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Edition 3.0 2023-03
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60794-2-10:2011. 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 60794-2-10 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 2011. This edition constitutes a technical revision.

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

a) updating of normative references;

b) updating of all relevant A1 and B1 fibre category and sub-category designations.

This International Standard is to be used in conjunction with IEC 60794-1-1:2022, IEC 60794-1-2:2021, IEC 60794-1-21:2015 and IEC 60794-1-21:2015/AMD1:2020, IEC 60794-1-22:2017, IEC 60794-1-23:2019 and IEC 60794-2:2017.

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

Draft	Report on voting
86A/2277/FDIS	86A/2311/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 of 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.

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OPTICAL FIBRE CABLES –

Part 2-10: Indoor optical fibre cables – Family specification for simplex and duplex cables

1 Scope

This part of IEC 60794 is a family specification that covers simplex and duplex optical fibre cables for indoor use ~~except for cables used in terminated assemblies specified by IEC 60794-2-50~~. The requirements of IEC 60794-2 are applicable to cables covered by this document.

For cables intended for installation in industrial applications specified in ~~ISO/IEC 24702~~ ISO/IEC 11801-1, MICE specifications ~~may~~ can be additionally required (see Clause B.2).

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.

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

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

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

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

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

IEC 60794-1-1:~~2008~~2022, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-2~~:2007~~, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance*

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 test methods*

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

IEC 60794-2:2017, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

~~IEC 60811-1-1, *Common test methods for insulating and sheathing materials of electric cables – Part 1-1: Methods for general application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*~~

~~NOTE 2 IEC 60811-1-1 is under revision to be replaced by IEC 60811-201, IEC 60811-202 and IEC 60811-203.~~

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

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

No terms and definitions are listed in this document.

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

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

4 Construction

4.1 General

In addition to the constructional requirements in IEC 60794-2, the following apply to simplex and duplex indoor cables.

The cable shall be designed and manufactured for an expected operating lifetime of at least 15 years. In this context, the attenuation of the installed cable at the operational wavelength(s) shall not exceed the values agreed between the customer and the supplier. The materials in the cable shall not present a health or environmental hazard within its intended use.

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

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 shall be used which meet the requirements of IEC 60793-2.

4.3 Buffer

If a buffer is required, it shall consist of one or more layers of inert material. The buffer shall be easily removable. For tight buffers, the buffer and fibre primary coating shall be removable in one operation over a minimum length of ~~10 mm to 25 mm~~ 15 mm, depending on customer requirements. For semi-tight buffers, the buffer shall be easily removable over a minimum length of ~~0,3 m to 0,5 m~~ 300 mm. For loose buffers, the buffer shall be easily removable over a length of not less than 1,0 m.

Buffer dimensions are shown in Table 1.

Table 1 – Dimensions of buffered fibres

Buffer type	Nominal diameter mm	Tolerances mm
Semi-tight or loose buffer	0,3 to 1,3	± 0,05
Tight buffer	0,3 to 1,0	± 0,05

4.4 Ruggedised fibre

Further protection can be provided to buffered fibres by surrounding one or two of the fibres with non-metallic strength members within a sheath of suitable polymeric material.

4.5 Slotted core

Cables of this construction are not commonly used.

4.6 Tube

One or two primary coated or buffered fibres are packaged (loosely or not) in a tube construction which may be filled. The tube may be reinforced with a composite wall.

The polymeric tube may be hard, in order to provide crush protection to the fibre bundle, or soft to enable easy strippability of the tube without the use of specialized tools.

If required the suitability of the tube shall be determined by an evaluation of its kink resistance in accordance with ~~IEC 60794-1-2~~ IEC 60794-1-23, Method G7.

4.7 Stranded loose tube

Cables of this construction are not commonly used, however two general designs can be employed:

a) loose tubes laid in parallel;

b) a number of homogeneous loose tubes stranded helically or with the reverse-oscillating (SZ) method

4.8 Ribbon structure

Cables of this construction are not commonly used.

4.9 Strength and anti-buckling members

The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibres are not subjected to strain in excess of limits agreed between the customer and the supplier.

The strength ~~and/or~~, anti-buckling member or both 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.

4.10 Ripcord

Ripcords are not commonly used.

4.11 Sheath

The cable shall have an overall protective sheath. The cable ~~diameter~~ dimension(s) shall be specified in the relevant ~~detail~~ specification ~~(or product specification)~~.

4.12 Sheath marking

~~If required, the cable shall be marked according to the local regulations or the agreement between the customer and the supplier.~~

Local regulations for sheath marking can apply. In the absence of local regulations, there can be an agreement between the customer and supplier.

4.13 Identification

In case of duplex cables, the cable design should enable clear polarity identification for each individual fibre. When fibre colouring is used for identification, standard colours shall be used as closely as possible (reasonable match) to IEC 60304.

4.14 Examples of typical cable ~~constructions~~ designs

Examples of ~~some main types of~~ typical cable ~~construction~~ designs are shown in Annex A. Other configurations are not excluded if they meet the mechanical, environmental and transmission requirements given in this document.

5 Dimensions – Optical fibres and primary coating

The dimensions of the individual primary coated fibres in the finished product shall be in accordance with one of the sectional specifications defined in IEC 60793-2 series. The fibre dimensions (e.g. cladding diameter or outer diameter including colouring) shall be verified in accordance with IEC 60793-1-20 for fibre geometry or IEC 60793-1-21 for coating geometry. Cable and cable element dimensions shall be measured in accordance with IEC 60794-1-1. For dimensions of buffers see Table 2.

6 Tests

6.1 General

Compliance with the specification requirements shall be verified by carrying out tests selected from the 6.2 to 6.5. It is not intended that all tests shall be carried out; the frequency of testing shall be agreed between the customer and supplier.

Unless otherwise specified, all tests shall be carried out at ~~ambient temperature~~ standard atmospheric conditions in accordance with IEC 60794-1-2.

These tests are not intended to define end-of-life performance.

See Annex B for a blank detail specification.

6.2 Dimensions

The fibre dimensions and tolerances shall be checked in accordance with the test method as specified in IEC 60793-1-20 for fibre geometry or IEC 60793-1-21 for coating geometry. 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 60811-1-1~~ IEC 60811-201 for insulation thickness and IEC 60811-203 for overall dimensions.

6.3 Mechanical requirements

6.3.1 General

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 it becomes possible to detect permanent changes in attenuation. The maximum value of this attenuation change shall be agreed between the customer and supplier.

6.3.2 Tensile performance

Method:	IEC 60794-1-21, E1
Diameter of chuck drums and transfer devices:	not less than 250 mm
Rate of transfer device:	either 100 mm/min or 100 N/min
Load:	T_M = 75 N applied for 10 min for simplex cables and normal duplex cables T_M = 150 N applied for 10 min for duplex cables which consist of independent simplex cables (see NOTE 1)

NOTE 1 In case of duplex cables that include two simplex cables and bearing the applied tensile force by the strength members of each simplex cable, as shown in Figure A.5 Figure A.6 (without the optional strength member) and Figure A.7, the tensile requirement for the duplex cable ~~shall~~ will be double that for the simplex cable. The rationale is that those simplex cables ~~may~~ can be taken out from the duplex cable and will be independently used.

NOTE 2 The requirements of tensile load depend on the construction of cables. Lower values ~~may~~ can be adopted for some types of cables, for example small factor simplex cables.

Length of sample:	~~sufficient to achieve the desired accuracy of measurement of attenuation change and shall be agreed between customer and supplier~~ no less than 50 m unless specified in the relevant specification. For cables requiring specialized anchoring devices, the minimum length shall be 25 m.
Requirements:	no change in attenuation after the test and there shall be no damage to the cable elements ~~Fibre strain shall not exceed a value agreed upon between customer and supplier~~ for 1 % proof-tested fibres, the fibre strain under short-term tensile load (T_M) 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. Under visual examination without magnification, there shall be no damage to the sheath or to the cable elements.

6.3.3 Crush

Method:	~~IEC 60794-1-2, E3~~ IEC 60794-1-21, E3A
Force (short term):	500 N
Duration:	1 min

Length between test locations:	500 mm
Requirements:	no change in attenuation after the test and there shall be no damage to the cable elements

NOTE In the case of flat cables the force is applied on the flat sides of the cable.

6.3.4 Impact

Method:	~~IEC 60794-1-2, E4~~ IEC 60794-1-21, E4
~~Radius of striking surface:~~	~~12,5 mm~~
Impact energy:	1,0 J
Number of impacts:	at least 3, each separated by at least 500 mm
Requirements:	no fibre breakage

NOTE In the case of flat cables the force is applied on the flat sides of the cable.

6.3.5 Bend

Method:	~~IEC 60794-1-2, E11A~~ IEC 60794-1-21, E11A
Mandrel diameter:	60 mm
Number of turns:	6
Number of cycles:	10
Requirements:	no fibre breakage

NOTE In the case of flat cables the force is applied on the flat sides of the cable.

6.3.6 Repeated bending

None.

6.3.7 Bending under tension

None.

6.3.8 Bending at low temperature

None.

6.3.9 Flexing

None.

6.3.10 Torsion

Method:	~~IEC 60794-1-2, E7~~ IEC 60794-1-21, E7
Number of cycles:	~~3~~ 10
Distance between fixed and rotating clamp:	125 x cable diameter but no less than 0,3 m and not more than 1 m
Tension load:	20 N
Requirements:	no fibre breakage

6.3.11 Kink

Method:	~~IEC 60794-1-2, E10~~ IEC 60794-1-21, E10
Minimum loop diameter:	20 times cable diameter
Requirement:	no kink shall occur

6.4 Environmental requirements – Temperature cycling

~~5.4.1 Temperature cycling~~

~~See Table 2.~~

~~Method: IEC 60794-1-2, F1~~

~~Table 2 – Temperature cycling conditions~~

	~~Low temperature T_A~~	~~High temperature T_B~~
~~a)~~	~~0 °C~~	~~+50 °C~~
~~b)~~	~~–5 °C~~	~~+50 °C~~
~~c)~~	~~–20 °C~~	~~+60 °C~~
~~d)~~	~~–45 °C~~	~~+60 °C~~
~~NOTE Condition a), b), c) or d) will be selected depending on application and customer requirements, for example condition c) is appropriate for applications to ISO/IEC 11801.~~		

For indoor simplex and duplex cables, -10 °C and +60 °C are the recommended low and high temperatures. Based on different environment classifications, other operating temperatures can be agreed upon between customer and supplier. Table 2 gives the operating temperature limits based on environmental classification.

Table 2 – Method: IEC 60794-1-22, F1

Low temperature T_{A2} °C	High temperature T_{B2} °C	Sources of temperature limits	
		Performance categories of connectors, components and protective housings [a]	Environmental classification of customer premises cabling [b]
-10	+60	C (recommended)	$M_xI_xC_1E_x$
-25	+70	OP	$M_xI_xC_2E_x$
-40	+70	I	$M_xI_xC_3E_x$

A suitable operating service environment (performance category) or environmental classification should be selected in accordance with the application. A complete list of operating service environments can be found in IEC 60794-1-1.

[a] Included in IEC 61753-1. The abbreviated terms stand for:
C: indoor controlled environment;
OP: outdoor protected environment;
I: industrial environment;

[b] Included in ISO/IEC 11801-1. For an introduction to the MICE environmental classification system use ISO/IEC TR 29106. The abbreviation MICE stands for: mechanical, ingress, climatic, electromagnetic.

Period t_1: sufficient so that the cable has reached, and stabilised to, the specified temperature

Number of cycles: 2

Length of sample: sufficient to achieve the desired accuracy of measurement of attenuation

Requirement: maximum increase in attenuation to be agreed between customer and supplier

6.5 Transmission requirements

6.5.1 General

The transmission requirements shall be in accordance with one of the sectional specifications defined in the IEC 60793-2 series and shall be agreed between the customer and supplier. The maximum cabled fibre attenuation shall comply with this specification.

~~NOTE 1 625 nm performance is optional depending on agreement between customer and supplier.~~

6.5.2 Single-mode optical fibres

See Table 3.

Table 3 – Common single-mode optical fibre requirements

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Uncabled optical fibre	4.2	IEC 60793-2-50		
Cabled fibre cut-off wavelength	4.2	$\lambda_{cc} < \lambda$ operational	IEC 60793-1-44	
~~Attenuation~~ Point discontinuities at 1 550 nm	4.2	≤ 0,10 dB	IEC 60793-1-40	

6.5.3 Single-mode dispersion unshifted (~~B1.1~~B-652.B) optical fibre

See Table 4.

Table 4 – Cabled fibre attenuation requirements for ~~B1.1~~ B-652.B optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm at 1 550 nm at 1 625 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.4 Single-mode dispersion unshifted (~~B1.3~~B-652.D) optical fibre

See Table 5.

Table 5 – Cabled fibre attenuation requirements for ~~B1.3~~ B-652.D optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm to 1 625 nm at 1 383 nm at 1 550 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.5 Single-mode (~~B6_a~~B-657.A) optical fibre

See Table 6.

Table 6 – Cabled fibre attenuation requirements for ~~B6_a~~ B-657.A optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm to 1 625 nm at 1 383 nm at 1 550 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.6 Single-mode (~~B6_b~~B-657.B) optical fibre

See Table 7.

Table 7 – Cabled fibre attenuation requirements for ~~B6_b~~ B-657.B optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm at 1 550 nm at 1 625 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.7 Multimode optical fibres

See Table 8.

Table 8 – Common multimode optical fibre requirements

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Uncabled optical fibre	4.2	IEC 60793-2-10		
~~Attenuation~~ Point discontinuities at 850 nm and 1 300 nm	4.2	≤ 0,10 dB	IEC 60793-1-40	

6.5.8 Multimode (~~A1a and A1b~~A1-OM1 to A1-OM5) optical fibres

See Table 9.

Table 9 – Cabled fibre attenuation requirements for ~~A1a and A1b~~ A1-OM1 to A1-OM5 optical fibres

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 850 nm at 1 300 nm		~~3,5~~ 3,0 dB/km 1,5 dB/km		

6.6 Fire performance

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. The tests to be applied, and the requirements, shall be agreed between the customer and supplier taking into account the fire hazard presented by the end use application in which the cable is intended to be used.

Annex A
(informative)

Examples of ~~some types~~ typical of cable ~~construction~~ designs

See Figure A.1 to Figure A.8 for examples of ~~types of~~ typical cable ~~construction~~ designs.

The main dimension(s) shall be agreed between the customer and supplier.

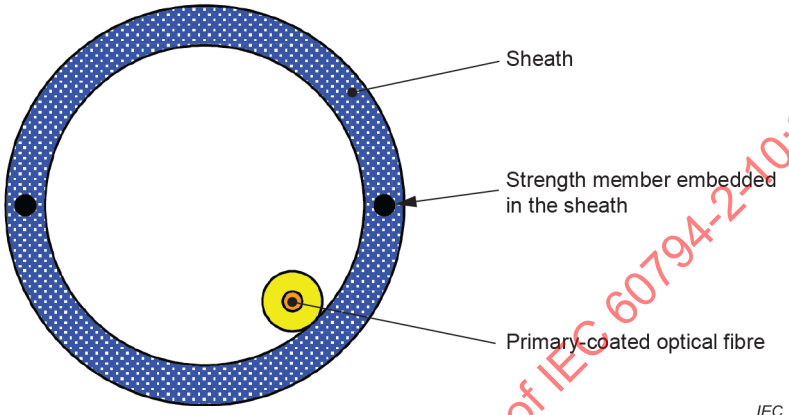

Figure A.1 – Simplex loose non-buffered fibre cable

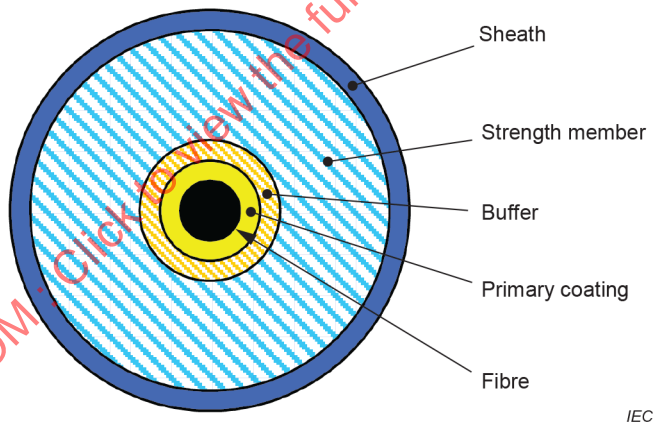

Figure A.2 – Simplex ruggedised fibre cable

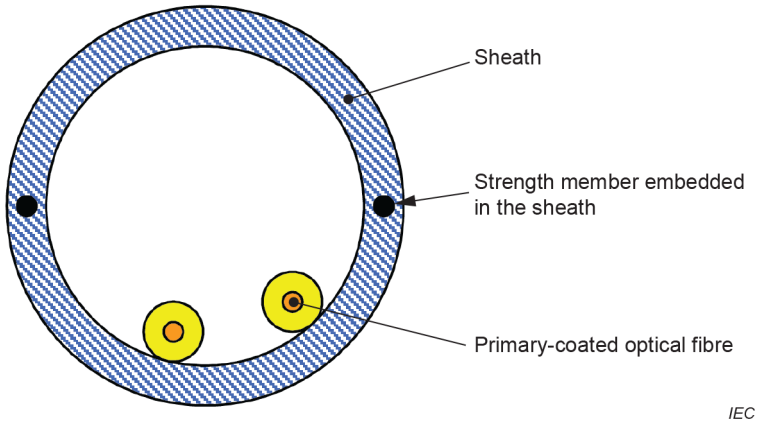

Figure A.3 – Duplex loose non-buffered fibre cable

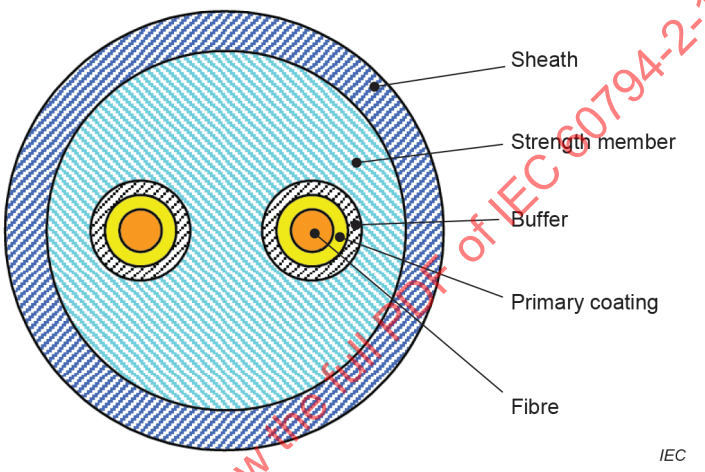

Figure A.4 – Duplex ruggedised fibre cable

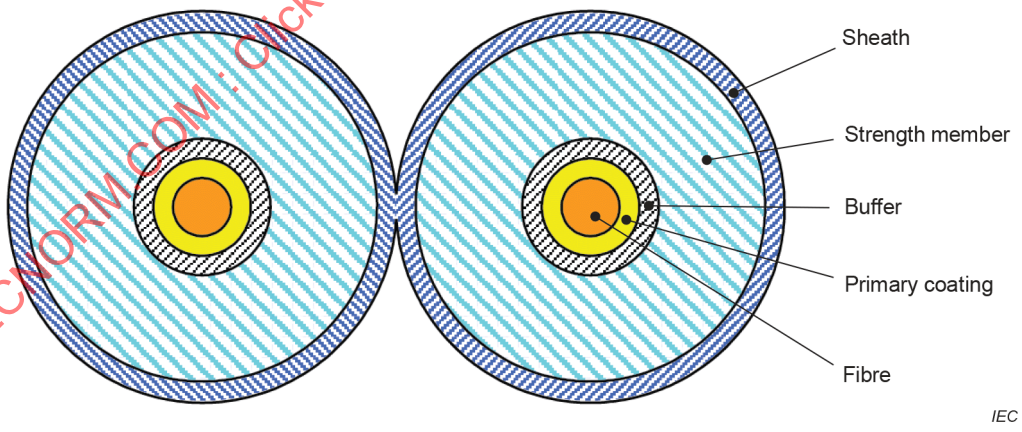

Figure A.5 – Duplex ruggedised fibre zip cord

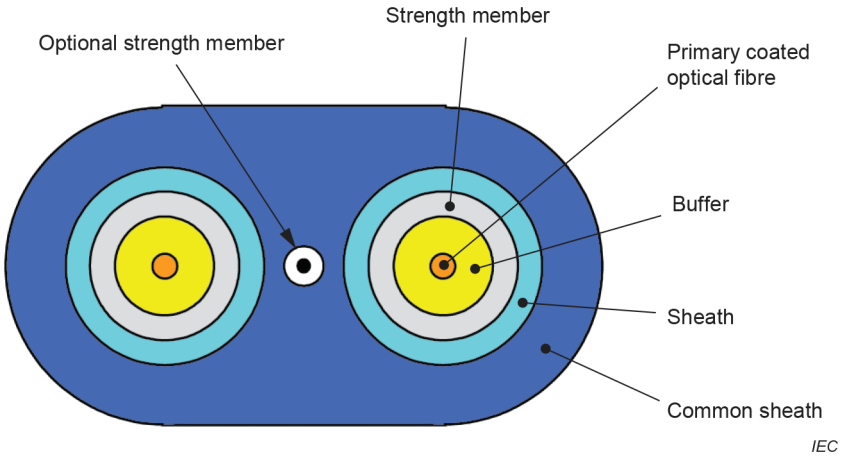

Figure A.6 – Duplex flat cable

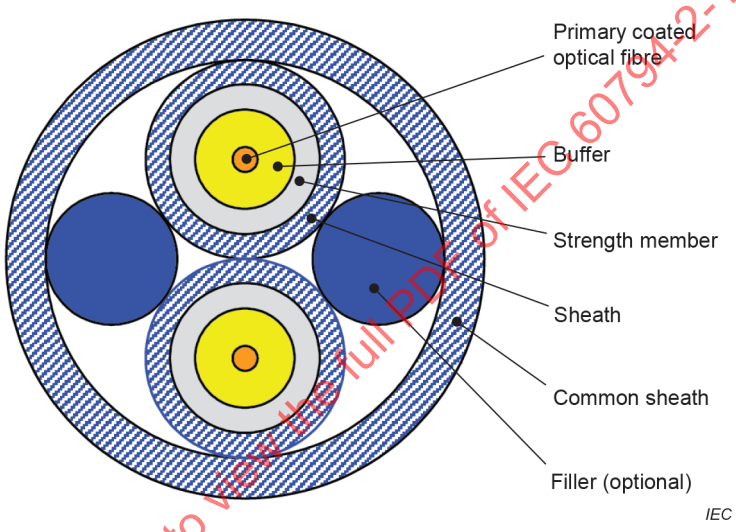

Figure A.7 – Duplex round cable

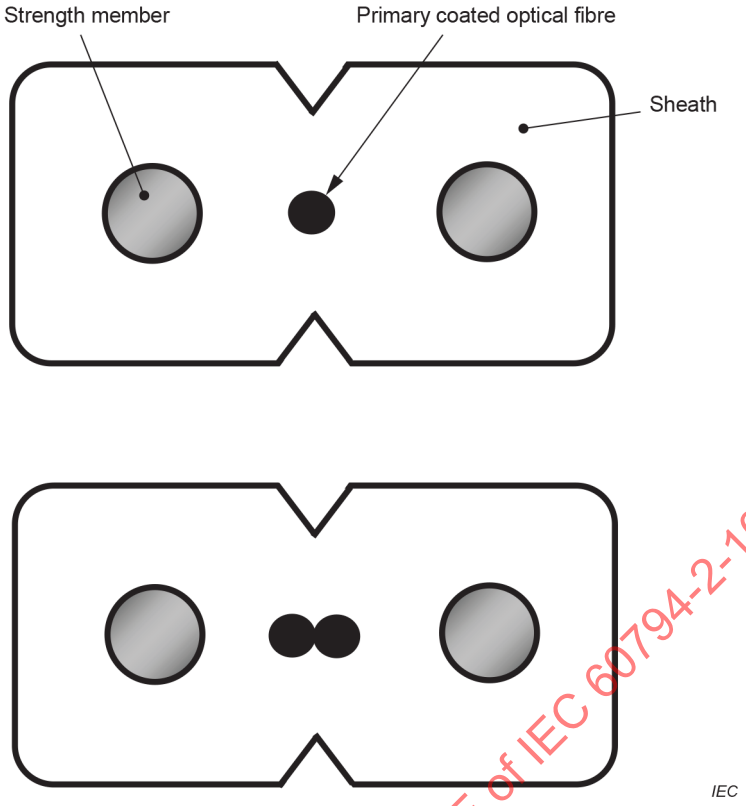

Figure A.8 – Simplex and duplex rectangular cables

Annex B
(informative)

Family specification of indoor cables – Simplex and duplex cables

B.1 Blank detail specification

B.1.1 Cable description

See Table B.1 for cable description.

Table B.1 – Cable description

(1) Prepared by		(2)	Document No : Issue : Date :
(3) Available from:	(4) Generic specification : Sectional specification :		IEC 60794-1-1 IEC 60794-2
(5) Additional references: ~~ISO/IEC 24702~~ ISO/IEC 11801-1 if required			
(6) Cable description:			
(7) Cable construction:			
Optical fibres			
Range of fibre count			
Modularity			
Construction – Optical fibres and primary coating – Strength and anti-buckling members Outer sheath – Material – Min. wall thickness Sheath marking – Customer requirement – Identification of manufacturer Fibre identification – Customer requirement			Additional remarks

(8) Application information:	
Application (indoor)	
Maximum outer diameter (d) or width and height	mm
Rated maximum tensile load	N
Minimum bending radius for operation	mm or n x o.d.
Temperature range:	
– Transport and storage	°C
– Installation	°C
– Operation	°C
Manufacturing cable length	
– Typical	m
– Nominal/tolerances:	-0 % / +1 %

B.1.2 Cable elements

See Table B.2 for cable elements.

Table B.2 – Cable elements

Characteristics (9)	IEC 60794-2:2017, subclause No.(10)	Family requirements (11)	Test methods (12)	Remarks (13)
Optical fibres and primary coating	4.1	Acc. DS		
Buffer	5.2	Acc. DS	Visual inspection	
Strength and anti-buckling member	5.7	Acc. DS	Visual inspection	

B.1.3 Cable construction

See Table B.3 for cable construction.

Table B.3 – Cable construction

Characteristics (9)	IEC 60794-2:2017, subclause No. (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Cable core		Acc. DS	Visual inspection	
Strength member – Longitudinal – Helical	5.7	Acc. DS	Visual inspection	
– Embedded in the sheath				
Sheath – Material – Minimum sheath thickness – Width and height – Optional protection – Abrasion resistance	5.11	 Acc. DS Acc. DS Acc. DS Acc. DS Acc. DS	 ~~IEC 60811-1-1~~ IEC 60811-202 ~~IEC 60811-1-1~~ IEC 60811-202 ~~IEC 60794-1-2~~ IEC 60794-1-21 Method E2A	
Sheath marking – Configuration, dimensions – Abrasion resistance	5.12	 Acc. DS Acc. DS	 Visual inspection ~~IEC 60794-1-2~~ IEC 60794-1-21 Method E2B	 Steel needle diameter d = 1,0 mm load: 4 N
Cable length				

B.1.4 Installation and operating conditions

See Table B.4 for installation and operating conditions.

Table B.4 – Installation and operating conditions

Characteristics (9)	IEC 60794-2:2017, subclause No. (10)	Family requirements (11)	Test methods (12)	Remarks (13)
General requirements Bend of cable element	7.2	Acc. DS	~~IEC 60794-1-2~~ IEC 60794-1-23 Method G1	

B.1.5 Mechanical, environmental and fire performance tests

See Table B.5 for mechanical, environmental and fire performance tests.

Table B.5 – Tests applicable

Characteristics (9)	IEC 60794-2:2017, sublause No. (10)	Family requirements (11)	Test Methods (12)	Remarks (13)
Tensile performance	7.3	See 6.3.2	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E1A	
Crush	7.3	See 6.3.3	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E3	
Impact	7.3	See 6.3.4	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E4	
Bending	7.3	See 6.3.5	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E11A	
Repeated bending	7.3	See 6.3.6	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E6	
Bending at low temperature	7.3	See 6.3.8	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E11A	
Flexing	7.3	See 6.3.9	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E8	
Torsion	7.3	See 6.3.10	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E7	
Kink	7.3	See 6.3.11	~~IEC 60794-1-2~~ IEC 60794-1-21 Method E10	
Sheath shrinkage	7.3		IEC 60794-1-22 Method F11	
Temperature cycling	7.3	See 6.4	~~IEC 60794-1-2~~ IEC 60794-1-22 Method F1	
Fire performance	7.4	See 6.6	IEC TR 62222	

B.2 Additional requirements for cables subject to the MICE environmental classification (~~ISO/IEC 24702~~ ISO/IEC 11801-1 and related standards)

Cables intended for installation in conformity with ~~ISO/IEC 24702~~ ISO/IEC 11801-1 and related standards ~~may~~ can require the specification of additional tests to ensure their suitability in the applicable environments defined by the mechanical, ingress, climatic and chemical, ~~and~~or electromechanical (MICE) classification. Such tests are outside of the scope of IEC 60794 cable specifications, and MICE criteria are not part of the requirements for 60794 specifications. The MICE tests ~~may~~ can be the same as, similar to, or substantially different from, the tests required by IEC 60794 specifications. It is possible that cables manufactured ~~per~~ in accordance with IEC 60794 specifications ~~may~~ will or ~~may~~ will not meet the MICE criteria. For supplemental discussion see IEC TR 62362.

Bibliography

IEC 60654-4, *Operating conditions for industrial-process measurement and control equipment – Part 4: Corrosive and erosive influences*

IEC 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

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 60811-501, *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 TR 61000-2-5, *Electromagnetic compatibility (EMC) – Part 2-5: Environment – Description and classification of electromagnetic environments~~. Basic EMC publication~~*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61918, *Industrial communication networks – Installation of communication networks in industrial premises*

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

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

IEC TR 62959, *Optical fibre cables – Shrinkage effects on cable and cable element end termination – Guidance*

~~ISO/IEC 24702: *Information technology – Generic cabling – Industrial premises*~~

~~ISO/IEC 11801, *Information technology – Generic cabling for customer premises*~~

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

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

IEC 60794-2-10

Edition 3.0 2023-03

INTERNATIONAL STANDARD

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

Câbles à fibres optiques – Partie 2-10: Câbles intérieurs à fibres optiques – Spécification de famille pour les câbles simplex et duplex

IEC 60794-2-10:2023-03(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

OPTICAL FIBRE CABLES –

Part 2-10: Indoor optical fibre cables – Family specification for simplex and duplex cables

FOREWORD

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IEC 60794-2-10 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 2011. This edition constitutes a technical revision.

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

a) updating of normative references;
b) updating of all relevant A1 and B1 fibre category and sub-category designations.

This International Standard is to be used in conjunction with IEC 60794-1-1:2022, IEC 60794-1-2:2021, IEC 60794-1-21:2015 and IEC 60794-1-21:2015/AMD1:2020, IEC 60794-1-22:2017, IEC 60794-1-23:2019 and IEC 60794-2:2017.

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

Draft	Report on voting
86A/2277/FDIS	86A/2311/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 of 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.

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OPTICAL FIBRE CABLES –

Part 2-10: Indoor optical fibre cables – Family specification for simplex and duplex cables

1 Scope

This part of IEC 60794 is a family specification that covers simplex and duplex optical fibre cables for indoor use. The requirements of IEC 60794-2 are applicable to cables covered by this document.

For cables intended for installation in industrial applications specified in ISO/IEC 11801-1, MICE specifications can be additionally required (see Clause B.2).

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

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 60793-1-40, *Optical fibres – Part 1-40: Attenuation measurement methods*

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

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

IEC 60794-1-1:2022, *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 60794-1-21, *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 test methods*

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

IEC 60794-2:2017, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

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

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

No terms and definitions are listed in this document.

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

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

4 Construction

4.1 General

In addition to the constructional requirements in IEC 60794-2, the following apply to simplex and duplex indoor cables.

The cable shall be designed and manufactured for an expected operating lifetime of at least 15 years. In this context, the attenuation of the installed cable at the operational wavelength(s) shall not exceed the values agreed between the customer and the supplier. The materials in the cable shall not present a health or environmental hazard within its intended use.

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

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 shall be used which meet the requirements of IEC 60793-2.

4.3 Buffer

If a buffer is required, it shall consist of one or more layers of inert material. The buffer shall be easily removable. For tight buffers, the buffer and fibre primary coating shall be removable in one operation over a minimum length of 15 mm, depending on customer requirements. For semi-tight buffers, the buffer shall be easily removable over a minimum length of 300 mm. For loose buffers, the buffer shall be easily removable over a length of not less than 1,0 m.

Buffer dimensions are shown in Table 1.

Table 1 – Dimensions of buffered fibres

Buffer type	Nominal diameter mm	Tolerances mm
Semi-tight or loose buffer	0,3 to 1,3	± 0,05
Tight buffer	0,3 to 1,0	± 0,05

4.4 Ruggedised fibre

Further protection can be provided to buffered fibres by surrounding one or two of the fibres with non-metallic strength members within a sheath of suitable polymeric material.

4.5 Slotted core

Cables of this construction are not commonly used.

4.6 Tube

One or two primary coated or buffered fibres are packaged (loosely or not) in a tube construction which may be filled. The tube may be reinforced with a composite wall.

The polymeric tube may be hard, in order to provide crush protection to the fibre bundle, or soft to enable easy strippability of the tube without the use of specialized tools.

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.

4.7 Stranded loose tube

Cables of this construction are not commonly used, however two general designs can be employed:

a) loose tubes laid in parallel;

b) a number of homogeneous loose tubes stranded helically or with the reverse-oscillating (SZ) method

4.8 Ribbon structure

Cables of this construction are not commonly used.

4.9 Strength and anti-buckling members

The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibres are not subjected to strain in excess of limits agreed between the customer and the supplier.

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

4.10 Ripcord

Ripcords are not commonly used.

4.11 Sheath

The cable shall have an overall protective sheath. The cable dimension(s) shall be specified in the relevant specification.

4.12 Sheath marking

Local regulations for sheath marking can apply. In the absence of local regulations, there can be an agreement between the customer and supplier.

4.13 Identification

In case of duplex cables, the cable design should enable clear polarity identification for each individual fibre. When fibre colouring is used for identification, standard colours shall be used as closely as possible (reasonable match) to IEC 60304.

4.14 Examples of typical cable designs

Examples of typical cable designs are shown in Annex A. Other configurations are not excluded if they meet the mechanical, environmental and transmission requirements given in this document.

5 Dimensions – Optical fibres and primary coating

The dimensions of the individual primary coated fibres in the finished product shall be in accordance with one of the sectional specifications defined in IEC 60793-2 series. The fibre dimensions (e.g. cladding diameter or outer diameter including colouring) shall be verified in accordance with IEC 60793-1-20 for fibre geometry or IEC 60793-1-21 for coating geometry. Cable and cable element dimensions shall be measured in accordance with IEC 60794-1-1. For dimensions of buffers see Table 2.

6 Tests

6.1 General

Compliance with the specification requirements shall be verified by carrying out tests selected from the 6.2 to 6.5. It is not intended that all tests shall be carried out; the frequency of testing shall be agreed between the customer and supplier.

Unless otherwise specified, all tests shall be carried out at standard atmospheric conditions in accordance with IEC 60794-1-2.

These tests are not intended to define end-of-life performance.

See Annex B for a blank detail specification.

6.2 Dimensions

The fibre dimensions and tolerances shall be checked in accordance with the test method as specified in IEC 60793-1-20 for fibre geometry or IEC 60793-1-21 for coating geometry. 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 60811-201 for insulation thickness and IEC 60811-203 for overall dimensions.

6.3 Mechanical requirements

6.3.1 General

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 it becomes possible to detect permanent changes in attenuation. The maximum value of this attenuation change shall be agreed between the customer and supplier.

6.3.2 Tensile performance

Method:	IEC 60794-1-21, E1
Diameter of chuck drums and transfer devices:	not less than 250 mm
Rate of transfer device:	either 100 mm/min or 100 N/min
Load:	T_M = 75 N applied for 10 min for simplex cables and normal duplex cables T_M = 150 N applied for 10 min for duplex cables which consist of independent simplex cables (see NOTE 1)

NOTE 1 In case of duplex cables that include two simplex cables and bearing the applied tensile force by the strength members of each simplex cable, as shown in Figure A.5 Figure A.6 (without the optional strength member) and Figure A.7, the tensile requirement for the duplex cable will be double that for the simplex cable. The rationale is that those simplex cables can be taken out from the duplex cable and will be independently used.

NOTE 2 The requirements of tensile load depend on the construction of cables. Lower values can be adopted for some types of cables, for example small factor simplex cables.

Length of sample:	no less than 50 m unless specified in the relevant specification. For cables requiring specialized anchoring devices, the minimum length shall be 25 m.
Requirements:	no change in attenuation after the test and there shall be no damage to the cable elements for 1 % proof-tested fibres, the fibre strain under short-term tensile load (T_M) 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. Under visual examination without magnification, there shall be no damage to the sheath or to the cable elements.

6.3.3 Crush

Method:	IEC 60794-1-21, E3A
Force (short term):	500 N
Duration:	1 min
Length between test locations:	500 mm
Requirements:	no change in attenuation after the test and there shall be no damage to the cable elements

NOTE In the case of flat cables the force is applied on the flat sides of the cable.

6.3.4 Impact

Method:	IEC 60794-1-21, E4
Impact energy:	1,0 J
Number of impacts:	at least 3, each separated by at least 500 mm
Requirements:	no fibre breakage

NOTE In the case of flat cables the force is applied on the flat sides of the cable.

6.3.5 Bend

Method:	IEC 60794-1-21, E11A
Mandrel diameter:	60 mm

Number of turns:	6
Number of cycles:	10
Requirements:	no fibre breakage

NOTE In the case of flat cables the force is applied on the flat sides of the cable.

6.3.6 Repeated bending

None.

6.3.7 Bending under tension

None.

6.3.8 Bending at low temperature

None.

6.3.9 Flexing

None.

6.3.10 Torsion

Method:	IEC 60794-1-21, E7
Number of cycles:	10
Distance between fixed and rotating clamp:	125 x cable diameter but no less than 0,3 m and not more than 1 m
Tension load:	20 N
Requirements:	no fibre breakage

6.3.11 Kink

Method:	IEC 60794-1-21, E10
Minimum loop diameter:	20 times cable diameter
Requirement:	no kink shall occur

6.4 Environmental requirements – Temperature cycling

For indoor simplex and duplex cables, -10 °C and +60 °C are the recommended low and high temperatures. Based on different environment classifications, other operating temperatures can be agreed upon between customer and supplier. Table 2 gives the operating temperature limits based on environmental classification.

Table 2 – Method: IEC 60794-1-22, F1

Low temperature T_{A2} °C	High temperature T_{B2} °C	Sources of temperature limits	
		Performance categories of connectors, components and protective housings [a]	Environmental classification of customer premises cabling [b]
-10	+60	C (recommended)	$M_xI_xC_1E_x$
-25	+70	OP	$M_xI_xC_2E_x$
-40	+70	I	$M_xI_xC_3E_x$

A suitable operating service environment (performance category) or environmental classification should be selected in accordance with the application. A complete list of operating service environments can be found in IEC 60794-1-1.

[a] Included in IEC 61753-1. The abbreviated terms stand for:
C: indoor controlled environment;
OP: outdoor protected environment;
I: industrial environment;

[b] Included in ISO/IEC 11801-1. For an introduction to the MICE environmental classification system use ISO/IEC TR 29106. The abbreviation MICE stands for: mechanical, ingress, climatic, electromagnetic.

Period t_1: sufficient so that the cable has reached, and stabilised to, the specified temperature

Number of cycles: 2

Length of sample: sufficient to achieve the desired accuracy of measurement of attenuation

Requirement: maximum increase in attenuation to be agreed between customer and supplier

6.5 Transmission requirements

6.5.1 General

The transmission requirements shall be in accordance with one of the sectional specifications defined in the IEC 60793-2 series and shall be agreed between the customer and supplier. The maximum cabled fibre attenuation shall comply with this specification.

6.5.2 Single-mode optical fibres

See Table 3.

Table 3 – Common single-mode optical fibre requirements

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Uncabled optical fibre	4.2	IEC 60793-2-50		
Cabled fibre cut-off wavelength	4.2	$\lambda_{cc} < \lambda$ operational	IEC 60793-1-44	
Point discontinuities at 1 550 nm	4.2	≤ 0,10 dB	IEC 60793-1-40	

6.5.3 Single-mode dispersion unshifted (B-652.B) optical fibre

See Table 4.

Table 4 – Cabled fibre attenuation requirements for B-652.B optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm at 1 550 nm at 1 625 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.4 Single-mode dispersion unshifted (B-652.D) optical fibre

See Table 5.

Table 5 – Cabled fibre attenuation requirements for B-652.D optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm to 1 625 nm at 1 383 nm at 1 550 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.5 Single-mode (B-657.A) optical fibre

See Table 6.

Table 6 – Cabled fibre attenuation requirements for B-657.A optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm to 1 625 nm at 1 383 nm at 1 550 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.6 Single-mode (B-657.B) optical fibre

See Table 7.

Table 7 – Cabled fibre attenuation requirements for B-657.B optical fibre

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 1 310 nm at 1 550 nm at 1 625 nm		≤ 1,0 dB/km ≤ 1,0 dB/km ≤ 1,0 dB/km		

6.5.7 Multimode optical fibres

See Table 8.

Table 8 – Common multimode optical fibre requirements

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Uncabled optical fibre	4.2	IEC 60793-2-10		
Point discontinuities at 850 nm and 1 300 nm	4.2	≤ 0,10 dB	IEC 60793-1-40	

6.5.8 Multimode (A1-OM1 to A1-OM5) optical fibres

See Table 9.

Table 9 – Cabled fibre attenuation requirements for A1-OM1 to A1-OM5 optical fibres

Characteristics	IEC 60794-2:2017, subclause No.	Requirements	Test methods	Remarks
Attenuation coefficient (cabled fibres)	7.3	Acc. DS	IEC 60793-1-40	
at 850 nm at 1 300 nm		3,0 dB/km 1,5 dB/km		

6.6 Fire performance

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 can be required by local or national legislation and regulation. The tests to be applied, and the requirements, shall be agreed between the customer and supplier taking into account the fire hazard presented by the end use application in which the cable is intended to be used.

Annex A
(informative)

Examples of typical of cable designs

See Figure A.1 to Figure A.8 for examples of typical cable designs.

The main dimension(s) shall be agreed between the customer and supplier.

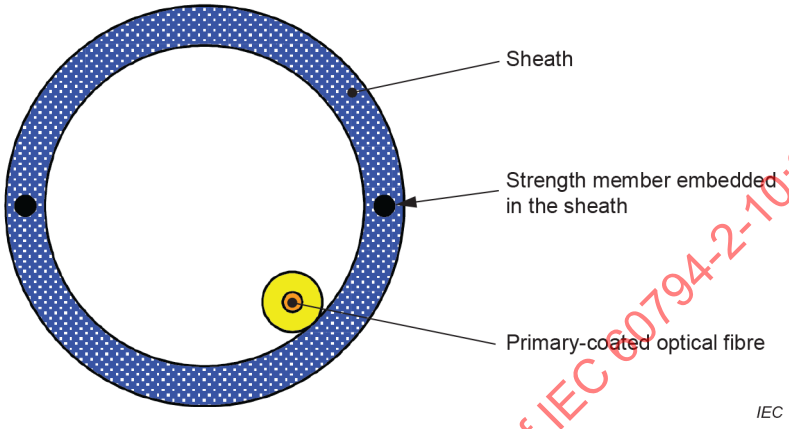

Figure A.1 – Simplex loose non-buffered fibre cable

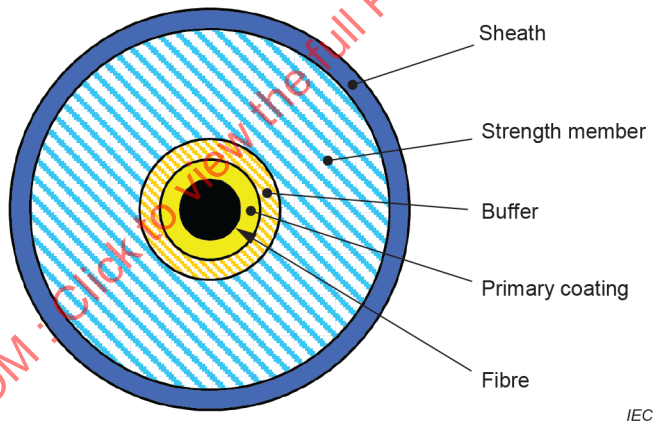

Figure A.2 – Simplex ruggedised fibre cable

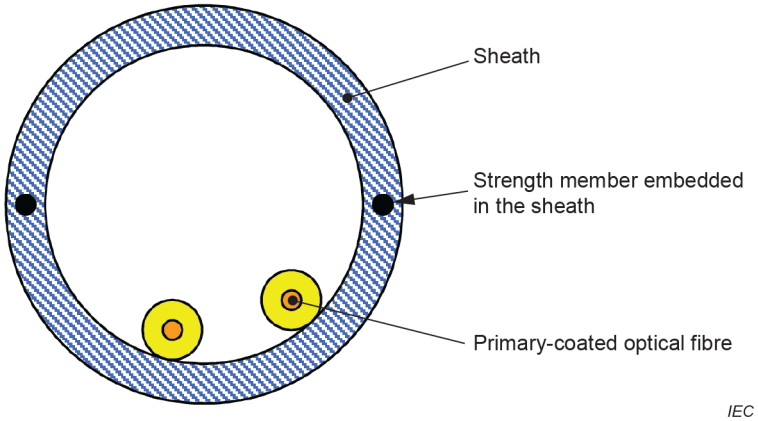

Figure A.3 – Duplex loose non-buffered fibre cable

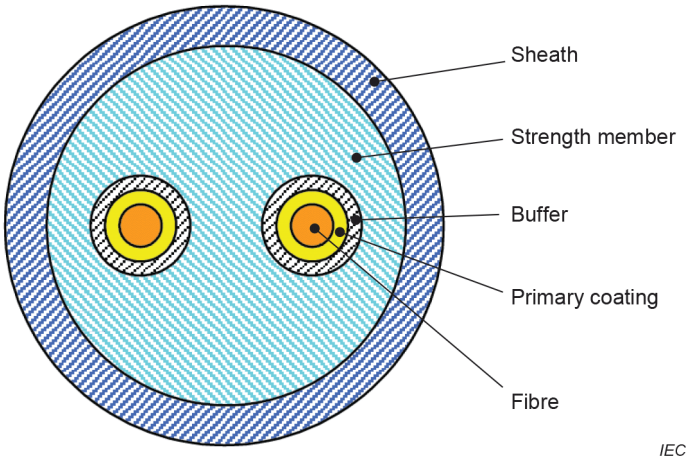

Figure A.4 – Duplex ruggedised fibre cable

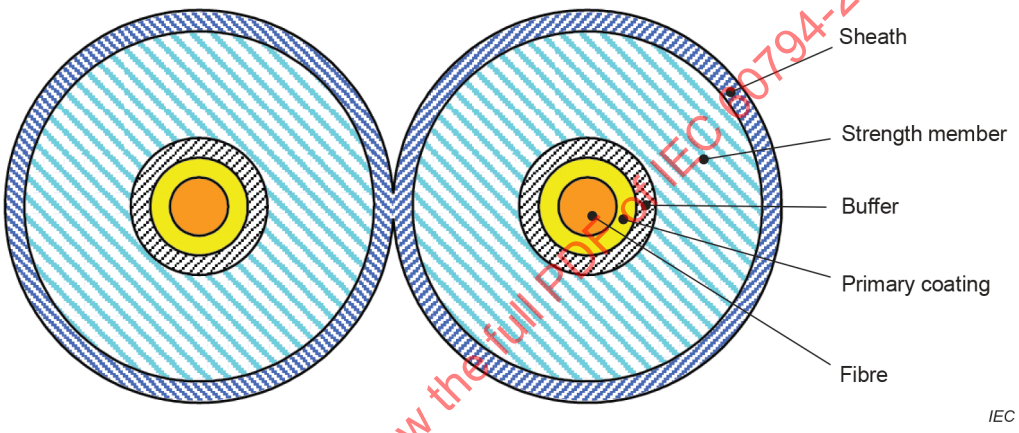

Figure A.5 – Duplex ruggedised fibre zip cord

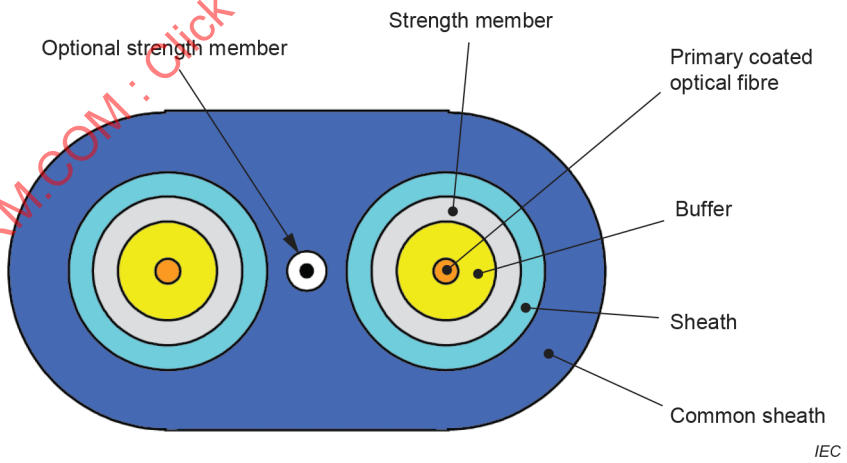

Figure A.6 – Duplex flat cable

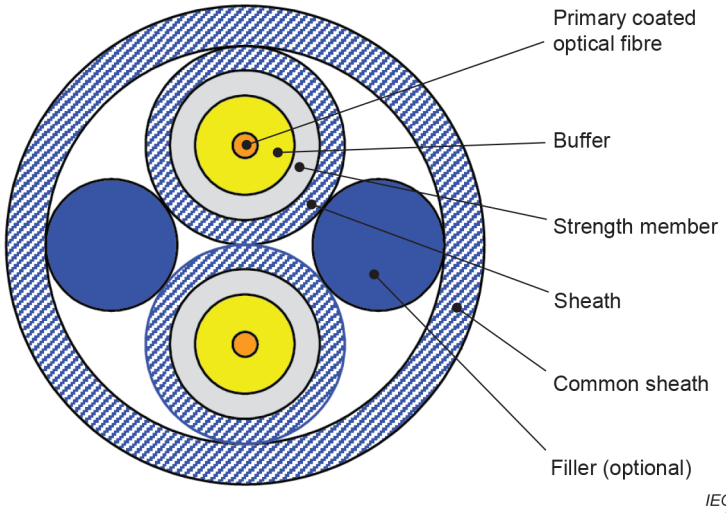

Figure A.7 – Duplex round cable

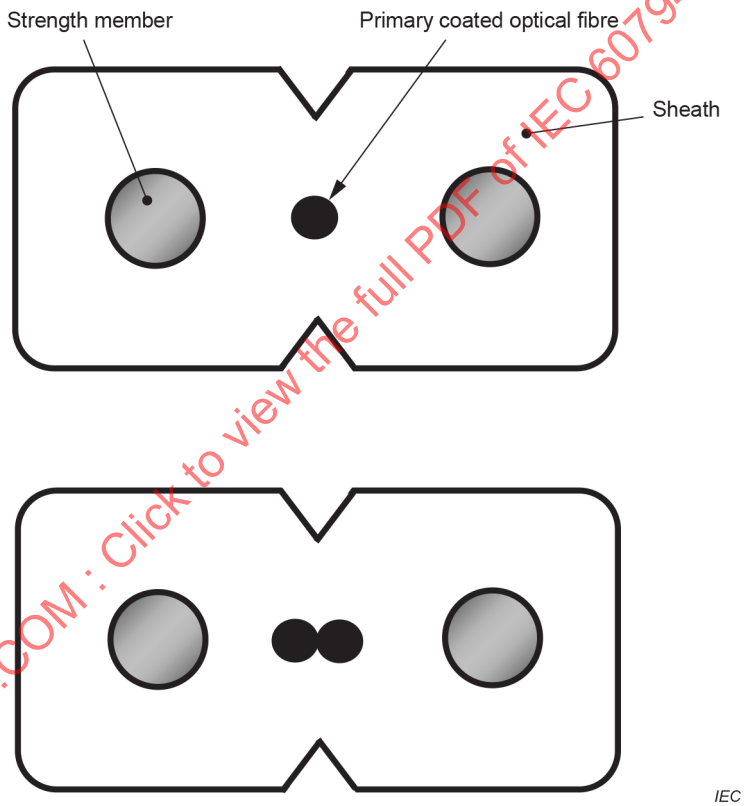

Figure A.8 – Simplex and duplex rectangular cables

Annex B
(informative)

Family specification of indoor cables – Simplex and duplex cables

B.1 Blank detail specification

B.1.1 Cable description

See Table B.1 for cable description.

Table B.1 – Cable description

(1) Prepared by		(2)	Document No : Issue : Date :
(3) Available from:	(4) Generic specification : Sectional specification :		IEC 60794-1-1 IEC 60794-2
(5) Additional references: ISO/IEC 11801-1 if required			
(6) Cable description:			
(7) Cable construction:			
Optical fibres			
Range of fibre count			
Modularity			
Construction – Optical fibres and primary coating – Strength and anti-buckling members Outer sheath – Material – Min. wall thickness Sheath marking – Customer requirement – Identification of manufacturer Fibre identification – Customer requirement			Additional remarks

(8) Application information:	
Application (indoor)	
Maximum outer diameter (d) or width and height	mm
Rated maximum tensile load	N
Minimum bending radius for operation	mm or n x o.d.
Temperature range:	
– Transport and storage	°C
– Installation	°C
– Operation	°C
Manufacturing cable length	
– Typical	m
– Nominal/tolerances:	-0 % / +1 %

B.1.2 Cable elements

See Table B.2 for cable elements.

Table B.2 – Cable elements

Characteristics (9)	IEC 60794-2:2017, subclause No.(10)	Family requirements (11)	Test methods (12)	Remarks (13)
Optical fibres and primary coating	4.1	Acc. DS		
Buffer	5.2	Acc. DS	Visual inspection	
Strength and anti-buckling member	5.7	Acc. DS	Visual inspection	

B.1.3 Cable construction

See Table B.3 for cable construction.

Table B.3 – Cable construction

Characteristics (9)	IEC 60794-2:2017, subclause No. (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Cable core		Acc. DS	Visual inspection	
Strength member – Longitudinal – Helical	5.7	Acc. DS	Visual inspection	
– Embedded in the sheath				
Sheath – Material – Minimum sheath thickness – Width and height – Optional protection – Abrasion resistance	5.11	 Acc. DS Acc. DS Acc. DS Acc. DS Acc. DS	 IEC 60811-202 IEC 60811-202 IEC 60794-1-21 Method E2A	
Sheath marking – Configuration, dimensions – Abrasion resistance	5.12	 Acc. DS Acc. DS	 Visual inspection IEC 60794-1-21 Method E2B	 Steel needle diameter d = 1,0 mm load: 4 N
Cable length				

B.1.4 Installation and operating conditions

See Table B.4 for installation and operating conditions.

Table B.4 – Installation and operating conditions

Characteristics (9)	IEC 60794-2:2017, subclause No. (10)	Family requirements (11)	Test methods (12)	Remarks (13)
General requirements Bend of cable element	7.2	Acc. DS	IEC 60794-1-23 Method G1	

B.1.5 Mechanical, environmental and fire performance tests

See Table B.5 for mechanical, environmental and fire performance tests.

Table B.5 – Tests applicable

Characteristics (9)	IEC 60794-2:2017, sublause No. (10)	Family requirements (11)	Test Methods (12)	Remarks (13)
Tensile performance	7.3	See 6.3.2	IEC 60794-1-21 Method E1A	
Crush	7.3	See 6.3.3	IEC 60794-1-21 Method E3	
Impact	7.3	See 6.3.4	IEC 60794-1-21 Method E4	
Bending	7.3	See 6.3.5	IEC 60794-1-21 Method E11A	
Repeated bending	7.3	See 6.3.6	IEC 60794-1-21 Method E6	
Bending at low temperature	7.3	See 6.3.8	IEC 60794-1-21 Method E11A	
Flexing	7.3	See 6.3.9	IEC 60794-1-21 Method E8	
Torsion	7.3	See 6.3.10	IEC 60794-1-21 Method E7	
Kink	7.3	See 6.3.11	IEC 60794-1-21 Method E10	
Sheath shrinkage	7.3		IEC 60794-1-22 Method F11	
Temperature cycling	7.3	See 6.4	IEC 60794-1-22 Method F1	
Fire performance	7.4	See 6.6	IEC TR 62222	

B.2 Additional requirements for cables subject to the MICE environmental classification (ISO/IEC 11801-1 and related standards)

Cables intended for installation in conformity with ISO/IEC 11801-1 and related standards can require the specification of additional tests to ensure their suitability in the applicable environments defined by the mechanical, ingress, climatic and chemical, or electromechanical (MICE) classification. Such tests are outside of the scope of IEC 60794 cable specifications, and MICE criteria are not part of the requirements for 60794 specifications. The MICE tests can be the same as, similar to, or substantially different from, the tests required by IEC 60794 specifications. It is possible that cables manufactured in accordance with IEC 60794 specifications will or will not meet the MICE criteria. For supplemental discussion see IEC TR 62362.

Bibliography

IEC 60654-4, *Operating conditions for industrial-process measurement and control equipment – Part 4: Corrosive and erosive influences*

IEC 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

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 60811-501, *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 TR 61000-2-5, *Electromagnetic compatibility (EMC) – Part 2-5: Environment – Description and classification of electromagnetic environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61918, *Industrial communication networks – Installation of communication networks in industrial premises*

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

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

IEC TR 62959, *Optical fibre cables – Shrinkage effects on cable and cable element end termination – Guidance*

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

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

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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CÂBLES À FIBRES OPTIQUES –

Partie 2-10: Câbles intérieurs à fibres optiques – Spécification de famille pour les câbles simplex et duplex

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L'IEC 60794-2-10 a été établie par le sous-comité 86A: Fibres et câbles, du comité d'études 86 de l'IEC: Fibres optiques. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2011. Cette édition constitue une révision technique.

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

a) mise à jour des références normatives;
b) mise à jour de toutes les désignations de catégories et de sous-catégories de fibres A1 et B1 pertinentes.

La présente Norme internationale doit être utilisée conjointement avec l'IEC 60794-1-1:2022, l'IEC 60794-1-2:2021, l'IEC 60794-1-21:2015 et l'IEC 60794-1-21:2015/AMD1:2020, l'IEC 60794-1-22:2017, l'IEC 60794-1-23:2019 et l'IEC 60794-2:2017.

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

Projet	Rapport de vote
86A/2277/FDIS	86A/2311/RVD

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

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

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 60794, publiées sous le titre général *Câbles à fibres optiques*, peut être consultée sur le site web de l'IEC.

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CÂBLES À FIBRES OPTIQUES –

Partie 2-10: Câbles intérieurs à fibres optiques – Spécification de famille pour les câbles simplex et duplex

1 Domaine d'application

La présente partie de l'IEC 60794 est une spécification de famille qui couvre les câbles à fibres optiques simplex et duplex pour usage intérieur. Les exigences de l'IEC 60794-2 sont applicables aux câbles couverts par le présent document.

Pour les câbles destinés à être installés dans des applications industrielles spécifiées dans l'ISO/IEC 11801-1, les spécifications MICE peuvent être exigées en plus (voir Article B.2).

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

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

IEC 60793-1-20, *Fibres optiques – Partie 1-20: Méthodes de mesure et procédures d'essai – Géométrie de la fibre*

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

IEC 60793-1-40, *Fibres optiques – Partie 1-40: Méthodes de mesurage de l'affaiblissement*

IEC 60793-1-44, *Fibres optiques – Partie 1-44: Méthodes de mesure et procédures d'essai – Longueur d'onde de coupure*

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

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

IEC 60793-2-50, *Fibres optiques – Partie 2-50: Spécifications de produits – Spécification intermédiaire pour les fibres unimodales de classe B*

IEC 60794-1-1:2022, *Câbles à fibres optiques – Partie 1-1: Spécification générique – Généralités*

IEC 60794-1-2, *Câbles à fibres optiques – Partie 1-2: Spécification générique – Procédures fondamentales d'essais des câbles optiques – Recommandations générales*

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

IEC 60794-1-22, *Câbles à fibres optiques – Partie 1-22: Spécification générique – Modes opératoires de base applicables aux essais des câbles optiques – Méthodes d'essais d'environnement*

IEC 60794-1-23, *Câbles à fibres optiques – Partie 1-23: Spécification générique – Procédures fondamentales d'essai des câbles optiques – Méthodes d'essai des éléments de câble*

IEC 60794-2:2017, *Câbles à fibres optiques – Partie 2: Câbles intérieurs – Spécification intermédiaire*

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

IEC 60811-203, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 203: Essais généraux – Mesure des dimensions extérieures*

3 Termes et définitions

Aucun terme n'est défini dans le présent document.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

4 Construction

4.1 Généralités

En complément des exigences de construction données dans l'IEC 60794-2, les dispositions suivantes s'appliquent aux câbles intérieurs simplex et duplex.

Le câble doit être conçu et fabriqué pour une espérance de durée de vie en service d'au moins 15 ans. Dans ce contexte, l'affaiblissement du câble installé à la ou aux longueurs d'ondes de fonctionnement ne doit pas dépasser les valeurs convenues entre le client et le fournisseur. Les matériaux utilisés dans le câble ne doivent pas présenter de danger pour la santé ou l'environnement dans le cadre de l'utilisation prévue.

Il ne doit pas y avoir d'épissures de fibre sur une longueur de livraison sauf accord contraire entre le client et le fournisseur.

Il doit être possible d'identifier chaque fibre individuellement sur toute la longueur du câble.

4.2 Fibres optiques et revêtement primaire

Des fibres optiques multimodales ou unimodales qui satisfont aux exigences de l'IEC 60793-2 doivent être utilisées.

4.3 Revêtement protecteur

Si un revêtement protecteur est exigé, il doit être formé d'une ou de plusieurs couches de matériau inerte. Le revêtement protecteur doit pouvoir être facilement retiré. Pour les revêtements protecteurs serrés, le revêtement protecteur lui-même et le revêtement primaire de la fibre doivent pouvoir être retirés en une seule opération sur une longueur minimale de 15 mm, en fonction des exigences du client. Pour les revêtements protecteurs semi-serrés, le revêtement protecteur doit pouvoir être facilement retiré sur une longueur d'au moins 300 mm. Pour les revêtements protecteurs à structure lâche, le revêtement protecteur doit pouvoir être facilement retiré sur une longueur d'au moins 1,0 m.

Les dimensions du revêtement protecteur sont données dans le Tableau 1.

Tableau 1 – Dimensions des fibres sous revêtement protecteur

Type de revêtement protecteur	Diamètre nominal mm	Tolérances mm
Revêtement protecteur semi-serré ou à structure lâche	0,3 à 1,3	± 0,05
Revêtement protecteur serré	0,3 à 1,0	± 0,05

4.4 Fibre renforcée

Une protection supplémentaire peut être adjointe à des fibres sous revêtement protecteur en entourant une ou deux des fibres présentes d'éléments de renfort non métalliques à l'intérieur d'une gaine en matériau polymère approprié.

4.5 Jonc rainuré

Les câbles construits de cette manière ne sont pas d'utilisation courante.

4.6 Tube

Une ou deux fibres sous revêtement primaire ou protecteur sont conditionnées (de manière lâche ou non) dans une construction tubulaire qui peut être remplie. Le tube peut être renforcé par une paroi composite.

Le tube polymère peut être dur, afin de fournir une protection contre l'écrasement au faisceau de fibres, ou mou pour faciliter la dénudabilité du tube sans l'utilisation d'outils spécialisés.

Si exigé, la conformité du tube doit être déterminée par une évaluation de sa résistance aux pliures, conformément à la Méthode G7 de l'IEC 60794-1-23.

4.7 Tube assemblé à structure lâche

Les câbles construits de cette manière ne sont pas d'utilisation courante, cependant deux conceptions générales peuvent être utilisées:

a) tubes à structure lâche disposés en parallèle;

b) un certain nombre de tubes à structure lâche homogènes assemblés de manière hélicoïdale ou selon la méthode en hélices inversées (SZ)

4.8 Structure en ruban

Les câbles construits de cette manière ne sont pas d'utilisation courante.

4.9 Éléments de renfort et d'antidéformation

Le câble doit être conçu avec des éléments de renfort suffisants pour remplir les conditions d'installation et de service de manière à ce que les fibres ne soient pas soumises à des contraintes dépassant les limites convenues entre le client et le fournisseur.

Les éléments de renfort, d'antidéformation ou les deux peuvent être métalliques ou non métalliques et peuvent être situés dans le cœur du câble ou sous la gaine, ou à l'intérieur de la gaine.

4.10 Filin de déchirement

Les filins de déchirement ne sont pas d'utilisation courante.

4.11 Gaine

Le câble doit posséder une gaine de protection intégrale. Les dimensions de câble doivent être indiquées dans la spécification applicable.

4.12 Marquage de la gaine

Les réglementations locales pour le marquage de la gaine peuvent s'appliquer. En l'absence de réglementations locales, il peut y avoir un accord entre le client et le fournisseur.

4.13 Identification

Dans le cas des câbles duplex, il convient que la conception du câble permette une identification claire de la polarité pour chaque fibre individuelle. Lorsque des couleurs sont utilisées pour l'identification des fibres, des couleurs normalisées aussi proches que possible (correspondance raisonnable) de celles de l'IEC 60304 doivent être utilisées.

4.14 Exemples de conceptions de câbles types

Des exemples de conceptions de câbles types sont présentés en Annexe A. D'autres configurations ne sont pas exclues si elles satisfont aux exigences mécaniques, environnementales et de transmission données dans le présent document.

5 Dimensions – Fibres optiques et revêtement primaire

Les dimensions des fibres individuelles sous revêtement primaire dans le produit fini doivent être conformes à l'une des spécifications intermédiaires définies dans la série IEC 60793-2. Les dimensions de la fibre (par exemple diamètre de la gaine ou diamètre extérieur y compris la coloration) doivent être vérifiées conformément à l'IEC 60793-1-20 pour la géométrie de la fibre ou l'IEC 60793-1-21 pour la géométrie du revêtement. Les dimensions du câble et des éléments du câble doivent être mesurées conformément à l'IEC 60794-1-1. Pour les dimensions des revêtements protecteurs, voir le Tableau 2.

6 Essais

6.1 Généralités

La conformité aux exigences de la spécification doit être vérifiée en réalisant les essais choisis du 6.2 au 6.5. Tous les essais ne doivent pas nécessairement être réalisés; la fréquence des essais doit faire l'objet d'un accord entre le client et le fournisseur.

Sauf spécification contraire, tous les essais doivent être réalisés dans des conditions atmosphériques normales conformément à l'IEC 60794-1-2.

Ces essais ne sont pas destinés à définir la performance en fin de vie.

Voir l'Annexe B pour une spécification particulière-cadre.

6.2 Dimensions

Les dimensions et tolérances des fibres doivent être vérifiées conformément à la méthode d'essai spécifiée dans l'IEC 60793-1-20 pour la géométrie de la fibre ou dans l'IEC 60793-1-21 pour la géométrie du revêtement. Le diamètre du revêtement protecteur et du câble, ainsi que l'épaisseur de la gaine, doivent être mesurés conformément aux méthodes de l'IEC 60811-201 pour l'épaisseur des enveloppes isolantes et de l'IEC 60811-203 pour les dimensions extérieures.

6.3 Exigences mécaniques

6.3.1 Généralités

Certains des essais suivants peuvent être réalisés sur une faible longueur d'échantillon de câble faisant encore partie intégrante d'une plus grande longueur. Ainsi, il devient possible de détecter des variations permanentes d'affaiblissement. La valeur maximale de cette modification d'affaiblissement doit faire l'objet d'un accord entre le client et le fournisseur.

6.3.2 Performances en traction

Méthode:	IEC 60794-1-21, E1
Diamètre des tambours et des dispositifs de transfert:	au moins 250 mm
Vitesse du dispositif de transfert:	100 mm/min ou 100 N/min
Charge:	T_M = 75 N appliquée pendant 10 min pour les câbles simplex et les câbles duplex normaux T_M = 150 N appliquée pendant 10 min pour les câbles duplex constitués de câbles simplex indépendants (voir NOTE 1)

NOTE 1 Dans le cas de câbles duplex constitués de deux câbles simplex, et supportant la force de traction appliquée par les éléments de renfort de chaque câble simplex, comme représenté sur la Figure A.5, la Figure A.6 (sans l'élément de renfort facultatif) et la Figure A.7, l'exigence de traction des câbles duplex sera le double de celle des câbles simplex. La raison en est que ces câbles simplex peuvent être extraits des câbles duplex et peuvent être utilisés de façon indépendante.

NOTE 2 Les exigences de charge de traction dépendent de la construction des câbles. Des valeurs plus faibles peuvent être adoptées pour certains types de câbles, par exemple câbles simplex de faible dimension unitaire.

Longueur d'échantillon:	au moins 50 m, sauf indication contraire dans la spécification applicable. Pour les câbles exigeant des dispositifs d'ancrage spécialisés, la longueur minimale doit être de 25 m.
Exigences:	aucune variation d'affaiblissement après l'essai, et il ne doit pas y avoir de dommage sur les éléments du câble pour 1 % des fibres soumises à essai, l'élongation de la fibre en condition de charge de traction à court terme (T_M) ne doit pas dépasser 60 % de la contrainte d'épreuve de la fibre et la variation de l'affaiblissement pendant l'essai doit être mesurée et enregistrée. D'autres critères peuvent faire l'objet d'un accord entre le client et le fournisseur. Aucune détérioration de la gaine ou des éléments du câble ne doit apparaître à l'examen visuel sans grossissement.

6.3.3 Écrasement

Méthode:	IEC 60794-1-21, E3A
Force (à court terme):	500 N
Durée:	1 min
Longueur entre les emplacements d'essai:	500 mm
Exigences:	aucune variation d'affaiblissement après l'essai, et il ne doit pas y avoir de dommage sur les éléments du câble

NOTE Dans le cas de câbles plats, la force est appliquée sur les côtés plats du câble.

6.3.4 Chocs

Méthode:	IEC 60794-1-21, E4
Energie de choc:	1,0 J
Nombre de chocs:	au moins 3, séparés chacun d'au moins 500 mm
Exigences:	pas de rupture de fibre

NOTE Dans le cas de câbles plats, la force est appliquée sur les côtés plats du câble.

6.3.5 Courbures

Méthode:	IEC 60794-1-21, E11A
Diamètre du mandrin:	60 mm
Nombre de spires:	6
Nombre de cycles:	10
Exigences:	pas de rupture de fibre

NOTE Dans le cas de câbles plats, la force est appliquée sur les côtés plats du câble.

6.3.6 Courbures répétées

Aucune.

6.3.7 Courbure sous contrainte

Aucune.

6.3.8 Courbure à basse température

Aucune.

6.3.9 Flexions

Aucune.

6.3.10 Torsion

Méthode:	IEC 60794-1-21, E7
Nombre de cycles:	10
Distance entre pince fixe et pince tournante:	125 x le diamètre du câble mais pas moins de 0,3 m et pas plus de 1 m
Charge de tension:	20 N
Exigences:	pas de rupture de fibre