BS EN 62149-2:2014

BSI Standards Publication

Fibre optic active components and devices — Performance standards

Part 2: 850 nm discrete vertical cavity surface emitting laser devices

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National foreword

This British Standard is the UK implementation of EN 62149-2:2014. It is identical to IEC 62149-2:2014. It supersedes BS EN 62149-2:2009 which is withdrawn.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.

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Fibre optic active components and devices - Performance standards - Part 2: 850 nm discrete vertical cavity surface emitting laser devices (IEC 62149-2:2014)

Composants et dispositifs actifs à fibres optiques - Normes de performances - Partie 2: Dispositifs discrets à laser 850 nm à cavité verticale émettant en surface (CEI 62149-2:2014)

Aktive Lichtwellenleiterbauelemente und geräte - Betriebsverhalten - Teil 2: Oberflächenemittierende 850-nm-Laserbauelemente mit Vertikalresonator (IEC 62149-2:2014)

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Foreword

The text of document 86C/1146/CDV, future edition 2 of IEC 62149-2, 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 62149-2:2014.

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)	2015-03-30
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-06-30

This document supersedes EN 62149-2:2009.

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 62149-2:2014 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60191	NOTE	Harmonized in EN 60191 Series.
IEC 60747-5-1	NOTE	Harmonized as EN 60747-5-1.
IEC 60749	NOTE	Harmonized in EN 60749 Series.
IEC 60825	NOTE	Harmonized in EN 60825 Series.
IEC 60874	NOTE	Harmonized in EN 60874 Series.
IEC 61280-1-3	NOTE	Harmonized as EN 61280-1-3.
IEC 62007-1	NOTE	Harmonized as EN 62007-1.
IEC 62007-2	NOTE	Harmonized as EN 62007-2.
IEC 62148-1	NOTE	Harmonized as EN 62148-1.
IEC 62149-1	NOTE	Harmonized as EN 62149-1.

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 60749-6	-	Semiconductor devices - Mechanical and climatic test methods - Part 6: Storage at high temperature	EN 60749-6	-
IEC 60749-7	-	Semiconductor devices - Mechanical and climatic test methods - Part 7: Internal moisture content measurement and the analysis of other residual gases	EN 60749-7	-
IEC 60749-10	-	Semiconductor devices - Mechanical and climatic test methods - Part 10: Mechanical shock	EN 60749-10	-
IEC 60749-11	-	Semiconductor devices - Mechanical and climatic test methods - Part 11: Rapid change of temperature - Two-fluid-bath method	EN 60749-11	-
IEC 60749-12	-	Semiconductor devices - Mechanical and climatic test methods - Part 12: Vibration, variable frequency	EN 60749-12	-
IEC 60749-25	-	Semiconductor devices - Mechanical and climatic test methods - Part 25: Temperature cycling	EN 60749-25	-
IEC 60749-26	-	Semiconductor devices - Mechanical and climatic test methods - Part 26: Electrostatic discharge (ESD) sensitivity testing - Human body model (HBM)	EN 60749-26	-
IEC 60825-1	-	Safety of laser products - Part 1: Equipment classification and requirements	EN 60825-1	-
IEC 60950-1	-	Information technology equipment - Safety - Part 1: General requirements	EN 60950-1	-
IEC 61300-2-4	-	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-4: Tests - Fibre/cable retention	EN 61300-2-4	-
IEC 61300-2-19	-	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-19: Tests - Damp heat (steady state)	EN 61300-2-19	-

Publication	Year	Title	EN/HD	Year
IEC 61300-2-48	-	Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-48: Tests - Temperature-humidity cycling	EN 61300-2-48	-
IEC 62148-15	-	Fibre optic active components and devices - Package and interface standards - Part 15: Discrete vertical cavity surface emitting laser packages	EN 62148-15	-
IEC Guide 107	-	Electromagnetic compatibility - Guide to the drafting of electromagnetic compatibility publications	-	-

CONTENTS

INTRODUCTION

Fibre optic laser devices are used to convert electrical signals into optical signals. This part of IEC 62149 covers the performance specification for 850 nm discrete vertical cavity surface emitting laser devices in fibre optic telecommunication and optical data transmission applications.

FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – PERFORMANCE STANDARDS –

Part 2: 850 nm discrete vertical cavity surface emitting laser devices

1 Scope

This part of IEC 62149 covers the performance specification for 850-nm discrete vertical cavity surface emitting laser (VCSEL) devices of transverse multimode types used for fibre optic telecommunication and optical data transmission applications. The performance standard contains a definition of the product performance requirements together with a series of sets of tests and measurements with clearly defined conditions, severities, and pass/fail criteria. The tests are intended to be run on a "once-off" basis to prove any product's ability to satisfy the performance standard's requirements.

A product that has been shown to meet all the requirements of a performance standard can be declared as complying with the performance standard, but should then be controlled by a quality assurance/quality conformance program.

Depending on the modulation speeds, sub-categorized specifications are defined. Types A1, A2, A3 and A4 correspond to 1,25 Gbit/s, 2,5 Gbit/s, 4,25 Gbit/s and 10 Gbit/s VCSELs, respectively.

Each sub-categorized specification is also defined by separate details depending on the device types, such as specifications for a VCSEL device without a monitor photodiode (case a) and for a VCSEL device with a monitor photodiode (case b).

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 60749-6, *Semiconductor devices – Mechanical and climatic test methods – Part 6: Storage at high temperature*

IEC 60749-7, *Semiconductor devices – Mechanical and climatic test methods – Part 7: Internal moisture content measurement and the analysis of other residual gases*

IEC 60749-10, *Semiconductor devices – Mechanical and climatic test methods – Part 10: Mechanical shock*

IEC 60749-11, *Semiconductor devices – Mechanical and climatic test methods – Part 11: Rapid change of temperature – Two-fluid-bath method*

IEC 60749-12, *Semiconductor devices – Mechanical and climatic test methods – Part 12: Vibration, variable frequency*

IEC 60749-25, *Semiconductor devices – Mechanical and climatic test methods – Part 25: Temperature cycling*

IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61300-2-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retention*

IEC 61300-2-19, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Damp heat (steady state)*

IEC 61300-2-48, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-48: Tests – Temperature-humidity cycling*

IEC 62148-15, *Fibre optic active components and devices – Package and interface standards – Part 15: Discrete vertical cavity surface emitting laser packages*

IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the following terms, definitions, symbols and abbreviations apply.

NOTE Terminology concerning *physical concepts, types of devices, general terms,* and that related to *ratings and characteristics* of semiconductor devices can be found in IEC 60747-5-1. In addition, definitions for *essential ratings and characteristics* of semiconductor optoelectronic devices for fibre optic system applications can be found in IEC 62007-1. Terminology and test methods for laser wavelength and spectral width of VCSEL devices are also found in IEC 61280-1-3.

3.1 Terms and definitions

The following terms are defined for the specific characteristics of VCSEL devices.

3.1.1
operating wavelength
peak centre laser wavelength of the vertical cavity surface emitting laser device when it is operated at the normal operating conditions specified in the sectional specification of the VCSEL

3.1.2
transverse mode
electromagnetic mode of a laser diode characterized by its power or field distribution in a section perpendicular to the direction of propagation, and in the direction perpendicular to the junction

Note 1 to entry: Depending on the mode behaviour (multi-mode or single-mode), the package type of the VCSEL device is also defined.

3.1.3
multi-mode
cross-section transverse mode of the laser beam profile with mode number greater than one, which means that the intensity profile has more than one spot, compared to the single-mode which corresponds to the cross-section transverse mode of the laser beam profile with mode number of one having the intensity profile of one circular spot

3.1.4
modulation speed
digital modulation speed with optimum modulation amplitude between the operating current and threshold current level

3.1.5
submount
substrate upon which a laser is mounted for assembly into the further packaging

3.1.6
VCSEL device without a monitor photodiode
VCSEL packaged device without a monitor photodiode

3.1.7
VCSEL device with a monitor photodiode
VCSEL packaged device with a monitor photodiode

3.2 Symbols and abbreviations

λ_p peak laser wavelength
I_{th} threshold current
V_{th} threshold voltage
I_{op} operating current
V_f forward voltage at operating current
R_s series resistance
η slope efficiency
P_o continuous laser output power (at connector output or pigtailed fibre output for packaged types)
$\Delta\lambda T/\Delta T$ wavelength change over temperature
θ beam divergence at $1/e^2$ intensity
t_r/t_f rise and fall time from 20 % to 80 % of the peak intensity
$\Delta\lambda_{rms}$ spectral width, RMS (at static condition)
RIN relative intensity noise
$\Delta R_S/\Delta T$ series resistance temperature coefficient

Abbreviation	Term
VCSEL	Vertical cavity surface emitting laser

4 Product parameters

4.1 Absolute limiting ratings

Absolute limiting (maximum and/or minimum) ratings imply that no catastrophic damage will occur if the product is subject to these ratings for short periods, provided each limiting parameter is in isolation and all other parameters have values within the normal performance parameters. It should not be assumed that limiting value of more than one parameter can be applied at any one time. The absolute maximum ratings of the subcategorized types A1, A2, A3 and A4 for modulation speeds are listed in Annex A and Annex B, depending on the device types.

4.2 Operating environment

The operating environment of all the sub-categorized types, A1, A2, A3 and A4, is specified in Table 1.

Table 1 – Operating environment

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Operating temperature	T_{op}	0	70	°C

4.3 Functional specification

Functional specifications of all the sub-categorized types, A1, A2, A3 and A4, for modulation speeds are listed in Annex A and Annex B, depending on the device types.

4.4 Diagrams

Diagrams of all the VCSEL device types are included in Annex A and Annex B.

5 Testing

5.1 General

Initial characterization and qualification shall be undertaken when a build standard has been completed and frozen. Qualification maintenance is carried out using periodic testing programs. Test conditions for all tests, unless otherwise stated, are 25 °C ± 2 °C.

5.2 Characterization testing

Characterization shall be carried out on at least 20 products taken from at least three different manufacturing lots. The characteristics and conditions of laser diode are tested at the operating temperature and the operating current to satisfy the functional specifications defined in 4.3.

5.3 Performance testing

Performance testing is undertaken when characterization testing is complete. The performance test plan and recommended performance test failure criteria are specified in Annex A and Annex B, depending on the device types.

6 Environmental specifications

6.1 General safety

All products meeting this standard shall conform to IEC 60950-1.

6.2 Laser safety

Fibre optic transmitters and transceivers using the laser diode specified in this standard shall be class 3R laser or lower class (class 1 or 1M) laser certified under any condition of operation. This includes single fault conditions, whether coupled into a fibre or out of an open bore. Fibre optic transmitters and transceivers using the laser diode specified in this standard shall be certified to be in conformance with IEC 60825-1.

Laser safety standards and regulations require that the manufacturer of a laser product provide information about the product's laser, safety features, labelling, use, maintenance and service. This documentation shall explicitly define requirements and usage restrictions on the host system necessary to meet these safety certifications.

6.3 Electromagnetic compatibility (EMC) requirements

Products defined in this standard shall comply with suitable requirements for electromagnetic compatibility (in terms of both emission and immunity), depending on particular usage/environment in which they are intended to be installed or integrated. Guidance to the drafting of such EMC requirements is provided in IEC Guide 107. Guidance for electrostatic discharge (ESD) is still under study.

Annex A
(normative)

Specifications for multimode 850-nm VCSEL device without a monitor photodiode (Case a)

A.1 Absolute limiting ratings

Absolute limiting (maximum and/or minimum) ratings (Table A.1) imply that no catastrophic damage will occur if the product is subject to these ratings for short periods, provided each limiting parameter is in isolation and all other parameters have values within the normal performance parameters. It should not be assumed that a limiting value of more than one parameter can be applied at any one time.

Table A.1 – Absolute limiting ratings

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Storage temperature	T_{stg}	–40	100	°C
Soldering condition	T_{sol}		260 °C, 10 s	
Laser diode				
Reverse bias voltage	V_{RB}		5	V
Continuous forward current	I_{FLD}		12	mA

A.2 Operating environment

The requirements of 4.2 shall be met.

A.3 Functional specification

Tables A.2 and A.3 contain the operating conditions for functional specifications and the functional specifications of 1,25/ 2,5/ 4,25/ 10 Gbit/s 850 nm VCSEL devices without a monitor photodiode at the operating conditions.

Table A.2 – Operating conditions for functional specification

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Operating forward current	I_{op}		7	mA
Operating forward bias voltage	V_f	1,6	2,5	V

Table A.3 – Functional specification

Parameter	Symbol	Value		Unit	Note
		Minimum	Maximum		
Laser diode					
Laser wavelength	λ_p	840	860	nm	CW
Spectral bandwidth, RMS	$\Delta\lambda_{rms}$		0,85	nm	CW
Threshold current	I_{th}		3,0	mA	
Threshold voltage	V_{th}		2,0	V	
Series resistance	R_s	20	65	Ω	I_{op}
Slope efficiency	η	*0,2*	*0,7*	mW/mA	I_{op},*TO*
		0,03	0,2	mW/mA	I_{op}, TOSA and pigtail
Continuous laser output power	P_O		20,0	mW	I_{op}, TO
			3,0	mW	I_{op}, TOSA and pigtail
Wavelength change over temperature	$\Delta\lambda/\Delta T$		0,07	nm/°C	
Rise and fall time	t_r/t_f		300/300	ps	1,25 Gbit/s, type A1a
			150/150	ps	2,5 Gbit/s, type A2a
			90/90	ps	4,25 Gbit/s, type A3a
			50/50	ps	10 Gbit/s, type A4a
Relative intensity noise	RIN		–130	dB/Hz	[a]

[a] At 1 GHz bandwidth for below 5 Gbit/s (at 5 GHz bandwidth for 10 Gbit/s) and optical power specified (typically a negative value).

A.4 Diagrams

Refer to IEC 62148-15.

A.5 Testing

A.5.1 Characterization testing

The requirements of 5.1 shall be met.

A.5.2 Performance testing

Performance testing is undertaken when characterization testing is complete.

Table A.4 – Performance test plan

No.	Test	Reference	Conditions	Sample size
1	Endurance test of:			
1.1	Package			
1.1.1	High temperature storage	IEC 60749-6	Temperature: $T = T_{stg\ max}$ Duration: 1 000 h	11
1.1.2	Low temperature storage		Temperature: $T = T_{stg\ min}$ Duration: >2 000 h	11
1.1.3	Temperature cycling	IEC 60749-25	Temperature: $T_A = T_{stg\ min}$ $T_B = T_{stg\ max}$ Number of cycles = 100	11
1.1.4	Damp heat	IEC 61300-2-19	T = +40 °C ± 2 °C RH: 93 % ± 2 % 96 h duration	11
1.1.5	Temperature-humidity cycling	IEC 61300-2-48, method A	–40 °C ± 2 °C to +85 °C ± 2 °C 85 ± 5 % RH at the maximum temperature 1 h minimum duration at extremes ≥1 °C/min rate of change 42 cycles	11
1.1.6	Fibre pull [a]	IEC 61300-2-4	5 N ± 0,5 N at 0,5 N/s 60 s duration for buffered fibres	11
1.2	Laser diode (submount)		Temperature: at least two test temperatures:	[b]
			φ_e specified, constant power	[b]
1.2.1			$T_{s1} = T_{s\ max}$	
1.2.2			$T_{s2} = <(T_{s1} – 20\ °C)$ Duration: >5 000 h	
2	Mechanical shock	IEC 60749-10	1 500 G, 0,5 ms 5 times/axis	11
3	Vibration	IEC 60749-12	20 g, 20 Hz – 2 000 Hz, 4 min/cycle, 4 cycles/axis	11
4	Rapid change of temperature	IEC 60749-11	ΔT = 100 °C, temperature change time <10 s, dwell time >2 min temperature reach time <5 min 15 cycles	11
5	ESD	IEC 60749-26	Human body model, positive and negative voltage pulses with a pulse interval of 300 ms	3
6	Internal moisture	IEC 60749-7	$\leq 5\ 000 \times 10^{-6}$ water vapour	11

[a] Applied to fibre pigtailed packages.

[b] These parameters can be determined from negotiation between manufacturer and user.

Table A.5 – Recommended performance test failure criteria

Devices	Parameter	Failure criterion	Measurement condition
Laser diode	Operating current	50 % increase [a]	25 °C or life test temperature
	Slope efficiency	10 % change [a]	25 °C or life test temperature
	Forward voltage	10 % change [a]	25 °C or life test temperature
	Kinks in L/I curve	Kink-free within 1,2 × P_{nom} (linearity change ≤10 %) [a]	$T_{op\ min}$, 25 °C, $T_{op\ max}$
Laser package	Operating current	50 % increase [a]	25 °C or life test temperature
	Fibre or connector output power	10 % change	Life test temperature I_{mon} set to initial value
	Kinks in L/I curve	Kink-free within 1,2 × P_{nom} (linearity change ≤10 %) [a]	$T_{op\ min}$, 25 °C, $T_{op\ max}$
	Tracking ratio (I_{mon} / P_{fibre})	< LSL ≥ USL	$T_{op\ min}$ ~ $T_{op\ max}$ At rated power level

[a] Change of pre- and post-test values in the detail specification.

Annex B
(normative)

Specifications for multimode 850 nm VCSEL device with a monitor photodiode (Case b)

B.1 Absolute limiting ratings

Absolute limiting (maximum and/or minimum) ratings (Table B.1) imply that no catastrophic damage will occur if the product is subject to these ratings for short periods, provided each limiting parameter is in isolation and all other parameters have values within the normal performance parameters. It should not be assumed that limiting value of more than one parameter can be applied at any one time.

Table B.1 – Absolute limiting ratings

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Storage temperature	T_{stg}	−40	100	°C
Soldering condition	T_{sol}		260 °C, 10 s	
Laser diode				
Reverse bias voltage	V_{RB}		5	V
Continuous forward current	I_{FLD}		12	mA
Monitor photodiode				
Maximum reverse voltage	V_{mR}		5,0	V
Maximum forward current	I_{mF}			mA

B.2 Operating environment

The requirements of 4.2 shall be met.

B.3 Functional specification

Tables B.2 and B.3 contain the operating conditions for functional specifications and the functional specifications of 1,25/ 2,5/ 4,25/ 10 Gbit/s 850-nm VCSEL devices with a monitor photodiode at the operating conditions.

Table B.2 – Operating conditions for functional specification

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Operating forward current	I_{op}		7	mA
Operating forward bias voltage	V_f	1,6	2,5	V

Table B.3 – Functional specification

Parameter	Symbol	Value		Unit	Note
		Minimum	Maximum		
Laser diode					
Laser wavelength	λ_p	840	860	nm	CW
Spectral bandwidth, RMS	$\Delta\lambda_{rms}$		0,85	nm	CW
Threshold current	I_{th}		3,0	mA	
Threshold voltage	V_{th}		2,0	V	
Series resistance	R_s	20	65	Ω	I_{op}
Slope efficiency	η	0,2	0,7	mW/mA	I_{op}, CAN
		0,03	0,2	mW/mA	I_{op}, TOSA and pigtail
Continuous laser output power	P_O		20,0	mW	I_{op}, CAN
			3,0	mW	I_{op}, TOSA and pigtail
Wavelength change over temperature	$\Delta\lambda/\Delta T$		0,07	nm/°C	
Rise and fall time	t_r/t_f		300/300	ps	1,25 Gbit/s, type A1b
			150/150	ps	2,5 Gbit/s, type A2b
			90/90	ps	4,25 Gbit/s, type A3b
			50/50	ps	10 Gbit/s, type A4b
Relative intensity noise	RIN		-130	dB/Hz	[a]
Monitor photodiode					[b]
Monitor current	I_m	0,1	1,0	mA	
Dark current	I_{mR0}		30	nA	P_{op} = 0 mW, V_{rev} = 3 V
Linearity of monitor diode current	L_m			%	
Capacitance	C_{tot}		100	pF	V_{rev} = 0 V, 1 MHz

[a] At 1 GHz bandwidth for below 5 Gbit/s (at 5 GHz bandwidth for 10 Gbit/s) and optical power specified (typically a negative value).

[b] This part applies only to the VCSELs with monitor photodiode at a room temperature condition of 25 °C.

B.4 Diagrams

Refer to IEC 62148-15.

B.5 Testing

B.5.1 Characterization testing

The requirements of 5.1 shall be met.

B.5.2 Performance testing

Performance testing is undertaken when characterization testing is complete.

Table B.4 – Performance test plan

No.	Test	Reference	Conditions	Sample size
1	Endurance test of:			
1.1	Package			
1.1.1	High temperature storage	IEC 60749-6	Temperature: $T = T_{stg\ max}$ Duration: 1 000 h	11
1.1.2	Low temperature storage		Temperature: $T = T_{stg\ min}$ Duration: > 2 000 h	11
1.1.3	Temperature cycling	IEC 60749-25	Temperature: $T_A = T_{stg\ min}$ $T_B = T_{stg\ max}$ Number of cycles = 100	11
1.1.4	Damp heat	IEC 61300-2-19	T= +40 °C ± 2 °C RH: 93 % ± 2 % 96 h duration	11
1.1.5	Temperature-humidity cycling	IEC 61300-2-48, method A	–40 °C ± 2 °C to +85 °C ± 2 °C 85 % ± 5 % RH at the maximum temperature 1 h minimum duration at extremes ≥1 °C/min rate of change 42 cycles	11
1.1.6	Fibre pull [a]	IEC 61300-2-4	5 N ± 0,5 N at 0,5 N/s 60 s duration for buffered fibres	11
1.2	Laser diode (submount)		Temperature: at least two test temperatures:	[b]
			φ_e specified, constant power	
12.1			$T_{s1} = T_{s\ max}$	[b]
1.2.2			$T_{s2} = < (T_{s1} - 20\ °C)$ Duration: >5 000 h	
1.3	Photodiode (in representative package)		Temperature: at least two test temperatures:	[b]
			V_r or I_r specified	[b]
1.3.1			T_{s1} = 125 °C min	
1.3.2			$T_{s2} = < (T_{s1} - 30\ °C)$ Duration: >1 000 h	11
2	Mechanical shock	IEC 60749-10	1 500 g, 0,5 ms 5 times/axis	11
3	Vibration	IEC 60749-12	20 g, 20 Hz – 2 000 Hz, 4 min/cycle, 4 cycle/axis	11
4	Rapid change of temperature	IEC 60749-11	ΔT =100 °C, temperature change time <10 s, dwell time >2 min temperature reach time <5 min 15 cycles	11
5	ESD	IEC 60749-26	Human body model, positive and negative voltage pulses with a pulse interval of 300 ms	3
6	Internal moisture	IEC 60749-7	≤ 5 000 $\times 10^{-6}$ water vapour	11

[a] Applied to fibre pigtailed packages.

[b] These parameters can be determined from negotiation between manufacturer and user.

Table B.5 – Recommended performance test failure criteria

Devices	Parameter	Failure criterion	Measurement condition
Laser diode	Operating current	50 % increase [a]	25 °C or life test temperature
	Slope efficiency	10 % change [a]	25 °C or life test temperature
	Forward voltage	10 % change [a]	25 °C or life test temperature
	Kinks in L/I curve	Kink-free within 1,2 × P_{nom} (linearity change ≤10 %) [a]	$T_{op\ min}$, 25 °C, $T_{op\ max}$
Photodiode	Dark current	USL or 10 nA increase	25 °C
Laser package	Operating current	50 % increase [a]	25 °C or life test temperature
	Fibre or connector output power	10 % change	Life test temperature I_{mon} set to initial value
	Kinks in L/I curve	Kink-free within 1,2 × P_{nom} (linearity change ≤10 %) [a]	$T_{op\ min}$, 25 °C, $T_{op\ max}$
	Tracking ratio (I_{mon}/P_{fibre})	<LSL >USL	$T_{op\ min}$ ~ $T_{op\ max}$ At rated power level
	Photodiode dark current	USL or 10 nA increase [a]	25 °C

[a] Change of pre- and post-test values in the detail specification.

Bibliography

IEC 60191 (all parts), *Mechanical standardization of semiconductor devices*

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

IEC 60749 (all parts), *Semiconductor devices – Mechanical and climate test methods*

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

IEC 60874 (all parts), *Fibre optic interconnecting devices and passive components – Connectors for optical fibres and cables*

IEC 61280-1-3, *Fibre optic communication subsystem test procedures – Part 1-3: General communication subsystems – Central wavelength and spectral width measurement*

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IEC 62148-1, *Fibre optic active components and devices – Package and interface standards – Part 1: General and guidance*

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