Optical amplifiers –

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL AMPLIFIERS –

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

FOREWORD

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IEC 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.

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

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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.

IEC 61292 consists of the following parts, under the new general title *Optical amplifiers:*

Part 1: Parameters of amplifier components
Part 2: Theoretical background for noise figure evaluation using the electrical spectrum analyzer
Part 3: Classification, characteristics and applications
Part 4: Maximum permissible optical power for the damage-free and safe use of optical amplifiers, including Raman amplifiers
Part 5: Polarization mode dispersion parameter – General parameter

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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- withdrawn;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 publication may be issued at a later date.
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 document can be expected.

Many new types of optical amplifiers are entering the marketplace and research on this subject is also stimulating many new types of fibre and non-fibre based optical amplifier research. With the introduction of such technologies as long-haul, 40Gb/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. IEC Technical Committee 31 (Electrical apparatus for explosive atmospheres) is also discussing the risk of ignition of hazardous environments by radiation from optical equipment.

The medical aspects have long been discussed at standards groups. IEC Technical Committee 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, therefore, provides a simple informative guideline on the maximum optical power permissible for optical amplifiers. To the best of our knowledge, this is the first international guideline on the maximum optical power permissible in optical fibre devices that takes both physical and medical viewpoints into consideration.
1 Scope and object

This 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:

- the optical power limit that causes thermal damage to the fibre, such as fibre fuse and fibre-coat burning;
- the maximum permissible exposure (MPE) to which the eyes/skin can be exposed without consequential injury;
- the optical power limit in the fibre that causes MPE on the eyes/skin after free-space propagation from the fibre;
- 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. In fact, the concept of hazard level and labelling is still evolving: more rigorous labelling requirements are under discussion in IEC Technical Committee 76 as of October 2003.

The 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.