IEC 60794-1-1

Edition 4.0 2015-11

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 60794-1-1:2015-11(en-fr)

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

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

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OPTICAL FIBRE CABLES –

Part 1-1: Generic specification – General

FOREWORD

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International Standard IEC 60794-1-1 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This bilingual version (2018-01) corresponds to the monolingual English version, published in 2015-11.

This fourth edition cancels and replaces the third edition, published in 2011. This edition constitutes a technical revision.

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

a) the expansion of the definitions, graphical symbols, terminology and abbreviations content, with the aim of making this standard the default and reference for all others in the IEC 60794-x series;

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

The text of this standard is based on the following documents:

CDV	Report on voting
86A/1651/CDV	86A/1667/RVC

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

The French version of this standard has not been voted upon.

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.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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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.

The object of this standard 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

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

IEC 60793-1-46, *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 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

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

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IEC 60794-1-22, *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.

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 attenuation or ≤±0,05 dB/km for 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, e.g. less than 10%. However for mechanical tests no deviation in excess of 0,15 dB shall be accepted. For environmental tests no deviation in excess of 0,10 dB/km shall be accepted.

b) no change in attenuation, multimode (Category A1): the total uncertainty of measurement shall be ≤ ±0,2 dB for attenuation or ≤ ±0,2 dB/km for 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, e.g. 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 standard shall be ≤ 2 % of maximum specified attenuation in IEC 60793-2-40 Annex A to G

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

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3.3
link design attenuation
LDA
statistical average attenuation value for a link of concatenated 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

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
cable load definitions (non-aerial applications)

3.6.1
long term load
T_L
acceptable amount of long term load which the cable may experience during operation (i.e. after installation is completed)

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

3.6.2
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.

3.7
cable load definitions and tensile testing terminology (self-supporting aerial applications)

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3.7.1
maximum allowable tension
MAT
maximum tensile load that may 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.

3.7.2
strain margin
value of cable elongation at the onset of fibre strain

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

3.7.3
breaking tension
tensile load that will produce physical rupture of the cable

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

3.7.4
maximum installation tension
MIT
maximum recommended stringing tension during installation

3.7.5
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.

3.8
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.

3.10
cable element
component of a cable designed to house and protect the optical fibres

Note 1 to entry: 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.

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3.11
polarization mode dispersion (PMD) terms

3.11.1
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.

3.11.2
polarization mode dispersion (PMD) value
average of DGD values across wavelengths

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

3.11.3
polarization mode dispersion (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.

3.11.4
link
length of cable composed of a number of individual cable sections

Note 1 to entry: Link PMD values are generally calculated according to 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

Note 1 to entry: The following synonyms are used in ISO/IEC 11801: 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 to endure aerial installation and provide long term service, without any external tensile support

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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 that has the dual performance functions of a conventional ground wire with telecommunication capabilities

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

3.17
hybrid 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

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

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: $(d1 - d2) / (d1 + d2)$ 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 $d1$.

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3.20
breakout cable
cable consisting of subunits which may 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 abbreviations

For the purposes of this document, the abbreviations 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
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
MIT	maximum installation tension
n x d	The product of a variable and the cable outer diameter used for determining appropriate sizes for bends, mandrels, etc.
n x OD	The product of a variable and the outer diameter of a microduct used for determining appropriate sizes for bends, mandrels, etc.
n x OD'	The product of a variable and the outer diameter of a protected microduct used for determining appropriate sizes for bends, mandrels, etc.
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
PE	polyethylene
RTS	rated tensile strength
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 according to IEC 60794-1-22, Method F1

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T_{A2}	temperature cycling test secondary low-temperature limit according to IEC 60794-1-22, Method F1
T_{B1}	temperature cycling test high-temperature limit according to IEC 60794-1-22, Method F1
T_{B2}	temperature cycling test secondary high-temperature limit according to IEC 60794-1-22, Method F1
T_L	long term load
T_S	short term load
W	weight of 1 km of cable, microduct fibre unit or any form of ducting, as applicable

5 Optical fibre cables

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.

6 Materials

6.1 Optical fibre

6.1.1 General

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

6.1.2 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.

6.1.3 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.

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6.1.4 Cable cut-off wavelength

For single-mode fibre, 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 B1.1, B1.3 and B6;

b) $\lambda_{cc} \leq 1\ 270$ nm for fibre category B2;

c) $\lambda_{cc} \leq 1\ 450$ nm for fibre categories B4 and B5;

d) $\lambda_{cc} \leq 1\ 530$ nm for fibre category B1.2.

6.1.5 Fibre colouring

If the primary coated fibres are coloured for identification, the coloured coating shall be readily identifiable throughout the lifetime of the cable and shall be a reasonable match to IEC 60304. Refer to 7.2 for the specification of fibre colour coding.

6.1.6 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 fibre 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 fibre 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 ps/√km with a probability of 10^{-4} that this value be exceeded for a numerical concatenation of at least 20 cables.

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

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 minimisation or replacement of harmful materials and improvements in waste disposal. Relevant standards 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.

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