



TECHNICAL REPORT



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD.....	4
INTRODUCTION.....	2
1 Scope and object	8
2 Normative references	8
3 Terms, definitions, and abbreviated terms	9
3.1 Terms and definitions.....	9
3.2 Abbreviated terms.....	8
4 Maximum transmissible optical power to keep fibres damage-free	9
4.1 General.....	9
4.2 Fibre fuse and its propagation.....	10
4.3 Loss-induced heating at connectors or splices	11
4.4 Connector endface damage induced by dust/contamination	12
4.5 Fibre coat burn/melt induced by tight fibre bending	15
4.6 Summary of the fibre damage	16
5 Maximum transmissible optical power to keep eyes and skin safe	16
5.1 Maximum transmissible exposure (MPE) on the surface of eye and skin	16
5.2 Maximum permissible optical power in the fibre for the safety of eye and skin.....	17
5.2.1 General	17
5.2.1 Power limit.....	17
5.2.2 Need for APR	18
5.2.3 Wavelengths.....	19
5.2.4 Locations.....	19
5.2.5 Nominal ocular hazard distance (NOHD).....	19
5.2.6 Power reduction times	19
5.2.7 Medical aspects of the safety of eyes and skin in existing standards	21
6 Maximum optical power permissible for optical amplifiers from the viewpoint of fibre damage as well as eye and skin safety	22
7 Conclusion	22
Annex A (informative) General information for optical fibre fuse	23
A.1 Introductory remark.....	23
A.2 Generating mechanism	23
A.3 Void formation mechanism	27
A.4 Propagation characteristic of a fibre fuse	27
A.5 Prevention and termination	29
A.5.1 General	29
A.5.2 Prevention methods.....	29
A.5.3 Termination methods	30
A.6 Additional safety information	32
A.7 Conclusion.....	33
Bibliography.....	34
Figure 1 – Experimental set-up for fibre fuse propagation	10
Figure 2 – Connection loss versus temperature increase	12
Figure 3 – Test set-up.....	13
Figure 4 – Surface condition contaminated with metal filings, before the test	14

Figure 5 – Variation of power attenuation during test at several power input values for plugs contaminated with metal filings	14
Figure 6 – Polishing surface condition contaminated with metal filing, after test	14
Figure 7 – Thermo viewer image of tightly bent SMF with optical power of 3 W at 1 480 nm	15
Figure 8 – Temperature of the coating surface of SMFs against bending with optical power of 3 W at 1 480 nm	16
Figure 9 – Maximum permissible power in the fibre against APR power reduction time	21
Figure A.1 – Front part of the fibre fuse damage generated in the optical fibre.....	23
Figure A.2 – SiO absorption model	25
Figure A.3 – Calculated fibre fuse propagation behaviour simulated with the SiO absorption model	26
Figure A.4 – Series of optical micrographs showing damage generated by 9,0 W 1 480 nm laser light suggesting a mechanism of periodic void formation.....	27
Figure A.5 – Images of fibre fuse ignition taken with an ultra-high-speed camera and an optical micrograph of the damaged fibre.....	28
Figure A.6 – Power density dependence of the fibre-fuse propagation velocity	29
Figure A.7 – Optical micrographs showing front part of the fibre fuse damage generated in SMF-28 fibres with various laser intensities (1 480 nm).....	29
Figure A.8 – Principle of the optical fibre fuse passive termination method and photograph of a fibre fuse terminator using a TEC structure.....	30
Figure A.9 – Photograph of hole- assistant assisted fibre and fibre fuse termination using a hole- assistant assisted fibre	31
Figure A.10 – Example of fibre fuse active termination scheme.....	32
Figure A.11 – Transformation of electrical signal by optical fibre fuse	32
Table 1 – Threshold power of fibre fuse propagation for various fibres.....	10
Table 2 – Measurement conditions.....	12
Table 3 – Examples of power limits for optical fibre communication systems having automatic power reduction to reduce emissions to a lower hazard level	17
Table 4 – Location types within an optical fibre communication system and their typical installations	19

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL AMPLIFIERS –

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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 TR 61292-4:2014. 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 TR 61292-4 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. It is a Technical Report.

This fourth edition cancels and replaces the third edition published in 2014. This edition constitutes a technical revision.

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- b) In particular, the descriptions provided in Clause 5 and Clause 6 have been modified significantly to reflect changes in the cited references. Unnecessary formulas and explanations that overlap with the references have been removed to simplify the document.
- c) New information has been added to Annex A on optical fibre burning when light enters an optical fibre with a bubble train formed by a fibre fuse.

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Draft	Report on voting
86C/1821/DTR	86C/1832/RVDTR

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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/standardsdev/publications.

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 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

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- amended.

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INTRODUCTION

This document is dedicated to the subject of maximally 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 is also stimulating the development of many new types of fibre and non-fibre based optical amplifiers. With the introduction of new technologies, such as long-haul, ~~over 40~~ beyond 100 Gb/s, WDM transmission, digital coherent transmission and Raman amplification, some optical amplifiers ~~may involve~~ employ optical pump sources with extremely high optical power – possibly up to several Watts. For example, erbium doped fibre amplifiers that provide extremely high output power are described in IEC TR 61292-8 [1]¹, and Raman amplifiers in IEC TR 61292-6 [2].

Excessively high optical power ~~may~~ can cause physical damage to the ~~fibres/~~optical fibres, components and equipment, in addition to presenting a medical ~~danger~~ hazard to the human eye and skin.

The possibility of fibre damage caused by high optical intensity has been discussed at technical conferences and in technical reports for many years. ~~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.~~ The use of high intensity optical amplifiers can cause problems in optical fibres, which include fibre fuse, heating in the splice points (connection points), fibre endface damage due to dust, and fibre coat burning due to tight fibre bending. For example, IEC TR 62547 [3] provides guidelines for the measurement of high-power damage sensitivity of single-mode fibre to bends, and IEC TR 62627-01 [4] describes cleaning methods for fibre optic connectors to reduce the risk of fibre endface damage. In addition, other standard groups are discussing the risk of ignition of hazardous environments caused by high-power 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.~~

The medical aspects of high-power optical radiation have also been addressed by standards. IEC 60825-2 defines the concept of hazard levels and corresponding labelling, which addresses the safety aspects of lasers specifically in relation to tissue damage.

In addition, IEC TR 60825-17 [5] describes safety measures to protect against effects caused exclusively by thermal, opto-mechanical and related effects in passive optical components and optical cables used in high power optical fibre communication systems. Moreover, ITU-T Recommendation G.664 [6] discusses the safety feature of automatic laser power reduction.

With the recently growing interest in high power fibre amplifiers and 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.

¹ Numbers in square brackets refer to the Bibliography.

This document 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 document provides informative guidelines on the threshold of high optical power that ~~causes~~ can cause high-temperature damage of the fibre. Also discussed is optical safety for manufacturers and users of optical amplifiers by ~~reiterating substantial~~ quoting 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 document identifies the following values for maximum permissible optical power in the optical amplifier for damage-free and safe operation:

- 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 consequent 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 optical power level for damage-free and safe ~~level of optical power~~ operation of the optical amplifier by comparing a) and c).

The objective of this document is to minimize potential confusion and misunderstanding in the industry that ~~might~~ can cause unnecessary alarms and hinder the progress and acceptance of advancing optical amplifier technologies in the market.

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

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

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 60825-1:2007, 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~~

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

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CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms, definitions, and abbreviated terms	8
3.1 Terms and definitions.....	8
3.2 Abbreviated terms.....	8
4 Maximum transmissible optical power to keep fibres damage-free	8
4.1 General.....	8
4.2 Fibre fuse and its propagation.....	9
4.3 Loss-induced heating at connectors or splices	10
4.4 Connector endface damage induced by dust/contamination	11
4.5 Fibre coat burn/melt induced by tight fibre bending	13
4.6 Summary of the fibre damage	14
5 Maximum transmissible optical power to keep eyes and skin safe	15
5.1 Maximum transmissible exposure (MPE) on the surface of eye and skin	15
5.2 Maximum permissible optical power in the fibre for the safety of eye and skin.....	15
5.2.1 Power limit.....	15
5.2.2 Need for APR	16
5.2.3 Wavelengths.....	17
5.2.4 Locations.....	17
5.2.5 Nominal ocular hazard distance (NOHD).....	17
5.2.6 Power reduction times	17
5.2.7 Medical aspects of the safety of eyes and skin in existing standards	18
6 Maximum optical power permissible for optical amplifiers from the viewpoint of fibre damage as well as eye and skin safety	19
7 Conclusion	19
Annex A (informative) General information for optical fibre fuse	20
A.1 Introductory remark.....	20
A.2 Generating mechanism	20
A.3 Void formation mechanism	24
A.4 Propagation characteristic of a fibre fuse	24
A.5 Prevention and termination	26
A.5.1 General	26
A.5.2 Prevention methods	26
A.5.3 Termination methods	27
A.6 Additional safety information	29
A.7 Conclusion.....	29
Bibliography.....	30
Figure 1 – Experimental set-up for fibre fuse propagation	9
Figure 2 – Connection loss versus temperature increase	11
Figure 3 – Test set-up.....	11
Figure 4 – Surface condition contaminated with metal filings, before the test	12
Figure 5 – Variation of power attenuation during test at several power input values for plugs contaminated with metal filings	13

Figure 6 – Polishing surface condition contaminated with metal filing, after test.....	13
Figure 7 – Thermo viewer image of tightly bent SMF with optical power of 3 W at 1 480 nm	14
Figure 8 – Temperature of the coating surface of SMFs against bending with optical power of 3 W at 1 480 nm	14
Figure 9 – Maximum permissible power in the fibre against APR power reduction time	18
Figure A.1 – Front part of the fibre fuse damage generated in the optical fibre.....	20
Figure A.2 – SiO absorption model	22
Figure A.3 – Calculated fibre fuse propagation behaviour simulated with the SiO absorption model	23
Figure A.4 – Series of optical micrographs showing damage generated by 9,0 W 1 480 nm laser light suggesting a mechanism of periodic void formation.....	24
Figure A.5 – Images of fibre fuse ignition taken with an ultra-high-speed camera and an optical micrograph of the damaged fibre.....	25
Figure A.6 – Power density dependence of the fibre-fuse propagation velocity	26
Figure A.7 – Optical micrographs showing front part of the fibre fuse damage generated in SMF-28 fibres with various laser intensities (1 480 nm)	26
Figure A.8 – Principle of the optical fibre fuse passive termination method and photograph of a fibre fuse terminator using a TEC structure.....	27
Figure A.9 – Photograph of hole-assisted fibre and fibre fuse termination using a hole-assisted fibre	28
Figure A.10 – Example of fibre fuse active termination scheme.....	29
Figure A.11 – Transformation of electrical signal by optical fibre fuse	29
Table 1 – Threshold power of fibre fuse propagation for various fibres.....	9
Table 2 – Measurement conditions.....	10
Table 3 – Examples of power limits for optical fibre communication systems having automatic power reduction to reduce emissions to a lower hazard level	16
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