

# TECHNICAL REPORT

---

## Optical amplifiers – Part 1: Parameters of amplifier components



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://www.iec.ch)

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00



# TECHNICAL REPORT

---

**Optical amplifiers –  
Part 1: Parameters of amplifier components**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE

---

ICS 33.160.10; 33.180.30

ISBN 2-8318-1040-0

## CONTENTS

FOREWORD.....	3
1 Scope and object.....	5
2 Normative references.....	5
3 Abbreviations.....	5
4 OFA components.....	6
5 Terms and definitions.....	6
5.1 Active fibre.....	6
5.2 Pump laser.....	8
5.3 WDM coupler.....	11
5.4 Optical isolator.....	12
5.5 ASE rejection filter.....	13
5.6 Pump rejection filter.....	13
5.7 Gain flattening filter (GFF).....	14
5.8 Tap coupler.....	15
5.9 PIN-photodiode (PIN-PD).....	16
5.10 Variable optical attenuator (VOA).....	17
5.11 Optical connectors.....	18
Bibliography.....	19
Figure 1 – Example of the components inside an EDFA operating in a co-propagating pumping scheme.....	6

preview generated by EVS

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

**OPTICAL AMPLIFIERS –****Part 1: Parameters of amplifier components**

## 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 61292-1, which is a technical report, has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 1998. It is a technical revision with updates reflecting new technology.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86C/853/DTR	86C/871/RVC

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

A list of all parts of the IEC 61292 series, published under the general title *Optical amplifiers*, can be found on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this technical report may be published later.

## OPTICAL AMPLIFIERS –

### Part 1: Parameters of amplifier components

#### 1 Scope and object

This part of IEC 61292, which is a technical report, applies to optical components of rare-earth doped fibre amplifiers. It provides information about the most relevant parameters of optical components especially for erbium doped fibre amplifiers (EDFAs).

The object of this technical report is to provide introductory information for a better understanding of EDFA operation and applications.

#### 2 Normative references

The following referenced documents are indispensable for the application 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/TR 61931, *Fibre optic – Terminology*

ITU-T Recommendation G. 650.1, *Definition and test methods for linear, deterministic attributes of single-mode fibre and cable*

NOTE A list of informative references is given in the Bibliography.

#### 3 Abbreviations

For the purposes of this document, the following abbreviations apply.

ASE	amplified spontaneous emission
EDFA	erbium-doped fibre amplifier
EDF	erbium-doped fibre
OFA	optical fibre amplifier
OA	optical amplifier
RMS(r.m.s)	root mean square
LD	laser diode
TEC	thermo-electric cooler
FBG	fibre Bragg grating
FWHM	full-width at half maximum
WDM	wavelength division multiplexing
GFF	gain flattening filter
PIN-PD	PIN-photodiode
VOA	variable optical attenuator
EDF	erbium doped fibre
PDL	polarization dependent loss (variation)
PMD	polarization mode dispersion
MTBF	mean time between failure