time – fall time – delay times ^a – peak emission wavelengths or cut-off frequency | d.c. current input pulse current pulse width and duty cycle specified I_F or Φ_e specified | t_r t_f $t_{d(on)},$ $t_{d(off)}$ f_c | | x x x x | s s s s nm Hz |
| ^a Where appropriate. | | | | | |
| ^b x represents the value to be specified. | | | | | |

4.6 Supplementary information

4.6.1 Typical curve or coefficient

Provide the curve or coefficient in 4.6.1.1 or 4.6.1.2.

4.6.1.1 Typical curve or coefficient of radiant power versus temperature and typical curve of radiant output power versus forward current (d.c. or pulse, as specified)

4.6.1.2 Typical curve or coefficient of radiant intensity versus temperature and typical curve of radiant intensity versus forward current (d.c. or pulse, as specified)

4.6.2 Typical curve or coefficient of change in peak emission wavelength versus temperature

4.6.3 Typical radiation diagram

4.6.4 Thermal resistance, ambient-rated or case-rated

5 Laser module with pigtails

5.1 Type

The laser module consists of the following basic parts:

- laser diode
 - pigtail
 - photodiodes
 - thermal sensor
 - TEC element
- } where appropriate

5.2 Semiconductor

5.2.1 Materials

The laser module consists of the following materials:

- laser diode (e.g. GaAs, GaAlAs, InGaAsP, InP)
 - photodiode (e.g. Ge, Si, GaInAs)
 - thermal sensor
 - TEC element
- } where appropriate

5.2.2 Structure

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Laser diode, e.g. gain guided, index guided, distributed feedback

5.3 Details of outline and encapsulation

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5.3.1 IEC and/or national reference number of the outline drawing

5.3.2 Method of encapsulation: glass/metal/plastic/other

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

5.3.4 Information on the pigtail fibre, e.g. type of fibre, kind of protection, connector, length

5.3.5 Information on the heatsinking of the package

5.4 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated

5.4.1 General conditions

- 5.4.1.1 Minimum and maximum storage temperatures (T_{stg})
- 5.4.1.2 Minimum and maximum operating case temperatures (T_{case})
- 5.4.1.3 Minimum and maximum operating submount temperature (T_{sub})
- 5.4.1.4 Maximum soldering temperature (soldering time and minimum distance to case) (T_{sold})
- 5.4.1.5 Minimum bend radius of pigtail (at specified distance from the case) (r)
- 5.4.1.6 Shock (maximum acceleration and pulse duration)
- 5.4.1.7 Vibration (maximum acceleration and frequency range)
- 5.4.1.8 Tensile force along cable axis

5.4.1.8.1 Untight structure

- Maximum tensile force on fibre (F)
- Maximum tensile force on cable (F)

5.4.1.8.2 Tight structure

- Maximum tensile force on cable (F)

5.4.2 Laser diode

For laser module without TEC, derating curve or derating factor shall be given for one of the parameters 5.4.2.2 to 5.4.2.5. For laser module with TEC, $T_{\text{sub}} = 25\text{ °C}$.

- 5.4.2.1 Maximum reverse voltage (V_{R})
- 5.4.2.2 Maximum continuous forward current (I_{F})
- 5.4.2.3 Maximum continuous radiant power (ϕ_{e})
- 5.4.2.4 Maximum pulsed forward current at stated frequency and pulse duration (I_{FP})
- 5.4.2.5 Maximum pulsed radiant power at stated frequency and pulse duration (ϕ_{ep})

5.4.3 Photodiode

- 5.4.3.1 Maximum reverse voltage (V_{R})
- 5.4.3.2 Maximum forward current (I_{F})

5.4.4 Thermal sensor (where appropriate)

5.4.4.1 Maximum ratings

- 5.4.4.1.1 Maximum power dissipation (P)

or

- 5.4.4.1.2 Maximum voltage supply (V)