

INTERNATIONAL STANDARD

IEC
60825-12

First edition
2004-02

Safety of laser products –

Part 12:

Safety of free space optical communication systems used for transmission of information

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF LASER PRODUCTS –

Part 12: Safety of free space optical communication systems
used for transmission of information

FOREWORD

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International Standard IEC 60825-12 has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment.

The text of this standard is based on the following documents:

FDIS	Report on voting
76/281/FDIS	76/285/RVD

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

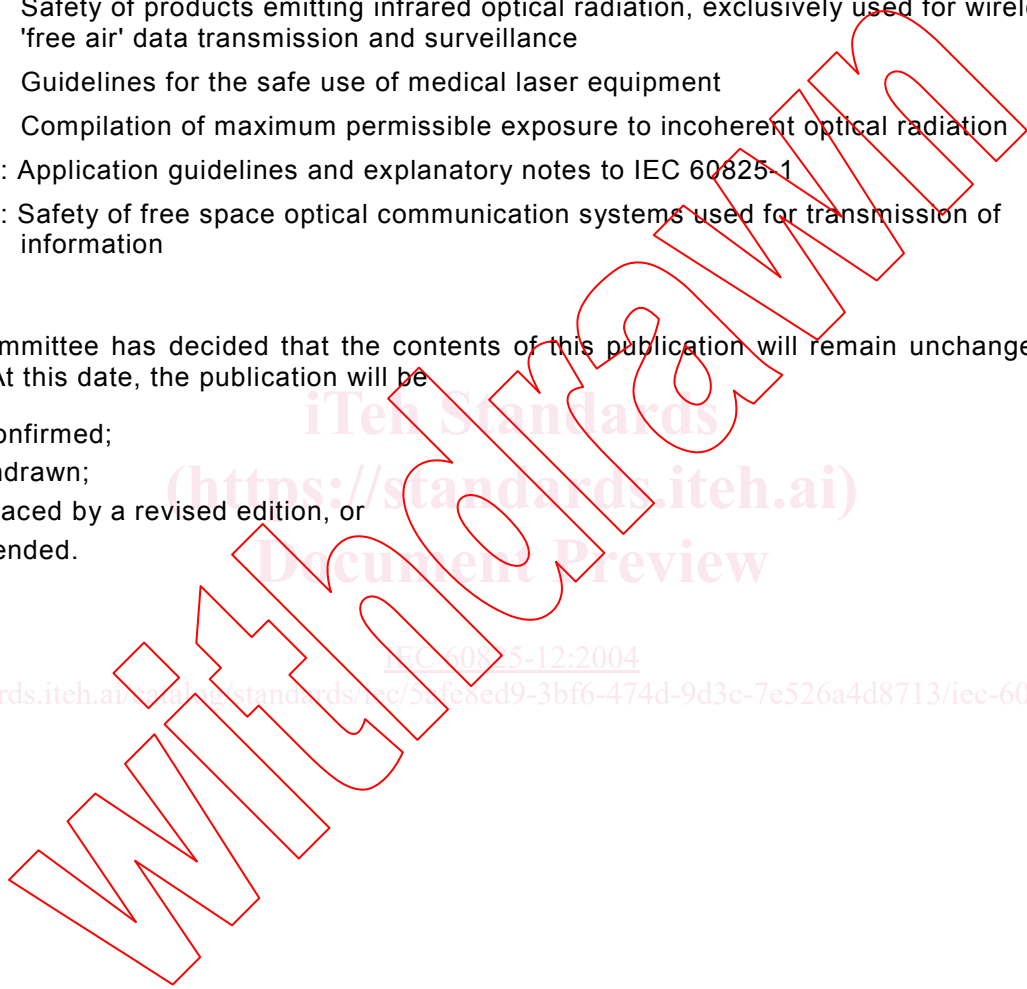
This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC consists of the following parts, under the general title: *Safety of laser products*:

- Part 1: Part 1: Equipment classification, requirements and user's guide
- Part 2: Safety of optical fibre communication systems
- Part 3: Guidance for laser displays and shows
- Part 4: Laser guards
- Part 5: Manufacturer's checklist for IEC 60825-1
- Part 6: Safety of products with optical sources, exclusively used for visible information transmission to the human eye
- Part 7: Safety of products emitting infrared optical radiation, exclusively used for wireless 'free air' data transmission and surveillance
- Part 8: Guidelines for the safe use of medical laser equipment
- Part 9: Compilation of maximum permissible exposure to incoherent optical radiation
- Part 10: Application guidelines and explanatory notes to IEC 60825-1
- Part 12: Safety of free space optical communication systems used for transmission of information

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

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- withdrawn;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



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SAFETY OF LASER PRODUCTS –

Part 12: Safety of free space optical communication systems used for transmission of information

1 Scope

This part of IEC 60825 provides requirements and specific guidance for the manufacture and safe use of laser products and systems used for point-to-point or point-to-multipoint free space optical data transmission. This standard only addresses the open beam portion of the system. If portions of the equipment or system incorporate optical fibre that extends from the confinements of the enclosure(s), the manufacturing and safety requirements under IEC 60825-1 apply to those portions only. This standard does not apply to systems designed for purposes of transmitting optical power for applications such as material processing or medical treatment. This standard also does not apply to the use of systems in explosive atmospheres.

Throughout this part of IEC 60825, light-emitting diodes (LEDs) are included whenever the word “laser” is used.

The objective of this part of IEC 60825 is to:

- provide information to protect people from potentially hazardous optical radiation produced by free space optical communication systems (FSOCS) by specifying engineering controls and requirements, administrative controls and work practices according to the degree of the hazard;
- specify requirements for manufacturing, installation, service and operating organisations in order to establish procedures and provide written information so that proper precautions can be adopted.

Because of the nature of FSOCS, also known as optical wireless or free-air information transmission systems, care must be taken in their manufacture as well as their installation, operation, maintenance and service to assure the safe deployment and use of these systems. This standard places the responsibility for certain product safety requirements, as well as requirements for providing appropriate information on how to use these systems safely, on the manufacturer of the system and/or transmitters. It places the responsibility for the safe deployment and use of these systems on the installer and/or operating organisation. It places the responsibility for adherence to safety instructions during installation and service operations on the installation and service organisations as appropriate, and during operation and maintenance functions on the operating organisation. It is recognised that the user of this standard may fall into one or more of the categories of manufacturer, installer, service organisation and/or operating organisation as mentioned above.

Any laser product is exempt from all further requirements of this part of IEC 60825 if

- classification by the manufacturer according to IEC 60825-1 shows that the emission level does not exceed the accessible emission limit (AEL) of Class 1 under all conditions of operation, maintenance, service and failure, and
- it does not contain an embedded laser product.

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 60825-1:1993, *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*¹
Amendment 1 (1997)
Amendment 2 (2001)

IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems*

3 Terms and definitions

3.1

access level

potential hazard at any accessible position associated with a free space optical communication system (FSOCS) installation

NOTE 1 The access level is based on the level of optical radiation which could become accessible in reasonably foreseeable circumstances, e.g. walking into an open beam path. It is closely related to the laser classification procedure in IEC 60825-1.

NOTE 2 Practically speaking, it takes two or more seconds to fully align an optical aid with a beam, (which might occur in an unrestricted location), and this delay is incorporated into the method for determining access level.

3.2

access level 1

level for which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits (AEL) of Class 1 for the applicable wavelengths and emission duration will not occur

3.3

access level 1M

level for which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits (AEL) of Class 1M for the applicable wavelengths and emission duration will not occur

NOTE If the applicable limit of access level 1M is larger than the limit of 3R and less than the limit of 3B, access level 1M is allocated.

3.4

access level 2

level for which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits of Class 2 for the applicable wavelengths and emission duration will not occur

3.5

access level 2M

level for which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits of Class 2M for the applicable wavelengths and emission duration will not occur

NOTE If the applicable limit of access level 2M is larger than the limit of 3R and less than the limit of 3B, access level 2M is allocated.

¹⁾ A consolidated edition (1.2) exists comprising IEC 60825-1 (1993) and its Amendments 1 (1997) and 2 (2001).

3.6**access level 3R**

level for which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits of Class 3R for the applicable wavelengths and emission duration will not occur

NOTE If the applicable limit of access level 1M or 2M is larger than the limit of 3R and less than the limit of 3B, access level 1M or 2M is allocated.

3.7**access level 3B**

level for which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits of Class 3B for the applicable wavelengths and emission duration will not occur

3.8**access level 4**

level for which, under reasonably foreseeable circumstances, it is possible that human access to laser radiation in excess of the accessible emission limits of Class 3B for the applicable wavelengths and emission duration could occur

3.9**automatic power reduction (APR)**

feature of a transmitter of a FSOCS, provided by the system equipment manufacturer, by which the accessible power in the nominal hazard zone (NHZ) or NHZ-Aided is reduced to a specified value within a specified time, whenever there is an event which could result in human exposure to optical radiation above the maximum permissible exposure (MPE), e.g. by a person entering the NHZ or NHZ-Aided as applicable. In FSOCS, this feature may be used by the transmitter manufacturer to determine the classification

3.10**beacon**

optical source whose function is to aid in pointing or alignment of an optical system

3.11**embedded laser product**

See definition 3.29 in IEC 60825-1.

3.12**end-to-end system**

FSOCS that is comprised of at least one transmitter, one receiver, and any peripheral hardware necessary for the effective transfer of data along the transmission path from one position in space to another

3.13**free space optical communication system (FSOCS)**

installed, portable, or temporarily mounted, through-the-air system typically used, intended or promoted for voice, data or multimedia communications and/or control purposes via the use of modulated optical radiation produced by a laser or LED. "Free space" means indoor and outdoor optical wireless applications with both non-directed and directed transmission. Emitting and detecting assemblies may or may not be separated

NOTE Refer to the conditions within Clause 1 (Scope) by which Class 1 FSOCS products are exempt from all requirements of this standard.

3.14**FSOCS transmitter; transmitter**

optical transmitter emitting radiation through the air and used in FSOCS

3.15

installation organisation; installer

organisation or individual who is responsible for the installation of a FSOCS

3.16

installation protection system (IPS)

feature of an installation site, provided by the installer or operating organisation, that has two functions: (1) it detects human entry into the accessible volume of either the NHZ for restricted or controlled locations or the NHZ-Aided for an unrestricted location, and; (2) once such entry is detected, causes reduction of the accessible power of the laser to a specified level within a specified time

3.17

location

position or site occupied or available for occupancy

NOTE Other standards may use the same terms for location types (3.18 – 3.21) with somewhat different definitions.

3.18

location of inaccessible space; inaccessible space

volume where a person cannot normally be located. All open space that is neither an unrestricted, restricted nor controlled location, i.e. the space that has a horizontal spacing more than 2,5 m from any unrestricted location and is both greater than 6 m above a surface in any unrestricted location, and more than 3 m above a surface in any restricted location

NOTE Inaccessible space may be entered by, for example, aircraft.

3.19

location with controlled access; controlled location

location where an engineering or administrative control measure is present to make it inaccessible except to authorized personnel with appropriate laser safety training

3.20

location with restricted access; restricted location

location that is normally inaccessible by the general public (including workers, visitors, and residents in the immediate vicinity) by means of any administrative or engineering control measure but that is accessible to authorized personnel (e.g. maintenance or service personnel including window cleaners in exterior locations) that may not have laser safety training

3.21

location with unrestricted access; unrestricted location

location where access to the transmission/receiver equipment and open beam is not limited (accessible to the general public)

3.22

manufacturer

organisation or individual who makes or assembles optical devices and other components for the construction or modification of an FSOCS

3.23

nominal hazard zone (NHZ) and NHZ-Aided

- a) NHZ: the volume within which the level of the direct, reflected or scattered radiation exceeds the applicable MPE (under measurement conditions indicated in IEC 60825-1). Exposure levels outside the boundary of the NHZ are below the applicable MPE
- b) NHZ-Aided: the volume within which, when optical aids are used, the level of the direct, reflected or scattered radiation exceeds the applicable MPE. Exposure levels outside the boundary of the NHZ-Aided are below the applicable MPE when optical aids are used

NOTE 1 These volumes are determined prior to activation of any IPS or APR systems unless the APR is used for classification under the conditions of 4.3 of this standard.

NOTE 2 Examples of NHZ and NHZ-Aided are provided in A.2.

3.24

operating organisation; operator

organisation or individual who is responsible for the operation and maintenance of an FSOCS

3.25

optically-aided viewing

use of optical aids (for example binoculars or magnifiers) to view an emitting source from within the emitted beam

NOTE 1 It is possible that telescopic optics, including binoculars, could increase the hazard to the eye by intrabeam viewing of a collimated beam when viewed at a distance.

NOTE 2 It is possible that hand magnifiers or eye-loupes could increase the hazard to the eye from viewing a close, but highly divergent, source.

3.26

primary beam

beam that transmits the modulated data signal

3.27

reasonably foreseeable event

event (or condition) when it is credible and its likelihood of occurrence (or existence) cannot be disregarded

3.28

service organisation

organisation or individual who is responsible for the service of an FSOCS

3.29

special tool

tool that is not readily available at retail consumer hardware stores

NOTE Typical tools in this category are intended for use with tamper-resistant fasteners.

3.30

spillover

beam radiant energy that propagates past the receiving terminal

3.31

unaided viewing; without optical aids

viewing an emitting source from within the emitted beam without using magnifiers or other optical aids, as with the naked eye (prescription eyeglasses and contact lenses are not considered optical aids)

4 Requirements

4.1 General remarks

FSOCS have limitations imposed by this standard that are dependent on the location type(s) in which they are installed. Product classification and access level restrictions by location type are summarized in Table 1.

In each location where emission is transmitted, crosses or is received, respective exposure conditions must be individually evaluated. Furthermore, potentially occupied locations along the beam path, within the NHZ or NHZ-Aided, must also be evaluated for acceptable access levels (Table 1) and appropriate controls applied. Locations traversed by partial reflections from windows within the beam path must also be evaluated if the emission could exceed

access level 1 or 2. At a given location, the installation and operational constraints applied from 4.2 shall be determined by whichever is the more hazardous; the transmitted or the received optical radiation.

Example 1: In the case of a location that receives access level 1 or 2 radiation but uses a Class 1M transmitter in the opposite direction, these combined conditions are acceptable for restricted locations but not for an unrestricted location unless the transmission equipment is installed as described in 4.2.1.1 to reduce the transmit access level to 1 or 2.

Example 2: For links with spillover beyond the receiver, but within the NHZ-Aided that is of access level 1M or 2M, the spillover (and any accessible radiation otherwise outside of the receiver path, e.g. in front of it) must be contained within a restricted or controlled location, an unrestricted location compliant with 4.2.1.1, or inaccessible space.

For Class 3B and Class 4 transmitters in controlled locations, the entire beam path that potentially passes through other location types, including inaccessible space, must comply with the access level restrictions of Table 1. This may be satisfied in some applications by continually monitoring the entire NHZ to ensure rapid automatic power reduction in the event of human interception of the beam path. Any spillover beyond the receiver, (and any accessible radiation otherwise outside of the receiver path – e.g. in front of it), within the NHZ, must also be contained in a controlled location or inaccessible space. Any additional spillover within the NHZ-Aided must be contained within a restricted or controlled location, an unrestricted location compliant with 4.2.1.1, or inaccessible space.

The following ranking of the access levels (in increasing order of hazard) shall apply in this part of IEC 60825: 1, 2, 1M, 2M, 3R, 3B, 4.

NOTE Because of the application, this is not the same as the ranking used in IEC 60825-1.

Table 1 – Restrictions for product classes and access levels

Location type	Permissible product classes and installation conditions	Permissible access levels
Unrestricted	Class 1 or 2 – No conditions Class 1M or 2M – See 4.2.1.1 Class 3R – See 4.2.1.2	1 or 2
Restricted	Class 1, 2, 1M or 2M – No conditions Class 3R – See 4.2.2.1	1, 2, 1M or 2M
Controlled	Class 1, 2, 1M, 2M, or 3R – No conditions Class 3B or 4 – See 4.2.3.1	1, 2, 1M, 2M, or 3R 3B or 4 – See 4.2.3.1
Inaccessible space	Not applicable	1, 2, 1M, 2M or 3R

The operating organisation has the ultimate responsibility for the installation, service, maintenance and safe use of the end-to-end system. This includes, especially

- identification of the location type at all portions of the entire transmission path, including beam spillover outside the receiver collection area and partial reflections from intermediate windows, where people may have access;
- ensuring that the product classification, access level requirements, and installation conditions from Table 1 are satisfied for those location types;
- ensuring that installation, maintenance and service are performed only by organisations with the capability of satisfying the requirements of 4.2.

Requirements for transmitter manufacturers, installers and service organisations are also included in this standard.