IEC TR 61292-4

Edition 3.0 2014-10

TECHNICAL REPORT

colour inside

Optical amplifiers –
Part 4: Maximum permissible optical power for the damage-free and safe use of optical amplifiers, including Raman amplifiers

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE V

ICS 33.160.10 33.180.30

ISBN 978-2-8322-1907-2

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FOREWORD

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IEC TR 61292-4, 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 third edition cancels and replaces the second edition, published in 2010, and constitutes a technical revision with updates reflecting new research in the subject area.

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

Enquiry draft	Report on voting
86C/1158/DTR	86C/1200/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.

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

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

The committee has decided that the contents of this publication will remain unchanged until the stability 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- withdrawn,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 publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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 technical report is dedicated to the subject of maximum permissible optical power for damage-free and safe use of optical amplifiers, including Raman amplifiers. Since the technology is quite new and still evolving, amendments and new editions to this report can be expected.

Many new types of optical amplifiers are entering the marketplace and research is also stimulating many new types of fibre and non-fibre based optical amplifier research. With the introduction of such technologies as long-haul, over 40 Gb/s, WDM transmission and Raman amplification, some optical amplifiers may involve optical pump sources with extremely high optical power – up to, possibly, several watts.

Excessively high optical power may cause physical damage to the fibres/optical components/equipment as well as present medical danger to the human eye and skin.

The possibility of fibre damage caused by high optical intensity has recently been discussed at some technical conferences. The use of high intensity optical amplifiers may cause problems in the fibre such as a fibre fuse, a heating in the splice point (connection point), and the fibre end-face damage due to dust and the fibre coat burning due to tight fibre bending. IEC SC 86A (Fibres and cables) has published IEC TR 62547, and SC 86B (Fibre optic interconnecting devices and passive components) has published IEC TR 62627-01. IEC TC 31 (Equipment for explosive atmospheres) is also discussing the risk of ignition of hazardous environments by radiation from optical equipment.

Medical aspects have long been discussed at standards groups. IEC TC 76 (Optical radiation safety and laser equipment) precisely describes in IEC 60825-2 the concept of hazard level and labelling and addresses the safety aspects of lasers specifically in relation to tissue damage.

ITU-T Study Group 15 (Optical and other transport networks) has published Recommendation G.664, which primarily discusses the automatic laser power reduction functionality for safety.

With the recent growth of interest in fibre Raman amplifiers, however, some difficulties have been identified among optical amplifier users and manufacturers in fully understanding the technical details and requirements across all such standards and agreements.

This technical report provides a simple informative guideline on the maximum optical power permissible for optical amplifiers for optical amplifier users and manufacturers.

OPTICAL AMPLIFIERS

Part 4: Maximum permissible optical power for the damage-free and safe use of optical amplifiers, including Raman amplifiers

1 Scope and object

This part of IEC 61292, which is a technical report, applies to all commercially available optical amplifiers (OAs), including optical fibre amplifiers (OFAs) using active fibres, as well as Raman amplifiers. Semiconductor optical amplifiers (SOAs) using semiconductor gain media are also included.

This technical report provides a simple informative guideline on the threshold of high optical power that causes high-temperature damage of fibre. Also discussed is optical safety for manufacturers and users of optical amplifiers by reiterating substantial parts of existing standards and agreements on eye and skin safety.

To identify the maximum permissible optical power in the optical amplifier from damage-free and safety viewpoints, this technical report identifies the following values:

a) the optical power limit that causes thermal damage to the fibre, such as fibre fuse and fibre-coat burning;

b) the maximum permissible exposure (MPE) to which the eyes/skin can be exposed without consequential injury;

c) the optical power limit in the fibre that causes MPE on the eyes/skin after free-space propagation from the fibre;

d) the absolute allowable damage-free and safe level of optical power of the optical amplifier by comparing (a) and (c).

The objective of this technical report is to minimize potential confusion and misunderstanding in the industry that might cause unnecessary alarm and hinder the progress and acceptance of advancing optical amplifier technologies and markets.

It is important to point out that the reader should always refer to the latest international standards and agreements because the technologies concerned are rapidly evolving.

The present technical report will be frequently reviewed and will be updated by incorporating the results of various studies related to OAs and OA-supported optical systems in a timely manner.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60825-1:2007, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 60825-2:2004, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*
Amendment 1 (2006)
Amendment 2 (2010)

IEC TR 60825-14:2004, *Safety of laser products – Part 14: A user's guide*

IEC TR 62547, *Guidelines for the measurement of high-power damage sensitivity of single-mode fibres to bends – Guidance for the interpretation of results*

IEC TR 62627-01, *Fibre optic interconnecting devices and passive components – Part 01: Fibre optic connector cleaning methods*

ITU-T Recommendation G.664:2012, *Optical safety procedures and requirements for optical transport systems*