BS EN 62007-1:2015

BSI Standards Publication

Semiconductor optoelectronic devices for fibre optic system applications

Part 1: Specification template for essential ratings and characteristics

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 62007-1:2015. It is identical to IEC 62007-1:2015. It supersedes BS EN 62007-1:2009 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/3, Fibre optic systems and active devices.

A list of organizations represented on this committee can be obtained on request to its secretary.

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

Published by BSI Standards Limited 2015

ISBN 978 0 580 81906 3
ICS 31.080.01; 31.260; 33.180.01

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2015.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 62007-1

June 2015

ICS 31.080.01; 31.260; 33.180.01

Supersedes EN 62007-1:2009

English Version

Semiconductor optoelectronic devices for fibre optic system applications - Part 1: Specification template for essential ratings and characteristics (IEC 62007-1:2015)

Dispositifs optoélectroniques à semiconducteurs pour application dans les systèmes à fibres optiques - Partie 1: Modèle de spécification relatif aux valeurs et caractéristiques essentielles (IEC 62007-1:2015)

Optoelektronische Halbleiterbauelemente für Anwendungen in Lichtwellenleitersystemen - Teil 1: Vorlage für Leistungsspezifikationen für wesentliche Grenz- und Kennwerte (IEC 62007-1:2015)

This European Standard was approved by CENELEC on 2015-05-04. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

The text of document 86C/1256/CDV, future edition 3 of IEC 62007-1, prepared by SC 86C "Fibre optic systems and active devices" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62007-1:2015.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-02-04
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-05-04

This document supersedes EN 62007-1:2009.

EN 62007-1:2015 includes the following significant technical changes with respect to EN 62007-1:2009:

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62007-1:2015 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

Publication	Year	Title	EN/HD	Year
IEC 60825	Series	Safety of laser products	EN 60825	Series
IEC 60747-5-1	-	Discrete semiconductor devices and integrated circuits - Part 5-1: Optoelectronic devices - General	EN 60747-5-1	-

CONTENTS

FOREWORD....5
1 Scope....7
2 Normative references....7
3 Terms, definitions and abbreviations....7
3.1 Terms and definitions....7
3.2 Abbreviations....9
4 LEDs for fibre optic systems or subsystems....9
4.1 Type....9
4.2 Semiconductor materials....9
4.3 Details of outline and encapsulation....9
4.4 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated....10
4.5 Electrical and optical characteristics....10
4.6 Supplementary information....11
5 Laser module with pigtails....12
5.1 Type....12
5.2 Semiconductor....12
5.2.1 Materials....12
5.2.2 Structure....12
5.3 Details of outline and encapsulation....12
5.4 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated....13
5.4.1 General conditions....13
5.4.2 Laser diode....13
5.4.3 Photodiode....13
5.4.4 Thermal sensor (where appropriate)....13
5.4.5 Thermoelectric cooler (where appropriate)....14
5.5 Electric and optical characteristics....14
5.6 Supplementary information....15
5.7 Hazards....16
6 PIN photodiodes for fibre optic systems or subsystems....16
6.1 Type....16
6.2 Semiconductor materials....16
6.3 Details of outline and encapsulation....16
6.4 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated....17
6.5 Electrical and optical characteristics....18
6.6 Supplementary information....18
7 Avalanche photodiodes (APDs) with or without pigtails....19
7.1 Type....19
7.2 Semiconductor....19
7.3 Details of outline and encapsulation....19
7.4 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated....19
7.5 Electrical and optical characteristics....19
7.6 Supplementary information....20
8 PIN-TIA modules for fibre optic systems or subsystems....21

8.1 Type 21
8.2 Semiconductor materials 21
8.3 Structure 21
8.4 Details of outline and encapsulation 21
8.5 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated 22
8.6 Operating conditions at T_{amb} = 25 °C, unless otherwise stated 22
8.7 Electrical and optical characteristics 23
8.8 Supplementary information 23
9 APD-TIA modules for fibre optic systems or subsystems 24
9.1 Type 24
9.2 Semiconductor materials 24
9.3 Structure 24
9.4 Details of outline and encapsulation 24
9.5 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated 24
9.6 Electrical and optical characteristics 25
10 Laser diode modules for pumping an optical fibre amplifier 26
10.1 Type 26
10.2 Semiconductor materials 26
10.3 Structure 26
10.4 Details of outline and encapsulation 26
10.5 Limiting values (absolute maximum ratings) over the operating temperature range, unless otherwise stated 27
10.6 Electrical and optical characteristics 27
10.7 Supplementary information 29
10.8 Hazards 29
11 Optical modulators for digital fibre optic applications 29
11.1 Type 29
11.2 Materials 29
11.3 Structure 29
11.4 Details of outline and encapsulation 30
11.5 Limiting values (absolute maximum ratings) 30
11.6 Electrical and optical characteristics 31
11.7 Supplementary information 32
11.8 Hazards 32
Bibliography 33

Table 1 – Limiting values for LEDs 10
Table 2 – Electrical and optical characteristics for LEDs 11
Table 3 – Electric and optical characteristics for laser modules with pigtails 14
Table 4 – Limiting values for PIN photodiodes 17
Table 5 – Electrical and optical characteristics for PIN photodiodes 18
Table 6 – Electrical and optical characteristics for avalanche photodiodes (APDs) with or without pigtails 20
Table 7 – Limiting values for PIN-TIA modules 22
Table 8 – Operating conditions for PIN-TIA modules 22
Table 9 – Electrical and optical characteristics for PIN-TIA modules 23

Table 10 – Limiting values for APD-TIA modules 25
Table 11 – Electrical and optical characteristics for APD-TIA modules 25
Table 12 – Limiting values for laser diode modules for pumping an optical fibre amplifier 27
Table 13 – Electrical and optical characteristics for laser diode modules for pumping an optical fibre amplifier 28
Table 14 – Limiting values for optical modulators for digital fibre optic applications 30
Table 15 – Electrical and optical characteristics for optical modulators for digital fibre optic applications 31

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

_____

SEMICONDUCTOR OPTOELECTRONIC DEVICES FOR FIBRE OPTIC SYSTEM APPLICATIONS –

Part 1: Specification template for essential ratings and characteristics

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

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 $<\Delta\Phi_e^2>$ to the mean square radiant power $<\Phi_e>^2$, normalized to a frequency band of unit width

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

$$RIN = 10\log_{10}\left\{<\Delta\Phi_e^2>\Big/\left(<\Phi_e>^2 \times \Delta f\right)\right\}$$

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

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

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	T_{amb}	x	x	°C
or case temperature	T_{case}	x	x	°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	 F F		 x x	 N N
Tight structure: – Tensile force on pigtail along its axis	 F		 x	 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 °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]	I_F or Φ_e, f_o, Δf_N specified	RIN		x	dB/Hz
or carrier-to-noise ratio[a]	I_F or Φ_e, f_c, Δf_N, f_m, m specified	C/N		x	dB
Output parameter					
either radiant output power	I_F specified (d.c. or pulse, or both)	Φ_e	x	x[a]	mW
or forward current	Φ_e specified	I_F	x[a]	x	mA
For devices without pigtail: Half-intensity angle[a]	I_F or Φ_e, angle ϕ specified	$\theta_{1/2}$		x	°
For devices without pigtail: Misalignment angle[a]	I_F or Φ_e, angle ϕ specified	$\Delta\theta$		x	°
Spectral radiation bandwidth	I_F or Φ_e specified	$\Delta\lambda$		x	nm
Bandwidth					
either switching times:	d.c. current			x	s
– rise time	input pulse current	t_r		x	s
– fall time	pulse width and duty cycle specified	t_f		x	s
– delay times[a]		$t_{d(on)}$, $t_{d(off)}$		x	s
– peak emission wavelengths					nm
or cut-off frequency	I_F or Φ_e specified	f_c	x		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

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

5.3 Details of outline and encapsulation

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_{sld})

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_{sub} = 25 °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)

5.4.5 Thermoelectric cooler (where appropriate)

5.4.5.1 Maximum cooler current under cooling and heating (I_{PE})

5.5 Electric and optical characteristics

See Table 3.

Table 3 – Electric and optical characteristics for laser modules with pigtails

Characteristics	Conditions at T_{sub} = 25 °C for laser with TEC, T_{amb} or T_{case} = 25 °C for laser module without TEC unless otherwise stated	Symbol	Requirements[c]		Unit
			Min.	Max.	
A. Laser diode					
Forward voltage	I_F or Φ_e specified	V_F		x	V
Threshold current		$I_{(TH)}$	x	x	mA
Radiant power at threshold	$I_F = I_{TH}$	$\phi_{e(TH)}$		x	μW
Forward current above threshold (for laser module without TEC)	Φ_e specified $T = T_{case}$ max. or T_{amb} max.	ΔI_F		x	mA
Differential efficacy (for laser module without TEC)	Φ_e or ΔI_F specified $T = T_{case}$ max. or T_{amb} max.	η_d	x	x	
Spectral characteristics					
Peak emission wavelength	Φ_e or ΔI_F specified CW-operation	λ_p[a]	x	x	nm
Either spectral radiation bandwidth FWHM	Φ_e or ΔI_F specified CW-operation	λ_p[a]		x	nm
or mode spacing and number of longitudinal modes	Φ_e or ΔI_F specified CW-operation	η_m		x	
Peak emission wavelength under modulation	Φ_e or ΔI_F specified modulation condition specified	λ_p[b]	x	x	nm
Spectral radiation bandwidth under modulation	Φ_e or ΔI_F specified modulation condition specified	λ_p[b]		x	
Additional spectral characteristics					
and/or centroidal wavelength	Φ_e or ΔI_F specified CW-operation	λ_{avg}[a]	x	x	nm
and/or spectral radiation r.m.s. bandwidth	Φ_e or ΔI_F specified	$\Delta\lambda_{rms}$[a]		x	nm
or mode spacing and number of longitudinal modes	Φ_e or ΔI_F specified	η_m		x	
or central wavelength under modulation	Φ_e or ΔI_F specified modulation condition specified	λ[b]	x	x	nm
or spectral radiation r.m.s. bandwidth under modulation	Φ_e or ΔI_F specified modulation condition specified	$\Delta\lambda_{rms}$[b]		x	nm
Single spectral mode laser module under specified direct modulation					
Spectral mode width	Φ_e or ΔI_F specified modulation condition specified	$\Delta\lambda_L$		x	nm
Side-mode suppression ratio	Φ_e or ΔI_F specified modulation condition specified	$SMSR$	x		dB
Spectral shift					
Spectral shift for module with TEC	ΔI_{F1}, ΔI_{F2}, ϕ_{e1}, ϕ_{e2}	$\Delta\lambda_c$		x	nm
Spectral shift for laser module without TEC	T_{amb}[a] or T_{case}[a], T_{amb}[b] or T_{case}[b]	$\Delta\lambda_c$		x	nm
Transient parameters					

Characteristics	Conditions at T_{sub} = 25 °C for laser with TEC, T_{amb} or T_{case} = 25 °C for laser module without TEC unless otherwise stated	Symbol	Requirements[c]		Unit
			Min.	Max.	
Rise time, fall time and/or Turn-on time, turn-off time	Bias current ΔI_F or ϕ_e input pulse current width and duty cycle specified Bias current ΔI_F or ϕ_e input pulse current width and duty cycle specified	t_r, t_f t_{on}, t_{off}		x x x x	s s s s
Cut-off frequency	Φ_e or ΔI_F specified	f_c	x	x	Hz
Carrier-to-noise ratio	ΔI_F or Φ_e, Δf, f_m, m and f_0 specified	C/N	x		dB
B. Monitor photodiode					
Dark current	Φ_e = 0 V_R specified	$I_{r(0)}$		x	μA
Reverse current under optical radiation	Φ_e or ΔI_F specified V_R specified	$I_{R(e)}$	x	x	μA
Diode capacitance or rise/fall time					
Either diode capacitance	V_R and f specified	C_{tot}		x	pF
or rise time, fall time	Φ_e or ΔI_F specified V_R specified	t_r, t_f		x	s
Tracking error	Either Φ_e or ΔI_F and V_R specified, Temperature range: 25 °C to T_{case} min. or T_{amb} min. or Φ_e or ΔI_F and V_R specified, Temperature range: 25 °C to T_{case} min. or T_{amb} min.	E_{R1} E_{R2}		x x	
C. Thermistor (where appropriate)					
Resistance	Thermistor current I_{tc} specified	R	x	x	Ω
Slope of resistance	Thermistor current I_{tc} specified. Temperature range: T_{sub}[a], T_{sub}[b]	$\Delta R/R$	x	x	
D. TEC current (where appropriate)					
TEC current	Φ_e or ΔI_F specified, Temperature range: T_{case} min. or T_{case} max.	I_{PE}		x	A
TEC voltage	Φ_e or ΔI_F specified, Temperature range: T_{case} or T_{amb} min. and max.	V_{PE}		x	V

[a] CW-operation.

[b] In modulation.

[c] x represents the value to be specified.

5.6 Supplementary information

5.6.1 DC forward current of the laser diode corresponding to ϕ_{eoo}

NOTE ϕ_{eoo} is the radiant power value of the laser chip on submount, representative of the performance and reliability of devices manufactured using the same technology and submitted to the same quality assurance procedures.

5.6.2 Response time of the thermistor temperature to the change of cooler current (where appropriate)

5.6.3 Thermal resistance between laser diode junction and case (without cooler): $R_{thj\text{-}c}$

5.6.4 s_{11} parameter

5.7 Hazards

See IEC 60825.

6 PIN photodiodes for fibre optic systems or subsystems

6.1 Type

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

6.2 Semiconductor materials

Si, Ge, InGaAs, etc.

6.3 Details of outline and encapsulation

6.3.1 IEC and/or national reference number of outline drawing

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

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

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

6.3.5 For devices with pigtail: information on the pigtail fibre, type of fibre, kind of protection, connector, length

6.3.6 Information on the heat sink of the package

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

See Table 4.

Table 4 – Limiting values for PIN photodiodes

Characteristics	Symbol	Requirements[a]		Unit
		Min.	Max.	
Storage temperature	T_{stg}	x	x	°C
Temperature				
either ambient temperature	T_{amb}	x	x	°C
or case temperature	T_{case}	x	x	°C
Soldering temperature at maximum soldering time and minimum distance to case specified	T_{sld}		x	°C
Reverse voltage	V_R		x	V
Power dissipation	P_{tot}		x	W
Radiant power on the sensitive area	Φ_e		x	W
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	F		x	N
– Tensile force on cladding along its axis	F		x	N
Tight structure:				
– Tensile force on pigtail along its axis	F		x	N

[a] x represents the value to be specified.

6.5 Electrical and optical characteristics

See Table 5.

Table 5 – Electrical and optical characteristics for PIN photodiodes

Characteristics	Conditions at T_{amb} or T_{case} = 25 °C unless otherwise stated	Symbol	Requirements[c]		Unit
			Min.	Max.	
Dark current					
Dark current	V_R specified, $\Phi_e = 0$	$I_{R(D)}$[a]		x	µA
Dark current at high temperature	V_R specified, $\Phi_e = 0$ T_{amb} or T_{case} specified	$I_{R(D)}$[b]		x	µA
Total capacitance	V_R, f specified, $\Phi_e = 0$	C_{tot}		x	pF
Noise current	V_R, $I_{R(e)}$, f_0, Δf_N, R_L, λ_p, $\Delta\lambda$ specified	I_n		x	µA
For devices without pigtail:					
Sensitivity along the specified mechanical axis	V_R, λ_p, $\Delta\lambda$, Φ_e specified	S_{FD}, S	x	x[a]	A/W
Spatial uniformity of sensitivity (where appropriate)	V_R, λ_p, $\Delta\lambda$ or Φ_e specified	ΔS		x	
For devices with pigtail: Sensitivity	V_R, λ_p, $\Delta\lambda$, Φ_e specified	S_{FD}, S	x	x[a]	
Bandwidth					GHz
either	V_R, λ_p, $\Delta\lambda$, pulse base Φ_{e1}, pulse top Φ_{e2}, R_L specified				
Switching time:					
– Rise time		t_r		x	s
– Fall time		t_f		x	s
– Delay times (where appropriate)		$t_{d(on)}$, $t_{d(off)}$		x	s
– Storage time		t_s		x	s
or					
Cut-off frequency	V_R, λ_p, $\Delta\lambda$, Φ_e, R_L specified	f_c	x		Hz

NOTE The specified voltage V_R is the same for all the characteristics, unless otherwise stated.

[a] Where appropriate.

[b] Term and/or letter symbol under consideration.

[c] x represents the value to be specified.

6.6 Supplementary information

6.6.1 Typical curve of dark current versus voltage, at different temperatures

6.6.2 Typical curve of total capacitance versus reverse voltage

6.6.3 Relative sensitivity versus wavelength

6.6.4 Relative sensitivity versus temperature

6.6.5 Derating curve or derating factor of maximum dissipation

7 Avalanche photodiodes (APDs) with or without pigtails

7.1 Type

Ambient-rated or case-rated APD for fibre optic systems or subsystems

7.2 Semiconductor

7.2.1 Materials: Si, Ge, InGaAs, etc.

7.2.2 Structure

7.3 Details of outline and encapsulation

7.3.1 IEC and/or national reference number of outline drawing

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

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

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

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

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

7.4.1 Minimum bend radius of the pigtail, where appropriate

7.4.2 Minimum and maximum storage temperature (T_{stg})

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

7.4.4 Maximum soldering temperature (T_{sld}) (soldering time and minimum distance to case to be specified)

7.4.5 Maximum power dissipation at ambient or case temperature of 25 °C (P_{tot}) and derating curve or derating factor

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

7.4.7 Maximum reverse current (I_R)

7.4.8 Maximum forward current (I_F)

7.5 Electrical and optical characteristics

V_R shall be the same for all characteristics; it shall be equal to 0,9 times the individually measured value of $V_{(BR)}$, unless otherwise specified.

See Table 6.

Table 6 – Electrical and optical characteristics for avalanche photodiodes (APDs) with or without pigtails

Characteristics	Conditions at T_{amb} or T_{case} = 25 °C unless otherwise stated	Symbol	Requirements[c]		Unit
			Min.	Max.	
Breakdown voltage	E_e or ϕ_e = 0, I_R specified	$V_{(BR)}$	x	x	
Reverse dark current					
Reverse dark current (NOTE 1)	E_e or ϕ_e = 0, V_R specified	I_R[a]		x	μA
Reverse dark current (NOTE 2)	E_e or ϕ_e = 0, V_R specified $T = T_{amb}$ max. or T_{case} max.	I_R[b]		x	μA
Sensitivity					
Sensitivity (NOTE 1)	V_{R1} (NOTE 2), ϕ_e, λ_{pp}, $\Delta\lambda$ specified	S[a]	x	x (NOTE 1)	A/W
Sensitivity (NOTE 2)	V_R, ϕ_e, λ_p, $\Delta\lambda$ specified	S[b]	x	x (NOTE 2)	A/W
Multiplication factor	V_{R1} (NOTE 2), λ_p, $\Delta\lambda$, ϕ_e specified	M	x		
Total capacitance	E_e or ϕ_e = 0; V_R, f specified	C_{tot}		x	pF
Small signal parameters					
Turn-on time and turn-off time	V_R, $\Delta\lambda$, R_L, ϕ_{e1}: peak radiant power ϕ_{e2}: offset radiant power	t_{on} t_{off}		x x	s s
Small signal cut-off frequency	V_R, λ_p, $\Delta\lambda$, ϕ_e and R_L specified	f_c	x		Hz
Excess noise factor	V_{R1} (NOTE 2), V_R, I_{PO}, λ_p, $\Delta\lambda$, M, f_0, Δf_N specified	F_e		x	
Noise current[a]	V_R, λ_p, $\Delta\lambda$, f, Δf_N specified	I_n		x	μA

NOTE 1 Where appropriate.

NOTE 2 Typically, V_{R1} is a small value at which negligible carrier multiplication takes place, or the voltage at which the device is fully depleted and has achieved its rated speed.

[a] Where appropriate.

[b] Term and/or letter symbol under consideration.

[c] x represents the value to be specified.

7.6 Supplementary information

7.6.1 Curve of breakdown voltage versus temperature

7.6.2 Curve of sensitivity versus wavelength

7.6.3 Curve of capacitance versus reverse voltage

7.6.4 Curve of multiplication factor versus reverse voltage at different temperatures

7.6.5 Curve of reverse dark current versus reverse voltage at different temperatures

7.6.6 Location of sensitive area by reference to the package (without pigtail)

7.6.7 Curve of excess noise factor versus reverse voltage (where appropriate)

7.6.8 Curve of noise current versus reverse voltage (where appropriate)

8 PIN-TIA modules for fibre optic systems or subsystems

8.1 Type

Ambient-rated or case-rated PIN-TIA modules for fibre optic systems or subsystems

The PIN-TIA module consists of the following basic parts:

– PIN photodiode;
– TIA circuits;
– fibre pigtail, pigtail connectors, receptacles (connectorized package).

8.2 Semiconductor materials

The PIN-TIA module consists of the following semiconductor materials:

– PIN photodiode: Si, Ge, InGaAs, etc.;
– TIA circuits: GaAs, Si, etc.

8.3 Structure

The structure of the PIN-TIA module is as follows:

– PIN photodiode: Mesa, planar, etc.;
– TIA circuits: CMOS, Bi-CMOS, HBT, Bi-polar etc.;
– information on the fibre coupling: taper type, lens coupling, etc.;
– information on the circuit: high impedance, transimpedance, bandwidth, etc.;
– information on the package: pigtail, receptacle (connectorized package), etc.

8.4 Details of outline and encapsulation

– IEC and/or national reference number of outline drawing
– Method of encapsulation: glass/metal/plastic/other
– Terminal identification and indication of any electrical connection between a terminal and the case
– Characteristics of the optical port: orientation relative to mechanical axis, position relative to mechanical axis, area, numerical aperture
– Information on the pigtail fibre: type of fibre, kind of protection, connector, length
– Information on the connector/receptacle

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

See Table 7.

Table 7 – Limiting values for PIN-TIA modules

Characteristics	Symbol	Requirements[a]		Unit
		Min.	Max.	
Storage temperature	T_{stg}	x	x	°C
Operating temperature				
either operating ambient temperature	T_{amb}	x	x	°C
or operating case temperature	T_{case}	x	x	°C
Soldering temperature at maximum soldering time and minimum distance to case specified	T_{sld}		x	°C
Supply voltages at specified terminals	V_{supp}	x	x	V
Radiant power at optical port	Φ_e		x	mW(W)
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 along cable axis:				
Untight structure – Tensile force on fibre – Tensile force on cable	 F F		 x x	 N N
Tight structure – Tensile force on cable	 F		 x	 N

[a] x represents the value to be specified.

8.6 Operating conditions at T_{amb} = 25 °C, unless otherwise stated

See Table 8.

Table 8 – Operating conditions for PIN-TIA modules

Characteristics	Symbol	Requirements		Unit
		Min.	Max.	
Supply voltages specified by terminal number	V_{supp}	x	x	V
Supply current (at T_{amb} max.) specified by terminal number	I_{supp}		x	mA
Load resistance	R_L	x		Ω

8.7 Electrical and optical characteristics

See Table 9.

Table 9 – Electrical and optical characteristics for PIN-TIA modules

Characteristics	Conditions at T_{amb} or T_{case} = 25 °C, unless otherwise stated	Symbol	Requirements[a]		Unit
			Min.	Max.	
Minimum detectable power	a) λ_p, $\Delta\lambda$, f_{mB}, B and C/N specified or b) λ_p, $\Delta\lambda$, bit rate, signal pattern and bit error rate specified	Φ_{eD}	x		dBm
Output noise power density	R_L, f_m, B, Φ_e specified λ_p, $\Delta\lambda$ specified	P_{n0}, λ		x	W/Hz
Frequency					
Low frequency output noise power density	R_L, f_m, B, λ_p and $\Delta\lambda$ specified, Φ_e = 0	P_{n0}, λ L_F		x	W/Hz
and Corner frequency	R_L, f_m, B, λ_p and $\Delta\lambda$ specified, Φ_e = 0	f_{cor}		x	Hz
Responsivity					
Responsivity (for module)	λ_p, $\Delta\lambda$, Φ_e, R_L specified	R_D	x		V/W
and					
Responsivity (for PIN photodiode only) (where appropriate)	V_R, λ_p, $\Delta\lambda$, Φ_e specified	R_D	x		A/W
Frequency response flatness	λ_p, $\Delta\lambda$, Φ_e, R_L specified f_1 and f_2 specified	$\Delta R_D/R_D$		x	
Bandwidth					
either					
Switching time:	λ_p, $\Delta\lambda$, Φ_{e1}, Φ_{e2}, R_L specified				
– Rise time – Fall time		t_r t_f		x x	ns ns
or Cut-off frequency	λ_p, $\Delta\lambda$, Φ_e, R_L specified	f_c	x		MHz (GHz)
Offset voltage (where appropriate)	λ_p, $\Delta\lambda$, Φ_e, R_L specified	V_{off}	x	x	V
Dark current (PIN photodiode only) (where appropriate)	V_R specified, Φ_e = 0	I_R		x	nA

[a] x represents the value to be specified.

8.8 Supplementary information

– Relative responsivity versus wavelength
– Typical thermal variation of the offset voltage
– Information on the equalization

9 APD-TIA modules for fibre optic systems or subsystems

9.1 Type

Ambient-rated or case-rated APD-TIA modules for fibre optic systems or subsystems

The APD-TIA module consists of the following basic parts:

– APD;
– TIA circuits;
– fibre pigtail, pigtail connectors, receptacles (connectorized package).

9.2 Semiconductor materials

The APD-TIA module consists of the following semiconductor materials:

– APD: Si, Ge, InGaAs, etc.;
– TIA circuits: GaAs, Si, etc.

9.3 Structure

The structure of the APD-TIA module is

– APD: Mesa, planar, etc.;
– TIA circuits: CMOS, Bi-CMOS, HBT, Bi-polar etc.;
– information on the fibre coupling: taper type, lens coupling, etc.;
– information on the circuit: high impedance, transimpedance, bandwidth, etc.;
– information on the package: pigtail, receptacle (connectorized package), etc.

9.4 Details of outline and encapsulation

– IEC and/or national reference number of outline drawing
– Method of encapsulation: glass/metal/plastic/other
– Terminal identification and indication of any electrical connection between a terminal and the case
– Characteristics of the optical port: orientation relative to mechanical axis, position relative to mechanical axis, area, numerical aperture
– Information on the pigtail fibre: type of fibre, kind of protection, connector, length
– Information on the connector/receptacle

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

See Table 10.

Table 10 – Limiting values for APD-TIA modules

Characteristics	Symbol	Requirements[a]		Unit
		Min.	Max.	
Storage temperature	T_{stg}	x	x	°C
Operating temperature Either operating ambient temperature or operating 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
Supply voltages at specified terminals	V_{supp}	x	x	V
APD reverse voltage	V_{br}		x	V
APD forward current and APD reverse current	I_f I_r		x x	mA mA
Optical input power	P_{in}		x	dBm
[a] x represents the value to be specified.				

9.6 Electrical and optical characteristics

See Table 11.

Table 11 – Electrical and optical characteristics for APD-TIA modules

Characteristics	Conditions at T_{amb} or T_{case} = 25 °C, unless otherwise stated	Symbol	Requirements[a]		Unit
			Min.	Max.	
Responsivity (for APD chip)	P_{in}, M, and λ_p specified	R_D	x		A/W
Breakdown voltage	I_r specified	V_{br}	x	x	V
Temperature coefficient of V_{br}	Minimum and maximum T_{case} specified	γ	x	x	V/°C
TIA supply voltage		V_{cc}	x	x	V
TIA supply current	V_{cc} specified	I_{cc}	x	x	A
Sensitivity	λ_p, extinction ratio, bit rate, signal pattern, and bit error rate specified	P_r		x	dBm
Overload	λ_p, extinction ratio, bit rate, signal pattern, and bit error rate specified	P_o	x		dBm
Bandwidth	λ_p and P_{in} specified		x		GHz
Output voltage	λ_p, P_{in}, and M specified				mV_{pp}
Output impedance		Z_0	x	x	Ω
Transimpedance	P_{in}, and M specified	Z_t	x	x	Ω
Optical return loss	λ_p specified	P_r			dBm
[a] x represents the value to be specified.					

10 Laser diode modules for pumping an optical fibre amplifier

10.1 Type

The laser module consists of the following basic parts:

– laser diode;
– fibre pigtail (where appropriate);
– lenses (where appropriate);
– photodiode (where appropriate);
– thermal sensor (where appropriate);
– TEC element (where appropriate);
– isolator (where appropriate).

10.2 Semiconductor materials

The laser diode module for pumping an optical fibre amplifier consists of the following semiconductor materials:

– laser diode: GaAs, GaAlAs, InGaAs, InGaAsP, InP, etc.
– photodiode: Ge, Si, InGaAs, etc.
– thermal sensor: } where appropriate
– TEC element: }

10.3 Structure

Laser diode: gain guided, index guided, distributed feedback, ridge waveguide, BH, etc.

10.4 Details of outline and encapsulation

– IEC and/or national reference number of the outline drawing
– Method of encapsulation: glass/metal/plastic/other
– Terminal identification and indication of any electrical connection between a terminal and the case
– Characteristics of the optical port: orientation relative to mechanical axis, position relative to mechanical axis, area, numerical aperture
– Information on the pigtail fibre: type of fibre, kind of protection, connector, and length
– Information on the heat sinking of the package

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

See Table 12.

Table 12 – Limiting values for laser diode modules for pumping an optical fibre amplifier

Characteristics	Symbol	Requirements[b]		Unit
		Min.	Max.	
A. General conditions				
Storage temperature	T_{stg}	x	x	°C
Operating case temperature	T_{case}	x	x	°C
Operating submount temperature (where appropriate)	T_{sub}	x	x	°C
Soldering temperature at maximum soldering time and at specified minimum distance to case	T_{sld}		x	°C
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 along cable axis				
Untight structure – Tensile force on fibre – Tensile force on cable	 F F		 x x	 N N
Tight structure – Tensile force on cable	 F		 x	 N
B. Laser diode [a]				
Reverse voltage	V_R		x	V
Continuous forward current	I_F		x	mA
Continuous radiant power	Φ_e		x	mW
C. Photodiode (where appropriate)				
Reverse voltage	V_R		x	V
Forward current	I_F		x	mA
D. Thermal sensor (where appropriate)				
Thermal sensor				
either Dissipation or Supply voltage	 P V_{supp}		 x x	 W V
E. Thermoelectric cooler (where appropriate)				
TEC current under cooling and heating	I_p		x	A

[a] For laser module without TEC, the derating curve or derating factor shall be given for one of the parameters of 10.5.10 to 10.5.13. For laser module with TEC, T_{sub} = 25 °C.

[b] x represents the value to be specified.

10.6 Electrical and optical characteristics

See Table 13.

Table 13 – Electrical and optical characteristics for laser diode modules for pumping an optical fibre amplifier

Characteristics	Conditions at T_{sub} = 25 °C for laser modules with TEC, T_{amb} or T_{case} = 25 °C for laser module without TEC, unless otherwise specified	Symbol	Requirements[c]		Unit
			Min.	Max.	
A. Laser diode					
Forward voltage	Φ_e or I_F specified	V_F		x	V
Forward current					
Forward current	Φ_e specified	I_F[a]		x	mA
Forward current at high temperature	Φ_e specified T_{case} = T_{case}, max.	I_F[b]		x	mA
Threshold current		$I_{(TH)}$	x	x	mA
Differential efficiency	Φ_e or ΔI_F specified ($\Delta I_F = I_F - I_{(TH)}$)	η_d	x	x	m
Spectral characteristics					
Peak emission wavelength	Φ_e or ΔI_F specified, CW condition	λ_p	x	x	nm
either Spectral radiation r.m.s. bandwidth	Φ_e or ΔI_F specified, CW condition	$\Delta\lambda_{rms}$		x	nm
or Spectral radiation bandwidth (FWHM)	Φ_e or ΔI_F specified, CW condition	$\Delta\lambda$		x	nm
Spectral shift with current or radiant power	ΔI_F[a], ΔI_F[b] or Φ_e[a], Φ_e[b] specified	$\Delta\lambda_c$ or $\Delta\lambda_p$		x x	nm/mA nm/mW
Spectral shift with temperature (for laser module with TEC)	T_{case}[a], T_{case}[b] specified Φ_e or ΔI_F specified	$\Delta\lambda_T$		x	nm/°C
Spectral shift with temperature (for laser module with TEC)	T_{amb}[a], T_{amb}[b] specified Φ_e or ΔI_F specified	$\Delta\lambda_T$		x	nm/°C
B. Monitor photodiode (where appropriate)					
Dark current	Φ_e = 0, V_R specified	$I_{R(D)}$		x	μA
Monitor current	Φ_e or ΔI_F specified, V_R specified	$I_{R(M)}$	x	x	mA
Tracking error					
Tracking error [a]	Φ_e or ΔI_F, V_R specified, Temperature range: 25 °C to T_{case}, min. or T_{amb}, min.	E_{R1}		x	
Tracking error [b]	Φ_e or ΔI_F, and V_R specified Temperature range: 25 °C to T_{case}, max. or T_{amb}, max.	E_{R2}		x	
C. Thermistor (where appropriate)					
Resistance	Thermistor current I_{tc} specified	R	x	x	Ω
Slope of resistance	Thermistor current I_{tc} specified Temperature range: T_{sub}[a], T_{sub}[b]	$\Delta R/R$	x	x	
D. TEC element (where appropriate)					
TEC current	Φ_e or ΔI_F, specified Temperature range: T_{case} min. or T_{case} max.	I_{PE}		x	A

Characteristics	Conditions at T_{sub} = 25 °C for laser modules with TEC, T_{amb} or T_{case} = 25 °C for laser module without TEC, unless otherwise specified	Symbol	Requirements[c]		Unit
			Min.	Max.	
TEC voltage	Φ_e or ΔI_F, specified Temperature range: T_{case} min. or T_{case} max.	V_{PE}		x	V
[a] CW-operation. [b] In modulation. [c] x represents the value to be specified.					

10.7 Supplementary information

– Median life under specified case temperature at specified output power

– DC forward current of the laser diode corresponding to Φ_{eoo}

NOTE Φ_{eoo} is the radiant power value of the laser chip on submount, representative of the performance and reliability of devices manufactured using the same technology and submitted to the same quality assurance procedures.

– Response time of the thermistor temperature with respect to the change of cooler current (where appropriate)

– Thermal resistance between laser diode junction and case (for the laser module without cooler)

10.8 Hazards

See IEC 60825.

11 Optical modulators for digital fibre optic applications

11.1 Type

The optical modulator module consists of following basic parts:

– modulator (Mach-Zehnder type, electro-absorption type, etc.);

– input and output fibre pigtail (where appropriate);

– thermal sensor (where appropriate);

– TEC element (where appropriate);

– photodiode (where appropriate).

11.2 Materials

The materials of optical modulators for digital fibre optic applications are

– modulator: InP, GaAs, InGaAs, InAlAs, InGaAsP, $LiNbO_3$, etc.;

– thermal sensor;

– TEC element;

– photodiode: Ge, Si, InGaAs, etc.

11.3 Structure

– Modulator: lumped type (Mach-Zehnder), travelling-wave type (Mach-Zehnder), Y-branch, MQW, etc.

– Optical isolator, photodiode, half-mirror, etc.

11.4 Details of outline and encapsulation

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

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

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

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

– Information on the pigtail fibre: type of fibre, kind of protection, length, connector type, angular orientation of the connector to the fibre polarization axis (where appropriate)

– Information on the heatsinking of the package

11.5 Limiting values (absolute maximum ratings)

Limiting values as shown in Table 14 are over the operating temperature range, unless otherwise stated. Relative humidity and air pressure should be specified for all devices in non-hermetically sealed packages.

Table 14 – Limiting values for optical modulators for digital fibre optic applications

Characteristics	Symbol	Requirements[b]		Unit
		Min.	Max.	
A. General conditions				
Storage temperature	T_{stg}	x	x	°C
Operating case temperature	T_{case}	x	x	°C
Operating submount temperature (where appropriate)	T_{sub}	x	x	°C
Soldering temperature at maximum soldering time and minimum distance to case specified	T_{sld}		x	°C
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
Acceleration (where appropriate)			x	m/s^2
Tensile force along cable axis:				
Untight structure – Tensile force on fibre – Tensile force on cable	 F F		 x x	 N N
Tight structure – Tensile force on cable	 F		 x	 N
Change of temperature when operational (where appropriate)	$\Delta T/t$		x	°C/min.
B. Modulator[a]				
Reverse voltage	V_R		x	V
Forward current	I_F		x	mA
Continuous input power	$\Phi_{e(in,cw)}$		x	mW
C. Thermal sensor (where appropriate)				
Thermal sensor				
either Dissipation power	 P_{tot}		 x	 W
or Supply voltage	 V_{supp}		 x	 V
D. Thermo-electric cooler (where appropriate)				
TEC current under cooling and heating	I_p		x	A

Characteristics	Symbol	Requirements[b]		Unit
		Min.	Max.	
E. Photodiode (where appropriate)				
Reverse voltage	V_R		x	V
Forward current	I_F		x	mA

[a] For modulator module without TEC, the derating curve or derating factor shall be given for one of the parameters of 11.5.9 to 11.5.11. For modulator module with TEC, T_{sub} = 25 °C.

[b] x represents the value to be specified.

11.6 Electrical and optical characteristics

See Table 15.

Table 15 – Electrical and optical characteristics for optical modulators for digital fibre optic applications

Characteristics	Conditions at T_{sub} = 25 °C for modulators with TEC, T_{amb} or T_{case} = 25 °C for modulators without TEC, unless otherwise stated	Symbol	Requirements[c]		Unit
			Min.	Max.	
A. Modulator					
Operating voltage	Extinction ratio specified, d.c. bias specified	V_π	x	x	V
Operating wavelength	Polarization, wavelength and input power specified	λ_{op}	x	x	nm (μm)
Insertion loss	Polarization, wavelength and input power specified	L_{in}		x	dB
Return loss	Polarization, wavelength and d.c. bias specified	R_L	x	x	dB
Extinction ratio	Polarization, wavelength and input power specified, d.c. bias specified	$E \times R$	x	x	dB
Frequency response	Polarization, wavelength and input power specified, d.c. bias specified	f_c		x	MHz (GHz)
Frequency response flatness	Polarization, wavelength and input power specified, d.c. bias specified	$\Delta R_D/R_D$		x	MHz/mV
Wavelength chirp	Polarization, wavelength and input power specified, d.c. bias specified	α		x	MHz/mV
B. Thermistor (where appropriate)					
Resistance	Thermistor current I_{tc} specified	R	x	x	Ω
Slope of resistance	Thermistor current I_{tc} specified	$\Delta R/R$	x	x	
	Temperature range: T_{sub}[a], T_{sub}[b]				

Characteristics	Conditions at T_{sub} = 25 °C for modulators with TEC, T_{amb} or T_{case} = 25 °C for modulators without TEC, unless otherwise stated	Symbol	Requirements[c]		Unit
			Min.	Max.	
C. Thermo-electric cooler element (where appropriate)					
TEC current	V_π specified Temperature range: T_{case} min. or T_{case} max.	I_{PE}		x	A
TEC voltage	V_π specified Temperature range: T_{case} min. or T_{case} max.	V_{PE}		x	V
Temperature difference between T_{case} and T_{sub}	TEC current, voltage and modulator operating condition specified	ΔT_{PE}		x	°C
D. Monitor photodiode (where appropriate)					
Dark current	Φ_e = 0, V_R specified	$I_{R(D)}$		x	nA
Monitor current	Φ_e specified V_R specified	$I_{R(M)}$	x	x	mA

[a] CW-operation.

[b] In modulation.

[c] x represents the value to be specified.

11.7 Supplementary information

– Extinction ratio (or output power) as a function of reverse voltage

– Response time of the thermal sensor temperature with respect to the change of cooler current (where appropriate)

– Bias stability (where appropriate)

– Bias temperature coefficient, in either V/°C or %/°C (where appropriate)

11.8 Hazards

See IEC 60825.

Bibliography

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication*

IEC 60050-845, *International Electrotechnical Vocabulary – Chapter 845: Lighting*

_____

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™