IEC 62149-4

Edition 3.0 2022-12
REDLINE VERSION

INTERNATIONAL STANDARD

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Fibre optic active components and devices – Performance standards – Part 4: 1 300 nm fibre optic transceivers for Gigabit Ethernet application

IEC 62149-42022-12 RLV(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.20

ISBN 978-2-8322-6312-9

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – PERFORMANCE STANDARDS –

Part 4: 1 300 nm fibre optic transceivers for Gigabit Ethernet application

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62149-4:2010. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 62149-4 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 third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

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

a) the normative references are updated;
b) the condition "for short periods" in 4.1 is removed;
c) the absolute limiting rating for soldering temperature in Table 1 is modified;
d) the maximal optical output power (multimode fibre) in Table 4 is increased from −3,5 dBm to −3 dBm, to align value with the referenced document;
e) a note is added to Table 7 to clarify that out-of-specification products are not allowed to pass the performance tests.

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

Draft	Report on voting
86C/1800/CDV	86C/1826/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 of 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
- amended.

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INTRODUCTION

Fibre optic transceivers are used to convert electrical signals into optical signals and vice versa. This document specifies performance standards for 1 300 nm fibre optic transceivers for Gigabit Ethernet application. The ISO/IEC/IEEE 8802-3 Gigabit Ethernet standard is used as the basis for determining the optical characteristics of the transceiver, which operates at a line rate of 1,25 Gbit/s.

FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – PERFORMANCE STANDARDS –

Part 4: 1 300 nm fibre optic transceivers for Gigabit Ethernet application

1 Scope

This part of IEC 62149 defines performance specifications for 1 300 nm fibre optic transceiver modules used for the ISO/IEC/IEEE 8802-3 Gigabit Ethernet application. 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 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~~ will then be controlled by a quality assurance/quality conformance 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 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test ~~T~~ Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads*

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

IEC 60068-2-38, *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test*

IEC ~~60028~~ 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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 60938-1, *Fixed inductors for electromagnetic interference suppression – Part 1: Generic specification*

IEC 60950-1~~:2001~~, *Information technology equipment – Safety – Part 1: General requirements*

IEC 61300-2-47, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-47: Tests – Thermal shocks*

~~ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*~~

ISO/IEC/IEEE 8802-3:2021, *Telecommunications and exchange between information technology systems – Requirements for local and metropolitan area networks – Part 3: Standard for Ethernet*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

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 Symbols

E_r	extinction ratio
~~I_{IH}~~ I_{ih}	data input current – high
~~I_{IL}~~ I_{il}	data input current – low
I_{out}	output current
P_a	alarm off level
P_d	alarm on level
P_o	optical output power
P_{opt}	optical input power
~~RH~~	~~relative humidity~~
~~R_{DL}~~ R_{dl}	data output load
S	receiver sensitivity
T_{amb}	ambient operating temperature
TD	transmit disable function
T_f	~~data~~ optical output fall time
T_r	~~data~~ optical output rise time
T_{stg}	storage temperature
V_{cc}	~~power~~ supply voltage
~~V_{IH}~~ $V_{ih} – V_{cc}$	data input voltage – high
~~V_{IL}~~ $V_{il} – V_{cc}$	data input voltage – low
V_{nom}	nominal operating voltage
V_{oh}	alarm output high voltage

$V_{oh} - V_{cc}$ data output voltage – high

V_{ol} alarm output low voltage

$V_{ol} - V_{cc}$ data output voltage – low

V_{pp} transmitter differential input voltage swing

ΔP_o optical output power change from pre-test value to post-test value

ΔS receiver sensitivity change from pre-test value to post-test value

$\Delta\lambda$ spectral width (RMS)

λ_{ce} central wavelength

3.3 Abbreviated terms

BER bit error ratio

ECL emitter-coupled logic

EO electro-optical

ESD electrostatic discharge

HBM human body model

LVTTL low voltage transistor-transistor logic

NRZ non-return-to-zero

PECL pseudo emitter-coupled logic

PRBS pseudo random bit sequence

RH relative humidity

SD signal detect

TTL transistor-transistor logic

TTL/CMOS transistor-transistor logic/complementary metal-oxide-semiconductor

4 Product parameters

4.1 Absolute limiting ratings

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

Table 1 – Absolute limiting ratings

Parameter	Symbol or abbreviated term	Minimum	Maximum	Unit
Storage temperature	T_{stg}	−40	+85	°C
Ambient operating temperature	T_{amb}	−10	+80	°C
Lead soldering temperature (minimum distance to case specified)			+260~~/~~ (for 10 s)	°C~~/s~~
Output current	I_{out}	0	50	mA
Data input voltage		−0,5	V_{cc}	V
Transmitter differential input voltage swing	V_{pp}	0,30	1,40	V
Supply voltage [a]		−0,5	~~(~~V_{nom} + 40~~ %)~~ %	V
Relative humidity [b]	RH	5	85	%
[a] Nominal operating voltages (V_{nom}) of 5 V and 3,3 V apply. ~~Refer to Annex A for variant references.~~				
[b] No condensation allowed.				

4.2 Operating environment

The parameters for the operating environment are shown in Table 2.

Table 2 – Operating environment

Parameter	Symbol or abbreviated term	Minimum	Maximum	Unit
Supply voltage [a]	V_{cc}	~~(~~V_{nom} − 5~~ %)~~ %	~~(~~V_{nom} + 5~~ %)~~ %	V
Ambient operating temperature	T_{amb}	0	70	°C
Relative humidity [b]	RH	5	85	%
[a] For a nominal operating voltage (V_{nom}) of 5 V. For 3,3 V nominal operating voltage~~ limits are~~, the minimum value is 3,15 V~~ to~~ and the maximum value is 3,45 V.				
[b] No condensation allowed.				

4.3 Functional specification

The specifications in Table 3 and Table 4 describe the functional requirements required to meet the ISO/IEC/IEEE 8802-3 PHY specifications.

Table 3 – Receiver section: functional specification

Parameter	Symbol	Minimum	Maximum	Unit
Receiver sensitivity [a]	S		−19	dBm
Maximum optical input power		−3		dBm
Optical return loss		12		dB
Alarm on level [f]	P_d	−45	−20	dBm
Alarm off level [f]	P_a		−19	dBm
Hysteresis		0,5	4,0	dB
Alarm response time			600	µs

Parameter	Symbol	Minimum	Maximum	Unit
Alarm output high voltage (option 1) [b]	V_{oh}	−1,1	−0,8	V
Alarm output low voltage (option 1) [b]	V_{ol}	−2,0	−1,6	V
Alarm output high voltage (option 2) [c]	V_{oh}	2	V_{cc}	V
Alarm output low voltage (option 2) [c]	V_{ol}	0	0,8	V
Data output voltage – low [d]	$V_{ol} - V_{cc}$	−1,950	−1,620	V
Data output voltage – high [d]	$V_{oh} - V_{cc}$	−1,045	−0,740	V
Data output load [e] [g]	R_{dl}	50		Ω
NOTE Refer to Table 2 for operating environment.				

[a] Minimum sensitivity and saturation levels for 1E-12 BER measured with a 9 dB extinction ratio source and (2^7 – 1) PRBS test signal.

[b] These voltages are measured with respect to V_{cc}.

[c] Outputs compatible with TTL and LVTTL inputs.

[d] Outputs compatible with 10K, 10KH, 100K ECL and PECL inputs.

[e] Outputs terminated to V_{cc} – 2 V.

[f] Alarm triggered when receive sensitivity is below that specified. Hysteresis value specified as $P_a - P_d$.

[g] Basic value.

Table 4 – Transmitter section: functional specification

Parameter	Symbol	Minimum	Maximum	Unit
Central wavelength	λ_{ce}	1 270	1 355	nm
Spectral width (RMS)	$\Delta\lambda$		4	nm
Optical output power (single-mode fibre) [a]	P_o	−11,0	−3,0	dBm
Optical output power (multimode fibre) [a] [e]	P_o	−11,5	−~~3,5~~ 3,0	dBm
Extinction ratio	E_r	9		dB
Optical output rise time (20 % – 80 %) [e]	T_r		0,26	ns
Optical output fall time (80 % – 20 %) [e]	T_f		0,26	ns
Output eye [b]				
Transmit disable function (optional) [d]	TD			
Data input current – low	I_{il}	−350		µA
Data input current – high	I_{ih}		350	µA
Data input voltage – low [c]	$V_{il} - V_{cc}$	−1,810	−1,475	V
Data input voltage – high [c]	$V_{ih} - V_{cc}$	−1,165	−0,880	V
Transmitter differential input voltage swing	V_{pp}	0,3		V
NOTE Refer to Table 2 for operating environment.				

[a] Output eye is power coupled into a single-mode fibre, 62,5/125 multimode fibre, or 50/125 multimode fibre.

[b] Compliant with ISO/IEC/IEEE 8802-3.

[c] Compatible with 10K, 10KH, 100K ECL, and PECL signals.

[d] Optional transmit disable function. Normal TTL function. Transmitter output enabled with no signal present. With logic "high" input, transmitter output is disabled.

[e] Measured at the output of a mode conditioning patchcord as specified in ISO/IEC/IEEE 8802-3:2021, 38.11.4.

4.4 Diagrams

The diagrams in Figure 1 and Figure 2 are representative examples for the receiver section and transmitter section.

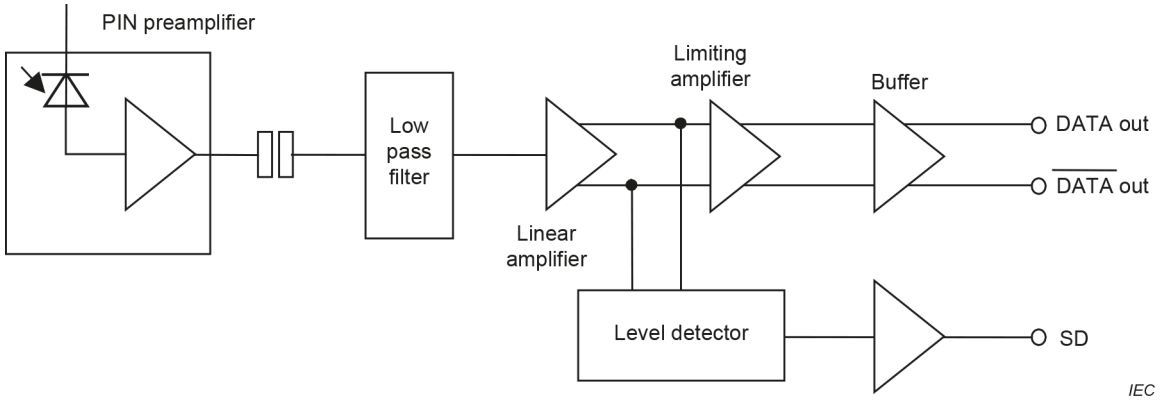

Figure 1 – Receiver section schematic

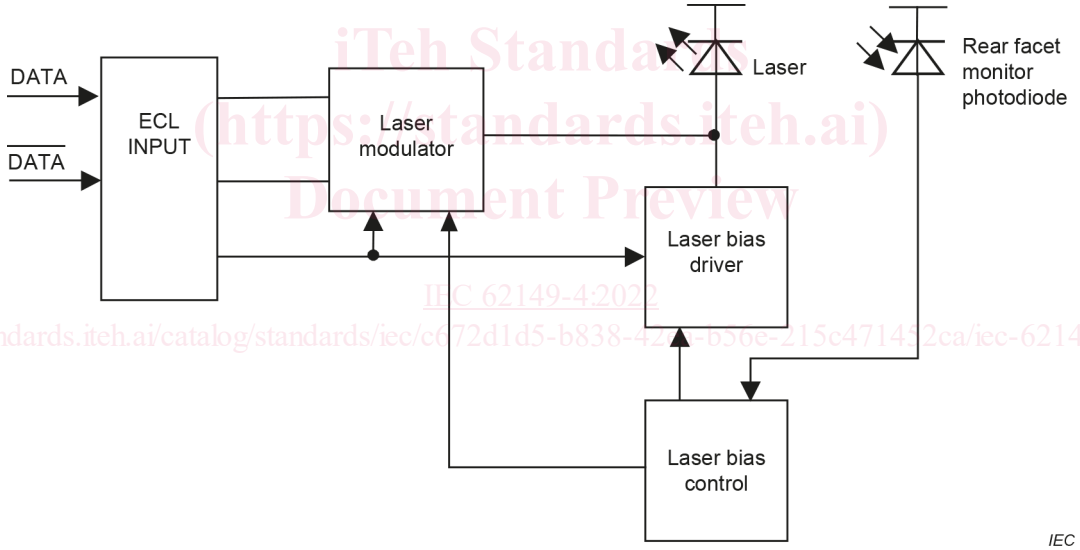

Figure 2 – Transmitter section schematic

4.5 Labelling

It is recommended that each transceiver (and supporting documentation) be labelled in a manner visible to the user with at least the following data:

a) this document reference, including variant type;

b) applicable safety warnings.

Labelling requirements for class 1 lasers are given in the laser safety standards referenced in 6.2.

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 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 test and test limits are given in Table 5 and Table 6.

Table 5 – Transmitter section characterization tests

Parameter	Test conditions [a]	Test limit minimum	Test limit maximum	Unit
	~~As a minimum 20 devices to be measured at 0 °C, 25 °C and 70 °C (±2 °C) and V_{cc} at (V_{nom} – 5 %) V and (V_{nom}) V and (V_{nom} + 5 %) V~~			
Optical output power	Single-mode fibre, PRBS 2^7 – 1 at 1,25 Gbit/s modulation	−11,0	−3,0	dBm
Centre wavelength	PRBS 2^7 – 1 at 1,25 Gbit/s modulation	1 270	1 355	nm
Spectral width	PRBS 2^7 – 1 at 1,25 Gbit/s modulation		4	nm
Extinction ratio	250 Mbit/s square wave	9		dB
Eye mask test	~~ANSI × 3,230 filter,~~ PRBS 2^7 – 1 at 1,25 Gbit/s modulation ISO/IEC/IEEE 8802-3:2021, 38.6.5	No hits	No hits	
Relative intensity noise (RIN)	~~ISO/IEC8802-3ae, Subclause 52.8.5~~ ISO/IEC/IEEE 8802-3:2021, 38.6.4		−120	dB/Hz
Rise and fall time	20 % to 80 %		0,26	ns

[a] A minimum of 20 devices to be measured at T_{amb} of 0 °C, 25 °C, and 70 °C ± 2 °C and with V_{cc} set at minimum operating voltage, at nominal operating voltage (V_{nom}), and at maximal operating voltage. Refer to Table 2 for minimum and maximum operating voltages.

Table 6 – Receiver section characterization tests

Parameter	Test conditions [a]	Test limit minimum	Test limit maximum	Unit
	~~As a minimum 20 devices to be measured at 0 °C, 25 °C and 70 °C (±2 °C) and V_{cc} at (V_{nom} – 5 %) V and (V_{nom}) V and (V_{nom} + 5 %) V~~			
Sensitivity at 1E-12 BER	PRBS modulation NRZ at 1,25 Gbit/s assuming 9 dB extinction ratio source		−19	dBm
Alarm level high	TTL/CMOS compatible logic level "1"			
Alarm level low	TTL/CMOS compatible logic level "0"			
Alarm on threshold	PRBS modulation NRZ at 1,25 Gbit/s assuming 9 dB extinction ratio source		−20,0	dBm
Alarm hysteresis	PRBS modulation NRZ at 1,25 Gbit/s assuming 9 dB extinction ratio source	0,5	4	dB
Maximum input errors	P_{opt} set to −2,4 dBm gate for 3 s using 9 dB extinction ratio source		3	

[a] A minimum of 20 devices to be measured at T_{amb} of 0 °C, 25 °C, and 70 °C ± 2 °C and with V_{cc} set at minimum operating voltage, at nominal operating voltage (V_{nom}), and at maximal operating voltage. Refer to Table 2 for minimum and maximum operating voltages.