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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Optical fibre cables –
Part 3: Outdoor cables – Sectional specification

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60794-3:2014. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60794-3 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition: the ribbon specification has been removed, because it is covered in IEC 60794-1-31.

The text of this International Standard is based on the following documents:

Draft	Report on voting
86A/2155/FDIS	86A/2184/RVD

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The language used for the development of this International Standard is English.

A list of all parts in the IEC 60794 series, published under the general title *Optical fibre cables*, 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 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC 60794-1-21, IEC 60794-1-22, IEC 60794-1-23, and IEC 60794-1-24 have been (or will be) divided into multiple standards which defines one test method each. IEC 60794-1-2:2021 gives cross references between old standards and new standards.

OPTICAL FIBRE CABLES –

Part 3: Outdoor cables – Sectional specification

1 Scope

This part of IEC 60794 specifies the requirements for optical fibre cables and cable elements which are intended to be used externally in communications networks. Other types of applications requiring similar types of cables can be considered.

Requirements for cables to be used in ducts, for directly buried applications, aerial cables and cables for lake and river crossings are included in this document. Also included are cables for specialized use in sewers and in water and gas pipes.

For aerial application, this document does not cover all functional aspects of cables installed in the vicinity of overhead power lines. For such applications, additional requirements and test methods ~~may~~ can be necessary. Moreover, this document excludes optical ground wires and cables attached to the phase or earth conductors of overhead power lines.

For cables for lake and river crossings, this document does not cover methods of cable repair, nor repair capability, nor does it cover cables for use with underwater line amplifiers.

~~NOTE IEC TR 62839-1[1] gives rules to built an environmental declaration if needed.~~

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60708, *Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath*

IEC 60793-1-21, *Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry* ~~[1]~~

IEC 60793-1-32, *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*

IEC 60793-1-40, *Optical fibres – Part 1-40: ~~Measurement methods and test procedures –~~ Attenuation measurement methods*

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

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

~~[1] To be published.~~

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-21:2015, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods*[2]

IEC 60794-1-22, *Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods*

IEC 60794-1-23, *Optical fibre cables – Part 1-23: Generic specification – Basic optical cable test procedures – Cable elements test methods*

IEC 60811-202, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

IEC 60811-406, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: ~~General~~ Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-604:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 604: Physical tests – Measurement of absence of corrosive components in filling compounds*

IEC 60811-607, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 607: Physical tests – Test for the assessment of carbon black dispersion in polyethylene and polypropylene*

~~IEC TR 62690, *Hydrogen effects in optical fibre cables – Guidelines*~~

~~IEC TR 62691, *Optical fibre cables – Guide to the installation of optical fibre cables*~~

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in IEC 60794-1-1 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

[2] ~~To be published.~~

4 Optical fibre

4.1 General

Optical fibres shall be used which meet the requirements of IEC 60793-2. The fibre type shall be agreed between the customer and supplier.

4.2 Attenuation

4.2.1 Attenuation coefficient

The maximum cabled fibre attenuation coefficient shall conform to IEC 60794-1-1. Particular values may be agreed between the customer and supplier.

The attenuation coefficient shall be measured in accordance with IEC 60793-1-40.

4.2.2 Attenuation uniformity – Attenuation discontinuities

Attenuation uniformity shall conform to IEC 60794-1-1.

4.3 Cut-off wavelength

For single-mode fibre, the cabled fibre cut-off wavelength λ_{cc} shall be less than the operational wavelength, when measured in accordance with IEC 60793-1-44, and in conformity with IEC 60794-1-1.

4.4 Fibre colouring

If the primary coated fibres are coloured for identification, the coloured coating shall be readily identifiable throughout the lifetime of the cable and shall be a reasonable match to IEC 60304.

4.5 Polarization mode dispersion (PMD)

Cabled single-mode fibre PMD shall conform to IEC 60794-1-1.

5 Cable element

5.1 General

Generally, optical cables comprise several elements or individual constituents, depending on the cable design which takes into account the cable application, operating environment and manufacturing processes, as well as the need to protect the fibre during handling and cabling.

The material(s) used for a cable element shall be selected to be compatible with the other elements in contact with it. An appropriate compatibility test method shall be defined in the family or detail specification.

When the fibres are in contact with a filling compound, the compatibility of the filling compound with the fibre coating shall be demonstrated by testing coating stripping force stability after accelerated ageing in accordance with ~~IEC 60794-1-21, Method E5~~ IEC 60794-1-23, method G10A, G10B, or G10C[3] method A, B, and C). Aging condition should be in accordance with IEC 60794-1-22, method F9[4], but alternative ageing conditions and tests may be agreed between the customer and supplier.

[3] These are intented to be replaced. See Introduction.

[4] This is intented to be replaced. See Introduction.

Optical elements are cable elements containing optical fibres and are designed to be a primary functional unit of the cable core. They may comprise any of the cable elements described in 5.2 to 5.7. Optical elements and each fibre within a cable element shall be uniquely identified, for example by colours, a positional configuration, markings, tapes, threads or as specified in the detail specification.

Tests may be performed on cable elements either in uncabled form or in a finished cable. Unless otherwise specified, testing shall be performed on cable elements in a finished cable. This means that testing shall be performed only on a finished cable if the cable element manufacturing operation is done by the same manufacturer as the cabling operation. Testing shall be performed on cable elements only if the cable element is supplied by a third party; this does not exclude testing of the finished cable.

Different types of optical elements are described in 5.2 to 5.7 and in IEC 60794-1-3.

5.2 Tight secondary coating or buffer

If a tight secondary coating is required, it shall consist of one or more layers of polymeric material. The coating shall be easily removable for splicing. For tight buffers, the buffer and fibre primary coating shall be removable in one operation over a length of 10 mm to 25 mm, depending on customer requirements. The nominal overall diameter of the secondary coating shall be between 800 µm and 900 µm. The value, which shall be agreed between the customer and supplier, shall have a tolerance of ±50 µm. The fibre/secondary coating eccentricity shall not exceed 75 µm, unless otherwise agreed between the customer and supplier.

The colour of the tight secondary coating shall be readily identifiable throughout the life-time of the cable and shall be a reasonable match to IEC 60304.

5.3 Ruggedized fibre

Further protection can be provided to tight secondary coated fibres by surrounding one or more with non-metallic strength members within a sheath of suitable material (e.g. for fan-out cables).

5.4 Slotted core

The slotted core is obtained by extruding a suitable material (for example polyethylene or polypropylene) with a defined number of slots, providing helical or SZ configuration along the core. One or more primary coated fibres or optical element is located in each slot which may be filled by compound.

The slotted core usually contains a central element which may be either metallic or non-metallic. In this case, there shall be adequate adhesion between the central element and the extruded core in order to obtain the required temperature stability and tensile behaviour for the slotted core element.

The profile of the slot shall be uniform and shall ensure the optical and mechanical performance required of the optical cable.

5.5 Polymeric tube

One or more primary coated fibres or other optical elements are packaged (loosely or not) in a tube construction which may be filled by compound. The tube may be reinforced with a composite wall. The polymeric tube may be hard, to provide some crush protection to the fibre bundle, or soft to enable easy strippability of the tube without specialized tools.

If required, the suitability of the tube shall be determined by an evaluation of its kink resistance in accordance with IEC 60794-1-23, method G7[5].

If used, the filling compound in the tube shall comply with IEC 60794-1-21:2015, method E15. The filled tube shall comply with ~~IEC 60794-1-21, Method E14~~ IEC 60794-1-22, method F16[6], when tested in tube or cabled form.

5.6 Ribbon

~~5.6.1 General~~

~~Optical fibre ribbons are optical fibres assembled in a composite linear array.~~

~~Fibres shall be arranged in parallel and formed into ribbons of typically 4, 6, 8, 12, 24 or 36 fibres each according to user requirements. The fibres within the ribbons shall remain parallel and not cross over.~~

~~The design intent is that adjacent fibres within a ribbon are contiguous and that fibre centre lines are straight, parallel and coplanar.~~

~~Unless otherwise specified, each ribbon shall be uniquely identified with a printed legend or by uniquely colouring the reference fibre in the ribbon and/or by colouring the matrix material of the ribbon.~~

~~Some parameters shall be measured in the ribbon since the corresponding tests on the primary coated fibre or finished cable are not sufficient for complete characterization. These parameters are identified below.~~

~~5.6.2 Dimensions~~

~~Unless otherwise specified in the detail specification, the maximum dimensions and the structural geometry of optical fibre ribbons shall be as shown in Table 1.~~

~~**Table 1 – Maximum dimensions of optical fibre ribbons**~~

			~~Fibre alignment~~	
	~~Width~~	~~Height~~	~~Extreme fibres~~	~~Planarity~~
~~Number of fibres~~ [a]	~~w~~	~~h~~	~~b~~	~~p~~
	~~µm~~	~~µm~~	~~µm~~	~~µm~~
~~4~~	~~1 220~~	~~360~~	~~786~~	~~50~~
~~6~~	~~1 648~~	~~360~~	~~1 310~~	~~50~~
~~8~~	~~2 172~~	~~360~~	~~1 834~~	~~50~~
~~12~~	~~3 220~~	~~360~~	~~2 882~~	~~75~~
~~24~~	~~6 500~~	~~360~~	~~Per 12f unit~~ [a]	~~Per 12f uni~~ [a]
~~36~~	~~9 800~~	~~360~~	~~Per 12f unit~~ [a]	~~Per 12f unit~~ [a]
~~[a] Per unit values are measured with the ribbon separated into the intended sub-units.~~				

5 This is intented to be replaced. See Introduction.

6 This is intented to be replaced. See Introduction.

~~More stringent requirements may need to be agreed between the customer and supplier, depending on the splice or the connector technique employed.~~

~~The dimensions and structural geometry can be verified with a type test, described as the visual measurement method (IEC 60794-1-23, Method G2) to establish and ensure proper control of the ribbon manufacturing process. Once the process is established, and in order to ensure functional performance, the width and height of the ribbons may be controlled and verified, for final inspection purposes, with an aperture gauge (IEC 60794-1-23, Method G3) or a dial gauge (IEC 60794-1-23, Method G4) or by the visual measurement methods.~~

~~**5.6.3 Mechanical requirements**~~

~~**5.6.3.1 Separability of individual fibres from a ribbon**~~

~~If fibre breakout capability is required, the ribbons shall be constructed in such a way that fibres can be separated from the ribbon construction, into sub-units or individual optical fibres, while meeting the following criteria:~~

~~a) the ribbon shall be tested for the ability to break out individual fibres using the tear (separability) test shown in IEC 60794-1-23, Method G5, or a method agreed upon between the customer and supplier;~~

~~b) breakout shall be accomplished without specialized tools or apparatus;~~

~~c) the fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance;~~

~~d) any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.~~

~~**5.6.3.2 Ribbon stripping**~~

~~The coating of individual fibres as well as the residual ribbon bonding material shall be easily removable. The method of removal shall be agreed between the customer and supplier or shall be defined in the detail specification.~~

~~**5.6.3.3 Torsion**~~

~~The mechanical and functional integrity of a fibre ribbon can be verified by carrying out the torsion test shown in IEC 60794-1-23, Method G6.~~

Optical fibre ribbons are optical fibres assembled in a composite linear array.

Ribbon structure, dimensions, mechanical requirements, and identification are specified in IEC 60794-1-31.

5.7 Metallic tube

5.7.1 Metallic tube on the optical core

A metallic tube (for example, aluminium tube) may be applied over the optical core (for example, aluminium spacer or stranded tube).

5.7.2 Fibres directly located in a metallic tube

One or more primary coated and coloured fibres are packaged in a metallic hermetically sealed tube, which shall be filled, if necessary, with a suitable compound to avoid water penetration.

The inside surface of the tube should be smooth without any defects.

6 Optical fibre cable construction

6.1 General

The intention is that the cable should be designed and manufactured for a predicted operating lifetime of at least 20 years. In this context, the attenuation of the installed cable at the operational wavelength(s) shall not exceed values agreed between the customer and supplier. The tests of this document are intended to assess the performance of cables, as manufactured and under agreed ageing and performance-limit tests. These tests are not intended to define end-of-life performance, but may be used as agreed between customer and supplier to predict such performance. The materials in the cable shall not present a health hazard within its intended use.

The fibres in the cables are usually of the same type, but some cables may contain multiple specified fibre types and fibres of the same type may have different origins.

There shall be no fibre splice in a delivery length, unless otherwise agreed by the customer and supplier.

It shall be possible to identify each individual fibre throughout the length of the cable.

For the particular case of cables for aerial application, to avoid excess fibre strain induced by the environmental conditions, such as wind loading or ice loading, the cable construction, and particularly the strength members, shall be selected to limit this strain to the value agreed between the customer and supplier.

6.2 Lay-up of the cable elements

Optical elements as described in Clause 5 may be laid up as follows:

a) optical element(s) without a stranding lay;

b) a number of homogeneous optical elements using helical or SZ configurations (ribbon elements may be laid up by stacking two or more elements);

c) a number of different configurations in slotted core such as tight coated, ribbon or tube;

d) a number of different configurations in a tube such as tight coated or ribbon;

e) if required, insulated copper conductors in single, pair or quad construction may be laid up with the optical elements.

6.3 Cable core filling

If specified, the element(s) and, in addition, the cable core shall contain water blocking material, such as ~~grease-like~~ filling and~~/~~ flooding compounds or dry ~~block~~ swellable water blocking materials, to prevent longitudinal water penetration in accordance with IEC 60794-1-22, method F5[7]. The material shall be easily removed without the use of substances considered to be hazardous or dangerous. The ~~grease-like~~ filling compound shall comply with ~~IEC 60794-1-21, Method E15~~ IEC 60794-1-23, method G9[8]. The cable shall pass the compound flow test of ~~Method E14 of IEC 60794-1-21~~ IEC 60794-1-22, method F16.

The blocking material used shall be compatible with the other relevant cable elements. Where a grease-like filling compound is used in cables containing metallic elements, it shall be tested for the presence of corrosive compounds in accordance with Clause ~~8~~ 4 of IEC 60811-604:2012.

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7 This is intented to be replaced. See Introduction.

8 This is intented to be replaced. See Introduction.

6.4 Strength member

The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibres are not subjected to strain in excess of limits agreed between the customer and supplier.

The strength member may be either metallic or non-metallic and may be located in the cable core and/or under the sheath and/or in the sheath.

If required, the aerial cable shall be equipped with a separate suspension strand. The location and the type of suspension strand depend on the installation practice and environmental conditions and shall be determined by agreement between the customer and supplier.

For example, the suspension strand and the cable core may form a "figure 8" construction or the cable may be fastened to a separate suspension strand by lashing or by other suitable means.

6.5 Moisture barrier

If specified, a moisture barrier shall be provided either by a continuous metallic sheath or by a metallic tape applied over the cable core with a longitudinal overlap and bonded to the sheath.

Alternatively, other constructions may be adopted by agreement between the customer and supplier.

In the case of a continuous metallic sheath, the material and its thickness shall be agreed between the customer and supplier.

Metallic materials that may be used include, but are not limited to, coated and uncoated aluminium and steel, copper and copper alloys. These metals may be either flat or corrugated as designated by the detail specification. Splicing of metallic tapes may be allowed, provided electrical continuity is ensured in the finished cable.

In the case of an aluminium moisture barrier tape, the thickness of the aluminium tape, the amount of overlap and the adhesion of the aluminium tape to the sheath shall be in accordance with IEC 60708. The tape may have a reduced nominal thickness by agreement between the user and the manufacturer. The effectiveness of the moisture barrier may be proved by an alternative test with agreement between the customer and supplier.

6.6 Cable sheath and armouring

6.6.1 Inner sheath

A cable inner sheath may be applied by agreement between the customer and supplier. When required for a specific construction, or for manufacturing purposes, cable cores or sub-units within the core, or both, may be covered by inner sheaths. Unless otherwise specified, the inner sheath shall be made of polyethylene.

6.6.2 Armouring

Where additional tensile strength or protection from external damage is required, armouring shall be provided (for example, corrugated steel tape or steel wire armour).

6.6.3 Outer sheath

6.6.3.1 General

The cable shall have a seamless sheath made of UV-stabilized weather-resistant ~~polyethylene, containing~~ material. In case of a black sheath, carbon black may be used and, in that case, the

material shall contain 2,0 % minimum well dispersed carbon black in accordance with IEC 60811-607, unless otherwise agreed between the customer and supplier. UV resistance can also be achieved through the use of other polymers and UV-stabilized master batches. The use of these types shall be agreed between the customer and supplier.

The sheath thickness (tested in accordance with IEC 60811-202) and cable overall diameter (tested in accordance with IEC 60811-203) and its variations shall take into account the installation conditions and shall be determined by the relevant specification or by agreement between the customer and supplier.

6.6.3.2 Tensile strength and elongation

In case of a polyethylene sheath, when tested in accordance with IEC 60811-501, the measured values of tensile strength shall be not less than

a) 10 MPa for low- or linear-low-density polyethylene,

b) 12,0 MPa for medium-density polyethylene, and

c) 16,5 MPa for high-density polyethylene.

The measured values of elongation at break shall be not less than 300 %.

Requirements for other material than PE, such as PP or PA, shall be agreed between customer and supplier.

6.6.3.3 Elongation at break after ageing

The mechanical characteristics of the sheath shall remain sufficiently constant during normal use. This is checked by determining the elongation at break according to IEC 60811-501 after an ageing test at 100 °C ± 2 °C for 10 × 24 h according to IEC 60811-401. The median of the values of elongation at break shall be not less than 300 %.

6.6.3.4 Resistance to environmental stress cracking

The resistance to environmental stress cracking shall comply with the requirements of IEC 60811-406. ~~Procedure~~ Method B shall be applied.

6.6.3.5 Outer protection of cables for lake and river crossings

The outer protection may be either a layer of polypropylene roves or an outer sheath of polyethylene or appropriate materials. The particular outer sheath shall be agreed between the customer and supplier.

If required, the outermost layer shall have a contrasting colour incorporated to facilitate visibility of cable movement during installation and maintenance operations.

6.7 Sheath marking

If required, the cable shall be marked by a method agreed between the customer and supplier. Common methods of marking are embossing, sintering, imprinting, hot foil and surface printing.

The information given in the marking text may include cable length, the number of fibres, fibre type, manufacturer's name and the date of manufacture.

The characters shall be spaced at intervals of not more than 1 m. The actual length of the cable shall be within $^{+1}_{0}$ % of the length indicated by the length marking. For example, 1 000 m of cable, if the starting sheath length mark was 0, should have a final sheath mark in the range 990 m to 1 000 m. Occasional illegible markings are permitted, provided that a legible mark is

located within 5 m of the illegible mark. Cables may be remarked in a second contrasting colour, if the first marking process is unsuccessful.

Marking may be provided as a single or double line of marking. A single line of marking shall be provided by marking longitudinally along the length of the cable. A double line of marking shall be provided with the two lines diametrically opposite each other, longitudinally along the length of the cable.

The abrasion resistance of the sheath markings shall be demonstrated in accordance with IEC 60794-1-21, method E2B[9].

For a double line of marking, the abrasion resistance test needs only be carried out on one line of marking.

~~**6.8 Hydrogen gas**~~

~~An informative guideline is given in IEC TR 62690.~~

7 Installation and operating conditions

Installation and operating conditions shall be agreed between the customer and supplier. Guidance is given in IEC TR 62691.

8 Characterization of cable elements

~~The following tests , as indicated in Table 2, are intended to characterize the different types of cable elements.~~

The tests indicated in Table 1 shall be used to characterize the different types of cable elements.

9 This is intented to be replaced. See Introduction.

Table 1 – Characteristics of different types of cable elements

Characteristics	Family requirements in this document	Test methods [a]	Remarks
Dimensions	5.2	IEC 60793-1-21	Secondary coating
Dimensions	5.3, 5.4, 5.6, 5.7	IEC 60811-202 and IEC 60811-203	Tight buffer, tube, slotted core and ruggedized elements
Dimensions	5.6	IEC 60794-1-23, methods G2 or G3 ~~or G4~~	Ribbon
Bend		IEC 60794-1-23, method G1	Secondary coating, tight buffer, tube
Strippability	5.2	IEC 60793-1-32	Primary or secondary fibre coatings and tight buffers
Strippability	5.6	As agreed between supplier and manufacturer	Ribbon
Separability of individual fibres from ribbon	5.6	IEC 60794-1-23, method G5	Ribbon
Kink	5.5	IEC 60794-1-23, method G7	Tube
Torsion	5.6	IEC 60794-1-23, method G6	Ribbon
Compound flow	5.5	~~IEC 60794-1-21, method E14~~ IEC 60794-1-22, method F16	Tube

[a] Some of these methods are under revision. See Introduction.

9 Optical fibre cable tests

Compliance with specification requirements shall be verified by carrying out tests as required by the relevant family or detail specification. Suitable tests are detailed in Table 2. It is not intended that all tests shall be carried out; the frequency of testing shall be agreed between the customer and supplier.

Guidance on qualification sampling and interpretation of test results are given in IEC 60794-1-1. The number of fibres tested shall be representative of the cable design and shall be agreed between the customer and supplier.

For some tests applicable to "figure 8" constructions, the tests shall be carried out with the suspension strand. If required by certain installation practices, the "figure 8" cable shall also be tested without the suspension strand.

Depending on the cable construction and its operational environment, hydrogen induced effects may be warranted. An informative guideline for hydrogen effects is given in IEC TR 62690.

Table 2 – Mechanical and environmental applicable tests

Characteristics	Family requirements	Test methods [a]	Remarks
Tensile performance		IEC 60794-1-21, method E1	
Sheath abrasion resistance		IEC 60794-1-21, method E2A	
Crush		IEC 60794-1-21, method E3	
Impact		IEC 60794-1-21, method E4	
Repeated bending		IEC 60794-1-21, method E6	
Torsion		IEC 60794-1-21, method E7	
Kink		IEC 60794-1-21, method E10	
Bend		IEC 60794-1-21, method E11	
Shotgun ~~resistance~~ damage		IEC 60794-1-21, method E13	Aerial cables with specific shotgun protection
Bending under tension		IEC 60794-1-21, method E18A	
Aeolian vibration		IEC 60794-1-21, method E19	Longspan aerial cables
Coiling performance		IEC 60794-1-21, method E20	Lake and river crossings
Temperature cycling		IEC 60794-1-22, method F1	
Water penetration		IEC 60794-1-22, method F5B or F5C	Water-blocked cables
Pneumatic resistance		IEC 60794-1-22, method F8	Unfilled cables protected by pressurisation
Ageing		IEC 60794-1-22, method F9	
Hydrostatic pressure		IEC 60794-1-22, method F10	Lake and river crossings
Ribbon stripping		~~IEC 60794-1-21 Method E5B~~ IEC 60794-1-23, method G10B	Ribbon cables
[a] The following methods are under revision. See Introduction.			

10 Quality assurance

It is the responsibility of the manufacturer to establish quality assurance by quality control procedures which ensure that the product meets the requirements of this document. When the customer wishes to specify acceptance tests to other quality procedures, it is essential that an agreement is reached between the customer and supplier at the time of ordering.

Bibliography

~~IEC TR 61282-3, *Fibre optic communication system design guides – Part 3: Calculation of link polarization mode dispersion*~~

IEC 60794-1-2:2021, *Optical fibre cables – Part 1-2: General specification – Basic optical test procedures – General guidance*

IEC 60794-1-24, *Optical fibre cables – Part 1-24: Generic specification – Basic optical cable test procedures – Electrical test methods*[10]

IEC 60794-1-3, *Optical fibre cables – Part 1-3: Generic specification – Optical cable elements*

IEC 60794-1-31, *Optical fibre cables – Part 1-31: Generic specification – Optical cable elements – Optical fibre ribbon*

IEC TR 62690, *Hydrogen effects in optical fibre cables – Guidelines*

IEC TR 62691, *Optical fibre cables – Guidelines to the installation of optical fibre cables*

IEC TR 62839-1, *Environmental declaration – Part 1: ~~Wires and cables and accessories products specific rules~~* [11] *Wires, cables and accessory products – Specific rules*

IEC TR 62959, *Optical fibre cables – Shrinkage effects on cable and cable element end termination – Guidance*

IEC TR 63194, *Guidance on colour coding of optical fibre cables*

[10] This publication has been withdrawn.

[11] ~~To be published.~~

IEC 60794-3

Edition 5.0 2022-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Optical fibre cables –
Part 3: Outdoor cables – Sectional specification

Câbles à fibres optiques –
Partie 3: Câbles extérieurs – Spécification intermédiaire

IEC 60794-3:2022-02(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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OPTICAL FIBRE CABLES –

Part 3: Outdoor cables – Sectional specification

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 60794-3 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition: the ribbon specification has been removed, because it is covered in IEC 60794-1-31.

The text of this International Standard is based on the following documents:

Draft	Report on voting
86A/2155/FDIS	86A/2184/RVD

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The language used for the development of this International Standard is English.

A list of all parts in the IEC 60794 series, published under the general title *Optical fibre cables*, 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 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.

INTRODUCTION

IEC 60794-1-21, IEC 60794-1-22, IEC 60794-1-23, and IEC 60794-1-24 have been (or will be) divided into multiple standards which defines one test method each. IEC 60794-1-2:2021 gives cross references between old standards and new standards.

OPTICAL FIBRE CABLES –

Part 3: Outdoor cables – Sectional specification

1 Scope

This part of IEC 60794 specifies the requirements for optical fibre cables and cable elements which are intended to be used externally in communications networks. Other types of applications requiring similar types of cables can be considered.

Requirements for cables to be used in ducts, for directly buried applications, aerial cables and cables for lake and river crossings are included in this document. Also included are cables for specialized use in sewers and in water and gas pipes.

For aerial application, this document does not cover all functional aspects of cables installed in the vicinity of overhead power lines. For such applications, additional requirements and test methods can be necessary. Moreover, this document excludes optical ground wires and cables attached to the phase or earth conductors of overhead power lines.

For cables for lake and river crossings, this document does not cover methods of cable repair, nor repair capability, nor does it cover cables for use with underwater line amplifiers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60708, *Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath*

IEC 60793-1-21, *Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry*

IEC 60793-1-32, *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*

IEC 60793-1-40, *Optical fibres – Part 1-40: Attenuation measurement methods*

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

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

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-21:2015, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods*

IEC 60794-1-22, *Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods*

IEC 60794-1-23, *Optical fibre cables – Part 1-23: Generic specification – Basic optical cable test procedures – Cable elements test methods*

IEC 60811-202, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

IEC 60811-406, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-604:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 604: Physical tests – Measurement of absence of corrosive components in filling compounds*

IEC 60811-607, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 607: Physical tests – Test for the assessment of carbon black dispersion in polyethylene and polypropylene*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in IEC 60794-1-1 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

4 Optical fibre

4.1 General

Optical fibres shall be used which meet the requirements of IEC 60793-2. The fibre type shall be agreed between the customer and supplier.

4.2 Attenuation

4.2.1 Attenuation coefficient

The maximum cabled fibre attenuation coefficient shall conform to IEC 60794-1-1. Particular values may be agreed between the customer and supplier.

The attenuation coefficient shall be measured in accordance with IEC 60793-1-40.

4.2.2 Attenuation uniformity – Attenuation discontinuities

Attenuation uniformity shall conform to IEC 60794-1-1.

4.3 Cut-off wavelength

For single-mode fibre, the cabled fibre cut-off wavelength λ_{cc} shall be less than the operational wavelength, when measured in accordance with IEC 60793-1-44, and in conformity with IEC 60794-1-1.

4.4 Fibre colouring

If the primary coated fibres are coloured for identification, the coloured coating shall be readily identifiable throughout the lifetime of the cable and shall be a reasonable match to IEC 60304.

4.5 Polarization mode dispersion (PMD)

Cabled single-mode fibre PMD shall conform to IEC 60794-1-1.

5 Cable element

5.1 General

Generally, optical cables comprise several elements or individual constituents, depending on the cable design which takes into account the cable application, operating environment and manufacturing processes, as well as the need to protect the fibre during handling and cabling.

The material(s) used for a cable element shall be selected to be compatible with the other elements in contact with it. An appropriate compatibility test method shall be defined in the family or detail specification.

When the fibres are in contact with a filling compound, the compatibility of the filling compound with the fibre coating shall be demonstrated by testing coating stripping force stability after accelerated ageing in accordance with IEC 60794-1-23, method G10A, G10B, or G10C[1] method A, B, and C). Aging condition should be in accordance with IEC 60794-1-22, method F9[2], but alternative ageing conditions and tests may be agreed between the customer and supplier.

Optical elements are cable elements containing optical fibres and are designed to be a primary functional unit of the cable core. They may comprise any of the cable elements described in 5.2 to 5.7. Optical elements and each fibre within a cable element shall be uniquely identified, for example by colours, a positional configuration, markings, tapes, threads or as specified in the detail specification.

Tests may be performed on cable elements either in uncabled form or in a finished cable. Unless otherwise specified, testing shall be performed on cable elements in a finished cable. This means that testing shall be performed only on a finished cable if the cable element manufacturing operation is done by the same manufacturer as the cabling operation. Testing shall be performed on cable elements only if the cable element is supplied by a third party; this does not exclude testing of the finished cable.

Different types of optical elements are described in 5.2 to 5.7 and in IEC 60794-1-3.

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1 These are intented to be replaced. See Introduction.

2 This is intented to be replaced. See Introduction.

5.2 Tight secondary coating or buffer

If a tight secondary coating is required, it shall consist of one or more layers of polymeric material. The coating shall be easily removable for splicing. For tight buffers, the buffer and fibre primary coating shall be removable in one operation over a length of 10 mm to 25 mm, depending on customer requirements. The nominal overall diameter of the secondary coating shall be between 800 µm and 900 µm. The value, which shall be agreed between the customer and supplier, shall have a tolerance of ±50 µm. The fibre/secondary coating eccentricity shall not exceed 75 µm, unless otherwise agreed between the customer and supplier.

The colour of the tight secondary coating shall be readily identifiable throughout the life-time of the cable and shall be a reasonable match to IEC 60304.

5.3 Ruggedized fibre

Further protection can be provided to tight secondary coated fibres by surrounding one or more with non-metallic strength members within a sheath of suitable material (e.g. for fan-out cables).

5.4 Slotted core

The slotted core is obtained by extruding a suitable material (for example polyethylene or polypropylene) with a defined number of slots, providing helical or SZ configuration along the core. One or more primary coated fibres or optical element is located in each slot which may be filled by compound.

The slotted core usually contains a central element which may be either metallic or non-metallic. In this case, there shall be adequate adhesion between the central element and the extruded core in order to obtain the required temperature stability and tensile behaviour for the slotted core element.

The profile of the slot shall be uniform and shall ensure the optical and mechanical performance required of the optical cable.

5.5 Polymeric tube

One or more primary coated fibres or other optical elements are packaged (loosely or not) in a tube construction which may be filled by compound. The tube may be reinforced with a composite wall. The polymeric tube may be hard, to provide some crush protection to the fibre bundle, or soft to enable easy strippability of the tube without specialized tools.

If required, the suitability of the tube shall be determined by an evaluation of its kink resistance in accordance with IEC 60794-1-23, method G7[3].

If used, the filling compound in the tube shall comply with IEC 60794-1-21:2015, method E15. The filled tube shall comply with IEC 60794-1-22, method F16[4], when tested in tube or cabled form.

5.6 Ribbon

Optical fibre ribbons are optical fibres assembled in a composite linear array.

Ribbon structure, dimensions, mechanical requirements, and identification are specified in IEC 60794-1-31.

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[3] This is intented to be replaced. See Introduction.

[4] This is intented to be replaced. See Introduction.

5.7 Metallic tube

5.7.1 Metallic tube on the optical core

A metallic tube (for example, aluminium tube) may be applied over the optical core (for example, aluminium spacer or stranded tube).

5.7.2 Fibres directly located in a metallic tube

One or more primary coated and coloured fibres are packaged in a metallic hermetically sealed tube, which shall be filled, if necessary, with a suitable compound to avoid water penetration.

The inside surface of the tube should be smooth without any defects.

6 Optical fibre cable construction

6.1 General

The intention is that the cable should be designed and manufactured for a predicted operating lifetime of at least 20 years. In this context, the attenuation of the installed cable at the operational wavelength(s) shall not exceed values agreed between the customer and supplier. The tests of this document are intended to assess the performance of cables, as manufactured and under agreed ageing and performance-limit tests. These tests are not intended to define end-of-life performance, but may be used as agreed between customer and supplier to predict such performance. The materials in the cable shall not present a health hazard within its intended use.

The fibres in the cables are usually of the same type, but some cables may contain multiple specified fibre types and fibres of the same type may have different origins.

There shall be no fibre splice in a delivery length, unless otherwise agreed by the customer and supplier.

It shall be possible to identify each individual fibre throughout the length of the cable.

For the particular case of cables for aerial application, to avoid excess fibre strain induced by the environmental conditions, such as wind loading or ice loading, the cable construction, and particularly the strength members, shall be selected to limit this strain to the value agreed between the customer and supplier.

6.2 Lay-up of the cable elements

Optical elements as described in Clause 5 may be laid up as follows:

a) optical element(s) without a stranding lay;

b) a number of homogeneous optical elements using helical or SZ configurations (ribbon elements may be laid up by stacking two or more elements);

c) a number of different configurations in slotted core such as tight coated, ribbon or tube;

d) a number of different configurations in a tube such as tight coated or ribbon;

e) if required, insulated copper conductors in single, pair or quad construction may be laid up with the optical elements.

6.3 Cable core filling

If specified, the element(s) and, in addition, the cable core shall contain water blocking material, such as filling and flooding compounds or dry swellable water blocking materials, to prevent longitudinal water penetration in accordance with IEC 60794-1-22, method F5[5]. The material shall be easily removed without the use of substances considered to be hazardous or dangerous. The filling compound shall comply with IEC 60794-1-23, method G9[6]. The cable shall pass the compound flow test of IEC 60794-1-22, method F16.

The blocking material used shall be compatible with the other relevant cable elements. Where a grease-like filling compound is used in cables containing metallic elements, it shall be tested for the presence of corrosive compounds in accordance with Clause 4 of IEC 60811-604:2012.

6.4 Strength member

The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibres are not subjected to strain in excess of limits agreed between the customer and supplier.

The strength member may be either metallic or non-metallic and may be located in the cable core and/or under the sheath and/or in the sheath.

If required, the aerial cable shall be equipped with a separate suspension strand. The location and the type of suspension strand depend on the installation practice and environmental conditions and shall be determined by agreement between the customer and supplier.

For example, the suspension strand and the cable core may form a "figure 8" construction or the cable may be fastened to a separate suspension strand by lashing or by other suitable means.

6.5 Moisture barrier

If specified, a moisture barrier shall be provided either by a continuous metallic sheath or by a metallic tape applied over the cable core with a longitudinal overlap and bonded to the sheath.

Alternatively, other constructions may be adopted by agreement between the customer and supplier.

In the case of a continuous metallic sheath, the material and its thickness shall be agreed between the customer and supplier.

Metallic materials that may be used include, but are not limited to, coated and uncoated aluminium and steel, copper and copper alloys. These metals may be either flat or corrugated as designated by the detail specification. Splicing of metallic tapes may be allowed, provided electrical continuity is ensured in the finished cable.

In the case of an aluminium moisture barrier tape, the thickness of the aluminium tape, the amount of overlap and the adhesion of the aluminium tape to the sheath shall be in accordance with IEC 60708. The tape may have a reduced nominal thickness by agreement between the user and the manufacturer. The effectiveness of the moisture barrier may be proved by an alternative test with agreement between the customer and supplier.

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5 This is intented to be replaced. See Introduction.

6 This is intented to be replaced. See Introduction.

6.6 Cable sheath and armouring

6.6.1 Inner sheath

A cable inner sheath may be applied by agreement between the customer and supplier. When required for a specific construction, or for manufacturing purposes, cable cores or sub-units within the core, or both, may be covered by inner sheaths. Unless otherwise specified, the inner sheath shall be made of polyethylene.

6.6.2 Armouring

Where additional tensile strength or protection from external damage is required, armouring shall be provided (for example, corrugated steel tape or steel wire armour).

6.6.3 Outer sheath

6.6.3.1 General

The cable shall have a seamless sheath made of UV-stabilized weather-resistant material. In case of a black sheath, carbon black may be used and, in that case, the material shall contain 2,0 % minimum well dispersed carbon black in accordance with IEC 60811-607, unless otherwise agreed between the customer and supplier. UV resistance can also be achieved through the use of other polymers and UV-stabilized master batches. The use of these types shall be agreed between the customer and supplier.

The sheath thickness (tested in accordance with IEC 60811-202) and cable overall diameter (tested in accordance with IEC 60811-203) and its variations shall take into account the installation conditions and shall be determined by the relevant specification or by agreement between the customer and supplier.

6.6.3.2 Tensile strength and elongation

In case of a polyethylene sheath, when tested in accordance with IEC 60811-501, the measured values of tensile strength shall be not less than

a) 10 MPa for low- or linear-low-density polyethylene,

b) 12,0 MPa for medium-density polyethylene, and

c) 16,5 MPa for high-density polyethylene.

The measured values of elongation at break shall be not less than 300 %.

Requirements for other material than PE, such as PP or PA, shall be agreed between customer and supplier.

6.6.3.3 Elongation at break after ageing

The mechanical characteristics of the sheath shall remain sufficiently constant during normal use. This is checked by determining the elongation at break according to IEC 60811-501 after an ageing test at 100 °C ± 2 °C for 10 × 24 h according to IEC 60811-401. The median of the values of elongation at break shall be not less than 300 %.

6.6.3.4 Resistance to environmental stress cracking

The resistance to environmental stress cracking shall comply with the requirements of IEC 60811-406. Method B shall be applied.

6.6.3.5 Outer protection of cables for lake and river crossings

The outer protection may be either a layer of polypropylene roves or an outer sheath of polyethylene or appropriate materials. The particular outer sheath shall be agreed between the customer and supplier.

If required, the outermost layer shall have a contrasting colour incorporated to facilitate visibility of cable movement during installation and maintenance operations.

6.7 Sheath marking

If required, the cable shall be marked by a method agreed between the customer and supplier. Common methods of marking are embossing, sintering, imprinting, hot foil and surface printing.

The information given in the marking text may include cable length, the number of fibres, fibre type, manufacturer's name and the date of manufacture.

The characters shall be spaced at intervals of not more than 1 m. The actual length of the cable shall be within $^{+1}_{0}$ % of the length indicated by the length marking. For example, 1 000 m of cable, if the starting sheath length mark was 0, should have a final sheath mark in the range 990 m to 1 000 m. Occasional illegible markings are permitted, provided that a legible mark is located within 5 m of the illegible mark. Cables may be remarked in a second contrasting colour, if the first marking process is unsuccessful.

Marking may be provided as a single or double line of marking. A single line of marking shall be provided by marking longitudinally along the length of the cable. A double line of marking shall be provided with the two lines diametrically opposite each other, longitudinally along the length of the cable.

The abrasion resistance of the sheath markings shall be demonstrated in accordance with IEC 60794-1-21, method E2B[7].

For a double line of marking, the abrasion resistance test needs only be carried out on one line of marking.

7 Installation and operating conditions

Installation and operating conditions shall be agreed between the customer and supplier. Guidance is given in IEC TR 62691.

8 Characterization of cable elements

The tests indicated in Table 1 shall be used to characterize the different types of cable elements.

7 This is intented to be replaced. See Introduction.

Table 1 – Characteristics of different types of cable elements

Characteristics	Family requirements in this document	Test methods [a]	Remarks
Dimensions	5.2	IEC 60793-1-21	Secondary coating
Dimensions	5.3, 5.4, 5.6, 5.7	IEC 60811-202 and IEC 60811-203	Tight buffer, tube, slotted core and ruggedized elements
Dimensions	5.6	IEC 60794-1-23, methods G2 or G3	Ribbon
Bend		IEC 60794-1-23, method G1	Secondary coating, tight buffer, tube
Strippability	5.2	IEC 60793-1-32	Primary or secondary fibre coatings and tight buffers
Strippability	5.6	As agreed between supplier and manufacturer	Ribbon
Separability of individual fibres from ribbon	5.6	IEC 60794-1-23, method G5	Ribbon
Kink	5.5	IEC 60794-1-23, method G7	Tube
Torsion	5.6	IEC 60794-1-23, method G6	Ribbon
Compound flow	5.5	IEC 60794-1-22, method F16	Tube
[a] Some of these methods are under revision. See Introduction.			

9 Optical fibre cable tests

Compliance with specification requirements shall be verified by carrying out tests as required by the relevant family or detail specification. Suitable tests are detailed in Table 2. It is not intended that all tests shall be carried out; the frequency of testing shall be agreed between the customer and supplier.

Guidance on qualification sampling and interpretation of test results are given in IEC 60794-1-1. The number of fibres tested shall be representative of the cable design and shall be agreed between the customer and supplier.

For some tests applicable to "figure 8" constructions, the tests shall be carried out with the suspension strand. If required by certain installation practices, the "figure 8" cable shall also be tested without the suspension strand.

Depending on the cable construction and its operational environment, hydrogen induced effects may be warranted. An informative guideline for hydrogen effects is given in IEC TR 62690.

Table 2 – Mechanical and environmental applicable tests

Characteristics	Family requirements	Test methods [a]	Remarks
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Torsion		IEC 60794-1-21, method E7	
Kink		IEC 60794-1-21, method E10	
Bend		IEC 60794-1-21, method E11	
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Coiling performance		IEC 60794-1-21, method E20	Lake and river crossings
Temperature cycling		IEC 60794-1-22, method F1	
Water penetration		IEC 60794-1-22, method F5B or F5C	Water-blocked cables
Pneumatic resistance		IEC 60794-1-22, method F8	Unfilled cables protected by pressurisation
Ageing		IEC 60794-1-22, method F9	
Hydrostatic pressure		IEC 60794-1-22, method F10	Lake and river crossings
Ribbon stripping		IEC 60794-1-23, method G10B	Ribbon cables

[a] The following methods are under revision. See Introduction.

10 Quality assurance

It is the responsibility of the manufacturer to establish quality assurance by quality control procedures which ensure that the product meets the requirements of this document. When the customer wishes to specify acceptance tests to other quality procedures, it is essential that an agreement is reached between the customer and supplier at the time of ordering.

Bibliography

IEC 60794-1-2:2021, *Optical fibre cables – Part 1-2: General specification – Basic optical test procedures – General guidance*

IEC 60794-1-24, *Optical fibre cables – Part 1-24: Generic specification – Basic optical cable test procedures – Electrical test methods*[8]

IEC 60794-1-3, *Optical fibre cables – Part 1-3: Generic specification – Optical cable elements*

IEC 60794-1-31, *Optical fibre cables – Part 1-31: Generic specification – Optical cable elements – Optical fibre ribbon*

IEC TR 62690, *Hydrogen effects in optical fibre cables – Guidelines*

IEC TR 62691, *Optical fibre cables – Guidelines to the installation of optical fibre cables*

IEC TR 62839-1, *Environmental declaration – Part 1: Wires, cables and accessory products – Specific rules*

IEC TR 62959, *Optical fibre cables – Shrinkage effects on cable and cable element end termination – Guidance*

IEC TR 63194, *Guidance on colour coding of optical fibre cables*

8 This publication has been withdrawn.

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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CÂBLES À FIBRES OPTIQUES –

Partie 3: Câbles extérieurs – Spécification intermédiaire

AVANT-PROPOS

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L'IEC 60794-3 a été établie par le sous-comité 86A: Fibres et câbles, du comité d'études 86 de l'IEC: Fibres optiques. Il s'agit d'une Norme internationale.

Cette cinquième édition annule et remplace la quatrième édition parue en 2014. Cette édition constitue une révision technique.

Cette édition contient la modification technique majeure suivante par rapport à l'édition précédente: la spécification relative aux rubans a été supprimée car elle est couverte par l'IEC 60794-1-31.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
86A/2155/FDIS	86A/2184/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Une liste de toutes les parties de la série IEC 60794, publiées sous le titre général *Câbles à fibres optiques,* peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu du présent document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

INTRODUCTION

L'IEC 60794-1-21, l'IEC 60794-1-22, l'IEC 60794-1-23 et l'IEC 60794-1-24 ont été (ou seront) divisées en plusieurs normes qui définissent chacune une méthode d'essai. L'IEC 60794-1-2:2021 donne des correspondances entre les anciennes et les nouvelles normes.

CÂBLES À FIBRES OPTIQUES –

Partie 3: Câbles extérieurs – Spécification intermédiaire

1 Domaine d'application

La présente partie de l'IEC 60794 spécifie les exigences relatives aux câbles et aux éléments de câble à fibres optiques destinés à être utilisés à l'extérieur dans des réseaux de télécommunication. D'autres types d'applications qui nécessitent des câbles d'une catégorie similaire peuvent être pris en considération.

Le présent document comporte des exigences qui concernent les câbles destinés à être installés dans des conduites, les câbles directement enterrés, les câbles aériens et les câbles pour traversées de lacs et de rivières. Il comporte également des câbles destinés à des utilisations spécialisées, dans les égouts et dans les conduites d'eau et de gaz.

Pour ce qui est des applications aériennes, le présent document ne couvre pas tous les aspects fonctionnels des câbles installés à proximité de lignes aériennes de transport d'énergie. De telles applications peuvent nécessiter l'adjonction d'exigences et de méthodes d'essai. En outre, le présent document exclut les câbles de garde avec fibres optiques et les câbles liés aux conducteurs de phase ou de terre des lignes aériennes de transport d'énergie.

Pour les câbles pour traversées de lacs et de rivières, le présent document ne couvre pas les méthodes de réparation du câble ni de capacité de réparation, et ne couvre pas les câbles utilisés dans les amplificateurs de lignes pour traversées de lacs et de rivières.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60304, *Couleurs de référence de l'enveloppe isolante pour câbles et fils pour basses fréquences*

IEC 60708, *Câbles pour basses fréquences à isolation polyoléfine et gaine polyoléfine à barrière d'étanchéité*

IEC 60793-1-21, *Fibres optiques – Partie 1-21: Méthodes de mesure et procédures d'essai – Géométrie du revêtement*

IEC 60793-1-32, *Fibres optiques – Partie 1-32: Méthodes de mesure et procédures d'essai – Dénudabilité du revêtement*

IEC 60793-1-40, *Fibres optiques – Partie 1-40: Méthodes de mesurage de l'affaiblissement*

IEC 60793-1-44, *Fibres optiques – Partie 1-44: Méthodes de mesure et procédures d'essai – Longueur d'onde de coupure*

IEC 60793-2, *Fibres optiques – Partie 2: Spécifications de produits – Généralités*

IEC 60794-1-1, *Câbles à fibres optiques – Partie 1-1: Spécification générique – Généralités*

IEC 60794-1-21:2015, *Câbles à fibres optiques – Partie 1-21: Spécification générique – Procédures fondamentales d'essais des câbles optiques – Méthodes d'essai mécanique*

IEC 60794-1-22, *Câbles à fibres optiques – Partie 1-22: Spécification générique – Modes opératoires de base applicables aux essais des câbles optiques – Méthodes d'essais d'environnement*

IEC 60794-1-23, *Câbles à fibres optiques – Partie 1-23: Spécification générique – Procédures fondamentales d'essais des câbles optiques – Méthodes d'essai des éléments de câble*

IEC 60811-202, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 202: Essais généraux – Mesure de l'épaisseur des gaines non métalliques*

IEC 60811-203, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 203: Essais généraux – Mesure des dimensions extérieures*

IEC 60811-401, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 401: Essais divers – Méthodes de vieillissement thermique – Vieillissement en étuve à air*

IEC 60811-406, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 406: Essais divers – Résistance des mélanges polyéthylène et polypropylène aux craquelures*

IEC 60811-501, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 501: Essais mécaniques – Détermination des propriétés mécaniques des mélanges pour les enveloppes isolantes et les gaines*

IEC 60811-604:2012, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 604: Essais physiques – Mesure de l'absence de composants corrosifs dans les matières de remplissage*

IEC 60811-607, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 607: Essais physiques – Essai pour l'évaluation de la dispersion du noir de carbone dans le polyéthylène et le polypropylène*

3 Termes, définitions, symboles et termes abrégés

Pour les besoins du présent document, les termes, définitions, symboles et termes abrégés de l'IEC 60794-1-1 s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

4 Fibres optiques

4.1 Généralités

Des fibres optiques qui satisfont aux exigences de l'IEC 60793-2 doivent être utilisées. Le type de fibre doit faire l'objet d'un accord entre le client et le fournisseur.

4.2 Affaiblissement

4.2.1 Affaiblissement linéique

L'affaiblissement linéique maximal d'une fibre câblée doit être conforme à l'IEC 60794-1-1. Des valeurs particulières peuvent faire l'objet d'un accord entre le client et le fournisseur.

L'affaiblissement linéique doit être mesuré conformément à l'IEC 60793-1-40.

4.2.2 Uniformité d'affaiblissement – Discontinuité d'affaiblissement

L'uniformité d'affaiblissement doit être conforme à l'IEC 60794-1-1.

4.3 Longueur d'onde de coupure

Pour les fibres unimodales, la longueur d'onde de coupure d'une fibre câblée λ_{cc} doit être inférieure à la longueur d'onde de fonctionnement lorsqu'elle est mesurée selon l'IEC 60793-1-44 et doit être conforme à l'IEC 60794-1-1.

4.4 Coloration des fibres

Lorsque le revêtement primaire des fibres est coloré à des fins d'identification, le revêtement coloré doit être facilement identifiable pendant toute la durée de vie du câble et doit correspondre, dans la mesure du possible, à l'IEC 60304.

4.5 Dispersion de mode de polarisation (PMD - *polarization mode dispersion*)

La PMD d'une fibre unimodale câblée doit être conforme à l'IEC 60794-1-1.

5 Élément de câble

5.1 Généralités

En règle générale, les câbles optiques comportent plusieurs éléments ou constituants individuels, selon la conception de câble élaborée en fonction de l'application, de l'environnement opérationnel et des procédés de fabrication ainsi que du besoin de protection de la fibre lors des manipulations et pendant la mise en câble.

Le ou les matériaux qui entrent dans la composition d'un élément de câble doivent être choisis de manière à être compatibles avec les autres éléments en contact avec eux. Une méthode d'essai de compatibilité appropriée doit être définie dans la spécification de famille ou particulière.

Lorsque les fibres sont en contact avec un composé de remplissage, la compatibilité du composé de remplissage avec le revêtement de la fibre doit être démontrée en effectuant un essai de stabilité de la force de dénudage du revêtement après vieillissement accéléré conformément à la méthode G10A, à la méthode G10B ou à la méthode G10C[1] méthode A, B et C) de l'IEC 60794-1-23. Il convient que la condition de vieillissement soit conforme à la méthode F9[2] de l'IEC 60794-1-22. D'autres essais et conditions de vieillissement peuvent faire l'objet d'un accord entre le client et le fournisseur.

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1 Il est prévu de remplacer ces méthodes. Voir l'Introduction.

2 Il est prévu de remplacer cette méthode. Voir l'Introduction.