



IEC 61290-1

Edition 2.0 2022-06
REDLINE VERSION

INTERNATIONAL STANDARD



**Optical amplifiers – Test methods –
Part 1: Power and gain parameters**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.30

ISBN 978-2-8322-3847-9

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	3
1 Scope and object	5
2 Normative references	5
3 Terms, definitions and abbreviated terms	6
3.1 Terms and definitions	6
3.2 Abbreviated terms	6
4 Optical power and gain test method	6
5 Optical power and gain parameters	6
6 Test results	12
Bibliography	15
Figure 1 – Typical behaviour of the gain as a function of input signal power	7
Figure 2 – Typical behaviour of the gain as a function of wavelength	8
Figure 3 – Typical behaviour of the gain as a function of temperature	9
Figure 4 – Typical behaviour of the gain as a function of wavelength	10
Figure 5 – Typical behaviour of the gain fluctuation as a function of time	10
Figure 6 – Typical behaviour of the output power fluctuation as a function of time	11
Figure 7 – Typical behaviour of the gain as a function of input signal power	12
Figure 8 – Typical behaviour of the output power as a function of input signal power	12

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL AMPLIFIERS – TEST METHODS –

Part 1: Power and gain parameters

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61290-1:2014. 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 61290-1 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 second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

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

- a) specification of gain ripple as a new parameter;
- b) specification of test method and test report for gain ripple measurements;
- c) use of the term “measurement uncertainty” instead of “measurement accuracy”.

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

Draft	Report on voting
86C/1746/FDIS	86C/1783/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 61290 series, published under the general title *Optical amplifiers – Test methods*, 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.

OPTICAL AMPLIFIERS – TEST METHODS –

Part 1: Power and gain parameters

1 ~~Scope and object~~

This part of IEC 61290 applies to all commercially available optical amplifiers (OAs) and optically amplified subsystems. It applies to OAs using optically pumped fibres (optical fibre amplifiers (OFAs) based on either rare-earth doped fibres or on the Raman effect), semiconductors (semiconductor optical amplifiers (SOAs)), and waveguides (planar optical waveguide amplifiers (POWAs)). It is specifically directed to single-channel amplifiers. Test methods for multichannel amplifiers are defined in the IEC 61290-10 series.

This document establishes uniform requirements for accurate and reliable measurements of the following OA parameters, as defined in IEC 61291-1:2012/2018, Clause 3:

- a) nominal output signal power;
- b) gain;
- c) reverse gain;
- d) maximum gain;
- e) maximum gain wavelength;
- f) maximum gain variation with temperature;
- g) gain wavelength band;
- h) gain wavelength variation;
- i) gain stability;
- j) polarization-dependent gain;
- k) gain ripple (SOA only);
- l) large-signal output stability;
- m) saturation output power;
- n) maximum output signal power;
- o) maximum total output power.

NOTE 1 The applicability of the test methods described in this document to distributed Raman amplifiers is still under study.

NOTE 2 All numerical values followed by ($\pm$) are suggested values for which the measurement is assured. Other values are acceptable if verified.

~~The object of this standard is specifically directed to single-channel amplifiers. For multichannel amplifiers, one should refer to the IEC 61290-10 series.~~

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 61290-1-1, *Optical amplifiers – Test methods – Part 1-1: Power and gain parameters – Optical spectrum analyzer method*

IEC 61290-1-2, *Optical amplifiers – Test methods – Part 1-2: Power and gain parameters – Electrical spectrum analyzer method*

IEC 61290-1-3, *Optical amplifiers – Test methods – Part 1-3: Power and gain parameters – Optical power meter method*

IEC 61291-1:~~2012~~2018, *Optical amplifiers – Part 1: Generic specification*

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Optical amplifiers – Test methods –
Part 1: Power and gain parameters**

**Amplificateurs optiques – Méthodes d'essai –
Partie 1: Paramètres de puissance et de gain**

CONTENTS

FOREWORD	3
1 Scope	5
2 Normative references	5
3 Terms, definitions and abbreviated terms	6
3.1 Terms and definitions.....	6
3.2 Abbreviated terms.....	6
4 Optical power and gain test method.....	6
5 Optical power and gain parameters	6
6 Test results	11
Bibliography.....	14
Figure 1 – Typical behaviour of the gain as a function of input signal power	7
Figure 2 – Typical behaviour of the gain as a function of wavelength	7
Figure 3 – Typical behaviour of the gain as a function of temperature	8
Figure 4 – Typical behaviour of the gain as a function of wavelength	9
Figure 5 – Typical behaviour of the gain fluctuation as a function of time	9
Figure 6 – Typical behaviour of the output power fluctuation as a function of time	10
Figure 7 – Typical behaviour of the gain as a function of input signal power	11
Figure 8 – Typical behaviour of the output power as a function of input signal power	11

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL AMPLIFIERS – TEST METHODS –**Part 1: Power and gain parameters****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61290-1 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 second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

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

- a) specification of gain ripple as a new parameter;
- b) specification of test method and test report for gain ripple measurements;
- c) use of the term “measurement uncertainty” instead of “measurement accuracy”.

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

Draft	Report on voting
86C/1746/FDIS	86C/1783/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 61290 series, published under the general title *Optical amplifiers – Test methods*, 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.

OPTICAL AMPLIFIERS – TEST METHODS –

Part 1: Power and gain parameters

1 Scope

This part of IEC 61290 applies to all commercially available optical amplifiers (OAs) and optically amplified subsystems. It applies to OAs using optically pumped fibres (optical fibre amplifiers (OFAs) based on either rare-earth doped fibres or on the Raman effect), semiconductors (semiconductor optical amplifiers (SOAs)), and waveguides (planar optical waveguide amplifiers (POWAs)). It is specifically directed to single-channel amplifiers. Test methods for multichannel amplifiers are defined in the IEC 61290-10 series.

This document establishes uniform requirements for accurate and reliable measurements of the following OA parameters, as defined in IEC 61291-1:2018, Clause 3:

- a) nominal output signal power;
- b) gain;
- c) reverse gain;
- d) maximum gain;
- e) maximum gain wavelength;
- f) maximum gain variation with temperature;
- g) gain wavelength band;
- h) gain wavelength variation;
- i) gain stability;
- j) polarization-dependent gain;
- k) gain ripple (SOA only);
- l) large-signal output stability;
- m) saturation output power;
- n) maximum output signal power;
- o) maximum total output power.

NOTE 1 The applicability of the test methods described in this document to distributed Raman amplifiers is still under study.

NOTE 2 All numerical values followed by ($\pm$) are suggested values for which the measurement is assured. Other values are acceptable if verified.

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 61290-1-1, *Optical amplifiers – Test methods – Part 1-1: Power and gain parameters – Optical spectrum analyzer method*

IEC 61290-1-2, *Optical amplifiers – Test methods – Part 1-2: Power and gain parameters – Electrical spectrum analyzer method*

IEC 61290-1-3, *Optical amplifiers – Test methods – Part 1-3: Power and gain parameters – Optical power meter method*

IEC 61291-1:2018, *Optical amplifiers – Part 1: Generic specification*

SOMMAIRE

AVANT-PROPOS	17
1 Domaine d'application	19
2 Références normatives	19
3 Termes, définitions et termes abrégés	20
3.1 Termes et définitions	20
3.2 Termes abrégés	20
4 Méthode d'essai de puissance optique et de gain	20
5 Paramètres de puissance optique et de gain	20
6 Résultats d'essais	26
Bibliographie.....	30
Figure 1 – Comportement typique du gain en fonction de la puissance du signal d'entrée	21
Figure 2 – Comportement typique du gain en fonction de la longueur d'onde	22
Figure 3 – Comportement typique du gain en fonction de la température	23
Figure 4 – Comportement typique du gain en fonction de la longueur d'onde	24
Figure 5 – Comportement typique de la fluctuation du gain en fonction du temps.....	24
Figure 6 – Comportement typique de la fluctuation de la puissance de sortie en fonction du temps	25
Figure 7 – Comportement typique du gain en fonction de la puissance du signal d'entrée	26
Figure 8 – Comportement typique de la puissance de sortie en fonction de la puissance du signal d'entrée.....	26

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

AMPLIFICATEURS OPTIQUES – MÉTHODES D'ESSAI –

Partie 1: Paramètres de puissance et de gain

AVANT-PROPOS

- 1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'attention est attirée sur le fait que certains des éléments du présent document de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets.

L'IEC 61290-1 a été établie par le sous-comité 86C: Systèmes et dispositifs actifs à fibres optiques, du comité d'études 86 de l'IEC: Fibres optiques. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2014. Cette édition constitue une révision technique.

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

- a) spécification de l'ondulation du gain en tant que nouveau paramètre;
- b) spécification de la méthode d'essai et du rapport d'essai pour les mesures d'ondulation du gain;
- c) utilisation du terme "incertitude de mesure" au lieu de "précision de mesure".

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

Projet	Rapport de vote
86C/1746/FDIS	86C/1783/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 61290, publiées sous le titre général *Amplificateurs optiques – Méthodes d'essai*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

AMPLIFICATEURS OPTIQUES – MÉTHODES D'ESSAI –

Partie 1: Paramètres de puissance et de gain

1 Domaine d'application

La présente partie de l'IEC 61290 s'applique à tous les amplificateurs optiques (AO) et sous-systèmes à amplification optique, disponibles sur le marché. Elle s'applique aux AO utilisant des fibres pompées optiquement (amplificateurs à fibres optiques (AFO) basés sur des fibres dopées aux terres rares ou sur l'effet Raman), des semiconducteurs (amplificateurs optiques à semiconducteurs (SOA)), et des guides d'ondes (amplificateurs à guide d'ondes optiques planaires (POWA)). Elle est spécifiquement centrée sur les amplificateurs à un seul canal. Les méthodes d'essai pour les amplificateurs à canaux multiples sont définies dans la série IEC 61290-10.

Le présent document établit des exigences uniformes pour des mesures précises et fiables des paramètres d'AO donnés ci-dessous, tels qu'ils sont définis dans l'IEC 61291-1:2018, Article 3:

- a) puissance nominale du signal de sortie;
- b) gain;
- c) gain inverse;
- d) gain maximal;
- e) longueur d'onde du gain maximal;
- f) variation maximale du gain en fonction de la température;
- g) bande de longueur d'onde du gain;
- h) variation du gain en fonction de la longueur d'onde;
- i) stabilité du gain;
- j) gain dépendant de la polarisation;
- k) ondulation du gain (SOA uniquement);
- l) stabilité de sortie grands signaux;
- m) puissance de sortie en saturation;
- n) puissance maximale du signal de sortie;
- o) puissance de sortie totale maximale.

NOTE 1 L'applicabilité des méthodes d'essai décrites dans le présent document à des amplificateurs à effet Raman répartis est toujours à l'étude.

NOTE 2 Toutes les valeurs numériques suivies de ($\pm$) sont des valeurs suggérées, pour lesquelles la mesure est assurée. D'autres valeurs sont acceptables, à condition d'être vérifiées.

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 61290-1-1, *Amplificateurs optiques – Méthodes d'essai – Partie 1-1: Paramètres de puissance et de gain – Méthode de l'analyseur de spectre optique*

IEC 61290-1-2, *Amplificateurs optiques – Méthodes d'essai – Partie 1-2: Paramètres de puissance et de gain – Méthode de l'analyseur de spectre électrique*

IEC 61290-1-3, *Amplificateurs optiques – Méthodes d'essai – Partie 1-3: Paramètres de puissance et de gain – Méthode par appareil de mesure de la puissance optique*

IEC 61291-1:2018, *Amplificateurs optiques – Partie 1: Spécification générique*