

Optical fibre cables —

Part 1-1: Generic specification — General

The European Standard EN 60794-1-1:1999 with the incorporation of amendment A1:2001 has the status of a British Standard

ICS 33.180.10

National foreword

This British Standard is the official English language version of EN 60794-1-1:1999, including amendment A1:2001. It is identical with IEC 60794-1-1:1999, including amendment 1:2000.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to subcommittee GEL/86/1, Optical fibres and cables, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Cross-references

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Foreword

The text of document 86A/471/FDIS, future edition 1 of IEC 60794-1-1, prepared by SC 86A, Fibres and cables, of IEC TC 86, Fibre optics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60794-1-1 on 1999-08-01.

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This standard is to be used in conjunction with EN 60794-1-2:1999.

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annexes A, B and C are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60794-1-1:1999 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of amendment 1:2000 to the International Standard IEC 60794-1-1:1999, prepared by SC 86A, Fibres and cables, of IEC TC 86, Fibre optics, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A1 to EN 60794-1-1:1999 on 2000-08-01 without any modification.

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OPTICAL FIBRE CABLES –

Part 1-1: Generic specification – General

1 Scope and object

This part of International Standard IEC 60794 applies to optical fibre cables for use with telecommunication equipment and devices employing similar techniques, and to cables having a combination of both optical fibres and electrical conductors.

The object of this standard is to establish uniform generic requirements for the geometrical, transmission, material, mechanical, ageing (environmental exposure) and climatic properties of optical fibre cables, and electrical requirements where appropriate.

Annex A contains information pertinent to short-distance links for many of the cables of this specification set.

Annex B contains guidance for users of this specification set in procuring optical cables compliant with these specifications.

Annex C is a guide to the installation of optical fibre cables.

2 Normative references

2.1 The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60794. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60794 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. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60189-1:1986, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*

IEC 60331:1970, *Fire-resisting characteristics of electric cables*

IEC 60332-1:1993, *Tests on electric cables under fire conditions – Part 1: Test on a single vertical insulated wire or cable*

IEC 60332-3:1992, *Tests on electric cables under fire conditions – Part 3: Tests on bunched wires or cables*

IEC 60754-1:1994, *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the amount of halogen acid gas*

IEC 60754-2:1991, *Test on gases evolved during combustion of electric cables – Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*

IEC 60793-1-1:1995, *Optical fibres – Part 1: Generic specification – Section 1: General*

IEC 60793-1-2:1995, *Optical fibres – Part 1: Generic specification – Section 2: Measuring methods for dimensions*

IEC 60793-1-3:1995, *Optical fibres – Part 1: Generic specification – Section 3: Measuring methods for mechanical characteristics*

IEC 60793-1-4:1995, *Optical fibres – Part 1: Generic specification – Section 4: Measuring methods for transmission and optical characteristics*

IEC 60793-1-5:1995, *Optical fibres – Part 1: Generic specification – Section 5: Measuring methods for environmental characteristics*

IEC 60793-2:1992, *Optical fibres – Part 2: Product specifications*

IEC 60811-1-1:1993, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*

IEC 60874-1:1993, *Connectors for optical fibres and cables – Part 1: Generic specification*

IEC 60885-1:1987, *Electrical test methods for electric cables – Part 1: Electrical tests for cables, cords and wires for voltages up to and including 450/750V*

IEC 61034-1:1997, *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*

IEC 61034-2:1997, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

IEC 61300-2-1:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*

IEC 61300-2-2:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-2: Tests – Mating durability*

CEI 61300-2-4:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retension*

CEI 61300-2-5:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-5: Tests – Torsion/twist*

CEI 61300-2-6:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-6: Tests – Tensile strength of coupling mechanism*

CEI 61300-2-12:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-12: Tests – Impact*

CEI 61300-3-1:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*

CEI 61300-3-11:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-11: Examinations and measurements – Engagement and separation forces*

2.2 References herein to the detail specification for cable attributes and parameters are intended to include the applicable other parts of this specification, the applicable family specifications contained therein, and the detail specification. Annex A of this specification contains such requirements for short distance links.

3 Definitions

Under consideration.

4 Optical fibre cables

Optical fibre cables, containing optical fibres and possibly electrical conductors, consist of the following types.

4.1 Cables for direct burial

4.2 Cables for installation in ducts

4.3 Cables for installation in tunnels

4.4 Overhead cables

4.5 Underwater cables for lakes, river crossings and fjords

4.6 Indoor cables

4.7 Portable cables

4.8 Equipment cables

4.9 Special purpose cables

5 Materials

5.1 Optical fibre material

Optical fibres shall be uniform in quality and their characteristics shall meet the requirements of IEC 60793-1-1 and IEC 60793-2.

5.2 Electrical conductors

The characteristics of any electrical conductors shall be in accordance with the relevant IEC standards as stated in the detail specification.

5.3 Other materials

Material used in the construction of optical fibre cables shall be compatible with the physical and optical properties of the fibres, and shall be in accordance with the relevant IEC standards as stated in the detail specification.

6 Cable construction

The construction, dimensions, weight, mechanical, optical, electrical and climatic properties of each type of optical fibre cable shall be as stated in the relevant detail specification.

7 Measuring methods – General

Not all tests are applicable to all cables.

Intrinsic characteristics of optical fibres are normally not measured by cable manufacturers. The relevant values are provided by optical fibre manufacturers, and available as unitary or statistical values.

If required, and as specified in the detail specification, tests may be carried out on aged samples.

8 Measuring methods for dimensions

The dimensions of the optical fibres, electrical conductors and cables shall be determined by subjecting samples to tests selected from table 1. The tests applied, acceptance criteria and number of samples shall be as specified in the detail specification.

Table 1 – Measuring methods for dimensions

Test method	Test	Characteristics covered by test method
IEC 60793-1-A1A	Refracted near field (see note 1)	Diameter of core (see notes 3, 4 and 5) Diameter of cladding Non-circularities
IEC 60793-1-A1B	Transverse interference method	Concentricity errors
IEC 60793-1-A2	Near field light distribution (see note 2)	Diameter of core (see notes 3, 4 and 5) Diameter of cladding Non-circularities Concentricity errors
IEC 60793-1-A3	Side view light distribution for primary coating	Diameter of primary coating Non-circularity of primary coating Concentricity error of primary coating
IEC 60793-1-A4	Mechanical diameter measurement	Diameter of cladding Diameter of primary coating Diameter of buffer Non-circularities
IEC 60793-1-A6	Delay of transmitted and/or reflected pulse	Length of fibre
IEC 60793-1-C1C	Backscattering technique	Length of fibre
IEC 60189-1	Mechanical	Diameter of electrical conductor
IEC 60811-1-1 IEC 60189-1	Mechanical	Thickness of insulation Thickness of sheaths Overall dimensions

NOTE 1 – The refracted near field technique is a direct application of the core definition based on the refractive index profile. This method gives the refractive index profile from which the dimensions and numerical aperture can be calculated.

NOTE 2 – With the near-field light distribution the dimensions obtained are correlated to the refractive index profile, but are not strictly in accordance with the definition of the core diameter.

NOTE 3 – For dimensions linked to the transmission part of single-mode fibres (i.e. diameter of mode field, concentricity of mode field), see IEC 60793-1-4.

NOTE 4 – For practical reasons, the core diameter of single-mode fibres is not normally specified.

NOTE 5 – A definition of the core diameter of single-mode fibres is under consideration.

9 Measuring methods for mechanical characteristics

The mechanical characteristics of optical fibre cables shall be verified by subjecting samples to tests selected from table 2. The tests applied, acceptance criteria and number of samples shall be as specified in the detail specification.

NOTE – Not all tests are applicable to all cables.

Table 2 – Measuring methods for mechanical characteristics

Test method	Test	Characteristics covered by test method
IEC 60794-1-2-E1	Tensile performance	
IEC 60794-1-2-E2	Abrasion	
IEC 60794-1-2-E3	Crush	Mechanical strength
IEC 60794-1-2-E4	Impact	
IEC 60794-1-2-E13	Shot-gun damage	
IEC 60794-1-2-E18	Bending under tension	
IEC 60794-1-2-E19	Aeolian vibration* and galloping*	
IEC 60794-1-2-E6	Repeated bending	
IEC 60794-1-2-E7	Torsion	
IEC 60794-1-2-E8	Flexing	Ease of handling
IEC 60794-1-2-E10	Kink	
IEC 60794-1-2-E11	Bend	
IEC 60794-1-2-E12	Cut-through resistance	
IEC 60794-1-2-E14	Compound flow	
IEC 60794-1-2-E15	Bleeding and evaporation	
IEC 60794-1-2-E17	Stiffness	
* Under consideration.		

10 Measuring methods for electrical characteristics

When electrical conductors are incorporated in an optical fibre cable, verification of various electrical characteristics may be necessary. Typical tests are shown in table 3. The tests applied and the acceptance criteria shall be as laid down in the detail specification.

Table 3 – Measuring methods for electrical characteristics

Test method	Test	Characteristics covered by test method
IEC 60189-1 IEC 60885-1	Conductor resistance Dielectric strength of insulation Insulation resistance	Characteristics of insulated electrical conductors

11 Measuring methods for transmission and optical characteristics

The transmission and optical characteristics of optical fibre in cables shall be verified by carrying out selected tests from those shown in table 4. The tests applied and acceptance criteria shall be as specified in the detail specification.

Table 4 – Transmission and optical characteristics of optical fibres

Test method	Test	Characteristics covered by the test method
Test methods of multimode and single-mode fibres		
IEC 60793-1-C1A	Cut-back technique	Attenuation
IEC 60793-1-C1B	Insertion loss technique	
IEC 60793-1-C1C	Backscattering technique	
IEC 60793-1-A1A	Refracted near-field method	Refractive index profile
IEC 60793-1-A1B	Transverse interference method	
IEC 60793-1-A2	Near-field light distribution	
IEC 60793-1-C1C	Backscattering technique	Point defects
IEC 60793-1-C4	Transmitted or radiated light power	Optical continuity
IEC 60793-1-C1C	Backscattering technique	
IEC 60793-1-C5A	Phase-shift method	Chromatic dispersion
IEC 60793-1-C5B	Spectral group delay measurement in the time domain	
IEC 60793-1-C10A	Transmitted power monitoring	Change of optical transmittance during mechanical and environmental tests
IEC 60793-1-C10B	Backscattering monitoring	
Test methods of multimode fibres		
IEC 60793-1-C2A	Impulse response	Bandwidth
IEC 60793-1-C2B	Frequency response	
IEC 60793-1-C6	Far-field light distribution	Numerical aperture
Test methods of single-mode fibres		
IEC 60793-1-C3A	Expandable drum	Microbending sensitivity
IEC 60793-1-C3B	Fixed diameter drum	
IEC 60793-1-C11	Macrobending sensitivity	Macrobending sensitivity
IEC 60793-1-C5C	Differential phase shift	Chromatic dispersion
IEC 60793-1-C5D	Interferometry *	
IEC 60793-1-C7A	Cut-off wavelength	Fibre cut-off wavelength
IEC 60793-1-C7B	Cable cut-off wavelength (jumper cable cut-off wavelength) *	Cabled fibre cut-off wavelength
IEC 60793-1-C9A	Direct far-field scan	Mode field diameter
IEC 60793-1-C9B	Variable aperture in the far field	
IEC 60793-1-C9C	Near-field scan	
* Under consideration.		

12 Measuring methods for environmental characteristics

The ability of optical fibre cables to meet environmental requirements without deterioration of their mechanical or optical properties shall be verified by subjecting samples to tests selected from table 5. The tests applied, the relevant temperatures and conditions, the number of samples and acceptance criteria shall be as stated in the detail specification.

Table 5 – Measuring methods for environmental characteristics

Test method	Test	Characteristics covered by test method
IEC 60331 IEC 60332-1; IEC 60332-3 IEC 60754-1; IEC 60754-2 IEC 61034-1; IEC 61034-2	Fire performance	Cable performance under fire conditions
IEC 60794-1-2-F1	Temperature cycling	Climatic characteristics
IEC 60794-1-2-F3 *	Sheath integrity	Sheath defects
IEC 60794-1-2-F5	Water penetration	Resistance to water penetration
IEC 60794-1-2-F7	Nuclear radiation	Resistance to nuclear radiation
IEC 60794-1-2-F8	Pneumatic resistance	Gas pressurization
IEC 60794-1-2-F9 *	Ageing	Environmental exposure
IEC 60794-1-2-E5	Stripping force stability of cabled optical fibres	Fibre stripping
* Under consideration.		

13 Measuring methods for cable element characterization

The tests shown in table 6 are intended to characterize the different types of cable elements for splicing purposes.

Table 6 – Measuring methods for cable element characterization

Test method	Test	Characteristics covered by the test method
IEC 60794-1-2-G1 IEC 60794-1-2-G2 IEC 60794-1-2-G3 IEC 60794-1-2-G4 IEC 60794-1-2-G5 IEC 60794-1-2-G6 IEC 60794-1-2-G7	Bend test for cable element Ribbon dimensions and geometry – visual method Ribbon dimensions – aperture gauge Ribbon dimensions – dial gauge Ribbon tear (separability) Ribbon torsion Tube kinking	Splicing

Annex A (informative)

Guide for optical cables for short distance links

A.1 General

A.1.1 Object

This annex provides additional guidance relating to optical fibre cables for use in short distance links in communication equipment. It allows the establishment of uniform requirements for the geometrical, optical, transmission, mechanical and environmental properties of optical fibre cables.

A.1.2 Optical fibre categories

Optical fibre cables used in short distance links shall be equipped with the following optical fibres:

- a) A2 category: for distances of several hundred metres up to 2 km;
- b) A3 category: for distances of a few hundred metres up to 1 km;
- c) A4 category: for distances up to 100 m.

The characteristics of the optical fibres used shall be specified as stated in the relevant product specification.

A.2 Measuring methods for dimensions

NOTE – Measurements for optical fibre dimensions should be carried out using the methods specified in IEC 60793-1-2.

A.2.1 Diameter measuring method

The measuring methods for diameter dimensions are given in table 1 of this standard and are applicable for optical fibre cables for short distance links.

A.2.2 Length measurement

This standard specifies two types of length measurements: either by mechanical means or by delay of transmitted and/or reflected pulses, as specified in IEC 60793-1-2.

In the case of cable measurement on coil or reel, the second method (IEC 60793-1-A6) can be used. Currently, a well-calibrated high resolution echometer or OTDR (optical time domain reflectometer) would allow a precision of a few centimetres over a length of 100 m to be reached, for example.

A.3 Measuring methods for mechanical characteristics

When the cable is to be used without end connectors, the tests described in this standard are applicable.

When the cable is to be used with end connectors, tests are applied on the cable only and the combined tests on cable plus connector assembly are carried out according to IEC 61300.

A.3.1 Measuring methods for cable mechanical characteristics

- Tensile performance (IEC 60794-1-2-E1)
- Abrasion (IEC 60794-1-2-E2)
- Crush (IEC 60794-1-2-E3)
- Impact (IEC 60794-1-2-E4)
- Stripping force stability (IEC 60794-1-2-E5)
- Repeated bending (IEC 60794-1-2-E6)
- Torsion (IEC 60794-1-2-E7)
- Flexing (IEC 60794-1-2-E8)
- Kink (IEC 60794-1-2-E10)
- Bend (IEC 60794-1-2-E11)

A.3.2 Measuring methods for connector mechanical characteristics

- Visual examination (IEC 61300-3-1)
- Impact (IEC 61300-2-12)
- Engagement and separation forces (IEC 61300-3-11)
- Mating durability (IEC 61300-2-2)
- Vibration (IEC 61300-2-1)
- Tensile strength of coupling mechanism (IEC 61300-2-6)
- Fibre/cable retention (IEC 61300-2-4)
- Torsion/twist (IEC 61300-2-5)

A.4 Measuring methods for transmission and optical characteristics

A.4.1 Attenuation

The cut-back technique with modified launching conditions described in the note below gives accurate results on short-length fibres.

However, in the case of short fibre or cable measurement, the contribution of measurement error cannot be ignored because short fibre or cable loss is very close to the measurement error.

The insertion loss method can be used where accuracy is not important.