IEC 60794-1-1

Edition 5.0 2023-05
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

Optical fibre cables –
Part 1-1: Generic specification – General

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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 commented version (CMV) of the official standard IEC 60794-1-1:2023 edition 5.0 allows the user to identify the changes made to the previous IEC 60794-1-1:2015 edition 4.0. 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 60794-1-1 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 2015. This edition constitutes a technical revision.

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

a) reorganization of the document to a more logical flow making it easier for the reader:
b) expansion of the tables to include names and definitions of all documents in the IEC 60794-x series;
c) expansion of the definitions, graphical symbols, terminology and abbreviations content, with the aim of making this document the default and reference for all others in the IEC 60794-x series;
d) inclusion of updated, reorganized and expanded optical fibre, attenuation and bandwidth subclauses, with the aim of making this document the default and reference for all others in the IEC 60794-x series.

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

Draft	Report on voting
86A/2286/FDIS	86A/2313/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,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

OPTICAL FIBRE CABLES –

Part 1-1: Generic specification – General

1 Scope

This part of IEC 60794 applies to optical fibre cables for use with communication equipment and devices employing similar techniques ~~and to cables having a combination of both optical fibres and electrical conductors~~. Electrical properties are specified for optical ground wire (OPGW) and optical phase conductor (OPPC) cables. Hybrid communication cables are specified in the IEC 62807 series. 1

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

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

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

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

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 measurement methods*

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

IEC 60793-1-46, *Optical fibres – Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance*

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

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

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

IEC 60793-2-40:2021, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

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

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

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

IEC 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

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*~~

~~ISO 14001, *Environmental management systems – Requirements with guidance for use*~~

~~ISO 14064-1, *Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*~~

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1
no change in attenuation
acceptance criterion for attenuation measurement that includes an allowance for measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards

Note 1 to entry: For a practical interpretation, the following values shall be used:

a) No change in attenuation, single-mode (class B): the total uncertainty of measurement shall be ≤ ± 0,05 dB for the attenuation or ≤ ± 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 (≤ ± 0,05 dB or ≤ ± 0,05 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 0,15 dB shall be accepted. For environmental tests no deviation in excess of 0,10 dB/km shall be accepted.

b) No change in attenuation, multimode (category A1): the total uncertainty of measurement shall be ≤ ± 0,2 dB for the attenuation or ≤ ± 0,2 dB/km for the attenuation coefficient.

[1] This document is progressively being replaced by the IEC 60794-1-2XX series.

Any measured value within this range shall be considered as “no change in attenuation”.

The requirement for these parameters is indicated as “no change (≤ ± 0,2 dB or ≤ ± 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.

c) No change in attenuation, plastic optical fibre (category A4): the total uncertainty of measurement for this document shall be ≤ 2 % of the maximum specified attenuation in IEC 60793-2-40:2021, Annex A to ~~C~~ Annex I.

Any measured value within this range shall be considered as “no change in attenuation”.

3.2
allowable change in attenuation
<during mechanical and environmental tests> change in attenuation that may be a value larger than the no change limits, depending on fibre category, single-mode or multimode, cable design and application

3.3
link design attenuation
LDA
statistical ~~average~~ upper bound for the attenuation ~~value for a link~~ coefficient of the concatenated optical fibre cables **2**

3.4
no change in fibre strain
acceptance criterion for fibre strain measurement that includes an allowance for measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards

Note 1 to entry: For a practical interpretation, the total uncertainty of measurement shall be ± 0,05 % strain. Any measured value within this range shall be considered as “no change in strain”.

3.5
allowable change in fibre strain
<during mechanical and environmental tests> level of strain that will not compromise fibre mechanical reliability for some of the parameters specified

~~Note 1 to entry: For 1 % proof-tested fibres, the fibre strain under long term tensile load (T_L) shall not exceed 20 % of this fibre proof strain (equal to absolute 0,2 % strain) and there shall be no change in attenuation during the test~~

~~Under short term tensile load (T_S) the fibre strain shall not exceed 60 % of the fibre proof strain and the attenuation change during test shall be measured and recorded.~~

~~Other criteria may be agreed between the customer and the supplier.~~

~~For fibres proof tested at higher levels the safe long term load will not scale linearly with proof strain, so a lower percentage of the proof strain is applicable. For greater than 1 % up to 2 % proof tested fibres, the strain at T_L shall be limited to 17 % of the proof test strain (equal to absolute 0,34 % strain for 2 % proof tested fibres).~~

3.6
circuit integrity **3**
ability of the cable under test to continue to operate in a designated manner whilst subjected to a specified flame source for a specified period of time

3.7
fire resistance **3**
ability of the cable under test to resist functional failure to operate in a designated manner whilst subjected to a specified flame source for a specified period of time

3.8
shrinkage
irreversible contraction after extrusion of plastic materials caused by heating or over time at ambient temperature

3.9
cable load definitions (non-aerial applications)

3.9.1
long-term load
T_L
acceptable amount of long-term load which the cable ~~may~~ can experience during operation (i.e. after installation is completed)

Note 1 to entry: Long-term load ~~may~~ can be due either to residual loading from the installation process ~~and/~~or environmental effect, or both. This is the rated maximum load for which a cable is subject to in long term tests.

Note 2 to entry: For 1 % proof-tested fibres, the fibre strain under long term tensile load (T_L) shall not exceed 20 % of this fibre proof strain (equal to absolute 0,2 % strain) and there shall be no change in attenuation during the test.

Note 3 to entry: For fibres proof tested at higher levels the safe long-term load will not scale linearly with the proof strain, so a lower percentage of the proof strain is applicable. For proof-tested fibres at levels higher than 1 % and up to 2 %, the strain at T_L shall be limited to 17 % of the proof-test strain (equal to absolute 0,34 % strain for 2 % proof tested fibres). **4**

3.9.2
short-term load
T_S
~~**TM**~~
acceptable amount of short-term load that can be applied to a cable without permanent degradation of the characteristics of the fibres, cable elements or sheath

Note 1 to entry: Short-term load is often called rated installation load.

Note 2 to entry: Under short term tensile load (T_S) the fibre strain shall not exceed 60 % of the proof strain (equal to absolute 0,6 % strain for 1 % proof-tested fibres) and the attenuation change during test shall be measured and recorded. **5**

3.10
cable load definitions and tensile testing terminology (self-supporting aerial applications)

3.10.1
maximum allowable tension
MAT
maximum tensile load that ~~may~~ can be applied to the cable without detriment to the performance requirements (e.g. attenuation, fibre reliability) due to fibre strain

Note 1 to entry: Due to installation codes the MAT value is sometimes restricted to be less than 60 % of the breaking tension of the cable.

Note 2 to entry: This is also called ultimate operational strength (UOS), equal to 60 % of RTS (and fibre strain < 0,35 %, 1/3 of proof test). MAT < 60 % UOS.

Note 3 to entry: This is also called every day stress (EDS), defined as 25 % of RTS and no fibre strain (< 0,05 %) and no attenuation increase (< 0,05 dB). **6**

3.10.2
strain margin
value of cable elongation at the onset of fibre strain

Note 1 to entry: The strain margin ~~may~~ can also be expressed as cable load (N) at the onset of the fibre strain.

3.10.3
breaking tension
tensile load that will produce physical rupture of the cable

Note 1 to entry: The breaking tension ~~may~~ can be calculated, provided that the design model has been validated.

3.10.4
maximum installation tension
MIT
maximum recommended stringing tension during installation

3.10.5
rated tensile strength
RTS
summation of the product of nominal cross-sectional area, nominal tensile strength, and stranding factor for each load bearing material in the cable construction

~~Note 1 to entry: See IEC 60794-4:2003, Annex A for details of the recommended method to calculate breaking tension of OPGW.~~

~~**3.7.6**~~
~~**creep**~~
~~tendency of a solid material to slowly move or deform permanently under the influence of stress~~

~~Note 1 to entry: The information derived from creep testing may be used in the sag-tension calculations during the design layout of aerial optical cables used along electrical power lines.~~

3.11
cable section
individual reel of cable, as produced

~~**3.9**~~
~~**fittings**~~
~~hardware used for stringing and clipping of aerial cables to the structures (e.g. towers, poles) at the end of the installation procedure~~

~~Note 1 to entry: Suspension, dead-end, vibration damper and bonding clamps hardware are designed for a specific size and/or type of aerial cable.~~

3.12
cable element
component of a cable designed to house and protect the optical fibres

Note 1 to entry: This was changed from “fibre optic unit” in IEC 60794-4-10 to “cable element” to be consistent with IEC 60794-1-23 and also to avoid confusion with IEC 60794-5-20.

Note 2 to entry: The cable sheath is included as a cable element.

3.13
polarization mode dispersion (PMD) terms

3.13.1
differential group delay
DGD
relative time delay between the two fundamental polarization modes (principal states of polarization) at the end of an optical fibre cable, at a particular time and wavelength

Note 1 to entry: Differential group delay is expressed in ps.

3.13.2
polarization mode dispersion value
PMD value
average of DGD values across wavelengths

Note 1 to entry: The polarization mode dispersion value is expressed in ps.

3.13.3
polarization mode dispersion coefficient
PMD coefficient
PMD value of an optical fibre cable divided by the square root sum of its length (km)

Note 1 to entry: The polarization mode dispersion coefficient is expressed in ps/√km.

3.13.4
link
length of cable composed of a number of individual cable sections

Note 1 to entry: Link PMD values are generally calculated in accordance with the formulae given in IEC TR 61282-3~~:2006~~ but may be measured.

~~**3.12**~~
~~**recovery time**~~
~~time allowed for any of the tests before performing the after test measurement~~

~~Note 1 to entry: For a practical interpretation, this is typically 5 minutes minimum.~~

~~**3.13**~~
~~**Ruggedized cable**~~
~~cable having enhanced mechanical performances~~

3.14
terminated cable assembly
~~length of cable provisioned with a connector at each end~~

cable terminated with connectors

Note 1 to entry: A patch cord or jumper is one type of a terminated cable assembly.

Note 2 to entry: The following ~~synonyms~~ terms for terminated cable assemblies with connector(s) at both ends are used in the ISO/IEC 11801 series: patch cords, work area cords and equipment cords.

3.15
aerial cable types

3.15.1
all dielectric self-supporting
ADSS
cable that is capable of enduring aerial installation and providing long term service, without any external tensile support

3.15.2
optical attached cable
OPAC
dielectric cable that is not self-supported, but attached to an electrical earth wire or phase conductor, using one of the following attachment methods: wrapped, lashed or preform attached

3.15.3
wrapped
lightweight flexible non-metallic (“wrap”) cable that can be wrapped helically around either the earth wire or the phase conductor using special machinery

3.15.4
lashed
non-metallic cables that are installed longitudinally alongside the earth wire, the phase conductor or on a separate support cable (on a pole route) and are held in position with a binder or adhesive cord

3.15.5
preform~~/spiral~~ attached
cable similar to the lashed cables but attached with the use of special preformed spiral attachment clips

3.15.6
optical ground wire
OPGW
metallic optical cable for overhead power lines that has the dual performance functions of a conventional ground wire with telecommunication capabilities

3.15.7
optical phase conductor
OPPC
Metallic hybrid optical cable that has the dual performance functions of a conventional phase conductor with telecommunication capabilities

3.16
composite cable
optical fibre cable containing more than one fibre category

3.17
hybrid communication cable
cable that contains more than one media type, including but not limited to optical fibres ~~and/or~~, twisted pair/quad cables ~~and/~~, or coaxial cables or all of them

3.18
rounding error
rule[2] of "rounding half away from zero" when the results recorded display more than the significant number of digits required in the acceptance criteria.

Note 1 to entry: Only the first digit beyond the number of significant digits is used in determining the rounding.

EXAMPLE 1: Against a requirement of 0,22 dB/km maximum attenuation, values up to 0,224 dB/km conform, whilst values of 0,225 dB/km and above are failures.

EXAMPLE 2: Against a requirement of ± 0,05 dB, values between -0,054 and +0,054 are deemed acceptable.

3.19
maximum allowable ovality
largest permissible ovality of the optical unit or its component calculated as:

$2 \times (d1 - d2) / (d1 + d2)$ in % where:

$d1$ is the maximum measured diameter of the cable or the component

$d2$ is the minimum diameter of the cable or the component at the same cross-section as $d1$

3.20
breakout cable
cable consisting of subunits which ~~may~~ can be separate fibre optical cables surrounded by a sheath of suitable material

Note 1 to entry: In the application this outer sheath of the breakout cable can be removed over a certain length and the subunits can be used as separate fibre optic cables.

[2] Please see ISO/IEC Guide 98-3:2008, Clause 7, on uncertainty of measurement for additional information.

4 Graphical symbols and abbreviated terms

For the purposes of this document, the abbreviated terms given in IEC TR 61931 as well as the following apply.

ADSS	all dielectric self-supporting
APL	aluminium/polyethylene laminate
ΔD	minimum wall thickness of a microduct
ΔD'	minimum thickness of the outer sheath of a protected microduct
D	nominal outer diameter of a microduct cable
d	nominal outer diameter of a cable (including microduct fibre units)
dc	nominal outer diameter of a conduit or subduct
DS	detail specification
EDS	every day stress
ID	nominal inner diameter of a microduct
I/O-port	input/output port for launching OF cables into and out of a pipe
λ_{CC}	cable cut-off wavelength
$\lambda_{operational}$	operational wavelength
LDA	link design attenuation ~~(tbd)~~
m	mass of 1 km of cable (in the context of tensile testing)
MAOC	maximum allowable ovality of cable
MAT	maximum allowable tension
MASS	metallic aerial self-supported cables
MICE	mechanical, ingress, climatic, or electromagnetic
MIT	maximum installation tension
$n \times d$	product of a variable and the cable outer diameter used for determining appropriate sizes for bends, mandrels, etc.
$n \times OD$	product of a variable and the outer diameter of a microduct used for determining appropriate sizes for bends, mandrels, etc.
$n \times OD$'	product of a variable and the outer diameter of a protected microduct used for determining appropriate sizes for bends, mandrels, etc.
OCEPL	optical cable to be used along electrical power lines
OD	nominal outer diameter of a microduct
OD'	nominal outer diameter of a protected microduct
OPAC	optical attached cable (or optical power attached cable)
OPGW	optical ground wire
OPPC	optical phase conductor
PE	polyethylene
RTS	rated tensile strength
S	outdoor subterranean or sub-surface environment
SPL	steel/polyethylene laminate
SZ	technique in which the lay reverses direction periodically
t_1	temperature cycling dwell time
T_{A1}	temperature cycling test low-temperature limit in accordance with IEC 60794-1-22, Method F1

T_{A2}	temperature cycling test secondary low-temperature limit in accordance with IEC 60794-1-22, Method F1
T_{B1}	temperature cycling test high-temperature limit in accordance with IEC 60794-1-22, Method F1
T_{B2}	temperature cycling test secondary high-temperature limit in accordance with IEC 60794-1-22, Method F1
T_L	long term load
T_o	tensile load at “no fibre strain”
T_S	short term load
UOS	ultimate operation strength
W	weight of 1 km of cable, microduct fibre unit or any form of ducting, as applicable

5 Optical fibre cables – IEC 60794 structure 7

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

- ~~indoor cables;~~
- ~~patch cords;~~
- ~~premises cabling;~~
- ~~cables for installation in ducts and lashed aerial cables;~~
- ~~cables for direct burial;~~
- ~~cables for installation in tunnels;~~
- ~~aerial cables;~~
- ~~drop cables;~~
- ~~underwater cables for lakes, river crossings and coastal applications;~~
- ~~microduct cabling;~~
- ~~cables for utility rights of way such as sewers, gas pipes and water pipes;~~
- ~~overhead cables (power lines);~~
- ~~optical cables for rapid/multiple deployment;~~
- ~~other optical fibre cable types not listed above.~~ 8

5.1 General

Optical fibre cables are a structure which is made of one or more elements containing optical fibres, mechanical strength elements and a surrounding jacket or surrounding jackets for protection against mechanical as well as environmental attacks. The IEC 60794 series consists of the following parts (see Table 1):

Table 1 – IEC 60794 structure 9

IEC 60794-1-1	Generic specification
IEC 60794-2	Indoor cables – Sectional specification
IEC 60794-3	Outdoor cables – Sectional specification
IEC 60794-4	Sectional specification – Aerial optical cables along electrical power lines
IEC 60794-5	Sectional specification – Microduct cabling for installation by blowing
IEC 60794-6	Indoor-outdoor cables – Sectional specification for indoor-outdoor cables
IEC 60794-7[3]	Sectional specification – Fire-resistant cables for data communication – Sectional specification

5.2 IEC 60794-1 series

The object of this series is to establish uniform generic requirements for the geometrical, transmission, material, mechanical, ageing (environmental exposure), climatic and electrical properties of optical fibre cables and cable elements. The series is shown in Table 2.

Table 2 – IEC 60794-1 series 10

IEC 60794-1	60794-1-1, Generic specification – General
	60794-1-2, Generic specification – Basic optical cable test procedures – General guidance
	60794-1-3, Generic specification – Optical cable elements

5.3 IEC 60794-2 series

The object of this series is to provide requirements that apply to optical fibre cables for indoor use in communications networks. Other types of applications requiring similar types of cables can be considered. The series is shown in Table 3.

Table 3 – IEC 60794-2 series 11

IEC 60794-2	IEC 60794-2-10, Indoor optical fibre cables – Family specification for simplex and duplex cables
	IEC 60794-2-11, Indoor cables – Detailed specification for simplex and duplex cables for use in premises cabling
	IEC 60794-2-20, Indoor cables – Family specification for multi-fibre optical cables
	IEC 60794-2-21, Indoor cables – Detailed specification for multi-fibre optical distribution cables for use in premises cabling
	IEC 60794-2-22, Indoor cables – Detail specification for multi-simplex breakout optical cables to be terminated with connectors
	IEC 60794-2-23[4], Indoor optical fibre cables – Detailed specification for multi-fibre cables for use in MPO connector terminated cable assemblies
	IEC 60794-2-24[5], Indoor optical fibre cables – Detailed specification for multiple multi-fibre unit cables for use in MPO connector terminated breakout cable assemblies
	IEC 60794-2-30, Indoor cables – Family specification for optical fibre ribbon cables for use in terminated cable assemblies

[3] This series is still at the development stage.

[4] Under development. Stage at the time of publication; IEC CD 60794-2-23:2022.

[5] Under development. Stage at the time of publication: IEC CC 60794-2-24:2022.

	IEC 60794-2-31, Indoor cables – Detailed specification for optical fibre ribbon cables for use in premises cabling
	IEC 60794-2-40, Indoor optical fibre cables – Family specification for A4 fibre cables
	IEC 60794-2-41, Indoor cables – Product specification for simplex and duplex buffered A4 fibres
	IEC 60794-2-42, Indoor optical fibre cables – Product specification for simplex and duplex cables with A4 fibres
	IEC 60794-2-50, Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies

5.4 IEC 60794-3 series

This series 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 series. Also included are cables for specialized use in sewers and rapid deployment. The series is shown in Table 4.

Table 4 – IEC 60794-3 series 12

IEC 60794-3	IEC 60794-3-10, Outdoor cables – Family specification for duct, directly buried and lashed aerial optical telecommunication cables
	IEC 60794-3-11, Outdoor cables – Product specification for duct, directly buried, and lashed aerial single-mode optical fibre telecommunication cables
	IEC 60794-3-12, Outdoor cables – Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling
	IEC 60794-3-20, Outdoor cables – Family specification for self-supporting aerial telecommunication cables
	IEC 60794-3-21, Outdoor cables – Product specification for optical self-supporting aerial telecommunication cables for use in premises cabling
	IEC 60794-3-30, Outdoor cables – Family specification for optical telecommunication cables for lakes, river crossings and coastal application
	IEC 60794-3-40, Outdoor cables – Family specification for cables for storm and sanitary sewers
	IEC 60794-3-70, Outdoor cables – Family specification for outdoor optical fibre cables for rapid/multiple deployment

5.5 IEC 60794-4 series

This series covers cable construction, test methods, optical, mechanical, environmental and electrical performance requirements for aerial optical fibre cables and cable elements which are intended to be used along power lines (OCEPL) as a high bandwidth transport media for communications and control optical signals, including optical ground wires (OPGW), optical phase conductors (OPPCs), metallic aerial self-supported cables (MASS), all-dielectric self-supporting cables (ADSS) and optical attached cables (OPAC). The series is shown in Table 5.

Table 5 – IEC 60794-4 series 13

IEC 60794-4	IEC 60794-4-10, Family specification – Optical ground wires (OPGW) along electrical power lines
	IEC 60794-4-20, Sectional specification- Aerial optical cables along electrical power lines – Family specification for ADSS (all dielectric self-supported) optical cables
	IEC 60794-4-30, Aerial optical cables along electrical power lines – Family specification for optical phase conductor (OPPC) optical cables

5.6 IEC 60794-5 series

This series specifies the requirements of microduct optical fibre cables, microduct fibre units, microducts and protected microducts for installation by blowing for outdoor use. The series is shown in Table 6.

Table 6 – IEC 60794-5 series 14

IEC 60794-5	IEC 60794-5-10, Family specification – Outdoor microduct optical fibre cables, microducts and protected microducts for installation by blowing
	IEC 60794-5-20,-Family specification – Outdoor microduct fibre units, microducts and protected microducts for installation by blowing

5.7 IEC 60794-6 series

This series covers general features of optical fibre cables applicable to outdoor as well as indoor environments, called “indoor-outdoor cables”. Indoor-outdoor cables are deployed in outside plant environments as well as in premises, thus fulfilling outdoor as well as indoor requirements. The series is shown in Table 7.

Table 7 – IEC 60794-6 series 15

IEC 60794-6	IEC 60794-6-10, Indoor-outdoor cables – Family specification for universal indoor-outdoor cables
	IEC 60794-6-20, Indoor-outdoor cables – Family specification for flame retardant outdoor cables
	IEC 60794-6-30, Indoor-outdoor cables – Family specification for weatherised indoor cables

5.8 IEC 60794-7 series 16

Under development.

6 Cable materials 17

6.1 Indoor cable materials 18

Generally, indoor optical cables comprise several elements or individual constituents, depending on the cable design which takes into account the cable application, flame and smoke ratings, 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. Table 8 provides some examples.

Table 8 – Indoor cables materials (examples) 19

Tight, semi-tight, loose buffering	Polymeric materials
Buffer tube	Polymeric materials, PBT
Strength member	Metallic or non-metallic material
Sheath	Halogen free, flame retardant, non corrosive, low smoke (HFFR LS), PVC, PVC (low smoke), PVDF

6.2 Outdoor cable materials 20

Generally, outdoor 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. Table 9 provides some examples.

Table 9 – Outdoor cable materials (examples) 21

Tight buffering	Polymeric materials
Buffer tube	Polymeric materials
Buffer tube filling	Grease-like and/or dry-block materials
Cable core filling	Grease-like and/or dry-block materials
Strength member	Metallic or non-metallic material
Armour	Corrugated steel tape, two-layer wrapped steel tape, steel wire armour or dielectric material
Sheath	UV-stabilized weather-resistant polymeric materials

6.3 Indoor/outdoor cable materials 22

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.

Indoor/outdoor cables generally possess the characteristics associated with outdoor cable designs having the environmental and mechanical robustness that makes them suitable for use in the outside plant, while simultaneously being relatively flexible, compact and lightweight and exhibiting the fire performance. Table 8 and Table 9 provide examples.

~~**6.2 Electrical conductors**~~

~~The characteristics of any electrical conductors shall be in accordance with the relevant IEC standards.~~

~~**6.3 Other materials**~~

~~Material used in the construction of optical fibre cables shall be compatible with the physical and optical properties of the fibres and shall be in accordance with the relevant IEC standards.~~

6.4 Environmental requirements for cable materials

When requested, information shall be provided on the overall environmental impact of the cable and cable material. This information should include manufacturing, cable handling and environmental impact during the lifetime of the cable. Examples of relevant information are the minimization or replacement of harmful materials and improvements in waste disposal. Relevant documents include ISO 14001 and ISO 14064-1.

7 Cable construction

7.1 General

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

7.2 Colour coding

7.2.1 Overview

Coding is essential to uniquely identify each fibre in a cable. Coding of fibres almost universally involves colouring of the fibre coating or buffer ~~(see 6.1.5)~~. The coding scheme employed will usually require inclusion of the coding of fibre, subunits, and units within the cable.

Coding schemes shall be agreed between the manufacturer and customer. The specific scheme is often the subject of regional norms. IEC 60304 identifies the colours to be used in fibre colouring, but does not ~~address the coding~~ specify which colour is for which fibre and IEC TR 63194 addresses colour coding of optical fibre cables, but does not specify which colour is for which fibre number. **23**

Sheath colour coding may be used for a variety of purposes and is most commonly used in indoor cables. Such sheath coding is often used to identify the categories of fibre in the cable or the application of the cable, amongst a number of other possibilities.

Unless otherwise specified, fibres, fibre ribbons, buffered tubes, micromodules and other cable elements shall be uniquely identified by a scheme agreed between the manufacturer and customer.

~~As per 6.1.5,~~ Colours shall be a reasonable match to IEC 60304. Other colours or schemes may be used, as agreed.

7.2.2 Fibre ~~colouring~~ colour coding

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. ~~Refer to 7.2 for the specification of fibre colour coding.~~

IEC TR 63194 provides information about the sequence of fibre colour coding that varies between different regions and countries.

7.2.3 Unit colour coding

If required as a part of the unique fibre identification scheme, units shall be uniquely identified.

If colours are used, they shall be a reasonable match to IEC 60304. If other methods, such as a print string, positional identification, threads, etc., are used, they shall conform to the intent of the identification scheme.

7.2.4 Sheath colour coding

Sheath colour coding, if used, shall be as agreed between the manufacturer and customer.

7.3 ~~Optical~~ Fibre

7.3.1 General

Optical fibres shall meet the requirements of IEC 60793-2. Annex A gives guidance on application performance standards.

7.3.2 Attenuation coefficient

The maximum cabled fibre attenuation coefficient shall conform to Annex A. Particular values may be agreed between the customer and supplier.

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

7.3.3 Attenuation uniformity – Attenuation discontinuities

The local attenuation shall not have point discontinuities in excess of 0,10 dB for single-mode fibre and 0,20 dB for multimode fibre, when measured in accordance with IEC 60793-1-40.

EXAMPLE Wavelength of 1 310/1 550/1 625 nm for SM fibres, wavelength of 850/1 300 nm for MM fibres.

7.3.4 Cable cut-off wavelength

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

Unless otherwise stated, this shall be:

a) λ_{cc} ≤ 1 260 nm for fibre categories ~~B1.1, B1.3 and B6~~ B-652.B, B-652.D and B-657.A1/A2;B2/B3;

a) λ_{cc} ≤ 1 270 nm for fibre category ~~B2~~ B-653.A/B;

b) λ_{cc} ≤ 1 450 nm for fibre categories ~~B4 and B5~~ B-655.C/D/E and B-656;

c) λ_{cc} ≤ 1 530 nm for fibre category ~~B1.2~~ B-654.A/B/C. **24**

7.3.5 Polarization mode dispersion (PMD)

Cabled single-mode fibre PMD shall be characterized on a statistical basis, not on an individual fibre basis, as described in IEC TR 61282-3. Measurements on individual cabled fibres shall be performed in accordance with IEC 60793-1-48. Measurements on uncabled fibres can be used to generate cabled fibre statistics when the design and processes are stable and the relationship between the PMD coefficients of uncabled and cabled fibres are known.

The manufacturer shall supply a PMD link design value, PMD_Q, that serves as a statistical upper bound PMD coefficient of the concatenated optical fibre cables within a possible optical link. Unless otherwise specified in the detail specification, the PMD_Q value shall be less than ~~0,5~~ 0,2 ps/√km with a probability of 10^{-4} that this value be exceeded for a numerical concatenation of at least 20 cables.

7.4 Buffer tubes **25**

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.

7.5 Tensile strength elements 26

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.

7.6 Crush protection elements 27

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

7.7 Water blocking elements 28

If specified, the element(s) and in addition the cable core shall contain water blocking material, such as grease-like or dry-block materials or both, to prevent longitudinal water penetration.

If specified, a moisture barrier shall be provided either by a continuous metallic sheath or by a metallic or non-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.

7.8 Sheath removal elements 29

If required, one or two ripcords may be provided beneath the sheath.

7.9 Cable sheath 30

The cable core shall be uniformly covered with a protective sheath.

For outdoor and indoor/outdoor cables the cable shall have a seamless sheath made of UV-stabilized weather-resistant polymer.

8 Measuring and test methods

8.1 General

Not all measurements and tests are applicable to all cables.

Intrinsic characteristics of optical fibres are not normally measured by cable manufacturers. The relevant values are provided by optical fibre manufacturers, and are available as unitary or statistical values. For practical reasons, the core diameter of single-mode fibres is not specified. Mode field diameter is the relevant specification parameter.

Test results shall follow the rule of “rounding half away from zero” (or rounding error), when the results recorded display more than the significant number of digits required in the acceptance criteria (see 3.18).

Guidance on selecting fibres for testing is given in Annex B.

8.2 Measuring methods for transmission and optical characteristics

The transmission and optical characteristics of optical fibre in cables shall be verified by carrying out selected tests from those shown in Table 10. The tests applied and acceptance criteria shall be as specified in the relevant specification.

Table 10 – Measuring methods for transmission and optical characteristics ~~of cabled optical fibres~~

Test method	Test	Characteristics covered by the test method
Test methods for multimode and single-mode fibre cables		
IEC 60793-1-40 method B	Insertion loss technique	Attenuation
IEC 60793-1-40 method C	Backscattering technique	Attenuation
IEC 60793-1-40 method C	Backscattering technique	Point defects
IEC 60793-1-46 method A IEC 60793-1-46 method B	Transmitted power monitoring Backscattering monitoring	Change of optical transmittance during mechanical and environmental tests
Test methods for single-mode fibres		
IEC 60793-1-48	Polarization mode dispersion	Polarization mode dispersion
NOTE Bandwidth, chromatic dispersion and cable cut-off wavelength are not measured on a cabled optical fibre.		

8.3 Measuring methods for dimensions

The dimensions of the optical fibres, electrical conductors, cable elements and optical cables shall be determined by subjecting samples to tests selected from Table 11. The tests applied, acceptance criteria and number of samples shall be as specified in the relevant specification.

Table 11 – Measuring methods for dimensions

Test method	Test	Characteristics covered by test method
IEC 60793-1-21	Coating geometry measurement	Diameter of primary coating Diameter of coloured fibre Diameter of secondary or “buffer” coating Non-circularities of secondary or “buffer” coating Primary coating-cladding concentricity error
IEC 60793-1-22 method A	Delay of transmitted and/or reflected pulse	Length of fibre
IEC 60793-1-22 method B	Backscattering technique	Length of fibre
IEC 60189-1	Mechanical	Diameter of electrical conductor
IEC 60811-201 IEC 60811-202 IEC 60811-203	Mechanical	Thickness of insulation – electrical conductors Thickness of sheaths and cable elements Overall dimensions

8.4 ~~Measuring~~ Test methods for mechanical characteristics

The mechanical characteristics of optical fibre cables shall be verified by subjecting samples to tests selected from IEC 60794-1-21, now the IEC 60794-1-1xx series. IEC 60794-1-2 shows the cross reference and lists all mechanical test methods **31**. The acceptance criteria shall be as specified in the relevant specifications.

8.5 ~~Measuring~~ Test methods for environmental characteristics

The environmental characteristics of optical fibre cables shall be verified by subjecting samples to tests selected from IEC 60794-1-22, now replaced with the IEC 60794-1-2xx series. IEC 60794-1-2 shows the cross reference and lists all environmental test methods. Guidance on selecting temperatures for environmental testing are given in Annex C **32**. The tests applied and acceptance criteria shall be as specified in the relevant specification.

8.6 ~~Measuring~~ Test methods for cable element characterization

Tests to characterize the different types of cable elements for handling purposes are given in IEC 60794-1-23, now replaced with the IEC 60794-1-3xx series. IEC 60794-1-2 shows the cross reference and lists all cable element test methods. **33**

8.7 Measuring and test methods for electrical characteristics

When electrical conductors or other metallic elements are incorporated in an optical fibre cable, verification of various electrical characteristics ~~may~~ can be necessary. Typical tests are shown in Table 12, in addition to those given in IEC 60794-1-24, now replaced with the IEC 60794-1-4xx series. IEC 60794-1-2 shows the cross reference and lists all electrical test methods. The tests applied and the acceptance criteria shall be as ~~laid down~~ specified in the relevant specification.

Table 12 – Measuring methods for electrical characteristics

Test method	Test	Characteristics covered by test method
IEC 60189-1	Conductor resistance	Characteristics of insulated electrical conductors
	Dielectric strength of insulation Insulation resistance	The insulation properties of conductors within optical fibre cables are normally just specified for the incoming material, pre-cabling.

For cables installed along overhead power lines, specialised tests are given in IEC 60794-1-24, Method H1: short-circuit test and Method H2: lightning test method, which has been withdrawn and replaced with IEC 60794-1-401 and IEC 60794-1-402, and in IEC 60794-4-20:~~2012~~2018, Annex C ~~(Electrical test (tracking)~~.

~~9 Related Technical Reports~~

~~Guidance to assist the user and installer with regard to the general aspects of the installation of optical fibre cables is covered by IEC TR 62691 [2]~~[6].

~~IEC TR 62222 [1] gives guidance on tests for assessing the fire performance of communication cables installed in buildings.~~

~~6 Numbers in square brackets refer to the Bibliography.~~

~~IEC TR 62362 [4] gives guidance on the selection of optical fibre cable specifications relative to mechanical, ingress, climatic or electromagnetic characteristics, as classified in ISO/IEC 24702 [9].~~

~~An evaluation of hydrogen induced effects within optical fibre cables is relevant for certain specialised designs, such as those for lakes, rivers, coastal and OPGW applications and those containing metallic tubes. More details on when detailed consideration may be warranted are given in IEC TR 62690 [3].~~

~~Guidelines on considerations that should be taken into account when testing optical fibres which are exposed to nuclear radiation are given in IEC TR 62283 [5].~~

~~Guidelines on considerations that should be taken into account when planning to connect different types of singlemode fibre are given in IEC/TR 62000 [6].~~

~~Guidance on techniques for the measurement of the coefficient of friction between cables and ducts is given in IEC TR 62470 [7].~~

Annex A
(informative)

Guidelines for specific ~~defined applications~~ optical fibre and cabled fibre performance

A.1 General

The fibre category should be agreed between the customer and supplier.

Applications of optical fibre cables are defined by many different standards organizations including IEC, ISO, IEEE and ITU.

A.2 Cabled fibre attenuation requirements

Cabled fibre attenuation requirements are given in Table A.1, Table A.2 and Table A.3.

Table A.1 – Maximum single-mode cabled fibre attenuation coefficient (dB/km), as given by ITU-T 34

~~Fibre category~~	~~Maximum attenuation coefficient (dB/km) at wavelengths (nm)~~			
	~~1 310 nm~~	~~1 383 nm~~	~~1 550 nm~~	~~1 625 nm~~
~~IEC 60793-2-50, B1.1 (dispersion unshifted) – ITU-T G.652.A~~	~~0,5~~	~~n/a~~	~~0,4~~	~~n/a~~
~~IEC 60793-2-50, B1.1 (dispersion unshifted) – ITU-T G.652.B~~	~~0,4~~	~~n/a~~	~~0,35~~	~~0,4~~
~~IEC 60793-2-50, B1.2 (cut-off shifted) – ITU-T G.654.A/B/C~~	~~n/a~~	~~n/a~~	~~0,22~~	~~n/a~~
~~IEC 60793-2-50, B1.3 (extended band) – ITU-T G.652.C~~	~~0,4~~	~~0,4 (1 310 to 1 625)~~	~~0,3~~	~~0,4~~
~~IEC 60793-2-50, B1.3 (extended band) – ITU-T G.652.D~~	~~0,4~~	~~0,4 (1 310 to 1 625)~~	~~0,3~~	~~0,4~~
~~IEC 60793-2-50, B2 (dispersion shifted) – ITU-T G.653.C/D~~	~~n/a~~	~~n/a~~	~~0,35~~	~~n/a~~
~~IEC 60793-2-50, B4 (non-zero dispersion shifted) – ITU-T G.655.C/D/E~~	~~n/a~~	~~n/a~~	~~0,35~~	~~0,4~~
~~IEC 60793-2-50, B5 (wideband non-zero dispersion shifted) – ITU-T G.656~~	~~n/a~~	~~0,4 (1 460)~~	~~0,35~~	~~0,4~~
~~IEC 60793-2-50, B6_a1, B6_a2 (bending loss insensitive) – ITU-T G.657.A1/A2~~	~~0,4~~	~~0,4 (1 310 to 1 625)~~	~~0,3~~	~~0,4~~
~~IEC 60793-2-50, B6_b2, B6_b3 (bending loss insensitive) – ITU-T G.657.B2/B3~~	~~0,5~~	~~0,4~~	~~0,3~~	~~0,4~~
~~n/a = not applicable~~				

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.B2/B3	0,40	0,40	0,40	0,40	0,30	0,30	0,40
n/a = not applicable							

These values are more applicable to cables ~~in the IEC 60794-3 [10] and IEC 60794-4 series,~~ that are used for long system applications (as defined by ITU-T). The introduction of link design attenuation (LDA) values is under consideration for certain fibre categories. Different attenuation values may be agreed between the customer and the supplier for certain cable constructions.

1 625 nm attenuation values are optionally specified by the customer.

A list of applications supported by A1 multimode optical fibres for multimode optical cables can be found in IEC 60793-2-10.

ISO/IEC 11801-1 provides information on supported applications for single-mode and multimode optical cables. It has ~~simplified the~~ permanent link requirements for cable attenuation by defining performance categories of cabled optical fibre. The categories can then be used in ~~channels~~ channel planning, defined by distance, which supports applications.

Table A.2 – Category A1 multimode fibre maximum cable attenuation coefficient (dB/km) 35

~~Fibre category~~	~~Attenuation coefficient at 850 nm~~	~~Attenuation coefficient at 1 300 nm~~	~~Performance category~~
~~IEC 60793-2-10, A1a.1 category~~	~~3,5~~	~~1,5~~	~~OM1, OM2~~
~~IEC 60793-2-10, A1a.2 category~~	~~3,5~~	~~1,5~~	~~OM3~~
~~IEC 60793-2-10, A1a.3 category~~	~~3,5~~	~~1,5~~	~~OM4~~
~~IEC 60793-2-10, A1b category~~	~~3,5~~	~~1,5~~	~~OM1, OM2~~

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.			

Table A.3 – Single-mode maximum cable attenuation coefficient (dB/km) 36

~~Fibre category~~	~~Wavelength (nm)~~	~~Maximum attenuation coefficient~~	~~Performance category~~
~~IEC 60793-2-50, B1.1, B1.3, or B6_a~~	~~1 310, 1 550~~	~~1,0~~	~~OS1[a]~~
~~IEC 60793-2-50, B1.3, or B6_a~~	~~1 310, 1 383, 1 550~~	~~0,4~~	~~OS2~~
~~[a] For OS1, the maximum attenuation of 1,0 dB is specified at 1 310 nm and 1 550 nm~~			

Fibre category	Attenuation coefficient at 1 310 nm	Attenuation coefficient at 1 383 nm	Attenuation coefficient at 1 550 nm	Attenuation coefficient at 1 625 nm	Performance category
IEC 60793-2-50, B-652.B, B-652-D, B-657.A1, B-657-A2, B-657-B2/B3	1,0	1,0	1,0	n/a	OS1a
IEC 60793-2-50, B-652.D	0,4	0,4	0,4	n/a	OS2
IEC 60793-2-50, B-657.A1	0,4	0,4	0,4	n/a	OS2
IEC 60793-2-50, B-657.A2	0,4	0,4	0,4	n/a	OS2

A.3 Cabled fibre bandwidth requirements

There are no bandwidth requirements on single-mode fibres.

For cables containing multimode fibres, the fibre should be specified at one of the performance levels defined in Table A.4 in terms of minimum bandwidth (MHz·km), wavelength, and type of measurement. The value for bandwidth is normally as given by the fibre supplier, rather than measured on the cabled fibre.

The fibre category and performance level should be agreed between the customer and supplier.

Table A.4 – Category A1 multimode cabled fibre bandwidth (MHz·km) 37

~~Fibre category~~	~~Nominal core diameter (µm)~~	~~Overfilled bandwidth at 850 nm~~	~~Overfilled bandwidth at 1300 nm~~	~~Effective modal bandwidth at 850 nm~~	~~Performance category~~
~~IEC 60793-2-10, A1a.1 category~~	~~50~~	~~200~~	~~500~~	~~n/a~~	~~OM1~~
~~IEC 60793-2-10, A1a.1 category~~	~~50~~	~~500~~	~~500~~	~~n/a~~	~~OM2~~
~~IEC 60793-2-10, A1a.2 category~~	~~50~~	~~1 500~~	~~500~~	~~2 000~~	~~OM3~~
~~IEC 60793-2-10, A1a.3 category~~	~~50~~	~~3 500~~	~~500~~	~~4 700~~	~~OM4~~
~~IEC 60793-2-10, A1b category~~	~~62,5~~	~~200~~	~~500~~	~~n/a~~	~~OM1~~
~~IEC 60793-2-10, A1b category~~	~~62,5~~	~~500~~	~~500~~	~~n/a~~	~~OM2~~
~~n/a = not applicable~~					

Fibre category	Nominal core diameter (µm)	Overfilled bandwidth at 850 nm	Overfilled bandwidth at 953 nm	Overfilled bandwidth at 1 300 nm	Effective modal bandwidth at 850 nm	Effective modal bandwidth at 953 nm	Performance category
IEC 60793-2-10, A1-OM1 category	62,5	200	n/a	500	n/a	n/a	OM1 [a]
IEC 60793-2-10, A1-OM2 category	50	500	n/a	500	n/a	n/a	OM2 [a]
IEC 60793-2-10, A1-OM3 category	50	1 500	n/a	500	2 000	n/a	OM3
IEC 60793-2-10, A1-OM4 category	50	3 500	n/a	500	4 700	n/a	OM4
IEC 60793-2-10, A1-OM5 category	50	3 500	1 850	500	4 700	2 470	OM5
n/a = not applicable [a] OM1 and OM2 are no longer supported but are shown here for completeness							

A.4 Type testing at 1 625 nm

When specifically requested by the customer specification, cables that are intended for use in systems operating in the L-band (1 565 nm to 1 625 nm) may be tested at 1 625 nm. Table A.5 below gives some guidance on possible pass/fail criteria. Actual requirements should be established by agreement between the customer and supplier, based on the particular cable application.

Table A.5 – Guidance values for 1 625 nm type test acceptance criteria 38

~~Test~~	~~Wavelength (nm)~~	~~Acceptance criteria[a,b]~~	
~~Attenuation – Point discontinuities~~	~~1 625~~	~~0,2 dB~~	
~~Temperature cycling~~	~~1 625~~	~~0,3 dB/km~~	
~~All other tests in the IEC 60794-1-2x series~~	~~1 625~~	~~0,3 dB~~	
~~[a] Results at 1 625 nm may be used to demonstrate compliance at 1 550 nm, using 1 550 nm acceptance criteria.~~ ~~[b] Results at 1 550 nm shall not be used to demonstrate compliance at 1 625 nm.~~			

Test	Wavelength nm	Acceptance criterion [a,b]
Maximum variation in attenuation – Point discontinuities	1 625	0,2 dB
Maximum change in attenuation coefficient during temperature cycling	1 625	0,6 dB/km [c]
Maximum change in attenuation for all other tests in the IEC 60794-1 series (during long-term load and after test)	1 625	0,5 dB[c]
[a] Results at 1 625 nm may be used to demonstrate compliance at 1 550 nm, using 1 550 nm acceptance criteria. [b] Results at 1 550 nm shall not be used to demonstrate compliance at 1 625 nm. [c] 0,4 dB/km or 0,4 dB higher than the acceptance criterion at 1 550 nm. The acceptance criteria at 1 550 nm can vary in the different cable specifications of the IEC 60794 series.		

Annex B
(informative)

Guidelines for qualification sampling

B.1 General

Typically, a wide range of fibre counts can be accommodated by a small range of generic optical fibre cables. For example, considering loose tube designs with 12 fibres per tube, a 6-element cable ~~could~~ can be produced in 12, 24, 36, 48, 60 or 72 fibre versions just by varying the number of tubes and dummy filler elements, within the same basic design. Similarly, cables with 6, 8, 12 and 24 elements ~~could~~ can provide options for 12 cables covering from ~~12~~ 72 to 288 fibres, within just 4 generic cable designs. This concept can be applied to different fibre counts. For qualification purposes, it ~~should~~ will probably only be necessary to test a subset of the fibre counts and element counts that represent the product range (e.g. the smallest and the largest element count designs). In the previous example, it ~~could~~ can be considered appropriate to test just one 6-element design and one 24-element design in order to prove a manufacturer's design and manufacturing capability.

This philosophy can equally be applied to other designs of optical cable such as single element designs, central tube cable designs or buffered optical fibre cable designs. For example, the smallest and the largest fibre count designs could be tested.

B.2 Fibre selection for cable testing

The cable being tested may contain a full complement of working fibres or may contain working and dummy/scrap fibres. A representative number of fibres that are tested ~~fibres~~ should be dispersed throughout the working units. For cables with multiple tube designs, non-working tubes or filler rods may be deployed but they ~~should~~ can be used in such a manner that they do not affect the performance of the test. The manufacturer ~~should~~ may position the working units within a cable such that they will be subjected to the full force of the test. It is recommended to test a minimum number of fibres of a full complement of fibres in a cable, as given in Table B.1.

Table B.1 – Recommended minimum number of tested fibres in a cable 39

Number of fibres in the cable	Recommended minimum number of tested fibres in a cable %
1 to 12	50
13 to 48	20
49 to 288	10
289 to 1 152	5
1 153 to 4 608	2
4 609 or more	1

Stranded loose tube cable designs with more than one active tube ~~should~~ may be tested as follows:

In a single layer cable design, at least one fibre from a minimum of 2 tubes ~~should~~ can be tested. In a multi-layer design, at least one fibre from a minimum of 2 tubes of each layer ~~should~~ may be tested. The selected tubes ~~should not~~ cannot be located next to each other and ~~should~~ may be fully populated with fibres although some may be scrap/dummy fibres.

Ribbon cables with a layered ribbon structure ~~should~~ may contain working fibres in the first, last, and central ribbon position. The working fibre being tested ~~should~~ may be located at both edges and in the middle of each of these ribbons. For partially bonded ribbon designs, a representative number of fibres, in accordance with Table B.1 and dispersed throughout the working units, shall be tested.

If agreed between the customer and supplier, optical fibres ~~within a tube~~ may be spliced to each other, for example~~, in cases where a test requires that no fibres should break~~. This is a convenient way to check all fibres under test.

The test report may record how many fibres in a cable were tested, where the tested fibres were positioned within the cable structure and if the optical performance of all tested fibres were measured individually or serially connected.

When a change in the design occurs, then only the tests that are affected by the design change need to be performed.

B.3 Pass/fail criteria

The acceptance criteria will depend on the application but would typically include no fibre break or a combination of “no change” (see Clause 3) and ~~permissible~~ allowable change in performance. These differences arise due to varying requirements before, during and after a test, as given in the relevant specification.

Annex C
(informative)

Preferred temperatures 40

The temperature limits listed in Table C.1 are preferred to be used as test parameters for temperature cycling, shrinkage and any other tests of optical fibre cables where these temperatures are suitable to be applied.

Table C.1 – Preferred low and high temperature 41

Low temperature T_A °C	High temperature T_B °C	Sources of temperature limits	
		Performance categories of connectors, components and protective housings [a]	Environmental classification of customer premises cabling [b]
-10	+60	C	$M_xI_xC_1E_x$
-10	+70	C^{HD}	-
-25	+70	OP	$M_xI_xC_2E_x$
-25	+85	OP^{HD}	-
-30	+60	S	-
-40	+65	A, G	-
-40	+70	I	$M_xI_xC_3E_x$
-40	+75	OP+	-
-40	+85	$OP+^{HD}$, I^{HD}, E	-

A suitable operating service environment (performance category) or environmental classification should be selected in accordance with the application.

[a] Included in IEC 61753-1. The abbreviations are as follows:
C: indoor controlled environment;
OP/OP+: outdoor protected environment;
S: outdoor subterranean or sub-surface environment;
A: outdoor aerial environment;
G: outdoor ground level environment;
I: industrial environment;
E: extreme environment;
^{HD}: indicates an extended upper temperature necessary due to additional dissipation by active electronics.

[b] Included in ISO/IEC 11801-1. For an introduction to the MICE environmental classification system use ISO/IEC TR 29106. For technical guidance use IEC TR 62362.

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IEC 60794-2-24, *Optical fibre cables – Part 2-23: Indoor optical fibre cables – Detailed specification for multiple multi-fibre unit cables for use in MPO connector terminated breakout cable assemblies*

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

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IEC 60794-2-20, *Optical fibre cables – Part 2-20: Indoor cables – Family specification for multi-fibre optical cables*

IEC 60794-2-21, *Optical fibre cables – Part 2.21: Indoor cables – Detailed specification for multi-fibre optical distribution cables for use in premises cabling*

IEC 60794-2-22, *Optical fibre cables – Part 2-22: Indoor cables – Detail specification for multi-simplex breakout optical cables to be terminated with connectors*

[7] This publication has been withdrawn.

IEC 60794-2-23, *Optical fibre cables – Part 2-23: Indoor optical fibre cables – Detailed specification for multi-fibre cables for use in MPO connector terminated cable assemblies*

IEC 60794-2-24, *Optical fibre cables – Part 2-24: Indoor optical fibre cables – Detailed specification for multiple multi-fibre unit cables for use in MPO connector terminated breakout cable assemblies*

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IEC 60794-2-40, *Optical fibre cables – Part 2-40: Indoor optical fibre cables – Family specification for A4 fibre cables*

IEC 60794-2-41, *Optical fibre cables – Indoor cables – Product specification for simplex and duplex buffered A4 fibres*

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IEC 60794-6-20, *Optical fibre cables – Part 6-20: Indoor-outdoor cables – Family specification for flame retardant outdoor cables*

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IEC TR 61931, *Fibre optic – Terminology*

IEC TR 62000, *Guidelines for combining different single-mode fibre sub-categories*

IEC TR 62222, *Fire performance of communication cables installed in buildings*

IEC TR 62283, *Optical fibres – Guidance for nuclear radiation tests*

IEC TR 62362, *Selection of optical fibre cable specifications relative to mechanical, ingress, climatic or electromagnetic characteristics – Guidance*

IEC TR 62470, *Guidance on techniques for the measurement of the coefficient of friction (COF) between cables and ducts*

[8] Under development.

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

IEC 62807-1, *Hybrid telecommunication cables – Part 1: Generic specification*

IEC TR 62901, *Guide for the selection of drop cables*

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

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ITU-TG.653, *Characteristics of a dispersion-shifted, single-mode optical fibre and cable*

ITU-T G.654, *Characteristics of a cut-off shifted single-mode optical fibre and cable*

ITU-T G.655, *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable*

ITU-T G.656, *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport*

ITU-T G.657, *Characteristics of a bending-loss insensitive single-mode optical fibre and cable*

List of comments

1 Scope is changed to show hybrid communication cables are covered in IEC 62807 series.

2 LDA definition is updated to reflect the statistical upper bound of the distribution.

3 New definitions for circuit integrity and fire resistance are added to support new publication IEC 60794-7 currently under development.

4 New notes are added to provide more clarity on long-term load.

5 New note is added to provide more clarity for short-term load.

6 New notes are added to provide more clarity for maximum allowable tension.

7 Clause 5 is redesigned and reorganized to make the document flow better than previous version.

8 This section is deleted and is reorganized into tables that provide better organization and definition.

9 First level hierarchy of new organizational structure. New table is added to show overall structure of the IEC 60794 series of standards.

10 Second level hierarchy of new organizational structure. IEC 60794-1 series table is added for better definition and clarity.

11 Second level hierarchy of new organizational structure. IEC 60794-2 series table is added for better definition and clarity.

12 Second level hierarchy of new organizational structure. IEC 60794-3 series table is added for better definition and clarity.

13 Second level hierarchy of new organizational structure. IEC 60794-4 series table is added for better definition and clarity.

14 Second level hierarchy of new organizational structure. IEC 60794-5 series table is added for better definition and clarity.

15 Second level hierarchy of new organizational structure. IEC 60794-6 series table is added for better definition and clarity.

16 Line item is added for new publication IEC 60794-7 which is currently under development.

17 Reorganized and added new subclause, cable materials to separate these items from cable construction.

18 New subclause is added to define indoor cables.

19 New tables are added to show indoor cable materials. Also added information showing cable element and type of material.

20 New subclause is added to better define outdoor cable materials.

21 New tables are added to show outdoor cable materials. Also added information showing cable element and type of material.

22 New subclause is added to define indoor/outdoor cables.

23 Added reference to technical report IEC TR 63194, Guidance on colour coding of optical fibre cables.

24 All fibre types are updated with new nomenclature.

25 New subclause is added to address recommendations for buffer tubes.

26 New subclause is added to address recommendations for tensile strength elements.

27 New subclause is added to address recommendations for crush protection elements.

28 New subclause is added to address recommendations for water blocking elements.

29 New subclause is added to address recommendations for sheath removal elements.

30 New subclause is added to address recommendations for cable sheath.

31 Added reference to new numbering of mechanical test procedures and added a reference to IEC 60794-1-2, Optical fibre cables - Part 1-2: Generic specification - Basic optical cable test procedures - General guidance

32 Added reference to new numbering of environmental test procedures and added a reference to IEC 60794-1-2, Optical fibre cables - Part 1-2: Generic specification - Basic optical cable test procedures - General guidance

33 Added reference to new numbering of cable element test procedures and added a reference to IEC 60794-1-2, Optical fibre cables - Part 1-2: Generic specification - Basic optical cable test procedures - General guidance

34 Table is updated to show additional wavelengths and attenuation values. Updated all fibre nomenclature.

35 Table is updated to include new fibre nomenclature and showed OM1 and OM2 are no longer supported.

36 Table is updated to include new fibre nomenclature and added additional wavelengths.

37 Table is updated to include new fibre nomenclature and added additional wavelengths.

38 Table is updated to include more detail on test and acceptance criteria.

39 New table is added to provide guidance on recommended number of fibres to test based on cable fibre count.

40 New Annex C is added to show preferred temperature ranges.

41 New temperature table is added to better illustrate ranges based on performance categories. Also added MICE classification.

IEC 60794-1-1

Edition 5.0 2023-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Optical fibre cables – Part 1-1: Generic specification – General

Câbles à fibres optiques – Partie 1-1: Spécification générique – Généralités

IEC 60794-1-1:2023-03(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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OPTICAL FIBRE CABLES –

Part 1-1: Generic specification – General

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 60794-1-1 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 2015. This edition constitutes a technical revision.

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

a) reorganization of the document to a more logical flow making it easier for the reader:
b) expansion of the tables to include names and definitions of all documents in the IEC 60794-x series;
c) expansion of the definitions, graphical symbols, terminology and abbreviations content, with the aim of making this document the default and reference for all others in the IEC 60794-x series;

d) inclusion of updated, reorganized and expanded optical fibre, attenuation and bandwidth subclauses, with the aim of making this document the default and reference for all others in the IEC 60794-x series.

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

Draft	Report on voting
86A/2286/FDIS	86A/2313/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,
- replaced by a revised edition, or
- amended.

OPTICAL FIBRE CABLES –

Part 1-1: Generic specification – General

1 Scope

This part of IEC 60794 applies to optical fibre cables for use with communication equipment and devices employing similar techniques. Electrical properties are specified for optical ground wire (OPGW) and optical phase conductor (OPPC) cables. Hybrid communication cables are specified in the IEC 62807 series.

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

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

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

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

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: Attenuation measurement methods*

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

IEC 60793-1-46, *Optical fibres – Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance*

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

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

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

IEC 60793-2-40:2021, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

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

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

IEC 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

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*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1
no change in attenuation
acceptance criterion for attenuation measurement that includes an allowance for measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards

Note 1 to entry: For a practical interpretation, the following values shall be used:

a) No change in attenuation, single-mode (class B): the total uncertainty of measurement shall be ≤ ± 0,05 dB for the attenuation or ≤ ± 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 (≤ ± 0,05 dB or ≤ ± 0,05 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 0,15 dB shall be accepted. For environmental tests no deviation in excess of 0,10 dB/km shall be accepted.

b) No change in attenuation, multimode (category A1): the total uncertainty of measurement shall be ≤ ± 0,2 dB for the attenuation or ≤ ± 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 (≤ ± 0,2 dB or ≤ ± 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.

c) No change in attenuation, plastic optical fibre (category A4): the total uncertainty of measurement for this document shall be ≤ 2 % of the maximum specified attenuation in IEC 60793-2-40:2021, Annex A to Annex I.

Any measured value within this range shall be considered as “no change in attenuation”.

[1] This document is progressively being replaced by the IEC 60794-1-2XX series.

3.2
allowable change in attenuation
<during mechanical and environmental tests> change in attenuation that may be a value larger than the no change limits, depending on fibre category, single-mode or multimode, cable design and application

3.3
link design attenuation
LDA
statistical upper bound for the attenuation coefficient of the concatenated optical fibre cables

3.4
no change in fibre strain
acceptance criterion for fibre strain measurement that includes an allowance for measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards

Note 1 to entry: For a practical interpretation, the total uncertainty of measurement shall be ± 0,05 % strain. Any measured value within this range shall be considered as “no change in strain”.

3.5
allowable change in fibre strain
<during mechanical and environmental tests> level of strain that will not compromise fibre mechanical reliability for some of the parameters specified

3.6
circuit integrity
ability of the cable under test to continue to operate in a designated manner whilst subjected to a specified flame source for a specified period of time

3.7
fire resistance
ability of the cable under test to resist functional failure to operate in a designated manner whilst subjected to a specified flame source for a specified period of time

3.8
shrinkage
irreversible contraction after extrusion of plastic materials caused by heating or over time at ambient temperature

3.9
cable load definitions (non-aerial applications)

3.9.1
long-term load
T_L
acceptable amount of long-term load which the cable can experience during operation (i.e. after installation is completed)

Note 1 to entry: Long-term load can be due either to residual loading from the installation process or environmental effect, or both. This is the rated maximum load for which a cable is subject to in long term tests.

Note 2 to entry: For 1 % proof-tested fibres, the fibre strain under long term tensile load (T_L) shall not exceed 20 % of this fibre proof strain (equal to absolute 0,2 % strain) and there shall be no change in attenuation during the test.

Note 3 to entry: For fibres proof tested at higher levels the safe long-term load will not scale linearly with the proof strain, so a lower percentage of the proof strain is applicable. For proof-tested fibres at levels higher than 1 % and up to 2 %, the strain at T_L shall be limited to 17 % of the proof-test strain (equal to absolute 0,34 % strain for 2 % proof tested fibres).

3.9.2
short-term load
T_S
acceptable amount of short-term load that can be applied to a cable without permanent degradation of the characteristics of the fibres, cable elements or sheath

Note 1 to entry: Short-term load is often called rated installation load.

Note 2 to entry: Under short term tensile load (T_S) the fibre strain shall not exceed 60 % of the proof strain (equal to absolute 0,6 % strain for 1 % proof-tested fibres) and the attenuation change during test shall be measured and recorded.

3.10
cable load definitions and tensile testing terminology (self-supporting aerial applications)

3.10.1
maximum allowable tension
MAT
maximum tensile load that can be applied to the cable without detriment to the performance requirements (e.g. attenuation, fibre reliability) due to fibre strain

Note 1 to entry: Due to installation codes the MAT value is sometimes restricted to be less than 60 % of the breaking tension of the cable.

Note 2 to entry: This is also called ultimate operational strength (UOS), equal to 60 % of RTS (and fibre strain < 0,35 %, 1/3 of proof test). MAT < 60 % UOS.

Note 3 to entry: This is also called every day stress (EDS), defined as 25 % of RTS and no fibre strain (< 0,05 %) and no attenuation increase (< 0,05 dB).

3.10.2
strain margin
value of cable elongation at the onset of fibre strain

Note 1 to entry: The strain margin can also be expressed as cable load (N) at the onset of the fibre strain.

3.10.3
breaking tension
tensile load that will produce physical rupture of the cable

Note 1 to entry: The breaking tension can be calculated, provided that the design model has been validated.

3.10.4
maximum installation tension
MIT
maximum recommended stringing tension during installation

3.10.5
rated tensile strength
RTS
summation of the product of nominal cross-sectional area, nominal tensile strength, and stranding factor for each load bearing material in the cable construction

3.11
cable section
individual reel of cable, as produced

3.12
cable element
component of a cable designed to house and protect the optical fibres

Note 1 to entry: This was changed from “fibre optic unit” in IEC 60794-4-10 to “cable element” to be consistent with IEC 60794-1-23 and also to avoid confusion with IEC 60794-5-20.

Note 2 to entry: The cable sheath is included as a cable element.

3.13
polarization mode dispersion (PMD) terms

3.13.1
differential group delay
DGD
relative time delay between the two fundamental polarization modes (principal states of polarization) at the end of an optical fibre cable, at a particular time and wavelength

Note 1 to entry: Differential group delay is expressed in ps.

3.13.2
polarization mode dispersion value
PMD value
average of DGD values across wavelengths

Note 1 to entry: The polarization mode dispersion value is expressed in ps.

3.13.3
polarization mode dispersion coefficient
PMD coefficient
PMD value of an optical fibre cable divided by the square root sum of its length (km)

Note 1 to entry: The polarization mode dispersion coefficient is expressed in ps/√km.

3.13.4
link
length of cable composed of a number of individual cable sections

Note 1 to entry: Link PMD values are generally calculated in accordance with the formulae given in IEC TR 61282-3 but may be measured.

3.14
terminated cable assembly
cable terminated with connectors

Note 1 to entry: A patch cord or jumper is one type of a terminated cable assembly.

Note 2 to entry: The following terms for terminated cable assemblies with connector(s) at both ends are used in the ISO/IEC 11801 series: patch cords, work area cords and equipment cords.

3.15
aerial cable types

3.15.1
all dielectric self-supporting
ADSS
cable that is capable of enduring aerial installation and providing long term service, without any external tensile support

3.15.2
optical attached cable
OPAC
dielectric cable that is not self-supported, but attached to an electrical earth wire or phase conductor, using one of the following attachment methods: wrapped, lashed or preform attached

3.15.3
wrapped
lightweight flexible non-metallic (“wrap”) cable that can be wrapped helically around either the earth wire or the phase conductor using special machinery

3.15.4
lashed
non-metallic cables that are installed longitudinally alongside the earth wire, the phase conductor or on a separate support cable (on a pole route) and are held in position with a binder or adhesive cord

3.15.5
preform attached
cable similar to the lashed cables but attached with the use of special preformed spiral attachment clips

3.15.6
optical ground wire
OPGW
metallic optical cable for overhead power lines that has the dual performance functions of a conventional ground wire with telecommunication capabilities

3.15.7
optical phase conductor
OPPC
Metallic hybrid optical cable that has the dual performance functions of a conventional phase conductor with telecommunication capabilities

3.16
composite cable
optical fibre cable containing more than one fibre category

3.17
hybrid communication cable
cable that contains more than one media type, including but not limited to optical fibres, twisted pair/quad cables, or coaxial cables or all of them

3.18
rounding error
rule[2] of “rounding half away from zero” when the results recorded display more than the significant number of digits required in the acceptance criteria.

Note 1 to entry: Only the first digit beyond the number of significant digits is used in determining the rounding.

EXAMPLE 1: Against a requirement of 0,22 dB/km maximum attenuation, values up to 0,224 dB/km conform, whilst values of 0,225 dB/km and above are failures.

EXAMPLE 2: Against a requirement of ± 0,05 dB, values between -0,054 and +0,054 are deemed acceptable.

3.19
maximum allowable ovality
largest permissible ovality of the optical unit or its component calculated as:

$2 \times (d1 - d2) / (d1 + d2)$ in % where:

$d1$ is the maximum measured diameter of the cable or the component

$d2$ is the minimum diameter of the cable or the component at the same cross-section as $d1$

[2] Please see ISO/IEC Guide 98-3:2008, Clause 7, on uncertainty of measurement for additional information.

3.20
breakout cable
cable consisting of subunits which can be separate fibre optical cables surrounded by a sheath of suitable material

Note 1 to entry: In the application this outer sheath of the breakout cable can be removed over a certain length and the subunits can be used as separate fibre optic cables.

4 Graphical symbols and abbreviated terms

For the purposes of this document, the abbreviated terms given in IEC TR 61931 as well as the following apply.

ADSS	all dielectric self-supporting
APL	aluminium/polyethylene laminate
ΔD	minimum wall thickness of a microduct
$\Delta D'$	minimum thickness of the outer sheath of a protected microduct
D	nominal outer diameter of a microduct cable
d	nominal outer diameter of a cable (including microduct fibre units)
dc	nominal outer diameter of a conduit or subduct
DS	detail specification
EDS	every day stress
ID	nominal inner diameter of a microduct
I/O-port	input/output port for launching OF cables into and out of a pipe
λ_{CC}	cable cut-off wavelength
$\lambda_{operational}$	operational wavelength
LDA	link design attenuation
m	mass of 1 km of cable (in the context of tensile testing)
MAOC	maximum allowable ovality of cable
MAT	maximum allowable tension
MASS	metallic aerial self-supported cables
MICE	mechanical, ingress, climatic, or electromagnetic
MIT	maximum installation tension
$n \times d$	product of a variable and the cable outer diameter used for determining appropriate sizes for bends, mandrels, etc.
$n \times OD$	product of a variable and the outer diameter of a microduct used for determining appropriate sizes for bends, mandrels, etc.
$n \times OD'$	product of a variable and the outer diameter of a protected microduct used for determining appropriate sizes for bends, mandrels, etc.
OCEPL	optical cable to be used along electrical power lines
OD	nominal outer diameter of a microduct
OD'	nominal outer diameter of a protected microduct
OPAC	optical attached cable (or optical power attached cable)
OPGW	optical ground wire
OPPC	optical phase conductor
PE	polyethylene
RTS	rated tensile strength

S	outdoor subterranean or sub-surface environment
SPL	steel/polyethylene laminate
SZ	technique in which the lay reverses direction periodically
t_1	temperature cycling dwell time
T_{A1}	temperature cycling test low-temperature limit in accordance with IEC 60794-1-22, Method F1
T_{A2}	temperature cycling test secondary low-temperature limit in accordance with IEC 60794-1-22, Method F1
T_{B1}	temperature cycling test high-temperature limit in accordance with IEC 60794-1-22, Method F1
T_{B2}	temperature cycling test secondary high-temperature limit in accordance with IEC 60794-1-22, Method F1
T_L	long term load
T_o	tensile load at “no fibre strain”
T_S	short term load
UOS	ultimate operation strength
W	weight of 1 km of cable, microduct fibre unit or any form of ducting, as applicable

5 Optical fibre cables – IEC 60794 structure

5.1 General

Optical fibre cables are a structure which is made of one or more elements containing optical fibres, mechanical strength elements and a surrounding jacket or surrounding jackets for protection against mechanical as well as environmental attacks. The IEC 60794 series consists of the following parts (see Table 1):

Table 1 – IEC 60794 structure

IEC 60794-1-1	Generic specification
IEC 60794-2	Indoor cables – Sectional specification
IEC 60794-3	Outdoor cables – Sectional specification
IEC 60794-4	Sectional specification – Aerial optical cables along electrical power lines
IEC 60794-5	Sectional specification – Microduct cabling for installation by blowing
IEC 60794-6	Indoor-outdoor cables – Sectional specification for indoor-outdoor cables
IEC 60794-7[3]	Sectional specification – Fire-resistant cables for data communication – Sectional specification

5.2 IEC 60794-1 series

The object of this series is to establish uniform generic requirements for the geometrical, transmission, material, mechanical, ageing (environmental exposure), climatic and electrical properties of optical fibre cables and cable elements. The series is shown in Table 2.

[3] This series is still at the development stage.

Table 2 – IEC 60794-1 series

IEC 60794-1	60794-1-1, Generic specification – General
	60794-1-2, Generic specification – Basic optical cable test procedures – General guidance
	60794-1-3, Generic specification – Optical cable elements

5.3 IEC 60794-2 series

The object of this series is to provide requirements that apply to optical fibre cables for indoor use in communications networks. Other types of applications requiring similar types of cables can be considered. The series is shown in Table 3.

Table 3 – IEC 60794-2 series

IEC 60794-2	IEC 60794-2-10, Indoor optical fibre cables – Family specification for simplex and duplex cables
	IEC 60794-2-11, Indoor cables – Detailed specification for simplex and duplex cables for use in premises cabling
	IEC 60794-2-20, Indoor cables – Family specification for multi-fibre optical cables
	IEC 60794-2-21, Indoor cables – Detailed specification for multi-fibre optical distribution cables for use in premises cabling
	IEC 60794-2-22, Indoor cables – Detail specification for multi-simplex breakout optical cables to be terminated with connectors
	IEC 60794-2-23[4], Indoor optical fibre cables – Detailed specification for multi-fibre cables for use in MPO connector terminated cable assemblies
	IEC 60794-2-24[5], Indoor optical fibre cables – Detailed specification for multiple multi-fibre unit cables for use in MPO connector terminated breakout cable assemblies
	IEC 60794-2-30, Indoor cables – Family specification for optical fibre ribbon cables for use in terminated cable assemblies
	IEC 60794-2-31, Indoor cables – Detailed specification for optical fibre ribbon cables for use in premises cabling
	IEC 60794-2-40, Indoor optical fibre cables – Family specification for A4 fibre cables
	IEC 60794-2-41, Indoor cables – Product specification for simplex and duplex buffered A4 fibres
	IEC 60794-2-42, Indoor optical fibre cables – Product specification for simplex and duplex cables with A4 fibres
	IEC 60794-2-50, Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies

5.4 IEC 60794-3 series

This series 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 series. Also included are cables for specialized use in sewers and rapid deployment. The series is shown in Table 4.

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4 Under development. Stage at the time of publication; IEC CD 60794-2-23:2022.

5 Under development. Stage at the time of publication: IEC CC 60794-2-24:2022.

Table 4 – IEC 60794-3 series

IEC 60794-3	IEC 60794-3-10, Outdoor cables – Family specification for duct, directly buried and lashed aerial optical telecommunication cables
	IEC 60794-3-11, Outdoor cables – Product specification for duct, directly buried, and lashed aerial single-mode optical fibre telecommunication cables
	IEC 60794-3-12, Outdoor cables – Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling
	IEC 60794-3-20, Outdoor cables – Family specification for self-supporting aerial telecommunication cables
	IEC 60794-3-21, Outdoor cables – Product specification for optical self-supporting aerial telecommunication cables for use in premises cabling
	IEC 60794-3-30, Outdoor cables – Family specification for optical telecommunication cables for lakes, river crossings and coastal application
	IEC 60794-3-40, Outdoor cables – Family specification for cables for storm and sanitary sewers
	IEC 60794-3-70, Outdoor cables – Family specification for outdoor optical fibre cables for rapid/multiple deployment

5.5 IEC 60794-4 series

This series covers cable construction, test methods, optical, mechanical, environmental and electrical performance requirements for aerial optical fibre cables and cable elements which are intended to be used along power lines (OCEPL) as a high bandwidth transport media for communications and control optical signals, including optical ground wires (OPGW), optical phase conductors (OPPCs), metallic aerial self-supported cables (MASS), all-dielectric self-supporting cables (ADSS) and optical attached cables (OPAC). The series is shown in Table 5.

Table 5 – IEC 60794-4 series

IEC 60794-4	IEC 60794-4-10, Family specification – Optical ground wires (OPGW) along electrical power lines
	IEC 60794-4-20, Sectional specification- Aerial optical cables along electrical power lines – Family specification for ADSS (all dielectric self-supported) optical cables
	IEC 60794-4-30, Aerial optical cables along electrical power lines – Family specification for optical phase conductor (OPPC) optical cables

5.6 IEC 60794-5 series

This series specifies the requirements of microduct optical fibre cables, microduct fibre units, microducts and protected microducts for installation by blowing for outdoor use. The series is shown in Table 6.

Table 6 – IEC 60794-5 series

IEC 60794-5	IEC 60794-5-10, Family specification – Outdoor microduct optical fibre cables, microducts and protected microducts for installation by blowing
	IEC 60794-5-20,-Family specification – Outdoor microduct fibre units, microducts and protected microducts for installation by blowing

5.7 IEC 60794-6 series

This series covers general features of optical fibre cables applicable to outdoor as well as indoor environments, called “indoor-outdoor cables”. Indoor-outdoor cables are deployed in outside plant environments as well as in premises, thus fulfilling outdoor as well as indoor requirements. The series is shown in Table 7.

Table 7 – IEC 60794-6 series

IEC 60794-6	IEC 60794-6-10, Indoor-outdoor cables – Family specification for universal indoor-outdoor cables
	IEC 60794-6-20, Indoor-outdoor cables – Family specification for flame retardant outdoor cables
	IEC 60794-6-30, Indoor-outdoor cables – Family specification for weatherised indoor cables

5.8 IEC 60794-7 series

Under development.

6 Cable materials

6.1 Indoor cable materials

Generally, indoor optical cables comprise several elements or individual constituents, depending on the cable design which takes into account the cable application, flame and smoke ratings, 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. Table 8 provides some examples.

Table 8 – Indoor cables materials (examples)

Tight, semi-tight, loose buffering	Polymeric materials
Buffer tube	Polymeric materials, PBT
Strength member	Metallic or non-metallic material
Sheath	Halogen free, flame retardant, non corrosive, low smoke (HFFR LS), PVC, PVC (low smoke), PVDF

6.2 Outdoor cable materials

Generally, outdoor 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. Table 9 provides some examples.

Table 9 – Outdoor cable materials (examples)

Tight buffering	Polymeric materials
Buffer tube	Polymeric materials
Buffer tube filling	Grease-like and/or dry-block materials
Cable core filling	Grease-like and/or dry-block materials
Strength member	Metallic or non-metallic material
Armour	Corrugated steel tape, two-layer wrapped steel tape, steel wire armour or dielectric material
Sheath	UV-stabilized weather-resistant polymeric materials

6.3 Indoor/outdoor cable materials

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.

Indoor/outdoor cables generally possess the characteristics associated with outdoor cable designs having the environmental and mechanical robustness that makes them suitable for use in the outside plant, while simultaneously being relatively flexible, compact and lightweight and exhibiting the fire performance. Table 8 and Table 9 provide examples.

6.4 Environmental requirements for cable materials

When requested, information shall be provided on the overall environmental impact of the cable and cable material. This information should include manufacturing, cable handling and environmental impact during the lifetime of the cable. Examples of relevant information are the minimization or replacement of harmful materials and improvements in waste disposal. Relevant documents include ISO 14001 and ISO 14064-1.

7 Cable construction

7.1 General

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

7.2 Colour coding

7.2.1 Overview

Coding is essential to uniquely identify each fibre in a cable. Coding of fibres almost universally involves colouring of the fibre coating or buffer. The coding scheme employed will usually require inclusion of the coding of fibre, subunits, and units within the cable.

Coding schemes shall be agreed between the manufacturer and customer. The specific scheme is often the subject of regional norms. IEC 60304 identifies the colours to be used in fibre colouring, but does not specify which colour is for which fibre and IEC TR 63194 addresses colour coding of optical fibre cables, but does not specify which colour is for which fibre number.

Sheath colour coding may be used for a variety of purposes and is most commonly used in indoor cables. Such sheath coding is often used to identify the categories of fibre in the cable or the application of the cable, amongst a number of other possibilities.

Unless otherwise specified, fibres, fibre ribbons, buffered tubes, micromodules and other cable elements shall be uniquely identified by a scheme agreed between the manufacturer and customer.

Colours shall be a reasonable match to IEC 60304. Other colours or schemes may be used, as agreed.

7.2.2 Fibre colour coding

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.

IEC TR 63194 provides information about the sequence of fibre colour coding that varies between different regions and countries.

7.2.3 Unit colour coding

If required as a part of the unique fibre identification scheme, units shall be uniquely identified.

If colours are used, they shall be a reasonable match to IEC 60304. If other methods, such as a print string, positional identification, threads, etc., are used, they shall conform to the intent of the identification scheme.

7.2.4 Sheath colour coding

Sheath colour coding, if used, shall be as agreed between the manufacturer and customer.

7.3 Fibre

7.3.1 General

Optical fibres shall meet the requirements of IEC 60793-2. Annex A gives guidance on application performance standards.

7.3.2 Attenuation coefficient

The maximum cabled fibre attenuation coefficient shall conform to Annex A. Particular values may be agreed between the customer and supplier.

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

7.3.3 Attenuation uniformity – Attenuation discontinuities

The local attenuation shall not have point discontinuities in excess of 0,10 dB for single-mode fibre and 0,20 dB for multimode fibre, when measured in accordance with IEC 60793-1-40.

EXAMPLE Wavelength of 1 310/1 550/1 625 nm for SM fibres, wavelength of 850/1 300 nm for MM fibres.

7.3.4 Cable cut-off wavelength

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

Unless otherwise stated, this shall be:

a) $\lambda_{cc} \leq 1\,260$ nm for fibre categories B-652.B, B-652.D and B-657.A1/A2;B2/B3;

b) $\lambda_{cc} \leq 1\,270$ nm for fibre category B-653.A/B;

c) $\lambda_{cc} \leq 1\,450$ nm for fibre categories B-655.C/D/E and B-656;

d) $\lambda_{cc} \leq 1\,530$ nm for fibre category B-654.A/B/C.

7.3.5 Polarization mode dispersion (PMD)

Cabled single-mode fibre PMD shall be characterized on a statistical basis, not on an individual fibre basis, as described in IEC TR 61282-3. Measurements on individual cabled fibres shall be performed in accordance with IEC 60793-1-48. Measurements on uncabled fibres can be used to generate cabled fibre statistics when the design and processes are stable and the relationship between the PMD coefficients of uncabled and cabled fibres are known.

The manufacturer shall supply a PMD link design value, PMD_Q, that serves as a statistical upper bound PMD coefficient of the concatenated optical fibre cables within a possible optical link. Unless otherwise specified in the detail specification, the PMD_Q value shall be less than 0,2 ps/√km with a probability of 10^{-4} that this value be exceeded for a numerical concatenation of at least 20 cables.

7.4 Buffer tubes

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.

7.5 Tensile strength elements

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.

7.6 Crush protection elements

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

7.7 Water blocking elements

If specified, the element(s) and in addition the cable core shall contain water blocking material, such as grease-like or dry-block materials or both, to prevent longitudinal water penetration.

If specified, a moisture barrier shall be provided either by a continuous metallic sheath or by a metallic or non-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.

7.8 Sheath removal elements

If required, one or two ripcords may be provided beneath the sheath.

7.9 Cable sheath

The cable core shall be uniformly covered with a protective sheath.

For outdoor and indoor/outdoor cables the cable shall have a seamless sheath made of UV-stabilized weather-resistant polymer.

8 Measuring and test methods

8.1 General

Not all measurements and tests are applicable to all cables.

Intrinsic characteristics of optical fibres are not normally measured by cable manufacturers. The relevant values are provided by optical fibre manufacturers, and are available as unitary or statistical values. For practical reasons, the core diameter of single-mode fibres is not specified. Mode field diameter is the relevant specification parameter.

Test results shall follow the rule of “rounding half away from zero” (or rounding error), when the results recorded display more than the significant number of digits required in the acceptance criteria (see 3.18).

Guidance on selecting fibres for testing is given in Annex B.

8.2 Measuring methods for transmission and optical characteristics

The transmission and optical characteristics of optical fibre in cables shall be verified by carrying out selected tests from those shown in Table 10. The tests applied and acceptance criteria shall be as specified in the relevant specification.

Table 10 – Measuring methods for transmission and optical characteristics

Test method	Test	Characteristics covered by the test method
Test methods for multimode and single-mode fibre cables		
IEC 60793-1-40 method B	Insertion loss technique	Attenuation
IEC 60793-1-40 method C	Backscattering technique	Attenuation
IEC 60793-1-40 method C	Backscattering technique	Point defects
IEC 60793-1-46 method A IEC 60793-1-46 method B	Transmitted power monitoring Backscattering monitoring	Change of optical transmittance during mechanical and environmental tests
Test methods for single-mode fibres		
IEC 60793-1-48	Polarization mode dispersion	Polarization mode dispersion
NOTE Bandwidth, chromatic dispersion and cable cut-off wavelength are not measured on a cabled optical fibre.		

8.3 Measuring methods for dimensions

The dimensions of the optical fibres, electrical conductors, cable elements and optical cables shall be determined by subjecting samples to tests selected from Table 11. The tests applied, acceptance criteria and number of samples shall be as specified in the relevant specification.

Table 11 – Measuring methods for dimensions

Test method	Test	Characteristics covered by test method
IEC 60793-1-21	Coating geometry measurement	Diameter of primary coating Diameter of coloured fibre Diameter of secondary or “buffer” coating Non-circularities of secondary or “buffer” coating Primary coating-cladding concentricity error
IEC 60793-1-22 method A	Delay of transmitted and/or reflected pulse	Length of fibre
IEC 60793-1-22 method B	Backscattering technique	Length of fibre
IEC 60189-1	Mechanical	Diameter of electrical conductor
IEC 60811-201 IEC 60811-202 IEC 60811-203	Mechanical	Thickness of insulation – electrical conductors Thickness of sheaths and cable elements Overall dimensions

8.4 Test methods for mechanical characteristics

The mechanical characteristics of optical fibre cables shall be verified by subjecting samples to tests selected from IEC 60794-1-21, now the IEC 60794-1-1xx series. IEC 60794-1-2 shows the cross reference and lists all mechanical test methods. The acceptance criteria shall be as specified in the relevant specifications.

8.5 Test methods for environmental characteristics

The environmental characteristics of optical fibre cables shall be verified by subjecting samples to tests selected from IEC 60794-1-22, now replaced with the IEC 60794-1-2xx series. IEC 60794-1-2 shows the cross reference and lists all environmental test methods. Guidance on selecting temperatures for environmental testing are given in Annex C. The tests applied and acceptance criteria shall be as specified in the relevant specification.

8.6 Test methods for cable element characterization

Tests to characterize the different types of cable elements for handling purposes are given in IEC 60794-1-23, now replaced with the IEC 60794-1-3xx series. IEC 60794-1-2 shows the cross reference and lists all cable element test methods.

8.7 Measuring and test methods for electrical characteristics

When electrical conductors or other metallic elements are incorporated in an optical fibre cable, verification of various electrical characteristics can be necessary. Typical tests are shown in Table 12, in addition to those given in IEC 60794-1-24, now replaced with the IEC 60794-1-4xx series. IEC 60794-1-2 shows the cross reference and lists all electrical test methods. The tests applied and the acceptance criteria shall be as specified in the relevant specification.

Table 12 – Measuring methods for electrical characteristics

Test method	Test	Characteristics covered by test method
IEC 60189-1	Conductor resistance	Characteristics of insulated electrical conductors
	Dielectric strength of insulation Insulation resistance	The insulation properties of conductors within optical fibre cables are normally just specified for the incoming material, pre-cabling.

For cables installed along overhead power lines, specialised tests are given in IEC 60794-1-24, Method H1: short-circuit test and Method H2: lightning test method, which has been withdrawn and replaced with IEC 60794-1-401 and IEC 60794-1-402, and in IEC 60794-4-20:2018, Annex C.

Annex A
(informative)

Guidelines for specific optical fibre and cabled fibre performance

A.1 General

The fibre category should be agreed between the customer and supplier.

Applications of optical fibre cables are defined by many different standards organizations including IEC, ISO, IEEE and ITU.

A.2 Cabled fibre attenuation requirements

Cabled fibre attenuation requirements are given in Table A.1, Table A.2 and Table A.3.

Table A.1 – Maximum single-mode cabled fibre attenuation coefficient (dB/km), as given by ITU-T

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.B2/B3	0,40	0,40	0,40	0,40	0,30	0,30	0,40
n/a = not applicable							

These values are more applicable to cables that are used for long system applications (as defined by ITU-T). The introduction of link design attenuation (LDA) values is under consideration for certain fibre categories. Different attenuation values may be agreed between the customer and the supplier for certain cable constructions.

1 625 nm attenuation values are optionally specified by the customer.

A list of applications supported by A1 multimode optical fibres for multimode optical cables can be found in IEC 60793-2-10.

ISO/IEC 11801-1 provides information on supported applications for single-mode and multimode optical cables. It has permanent link requirements for cable attenuation by defining performance categories of cabled optical fibre. The categories can then be used in channel planning, defined by distance, which supports applications.

Table A.2 – Category A1- multimode fibre maximum cable attenuation coefficient (dB/km)

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.			

Table A.3 – Single-mode maximum cable attenuation coefficient (dB/km)

Fibre category	Attenuation coefficient at 1 310 nm	Attenuation coefficient at 1 383 nm	Attenuation coefficient at 1 550 nm	Attenuation coefficient at 1 625 nm	Performance category
IEC 60793-2-50, B-652.B, B-652-D, B-657-A1, B-657-A2, B-657-B2/B3	1,0	1,0	1,0	n/a	OS1a
IEC 60793-2-50, B-652.D	0,4	0,4	0,4	n/a	OS2
IEC 60793-2-50, B-657.A1	0,4	0,4	0,4	n/a	OS2
IEC 60793-2-50, B-657.A2	0,4	0,4	0,4	n/a	OS2

A.3 Cabled fibre bandwidth requirements

There are no bandwidth requirements on single-mode fibres.

For cables containing multimode fibres, the fibre should be specified at one of the performance levels defined in Table A.4 in terms of minimum bandwidth (MHz·km), wavelength, and type of measurement. The value for bandwidth is normally as given by the fibre supplier, rather than measured on the cabled fibre.

The fibre category and performance level should be agreed between the customer and supplier.

Table A.4 – Category A1 multimode cabled fibre bandwidth (MHz·km)

Fibre category	Nominal core diameter (µm)	Overfilled bandwidth at 850 nm	Overfilled bandwidth at 953 nm	Overfilled bandwidth at 1 300 nm	Effective modal bandwidth at 850 nm	Effective modal bandwidth at 953 nm	Performance category
IEC 60793-2-10, A1-OM1 category	62,5	200	n/a	500	n/a	n/a	OM1 [a]
IEC 60793-2-10, A1-OM2 category	50	500	n/a	500	n/a	n/a	OM2 [a]
IEC 60793-2-10, A1-OM3 category	50	1 500	n/a	500	2 000	n/a	OM3
IEC 60793-2-10, A1-OM4 category	50	3 500	n/a	500	4 700	n/a	OM4
IEC 60793-2-10, A1-OM5 category	50	3 500	1 850	500	4 700	2 470	OM5

n/a = not applicable

[a] OM1 and OM2 are no longer supported but are shown here for completeness

A.4 Type testing at 1 625 nm

When specifically requested by the customer specification, cables that are intended for use in systems operating in the L-band (1 565 nm to 1 625 nm) may be tested at 1 625 nm. Table A.5 below gives some guidance on possible pass/fail criteria. Actual requirements should be established by agreement between the customer and supplier, based on the particular cable application.

Table A.5 – Guidance values for 1 625 nm type test acceptance criteria

Test	Wavelength nm	Acceptance criterion [a,b]
Maximum variation in attenuation – Point discontinuities	1 625	0,2 dB
Maximum change in attenuation coefficient during temperature cycling	1 625	0,6 dB/km [c]
Maximum change in attenuation for all other tests in the IEC 60794-1 series (during long-term load and after test)	1 625	0,5 dB[c]

[a] Results at 1 625 nm may be used to demonstrate compliance at 1 550 nm, using 1 550 nm acceptance criteria.

[b] Results at 1 550 nm shall not be used to demonstrate compliance at 1 625 nm.

[c] 0,4 dB/km or 0,4 dB higher than the acceptance criterion at 1 550 nm. The acceptance criteria at 1 550 nm can vary in the different cable specifications of the IEC 60794 series.

Annex B
(informative)

Guidelines for qualification sampling

B.1 General

Typically, a wide range of fibre counts can be accommodated by a small range of generic optical fibre cables. For example, considering loose tube designs with 12 fibres per tube, a 6-element cable can be produced in 12, 24, 36, 48, 60 or 72 fibre versions just by varying the number of tubes and dummy filler elements, within the same basic design. Similarly, cables with 6, 8, 12 and 24 elements can provide options for 12 cables covering from 72 to 288 fibres, within just 4 generic cable designs. This concept can be applied to different fibre counts. For qualification purposes, it will probably only be necessary to test a subset of the fibre counts and element counts that represent the product range (e.g. the smallest and the largest element count designs). In the previous example, it can be considered appropriate to test just one 6-element design and one 24-element design in order to prove a manufacturer's design and manufacturing capability.

This philosophy can equally be applied to other designs of optical cable such as single element designs, central tube cable designs or buffered optical fibre cable designs. For example, the smallest and the largest fibre count designs could be tested.

B.2 Fibre selection for cable testing

The cable being tested may contain a full complement of working fibres or may contain working and dummy/scrap fibres. A representative number of fibres that are tested should be dispersed throughout the working units. For cables with multiple tube designs, non-working tubes or filler rods may be deployed but they can be used in such a manner that they do not affect the performance of the test. The manufacturer may position the working units within a cable such that they will be subjected to the full force of the test. It is recommended to test a minimum number of fibres of a full complement of fibres in a cable, as given in Table B.1.

Table B.1 – Recommended minimum number of tested fibres in a cable

Number of fibres in the cable	Recommended minimum number of tested fibres in a cable %
1 to 12	50
13 to 48	20
49 to 288	10
289 to 1 152	5
1 153 to 4 608	2
4 609 or more	1

Stranded loose tube cable designs with more than one active tube may be tested as follows:

In a single layer cable design, at least one fibre from a minimum of 2 tubes can be tested. In a multi-layer design, at least one fibre from a minimum of 2 tubes of each layer may be tested. The selected tubes cannot be located next to each other and may be fully populated with fibres although some may be scrap/dummy fibres.

Ribbon cables with a layered ribbon structure may contain working fibres in the first, last, and central ribbon position. The working fibre being tested may be located at both edges and in the middle of each of these ribbons. For partially bonded ribbon designs, a representative number of fibres, in accordance with Table B.1 and dispersed throughout the working units, shall be tested.

If agreed between the customer and supplier, optical fibres may be spliced to each other, for example. This is a convenient way to check all fibres under test.

The test report may record how many fibres in a cable were tested, where the tested fibres were positioned within the cable structure and if the optical performance of all tested fibres were measured individually or serially connected.

When a change in the design occurs, then only the tests that are affected by the design change need to be performed.

B.3 Pass/fail criteria

The acceptance criteria will depend on the application but would typically include no fibre break or a combination of “no change” (see Clause 3) and allowable change in performance. These differences arise due to varying requirements before, during and after a test, as given in the relevant specification.

Annex C
(informative)

Preferred temperatures

The temperature limits listed in Table C.1 are preferred to be used as test parameters for temperature cycling, shrinkage and any other tests of optical fibre cables where these temperatures are suitable to be applied.

Table C.1 – Preferred low and high temperature

Low temperature T_A °C	High temperature T_B °C	Sources of temperature limits	
		Performance categories of connectors, components and protective housings [a]	Environmental classification of customer premises cabling [b]
-10	+60	C	$M_xI_xC_1E_x$
-10	+70	C^{HD}	-
-25	+70	OP	$M_xI_xC_2E_x$
-25	+85	OP^{HD}	-
-30	+60	S	-
-40	+65	A, G	-
-40	+70	I	$M_xI_xC_3E_x$
-40	+75	OP+	-
-40	+85	$OP+^{HD}$, I^{HD}, E	-

A suitable operating service environment (performance category) or environmental classification should be selected in accordance with the application.

[a] Included in IEC 61753-1. The abbreviations are as follows:
C: indoor controlled environment;
OP/OP+: outdoor protected environment;
S: outdoor subterranean or sub-surface environment;
A: outdoor aerial environment;
G: outdoor ground level environment;
I: industrial environment;
E: extreme environment;
^{HD}: indicates an extended upper temperature necessary due to additional dissipation by active electronics.

[b] Included in ISO/IEC 11801-1. For an introduction to the MICE environmental classification system use ISO/IEC TR 29106. For technical guidance use IEC TR 62362.

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IEC 60794-2-23, *Optical fibre cables – Part 2-23: Indoor optical fibre cables – Detailed specification for multi-fibre cables for use in MPO connector terminated cable assemblies*

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IEC 60794-2, (all parts), *Optical fibre cables – Part 2-X Indoor optical fibre cables*

IEC 60794-2-10, *Optical fibre cables – Part 2-10: Indoor optical fibre cables – Family specification for simplex and duplex cables*

IEC 60794-2-11, *Optical fibre cables – Part 2-11: Indoor cables – Detailed specification for simplex and duplex cables for use in premises cabling*

IEC 60794-2-20, *Optical fibre cables – Part 2-20: Indoor cables – Family specification for multi-fibre optical cables*

IEC 60794-2-21, *Optical fibre cables – Part 2.21: Indoor cables – Detailed specification for multi-fibre optical distribution cables for use in premises cabling*

IEC 60794-2-22, *Optical fibre cables – Part 2-22: Indoor cables – Detail specification for multi-simplex breakout optical cables to be terminated with connectors*

IEC 60794-2-23, *Optical fibre cables – Part 2-23: Indoor optical fibre cables – Detailed specification for multi-fibre cables for use in MPO connector terminated cable assemblies*

6 This publication has been withdrawn.

IEC 60794-2-24, *Optical fibre cables – Part 2-24: Indoor optical fibre cables – Detailed specification for multiple multi-fibre unit cables for use in MPO connector terminated breakout cable assemblies*

IEC 60794-2-30, *Optical fibre cables – Part 2-30: Optical fibre cables – Indoor cables – Family specification for optical fibre ribbon cables for use in terminated cable assemblies*

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IEC 60794-2-40, *Optical fibre cables – Part 2-40: Indoor optical fibre cables – Family specification for A4 fibre cables*

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IEC 60794-3-12, *Optical fibre cables – Part 3-12: Outdoor cables – Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling*

IEC 60794-3-20, *Optical fibre cables – Part 3-20: Outdoor cables- Family specification for self-supporting aerial telecommunication cables*

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

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

IEC TR 61931, *Fibre optic – Terminology*

IEC TR 62000, *Guidelines for combining different single-mode fibre sub-categories*

IEC TR 62222, *Fire performance of communication cables installed in buildings*

IEC TR 62283, *Optical fibres – Guidance for nuclear radiation tests*

IEC TR 62362, *Selection of optical fibre cable specifications relative to mechanical, ingress, climatic or electromagnetic characteristics – Guidance*

IEC TR 62470, *Guidance on techniques for the measurement of the coefficient of friction (COF) between cables and ducts*

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IEC 62807-1, *Hybrid telecommunication cables – Part 1: Generic specification*

IEC TR 62901, *Guide for the selection of drop cables*

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[7] Under development.

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

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO/IEC 11801 (all parts), *Information technology – Generic cabling for customer premises*

ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

ISO/IEC 11801-3, *Information technology – Generic cabling for customer premises – Part 3: Industrial premises*

ISO/IEC TR 29106, *Information technology – Generic cabling – Introduction to the MICE environmental classification*

ISO 14001, *Environmental management systems – Requirements with guidance for use*

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ITU-T G.657, *Characteristics of a bending-loss insensitive single-mode optical fibre and cable*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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CÂBLES À FIBRES OPTIQUES –

Partie 1-1: Spécification générique – Généralités

AVANT-PROPOS

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L'IEC 60794-1-1 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 2015. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) réorganisation du document en un flux plus logique pour faciliter la lecture;
b) extension des tableaux pour inclure les noms et définitions de tous les documents de la série IEC 60794-x;

c) extension du contenu des définitions, des symboles graphiques, de la terminologie et des abréviations, dans le but de faire du présent document le document par défaut et la référence pour tous les autres documents de la série IEC 60794-x;

d) ajout d'alinéas étendus, mis à jour et réorganisés sur la largeur de bande et l'affaiblissement des fibres optiques, dans le but de faire du présent document le document par défaut et la référence pour tous les autres documents de la série IEC 60794-x.

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

Projet	Rapport de vote
86A/2286/FDIS	86A/2313/RVD

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

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

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/publications.

Une liste de toutes les parties de la série IEC 60794, publiée sous le titre général *Câbles à fibres optiques*, se trouve sur le site web de l'IEC.

Le comité a décidé que le contenu de ce 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. A cette date, le document sera

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

CÂBLES À FIBRES OPTIQUES –

Partie 1-1: Spécification générique – Généralités

1 Domaine d'application

La présente partie de l'IEC 60794 s'applique aux câbles à fibres optiques destinés à être utilisés avec des équipements de communication et des dispositifs utilisant des techniques similaires. Les propriétés électriques sont spécifiées pour les câbles de garde à fibres optiques (OPGW) et les câbles conducteurs de phase à fibres optiques (OPPC). Les câbles de communication hybrides sont spécifiés dans la série IEC 62807.

Le présent document a pour objet d'établir des exigences génériques uniformes relatives aux caractéristiques géométriques, de transmission, de matériaux, mécaniques, de vieillissement (exposition à l'environnement), climatiques et électriques des câbles et des éléments de câbles à fibres optiques, le cas échéant.

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 60189-1, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods (disponible en anglais seulement)*

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

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

IEC 60793-1-22, *Fibres optiques – Partie 1-22: Méthodes de mesure et procédures d'essai - Mesure de la longueur*

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 60793-1-46, *Fibres optiques – Partie 1-46: Méthodes de mesure et procédures d'essai – Contrôle des variations du facteur de transmission optique*

IEC 60793-1-48, *Fibres optiques – Partie 1-48: Méthodes de mesure et procédures d'essai – Dispersion de mode de polarisation*

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

IEC 60793-2-10, *Fibres optiques – Partie 2-10: Spécifications de produits – Spécification intermédiaire pour les fibres multimodales de catégorie A1*

IEC 60793-2-40:2021, *Fibres optiques – Partie 2-40: Spécifications de produits – Spécification intermédiaire pour les fibres multimodales de catégorie A4*

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

IEC 60794-1-22[1], *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 60811-201, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 201: Essais généraux – Mesure de l'épaisseur des enveloppes isolantes*

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*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants 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

3.1
absence de variation de l'affaiblissement
critère d'acceptation pour la mesure de l'affaiblissement qui inclut une tolérance pour l'incertitude de mesure provenant des erreurs de mesure ou des erreurs d'étalonnage dues à un déficit en normes de référence adaptées

Note 1 à l'article: Pour une interprétation pratique, les valeurs suivantes doivent être utilisées:

a) absence de variation de l'affaiblissement, unimodales (classe B): incertitude totale de mesure, qui doit être ≤ ± 0,05 dB pour l'affaiblissement ou ≤ ± 0,05 dB/km pour l'affaiblissement linéique. Toute valeur mesurée dans cette plage doit être considérée comme représentant une absence de variation de l'affaiblissement".

   Les exigences relatives à ces paramètres sont indiquées comme "Absence de variation (≤ ± 0,05 dB ou ≤ ± 0,05 dB/km)".

   Par accord entre le client et le fournisseur, un écart mineur par rapport à cette limite peut être accepté à une basse fréquence, par exemple moins de 10 %. Toutefois, pour les essais mécaniques, aucun écart supérieur à 0,15 dB ne doit être accepté. Pour les essais d'environnement, aucun écart supérieur à 0,10 dB/km ne doit être accepté;

b) absence de variation de l'affaiblissement, multimodales (catégorie A1): l'incertitude totale de mesure doit être ≤ ± 0,2 dB pour l'affaiblissement ou ≤ ± 0,2 dB/km pour l'affaiblissement linéique.

   Toute valeur mesurée dans cette plage doit être considérée comme représentant une absence de variation de l'affaiblissement".

   Les exigences relatives à ces paramètres sont indiquées comme "Absence de variation (≤ ± 0,2 dB ou ≤ ± 0,2 dB/km)".

   Par accord entre le client et le fournisseur, un écart mineur par rapport à cette limite peut être accepté à une basse fréquence, par exemple moins de 10 %. Toutefois, pour les essais mécaniques, aucun écart

[1] Ce document va progressivement être remplacé par la série IEC 60794-1-2XX.

supérieur à 0,5 dB ne doit être accepté. Pour les essais d'environnement, aucun écart supérieur à 0,5 dB/km ne doit être accepté;

c) absence de variation de l'affaiblissement, fibre optique plastique (catégorie A4): l'incertitude totale de mesure pour le présent document doit être ≤ 2 % de l'affaiblissement maximal spécifié dans l'EC 60793-2-40:2021, Annexe A à Annexe I.

Toute valeur mesurée dans cette plage doit être considérée comme représentant une absence de variation de l'affaiblissement".

3.2
variation admissible de l'affaiblissement
<lors des essais mécaniques et des essais d'environnement> variation de l'affaiblissement qui peut être une valeur supérieure à la limite d'absence de variation, selon la catégorie de fibres, unimodale ou multimodale, la conception et l'application des câbles

3.3
affaiblissement de la conception des liaisons
LDA
limite supérieure statistique de l'affaiblissement linéique des câbles à fibres optiques concaténés

3.4
absence de variation de l'allongement de la fibre
critère d'acceptation de la mesure de l'allongement de la fibre qui inclut une tolérance pour l'incertitude de mesure provenant des erreurs de mesure ou des erreurs d'étalonnage dues à un déficit en normes de référence adaptées

Note 1 à l'article: Pour l'interprétation, l'incertitude totale de mesure doit être un allongement de ± 0,05 %. Toute valeur mesurée dans cette plage doit être considérée comme représentant une "absence de variation de l'allongement".

3.5
variation admissible de l'allongement de la fibre
<lors des essais mécaniques et des essais d'environnement> niveau de déformation qui ne compromet pas la fiabilité mécanique des fibres pour certains des paramètres spécifiés

3.6
intégrité du circuit
aptitude du câble en essai à continuer de fonctionner de la façon prévue lorsqu'il est soumis à une source de chaleur par flamme spécifiée pendant une durée précise

3.7
résistance au feu
aptitude du câble en essai à résister à une défaillance fonctionnelle pour fonctionner de la façon prévue lorsqu'il est soumis à une source de chaleur par flamme spécifiée pendant une durée précise

3.8
rétrécissement
contraction irréversible après extrusion des matériaux plastiques, provoquée par le chauffage ou une exposition prolongée à la température ambiante

3.9
définitions des charges sur les câbles (pour les applications non aériennes)

3.9.1
charge à long terme
T_L
quantité acceptable de charge à long terme que le câble peut subir en fonctionnement (c'est-à-dire une fois l'installation terminée)

Note 1 à l'article: La charge à long terme peut être due à la charge résiduelle issue du processus d'installation et/ou à un effet d'environnement. Il s'agit de la charge maximale assignée à laquelle est soumis un câble dans les essais à long terme.

Note 2 à l'article: Pour les fibres ayant été soumises à l'essai de sélection à 1 %, l'allongement (T_L) ne doit pas dépasser 20 % de l'allongement d'épreuve de ces fibres (c'est-à-dire un allongement absolu de 0,2 %) et l'affaiblissement ne doit pas varier pendant l'essai.

Note 3 à l'article: Pour les fibres ayant été soumises à des essais de sélection plus élevés, la charge de sécurité à long terme n'est pas linéairement proportionnelle à la déformation d'épreuve, ainsi un pourcentage de déformation d'épreuve plus faible est applicable. Pour les fibres ayant été soumises à des essais de sélection supérieurs à 1 % et jusqu'à 2 %, l'allongement T_L doit être limité à 17 % de la déformation d'épreuve (c'est-à-dire une déformation absolue de 0,34 % pour des fibres ayant été soumises à un essai de sélection à 2 %).

3.9.2
charge à court terme
T_S
quantité acceptable de charge à court terme qui peut être appliquée à un câble sans dégradation permanente des caractéristiques des fibres, des éléments de câbles ou de la gaine

Note 1 à l'article: La charge à court terme est souvent appelée la charge nominale d'installation.

Note 2 à l'article: En condition de charge de traction à court terme (T_S) l'allongement de la fibre ne doit pas dépasser 60 % de la déformation d'épreuve de la fibre (égale à l'allongement absolu de 0,6 % pour des fibres ayant été soumises à l'essai de sélection à 1 %) et la variation de l'affaiblissement pendant l'essai doit être mesurée et enregistrée.

3.10
définitions des charges sur les câbles et terminologie d'essai de traction (applications aériennes autoporteuses)

3.10.1
tension maximale admissible
MAT
charge de traction maximale qui peut être appliquée au câble sans déroger aux exigences de performances (par exemple l'affaiblissement et la fiabilité de la fibre) en raison de la déformation des fibres

Note 1 à l'article: En raison des codes d'installation, la valeur de MAT est parfois limitée à moins de 60 % de la tension de rupture du câble.

Note 2 à l'article: Il s'agit également de la résistance opérationnelle ultime (UOS - Ultimate Operational Strength) égale à 60 % de la RTS (et de l'allongement de la fibre < 0,35 %, 1/3 de l'essai d'épreuve). MAT < 60 % UOS.

Note 3 à l'article: Egalement appelée Contrainte quotidienne (EDS, Every Day Stress) définie à 25 % de la RTS, sans allongement de fibre (< 0,05 %) et sans augmentation de l'affaiblissement (0,05 dB).

3.10.2
marge de déformation
valeur de déformation du câble au début de la déformation des fibres

Note 1 à l'article: La marge d'allongement peut également s'exprimer comme la charge d'un câble (N) au début de l'allongement des fibres.

3.10.3
tension de rupture
charge de traction qui entraîne une rupture physique du câble

Note 1 à l'article: La tension de rupture peut être calculée, à condition que le modèle de conception ait été validé.

3.10.4
tension d'installation maximale
MIT
tension de déroulage maximale recommandée pendant l'installation

3.10.5
résistance à la traction nominale
RTS
somme du produit de la section nominale, de la résistance nominale à la traction et du facteur de toronnage pour chaque matériau subissant une traction dans la construction du câble

3.11
section de câble
touret individuel de câble, conforme à la production

3.12
élément de câble
composant d'un câble conçu pour héberger et protéger les fibres optiques

Note 1 à l'article: le terme "unité de fibre optique" de l'IEC 60794-4-10 a été remplacé par "élément de câble" pour rester cohérent avec l'IEC 60794-1-23 et pour éviter toute confusion avec l'IEC 60794-5-20.

Note 2 à l'article: La gaine du câble est incluse en tant qu'élément de câble.

3.13
termes relatifs à la dispersion modale de polarisation (PMD, Polarization Mode Dispersion)

3.13.1
retard de groupe différentiel
DGD
retard relatif entre les deux modes fondamentaux de polarisation (états principaux de polarisation) à l'extrémité d'un câble à fibres optiques, à une longueur d'onde et un moment particuliers

Note 1 à l'article: Le retard de groupe différentiel est exprimé en ps.

Note 2 à l'article: L'abréviation "DGD" est dérivée du terme anglais développé correspondant "differential group delay".

3.13.2
valeur de dispersion modale de polarisation
valeur PMD
moyenne des valeurs de DGD sur plusieurs longueurs d'onde

Note 1 à l'article: La valeur de dispersion modale de polarisation est exprimée en ps.

Note 2 à l'article: L'abréviation "PMD" est dérivée du terme anglais développé correspondant "polarization mode dispersion".

3.13.3
coefficient de dispersion modale de polarisation
coefficient PMD
valeur de PMD d'un câble à fibres optiques divisée par la racine carrée de sa longueur (km)

Note 1 à l'article: Le coefficient de dispersion modale de polarisation est exprimé en ps/√km.

3.13.4
lien
longueur de câble composée d'un nombre de sections de câbles individuels

Note 1 à l'article: Les valeurs de PMD des liens sont généralement calculées selon les formules données dans l'IEC TR 61282-3, mais elles peuvent être mesurées.

3.14
câble assemblé équipé
câble se terminant par des connecteurs

Note 1 à l'article: Un cordon de brassage ou un cavalier est un type de câble assemblé équipé.

Note 2 à l'article: Les termes suivants relatifs aux câbles assemblés équipés dotés d'un ou de plusieurs connecteur(s) aux extrémités sont utilisés dans la série ISO/IEC 11801: cordons de brassage, cordons de zone de travail et cordons d'équipements.

3.15
types de câbles aériens

3.15.1
autoporteur tout diélectrique
ADSS
câble capable de supporter une installation aérienne et de fonctionner longtemps sans support de traction externe

3.15.2
câble optique attaché
OPAC
câble diélectrique non autoporteur, mais fixé à un câble de terre électrique ou à un conducteur de phase en utilisant une des méthodes de fixation suivante: par enroulement, lacé ou fixé avec un dispositif préformé

3.15.3
par enroulement
câble non métallique souple de construction légère (enroulement) qui peut être enroulé de manière hélicoïdale autour du câble de terre ou du conducteur de phase en utilisant une machine spéciale

3.15.4
lacé
câbles non métalliques installés de manière longitudinale le long du câble de terre, du conducteur de phase ou sur un câble de support séparé (sur une ligne de poteaux) et qui sont maintenus en place au moyen d'un filin de frettage ou d'un cordon adhésif

3.15.5
avec un dispositif préformé
câble analogue aux câbles lacés, mais fixé à l'aide de brides de fixation spéciales préformées en spirale

3.15.6
câble de garde à fibres optiques
OPGW
câble optique métallique destiné aux lignes aériennes de puissance et remplissant une double fonction de câble de garde classique avec des capacités de télécommunication

3.15.7
conducteur de phase à fibres optiques
OPPC
câble optique métallique hybride remplissant une double fonction de conducteur de phase conventionnel avec des capacités de télécommunication

3.16
câble composite
câble à fibres optiques contenant plusieurs catégories de fibres

3.17
câble de communication hybride
câble contenant plusieurs types de supports, incluant, mais sans y être limité, des câbles à fibres optiques et/ou des câbles à paires/quartes torsadées et/ou des câbles coaxiaux

3.18
erreur d'arrondi
règle[2] de "l'arrondi en s'éloignant de zéro", lorsque les résultats enregistrés affichent plus de chiffres significatifs que le nombre exigé dans les critères d'acceptation.

Note 1 à l'article: Seul le premier chiffre au-delà du nombre de chiffres significatifs est utilisé pour déterminer l'arrondi.

EXEMPLE 1: Pour une exigence d'affaiblissement maximal de 0,22 dB/km, les valeurs jusqu'à 0,224 dB/km sont conformes, alors que les valeurs supérieures ou égales à 0,225 dB/km ne le sont pas.

EXEMPLE 2: Pour une exigence de ± 0,05 dB, les valeurs comprises entre -0,054 et +0,054 sont considérées comme étant acceptables.

3.19
ovalité maximale admissible
plus grande ovalité admissible de l'unité optique ou de son composant calculée par la formule suivante:

$2 \times (d1 - d2) / (d1 + d2)$ en % où:

$d1$ est le diamètre mesuré maximal du câble ou du composant

$d2$ est le diamètre minimal du câble ou du composant à la même section que $d1$

3.20
câble épanoui
câble composé de sous-unités de fibres pouvant être des câbles à fibres optiques indépendants, entourés d'une gaine externe constituée d'un matériau approprié

Note 1 à l'article: En conditions d'application, cette gaine externe du câble épanoui peut être retirée sur une certaine longueur, permettant d'utiliser les sous-unités de fibres comme des câbles fibroniques indépendants.

4 Symboles graphiques et abréviations

Pour les besoins du présent document, les abréviations données dans l'IEC TR 61931 ainsi que les suivantes s'appliquent.

ADSS	All Dielectric Self-Supporting (autoporteur tout diélectrique)
APL	Aluminium/Polyéthylène Laminé
ΔD	épaisseur minimale des parois d'un microconduit
ΔD'	épaisseur minimale de la gaine externe d'un microconduit protégé
D	diamètre extérieur nominal d'un câble en microconduit
d	diamètre extérieur nominal d'un câble (y compris les unités de fibres pour microconduit)
dc	diamètre extérieur nominal d'une conduite ou d'une sous-conduite
DS	Detail Specification (spécification particulière)
EDS	Every Day Stress (contrainte quotidienne)
ID	diamètre intérieur nominal d'un microconduit
Port E/S	port d'entrée/sortie pour l'injection et l'extraction de câbles à fibres optiques dans un tuyau
λ_{CC}	longueur d'onde de coupure en câble
$\lambda_{opérationnelle}$	longueur d'onde opérationnelle

[2] Consulter le Guide ISO/IEC 98-3:2008, Article 7, relatif à l'incertitude de mesure pour obtenir des informations supplémentaires.

LDA	Link Design Attenuation (affaiblissement de la conception des liaisons)
m	masse de 1 km de câble (dans le cadre des essais de traction)
MAOC	Maximum Allowable Ovality of Cable (ovalité maximale admissible du câble)
MAT	Maximum Allowable Tension (tension maximale admissible)
MASS	câbles autoportés aériens métalliques
MICE	Mechanical, Ingress, Climatic, or Electromagnetic (mécanique, pénétration, climatique ou électromagnétique)
MIT	Maximum Installation Tension (tension d'installation maximale)
$n \times d$	produit d'une variable et du diamètre extérieur du câble utilisé pour déterminer les tailles appropriées pour les courbures, mandrins, etc.
$n \times OD$	produit d'une variable par le diamètre extérieur d'un microconduit, utilisé pour déterminer les tailles appropriées des courbures, des mandrins, etc.
$n \times OD'$	produit d'une variable par le diamètre extérieur d'un microconduit protégé, utilisé pour déterminer les tailles appropriées des courbures, des mandrins, etc.
OCEPL	éléments de câble destinés à être utilisés sur des lignes électriques
OD	diamètre extérieur nominal d'un microconduit
OD'	diamètre extérieur nominal d'un microconduit protégé
OPAC	OPtical Attached Cable (câble optique attaché)
OPGW	OPtical Ground Wire (câbles de garde à fibres optiques)
OPPC	OPtical Phase Conductor (conducteur de phase à fibres optiques)
PE	PolyEthylène
RTS	Rated Tensile Strength (résistance à la traction nominale)
S	environnement souterrain ou en subsurface extérieur
SPL	Steel/Polyethylene Laminate (acier/polyéthylène laminé)
SZ	technique dans laquelle le sens de toronnage est inversé périodiquement
t_1	temps nécessaire à la stabilisation pour un cycle de température
T_{A1}	limite de température basse de l'essai de cycle de température conformément à l'IEC 60794-1-22, Méthode F1
T_{A2}	limite de température basse secondaire de l'essai de cycle de température conformément à l'IEC 60794-1-22, Méthode F1
T_{B1}	limite de température haute de l'essai de cycle de température conformément à l'IEC 60794-1-22, Méthode F1
T_{B2}	limite de température haute secondaire de l'essai de cycle de température conformément à l'IEC 60794-1-22, Méthode F1
T_L	charge à long terme
T_o	charge de traction "sans allongement des fibres"
T_S	charge à court terme
UOS	Ultimate Operation Strength (résistance opérationnelle ultime)
W	poids de 1 km de câble, d'unité de fibre pour microconduit ou de toute forme de conduit, selon le cas

5 Câbles à fibres optiques – Structure de l'IEC 60794

5.1 Généralités

Les câbles à fibres optiques sont une structure constituée d'un ou de plusieurs éléments contenant des fibres optiques, des éléments de résistance mécanique et un/des conteneur(s) pour assurer la protection contre les attaques mécaniques et environnementales. La série IEC 60794 comprend les parties suivantes (voir Tableau 1):

Tableau 1 – Structure de l'IEC 60794

IEC 60794-1-1	Spécification générique
IEC 60794-2	Câbles intérieurs - Spécification intermédiaire
IEC 60794-3	Câbles extérieurs - Spécification intermédiaire
IEC 60794-4	Spécification intermédiaire – Câbles optiques aériens le long des lignes électriques de transport d'énergie
IEC 60794-5	Spécification intermédiaire – Câblage en micro conduits pour installation par soufflage
IEC 60794-6	Câbles intérieurs/extérieurs - Spécification intermédiaire pour les câbles intérieurs/extérieurs
IEC 60794-7[3]	Sectional specification – Fire-resistant cables for data communication – Sectional specification (disponible en anglais seulement)

5.2 Série IEC 60794-1

Cette série a pour objet d'établir des exigences génériques uniformes relatives aux caractéristiques géométriques, de transmission, de matériaux, mécaniques, de vieillissement (exposition à l'environnement), climatiques et électriques des câbles et des éléments de câbles à fibres optiques. La série est présentée dans le Tableau 2.

Tableau 2 – Série IEC 60794-1

IEC 60794-1	60794-1-1, Spécification générique - Généralités
	60794-1-2 Spécification générique - Procédures fondamentales d'essais des câbles optiques - Lignes directrices générales
	60794-1-3 Spécification générique - Eléments de câbles optiques

5.3 Série IEC 60794-2

Cette série a pour objet de fournir des exigences qui s'appliquent aux câbles à fibres optiques destinés à une utilisation en intérieur dans les réseaux de communication. D'autres types d'applications exigeant des types de câbles similaires peuvent être pris en considération. La série est présentée dans le Tableau 3.

[3] Cette série est encore au stade du développement.