

Safety of laser products —

Part 2: Safety of optical fibre communication systems

The European Standard EN 60825-2:1994 has the status of a
British Standard

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National foreword

This British Standard has been prepared under the direction of the Electrotechnical Sector Board and is the English language version of EN 60825-1:1994 *Safety of laser products — Part 2: Safety of optical fibre communication systems* including amendment A1:1998 and corrigendum March 1993, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 825-2:1993 including Amendment 1:1997, published by the International Electrical Commission (IEC).

BS EN 60825 consists of the following Parts:

- *Part 1: Equipment classification, requirements and user's guide;*
- *Part 2: Safety of optical fibre communication equipment systems.*

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Descriptors: Laser product, radiation safety, user's guide, telecommunication, optical fibre

English version

Safety of laser products Part 2: Safety of optical fibre communication systems

(includes amendment A1:1998)
(IEC 825-2:1993 + A1:1997)

Sécurité des appareils à laser
Partie 2: Sécurité des systèmes de
télécommunication par fibres optiques
(inclut l'amendement A1:1998)
(CEI 825-2:1993 + A1:1997)

Sicherheit von Lasereinrichtungen
Teil 2: Sicherheit von
Lichtwellenleiter-Kommunikations-systemen
(enthält Änderung A1:1998)
IEC 825-2:1993 + A1:1997)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The text of document 76(CO)30, as prepared by IEC Technical Committee No. 76: Laser equipment, was submitted to the IEC-CENELEC parallel vote in January 1993.

The reference document was approved by CENELEC as EN 60825-2 on 8 December 1993.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1994-12-01
- latest date of withdrawal of conflicting national standards (dow) 1994-12-01

For products which have complied with the relevant national standard before 1994-12-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1999-12-01.

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information. In this standard, Annex A and Annex C are informative and Annex B and Annex ZA are normative.

Foreword to amendment A1

The text of document 76/162/FDIS, future amendment 1 to IEC 60825-2:1993, prepared by IEC TC 76, Optical radiation safety and laser equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60825-2:1994 on 1998-4-01-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-10-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1998-10-01

Annexes designated “informative” are given for information only. In this standard, Annex D and Annex E are informative.

NOTE Harmonized as HD 485 S1:1987 (not modified)

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1 Scope

This part 2 of IEC 825 provides requirements and specific guidance for the safe use of optical fibre and/or control communication systems where optical power may be accessible at great distance from the optical source. It does not apply to optical fibre systems primarily designed to transmit optical power for applications such as material processing or medical treatment.

Throughout this part of IEC 825, light emitting diodes (LEDs) are included whenever the word “laser” is used.

The objective of this part 2 of IEC 825 is to:

- protect people from optical radiation resulting from optical fibre communication systems. This requires the introduction of engineering requirements and work practices according to the degree of hazard;
- lay down requirements for manufacturers and operating organizations in order to establish procedures and supply information so that proper precautions can be adopted;
- ensure adequate warning to individuals of hazards associated with optical fibre communication systems through signs, labels and instructions;
- reduce the possibility of injury by minimising unnecessary accessible radiation and to give improved control of the optical radiation through protective features and provide safe usage of products by specifying user control measures.

Annex A gives a more detailed rationale for this part of IEC 825.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 825. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 825 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 794-2:1989, *Optical fibre cables — Part 2: Product specifications*.

IEC 825-1:1993, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*.

3 Definitions

For the purposes of this part of IEC 825, the following definitions apply. They are in addition to those given in IEC 825-1.

3.1

automatic power reduction

a feature of an optical fibre communication system by which the accessible power is reduced to a specified level within a specified time, whenever there is an event which could result in human exposure to radiation, e.g. a fibre cable break

3.2

enclosed system

system in which, during normal operation, the optical radiation is totally enclosed, e.g. by light-proof cabinets, components, total internal reflection or optical fibre cables and connectors

3.3

end-user

the person/organization using the optical fibre communication system in the manner the system was designed to be used. The user cannot necessarily control the power generated and transmitted within the system

3.4

hazard level

the potential hazard at any accessible location within an optical fibre communication system. It is based on the level of optical radiation which could become accessible in reasonably foreseeable circumstances, e.g. a fibre cable break. It is closely related to the laser classification procedure in IEC 825-1

3.5

hazard level 1

a hazard level 1 is allocated to any part within an optical fibre communication system at 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

3.6

hazard level 2

a hazard level 2 is allocated to any part within an optical fibre communication system at 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

3.7**hazard level 3A**

a hazard level 3A is allocated to any part within an optical fibre communication system at which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits of class 3A for the applicable wavelengths and emission duration will not occur

3.8**hazard level $k \times 3A$**

in the wavelength range 400 nm to 4 000 nm, a hazard level $k \times 3A$ is allocated to any part within an optical fibre communication system at which, under reasonably foreseeable circumstances, human access to laser radiation in excess of the accessible emission limits of hazard level $k \times 3A$ for the applicable wavelengths and emission duration will not occur. For purposes of the $k \times 3A$ hazard level evaluation, class 3A AEL table is used and the minimum measurement distance shall be increased to 250 mm from the apparent source and the time base used shall be 10 s provided longer viewing durations are not reasonably foreseeable

NOTE The value of k is not a constant and need not be calculated (see Annex A for rationale).

3.9**hazard level 3B**

a hazard level 3B is allocated to any part within an optical fibre communication system at 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

3.10**hazard level 4**

a hazard level 4 is allocated to any part within an optical fibre communication system at 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 may occur

3.11**light emitting diode (LED)**

any semiconductor p-n junction device which can be made to produce electromagnetic radiation by radiative recombination in the semi-conductor in the wavelength range from 180 nm to 1 mm (The optical radiation is produced primarily by the process of spontaneous emission, although some stimulated emission may be present.)

3.12**local operator control**

an optical communication system is under local operator control if the operating controls and the optical output may be directly monitored simultaneously by a single operator who has control over the potential human access to optical radiation

3.13**location with controlled access**

a location where access to the protective housing (enclosure) is controlled and is accessible only to authorized persons who have received adequate training in laser safety and servicing of the system involved. Examples include optical cable ducts and switching centres

3.14**location with restricted access**

a location where access to the protective housing (enclosure) is restricted and not open to the public. Examples include industrial and commercial premises

3.15**location with unrestricted access**

a location where access to the protective housing (enclosure) is unrestricted. Examples include domestic premises and those open to the public

3.16**manufacturer**

an organization/individual who assembles optical devices and other components in order to construct or modify an optical fibre communication system

3.17**operating organization**

an organization/individual who is responsible for the installation and/or operation of an optical fibre communication system

3.18**optical fibre communication system**

an engineered assembly for the generation, transference and reception of optical radiation arising from lasers in which the transference is by means of optical fibre for communication and/or control purposes

3.19**reasonably foreseeable event**

an event the occurrence of which under given circumstances can be predicted fairly accurately, and the occurrence probability or frequency of which is not low or very low

examples of reasonably foreseeable events might include the following: fibre cable break, optical connector disconnection, operator error or inattention to safe working practices
reckless use or use for completely inappropriate purposes is not to be considered as a reasonably foreseeable event

4 Manufacturing requirements

4.1 Engineering specifications

4.1.1 General remarks

Optical fibre communication systems require certain built-in safety features, depending on their hazard level. The manufacturer of the optical fibre communication system is responsible for the allocation of the hazard level and the compliance with the manufacturing requirements. These requirements are summarised in Annex B.

Whenever alterations which may affect hazard levels are made to the optical fibre communication system, the person or organization performing such modification shall reassess hazard levels by carrying out tests and measurements wherever appropriate for ensuring compliance and, where the hazard level has changed, relabelling.

Manufacturers of ready-for-use optical transmission equipment which is to be supplied to end-users are responsible for assessing hazard levels of the optical system under all reasonably foreseeable circumstances and for the compliance with the appropriate manufacturing and safety requirements.

For other optical communication systems, the operating organization has the ultimate responsibility for the safety of the system. This includes especially:

- the identification of the location type at all subdivisions of the entire transmission path;
- the assessment of hazard level at any location in the case of reasonably foreseeable events;
- assuring compliance with the manufacturing and safety requirements.

Optical fibre communications systems that also transmit electrical power shall meet the requirements of this standard in addition to any applicable electrical standard.

4.1.2 Cable design

The mechanical design of optical fibre cables shall be specified according to the hazard level.

If such cables are not at a controlled location:

4.1.2.1 All systems shall have mechanical characteristics of the individual single or multiple fibre cable not less than those required by IEC 794-2.

4.1.2.2 Locations with hazard levels in excess of 3A shall have the above cable requirements with further and adequate mechanical protection.

4.1.3 Cable connectors

4.1.3.1 All systems operating in unrestricted locations in which cable connectors are accessible require the use of a tool for disconnection if hazard level 1 can be exceeded.

4.1.3.2 All systems operating in restricted locations in which cable connectors are accessible require the use of a tool for disconnection if hazard level 3A can be exceeded.

4.1.3.3 All systems operating in controlled locations in which cable connectors are accessible require the use of a tool for disconnection if hazard level $k \times 3A$ can be exceeded.

4.1.3.4 Positioning of the connector in a way that prevents human access to a higher hazard level is an acceptable feature to ensure that these requirements are met.

4.1.4 Automatic power reduction

Automatic power reduction may be used to control the hazard level.

4.2 Labelling

4.2.1 Optical fibre cables should carry appropriate markings to distinguish them from cables containing other services, e.g. electricity.

4.2.2 Sleeving, a tag or a tape shall be associated with each optical connector if the hazard level at the location is in excess of hazard level 1. The sleeving, tag or tape shall be coloured yellow with the warning label according to Figure 14 of IEC 825-1 and the hazard level number incorporated in the explanatory label according to Figure 15 of IEC 825-1, both labels appropriately reduced in size.

4.2.3 Groups of connectors such as patch panels may be labelled as a group, with just a single clearly visible location hazard label rather than having each connector individually labelled. If a group of connectors are enclosed within a box, a label shall be clearly visible both before and after the access panel is opened, this may require the use of more than one label.

4.3 Provision of information

Manufacturers of ready-for-use optical fibre communication systems shall provide the operating organization with the following information:

- a) adequate description of the engineering design features incorporated into the product to prevent access to hazardous levels of optical radiation;
- b) adequate instructions for proper assembly, maintenance and safe use including clear warnings concerning precautions to avoid possible exposure to hazardous radiation;
- c) a statement in SI units of the power propagating in the fibre at all locations in the system, together with the pulse duration and pulse repetition frequency, or maximum modulation frequency. The cumulative measurement uncertainty and any expected variation in the measured quantities at any time after manufacture shall also be provided;
- d) a statement of the range of operating wavelength(s) within the optical fibre communication system at the time of manufacture and under specified conditions as well as the range of emission wavelengths expected during normal operation at any time after manufacture;
- e) the reaction time of any automatic power reduction system;
- f) legible reproductions (in appropriate colours or black and white) of all required labels and hazard warnings to be displayed at locations within an optical fibre communication system;
- g) a clear indication of all locations of apertures and fibre connectors;
- h) a listing of controls, adjustments and procedures for operation and maintenance, including a warning where appropriate;
- i) advice on safe operating procedures and warnings concerning known malpractices, malfunctions and hazardous failure modes. Where maintenance procedures are detailed, they shall wherever possible include explicit instructions on safe procedures to be followed;
- j) where installation or servicing requires that an automatic power reduction system is overridden, information to enable the operating organization to specify a safe system of work at such times, and a safe procedure for reinstating and safe testing of the automatic power reduction system;
- k) any other information relevant to the safe use of the optical fibre communication system.

4.4 Assessment of hazard level

4.4.1 The hazard level is determined by the measurement of optical radiation accessible in any reasonably foreseeable event. The methods for determination of compliance with the specified radiation limit values are the same as those described for classification in IEC 825-1.

Measurements need to be taken under the appropriate conditions, e.g. simulated fibre cable break, and shall be based on the relevant clauses in IEC 825-1. The assessment of the hazard level shall take place 1 s after the reasonably foreseeable event (e.g. fibre cable break), unless measurement at a later time would result in a larger exposure.

In circumstances where it is difficult to carry out direct measurements, an assessment of hazard level based on calculations may be acceptable. For example, knowledge of the laser power and fibre attenuation may allow assessment of the hazard at any particular location.

4.4.2 Tests shall be carried out under reasonably foreseeable fault conditions.

In some complex systems (e.g., where the optical output is dependent on the integrity of other components and the performance of circuit design and software), it may be necessary to use other recognized methods for hazard/safety assessment (see Annex C).

4.4.3 For optical fibre communication systems with automatic power reduction, the hazard level will be determined by the normal level of power in the fibre and the speed of the automatic power reduction. The speed of power reduction required to obtain a specific hazard level can be determined from the AEL tables in IEC 825-1. For example, a relatively high optical power level on a fibre together with a high speed automatic power reduction could have the same hazard level as a relatively low optical power on the fibre together with a slower automatic power reduction.

4.5 Requirements for installation

4.5.1 Optical fibre communication systems operating in unrestricted locations shall have a hazard level of 1, 2 or 3A.

4.5.2 Optical fibre communication systems operating in restricted locations shall have a hazard level of 1, 2, 3A or $k \times 3A$.

4.5.3 Optical fibre communication systems operating in controlled locations shall have a hazard level of 1, 2, 3A, $k \times 3A$ or 3B.

4.5.4 No optical fibre communication system shall have locations with a hazard level 4.