

INTERNATIONAL STANDARD



Optical fibre cables –

Part 2-50: Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2023 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
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 It also gives information on projects, replaced and withdrawn publications.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 60794-2-50

Edition 3.0 2023-03
REDLINE VERSION

INTERNATIONAL STANDARD



Optical fibre cables –

Part 2-50: Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.10

ISBN 978-2-8322-6746-2

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Construction	8
4.1 General.....	8
4.2 Optical fibres and primary coating.....	8
4.3 Buffer.....	8
4.4 Tube	9
4.5 Strength and anti-buckling members	9
4.6 Sheath	9
4.7 Sheath marking.....	9
4.8 Examples of cable constructions	9
5 Tests	10
5.1 General.....	10
5.2 Dimensions	10
5.3 Mechanical requirements	11
5.3.1 Tensile performance	11
5.3.2 Crush	11
5.3.3 Impact	12
5.3.4 Repeated bending	12
5.3.5 Bend.....	12
5.3.6 Torsion	13
5.3.7 Bend at low temperature.....	13
5.3.8 Kink	14
5.3.9 Sheath pull-off force	14
5.3.10 Abrasion resistance of cable marking	14
5.3.11 Buffered fibre movement under compression	14
5.4 Environmental requirements	15
5.4.1 Temperature cycling	15
5.4.2 Sheath shrinkage (informative)	16
6 Transmission requirements.....	17
7 Fire performance	17
Annex A (informative) Examples of types of cable constructions	18
Annex B (informative) Guidance on the selection of tests applicable to optical fibre cables for use in patchcords terminated cable assemblies	24
Bibliography.....	27
Figure A.1 — Simplex loose non-buffered fibre cable	
Figure A.2 — Simplex fibre cable	
Figure A.3 — Duplex loose non-buffered fibre cable	
Figure A.4 — Duplex fibre cable	
Figure A.5 — Duplex fibre zip cord	
Figure A.6 — Duplex flat cable	

Figure A.7 – Duplex round cable (breakout cable)	
Figure A.1 – Simplex non-buffered cable	21
Figure A.2 – Simplex cable	21
Figure A.3 – Duplex non-buffered cable	21
Figure A.4 – Duplex cable	22
Figure A.5 – Duplex zip cord cable	22
Figure A.6 – Duplex flat cable	23
Figure A.7 – Duplex round cable (breakout cable).....	23
Table 1 – Outer dimensions of buffered fibres.....	9
Table 2 – Temperature cycling ranges according to the application environment	
Table 2 – Preferred low and high temperatures	16
Table B.1 – Cable test method summary.....	24
Table B.2 – Blank detail specification for cable testing agreement	26

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRE CABLES –

Part 2-50: Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies

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 redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60794-2-50:2020. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60794-2-50 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2020. This edition constitutes a technical revision.

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

- a) added IEC 60793-1-46 and IEC 60794-1-211 to the normative references;
- b) changed the load duration for the tensile test from 5 min to 10 min;
- c) clarified the distance between the clamps for torsion test to 125 times cable diameter, but not less than 0,3 m;
- d) recommended the temperatures $-10\text{ }^{\circ}\text{C}$ and $+60\text{ }^{\circ}\text{C}$ for indoor simplex and duplex cables and included the low and high temperatures for category C, C^{HD}, OP and OP^{HD} according to the operating service environments in IEC 61753-1 for temperature cycling and shrinkage testing;
- e) updated the shrinkage test standard to IEC 60794-1-211, F11A, and changed the requirement to maximum 20 mm;
- f) replaced the text for the fire performance with an improved description.

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

Draft	Report on voting
86A/2284/FDIS	86A/2316/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 the 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 publication 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.

INTRODUCTION

This document includes test methods according to IEC 60794-1-21, IEC 60794-1-22 and IEC 60794-1-23 that will be split into single documents and individually renumbered in the IEC 60794-1-1xx series, IEC 60794-1-2xx series and IEC 60794-1-3xx series. Full cross-reference details are given in IEC 60794-1-2.

OPTICAL FIBRE CABLES –

Part 2-50: Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies

1 Scope

This part of IEC 60794 is a family specification that specifies requirements for simplex and duplex optical fibre cables for use in terminated cable assemblies or **as used** for termination ~~with optical fibre~~ of passive components.

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 60793-1-20, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

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: Attenuation measurement methods*

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

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

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

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

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

IEC 60794-1-211, *Optical fibre cables – Part 1-211: Generic specification – Basic optical cable test procedures – Environmental test methods – Sheath shrinkage, method F11*

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 60794-2, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

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 terms and definitions given in IEC 60794-1-1 and the following 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

terminated cable assembly

~~short length of cable provisioned with a connector at both ends~~

cable terminated with connectors

Note 1 to entry: Examples from the ISO/IEC 11801 series are optical fibre-optic cords used to establish connections on patch panels, equipment and at work areas or to connect outlets to the terminal equipment.

Note 2 to entry: A so called patch cord or jumper is one type of a terminated cable assembly.

4 Construction

4.1 General

In addition to the constructional requirements in IEC 60794-2, the following considerations apply to simplex and duplex indoor cables for use in terminated cable assemblies.

It is not the intention of this document to specify the finished terminated cable assembly complete with terminations.

There shall be no fibre splice in a delivery length. It shall be possible to identify each individual fibre throughout the length of the cable.

4.2 Optical fibres and primary coating

Multimode or single-mode optical fibres meeting the requirements of IEC 60793-2-10 sub-categories A1-OM1 ~~and~~ or A1-OM2 to A1-OM5 or IEC 60793-2-50 class B shall be used.

4.3 Buffer

If a tight or semi-tight (loosely applied) buffer is required, it shall consist of one or more layers of inert material. Unless otherwise specified, the tight buffer shall be ~~removable~~ removed in one operation together with fibre coating over the specified length. Semi-tight tubes may be filled. For semi-tight and loose buffer, the buffer material is ~~stripped off~~ removed for a specified length leaving the primary coating of the fibre intact.

Specified buffer strippability **minimum** lengths:

- tight: 15 mm;
- semi tight: 300 mm;
- loose: 1,0 m ~~minimum~~.

Strip force shall comply to the values stated in the relevant specification and the evaluation shall be carried out according to IEC 60793-1-32.

Buffer dimensions are shown in Table 1.

Table 1 – Outer dimensions of buffered fibres

Nominal outer diameter mm	Tolerance mm
0,3 to 0,9	±0,05

Lower tolerance levels can be a requirement for buffered fibres having a low nominal diameter within the specified range. In such cases, tolerance values shall be agreed between supplier and customer.

4.4 Tube

One or two primary coated or buffered fibres are packaged ~~(loosely or not)~~ in a tube construction which may be filled. A tube is a cable element that is not covered in 4.3 and typically has a larger outer diameter than what is specified in 4.3. The 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.

4.5 Strength and anti-buckling members

The cable shall be designed with sufficient strength members to meet the requirements of this document.

The strength and/or anti-buckling member may be either metallic or non-metallic and may be located in the cable core and/or under the sheath and/or in the sheath.

4.6 Sheath

The cable shall have a uniform overall protective sheath. The cable diameter shall be specified in the relevant ~~detail~~ specification ~~(or product specification)~~. Sheath removal is an important feature of these cables. Sheath pull-off force shall be determined in accordance with IEC 60794-1-21, method E21.

4.7 Sheath marking

If required, the cable shall be marked as agreed between the customer and supplier. ~~The marking shall be resistant to abrasion, which shall be verified in accordance with IEC 60794-1-21, method E2B, method 2.~~

4.8 Examples of cable constructions

Examples of ~~some main types of~~ cable constructions are shown in Annex A.

Other configurations are not excluded if they meet the mechanical, environmental, transmission and termination requirements given in this document.

5 Tests

5.1 General

Compliance with the specification requirements shall be verified by carrying out tests selected from Clause 5. It is not intended that all tests be carried out in all cases, and Annex B provides guidance on the selection of applicable tests. The tests to be applied and the frequency of testing ~~shall need to~~ be agreed between the customer and supplier.

Some of the following tests can be performed on a short sample length of cable which is still an integral part of a longer length, thus making it possible to detect permanent changes in attenuation. As a general requirement for the tests specified in this document, the ~~spirit~~ goal is to keep "no change in attenuation" criteria at the end of each evaluation, although the parameters specified in this document may be affected by measurement uncertainty arising either from measurement errors or calibration errors. The optical total uncertainty of measurement for this document shall be $\pm 0,05$ dB for single-mode fibres and $\pm 0,2$ dB for multimode fibres. Any measured value within this range shall be considered as "no change in attenuation".

~~Cabled~~ Single-mode fibres ~~cables~~ are measured at 1 550 nm or 1 625 nm and the measuring wavelength shall be agreed between the customer and supplier. ~~Cabled~~ Multimode fibres ~~cables~~ are measured at 850 nm or 1 300 nm and the measuring wavelength shall be agreed between the customer and supplier. Measurements of attenuation shall be carried out according to IEC 60793-1-40. Change in attenuation measurements shall be carried out according to IEC 60793-1-46.

NOTE The optimized wavelength for multimode fibres A1-OM3 and A1-OM4 is 850 nm and for A1-OM5 fibre, the targeted operational wavelength ~~(s)~~ range is ~~between~~ in the vicinity of 850 nm ~~and to~~ 950 nm.

If loops are used within a test to fix the ends of a cable, the loop diameter shall be equal or greater than the specified minimum cable bend diameter to avoid cable damage and excessive mode filtering in multimode fibre.

Unless otherwise specified, all tests shall be carried out at expanded test conditions as specified in IEC 60794-1-2.

5.2 Dimensions

The fibre dimensions and tolerances shall be checked in accordance with test method IEC 60793-1-20 or IEC 60793-1-21. The diameter of the buffer and of the cable, as well as the thickness of the sheath, shall be measured in accordance with the methods of IEC 60811-202 and IEC 60811-203.

The nominal outer cable diameter is abbreviated as "d" in this document. "d" for the different cable constructions is defined as follows:

- for simplex cable, "d" is the outer diameter;
- for zip cord cable, "d" is the outer diameter of the simplex cable which is used to be combined with another simplex cable to form a zip cord;
- for duplex flat cable, "d" is the outer diameter of the inner cables which include the optical fibre, the buffer, the strength members and the sheath;
- for duplex round cable, "d" is the outer diameter of the inner cables which include the optical fibre, the buffer, the strength members and the sheath.

The cable diameter tolerance shall be $\pm 0,2$ mm.

The deviation of the average sheath thickness shall be within the tolerance of $\pm 0,1$ mm for 100 % of the cable length.

5.3 Mechanical requirements

5.3.1 Tensile performance

Method: IEC 60794-1-21, E1

Diameter of chuck drums and transfer devices: not less than the minimum loaded bending diameter specified for the cable, at least 250 mm diameter.

Load for ~~5~~ 10 min:

- simplex cables $d < 1,2$ mm at 50 N; simplex cables $1,2 \text{ mm} \leq d \leq 2,0$ mm at 70 N; simplex cables $d > 2,0$ mm at 100 N;
- duplex round cables at 100 N;
- zipcord and duplex flat cables $d \leq 2,0$ mm at 140 N; zipcord and duplex flat cables $d > 2,0$ mm at 200 N.

Length of sample: sufficient to achieve the desired accuracy of measurement of attenuation change shall be agreed between the customer and supplier.

Requirements:

- in all cases, fibre strain shall ~~be less than 0,6 %~~ not exceed 60 % of the proof strain (equals to absolute 0,6 % strain for 1 % proof-tested fibres);
- the maximum allowable increase in attenuation during the test shall be specified in the ~~product~~ relevant specification;
- there shall be no change in attenuation after the test.
- ~~— there shall be no damage to the cable elements.~~

5.3.2 Crush

Method: IEC 60794-1-21, E3A

Force short-term:

- 300 N for simplex/duplex cables with $d \leq 2,0$ mm;
- 500 N for simplex/duplex cables with $d > 2,0$ mm.

Duration short-term: 1 min

Number of crushes short-term: 1

Force long-term:

- 100 N for simplex/duplex cables with $d \leq 2,0$ mm;
- 200 N for simplex/duplex cables with $d > 2,0$ mm.

Duration long-term: 10 min

Number of crushes long-term: 1, separated at least 500 mm to any other loaded position.

Requirements:

- the maximum increase in attenuation during the test with a long-term force shall be specified in the ~~product~~ relevant specification;
- there shall be no change in attenuation after the test with short-term and long-term force;
- there shall be no damage to the cable elements; any flattening of cable elements is not considered as damage.

For cables having a non-circular cross section, the force shall be applied in the direction of the minor axis (perpendicular to the major axis), as shown in Figure A.6 as an example.

5.3.3 Impact

Method: IEC 60794-1-21, E4

- impact energy: 0,5 J for simplex/duplex cables with $d \leq 2,0$ mm; 1,0 J for simplex/duplex cables with $d > 2,0$ mm;
- number of impacts: ~~at least~~ 3, each separated at least 500 mm.

Requirements:

- there shall be no change in attenuation after the test;
 - there shall be no damage to the cable elements; any flattening of cable elements is not considered as damage.
- ~~— any imprint of the striking surface on the cable sheath is not considered mechanical damage.~~

For cables having a non-circular cross section, the force shall be applied in the direction of the minor axis (perpendicular to the major axis), as shown in Figure A.5 and Figure A.6.

5.3.4 Repeated bending

Method: IEC 60794-1-21, E6

Bending diameter:

- 60 mm for simplex and non-circular duplex cables (consider the cable diameter is the minor dimension);
- 40 times cable diameter for ~~circular~~ round duplex cables but not less than 60 mm.

Number of cycles: 200

Mass of weights: sufficient to contour the apparatus, for example 1 kg to 2 kg.

Requirements:

- the maximum increase in attenuation during the test shall be specified in the ~~product~~ relevant specification;
- there shall be no change in attenuation after the test;
- there shall be no damage to the cable elements; any flattening of cable elements is not considered as damage.

NOTE For cables having a non-circular cross section, the bend requirements are determined using the minor axis as the cable diameter with bending in the direction of the preferential bend, as shown in Figure A.5 and Figure A.6.

5.3.5 Bend

Method: IEC 60794-1-21, E11A

Bending diameter: 20 times cable diameter, but not less than 60 mm (for non-circular cables see note below).

NOTE A cable with smaller bend diameter than specified above can be required for an application. Such a cable can contain bending loss insensitive (enhanced macrobend loss) fibre(s). A smaller bending diameter can be agreed between customer and supplier.

Number of turns ~~per helix~~: 6

Number of cycles: 3

Length of sample: sufficient to carry out the test.

Prior to bending: at both ends of the sample, all the cable components shall be fixed together, for example by ~~loops~~ clamps or glue.

Requirements:

- the maximum increase in attenuation during the test shall be specified in the ~~product~~ relevant specification;
- there shall be no change in attenuation after the test;
- there shall be no damage to the cable elements; any flattening of cable elements is not considered as damage.

NOTE For cables having a non-circular cross section, the bend requirements are determined using the minor axis as the cable diameter with bending in the direction of the preferential bend, as shown in Figure A.5 and Figure A.6.

5.3.6 Torsion

Method: IEC 60794-1-21, E7

Number of cycles: 10

Distance between fixed and rotating clamps: ~~greater than 0,3 m or~~ 125 times cable diameter (for non-circular cables, the cable diameter is the minor dimension) but not less than 0,3 m.

Length of sample: sufficient to carry out the test.

Unless otherwise specified in the ~~detail~~ relevant specification, ~~specimen~~ sample sag or bend may be minimized by applying tension sufficient to keep the ~~specimen~~ sample straight.

Requirements:

- the maximum increase in attenuation during the test shall be specified in the ~~product~~ relevant specification;
- there shall be no change in attenuation after the test;
- there shall be no damage to the cable elements.

5.3.7 Bend at low temperature

Method: IEC 60794-1-21, E11A

Bending diameter: 20 times cable diameter (for non-circular cables, the cable diameter is the minor dimension) but not less than 60 mm.

NOTE A cable with smaller bend diameter than specified above can be required for an application. Such a cable can contain bending loss insensitive (enhanced macrobend loss) fibre(s). A smaller bending diameter can be agreed between customer and supplier.

Number of cycles: 2

Number of turns ~~per helix~~: 4

Test temperature: 0 °C ~~for applications at category C and C^{HD} environment;~~

~~The acronyms for the categories are specified in IEC 61753-1. A suitable category should be selected according to the application. See Table 2.~~

Requirements:

- the maximum increase in attenuation during the test shall be specified in the ~~product~~ relevant specification;
- there shall be no change in attenuation after the test;
- there shall be no damage to the cable elements; any flattening of cable elements is not considered as damage.

5.3.8 Kink

Method: IEC 60794-1-21, E10

Inner loop diameter (for non-circular cables, the cable diameter is the minor dimension):
~~5 times cable diameter.~~

- for cables with outer diameter $\leq 3,0$ mm, to be 15 mm;
- for cables with outer diameter $> 3,0$ mm, to be 5 times the cable outer diameter.

NOTE This is not an operational parameter; this is to address short-term installation/handling performance.

Requirement: no kink on cable shall occur when submitted to the specified loop diameter.

5.3.9 Sheath pull-off force

Method: IEC 60794-1-21, E21

Rate of separation: ≤ 200 mm/min

Strip length: 50 mm

Requirement: the force to strip the sheath shall not be greater than 15 N.

5.3.10 Abrasion resistance of cable marking

Method: IEC 60794-1-21, E2B, method 2

Number of cycles: 50

Requirement: the marking shall be legible on completion of the test, after the number of specified cycles.

5.3.11 Buffered fibre movement under compression

Method: IEC 60794-1-21, E22

Compression distance: 1 mm

Number of movements: 5

Requirements:

- the maximum increase in attenuation during the test shall be specified in the ~~product~~ **relevant** specification;
- the reaction force shall be less than 1 N at 0,4 mm.

5.4 Environmental requirements

5.4.1 Temperature cycling

~~Method: IEC 60794-1-22, Method F12~~

~~Period t_1 and the number of cycles shall be according Table 2.~~

~~Length of sample: 10 m~~

~~At both ends of the sample, all components of the cable shall be fixed together, for example with loops or glue.~~

~~The temperature cycling range used for the test shall be taken from the intended application environment of the final assembly as described in Table 2.~~

~~Requirements:~~

- ~~— the maximum change in attenuation during the test shall be specified in the relevant product specification;~~
- ~~— there shall be no change in attenuation after the test.~~

~~Table 2 – Temperature cycling ranges according to the application environment~~

Category ^a	Environment description	Temperature extreme T_A °C	Temperature extreme T_B °C	Soak time t_1 h	Number of cycles
C	Indoor-controlled	–10	+60	1	5
C ^{HD}	Indoor-controlled with heat dissipation	–10	+70	1	5

~~^a The acronyms for the categories are specified in IEC 61753-1. A suitable category should be selected according the application.~~

Method: IEC 60794-1-22, method F12

Length of device under test (DUT): 10 m

NOTE The length of the DUT is the length between the fixing points of all components of the cable. The cable sample length is longer to allow for connection to the optical measurement device outside the temperature chamber.

At both ends of the length of the DUT, all components of the cable shall be fixed together, for example with clamps or glue.

For indoor simplex and duplex cables, –10 °C and +60 °C are the recommended low and high temperatures. Specific operating temperatures can be agreed between customer and supplier. Table 2 gives the preferred operating temperatures.

Table 2 – Preferred low and high temperatures

Low temperature T_A °C	High temperature T_B °C	Sources of temperatures (informative)		Remark
		Performance categories of connectors, components and protective housings ^a	Environmental classification of customer premises cabling ^b	
–10	+60	C	$M_x I_x C_1 E_x$	Recommended
–10	+70	C^{HD}	-	
–25	+70	OP	$M_x I_x C_2 E_x$	
–25	+85	OP^{HD}	-	
<p>A suitable operating service environment (performance category) or environmental classification should be selected according to the application. A complete list of operating service environments can be found in IEC 60794-1-1.</p> <p>^a Included in IEC 61753-1. The abbreviations represent:</p> <p>C: indoor controlled environment;</p> <p>OP: outdoor protected environment;</p> <p>HD: indicates an extended upper temperature necessary due to additional dissipation by active electronics.</p> <p>^b Included in ISO/IEC 11801-1. For an introduction to the MICE environmental classification system, use ISO/IEC TR 29106. The abbreviation MICE represents: mechanical, ingress, climatic, electromagnetic.</p>				

Soak time t_1 : 1 h

Number of cycles: 5

Requirements:

- the maximum change in attenuation during the test shall be specified in the relevant specification;
- there shall be no change in attenuation after the test.

5.4.2 Sheath shrinkage ~~(informative)~~

~~Information on cable shrinkage characterization of optical fibre cables, related test methods and guidance for shrinkage grade classification are given in IEC TR 62959⁴. Following an example for characterization:~~

~~Method: IEC 60794-1-22, F11~~

~~Exposure temperature: the highest operation temperature specified for the cable according to the performance category in Table 2.~~

~~Exposure duration: according to the performance category in Table 2.~~

~~Number of cycles: according to the performance category in Table 2.~~

~~Nominal length of samples: 1 m.~~

⁴ ~~Under preparation. Stage at the time of publication: IEC/PCC 62959:2019.~~

~~On completion of the corresponding number of cycles, report the maximum shrinkage of the cable samples. Requirements shall be specified in the product specification.~~

Method: IEC 60794-1-211, F11A

Low and high temperature: One pair should be selected in Table 2 according to the application.

Nominal length of samples: 1 m

Soak time t_1 : 1 h

Number of cycles: 5

Requirement: The maximum sheath shrinkage shall be equal or less than 20 mm.

NOTE IEC TR 62959 provides information on cable shrinkage characterisation of optical fibre cables that consist of standard glass optical fibres for telecommunication applications. The characterisation is directed to the effects of cable shrinkage or cable element shrinkage on the termination of cables.

6 Transmission requirements

The transmission requirements shall be ~~verified~~ in accordance with ~~IEC 60793-1-40~~ IEC 60793-2-10 or IEC 60793-2-50 and shall be agreed between customer and supplier. Maximum cable attenuation shall comply with IEC 60794-1-1.

7 Fire performance

All cables according to this document shall pass fire performance specifications. The requirements may differ in different regions (e.g. North America, EU). But they also can differ from country to country.

NOTE 1 IEC TR 62222 provides guidance and recommendations for the requirements and test methods for the fire performance of communication cables when installed in buildings. The recommendations relate to typical applications and installation practices, and an assessment of the fire hazards presented. Account is also taken of applicable legislation and regulation.

IEC TR 62222 references several IEC fire performance test methods and also other test methods that ~~may~~ can be required by local or national legislation and regulation. It is important that the tests to be applied fulfil the national legislation and regulation and the specific requirements by its intended use.

Products placed on the EU or UK market should determine whether harmonised EN 50575 is applicable after checking with local regulations.

Annex A (informative)

Examples of ~~types of~~ cable constructions

Figure A.1 to Figure A.7 shows examples of ~~types of~~ cable constructions. The main dimensions depend on agreement between customer and supplier.

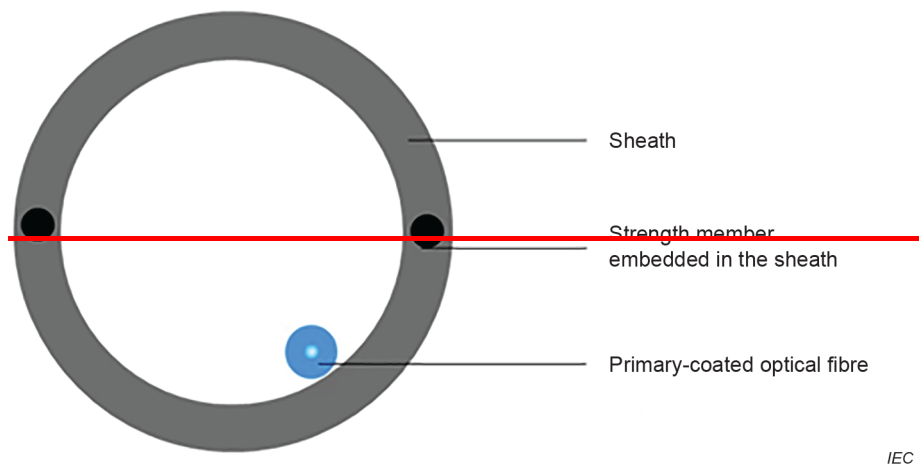


Figure A.1 – Simplex loose non-buffered fibre cable

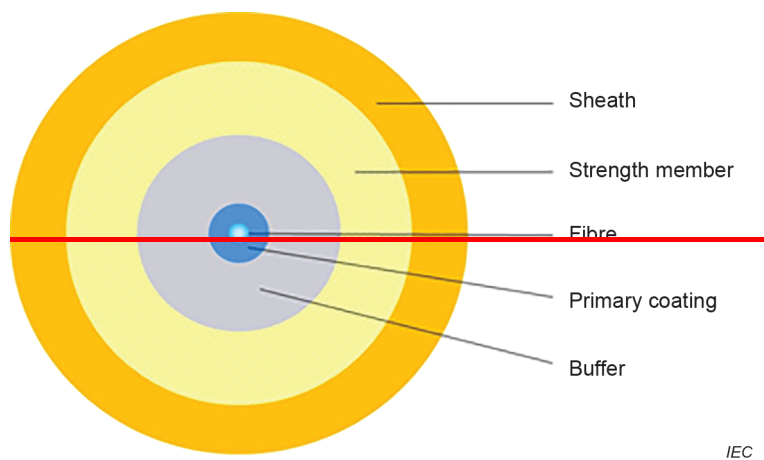


Figure A.2 – Simplex fibre cable

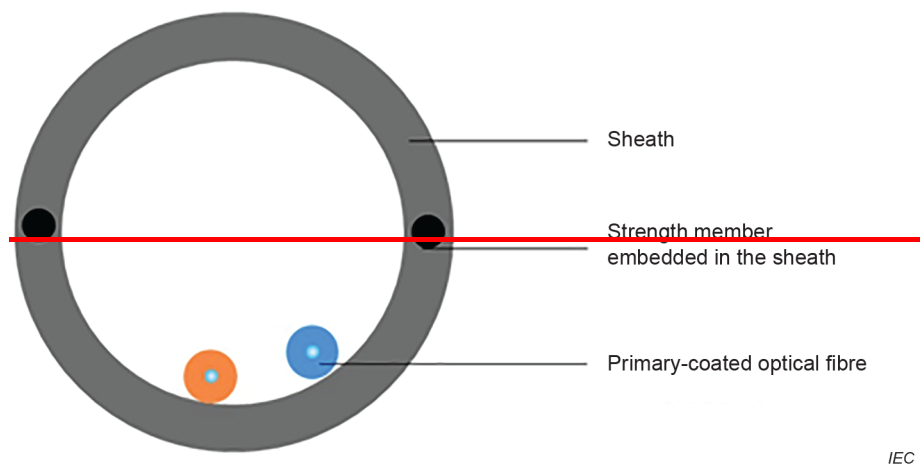


Figure A.3 – Duplex loose non-buffered fibre cable

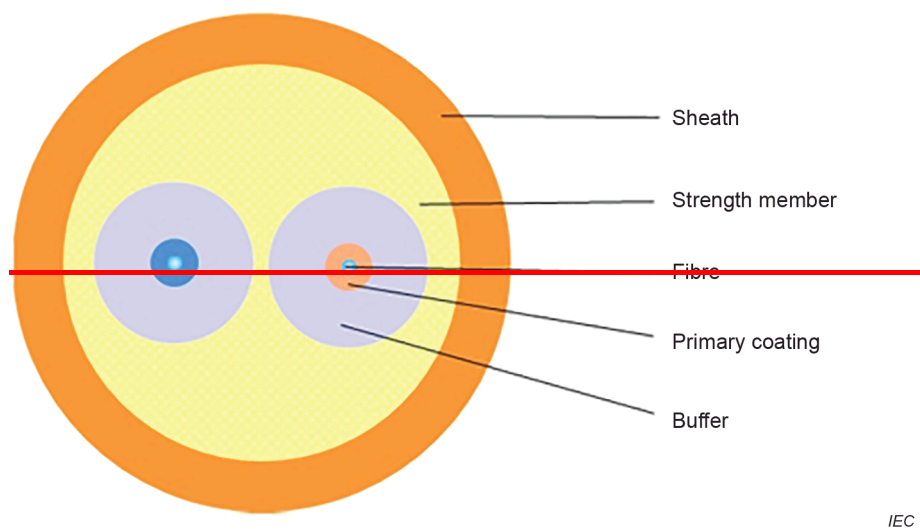


Figure A.4 – Duplex fibre cable

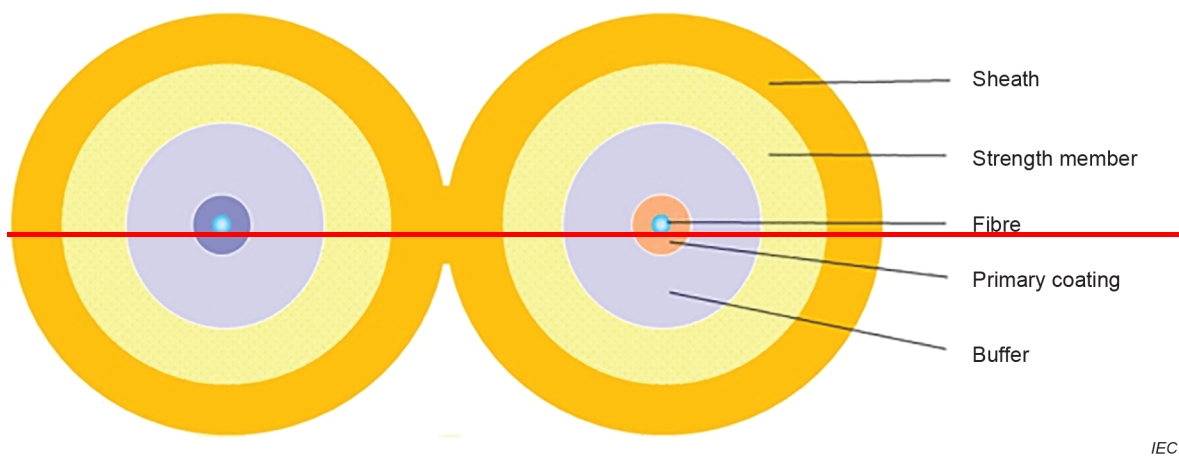


Figure A.5 – Duplex fibre zip-cord

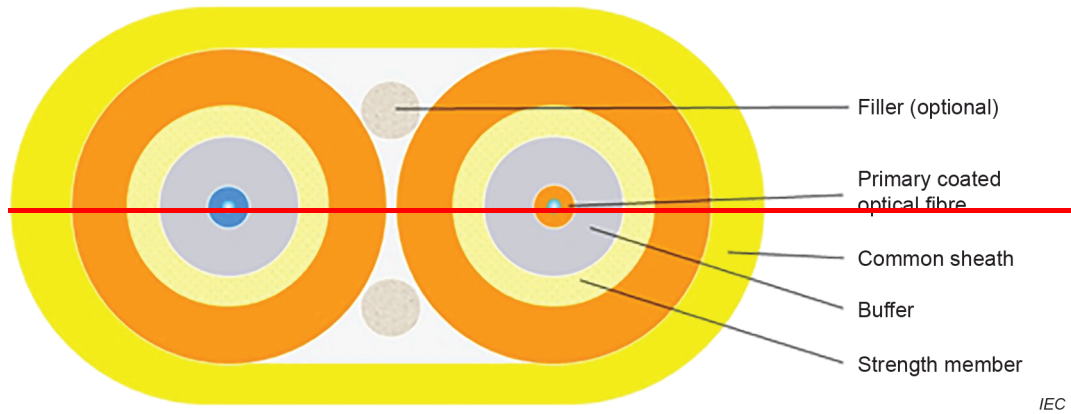


Figure A.6 – Duplex flat cable

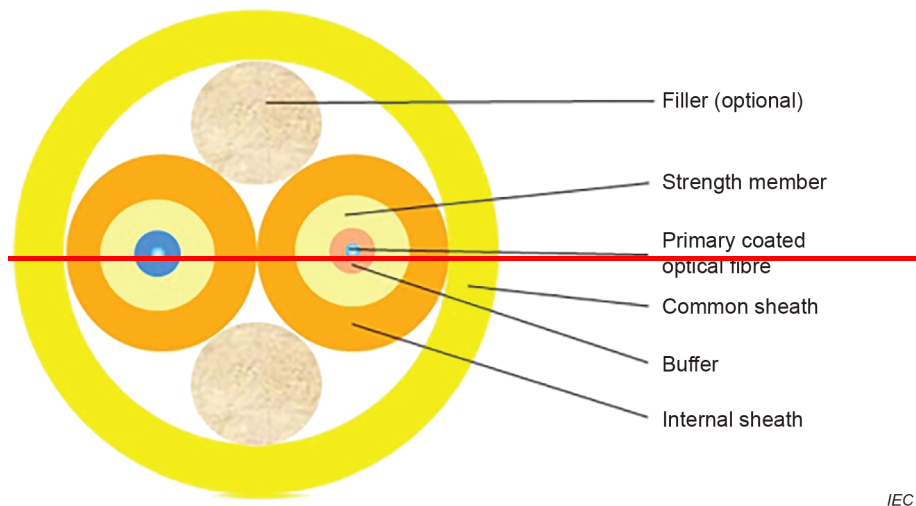


Figure A.7 – Duplex round cable (breakout cable)

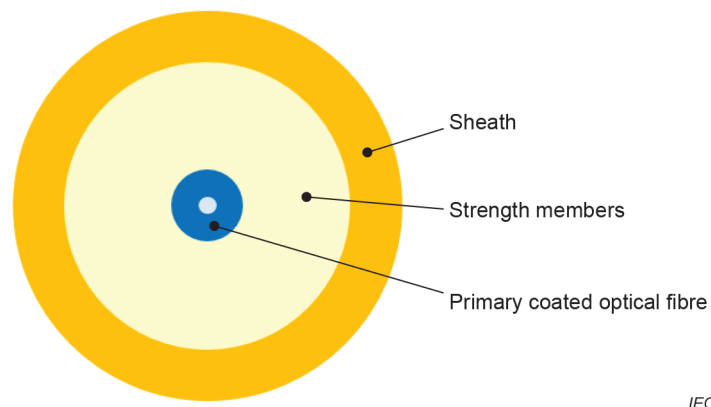


Figure A.1 – Simplex non-buffered cable

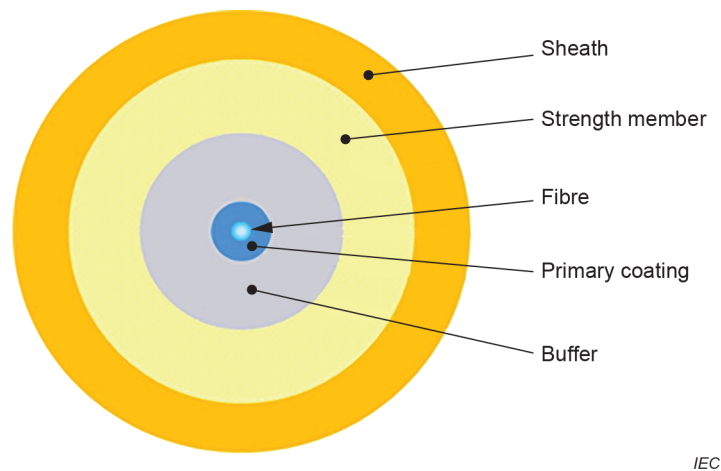


Figure A.2 – Simplex cable

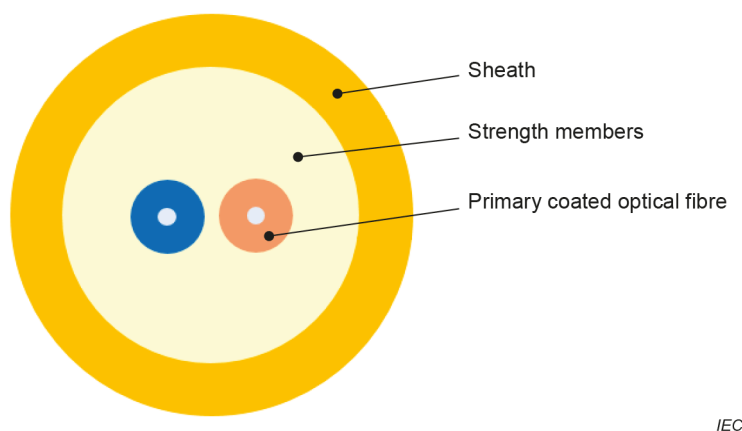
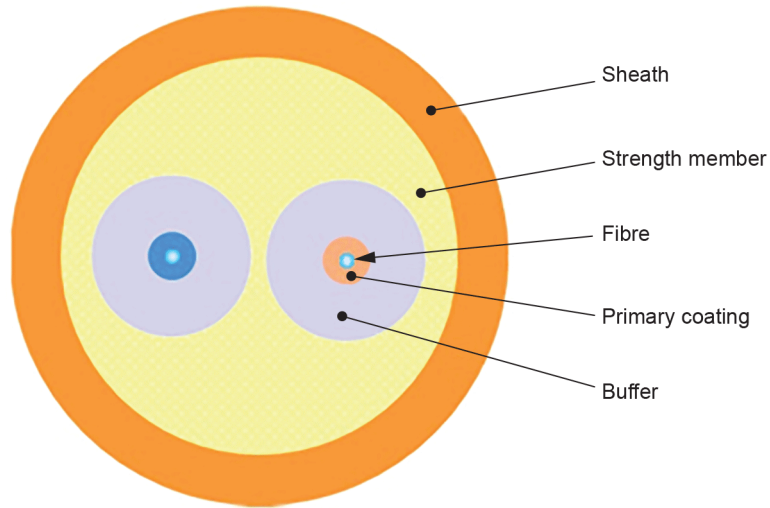
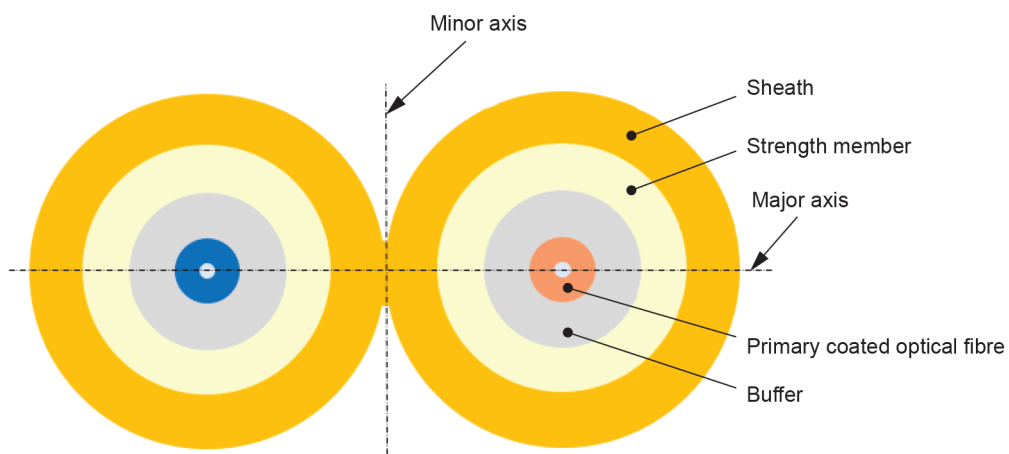


Figure A.3 – Duplex non-buffered cable



IEC

Figure A.4 – Duplex cable



IEC

Figure A.5 – Duplex zip cord cable