IEC 60794-4

Edition 2.0 2018-06
REDLINE VERSION

INTERNATIONAL STANDARD

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Optical fibre cables –
Part 4: Sectional specification – Aerial optical cables along electrical power lines

IEC 60794-4:2018-06 RLV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 33.180.10

ISBN 978-2-8322-5850-7

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OPTICAL FIBRE CABLES –

Part 4: Sectional specification – Aerial optical cables along electrical power lines

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International Standard IEC 60794-4 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee TC 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2003. This edition constitutes a technical revision.

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

a) the specification has been streamlined by cross-referencing IEC 60794-1-1;
b) the classification as type tests or routine tests has been deleted;
c) cable kink test has been deleted;
d) creep test for ADSS is referred to IEC 60794-4-20.

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

FDIS	Report on voting
86A/1862/FDIS	86A/1868/RVD

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

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

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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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OPTICAL FIBRE CABLES –

**Part 4: Sectional specification –
Aerial optical cables along electrical power lines**

1 Scope

~~This part of IEC 60794 specifies the electrical, mechanical and optical requirements and test methods for aerial optical cables including OPGW (optical ground wire), OPPC (optical phase conductor), MASS (metallic aerial self-supported cable), ADSS (all-dielectric self-supporting cable) and OPAC (optical attached cable).~~

This part of IEC 60794 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 (OPPC), metallic aerial self-supported cables (MASS), all-dielectric self-supporting cables (ADSS) and optical attached cables (OPAC).

This document excludes figure-8 optical cables to be used on telephone utility poles.

The IEC TR 62839-1 gives recommendations to provide the customer with the environmental declaration on request.

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.

~~They complete the normative references already listed in the generic specification (IEC 60794-1-1, Clause 2, and IEC 60794-1-2, Clause 2) and in the sectional specification (IEC 60794-3, Clause 2).~~

IEC 60104~~:1987~~, *Aluminium-magnesium-silicon alloy wire for overhead line conductors*

IEC 60304~~:1982~~, *Standard colours for insulation for low-frequency cables and wires*

~~IEC 60708-1:1981, *Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath – Part 1: General design details and requirements*~~

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

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

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

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

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

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

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

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

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

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

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

IEC 60794-3~~:2001~~, *Optical fibre cables – Part 3: Outdoor cables – Sectional specification*

IEC 60794-4-20:2012, *Optical fibre cables – Part 4-20: Aerial optical cables along power lines – Family specification for ADSS (All Dielectric Self Supported) optical cables*

~~IEC 60811-4-2:1990, *Common test methods for insulating and sheathing materials of electric cables – Part 4: Methods specific to polyethylene and polypropylene compounds – Section Two: Elongation at break after pre-conditioning – Wrapping test after pre-conditioning – Wrapping test after thermal ageing in air – Measurement of mass increase – Long term stability test (Appendix A) – Test method for copper-catalysed oxidative degradation (Appendix B)*~~

~~IEC 60811-5-1:1990, *Common test methods for insulating and sheathing materials of electric cables – Part 5: Methods specific to filling compounds – Section one: Drop point – Separation of oil – Lower temperature brittleness – Total acid number – Absence of corrosive components – Permittivity at 23 °C – DC resistivity at 23 °C and 100 °C*~~

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

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

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

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

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

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

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

IEC 60888~~:1987~~, *Zinc-coated steel wires for stranded conductors*

IEC 60889~~:1987~~, *Hard-drawn aluminium wire for overhead line conductors*

IEC 61089:1991, *Round wire concentric lay overhead electrical stranded conductors*

IEC 61232~~:1993~~, *Aluminium-clad steel wires for electrical purposes*

IEC 61394~~:1997~~, *Overhead lines – ~~Characteristics of~~ Requirements for greases for aluminium, aluminium alloy and steel bare conductors*

IEC 61395~~:1998~~, *Overhead electrical conductors – Creep test procedures for stranded conductors*

3 Terms, definitions, symbols and ~~abbreviations of cables~~ abbreviated terms

For the purposes of this document, the ~~following~~ terms, definitions, symbols and ~~abbreviations of cables~~ abbreviated terms given in IEC 60794-1-1 apply.

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

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

~~**3.1 Definitions**~~

~~**3.1.1**~~
~~**MAT**~~
~~**maximum allowable tension**~~
~~maximum tensile load that may be applied to the cable without detriment to the tensile performance requirement (optical performance, fibre strain)~~

~~**3.1.2**~~
~~**RTS**~~
~~**rated tensile strength**~~
~~summation of the product of nominal cross-sectional area, minimum tensile strength and stranding factor for each load bearing material in the cable construction (refer to Annex A in the case of OPGW)~~

~~**3.1.3**~~
~~**strain margin**~~
~~amount of strain the OCEPL can sustain without strain on the fibres due to the OCEPL's elongation~~

~~**3.2 Abbreviations of cables**~~

~~ADSS all-dielectric self-supporting cable~~

~~MASS metallic aerial self-supported cable which is not designed to have ground or phase capability~~

~~OCEPL optical cable to be used along electrical power lines~~

~~OPAC optical attached cable consisting of the following three attachment methods:~~

- ~~**wrapped:** all-dielectric (wrap). Using special machinery, a lightweight flexible non-metallic cable can be wrapped helically around either the earth wire or the phase conductor.~~
- ~~**lashed:** non-metallic cables that are installed longitudinally alongside the earth wire, the phase conductor or on a separate catenary (on a pole route) and are held in position with a binder or adhesive cord.~~
- ~~**preform attached:** similar to the lashed cables except that the method of attachment involves the use of special preformed spiral attachment clips.~~

~~OPGW optical ground wire. An OPGW has the dual performance functions of a conventional ground wire with telecommunication capabilities.~~

~~OPPC optical phase conductor. An OPPC has the dual performance functions of a phase conductor with telecommunication capabilities.~~

4 Optical fibre

4.1 General

Single-mode optical fibre which meets the requirements of IEC 60793-2 shall be used. Fibres other than those specified above can be used, if mutually agreed between the ~~customer~~ user and the supplier.

4.2 Attenuation

4.2.1 Attenuation coefficient

The typical maximum cable attenuation coefficient ~~of a cable at 1 310 nm is 0,45 dB/km and/or at 1 550 nm it is 0,30 dB/km~~ shall conform to IEC 60794-1-1.

Particular values ~~shall~~ may be agreed between the customer and supplier. The attenuation coefficient shall be measured in accordance with IEC 60793-1-40.

4.2.2 Attenuation uniformity-attenuation discontinuities

~~**4.2.2.1 Attenuation discontinuities**~~

~~The local attenuation shall not have point discontinuities in excess of 0,10 dB.~~

~~The test method best suited to provide the functional requirements is in accordance with IEC 60793-1-40.~~

~~**4.2.2.2 Attenuation linearity**~~

~~The functional requirements are under consideration.~~

Point discontinuities shall be measured in accordance with IEC 60793-1-40, method C, and conform to IEC 60794-1-1.

4.3 Cut-off wavelength of cabled fibre

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

4.4 Fibre colouring

If the primary coated fibres are coloured for identification, the coloured coating shall be readily identifiable throughout the lifetime of the cable and shall be a reasonable match to IEC 60304. ~~If required, the colouring shall permit sufficient light to be transmitted through the primary coating to allow local light injection and detection. Alternatively, the colour may be removable.~~

4.5 Polarization mode dispersion (PMD)

~~Refer to 5.5 of IEC 60794-3.~~

Cabled single-mode fibre PMD shall be measured in accordance with IEC 60793-1-48 and conform to IEC 60794-1-1.

5 Cable element

5.1 General

Generally, optical cables comprise several elements or individual constituents, depending on the cable design, which take 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 ~~product~~ detail specification.

When the fibres are in contact with a filling compound, the compatibility of the filling compound with the fibre coating shall be demonstrated by testing coating stripping force stability after accelerated ageing in accordance with IEC 60794-1-21, method E5. Alternative ageing conditions and tests may be agreed between the customer and supplier.

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

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

Different types of optical elements are described below.

5.2 Slotted core

~~The slotted core is either a metallic (for example, aluminium alloy) or non-metallic (for example, polyethylene or polypropylene) material with a defined number of slots, with longitudinal, helical or SZ configuration along the core. One or more primary coated fibres or optical element is located in each slot which shall be filled, if necessary, with a suitable water blocking system.~~

~~If metallic, it shall be electrically bonded with the other metallic elements of the cable. If non-metallic, the slotted core usually contains a central element which shall be non-metallic. In this case, there shall be adequate adhesion between the central element and the extruded~~

~~core in order to obtain the required temperature stability and tensile behaviour for the slotted core element.~~

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

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

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

5.3 ~~Plastic~~ Polymeric tube

One or more primary coated fibres or optical elements are packaged (loosely or not) in a tube construction which shall be filled, ~~if necessary, with a suitable water~~ use dry-blocking ~~system~~ methods or be otherwise water blocked. The plastic tube may be reinforced with a composite wall.

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

If used, the filling compound in the tube shall comply with ~~IEC 60794-1-2, Method E14 (compound flow (drip)) or Method E15 (bleeding and evaporation)~~ the evaporation test in accordance with IEC 60794-1-21, method E15. The filled tube shall comply with drip test in accordance with IEC 60794-1-22, method F16, when tested in tube or cabled form.

NOTE Method E15 of IEC 60794-1-21 will be transferred in IEC 60794-1-23:—[1] as method G9.

5.4 Ribbon

Optical fibre ribbons are assembled optical fibres; they shall be in accordance with IEC 60794-3.

NOTE The technical content of IEC 60794-3 regarding optical fibre ribbons will be moved to IEC 60794-1-31:—[2]. Users are directed to that document when it is issued.

5.5 Metallic tube

5.5.1 General

Constructions having fibres within a hermetically sealed tube shall consider the possibility of evolution of hydrogen gas. See 9.9 for guidance.

5.5.2 Metallic tube on the optical core

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

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1 This second edition is under preparation. Stage at the time of publication: IEC/NFDIS 60794-1-23:2018.

2 Under preparation. Stage at the time of publication: IEC/APUB 60794-1-31:2018.

5.5.3 Fibres directly located in a metallic tube

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

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

6 Optical fibre cable construction

6.1 General

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

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

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

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

If mutually agreed between ~~customer~~ purchaser and ~~supplier~~ manufacturer to avoid excess fibre strain induced by the environmental conditions, such as wind or ice loading, the cable construction and particularly the strength members shall be selected to avoid any long-term detrimental effects on fibres up to the specified MAT.

The optical fibre unit shall house the optical fibres and protect them from damage due to environmental or mechanical forces such as longitudinal compression, crushing, bending, twisting, tensile stress, long- and short-term heat effects.

The aerial cable types covered by this document can be divided into the following groups:

a) optical ground wire or optical phase conductor (OPGW or OPPC);

b) all-dielectric self-supporting cable (ADSS);

c) optical attached cables (OPAC);

d) metallic aerial self-supported cables (MASS).

These aerial cables have different constructions, environmental and electrical operating conditions for use on high-voltage lines.

6.2 Lay-up of the cable elements

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

a) optical element(s) without a stranding lay, such as a single optical unit in the cable centre~~, which may contain one or more optical elements~~;

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