SLOVENSKI STANDARD

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Eno-rodni optični kabel (cevna/neposredno zakopana vgradnja)*

Single mode optical cable (duct/direct buried installation)

ICS 33.180.10

Referenčna številka
SIST EN 187105:2004(en)

EUROPEAN STANDARD **EN 187105**

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ICS 33.180.10

English version

Single mode optical cable (duct/direct buried installation)

Câbles à fibres optiques unimodales (installations en conduite/ directement enterrées)

Einmoden-Lichtwellenleiterkabel für Röhren- und direkte Erdverlegung

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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

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 86A, Optical fibres and optical fibre cables.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 187105 on 2001-12-04.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2002-12-01

– latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2004-12-01

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1 Scope

This document sets forth telecom operators', other service providers' and manufacturers' view of proposed technical requirements and characteristics of single mode optical fibres and cables for duct and direct buried installation.

This specification includes proposed functional mechanical, environmental and optical requirements, recommended features, and test methods for assessing the product against the stated requirements.

The specified test methods where applicable, are those referenced in EN 60794-1-1 "Optical fibre cables – Part 1-1: Generic specification – General" and described in detail in EN 60794-1-2 "Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures".

The requirements of this specification shall be used in conjunction with EN 60794-3 "Optical fibre cables - Part 3: Duct, buried and aerial cables - Sectional specification" and EN 60794-3-10 "Optical fibre cables – Part 3-10: External cables – Duct and directly buried optical telecommunication cables – Family specification".

Multimode fibre requirements are not addressed in this document.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

EN 50290-2-24	2002	Communication cables - Part 2-24: Common design rules and construction - PE sheathing
EN 50290-2-28	2002	Communication cables - Part 2-28: Common design rules and construction - Filling compounds for filled cables
EN 50290-3	[1]	Communication cables – Part 3: Quality assessment
EN 60793-1-30	2002	Optical fibres - Part 1-30: Measurement methods and test procedures – Fibre proof (IEC 60793-1-30)
EN 60793-1-32	[2]	Optical fibres - Part 1-32: Measurement methods and test procedures – Coating strippability (IEC 60793-1-32)
EN 60793-1-33	2002	Optical fibres - Part 1-33: Measurement methods and test procedures – Stress corrosion susceptibility (IEC 60793-1-33)
EN 60793-1-40	[2]	Optical fibres - Part 1-40: Measurement methods and test procedures – Attenuation (IEC 60793-1-40)
EN 60793-1-42	2002	Optical fibres - Part 1-42: Measurement methods and test procedures – Chromatic dispersion (IEC 60793-1-42)
EN 60793-1-44	2002	Optical fibres - Part 1-44: Measurement methods and test procedures – Cut-off wavelength (IEC 60793-1-44)
EN 60793-1-45	[2]	Optical fibres - Part 1-45: Measurement methods and test procedures – Mode field diameter (IEC 60793-1-45)
EN 60793-1-47	2002	Optical fibres - Part 1-47: Measurement methods and test procedures – Macrobending loss attenuation (IEC 60793-1-47)

[1] At draft stage.
[2] Awaiting publication pending ratification of prAA.

EN 60794-1-1	2002	Optical fibre cables - Part 1-1: Generic specification – General (IEC 60794-1-1:2001)
EN 60794-1-2	1999	Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures (IEC 60794-1-2:1999)
EN 60794-3	2002	Optical fibre cables – Part 3: Duct, buried and aerial cables – Sectional specification (IEC 60794-3:2001)
EN 60794-3-10	2002	Optical fibre cables – Part 3-10:– External cables – Duct and directly buried optical telecommunication cables - Family specification (IEC 60794-3-10)
EN 60811-1-1	1995	Insulating and sheathing materials of electric cables – Common test methods – Part 1: General application – Section 1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties (IEC 60811-1-1:1993)
EN 61663-1	1999	Lightning protection – Telecommunication lines – Part 1: Fibre optic installations (IEC 61663-1:1999)
EN 188000	1992	Generic specification: Optical fibres
EN 188100	1995	Sectional specification: Single-mode (SM) optical fibre
EN 188101	1995	Family specification: Single-mode dispersion unshifted (B1.1) optical fibre
EN 188102	1995	Family specification: Single-mode dispersion shifted (B2) optical fibre
HD 402 S2	1984	Standard colours for insulation for low-frequency cables and wires (IEC 60304:1982)
IEC 60708-1	1981	Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath – Part 1: General design details and requirements
IEC 60793-1-1	1995	Optical fibres – Part 1-1: Generic specification – General
IEC 60793-1-2	1995	Optical fibres – Part 1-2: Generic specification – Measuring methods for dimensions
IEC 60793-1-4	1995	Optical fibres – Part 1-4: Generic specification - Measuring methods for transmission and optical characteristics
IEC 60793-1-5	1995	Optical fibres – Part 1-5: Generic specification - Measuring methods for environmental characteristics
IEC 60793-2	1998	Optical fibres – Part 2: Product specifications
IEC 61282-3		Guidelines for the calculation of PMD in fiber optic systems
IEC 61931	1998	Fibre optic – Terminology *(Technical Report)*
IEC 61941	2000	Optical fibres – Polarization mode dispersion measurement techniques for single-mode optical fibres *(Technical Specification)*

3 Terminology

Unless otherwise specified the definitions are given in IEC 61931.

4 General information

Single mode optical fibres are widely used for communication purposes and cabled to satisfy the functional requirements of the installation environment. For duct installation, the environment and infrastructure can be varied and may also involve the use of single and multiple subducts. Directly buried cables may be installed by a variety of methods such as ploughing, trenching and moling with different environments and infrastructure. This may involve specific cable design solutions based on either light, medium or heavy armouring. It is recognised that certain designs of cable for direct buried applications involving light armour may also be suitable for duct installation. The functional requirements and test methods featured in this specification are based upon adherence to established and recognised installation techniques such as those highlighted in the informative annex C (Guide to the installation of optical fibre cable) of EN 60794-1-1.

4.1 General cable description

4.1.1 Characteristics of optical fibre

Single mode optical fibres are classified according to their operational wavelength and dispersion characteristics. The fibres covered by this specification are categorised as type B and described in IEC 60793-1-1. The predominant fibre types featured in this specification include, dispersion unshifted (B1.1, B1.3), dispersion shifted (B2) and non-zero dispersion (B4). Unless otherwise specified, requirements of applicable European single mode fibre standards (EN 188000, EN 188100, EN 188101 and EN 188102) have to be used in this standard.

Optical fibres are inherently robust and strong, but the strength can be drastically reduced due to the combination of environmental conditions, unavoidable microscopic surface flaws introduced during fibre manufacture and stresses imposed on the fibre during handling, cabling and installation. The strength degradation can be as a result of dynamic or static fatigue as well as through ageing with no stress component. Dynamic fatigue is more likely to occur during installation whilst static fatigue could occur over the lifetime of the fibre arising from residual strain in the cable or within coiled fibre housed in a splice enclosure or footway box. The attenuation of cabled fibre could also increase during its lifetime if the fibre is not suitably protected from mechanical stresses and environmental hazards or if inappropriate and incompatible materials are used in the cable construction.

The recommended cable design features, test parameters and requirements outlined in this specification are designed to mitigate these risks and hazards for the optical fibres involved.

4.1.2 Characteristics of optical fibre cable elements

Optical fibre cable elements such as loose buffer tubes, slotted core, fibre ribbons, fibre bundles and central/core tubes shall be suitably designed to provide adequate means of fibre location, identification, modularity, protection during cable manufacture, installation and termination. The structure of these elements and the materials used in their manufacture shall not have any long term detrimental effects on fibre performance during the service life of the cable, splice enclosure and/ or cabinet. To satisfy these functional requirements, the different elements shall comply with the requirements of clause 5 in EN 60794-3 as well as those outlined in clause 4 of this standard.

4.1.3 Characteristics of optical fibre cables

Optical fibre cable for duct and direct buried applications shall be designed, manufactured and installed to ensure stable and consistent fibre performance for a predicted operating lifetime of at least 20 years under the prevailing environmental conditions. The required levels of protection for the fibre can be achieved by laying up or assembling the cable elements in association with suitable strength and/or anti buckling members. These can be either metallic in nature or non-metallic and positioned at the centre of the cable core or as peripheral members in or underneath the outer cable sheath. Protection from water and moisture ingress can be achieved by the inclusion of moisture barrier tapes, either metallic or non metallic, and water blocking or swellable materials.

4.1.4 Environmental and product safety requirements

IEC Guide 104 should be taken into account as far as possible. The materials of the cables in contact with the environment shall not be hazardous to environment and personnel.

4.1.5 Informative note: Upgrading to meet future network requirements

Single mode optical fibre transmission continues to offer the potential for ever increasing speed and information transmission capacity. This specification has been prepared with these future developments and upgrades in mind, such that some of the requirements outlined for fibre and cable may not be necessary for all applications but may prove to be essential for future uses.

4.2 Optical fibre spliceability

All of the single mode fibre types covered in this specification can readily achieve very low splice loss levels using a range of commercially available techniques.

4.3 Testing

For all test procedures, the test conditions shall be the standard atmospheric conditions (23 °C ± 5 °C, and 20 % - 70 % relative humidity), unless otherwise specified. All measured and computed values are to be rounded to the number of decimal places given in the corresponding requirement or objective.

The parameters specified in this standard may be affected by measurement uncertainty arising either from measurement errors or calibration errors due to a lack of suitable standards. Acceptance criteria shall be interpreted with respect to this consideration. The total uncertainty of measurement for this standard shall be less than or equal to 0.05 dB for attenuation. The expression of ”no change in attenuation” means that any change in measurement value, either positive or negative, within the uncertainty of measurement shall be ignored.

Some of the mechanical and environmental tests in 5.5 and 5.6 can be performed on a short sample length of cable which is still an integral part of a longer length. Thus it becomes possible to detect permanent changes in attenuation.

5 Requirements for cabled single mode optical fibres

5.1 Fibre materials

The materials used in the manufacture of single mode optical fibres for incorporation into cables to this specification, shall be of a uniform quality. The core and cladding regions of the fibre shall be made from predominantly purified silica (SiO_2) with a defined and closely controlled refraction index difference. The refraction index of either the core and/or the cladding shall be controlled by the inclusion of small amounts of highly purified dopant materials.

The glass surface shall be protected with one or more layers of suitable inert coating material, such as UV cured acrylates. The coating shall be in intimate contact with the cladding surface and satisfy the requirements of 3.4.2 (coating strip force) to facilitate removal for connecting and splicing purposes without damage to the fibre and to avoid delamination which may expose the glass surface to the environment. The coating surface shall only be cleaned (e.g from cable filling compounds) with cleaning agents recommended by the fibre manufacturer. In all circumstances the use of chlorine-based cleaning agents shall be prohibited because of its health hazard.

5.2 Optical requirements

5.2.1 Attenuation coefficient

The cable attenuation coefficient requirements where applicable, for type B1.1, B1.3, B2 and B4 single mode fibres covered by this specification shall meet EN 60794-3-10 and shall be specified in the following windows:

1 285 - 1 330 nm

1 530 - 1 570 nm

1 570 - 1 625 nm

NOTE Fibre types B2 and B4 only operate at the 1 550 nm window.

The specification shall be

at 1 310 nm: ≤ 0,38 dB/km,

at 1 550 nm: ≤ 0,25 dB/km for B1.1, B1.3 and B2 fibres,

≤ 0,27 dB/km for B4 fibres,

at 1 625 nm: under consideration in IEC.

Test procedure:

Measurements shall be made in accordance with EN 60793-1-40.

5.2.2 Point discontinuities

Point discontinuities / local variations representing non-reflective events shall be: ≤ 0,10 dB.

Extended variations for fibre lengths in excess of 1 km shall be: ≤ 0,10 dB/km.

Test procedure:

Measurements shall be made in accordance with EN 60793-1-40 method C (back scattering technique).

Measurement variables:

wavelength: 1 550 nm;

distance resolution (pulse width): ≤ 1 μs.

5.2.3 Chromatic dispersion

Chromatic dispersion shall comply with IEC 60793-2.

NOTE For information, the requirements given in IEC 60793-2 are as follows:

The zero dispersion wavelength λo shall be
1 300 nm ≤ λo ≤ 1 324 nm (dispersion unshifted fibres – type B1.1 and B1.3),
1 500 nm ≤ λo ≤ 1 600 nm (dispersion shifted fibres – type B2).

The maximum value of the zero dispersion slope coefficient So shall be
So ≤ 0,093 ps / nm2.km (dispersion unshifted fibres – type B1.1 and B1.3),
So ≤ 0,085 ps / nm2.km (dispersion shifted fibres – type B2),
So not specified for non-zero dispersion fibres – type B4.

Test procedure:

Chromatic dispersion measurements shall be made in accordance with EN 60793-1-42.

5.2.4 Cut-off wavelength

Cable cut-off wavelength shall be

≤ 1 260 nm for fibre types B1.1 and B1.3,

≤ 1 260 nm for fibre type B2,

≤ 1 480 nm for fibre type B4.

Test procedure:

Cut-off wavelength measurements shall be made in accordance with EN 60793-1-44.

5.2.5 Mode field diameter

The mode field diameter requirements shall comply with IEC 60793-2.

NOTE For information, the requirements given in IEC 60793-2 are as follows:
The nominal mode field diameter (2w) shall be
8,6 µm ≤ 2w ≤ 9,5 µm at 1 310 nm (dispersion unshifted fibres – type B1.1 and B1.3),
7,0 µm ≤ 2w ≤ 8,5 µm at 1 550 nm (dispersion shifted fibres – type B2).
A deviation from the chosen nominal value shall be < 10 %.
Values are under consideration for non-zero dispersion shifted fibres – type B4.

Test procedure:

The mode field diameter measurements shall be made in accordance with EN 60793-1-45.

5.2.6 Macrobending sensitivity

The macrobending attenuation per 100 turns of fibre on a mandrel, 60 mm in diameter shall not exceed 0,2 dB at 1 550 nm.

The fibre macrobend measurement is to be made in accordance with EN 60793-1-47.

NOTE Care must be taken for fibre deployment to avoid multiple loops of bend radius < 30 mm, since attenuation may be increased and fibre lifetime may be decreased due to the high induced bending stress.

5.2.7 Polarisation mode dispersion (PMD)

Polarisation mode dispersion (PMD) is usually described in terms of a differential group delay (DGD), which is the propagation time difference between the principal states of polarisation of an optical signal. PMD in cabled fibres and optical components causes an optical pulse to spread in the time domain, which may impair the performance of a long length and high bit rate (e.g. 10 Gbit/s transport over 400 km) optical fibre system. For these systems only the following evaluation may be useful.

Concerning the statistical nature of PMD in installed cable links reference is made to annex A of EN 60794-3.

The appropriate test method shall be selected from IEC 61941, which also describes the statistical nature of PMD (see scope: "… PMD is a random effect…For this reason a useful way to characterize PMD in long fibres is in terms of the expected value…").

Considering this particular situation, the requirements on PMD for 10 Gbit/s systems are as follows:

- the cable PMD coefficient shall be ≤ 0,5 ps.km$^{-1/2}$;
- a statistical evaluation of PMD is sufficient and there is normally no need to measure every cable and/or fibre length;
- in cable links, only the PMD link design value is relevant. Therefore, single cables of a link may exceed the above given limit. In practice, typical PMD link design value are ≤ 0,2 ps.km$^{-1/2}$.

NOTE For 40 Gbit/s systems, lower PMD values will be needed.

5.2.8 Refractive group index

The refractive group index shall be given at 1 310 nm for fibre type B1 and at 1 550 nm for fibre types B1, B2 and B4.