IEC 60794-1-1

Edition 5.0 2023-05
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

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

IEC 60794-1-1:2023-05 CMV(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 60794-1-1

Edition 5.0 2023-05
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.10

ISBN 978-2-8322-7058-5

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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