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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Optical amplifiers –
Part 2: Single channel applications – Performance specification template

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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.
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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 61291-2:2016. 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 61291-2 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 fifth edition cancels and replaces the fourth edition published in 2016. This edition constitutes a technical revision.

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

a) the test methods for gain ripple in Table 2, Table 4 and Table 6 refer now to the IEC 61290-1 series;
b) the SOA definition (3.1.3) refers now to IEC 61931.

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

Draft	Report on voting
86C/1849/FDIS	86C/1858/RVD

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 61291 series, published under the general title *Optical amplifiers*, 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.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This document is devoted to the subject of optical amplifiers. The technology of optical amplifiers is still rapidly evolving, hence amendments and new additions to this document can be expected. Each abbreviated term introduced in this document is generally explained in the text the first time it appears. However, for an easier understanding of the whole text, a list of all abbreviated terms used in this document is given in Clause 3.

OPTICAL AMPLIFIERS –

Part 2: Single channel applications – Performance specification template

1 Scope

This part of IEC 61291 provides a performance specification template applicable to optical amplifiers (OAs) used in single channel applications. Multichannel applications are covered in IEC 61291-4.

The objective of this ~~performance specification~~ template is to provide a framework for the preparation of performance standards and/or product specifications ~~on~~ defining the performance of OA devices used in single channel applications. ~~In the performance standards or product specifications, other specifications such as ratings, operating conditions, tests and pass/fail criteria could be included in addition to the requirements based on this performance specification template.~~ In addition to the requirements specified in this template, a performance standard or product specification could include other parameters, such as ratings, operating conditions, tests, and pass/fail criteria.

For a particular application, product specification writers ~~may~~ could add specification parameters and/or groups of specification parameters ~~for particular applications~~ to this template, without removing the parameters specified in this document. ~~However, product specification writers should not remove specification parameters specified in this standard.~~

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

~~IEC 61000 (all parts), *Electromagnetic compatibility (EMC)*~~

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for equipment in residential environments*

IEC 61290-1 (all parts), *Optical amplifiers – Test methods – Part 1: Power and gain parameters*

IEC 61290-3 (all parts), *Optical amplifiers – Test methods – Part 3: Noise figure parameters*

IEC 61290-4-3, *Optical amplifiers – Test methods – Part 4-3: Power transient parameters – Single channel optical amplifiers in output power control*

IEC 61290-5 (all parts), *Optical amplifiers – Test methods – Part 5: Reflectance parameters*

IEC 61290-6-1, *Optical fibre amplifiers – Basic specification – Part 6-1: Test methods for pump leakage parameters – Optical demultiplexer*

IEC 61290-11 (all parts), *Optical amplifiers – Test methods – Part 11: Polarization mode dispersion parameter*

IEC 61291-1, *Optical amplifiers – Part 1: Generic specification*

IEC 61291-5-2, *Optical amplifiers – Part 5-2: Qualification specifications – Reliability qualification for optical fibre amplifiers*

IEC TS 62538:2008, *Categorization of optical devices*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61291-1, IEC TS 62538 and the following apply.

NOTE Possible supplementary definitions specific to OAs for single channel applications can be given in product specifications.

3.1.1
optical amplifier
OA
optical waveguide device containing a suitably pumped, active medium that is able to amplify an optical signal

[SOURCE: IEC TR 61931:1998, 2.7.75]

3.1.2
optical fibre amplifier
OFA
optical amplifier made of active optical fibre that is doped with rare-earth ions or that presents non-linear optical effects in order to obtain optical amplification

3.1.3
semiconductor optical amplifier
SOA
optical amplifier in which the active optical waveguide is formed by a semiconductor laser diode structure and will be electrically pumped

Note 1 to entry: The structure of these amplifiers is similar to that of Fabry-Perot laser diodes but with anti-reflection design elements at the end-face surfaces. The signal is amplified through the stimulated emission phenomenon in the gain medium.

[SOURCE: IEC TR 61931:1998, 2.7.77, modified – The note to entry has been added.]

3.1.4
optical element
unpackaged or partially packaged optical basic unit, typically non repairable and non-re-workable (at least by users)

Note 1 to entry: Examples of optical elements include laser chips or laser diodes, photodiodes, lenses, prisms, optical collimators, grating chips and filter chips.

[SOURCE: IEC TS 62538:2008, 2.2.1]

3.1.5
optical component
packaged unit comprising at least one optical element, typically non repairable and non-re-workable (at least by users), suitably pigtailed or connectorized

Note 1 to entry: Examples of optical components include packaged lasers, photodiodes, optical splitters, couplers, attenuators, isolators, MEMS, and modulators.

[SOURCE: IEC TS 62538:2008, 2.2.2]

3.1.6
optical module
packaged integration of optical components and/or elements, accomplishing defined functionality, typically repairable and re-workable

Note 1 to entry: An optical module may comprise electronic components.

Note 2 to entry: An optical module is to be used as it is; users are not normally enabled to re-arrange inner components or add other components inside.

[SOURCE: IEC TS 62538:2008, 2.2.5]

3.1.7
OFA component
fibre-pigtailed optical component that consists of fibre based gain medium such as an erbium-doped fibre, one or more optical isolator(s), optical couplers for the wavelength-selector or the power monitor, a package, and fibres

Note 1 to entry: An OFA component may include an optical filter, such as a gain equalizing filter or ASE rejection filter, and possibly other components.

3.1.8
OFA module
fibre-pigtailed optical module that consists of an OFA component, pump laser component(s) with driving circuit, monitor photodiode component(s) with driving circuit, and a control circuit

3.1.9
SOA element
optical element of SOA that consists of a semiconductor chip

3.1.10
SOA component
fibre-pigtailed optical component that consists of an SOA element, lenses, optical isolator(s) (if necessary), a thermoelectric cooler (TEC), a thermistor, a package, and fibres

3.2 Abbreviated terms

EMC electromagnetic compatibility
OA optical amplifier
OFA optical fibre amplifier
SOA semiconductor optical amplifier
TEC thermoelectric cooler

4 Performance specification templates for power amplifiers

The following templates contain a minimum set of performance parameters to be included in the specifications for OFA components or modules (see Table 1) and SOA components (see Table 2) used as power amplifiers in single channel applications. The tables include specification criteria (in terms of the maximum values, minimum values or both) and references

to the corresponding standards describing the test methods. Note that the list of the minimum parameters for SOAs (see Table 2) covers SOA components only, because most SOA products are currently ~~traded~~ commercialized in the form of ~~the component using~~ a package, such as a butterfly-type package, which contains only the SOA.

Table 1 – Minimum relevant parameters for power amplifiers based on OFA components or modules using active fibre specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics	Input power range		dBm			IEC 61290-1 series
	Output power range[a]		dBm			IEC 61290-1 series
	Gain[a]		dB			IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance[b]		dB	n/a		IEC 61290-5 series
	Return loss[b]		dB		n/a	IEC 61290-3 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Pump leakage to input		dBm	n/a		IEC 61290-6-1
	Pump leakage to output		dBm	n/a		IEC 61290-6-1
	Maximum total output power		dBm	n/a		IEC 61290-1 series
Environmental and reliability parameters	Operating temperature		°C	See IEC 61291-5-2	See IEC 61291-5-2	
	Maximum operating relative humidity		%	n/a	See IEC 61291-5-2	
	Maximum operating vibration severity	Range of frequencies	Hz	See IEC 61291-5-2	See IEC 61291-5-2	
		Amplitude peak-to-peak	mm	n/a	See IEC 61291-5-2	
		Duration	s	n/a	See IEC 61291-5-2	
	Storage temperature		°C	See IEC 61291-5-2	See IEC 61291-5-2	
	Maximum storage relative humidity		%	n/a	See IEC 61291-5-2	
	Maximum shock severity, free drop	Drop height	mm	n/a	See IEC 61291-5-2	
	Failure rate		FIT	n/a	See IEC 61291-5-2	

	Parameters	Unit	Minimum values	Maximum values	IEC test method

[a] Either output power range, gain, or both shall be stated.

[b] Either input reflectance or return loss shall be specified.

n/a: not applicable

Table 2 – Minimum relevant parameters for power amplifiers based on SOA components specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics[a]	Input power range		dBm			IEC 61290-1 series
	Output power range[b]		dBm			IEC 61290-1 series
	Gain[b]		dB	n/a		IEC 61290-1 series
	Saturation output power		dBm	n/a		IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Gain ripple[c]		dB	n/a		~~Under consideration~~ IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Maximum total output power		dBm	n/a		IEC 61290-1 series
Environmental and reliability parameters[c]	Operating temperature		°C			
	Maximum operating relative humidity		%	n/a		
	Maximum operating vibration severity	Range of frequencies	Hz			
		Amplitude peak-to-peak	mm	n/a		
		Duration	s	n/a		
	Storage temperature		°C			
	Maximum storage relative humidity		%	n/a		

	Parameters		Unit	Minimum values	Maximum values	IEC test method
	Maximum shock severity, free drop	Drop height	mm	n/a		
	Failure rate		FIT	n/a		
Operating condition[a,d]	Forward current		mA			
	Forward bias voltage		V			
	Gain peak wavelength		nm			
	TEC current		A			
	TEC voltage		V			
	Thermistor resistance		Ω			
	Thermistor constant					

[a] Detailed information about SOA characteristics for saturation output power, gain, gain ripple, signal-spontaneous noise figure, polarization dependent gain, maximum total output power, and operating conditions are described in IEC TR 61292-9.

[b] Either output power range, gain, or both shall be stated.

[c] ~~Measurement method should be defined in other documents.~~

[c] ~~There are no IEC publications regarding SOA reliability. There are two documents regarding reliability of fibre optic active components and devices. These are IEC TR 62572-2 and IEC 62572-3, which deal with laser modules.~~ There are no IEC publications specifying reliability parameters for SOAs. The reliability of laser modules is addressed in IEC TR 62572-2, and reliability parameters for laser modules are specified in IEC 62572-3.

[d] Operating conditions of a TEC and thermistor are commonly specified in IEC 62149-3, which ~~covers the~~ is a performance standard for ~~2,5 Gb/s~~ modulator-integrated laser diode ~~modules~~ transmitters for 40-Gbit/s fibre optic transmission systems.

5 Performance specification templates for pre-amplifiers

The following templates contain a minimum set of performance parameters to be included in the specifications for OFA components or modules (see Table 3) and SOA components (see Table 4) used as pre-amplifiers in single channel applications. The tables include specification criteria (in terms of the maximum values, minimum values, or both) and references to the corresponding standards describing the test methods. Note that the list of the minimum parameters for SOAs (see Table 4) covers SOA components only, because most SOA products are currently ~~traded~~ commercialized in the form of ~~the component using~~ a package, such as a butterfly-type package, which contains only the SOA.

Table 3 – Minimum relevant parameters for pre-amplifiers based on OFA components or modules using active fibre specified for single channel applications

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics	Input power range	dBm			IEC 61290-1 series
	Output power range[a]	dBm			IEC 61290-1 series
	Gain[a]	dB			IEC 61290-1 series
	Wavelength band	nm			IEC 61290-1 series
	Available signal wavelength band	nm			IEC 61290-1 series
	Signal-spontaneous noise figure	dB	n/a		IEC 61290-3 series
	Polarization dependent gain	dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Input reflectance[b]	dB	n/a		IEC 61290-5 series
	Return loss[b]	dB		n/a	IEC 61290-3 series
	Maximum reflectance tolerable at input	dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output	dB	n/a		IEC 61290-5 series
	Pump leakage to input	dBm	n/a		IEC 61290-6-1
	Pump leakage to output	dBm	n/a		IEC 61290-6-1
	Maximum total output power	dBm	n/a		IEC 61290-1 series
Transient parameters[c]	Transient power response	dB	n/a		IEC 61290-4-3
	Transient power response time	s	n/a		IEC 61290-4-3
	Transient power overcompensation response	dB	n/a		IEC 61290-4-3
	Steady state power offset	dB	n/a		IEC 61290-4-3

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Environmental and reliability parameters	Operating temperature		°C	See IEC 61291-5-2	See IEC 61291-5-2	
	Maximum operating relative humidity		%	n/a	See IEC 61291-5-2	
	Maximum operating vibration severity	Range of frequencies	Hz	See IEC 61291-5-2	See IEC 61291-5-2	
		Amplitude peak-to-peak	mm	n/a	See IEC 61291-5-2	
		Duration	s	n/a	See IEC 61291-5-2	
	Storage temperature		°C	See IEC 61291-5-2	See IEC 61291-5-2	
	Maximum storage relative humidity		%	n/a	See IEC 61291-5-2	
	Maximum shock severity, free drop	Drop height	mm	n/a	See IEC 61291-5-2	

[a] Either output power range, gain, or both shall be stated.

[b] Either input reflectance or return loss shall be specified.

[c] Transient parameters are applicable to OFA modules with output power control.

Table 4 – Minimum relevant parameters for pre-amplifiers based on SOA components specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics[a]	Input power range		dBm			IEC 61290-1 series
	Output power range[b]		dBm			IEC 61290-1 series
	Gain[b]		dB	n/a		IEC 61290-1 series
	Saturation output power		dBm	n/a		IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Gain ripple[c]		dB	n/a		~~Under consideration~~ IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Maximum total output power		dBm	n/a		IEC 61290-1 series
Environmental and reliability parameters[c]	Operating temperature		°C			
	Maximum operating relative humidity		%	n/a		
	Maximum operating vibration severity	Range of frequencies	Hz			
		Amplitude peak-to-peak	mm	n/a		
		Duration	s	n/a		
	Storage temperature		°C			
	Maximum storage relative humidity		%	n/a		
	Maximum shock severity, free drop	Drop height	mm	n/a		
	Failure rate		FIT	n/a		

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Operating condition[a,d]	Forward current	mA			
	Forward bias voltage	V			
	Gain peak wavelength	nm			
	TEC current	A			
	TEC voltage	V			
	Thermistor resistance	Ω			
	Thermistor constant				

[a] Detailed information about SOA characteristics for saturation output power, gain, gain ripple, signal-spontaneous noise figure, polarization dependent gain, maximum total output power, and operating conditions are described in IEC TR 61292-9.

[b] Either output power range, gain, or both shall be stated.

[e] ~~Measurement method should be defined in other documents.~~

[c] ~~There are no IEC publications regarding SOA reliability. There are two documents regarding The reliability of fibre optic active components and devices. These are IEC TR 62572-2 and IEC 62572-3, which deal with laser modules.~~ There are no IEC publications specifying reliability parameters for SOAs. The reliability of laser modules is addressed in IEC TR 62572-2, and reliability parameters for laser modules are specified in IEC 62572-3.

[d] Operating conditions of a TEC and thermistor are commonly specified in IEC 62149-3, which ~~covers the~~ is a performance standard for ~~2,5 Gb/s~~ modulator-integrated laser diode ~~modules~~ transmitters for 40-Gbit/s fibre optic transmission systems .

6 Performance specification templates for line amplifiers

The following templates contain a minimum set of performance parameters to be included in specifications for OFA components and modules (see Table 5) and SOA components (see Table 6) used as line amplifiers in single channel applications. These tables include specification criteria (in terms of the maximum values, minimum values or both) and references to the corresponding standards describing the test methods. Note that the list of the minimum parameters for SOAs (see Table 6) covers SOA components only, because most SOA products are currently ~~traded~~ commercialized in the form of ~~the component using~~ a package, such as a butterfly-type package, which contains only the SOA.

Table 5 – Minimum relevant parameters for line amplifiers based on OFA components or modules using active fibre specified for single channel applications

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics	Input power range	dBm			IEC 61290-1 series
	Output power range[a]	dBm			IEC 61290-1 series
	Gain[a]	dB			IEC 61290-1 series
	Saturation output power	dBm	n/a		IEC 61290-1 series
	Wavelength band	nm			IEC 61290-1 series
	Signal-spontaneous noise figure	dB	n/a		IEC 61290-3 series
	Polarization dependent gain	dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Input reflectance	dB[b]	n/a		IEC 61290-5 series
	Return loss	dB[b]		n/a	IEC 61290-3 series
	Maximum reflectance tolerable at input	dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output	dB	n/a		IEC 61290-5 series
	Pump leakage to input	dBm	n/a		IEC 61290-6-1
	Pump leakage to output	dBm	n/a		IEC 61290-6-1
	Maximum total output power	dBm	n/a		IEC 61290-1 series
	Polarization mode dispersion	ps	n/a		IEC 61290-11 series
Transient parameters[c]	Transient power/gain response	dB	n/a		IEC 61290-4-3
	Transient power/gain response time	s	n/a		IEC 61290-4-3
	Transient power/gain overcompensation response	dB	n/a		IEC 61290-4-3
	Steady state power/gain offset	dB	n/a		IEC 61290-4-3

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Environmental and reliability parameters	Operating temperature		°C	See IEC 61291 -5-2	See IEC 61291 -5-2	
	Maximum operating relative humidity		%	n/a	See IEC 61291 -5-2	
	Maximum operating vibration severity	Range of frequencies	Hz	See IEC 61291 -5-2	See IEC 61291 -5-2	
		Amplitude peak-to-peak	mm	n/a	See IEC 61291 -5-2	
		Duration	s	n/a	See IEC 61291 -5-2	
	Storage temperature		°C	See IEC 61291 -5-2	See IEC 61291 -5-2	
	Maximum storage relative humidity		%	n/a	See IEC 61291 -5-2	
	Maximum shock severity, free drop	Drop height	mm	n/a	See IEC 61291 -5-2	

[a] Either output power range, gain, or both shall be stated.

[b] Either input reflectance or return loss shall be specified.

[c] Transient parameters are applicable to OFA modules with output power control.

Table 6 – Minimum relevant parameters for line amplifiers based on SOA components specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics[a]	Input power range		dBm			IEC 61290-1 series
	Output power range[b]		dBm			IEC 61290-1 series
	Gain[b]		dB	n/a		IEC 61290-1 series
	Saturation output power		dBm	n/a		IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Gain ripple[c]		dB	n/a		~~Under consideration~~ IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Maximum total output power		dBm	n/a		IEC 61290-1 series
	Polarization mode dispersion		ps	n/a		IEC 61290-11-1
Environmental and reliability parameters[c]	Operating temperature		°C			
	Maximum operating relative humidity		%	n/a		
	Maximum operating vibration severity	Range of frequencies	Hz			
		Amplitude peak-to-peak	mm	n/a		
		Duration	s	n/a		
	Storage temperature		°C			
	Maximum storage relative humidity		%	n/a		
	Maximum shock severity, free drop	Drop height	mm	n/a		
	Failure rate		FIT	n/a		

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Operating condition[a,d]	Forward current	mA			
	Forward bias voltage	V			
	Peak wavelength	nm			
	TEC current	A			
	TEC voltage	V			
	Thermistor resistance	Ω			
	Thermistor constant				

[a] Detailed information about SOA characteristics for saturation output power, gain, gain ripple, signal-spontaneous noise figure, polarization dependent gain, maximum total output power, and operating conditions are described in IEC TR 61292-9.

[b] Either output power range, gain, or both shall be stated.

[e] ~~Measurement method should be defined in other documents.~~

[c] ~~There are no IEC publications regarding the SOA reliability. There are two documents regarding The reliability of fibre optic active components and devices. These are IEC TR 62572-2 and IEC 62572-3, which deal with laser modules.~~ There are no IEC publications specifying reliability parameters for SOAs. The reliability of laser modules is addressed in IEC TR 62572-2, and reliability parameters for laser modules are specified in IEC 62572-3.

[d] Operating conditions of a TEC and thermistor are commonly specified in IEC 62149-3, which covers the performance standard for ~~2,5 Gb/s~~ modulator-integrated laser diode ~~modules~~ transmitters for 40-Gbit/s fibre optic transmission systems.

7 Electromagnetic compatibility (EMC) requirements

The devices and assemblies addressed by this document 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~~ the emission requirements specified in IEC 61000-6-3 and with the immunity requirements specified in IEC 61000-6-1. Other EMC requirements are standardized in the IEC 61000 series.

8 Laser safety requirements

The devices and assemblies addressed by this document shall be classified into the appropriate laser class as covered in IEC 60825-1.

Bibliography

IEC 61000 (all parts), *Electromagnetic compatibility (EMC)*

IEC 61280 (all parts), *Fibre optic communication subsystem test procedures*

IEC 61291-4, *Optical amplifiers – Part 4: Multichannel applications – Performance specification template*

IEC TR 61292-9, *Optical amplifiers – Part 9: Semiconductor optical amplifiers (SOAs)*

IEC TR 61931:1998, *Fibre optic – Terminology*

IEC 62148-11, *Fibre optic active components and devices – Package and interface standards – Part 11: 14-pin active device modules*

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

IEC 62149-3, *Fibre optic active components and devices – Performance standards – Part 3: Modulator-integrated laser diode transmitters for ~~2,5 Gbit/s to~~ 40-Gbit/s fibre optic transmission systems*

IEC TR 62572-2, *Fibre optic active components and devices – Reliability standards – Part 2: Laser module degradation*

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

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

IEC 61291-2

Edition 5.0 2023-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Optical amplifiers –
Part 2: Single channel applications – Performance specification template

Amplificateurs optiques –
Partie 2: Applications à un seul canal – Modèle de spécifications de performances

IEC 61291-2:2023-02(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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OPTICAL AMPLIFIERS –

Part 2: Single channel applications – Performance specification template

FOREWORD

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IEC 61291-2 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 fifth edition cancels and replaces the fourth edition published in 2016. This edition constitutes a technical revision.

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

a) the test methods for gain ripple in Table 2, Table 4 and Table 6 refer now to the IEC 61290-1 series;
b) the SOA definition (3.1.3) refers now to IEC 61931.

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

Draft	Report on voting
86C/1849/FDIS	86C/1858/RVD

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 61291 series, published under the general title *Optical amplifiers*, 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.

INTRODUCTION

This document is devoted to the subject of optical amplifiers. The technology of optical amplifiers is still rapidly evolving, hence amendments and new additions to this document can be expected. Each abbreviated term introduced in this document is generally explained in the text the first time it appears. However, for an easier understanding of the whole text, a list of all abbreviated terms used in this document is given in Clause 3.

OPTICAL AMPLIFIERS –

Part 2: Single channel applications – Performance specification template

1 Scope

This part of IEC 61291 provides a performance specification template applicable to optical amplifiers (OAs) used in single channel applications. Multichannel applications are covered in IEC 61291-4.

The objective of this template is to provide a framework for the preparation of performance standards and/or product specifications defining the performance of OA devices used in single channel applications. In addition to the requirements specified in this template, a performance standard or product specification could include other parameters, such as ratings, operating conditions, tests, and pass/fail criteria.

For a particular application, product specification writers could add specification parameters and/or groups of specification parameters to this template without removing the parameters specified in this document.

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

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for equipment in residential environments*

IEC 61290-1 (all parts), *Optical amplifiers – Test methods – Part 1: Power and gain parameters*

IEC 61290-3 (all parts), *Optical amplifiers – Test methods – Part 3: Noise figure parameters*

IEC 61290-4-3, *Optical amplifiers – Test methods – Part 4-3: Power transient parameters – Single channel optical amplifiers in output power control*

IEC 61290-5 (all parts), *Optical amplifiers – Test methods – Part 5: Reflectance parameters*

IEC 61290-6-1, *Optical fibre amplifiers – Basic specification – Part 6-1: Test methods for pump leakage parameters – Optical demultiplexer*

IEC 61290-11 (all parts), *Optical amplifiers – Test methods – Part 11: Polarization mode dispersion parameter*

IEC 61291-1, *Optical amplifiers – Part 1: Generic specification*

IEC 61291-5-2, *Optical amplifiers – Part 5-2: Qualification specifications – Reliability qualification for optical fibre amplifiers*

IEC TS 62538:2008, *Categorization of optical devices*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61291-1, IEC TS 62538 and the following apply.

NOTE Possible supplementary definitions specific to OAs for single channel applications can be given in product specifications.

3.1.1
optical amplifier
OA
optical waveguide device containing a suitably pumped, active medium that is able to amplify an optical signal

[SOURCE: IEC TR 61931:1998, 2.7.75]

3.1.2
optical fibre amplifier
OFA
optical amplifier made of active optical fibre that is doped with rare-earth ions or that presents non-linear optical effects in order to obtain optical amplification

3.1.3
semiconductor optical amplifier
SOA
optical amplifier in which the active optical waveguide is formed by a semiconductor laser diode structure and will be electrically pumped

Note 1 to entry: The structure of these amplifiers is similar to that of Fabry-Perot laser diodes but with anti-reflection design elements at the end-face surfaces. The signal is amplified through the stimulated emission phenomenon in the gain medium.

[SOURCE: IEC TR 61931:1998, 2.7.77, modified – The note to entry has been added.]

3.1.4
optical element
unpackaged or partially packaged optical basic unit, typically non repairable and non-re-workable (at least by users)

Note 1 to entry: Examples of optical elements include laser chips or laser diodes, photodiodes, lenses, prisms, optical collimators, grating chips and filter chips.

[SOURCE: IEC TS 62538:2008, 2.2.1]

3.1.5
optical component
packaged unit comprising at least one optical element, typically non repairable and non-re-workable (at least by users), suitably pigtailed or connectorized

Note 1 to entry: Examples of optical components include packaged lasers, photodiodes, optical splitters, couplers, attenuators, isolators, MEMS, and modulators.

[SOURCE: IEC TS 62538:2008, 2.2.2]

3.1.6
optical module
packaged integration of optical components and/or elements, accomplishing defined functionality, typically repairable and re-workable

Note 1 to entry: An optical module may comprise electronic components.

Note 2 to entry: An optical module is to be used as it is; users are not normally enabled to re-arrange inner components or add other components inside.

[SOURCE: IEC TS 62538:2008, 2.2.5]

3.1.7
OFA component
fibre-pigtailed optical component that consists of fibre based gain medium such as an erbium-doped fibre, one or more optical isolator(s), optical couplers for the wavelength-selector or the power monitor, a package, and fibres

Note 1 to entry: An OFA component may include an optical filter, such as a gain equalizing filter or ASE rejection filter, and possibly other components.

3.1.8
OFA module
fibre-pigtailed optical module that consists of an OFA component, pump laser component(s) with driving circuit, monitor photodiode component(s) with driving circuit, and a control circuit

3.1.9
SOA element
optical element of SOA that consists of a semiconductor chip

3.1.10
SOA component
fibre-pigtailed optical component that consists of an SOA element, lenses, optical isolator(s) (if necessary), a thermoelectric cooler (TEC), a thermistor, a package, and fibres

3.2 Abbreviated terms

EMC electromagnetic compatibility
OA optical amplifier
OFA optical fibre amplifier
SOA semiconductor optical amplifier
TEC thermoelectric cooler

4 Performance specification templates for power amplifiers

The following templates contain a minimum set of performance parameters to be included in the specifications for OFA components or modules (see Table 1) and SOA components (see Table 2) used as power amplifiers in single channel applications. The tables include specification criteria (in terms of the maximum values, minimum values or both) and references to the corresponding standards describing the test methods. Note that the list of the minimum parameters for SOAs (see Table 2) covers SOA components only, because most SOA products are currently commercialized in the form of a package, such as a butterfly-type package, which contains only the SOA.

Table 1 – Minimum relevant parameters for power amplifiers based on OFA components or modules using active fibre specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics	Input power range		dBm			IEC 61290-1 series
	Output power range[a]		dBm			IEC 61290-1 series
	Gain[a]		dB			IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance[b]		dB	n/a		IEC 61290-5 series
	Return loss[b]		dB		n/a	IEC 61290-3 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Pump leakage to input		dBm	n/a		IEC 61290-6-1
	Pump leakage to output		dBm	n/a		IEC 61290-6-1
	Maximum total output power		dBm	n/a		IEC 61290-1 series
Environmental and reliability parameters	Operating temperature		°C	See IEC 61291-5-2	See IEC 61291-5-2	
	Maximum operating relative humidity		%	n/a	See IEC 61291-5-2	
	Maximum operating vibration severity	Range of frequencies	Hz	See IEC 61291-5-2	See IEC 61291-5-2	
		Amplitude peak-to-peak	mm	n/a	See IEC 61291-5-2	
		Duration	s	n/a	See IEC 61291-5-2	
	Storage temperature		°C	See IEC 61291-5-2	See IEC 61291-5-2	
	Maximum storage relative humidity		%	n/a	See IEC 61291-5-2	
	Maximum shock severity, free drop	Drop height	mm	n/a	See IEC 61291-5-2	
	Failure rate		FIT	n/a	See IEC 61291-5-2	

[a] Either output power range, gain, or both shall be stated.

[b] Either input reflectance or return loss shall be specified.

n/a: not applicable

Table 2 – Minimum relevant parameters for power amplifiers based on SOA components specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics[a]	Input power range		dBm			IEC 61290-1 series
	Output power range[b]		dBm			IEC 61290-1 series
	Gain[b]		dB	n/a		IEC 61290-1 series
	Saturation output power		dBm	n/a		IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Gain ripple		dB	n/a		IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Maximum total output power		dBm	n/a		IEC 61290-1 series
Environmental and reliability parameters[c]	Operating temperature		°C			
	Maximum operating relative humidity		%	n/a		
	Maximum operating vibration severity	Range of frequencies	Hz			
		Amplitude peak-to-peak	mm	n/a		
		Duration	s	n/a		
	Storage temperature		°C			
	Maximum storage relative humidity		%	n/a		
	Maximum shock severity, free drop	Drop height	mm	n/a		
	Failure rate		FIT	n/a		

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Operating condition[a,d]	Forward current	mA			
	Forward bias voltage	V			
	Gain peak wavelength	nm			
	TEC current	A			
	TEC voltage	V			
	Thermistor resistance	Ω			
	Thermistor constant				

[a] Detailed information about SOA characteristics for saturation output power, gain, gain ripple, signal-spontaneous noise figure, polarization dependent gain, maximum total output power, and operating conditions are described in IEC TR 61292-9.

[b] Either output power range, gain, or both shall be stated.

[c] There are no IEC publications specifying reliability parameters for SOAs. The reliability of laser modules is addressed in IEC TR 62572-2, and reliability parameters for laser modules are specified in IEC 62572-3.

[d] Operating conditions of a TEC and thermistor are commonly specified in IEC 62149-3, which is a performance standard for modulator-integrated laser diode transmitters for 40-Gbit/s fibre optic transmission systems.

5 Performance specification templates for pre-amplifiers

The following templates contain a minimum set of performance parameters to be included in the specifications for OFA components or modules (see Table 3) and SOA components (see Table 4) used as pre-amplifiers in single channel applications. The tables include specification criteria (in terms of the maximum values, minimum values, or both) and references to the corresponding standards describing the test methods. Note that the list of the minimum parameters for SOAs (see Table 4) covers SOA components only, because most SOA products are currently commercialized in the form of a package, such as a butterfly-type package, which contains only the SOA.

Table 3 – Minimum relevant parameters for pre-amplifiers based on OFA components or modules using active fibre specified for single channel applications

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics	Input power range	dBm			IEC 61290-1 series
	Output power range[a]	dBm			IEC 61290-1 series
	Gain[a]	dB			IEC 61290-1 series
	Wavelength band	nm			IEC 61290-1 series
	Available signal wavelength band	nm			IEC 61290-1 series
	Signal-spontaneous noise figure	dB	n/a		IEC 61290-3 series
	Polarization dependent gain	dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Input reflectance[b]	dB	n/a		IEC 61290-5 series
	Return loss[b]	dB		n/a	IEC 61290-3 series
	Maximum reflectance tolerable at input	dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output	dB	n/a		IEC 61290-5 series
	Pump leakage to input	dBm	n/a		IEC 61290-6-1
	Pump leakage to output	dBm	n/a		IEC 61290-6-1
	Maximum total output power	dBm	n/a		IEC 61290-1 series
Transient parameters[c]	Transient power response	dB	n/a		IEC 61290-4-3
	Transient power response time	s	n/a		IEC 61290-4-3
	Transient power overcompensation response	dB	n/a		IEC 61290-4-3
	Steady state power offset	dB	n/a		IEC 61290-4-3

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Environmental and reliability parameters	Operating temperature		°C	See IEC 61291 -5-2	See IEC 61291 -5-2	
	Maximum operating relative humidity		%	n/a	See IEC 61291 -5-2	
	Maximum operating vibration severity	Range of frequencies	Hz	See IEC 61291 -5-2	See IEC 61291 -5-2	
		Amplitude peak-to-peak	mm	n/a	See IEC 61291 -5-2	
		Duration	s	n/a	See IEC 61291 -5-2	
	Storage temperature		°C	See IEC 61291 -5-2	See IEC 61291 -5-2	
	Maximum storage relative humidity		%	n/a	See IEC 61291 -5-2	
	Maximum shock severity, free drop	Drop height	mm	n/a	See IEC 61291 -5-2	

[a] Either output power range, gain, or both shall be stated.

[b] Either input reflectance or return loss shall be specified.

[c] Transient parameters are applicable to OFA modules with output power control.

Table 4 – Minimum relevant parameters for pre-amplifiers based on SOA components specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics[a]	Input power range		dBm			IEC 61290-1 series
	Output power range[b]		dBm			IEC 61290-1 series
	Gain[b]		dB	n/a		IEC 61290-1 series
	Saturation output power		dBm	n/a		IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Gain ripple		dB	n/a		IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Maximum total output power		dBm	n/a		IEC 61290-1 series
Environmental and reliability parameters[c]	Operating temperature		°C			
	Maximum operating relative humidity		%	n/a		
	Maximum operating vibration severity	Range of frequencies	Hz			
		Amplitude peak-to-peak	mm	n/a		
		Duration	s	n/a		
	Storage temperature		°C			
	Maximum storage relative humidity		%	n/a		
	Maximum shock severity, free drop	Drop height	mm	n/a		
	Failure rate		FIT	n/a		

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Operating condition[a,d]	Forward current	mA			
	Forward bias voltage	V			
	Gain peak wavelength	nm			
	TEC current	A			
	TEC voltage	V			
	Thermistor resistance	Ω			
	Thermistor constant				

[a] Detailed information about SOA characteristics for saturation output power, gain, gain ripple, signal-spontaneous noise figure, polarization dependent gain, maximum total output power, and operating conditions are described in IEC TR 61292-9.

[b] Either output power range, gain, or both shall be stated.

[c] There are no IEC publications specifying reliability parameters for SOAs. The reliability of laser modules is addressed in IEC TR 62572-2, and reliability parameters for laser modules are specified in IEC 62572-3.

[d] Operating conditions of a TEC and thermistor are commonly specified in IEC 62149-3, which is a performance standard for modulator-integrated laser diode transmitters for 40-Gbit/s fibre optic transmission systems .

6 Performance specification templates for line amplifiers

The following templates contain a minimum set of performance parameters to be included in specifications for OFA components and modules (see Table 5) and SOA components (see Table 6) used as line amplifiers in single channel applications. These tables include specification criteria (in terms of the maximum values, minimum values or both) and references to the corresponding standards describing the test methods. Note that the list of the minimum parameters for SOAs (see Table 6) covers SOA components only, because most SOA products are currently commercialized in the form of a package, such as a butterfly-type package, which contains only the SOA.

Table 5 – Minimum relevant parameters for line amplifiers based on OFA components or modules using active fibre specified for single channel applications

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics	Input power range	dBm			IEC 61290-1 series
	Output power range[a]	dBm			IEC 61290-1 series
	Gain[a]	dB			IEC 61290-1 series
	Saturation output power	dBm	n/a		IEC 61290-1 series
	Wavelength band	nm			IEC 61290-1 series
	Signal-spontaneous noise figure	dB	n/a		IEC 61290-3 series
	Polarization dependent gain	dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level	dBm	n/a		IEC 61290-3 series
	Input reflectance	dB[b]	n/a		IEC 61290-5 series
	Return loss	dB[b]		n/a	IEC 61290-3 series
	Maximum reflectance tolerable at input	dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output	dB	n/a		IEC 61290-5 series
	Pump leakage to input	dBm	n/a		IEC 61290-6-1
	Pump leakage to output	dBm	n/a		IEC 61290-6-1
	Maximum total output power	dBm	n/a		IEC 61290-1 series
	Polarization mode dispersion	ps	n/a		IEC 61290-11 series
Transient parameters[c]	Transient power/gain response	dB	n/a		IEC 61290-4-3
	Transient power/gain response time	s	n/a		IEC 61290-4-3
	Transient power/gain overcompensation response	dB	n/a		IEC 61290-4-3
	Steady state power/gain offset	dB	n/a		IEC 61290-4-3

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Environmental and reliability parameters	Operating temperature		°C	See IEC 61291 -5-2	See IEC 61291 -5-2	
	Maximum operating relative humidity		%	n/a	See IEC 61291 -5-2	
	Maximum operating vibration severity	Range of frequencies	Hz	See IEC 61291 -5-2	See IEC 61291 -5-2	
		Amplitude peak-to-peak	mm	n/a	See IEC 61291 -5-2	
		Duration	s	n/a	See IEC 61291 -5-2	
	Storage temperature		°C	See IEC 61291 -5-2	See IEC 61291 -5-2	
	Maximum storage relative humidity		%	n/a	See IEC 61291 -5-2	
	Maximum shock severity, free drop	Drop height	mm	n/a	See IEC 61291 -5-2	

[a] Either output power range, gain, or both shall be stated.

[b] Either input reflectance or return loss shall be specified.

[c] Transient parameters are applicable to OFA modules with output power control.

Table 6 – Minimum relevant parameters for line amplifiers based on SOA components specified for single channel applications

	Parameters		Unit	Minimum values	Maximum values	IEC test method
Transmission characteristics[a]	Input power range		dBm			IEC 61290-1 series
	Output power range[b]		dBm			IEC 61290-1 series
	Gain[b]		dB	n/a		IEC 61290-1 series
	Saturation output power		dBm	n/a		IEC 61290-1 series
	Wavelength band		nm			IEC 61290-1 series
	Gain ripple		dB	n/a		IEC 61290-1 series
	Signal-spontaneous noise figure		dB	n/a		IEC 61290-3 series
	Polarization dependent gain		dB	n/a		IEC 61290-1 series
	Forward amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Reverse amplified spontaneous emission power level		dBm	n/a		IEC 61290-3 series
	Input reflectance		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at input		dB	n/a		IEC 61290-5 series
	Maximum reflectance tolerable at output		dB	n/a		IEC 61290-5 series
	Maximum total output power		dBm	n/a		IEC 61290-1 series
	Polarization mode dispersion		ps	n/a		IEC 61290-11-1
Environmental and reliability parameters[c]	Operating temperature		°C			
	Maximum operating relative humidity		%	n/a		
	Maximum operating vibration severity	Range of frequencies	Hz			
		Amplitude peak-to-peak	mm	n/a		
		Duration	s	n/a		
	Storage temperature		°C			
	Maximum storage relative humidity		%	n/a		
	Maximum shock severity, free drop	Drop height	mm	n/a		
	Failure rate		FIT	n/a		

	Parameters	Unit	Minimum values	Maximum values	IEC test method
Operating condition[a,d]	Forward current	mA			
	Forward bias voltage	V			
	Peak wavelength	nm			
	TEC current	A			
	TEC voltage	V			
	Thermistor resistance	Ω			
	Thermistor constant				

[a] Detailed information about SOA characteristics for saturation output power, gain, gain ripple, signal-spontaneous noise figure, polarization dependent gain, maximum total output power, and operating conditions are described in IEC TR 61292-9.

[b] Either output power range, gain, or both shall be stated.

[c] There are no IEC publications specifying reliability parameters for SOAs. The reliability of laser modules is addressed in IEC TR 62572-2, and reliability parameters for laser modules are specified in IEC 62572-3.

[d] Operating conditions of a TEC and thermistor are commonly specified in IEC 62149-3, which covers the performance standard for modulator-integrated laser diode transmitters for 40-Gbit/s fibre optic transmission systems.

7 Electromagnetic compatibility (EMC) requirements

The devices and assemblies addressed by this document shall comply with the emission requirements specified in IEC 61000-6-3 and with the immunity requirements specified in IEC 61000-6-1. Other EMC requirements are standardized in the IEC 61000 series.

8 Laser safety requirements

The devices and assemblies addressed by this document shall be classified into the appropriate laser class as covered in IEC 60825-1.

Bibliography

IEC 61000 (all parts), *Electromagnetic compatibility (EMC)*

IEC 61280 (all parts), *Fibre optic communication subsystem test procedures*

IEC 61291-4, *Optical amplifiers – Part 4: Multichannel applications – Performance specification template*

IEC TR 61292-9, *Optical amplifiers – Part 9: Semiconductor optical amplifiers (SOAs)*

IEC TR 61931:1998, *Fibre optic – Terminology*

IEC 62148-11, *Fibre optic active components and devices – Package and interface standards – Part 11: 14-pin active device modules*

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

IEC 62149-3, *Fibre optic active components and devices – Performance standards – Part 3: Modulator-integrated laser diode transmitters for 40-Gbit/s fibre optic transmission systems*

IEC TR 62572-2, *Fibre optic active components and devices – Reliability standards – Part 2: Laser module degradation*

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

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

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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AMPLIFICATEURS OPTIQUES –

Partie 2: Applications à un seul canal – Modèle de spécifications de performances

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L'IEC 61291-2 a été établie par le sous-comité 86C: Systèmes et dispositifs actifs à fibres optiques, du comité d'études de l'IEC 86: Fibres optiques. Il s'agit d'une Norme internationale.

Cette cinquième édition annule et remplace la quatrième édition parue en 2016. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) les méthodes d'essai pour l'ondulation du gain dans le Tableau 2, le Tableau 4 et le Tableau 6 font maintenant référence à la série IEC 61290-1;
b) la définition de SOA (3.1.3) fait maintenant référence à l'IEC 61931.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
86C/1849/FDIS	86C/1858/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 61291, publiées sous le titre général *Amplificateurs optiques*, se trouve sur le site web de l'IEC.

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- amendé.

INTRODUCTION

Le présent document est consacré au domaine des amplificateurs optiques. La technologie des amplificateurs optiques se développe encore rapidement, de sorte que des amendements et de nouveaux ajouts au présent document sont à prévoir. Chaque abréviation introduite dans le présent document est en général expliquée dans le texte la première fois où elle apparaît. Cependant, pour faciliter la compréhension de l'ensemble du texte, une liste de toutes les abréviations utilisées dans le présent document est donnée à l'Article 3.

AMPLIFICATEURS OPTIQUES –

Partie 2: Applications à un seul canal – Modèle de spécifications de performances

1 Domaine d'application

La présente partie de l'IEC 61291 fournit un modèle de spécifications de performances applicable aux amplificateurs optiques (AO) utilisés dans le cadre d'applications à un seul canal. Les applications multicanaux sont couvertes dans l'IEC 61291-4.

L'objectif de ce modèle est de fournir un cadre pour l'établissement de normes de performances et/ou de spécifications de produit définissant les performances des dispositifs AO utilisés dans le cadre d'applications à un seul canal. En plus des exigences spécifiées dans ce modèle, une norme de performances ou une spécification de produit peut inclure d'autres paramètres, tels que des valeurs assignées, des conditions de fonctionnement, des essais et des critères de succès/défaillance.

Pour une application particulière, les rédacteurs de spécifications de produit peuvent ajouter des paramètres de spécification et/ou des groupes de paramètres de spécification à ce modèle, sans supprimer les paramètres spécifiés dans le présent document.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60825-1, *Sécurité des appareils à laser – Partie 1: Classification des matériels et exigences*

IEC 61000-6-1, *Compatibilité électromagnétique (CEM) – Partie 6-1: Normes génériques – Norme d'immunité pour les environnements résidentiels, commerciaux et de l'industrie légère*

IEC 61000-6-3, *Compatibilité électromagnétique (CEM) – Partie 6-3: Normes génériques – Norme sur l'émission pour les environnements résidentiels*

IEC 61290-1 (toutes les parties), *Amplificateurs optiques – Méthodes d'essai – Partie 1: Paramètres de puissance et de gain*

IEC 61290-3 (toutes les parties), *Amplificateurs optiques – Méthodes d'essai – Partie 3: Paramètres du facteur de bruit*

IEC 61290-4-3, *Amplificateurs optiques – Méthodes d'essai – Partie 4-3: Paramètres de puissance transitoire – Amplificateurs optiques monocanaux commandés par la puissance de sortie*

IEC 61290-5 (toutes les parties), *Amplificateurs optiques – Méthodes d'essai – Partie 5: Paramètres de réflectance*

IEC 61290-6-1, *Amplificateurs à fibres optiques – Spécification de base – Partie 6-1: Méthodes d'essai pour les paramètres de fuite de pompe – Démultiplexeur optique*

IEC 61290-11 (toutes les parties), *Amplificateurs optiques – Méthodes d'essai – Partie 11: Paramètre de dispersion du mode de polarisation*

IEC 61291-1, *Amplificateurs optiques – Partie 1: Spécification générique*

IEC 61291-5-2, *Amplificateurs optiques – Partie 5-2: Spécifications de qualification – Qualification de fiabilité pour amplificateurs à fibres optiques*

IEC TS 62538:2008, *Categorization of optical devices* (disponible en anglais seulement)

3 Termes, définitions et abréviations

3.1 Termes et définitions

Pour les besoins du présent document, les termes et définitions donnés dans l'IEC 61291-1, l'IEC TS 62538 ainsi que les suivants s'appliquent.

NOTE D'éventuelles définitions supplémentaires spécifiques aux AO pour les applications à un seul canal peuvent être fournies dans les spécifications de produit.

3.1.1
amplificateur optique
AO
dispositif à guide d'ondes optique composé d'un milieu actif pompé de manière adéquate, capable d'amplifier un signal optique

[SOURCE: IEC TR 61931:1998, 2.7.75]

3.1.2
amplificateur à fibres optiques
OFA
amplificateur optique constitué d'une fibre optique active dopée avec des ions de terres rares, ou présentant des effets optiques non linéaires afin d'obtenir une amplification optique

3.1.3
amplificateur optique à semiconducteur
SOA
amplificateur optique dans lequel le guide d'ondes optique actif est constitué d'une structure diode laser à semiconducteur et pompé électriquement

Note 1 à l'article: La structure de ces amplificateurs est similaire à celle des diodes laser Fabry-Perot, mais avec des éléments de conception antiréfléchissement au niveau des surfaces d'extrémité. Le signal est amplifié par le phénomène d'émission stimulée dans le milieu amplificateur.

[SOURCE: IEC TR 61931:1998, 2.7.77, modifié – La note à l'article a été ajoutée.]

3.1.4
élément optique
unité optique de base non emballée ou partiellement emballée, ne pouvant généralement pas être réparée ou refaçonnée (au moins par les utilisateurs)

Note 1 à l'article: Les puces laser ou les diodes laser, les photodiodes, les lentilles, les prismes, les collimateurs optiques, les puces de réseau et les puces de filtre sont des exemples d'éléments optiques.

[SOURCE: IEC TS 62538:2008, 2.2.1]

3.1.5
composant optique
unité emballée comprenant au moins un élément optique, ne pouvant généralement pas être réparé ou refaçonné (au moins par les utilisateurs), convenablement équipée d'une fibre amorce ou connectorisée

Note 1 à l'article: Les lasers emballés, les photodiodes, les répartiteurs optiques, les coupleurs, les atténuateurs, les isolateurs, les MEMS et les modulateurs sont des exemples de composants optiques.

[SOURCE: IEC TS 62538:2008, 2.2.2]

3.1.6
module optique
intégration emballée de composants et/ou éléments optiques, ayant une fonctionnalité définie, généralement réparable et refaçonnable

Note 1 à l'article: Un module optique peut inclure des composants électroniques.

Note 2 à l'article: Un module optique est destiné à être utilisé tel quel; les utilisateurs ne sont normalement pas autorisés à réorganiser les composants internes ou à en rajouter.

[SOURCE: IEC TS 62538:2008, 2.2.5]

3.1.7
composant OFA
composant optique à fibre amorce, qui se compose d'un milieu amplificateur à base de fibres comme une fibre dopée à l'erbium, d'un ou plusieurs isolateurs optiques, de coupleurs optiques pour le sélecteur de longueur d'onde ou le contrôleur de puissance, d'un emballage et de fibres

Note 1 à l'article: Un composant OFA peut inclure un filtre optique, comme un filtre d'égalisation de gain ou un filtre de réjection ASE, et éventuellement d'autres composants.

3.1.8
module OFA
module optique à fibre amorce, constitué d'un composant OFA, d'un ou plusieurs composants de laser de pompage avec un circuit de contrôle, d'un ou plusieurs composants de photodiode de surveillance avec un circuit de contrôle et un circuit de commande

3.1.9
élément SOA
élément optique d'un SOA qui se compose d'une puce de semiconducteur

3.1.10
composant SOA
composant optique à fibre amorce, constitué d'un élément SOA, de lentilles, d'un ou plusieurs isolateurs optiques (le cas échéant), d'un refroidisseur optique (TEC), d'une thermistance, d'un emballage et de fibres

3.2 Abréviations

CEM compatibilité électromagnétique
AO amplificateur optique
OFA amplificateur à fibres optiques (optical fibre amplifier)
SOA amplificateur optique à semiconducteur (semiconductor optical amplifier)
TEC refroidisseur thermoélectrique (thermoelectric cooler)

4 Modèles de spécifications de performances pour amplificateurs de puissance

Les modèles suivants contiennent un ensemble minimal de paramètres de performances à inclure dans les spécifications des composants ou modules OFA (voir Tableau 1) et des composants SOA (voir Tableau 2) utilisés comme amplificateurs de puissance dans applications à un seul canal. Les tableaux comprennent des critères de spécification (en ce qui concerne les valeurs maximales, les valeurs minimales ou les deux) et des références aux normes correspondantes décrivant les méthodes d'essai. Noter que la liste des paramètres minimaux pour les SOA (voir Tableau 2) couvre uniquement les composants SOA, car la plupart des produits SOA sont actuellement commercialisés sous la forme d'un boîtier, de type butterfly par exemple, contenant uniquement le SOA.

Tableau 1 – Paramètres minimaux applicables pour les amplificateurs de puissance basés sur des composants ou modules OFA utilisant une fibre active spécifiée pour des applications à un seul canal

	Paramètres		Unité	Valeurs minimales	Valeurs maximales	Méthode d'essai de l'IEC
Caractéristiques de transmission	Plage de puissances d'entrée		dBm			Série IEC 61290-1
	Plage de puissances de sortie[a]		dBm			Série IEC 61290-1
	Gain[a]		dB			Série IEC 61290-1
	Bande de longueur d'onde		nm			Série IEC 61290-1
	Facteur de bruit signal/émission spontanée		dB	NA		Série IEC 61290-3
	Gain en fonction de la polarisation		dB	NA		Série IEC 61290-1
	Niveau de puissance de l'émission spontanée en amplification inverse		dBm	NA		Série IEC 61290-3
	Réflectance d'entrée[b]		dB	NA		Série IEC 61290-5
	Affaiblissement de réflexion[b]		dB		NA	Série IEC 61290-3
	Réflectance maximale tolérable à l'entrée		dB	NA		Série IEC 61290-5
	Réflectance maximale tolérable à la sortie		dB	NA		Série IEC 61290-5
	Fuite de pompage en entrée		dBm	NA		IEC 61290-6-1
	Fuite de pompage en sortie		dBm	NA		IEC 61290-6-1
	Puissance de sortie totale maximale		dBm	NA		Série IEC 61290-1
Paramètres de fiabilité et environnementaux	Température de fonctionnement		°C	Voir IEC 612 91-5-2	Voir IEC 612 91-5-2	
	Humidité relative maximale en fonctionnement		%	NA	Voir IEC 612 91-5-2	
	Sévérité maximale de vibrations en fonctionnement	Plage de fréquences	Hz	Voir IEC 61291-5-2	Voir IEC 612 91-5-2	
		Amplitude crête à crête	mm	NA	Voir IEC 612 91-5-2	
		Durée	s	NA	Voir IEC 612 91-5-2	
	Température de stockage		°C	Voir IEC 612 91-5-2	Voir IEC 612 91-5-2	
	Humidité relative maximale de stockage		%	NA	Voir IEC 612 91-5-2	