SLOVENSKI STANDARD
oSIST prEN IEC 60825-12:2022

01-januar-2022

Varnost laserskih izdelkov - 12. del: Varnost optičnih komunikacijskih sistemov v prostem prostoru, ki se uporabljajo za prenos informacij

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

Sicherheit von Lasereinrichtungen - Teil 12: Sicherheit von optischen Freiraumkommunikationssystemen für die Informationsübertragung

Sécurité des appareils à laser - Partie 12 : Sécurité des systèmes de communication optiques en espace libre utilisés pour la transmission d'informations

Ta slovenski standard je istoveten z: **prEN IEC 60825-12:2021**

ICS:

31.260	Optoelektronika, laserska oprema	Optoelectronics. Laser equipment
33.180.01	Sistemi z optičnimi vlakni na splošno	Fibre optic systems in general

oSIST prEN IEC 60825-12:2022 **en**

76/687/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 60825-12 ED3**	
DATE OF CIRCULATION: **2021-11-05**	CLOSING DATE FOR VOTING: **2022-01-28**
SUPERSEDES DOCUMENTS: **76/655/CD, 76/663A/CC**	

IEC TC 76 : OPTICAL RADIATION SAFETY AND LASER EQUIPMENT	
SECRETARIAT: United States of America	SECRETARY: Mr William Ertle
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 108	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☒ SAFETY	
☒ SUBMITTED FOR CENELEC PARALLEL VOTING **Attention IEC-CENELEC parallel voting** The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

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

PROPOSED STABILITY DATE: 2026

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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.

This third edition cancels and replaces the Ed 2.0 published in 2019, and constitutes a technical revision.

This third edition includes the following significant technical changes with respect to the previous edition 2.0:

a) Where relevant and appropriate references to IEC 60825-1 have been changed to a specific dated reference i.e. IEC 60825-1: 2014.

b) Condition 2 has been changed from 7 mm aperture stop and 70 mm distance to,

   - For wavelengths less than 1 400 nm, 3,5 mm aperture stop and 35 mm distance,
   - For wavelengths equal to or greater than 1 400 nm, 3,5 mm aperture stop and 14 mm distance.

c) For wavelengths between 1 200 nm and 1 400 nm, an additional limitation is required equal to the equivalent radiant power of the skin MPE. C_7 has therefore been revised in accordance with IEC 60825-1:2014, but with this additional limitation related to the skin MPE; see 4.2.

d) Additional detail added regarding time base, see 4.8.

e) Additional clarification added to Clause 8 regarding the content and formatting of labels.

f) Annex A has been added, providing a rationale for the differences in approach between this document and IEC 60825-1:2014.

g) Annex B has been added, providing clarification of the meaning of the term “access level”.

h) Worked examples have been added for a variety of scenarios, see annexes C.1 to C.4.

i) Annex C.5 has been added on UAS, unmanned aerial systems.

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

FDIS	Report on voting
76/XX/FDIS	76/XX/RVD

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

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

The list of all parts of the IEC 60825 series, published under the title *Safety of laser products*, 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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

The National Committees are requested to note that for this document the stability date is 2024.

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

INTRODUCTION

The objective of this document is to:

- protect people from optical radiation emitted by FSOCSs;
- safety requirements and guidance for the design, manufacture and use of laser products or laser systems, which emit laser radiation for the purpose of free space optical data transmission;
- guidance for installation, operation, maintenance and service to assure the safe deployment and use of such laser systems.

This document only addresses the open beam portion of the laser product or laser system.

This document 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 or the transmitters. It places the responsibility for the safe deployment and use of these systems on the installer or the operating organization. It places the responsibility for adherence to safety instructions during installation and service operations on the installation and service organizations as appropriate, and during operation and maintenance functions on the operating organization. It is recognized that the user of this document may fall into one or more of the categories of manufacturer, installer, service organization and/or operating organization as mentioned above.

Annex A gives a more detailed rationale for this document, and some examples are given in Annex C.

SAFETY OF LASER PRODUCTS –

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

1 Scope

This document is applicable to products that emit laser radiation for the purpose of free space optical data transmission.

This document does not apply to laser products designed for the purposes of transmitting optical power for applications such as material processing or medical treatment. This document also does not apply to the use of laser products in explosive atmospheres (see IEC 60079-0). Light-emitting diodes employed by free space optical communication systems, used for the purpose of free space optical data transmission, do not fall into the scope of this document.

NOTE If the laser product incorporates an optical fibre that extends from the confinements of the enclosure, the requirements in IEC 60825-2 applies.

2 Normative references

The following documents are referred to in the text such a way that some or all of their content constitutes requirement 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 60825-1:2014, *Safety of laser products – Part 1: Equipment classification and requirements*

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

3 Terms and definitions

For the purposes of this document, the terms and conditions contained in IEC 60825-1:2014 as well as the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
access level
potential hazard at any accessible position associated with a free space optical communication system (FSOCS) installation

Note 1 to entry: The access level is based on the level of laser 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. The meaning of access level is clarified in Annex B.

Note 2 to entry: 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
assigned hazard at any accessible location within a FSOCS at which, under any reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 1 as defined in Clause 4 of this document, will not exceed the accessible emission limits of Class 1 for the applicable wavelengths and emission duration, with additional constraints as defined 4.3

Note 1 to entry: The "additional constraints" mentioned above refer to additional and stricter constraints that 4.3 of this document places on the values specified in IEC 60825-1:2014 for the accessible emission limits of Class 1 in the wavelength range 1 200 to 1 400 nm.

3.3
access level 1M
assigned hazard at any accessible location within a FSOCS at which, under any reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 1M as defined in Clause 4 of this document, will not exceed the accessible emission limits of Class 1 for the applicable wavelengths and emission, with additional constraints as defined 4.3

Note 1 to entry: The "additional constraints" mentioned above refer to additional and stricter constraints that 4.3 of this document places on the values specified in IEC 60825-1:2014 for the accessible emission limits of Class 1 in the wavelength range 1 200 to 1 400 nm.

3.4
access level 2
assigned hazard at any accessible location within a FSOCS at which, under any reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 2 as defined in Clause 4 of this document, will not exceed the accessible emission limits of Class 2 for the applicable wavelengths and emission duration, with additional constraints as defined 4.4

3.5
access level 2M
assigned hazard at any accessible location within a FSOCS at which, under any reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 2M as defined in Clause 4 of this document, will not exceed the accessible emission limits of Class 2 for the applicable wavelengths and emission duration, with additional constraint as defined 4.4

3.6
access level 3R
assigned hazard at any accessible location within a FSOCS at which, under any reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 3R as defined in Clause 4 of this document, will not exceed the accessible emission limits of Class 3R for the applicable wavelengths and emission duration, with additional constraints as defined 4.5

Note 1 to entry: The "additional constraints" mentioned above refer to additional and stricter constraints that 4.2.2.4 of this document places on the values specified in IEC 60825-1:2014 for the accessible emission limits of Class 1 in the wavelength range 1 200 to 1 400 nm.

3.7
access level 3B
assigned hazard at any accessible location within a FSOCS at which, under any reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 3B as defined in Clause 4 of this document, will not exceed the accessible emission limits of Class 3B for the applicable wavelengths and emission duration

3.8
access level 4
assigned hazard at any accessible location within a FSOCS at which, under any reasonably foreseeable event, human access to laser radiation (accessible emission), evaluated by the measurement conditions for access level 4 as defined in Clause 4 of this document, will exceed the accessible emission limits of Class 3B for the applicable wavelengths and emission duration

Note 1 to entry: This document is applicable for the operation and maintenance of FSOCS. In order to achieve an adequate level of safety for persons who may come into contact with the optical transmission path, access level 4 is not permitted within this document. It is permitted to use protection systems, such as automatic power reduction (APR, see 3.10) or installation protection system (IPS: see 3.18), to achieve the required access level where the transmitted power under any operating conditions (e.g. normal and fault operation) exceeds that permitted for a particular location type. For instance, it is possible for accessible parts of an FSOCS to be access level 1 even though the power transmitted down the free space under normal operating conditions is Class 4.

3.9
aperture for transmitter
aperture portion of FSOCS through which the beam for transmission is emitted

3.10
automatic power reduction
APR
feature of a transmitter of an FSOCS, provided by the system equipment manufacturer, by which the accessible power in the nominal hazard zone (NHZ) or extended nominal hazard zone (ENHZ) is reduced to a specified value within a specified time

Note 1 to entry: The term “automatic power reduction” (APR) used in this document encompasses the following terms used in recommendations of the International Telecommunication Union ITU Recommendation G.664:

- automatic laser shutdown (ALS);
- automatic power reduction (APR);
- automatic power shutdown (APSD).

Note 2 to entry: The accessible power in the NHZ or ENHZ 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 ENHZ, as applicable. In an FSOCS, this feature may be used by the transmitter manufacturer to determine the classification.

3.11
beacon
optical source whose function is to aid in pointing or alignment of an optical system

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
extended nominal hazard zone
ENHZ
volume within which, when optical aids are used, the level of eye exposure to direct, reflected or scattered radiation exceeds the applicable maximum permissible exposure (MPE) as defined in IEC 60825-1:2014

Note 1 to entry: Exposure levels outside the boundary of the ENHZ are below the applicable MPE when optical aids are used.

Note 2 to entry: This volume is determined prior to activation of any IPS or APR systems unless the APR is used for classification under the conditions of 5 of this document.

3.14
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 FSOC transmitter

Note 1 to entry: “Free space” means indoor and outdoor optical wireless applications with both non-directed and directed transmission.

Note 2 to entry: Emitting and detecting assemblies may or may not be separated.

3.15
FSOC transmitter
transmitter
optical transmitter emitting radiation through the air and used in an FSOCS

3.16
human access
a) ability of the human body to meet laser radiation emitted by the laser product, i.e. radiation that can be intercepted outside of the protective housing, or

b) ability of a cylindrical probe with a diameter of 100 mm and a length of 100 mm to intercept levels of radiation of Class 3B and below, or

c) ability of a human hand or arm to intercept levels of radiation above the AEL of Class 3B,

d) also, for levels of radiation within the protective housing that are equivalent to Class 3B or Class 4, ability of any part of the human body to meet hazardous laser radiation that can be reflected directly by any single introduced flat surface from the interior of the product through any opening in its protective housing

Note 1 to entry: For laser products that provide walk-in access, it is necessary to consider radiation both inside and outside of the protective housing for the determination of human access. Human access inside the protective housing can be prevented by engineering controls such as automatic detection systems.

3.17
installation organization
installer
organization or individual who is responsible for the installation of an FSOCS

3.18
installation protection system
IPS
feature of an installation site, provided by the installer or operating organization, that has two functions: (1) it detects human entry into the accessible volume of either the NHZ for restricted or controlled locations or the ENHZ 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

3.19
interlock
means either of preventing access to a hazardous location until the hazard is removed, or of automatically removing the hazardous condition when access is gained

3.20
location
position or site occupied or available for occupancy

Note 1 to entry: Other standards may use the same terms for location types (3.21 τo 3.24) with somewhat different definitions.

3.21
location of inaccessible space
inaccessible space
volume where a person cannot normally be located, 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 1 to entry: Inaccessible space may be entered by, for example, aircraft.

Note 2 to entry: All open space that is neither an unrestricted, restricted nor controlled location.

3.22
location with controlled access
controlled location
location where an engineering and administrative control measure is present to make it inaccessible except to authorized personnel with appropriate laser safety training

3.23
location with restricted access
restricted location
location that is normally inaccessible to 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) who may not have laser safety training

3.24
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)

3.25
manufacturer
organization or individual who makes or assembles optical devices and other components for the construction or modification of an FSOCS

3.26
nominal hazard zone
NHZ
volume within which the level of eye exposure to direct, reflected or scattered radiation exceeds the applicable maximum permissible exposure (MPE) as defined in IEC 60825-1.

Note 1 to entry: Exposure levels outside the boundary of the NHZ are below the applicable MPE.

Note 2 to entry: This volume is determined prior to activation of any IPS or APR systems unless the APR is used for classification under the conditions of Clause 5 of this document.

3.27
operating organization
operator
organization or individual who is responsible for the operation and maintenance of an FSOCS

3.28
optically-aided viewing
use of optical aids (for example, binoculars or magnifiers) to view an emitting source from within the emitted beam

Note 1 to entry: 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.

3.29
removable laser system
laser system that can be removed from its protective housing and operated by simply plugging into electrical mains or connection to a battery

3.30
primary beam
beam that transmits the modulated data signal

3.31
reasonably foreseeable event
event (or condition) that is credible and whose likelihood of occurrence (or existence) cannot be disregarded

3.32
service organization
organization or individual who is responsible for the service of an FSOCS

Note 1 to entry: The term service is defined in 3.79 of IEC 60825-1:2014.

3.33
special tool
tool that is not readily available at retail consumer hardware stores

Note 1 to entry: Typical tools in this category are intended for use with tamper-resistant fasteners.

3.34
spillover
beam radiant energy that propagates past the receiving terminal

3.35
time base
emission duration to be considered for determination of access level

3.36
without optical aids
optically unaided
without using magnifiers or other optical aids, as with the naked eye

Note 1 to entry: Prescription eyeglasses and contact lenses are not considered optical aids.

4 Assessment of access level

4.1 General

For FSOC transmitter shall comply with the applicable requirement of IEC 60825-1:2014.

If an FSOCS incorporates a removable laser system, that removable laser system shall comply with the applicable requirements of IEC 60825-1.

FSOCSs have limitations imposed by this document 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 2.

For each location where emission is transmitted, crosses or is received, respective exposure conditions shall be individually evaluated. Furthermore, potentially occupied locations along the beam path, within the NHZ or ENHZ, shall also be evaluated for acceptable access levels (Table 2) and appropriate controls applied. Locations traversed by partial reflections from windows within the beam path shall also be evaluated if the emission could exceed access level 1 or 2. At a given location, the installation and operational constraints applied from Clause 6 shall be determined by whichever is the more hazardous: the transmitted or the received optical radiation.

Determination of access levels is the ultimate responsibility of the manufacturer and the operating organization. However, they may be determined by the maintenance, installation or service organization. The methods for determining compliance with an access level are the same as those described for classification in IEC 60825-1 except for the following.

a) The access level within a designated location shall be determined at any position relative to an FSOCS transmitter where the access level is maximized, and could depend on intermediate system elements such as windows.

b) The access level may depend on the activation of an IPS or APR system.

c) If an IPS or APR system is monitoring the location in question, it shall meet the performance requirements defined in 5.3.2. Otherwise, the same method used for classification is also used for determination of access level. For viewing conditions without optical aids refer to the tables of MPEs in IEC 60825-1.

Verification testing of access levels shall be carried out under reasonably foreseeable fault conditions to ensure that the APR and/or IPS, if used, is operating properly. In circumstances where it is difficult to carry out direct measurements, an assessment of the access level based on calculations is acceptable. Faults which result in the emission of radiation in excess of the applicable AEL for a limited period only and for which it is not reasonably foreseeable that human access to the radiation will occur before the product is taken out of service or adjusted down below the AEL, need not be considered.

4.2 Determination of access level and the use of Condition 2

The access level is determined by the measurement of the optical radiation that could become accessible following any reasonably foreseeable event during operation and maintenance. The methods for the determination of compliance with the specified radiation limit values are the same as those described for classification in IEC 60825-1.

All three conditions shall be tested. Condition 1 and Condition 3 shall be tested according to IEC 60825-1.

Condition 2 measurements to establish access levels shall be made with,

- For wavelength less than 1 400 nm, 3,5 mm aperture at a distance of 35 mm
- For wavelength equal or greater than 1 400 nm, 3,5 mm aperture at a distance of 14 mm

from the end of the FSOCS transmitter (this simulates a ×18 magnifier), as described in Table.1.

In addition to the above, if handheld device and for all wavelengths, the total emission from the FSOCS transmitter for Access Level 3B systems shall not exceed the AEL of Class 3B.

In circumstances where it is difficult to carry out direct measurements, an assessment of access level based on calculations is acceptable.

For an FSOCS with automatic power reduction (see 5.3.2 for APR performance requirements), the access level will be determined by the accessible emission (pulse or continuous wave) after the time interval of 2 s. Additionally the MPE requirement in 5.2 shall be satisfied.

Table 1 – Measurement aperture diameters and distances for the default (simplified) evaluation

	Condition 1 Applied to collimated beam where e.g. telescope or binoculars may increase the hazard		**Condition 2** [a] Applicable to optical fibre communication systems, see IEC 60825-2 Applicable to free space optical communication systems		**Condition 3** Applied to determine irradiation relevant for the optically unaided eye, for low power magnifiers and for scanning beams	
Wavelength nm	**Aperture stop diameter** mm	**Distance** [b] mm	**Aperture stop diameter** mm	**Distance** [b] mm	**Aperture stop diameter** mm	**Distance** [b] mm
< 302,5	–	–	–	–	See IEC 60825-1	See IEC 60825-1
≥ 302,5 to < 400	See IEC 60825-1	See IEC 60825-1	3,5	35	See IEC 60825-1	See IEC 60825-1
≥ 400 to < 1 400	See IEC 60825-1	See IEC 60825-1	3,5	35	See IEC 60825-1	See IEC 60825-1
≥ 1 400 to < 4 000	See IEC 60825-1	See IEC 60825-1	3,5	14	See IEC 60825-1	See IEC 60825-1
≥ 4 000 to < 10^5	–	–	–	–	See IEC 60825-1	See IEC 60825-1
≥ 10^5 to < 10^6	–	–	–	–	See IEC 60825-1	See IEC 60825-1

NOTE 1 The descriptions below the “Condition” headings are typical cases for information only and are not intended to be exclusive.

NOTE 2 Limitations of the classification scheme are discussed in IEC 60825-1:2014, Clause C.3, suggesting cases where additional risk analysis and warnings might be appropriate. Condition 2 was used in previous editions of IEC 60825-1 as the “magnifying glass” condition.

NOTE 3 The values for Condition 1 and Condition 3 shall be taken from Table 10 in IEC 60825-1:2014.

[a] The definition of Condition 2 in this table is modelled on x 7 and x18 magnifying optics for the wavelength ranges of 302,5 nm to 1 400 nm and 1 400 nm to 4 000 nm, respectively. This is represented by a 3,5 mm aperture stop at a distance of 35 mm or 14 mm from the end of the fibre. The aperture stop diameter of 3,5 mm (rather than 7 mm) is used because a magnifying optics would only be used in a situation where there is sufficient light, and thus the pupil would be constricted. Also note that when multimode fibres having large core diameters are used for OFCSs, the mitigating effect of the large angular subtense may be considered.

[b] The distance values specified in this table apply only for the determination of the access level labelling that is required on the transmitter device itself. To determine the access level that is applicable to locations / zones along the beam path only the respective aperture stop diameters apply.