

# Optical fibre cables —

## Part 1-1: Generic specification — General

The European Standard EN 60794-1-1:2002 has the status of a  
British Standard

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# National foreword

This British Standard is the official English language version of EN 60794-1-1:2002. It is identical with IEC 60794-1-1:2001. It supersedes BS EN 60794-1-1:2000 and A1/2001 which are withdrawn. Together with BS EN 60794-1-2:2003 it supersedes BS EN 187000:1994 which is withdrawn.

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:

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**Optical fibre cables**  
**Part 1-1: Generic specification - General**  
(IEC 60794-1-1:1999)

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Partie 1-1: Spécification générique  
Généralités  
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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.

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

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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.

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## Endorsement notice

The text of the International Standard IEC 60794-1-1:1999 was approved by CENELEC as a European Standard 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 retention*

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)<br>Diameter of cladding<br>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)<br>Diameter of cladding<br>Non-circularities<br>Concentricity errors |
| IEC 60793-1-A3               | Side view light distribution for primary coating | Diameter of primary coating<br>Non-circularity of primary coating<br>Concentricity error of primary coating  |
| IEC 60793-1-A4               | Mechanical diameter measurement                  | Diameter of cladding<br>Diameter of primary coating<br>Diameter of buffer<br>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<br>IEC 60189-1 | Mechanical                                       | Thickness of insulation<br>Thickness of sheaths<br>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<br>IEC 60885-1 | Conductor resistance<br>Dielectric strength of insulation<br>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                                  | Macrobanding sensitivity                                        | Macrobanding 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<br>(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<br>IEC 60332-1; IEC 60332-3<br>IEC 60754-1; IEC 60754-2<br>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<br>IEC 60794-1-2-G2<br>IEC 60794-1-2-G3<br>IEC 60794-1-2-G4<br>IEC 60794-1-2-G5<br>IEC 60794-1-2-G6<br>IEC 60794-1-2-G7 | Bend test for cable element<br>Ribbon dimensions and geometry – visual method<br>Ribbon dimensions – aperture gauge<br>Ribbon dimensions – dial gauge<br>Ribbon tear (separability)<br>Ribbon torsion<br>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.