

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fibre optic active components and devices – Performance standards –
Part 3: Modulator-integrated laser diode transmitters for 40-Gbit/s fibre optic
transmission systems**

**Composants et dispositifs actifs fibroniques – Normes de performances –
Partie 3: Émetteurs à diodes laser à modulateur intégré pour systèmes de
transmission fibroniques 40 Gbit/s**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES –
PERFORMANCE STANDARDS –****Part 3: Modulator-integrated laser diode transmitters
for 40-Gbit/s fibre optic transmission systems**

FOREWORD

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IEC 62149-3 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2020. This edition constitutes a technical revision.

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

- a) specification of pull force for fibre pull test in Table 6 according to fibre type;
- b) change of symbol for kink free radiant power in Table 4 and Table 5;
- c) replacement of undefined symbols in Table 7;
- d) addition of IEC 62149-1 as a normative reference.

The text of this International Standard is based on the following documents:

Draft	Report on voting
86C/1839/CDV	86C/1864/RVC

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62149 series, published under the general title *Fibre optic active components and devices – Performance standards*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

Fibre optic transmitters are used to convert electrical signals into optical signals. This document covers the performance standard for optical modulators monolithically integrated with laser diodes for 40 Gbit/s optical telecommunication systems. This document is applicable for on-off keying formats.

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FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – PERFORMANCE STANDARDS –

Part 3: Modulator-integrated laser diode transmitters for 40-Gbit/s fibre optic transmission systems

1 Scope

This part of IEC 62149 covers the performance specification for electroabsorption (EA) type optical modulators monolithically integrated with laser diodes for 40 Gbit/s fibre optic transmission systems. This document contains definitions for product performance requirements as well as a series of tests and measurements, for which clearly defined conditions, severities and pass/fail criteria are provided. The tests are intended to be run as an initial design verification to prove any product's ability to satisfy this document's requirements. This document is applicable for on-off keying modulation formats.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

IEC 60749-26, *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 or cable retention*

IEC 62007-1, *Semiconductor optoelectronic devices for fibre optic system applications – Part 1: Specification template for essential ratings and characteristics*

IEC 62149-1, *Fibre optic active components and devices – Performance standards – Part 1: General and guidance*

IEC 62572-3, *Fibre optic active components and devices – Reliability standards – Part 3: Laser modules used for telecommunication*

ITU-T Recommendation G.694.1, *Spectral grids for WDM applications: DWDM frequency grid*

ITU-T Recommendation G.957, *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*

MIL-STD-883-1, *U.S. Department of Defense – Test method standard – Environmental test methods for microcircuits, Part 1: Test methods 1000-1999*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62007-1 and IEC 62149-1 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.2 Abbreviated terms

EA	electroabsorption
LD	laser diode
LSL	lower standard limit
PD	photodiode
PRBS	pseudo-random bit sequence
RF	radio frequency
RH	relative humidity
USL	upper standard limit

4 Product parameters

4.1 Absolute limiting ratings

Absolute limiting (maximum and/or minimum) ratings given in Table 1 imply that no catastrophic damage will occur if the product is subject to these ratings, 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 values of more than one parameter can be applied at any one time.

Table 1 – Absolute limiting ratings

Parameter	Symbol	Minimum	Maximum	Unit
Operating case temperature (at the bottom of the case)	T_{case}	0	+70	°C
Storage temperature	T_{stg}	-40	+85	°C
Soldering temperature (minimum distance to case specified)	T_{sld}	-	+260 (for 10 s)	°C
Laser diode				
Reverse voltage	$V_{R(LD)}$	-	2	V
Continuous forward current	$I_{F(LD)}$	-	200	mA
Continuous radiant power	ϕ_e	-	10	mW
Photodiode				
Reverse voltage	$V_{R(PD)}$	-	10	V
Forward current	$I_{F(PD)}$	-	1	mA
Modulator				
Reverse modulation voltage	V_{Rm}	-	5	V
Forward modulation voltage	V_{Fm}	-	1	V
Thermal electric cooler				
Cooler current under cooling and heating	I_p	-	1,5	A
Cooler voltage under cooling and heating	V_p	-	2,5	V

4.2 Operating environment

The operating environment is indicated in Table 2.

Table 2 – Operating environment

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

4.3 Functional specification

Functional specification shall be within the limit specified in Table 4 at the operating conditions specified in Table 3.

Table 3 – Operating conditions for functional specification

Parameter	Symbol	Value		Unit
		Minimum	Maximum	
Laser operating current	I_{op}	50	200	mA
Laser operating temperature	T_{op}	15	35	°C
Reverse modulation centre voltage	V_{Rmc}	0,5	1,5	V
Peak to peak modulation voltage	V_{Rmpp}	2	3	V
NOTE Operating conditions are adjusted to match ITU-T Recommendation G.694.1 wavelength within the above specified limit.				

Table 4 – Functional specification

Characteristics and conditions at $T_{LD} = T_{op}$, $I_{F(LD)} = I_{op}$ $V_{Rm} = 0$ V, unless otherwise stated	Symbol	Value		Unit	
		Minimum	Maximum		
Laser and modulator diode					
Modulation speed	X	–	43,02 ^a	Gbit/s	
Forward voltage at specified ϕ_e or I_{op}	$V_{F(LD)}$	–	2,2	V	
Threshold current	$I_{(TH)}$	–	50	mA	
Radiant power at specified I_{op}	ϕ_e	0,5	–	mW	
Kink free radiant power	ϕ_{ek}	0,6	–	mW	
Extinction ratio at specified ϕ_e or I_{op} (under modulated conditions) ^b	r_{ER}	8,2	–	dB	
Peak emission wavelength at specified ϕ_e or I_{op} (under modulated conditions) ^{b, c}	λ_P	c	c	nm	
Side-mode suppression ratio at specified ϕ_e or I_{op} (under modulated conditions) ^b	r_{SMSR}	30	–	dB	
Switching times at specified ϕ_e or I_{op} (under modulated conditions)	Rise time ^b	t_r	–	600/ X	ps
	Fall time ^b	t_f	–	600/ X	ps
RF return loss at specified ϕ_e or I_{op} ^d	S_{11}	6,0	–	dB	
Transmission penalty due to dispersion at specified ϕ_e or I_{op} , under modulated conditions and specified fibre length ^b	P_e	–	2	dB	
Monitor photodiode					
Dark current at $\phi_e = 0$ and specified $V_{R(PD)}$	I_{DARK}	–	10	nA	
Monitor current at specified ϕ_e or I_{op} and $V_{R(PD)}$	I_M	50	2 000	μ A	
Tracking error between operating temperature range with reference at 25 °C at specified ϕ_e or I_{op} and $V_{R(PD)}$ specified	E_{tr}	–0,5	0,5	dB	
Thermal sensor					
Resistance at specified sensor current	R_s	9,5	10,5	k Ω	
Thermistor B constant ^e	B	3 300	3 950	K	
Thermal electric cooler					
Cooler current at $\Delta T = T_{case(max)} - T_{LD}$ and $\Delta T = T_{LD} - T_{case(min)}$ at specified ϕ_e or I_{op}	I_p	–	1,5	A	
Cooler voltage at $\Delta T = T_{case(max)} - T_{LD}$ and $\Delta T = T_{LD} - T_{case(min)}$ at specified ϕ_e or I_{op}	V_p	–	2,5	V	
<p>^a Upper limit in this document. Actual maximum modulation speed shall be designated by a system requirement.</p> <p>^b Definition and condition according to ITU-T Recommendation G.957, PRBS 2²³ – 1, $V_{Rm} = V_{Rmc} \pm 1/2 V_{Rmpp}$.</p> <p>^c According to ITU-T Recommendation G.694.1.</p> <p>^d $V_{Rm} = 1/2 V_{Rmpp}$, 50 Ω termination, measurement frequency should be specified by system requirement.</p> <p>^e $B = \ln(R/R_0)/(1/T - 1/T_0)$ where R is the resistance at ambient temperature T (K) and R_0 is the resistance at ambient temperature T_0 (K).</p>					

4.4 Diagrams

Figure 1 provides a representative schematic diagram of a modulator-integrated laser diode transmitter.

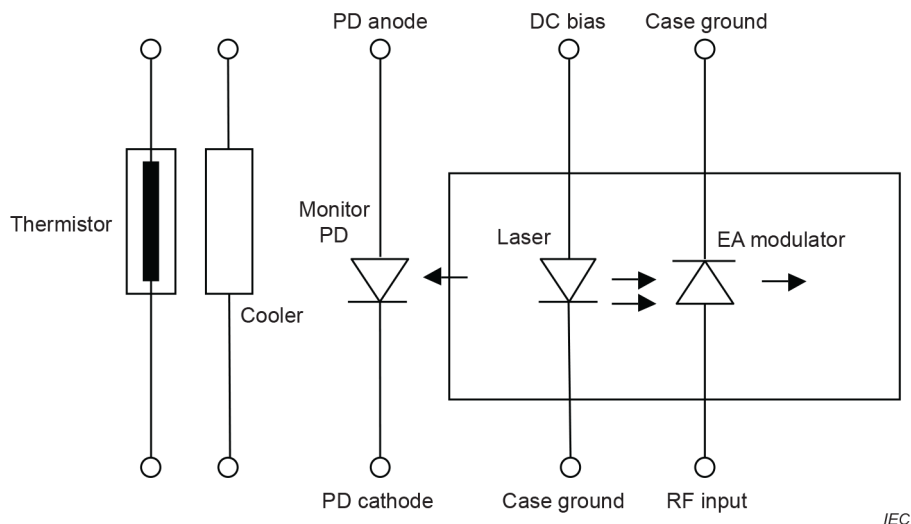


Figure 1 – Schematic diagram of a modulator-integrated laser diode transmitter

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. Case temperature conditions for all tests are $25\text{ °C} \pm 2\text{ °C}$ unless otherwise stated.

5.2 Characterization testing

Characterization shall be carried out on at least 20 transmitters, taken from at least three different manufacturing lots. The test conditions are detailed in Table 5.