

INTERNATIONAL STANDARD

COMMENTED VERSION

Optical fibre cables -
Part 3-11: Outdoor cables — ~~Product~~ Detailed specification for duct, directly
buried, and lashed aerial ~~single-mode~~ optical fibre telecommunication cables

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

Optical fibre cables -
Part 3-11: Outdoor cables -
Product Detailed specification for duct, directly buried, and lashed aerial
~~single-mode~~ optical fibre telecommunication cables

FOREWORD

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This commented version (CMV) of the official standard IEC 60794-3-11:2026 edition 3.0 allows the user to identify the changes made to the previous IEC 60794-3-11:2010 edition 2.0. Furthermore, comments from IEC SC 86A experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 60794-3-11 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) subclause 5.2.2 has been enlarged to include fibre type B-657.B2;
- b) this document has been updated to include multimode optical fibres.

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

Draft	Report on voting
86A/2712/FDIS	86A/2731/RVD

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

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

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/publications.

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, or
- revised.

1 Scope

This part of IEC 60794 sets forth ~~technical~~ detailed requirements and characteristics specific to this type of ~~single-mode~~ optical fibre cables for duct, direct buried, and lashed installation.

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

The specified test methods, where applicable, are those referenced in IEC 60794-1-1 and IEC 60794-1-2.

The requirements of this document supplement those of the sectional specification IEC 60794-3 and the family specification IEC 60794-3-10.

~~Multimode fibre requirements are not addressed in this standard; see IEC 60794-3-12.~~

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 60793-1-22, *Optical fibres - Part 1-22: Measurement methods and test procedures - Length measurement*

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

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

IEC 60793-1-48, *Optical fibres - Part 1-48: Measurement methods and test procedures - Polarization mode dispersion*

IEC 60793-2-10, *Optical fibres - Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres*

IEC 60793-2-50, *Optical fibres - Part 2-50: Product specifications - Sectional specification for class B single-mode fibres*

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

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

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

IEC 60794-1-22:2017, *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 element test methods*

IEC 60794-1-101, *Optical fibre cables - Part 1-101: Generic specification - Basic optical cable test procedures - Mechanical tests methods - Tensile, method E1*

IEC 60794-1-102:—¹, *Optical fibre cables - Part 1-102: Generic specification - Basic optical cable test procedures - Mechanical tests methods - Abrasion, Method E2*

IEC 60794-1-103:—², *Optical fibre cables - Part 1-103: Generic specification - Basic optical cable test procedures - Mechanical tests methods - Crush, Method E3*

IEC 60794-1-104, *Optical fibre cables - Part 1-104: Generic specification - Basic optical cable test procedures - Mechanical tests methods - Impact, method E4*

IEC 60794-1-106:—³, *Optical fibre cables - Part 1-106: Generic specification - Basic optical cable test procedures - Mechanical tests methods - Repeated bending, Method E6*

IEC 60794-1-107, *Optical fibre cables - Part 1-107: Generic specification - Basic optical cable test procedures - Mechanical test methods - Torsion, method E7*

IEC 60794-1-111:2023, *Optical fibre cables - Part 1-111: Generic specification - Basic optical cable test procedures - Mechanical tests methods - Bend, method E11*

IEC 60794-1-201, *Optical fibre cables - Part 1-201: Generic specification - Basic optical cable test procedures - Environmental test methods - Temperature cycling, method F1*

IEC 60794-1-209, *Optical fibre cables - Part 1-209: Generic specification - Basic optical cable test procedures - Environmental test methods - Ageing, method F9*

IEC 60794-1-219, *Optical fibre cables - Part 1-219: Generic specification - Basic optical cable test procedures - Material compatibility test, method F19*

IEC 60794-1-307, *Optical fibre cables - Part 1-307: Generic specification - Basic optical cable test procedures - Cable element test methods - Tube kinking, method G7*

IEC 60794-1-309, *Optical fibre cables - Part 1-309: Generic specification - Basic optical cable test procedures - Cable element test methods - Bleeding and evaporation of filling or flooding compounds, Method G9*

IEC 60794-1-310, *Optical fibre cables - Part 1-310: Generic specification - Basic optical cable test procedures - Cable element test methods - Strippability, method G10*

IEC 60794-1-403, *Optical fibre cables - Part 1-403: Generic specification - Basic optical cable test procedures - Electrical test methods - Electrical continuity test of cable metallic elements, method H3*

¹ Under preparation. Stage at the time of publication: IEC CDV 60794-1-102.

² Under preparation. Stage at the time of publication: IEC CDV 60794-1-103.

³ Under preparation. Stage at the time of publication: IEC CDV 60794-1-106.

IEC 60794-3 (all parts), *Optical fibre cables - Part 3: Sectional specification - Outdoor cables*

IEC 60794-3-10, *Optical fibre cables - Part 3-10: Outdoor cables - Family specification for duct, directly buried and lashed aerial optical telecommunication cables*

~~IEC 60811-1-1, Common Test methods for insulating and sheathing materials of electric cables and optical cables — Part 1-1: methods for general application — Measurement of thickness and overall dimensions — Tests for determining the mechanical properties~~

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 TR 61931, *Fibre optic - Terminology*

IEC 61753-1, *Fibre optic interconnecting devices and passive components - Performance standard - Part 1: General and guidance*

~~IEC/TR 62000, Single mode fibre compatibility guidelines~~

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TR 61931 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.2 Symbols

The following symbols are used in this document:

λ_{cc}	cable cut-off wavelength
d	outer cable diameter
SZ	technique in which the lay reverses direction periodically

4 General information requirements

4.1 Overview

~~Single-mode~~ Optical fibres are widely used for telecommunication purposes and are cabled to satisfy the functional requirements of the installation environment. Further, cables placed into ducts and sub-ducts ~~may~~ can be installed using solely, or a combination of, pushing, pulling, air-assisted, ~~or other non-listed~~ installation techniques.

For duct installation, the environment and infrastructure can be varied and ~~may~~ can also involve the use of single and multiple sub-ducts.

Directly buried cables ~~may~~ can be installed by a variety of methods such as ploughing and trenching with different environments and infrastructure. This ~~may~~ can require specific cable

design solutions based on multiple layers of armours and sheaths. It is recognised that certain designs of cable for direct buried applications involving such solutions ~~may can~~ also be suitable for duct installation. ~~The functional requirements and test methods featured in this specification are based upon adherence to established and recognised installation techniques such as those included in Annex C of IEC 60794-1-1.~~

~~NOTE Annex C of IEC 60794-1 should become a technical report.~~

For aerial installation on poles, lashed aerial in metropolitan networks it is important to minimise in-service cable movement. Movement of the cable produced by thermal changes, cable weight, ice loading, wind, etc. can have a detrimental effect on the aerial cable.

4.2 General cable description

4.2.1 Characteristics of optical fibre

Single-mode optical fibres are classified according to their operational wavelength, dispersion and bending loss characteristics. The fibres covered by this document are categorised as type B and are described in IEC 60793-2-50. Single-mode fibre types featured in this document are:

- dispersion unshifted (~~B1.1, B1.3~~B-652.B/D);
- bending loss insensitive (~~B6~~B-657.B3/A1/A2);
- dispersion shifted (~~B2~~B-653.A/B);
- cut-off shifted (~~B1.2~~B-654.A/B/C/D/E), non-zero dispersion (~~B4~~B-655.C/D/E) ~~While cut-off shifted B1.2 fibre can be used in terrestrial applications, it is mainly used in submarine applications;~~
- wide-band non-zero dispersion-shifted (~~B5~~B-656).

Multimode optical fibres are classified according to their operational wavelength and modal bandwidth. Multimode fibres as covered by this document are Category A1 as specified in IEC 60793-2-10. Multimode fibre types featured in this document are:

- A1-OM2
- A1-OM3
- A1-OM4
- A1-OM5

~~(See Annex A for ITU-T cabled optical fibre references).~~

NOTE Annex A provides further guidance on ITU-T and IEC cabled fibre and fibre references.

4.2.2 Characteristics of optical fibre cable elements

Optical fibre cable elements such as buffer tubes ~~(loose or not), slotted core, fibre ribbons, fibre bundles and central/core tubes shall be suitably,~~ tensile strength elements, crush protection elements, water blocking elements, sheath removal elements and cable sheath shall be designed to provide adequate means of fibre location, identification, modularity, protection during cable manufacture, installation, and termination.

The structure of these elements, and the materials used in their manufacture, shall not have any long-term detrimental effects on fibre performance during the service life of the cable, splice enclosure ~~and/or~~ cabinet.

To satisfy these functional requirements, the different elements shall comply with the requirements of the IEC 60794-1-3x series, IEC 60794-3 and Clause ~~6~~ 7 of this standard.

4.2.3 Characteristics of optical fibre cables

Optical fibre cables, for the intent of this document, are completed cable products as shipped by the manufacturer, typically on disposable reels. Such products do not require additional assembly, or the use of additional materials or protection to meet the requirements of this document. ~~Some assembly or added protection is usually required only where the cables are terminated to other cables or equipment, and typically involve the use of an optical fibre closure or other hardware to protect cable splice or connectorization points.~~ When the cables are terminated to other cables or equipment involving the use of an optical fibre closure or other hardware to protect fibre splices or connectorization points and other cable elements such as loose tubes, fibres or ribbons, a specific assembly or additional protection shall be implemented as specified in IEC 61753-1.

The required levels of protection for the fibre can be achieved by laying up or assembling the cable elements in association with suitable strength ~~and~~ members, or anti-buckling members, or both. These can be either metallic or non-metallic and positioned at the centre of the cable core or as peripheral members in or underneath the outer cable sheath. The cable ~~may~~ can also contain moisture barrier tapes, metallic or non-metallic tapes, and water blocking or swellable materials.

4.2.4 Environmental and product safety requirements

IEC Guide 104, which defines procedures for the preparation of safety publications, should be taken into account ~~as far as possible~~. The materials of the cables in contact with the environment shall not be hazardous to the environment and personnel.

It should be noted that the cables specified by this document are rarely accessible once installed. Therefore, the risk of exposure to hazardous materials, if any, is mostly a concern in the handling of the cable during manufacturing and installation. Additionally, the type of outer sheath specified in this document is generally considered to be non-toxic, therefore the risk to the environment or personnel is minimal once properly installed.

This document does not address the use of all types of cable materials that may be utilized in various cable designs to support meeting the requirements unique to a specific type of special application (e.g. very high temperatures or resistance to specific chemical attack). In such cases, it is incumbent on the customer and supplier to agree on the requirements applicable to such materials and cable designs, and to determine any special handling precautions or instructions ~~needed as a result~~ required because of their use.

4.3 Optical fibre splice-ability

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

Typical bi-directional splice losses at 1 550 nm should be below 0,1 dB, with an average of 0,05 dB for fusion splices between fibres of the same category ~~(B1-B1, or B2-B2, etc.)~~ performed by skilled operators on active alignment splicers according to the current best practices. Additional fibre compatibility guidelines are provided in IEC/TR 62000.

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

Typical bi-directional splice losses at 850 nm should be below 0,1 dB, with an average of 0,05 dB for fusion splices between fibres of the same category performed by skilled operators.

NOTE 1 Higher maximum splice losses can be tolerated without affecting the link transmission capability.

NOTE 2 In general, splices of fibres of the same category, but from different manufacturers or different production processes, or both do not exceed the values given in 4.3.

NOTE 3 If fibres of different categories ~~(B1-B2, B1-B4, etc.)~~ are spliced, typically the splice loss is slightly higher than with splices between fibres of the same category.

4.4 Testing

4.4.1 General

For all test procedures, the atmospheric test conditions shall be ~~(23 °C ± 5 °C, and 20 % to 70 % relative humidity), unless otherwise~~ as specified in IEC 60794-1-2. All measured and computed values ~~are to~~ shall be rounded to the number of decimal places given in the corresponding acceptance criteria for each requirement. The minimum number of tested fibres ~~to be tested shall be agreed upon between the customer and supplier~~ in a cable should be as recommended in IEC 60794-1-1.

4.4.2 ~~No change in attenuation~~

4.4.2.1 ~~General~~

For some of the parameters specified in this document, the objective is no change in attenuation.

These parameters ~~may~~ can be affected by measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards. Acceptance criteria shall be interpreted with respect to this consideration.

4.4.2 No change in attenuation ~~—single-mode~~

The total uncertainty of measurement for ~~this standard~~ a single-mode fibre shall be $\leq 0,05$ dB for attenuation or $\pm 0,05$ dB/km for the attenuation coefficient. Any measured value within this range shall be considered as "no change in attenuation".

The requirement for these parameters is indicated as "no change ($\leq 0,05$ dB)" or "no change ($\leq 0,05$ dB/km)". By agreement between the customer and the supplier, ~~minor~~ a deviation not exceeding 10 % from the required limits may be accepted at some low frequency, ~~e.g. less than 10 %~~. However, for mechanical tests, no deviation in excess of 0,15 dB shall be accepted. For environmental tests, no deviation in excess of 0,10 dB/km shall be accepted.

The total uncertainty of measurement for a multimode fibre shall be $\leq 0,2$ dB for the attenuation or $\leq 0,2$ dB/km for the attenuation coefficient. Any measured value within this range shall be considered as "no change in attenuation".

The requirement for these parameters is indicated as "no change ($\leq 0,2$ dB or $\leq 0,2$ dB/km)". By agreement between customer and supplier, minor deviation from this limit may be accepted at some low frequency, for example less than 10 %. However, for mechanical tests, no deviation in excess of 0,5 dB shall be accepted. For environmental tests, no deviation in excess of 0,5 dB/km shall be accepted.

4.4.3 No change in fibre strain

For some of the parameters specified in this document, the objective is zero strain.

These parameters ~~may~~ can be affected by measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards. Acceptance criteria shall be interpreted with respect to this consideration.

The total uncertainty of measurement for this standard shall be $\pm 0,05$ % strain. Any measured value within this range shall be considered as "zero".

5 Detailed requirements for cabled ~~single-mode~~ optical fibres

5.1 Fibre materials

Use ~~single-mode~~ optical fibre as specified in IEC 60793-2-50, or multimode optical fibre as specified in IEC 60793-2-10.

The coating surface shall be cleaned (e.g. from cable filling compounds) only with the cleaning agents recommended by the fibre manufacturer. In any case, chlorine-based cleaning agents shall not be used because of the health hazards involved.

5.2 Optical requirements

5.2.1 General

All ~~single-mode~~ optical fibre transmission attributes shall comply with IEC 60793-2-50, and multimode optical transmission attributes shall comply with IEC 60793-2-10. Attributes of the cabled fibre (attenuation, point discontinuity, polarization mode dispersion, cable cut-off wavelength and group index) are specified in 5.2.2 to 5.2.6. ~~Other fibre attributes in IEC 60793-2-50 are summarized in the informative Annex B.~~

5.2.2 Attenuation coefficient

The cabled fibre attenuation coefficients for the fibre types covered by this document shall meet the requirements specified in Table 1 for ~~Single-mode fibres, or as otherwise agreed upon between the customer and the supplier~~ and in Table 2 for (multimode fibres).

Table 1 – Requirements for the attenuation coefficient of ~~single-mode~~ cabled fibre

Wavelength	Fibre type (maximum attenuation in dB/km)						
	B1.1	B1.2	B1.3	B2	B4	B5	B6 ^a
1 310 nm	0,40	NA	0,40	0,50	^a	NA	0,40
1 383 nm	NA	NA	0,40 ^b	NA	NA	NA	0,40 ^b
1 550 nm	0,35	0,30	0,30	0,35	0,35	0,35	0,30
1 625 nm	0,40 ^c	0,40 ^c	0,40 ^c	0,40 ^c	0,40 ^c	0,40 ^c	0,40 ^c
NA = Not applicable. ^a 1 310 nm is not specified unless agreed otherwise between the customer and the supplier. ^b 1383 nm attenuation is specified after hydrogen aging as per IEC 60793-2-50. ^c 1625 nm attenuation values are optionally specified by the customer.							

~~Fibre type definitions are provided in IEC 60793-2-50 for single-mode fibre. For informative purposes, they are described below:~~

- ~~B1.1: Single-mode fibre with a zero dispersion between 1 300 nm to 1 324 nm, which is optimised for use in the 1 310 nm region and is compatible in the 1 550 nm region.~~
- ~~B1.2: Dispersion unshifted single-mode fibre that is optimised for 1 550 nm transmission with a cable cut-off wavelength <1 530 nm.~~
- ~~B1.3: Single-mode fibre similar to B1.1 but has a low loss at 1383 nm to provide additional compatibility between 1 360 nm to 1 460 nm.~~

- ~~B2: Dispersion shifted single-mode fibre with a zero dispersion in the 1 525 nm to 1 575 nm region.~~
- ~~B4: A non-zero dispersion shifted single-mode fibre (NZDSF) that is optimised for 1 550 nm transmission with the zero dispersion outside the 1 530 nm to 1 565 nm region.~~
- ~~B5: A non-zero dispersion shifted single-mode fibre (NZDSF) that is optimised for 1 460 nm to 1 625 nm transmission with the zero dispersion region below 1 460 nm.~~
- ~~B6_a: A bending loss insensitive fibre compatible with B1.3 fibre that is suitable for use in the access networks, including inside buildings.~~

Test procedure:

Fibre category	Maximum attenuation coefficient (dB/km) at wavelengths (nm)						
	1 310 nm	1 310 to 1 625 nm	1 383 nm	1 460 nm	1 550 nm	1 530 to 1 565 nm	1 625 nm
IEC 60793-2-50, B-652.B (dispersion unshifted) – ITU-T G.652.B	0,40	n/a	n/a	n/a	0,35	n/a	0,40
IEC 60793-2-50, B-652.D (dispersion unshifted) – ITU-T G.652.D	0,40	0,40	0,40	0,40	0,30	0,30	0,40
IEC 60793-2-50, B-654.A/B/C (cut-off shifted) – ITU-T G.654.A/B/C	n/a	n/a	n/a	n/a	0,22	n/a	n/a
IEC 60793-2-50, B-654.D (cut-off shifted) – ITU-T G.654.D	n/a	n/a	n/a	n/a	0,20	n/a	n/a
IEC 60793-2-50, B-654.E (cut-off shifted) – ITU-T G.654.E	n/a	n/a	n/a	n/a	0,23	n/a	n/a
IEC 60793-2-50, B-653.A/B (dispersion shifted) – ITU-T G.653.A/B	n/a	n/a	n/a	n/a	0,35	n/a	n/a
IEC 60793-2-50, B-655.C/D/E (non-zero dispersion shifted) – ITU-T G.655.C/D/E	n/a	n/a	n/a	n/a	0,35	n/a	0,40
IEC 60793-2-50, B-656 (wideband non-zero dispersion shifted) – ITU-T G.656	n/a	n/a	n/a	0,4	0,35	n/a	0,40
IEC 60793-2-50, B-657.A1/A2 (bending loss insensitive) – ITU-T G.657.A1/A2	0,40	0,40	0,40	0,40	0,30	0,30	0,40
IEC 60793-2-50, B-657.B2/B3 (bending loss insensitive) – ITU-T G.657.B3	0,40	0,40	0,40	0,40	0,30	0,30	0,40
n/a = not applicable							

Table 2 – Requirements for the attenuation coefficient of cabled multimode fibre

Fibre category	Attenuation coefficient at 850 nm	Attenuation coefficient at 1 300 nm	Performance category
IEC 60793-2-10, A1-OM1 category	3,5	1,5	OM1 ^a
IEC 60793-2-10, A1-OM2 category	3,5	1,5	OM2 ^a
IEC 60793-2-10, A1-OM3 category	3,0	1,5	OM3
IEC 60793-2-10, A1-OM4 category	3,0	1,5	OM4
IEC 60793-2-10, A1-OM5 category	3,0	1,5	OM5
^a OM1 and OM2 are no longer supported but are shown here for completeness.			