

INTERNATIONAL STANDARD



**Optical fibre cables –
Part 2-20: Indoor cables – Family specification for multi-fibre optical cables**

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Part 2-20: Indoor cables – Family specification for multi-fibre optical cables

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CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	7
4 Construction	7
4.1 General.....	7
4.2 Optical fibres	8
4.3 Buffer.....	8
4.4 Ruggedized fibre.....	8
4.5 Slotted core	8
4.6 Tube	9
4.7 Stranded tube	9
4.8 Ribbon structure	9
4.9 Strength and anti-buckling members	9
4.10 Ripcord.....	9
4.11 Sheath.....	9
4.12 Sheath marking.....	9
4.13 Identification	9
4.14 Examples of cable constructions	10
5 Tests	10
5.1 General.....	10
5.2 Dimensions	10
5.3 Mechanical requirements	10
5.3.1 Cable Tensile performance	10
5.3.2 Cable Crush	11
5.3.3 Cable Impact	11
5.3.4 Cable Bending	11
5.3.5 Cable Repeated bending	12
5.3.6 Cable Bending under tension	12
5.3.7 Cable Bending at low temperature	12
5.3.8 Cable Flexing	12
5.3.9 Cable Torsion	12
5.3.10 Cable Cable Kink.....	13
5.4 Environmental requirements – Temperature cycling	13
5.5 Transmission requirements	14
5.5.1 General	14
5.5.2 Single-mode optical fibres	14
5.5.3 Single-mode dispersion unshifted (B-652.B) optical fibre	14
5.5.4 Single-mode dispersion unshifted (B-652.D) optical fibre	15
5.5.5 Single-mode (B-657.A) optical fibre	15
5.5.6 Single-mode (B-657.B) optical fibre	15
5.5.7 Multimode optical fibres	15
5.5.8 Multimode (A1-OM1 to A1-OM5) optical fibres	16
5.6 Fire performance	16
Annex A (informative) Examples of cable constructions	17
Annex B (informative) Family specification for multi-fibre optical cables – Blank detail specification and minimum requirements.....	22

B.1	Blank detail specification	22
B.1.1	General	22
B.1.2	Cable description	22
B.1.3	Cable element	23
B.1.4	Cable construction	24
B.1.5	Installation and operating conditions	25
B.1.6	Mechanical and environmental tests	25
B.2	Cables subject to the MICE environmental classification (ISO/IEC 11801-1 and related standards)	26
Bibliography		27
Figure A.1	– Example of cross-section of a 12-fibre cable	17
Figure A.2	– Example of cross-section of a 36-fibre cable	17
Figure A.3	– Example of cross-section of a 6-fibre break-out cable	18
Figure A.4	– Example of cross-section of a 24-fibre break-out cable	18
Figure A.5	– Example of cross-section of a slotted core type indoor cable with 4-fibre ribbons	19
Figure A.6	– Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 2-fibre ribbons	19
Figure A.7	– Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 4-fibre bundles	20
Figure A.8	– Example of multi-fibre unitube cable	20
Figure A.9	– Example of multi-fibre cable	20
Figure A.10	– Example of a retractable (micro-module) cable	21
Table 1	– Dimensions of buffered fibres	8
Table 2	– Sample temperature cycling values	8
Table 2	– Typical values for temperature cycling	13
Table 3	– Common single-mode optical fibre requirements	14
Table 4	– Cabled fibre attenuation requirements for B-652.B optical fibre	14
Table 5	– Cabled fibre attenuation requirements for B-652.D optical fibre	15
Table 6	– Cabled fibre attenuation requirements for B-657.A optical fibre	15
Table 7	– Cabled fibre attenuation requirements for B-657.B optical fibre	15
Table 8	– Common multimode optical fibre requirements	15
Table 9	– Cabled fibre attenuation requirements for A1-OM1 to A1-OM5 optical fibres	16
Table B.1	– Cable description	22
Table B.2	– Cable element	23
Table B.3	– Cable construction	24
Table B.4	– Installation and operating conditions	25
Table B.5	– Tests applicable	25

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OPTICAL FIBRE CABLES –

Part 2-20: Indoor cables – Family specification for multi-fibre optical cables

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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 60794-2-20:2013. 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 60794-2-20 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2013. This edition constitutes a technical revision.

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

- a) update of the normative references;
- b) review update of parameters and requirements for mechanical tests and environmental tests, maintaining alignment with additional relevant standards in the IEC 60794-2 series;
- c) addition of cabled fibre attenuation requirements;
- d) addition of cable design examples.

This document is to be used in conjunction with IEC 60794-1-1:2023, IEC 60794-1-2:2021, IEC 60794-1-21:2015 and IEC 60794-1-21:2015/AMD: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/2431/FDIS	86A/2520/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

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- withdrawn, or
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OPTICAL FIBRE CABLES –

Part 2-20: Indoor cables – Family specification for multi-fibre optical cables

1 Scope

This part of IEC 60794 is a family specification covering multi-fibre optical cables for indoor use. The requirements of the sectional specification IEC 60794-2 are applicable to cables covered by this document. Annex B contains a blank detail specification and general guidance in case the cables are intended to be used in installations governed by the MICE table of ~~ISO/IEC 24702 (Industrial premises) [11]~~⁴ ISO/IEC 11801-1.

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—These reference complete the normative references already listed in the generic specification (IEC 60794-1-1 and IEC 60794-1-2).~~

~~IEC 60189-1, Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods~~

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

IEC 60793-1-20, *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 60793-1-46, *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 60794-1-1:2023, *Optical fibre cables – Part 1-1: Generic specification – General*

⁴—~~Figures in square brackets refer to the Bibliography.~~

IEC 60794-1-2:2021, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance*

~~IEC 60794-1-20:2021, *Optical fibre cables – Part 1-20: Generic specification – Basic optical cable test procedures – General and definitions*²~~

IEC 60794-1-21:2015, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods*
IEC 60794-1-21:2015/AMD1:2020

IEC 60794-1-22:2017, *Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods*

IEC 60794-1-23:2019, *Optical fibre cables – Part 1-23: Generic specification – Basic optical cable test procedures – Cable element test methods*

IEC 60794-1-31, *Optical fibre cables – Part 1-31: Generic specification – Optical cable elements – Optical fibre ribbon*

IEC 60794-2:2002/2017, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

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

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

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

~~IEC 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 504: Mechanical tests – Bending tests at low temperature for insulation and sheaths*~~

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60794-1-1 apply.

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 considerations apply to multi-fibre indoor cables.

The cable shall be designed and manufactured for an expected operating lifetime of at least 15 years. In this context, the attenuation at the operational wavelength(s) of the optical fibres

²~~To be published.~~

contained in the installed cable shall not exceed values ~~agreed between customer and supplier~~ specified in 5.5. The materials in the cable shall not present a health or environmental hazard within its intended use.

Optical elements may comprise any of the cable elements described in 4.3 to 4.8 or in IEC 60794-1-3.

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

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

4.2 Optical fibres

~~Class A1 multimode fibres which meet the requirements of IEC 60793-2-10 or class B sub-categories B1.1, B1.3, B6_a, and B6_b single-mode optical fibres which meet the requirements of IEC 60793-2-50 shall be used. The linear coefficient of optical fibre attenuation and attenuation point discontinuity may be affected by the cable manufacturing process. Maximum values for these optical characteristics shall be agreed between customer and supplier.~~

Multimode or single-mode optical fibres meeting the requirements of IEC 60793-2-10 sub-categories A1-OM1 to A1-OM5 or IEC 60793-2-50 categories B-652 and B-657 shall be used. The linear coefficient of optical fibre attenuation and attenuation point discontinuity may be affected by the cable manufacturing process. Maximum values for these optical characteristics shall be as specified in 5.5.

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. 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 ~~to 25 mm~~, depending on customer requirements. For semi-tight buffers, the buffer shall be easily removable over a minimum length of ~~0,3 m to 2,0 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 1,4 1,3	±0,05
Tight buffer	0,3 to 1,0	±0,05

4.4 Ruggedized fibre

Further protection can be provided to tight or semi-tight buffered fibres by surrounding them with non-metallic strength members within a sheath of suitable material.

4.5 Slotted core

The slotted core is obtained by extruding a suitable material with a defined number of slots, providing helical or SZ (reverse-oscillating lay) configuration along the core. One or more primary coated fibres or optical elements such as ribbons or fibre bundles are located in each slot.

4.6 Tube

One or more primary coated or buffered fibres or ribbons 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, to provide some crush protection to the fibre bundle or soft to enable easy stripability of the tube without specialized tools.

4.7 Stranded tube

Multiple tubes, containing one or more primary coated or buffered fibres or ribbons, ~~are~~ may be:

- stranded around a central member,
- non-stranded, or
- homogeneous optical tubes stranded using helical or SZ configurations.

For the sake of preserving cable geometry, some tubes may be "filler" or "empty" elements not containing optical fibres.

4.8 Ribbon structure

Ribbon structures shall conform to ~~6.5 and 8.2.3 of IEC 60794-3:2004~~ IEC 60794-1-31. Fibres shall be arranged to be parallel and formed into ribbons so that the fibres remain parallel and do not cross over.

Partially bonded ribbon structures enable the optical fibre ribbon to be rolled up easily and accommodated very tightly in cables. Unless otherwise specified, each ribbon shall be uniquely identified with a printed legend or by uniquely colouring the reference fibre and/or by colouring the matrix material of the ribbon.

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 customer and supplier~~ specified in 5.3.1.

The strength and ~~or~~ anti-buckling members 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

If required, a ripcord may be provided beneath the sheath.

4.11 Sheath

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

4.12 Sheath marking

If required, the cable shall be marked as agreed between customer and supplier. The marking can include identifying marks regarding the manufacturer, fire resistance ratings, jacket length, date of manufacture, etc.

4.13 Identification

Optical fibres, buffers and sub-unit sheaths shall be easily and uniquely identifiable through the use of a suitable colour code according to IEC 60304 and/or an easily visible numbering scheme to be agreed between customer and supplier.

4.14 Examples of cable constructions

Examples of some ~~main~~ types of cable construction are shown in Annex A. Other configurations (e.g. multi-layer constructions) are not precluded if they meet the mechanical, environmental and transmission requirements given in this document.

5 Tests

5.1 General

Compliance with relevant detail specification requirements shall be verified by carrying out tests selected from 5.2 to 5.6. It is not intended that all tests be carried out; the frequency of testing shall be agreed between customer and supplier.

~~Unless otherwise specified, all tests shall be carried out at room temperature: $(23 \pm 5) ^\circ\text{C}$.~~

~~Attenuation measurements shall be conducted at the highest specified wavelength.~~

~~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 within the measurement uncertainty of the equipment used (see 4.8.2, Assessment of uncertainties in IEC 60794-1-20:201X). The wavelength and maximum value of this attenuation change shall be agreed between customer and supplier.~~

Unless otherwise specified, all tests shall be carried out at standard atmospheric conditions according to IEC 60794-1-2. These tests are not intended to define end-of-life performance.

The attenuation of cabled fibres shall be as specified in 5.5.

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 fibre sub-categories A1-OM3 and A1-OM4 is 850 nm and for A1-OM5 fibre, the targeted operational wavelength(s) is between 850 nm and 950 nm.

5.2 Dimensions

The fibre dimensions and tolerances shall be checked in accordance with the test method ~~C~~ of as specified in 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 60189-1~~ IEC 60811-202 and IEC 60811-203.

5.3 Mechanical requirements

5.3.1 ~~Cable~~ Tensile performance

Method:	IEC 60794-1-21 E1A and/or E1B [4] , method E1
Diameter of chuck drums and transfer devices:	not smaller than the minimum bending diameter specified for the cable under load
Velocity of transfer device:	either 100 mm/min or 100 N/min
Load and duration:	400 N or $9,8 \times$ the weight mass of 1 km of cable, whichever is greater, and for a minimum period of 5 10 min
Length of sample:	≥ 50 m and sufficient to achieve the desired accuracy of measurement of attenuation change (typically 300 m) and shall be agreed between customer and supplier

Requirements: ~~for E1A there shall be no change in attenuation after the test~~
~~for E1B allowed fibre strain to be agreed between supplier and customer~~
 there shall be no change in attenuation after the test; there shall be no visible damage to the cable elements

~~Fibre strain above 60 % of the proof test of the all-glass fibre while under test load is not recommended.~~

The fibre strain shall be less than 60 % of the proof test level of the fibre.

~~NOTE~~ For certain applications specifying MICE classification of ISO/IEC ~~24702~~ 11801-1 and related standards, different load and duration values may be agreed between customer and supplier.

For exceptionally high fibre count cables, different load values may be agreed between customer and supplier.

5.3.2 ~~Cable~~ Crush

Method: IEC 60794-1-21 ~~E3~~, method E3A

~~Force during installation: 500 N~~

~~Duration during installation: 1 min~~

~~Force during operation: 300 N~~

~~Duration during operation: 15 min~~

~~Length between test locations: 500 mm~~

Total force applied (short term): 500 N

Duration of application of the force: 1 min

Number of tests: 3

Spacing between test places: 500 mm

Requirements: no change in attenuation during the operational test and after the installation test; there shall be no visible damage to the cable elements

NOTE For certain applications specifying MICE classification of ISO/IEC ~~24702~~ 11801-1 and related standards, different force values ~~may~~ can be agreed between customer and supplier.

5.3.3 ~~Cable~~ Impact

Method: IEC 60794-1-21 ~~,~~, method E4

Radius of striking surface: ~~12,5~~ 300 mm

Impact energy: 1,0 J

Number of impacts: at least 3, each separated at least 500 mm

Requirements: no fibre breakage

NOTE For certain applications specifying MICE classification of ISO/IEC ~~24702~~ 11801-1 and related standards, impact energy values ~~may~~ can be agreed between customer and supplier.

5.3.4 ~~Cable~~ Bending

Method: IEC 60794-1-21 ~~,~~, method E11A

Mandrel diameter: 20 times cable diameter

Number of turns ~~per helix~~: 6

Number of cycles: 10

Requirements: no fibre breakage

NOTE For certain applications specifying MICE classification of ISO/IEC-24702 11801-1 and related standards, different mandrel diameter values ~~may~~ can be agreed between customer and supplier.

5.3.5 ~~Cable~~ Repeated bending

Method: IEC 60794-1-21-, method E6
 Bending radius: 20 times cable diameter
 Number of cycles: 25
 Mass of weights: sufficient to minimize specimen sag or bend – typically 4 kg
 Requirements: under visual examination without magnification, there shall be no damage to the sheath and to the cable elements

5.3.6 ~~Cable~~ Bending under tension

Method: IEC 60794-1-21-~~E18~~, method E18A
 Bending radius: 20 times cable diameter
 Load: 400 N or weight of 1 km of cable, whichever is greater
 Requirements: no change in attenuation after the test, and there shall be no visible damage to the cable elements

5.3.7 ~~Cable~~ Bending at low temperature

Method: IEC 60794-1-21-, method E11A (~~see IEC 60811-504~~)
 Bending radius: 10 times cable diameter
 Test temperature: 0 °C, -10 °C or -15 °C depending on application and customer requirements
 Number of turns ~~per helix~~: ~~according to IEC 60811-504~~ 4
 Number of cycles: 2
 Requirements: ~~in addition to the requirements of IEC 60811-504~~, no visible damage to cable sheath, and no fibre shall break during the test

5.3.8 ~~Cable~~ Flexing

Method: IEC 60794-1-21-, method E8
 Number of cycles: 100
 Pulley diameter: 20 times cable diameter
 Mass of weights: 2 kg (minimum)
 Requirements: no fibre breakage

NOTE For certain applications specifying MICE classification of ISO/IEC-24702 11801-1 and related standards, different pulley diameter values ~~may~~ can be agreed between customer and supplier.

5.3.9 ~~Cable~~ Torsion

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

NOTE For certain applications specifying MICE classification of ISO/IEC-24702 11801-1 and related standards, different values for the number of cycles ~~may~~ can be agreed between customer and supplier.

5.3.10 Cable Kink

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

5.4 Environmental requirements – Temperature cycling

For indoor multi-fibre cables, -10 °C and $+60\text{ °C}$ are the recommended low and high temperatures. Based on different environment classifications, other operating temperatures may be agreed upon between customer and supplier. Table 2 gives the operating temperature limits based on environmental classification.

~~Table 2 – Sample temperature cycling values~~

	<i>Low temperature T_A</i>	<i>High temperature T_B</i>
a)*	0 °C	$+50\text{ °C}$
b)	-5 °C	$+50\text{ °C}$
c)	-20 °C	$+60\text{ °C}$
d)	-40 °C	$+60\text{ °C}$

*—Condition a), b) c) or d) shall be selected depending on application and customer requirements, for example condition c) is appropriate for applications to ISO/IEC 11801 [10].

Table 2 – Typical values for temperature cycling

Low temperature T_{A2} $^{\circ}\text{C}$	High temperature T_{B2} $^{\circ}\text{C}$	Sources of temperature limits	
		Performance categories of connectors, components and protective housings ^a	Environmental classification of customer premises cabling ^b
-10	$+60$	C (recommended)	$M_x I_x C1E_x$
-25	$+70$	OP	$M_x I_x C2E_x$
-40	$+70$	I	$M_x I_x C3E_x$

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 60794-1-1:2023.

^a Included in IEC 61753-1. The abbreviations represent:

- 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 represents: mechanical, ingress, climatic, electromagnetic.

Method:	IEC 60794-1-22-, method F1
Period:	t_1 = sufficient time such that the cable has reached thermal stability throughout its entire length at the specified temperature (e.g. 8 h $\leq t_1 \leq$ 24 h) (for additional information, see IEC 60794-1-22:2017, Table 1 in method F1)
Number of cycles:	2
Length of sample:	sufficient to achieve the desired accuracy of measurement of attenuation
Requirements:	the wavelength and maximum increase in attenuation both at T_A and T_B and after returning to thermal stability at ambient temperature shall be agreed between the customer and supplier the maximum change in attenuation during the test shall be specified in the relevant detail specification; there shall be no change in attenuation after the test.

5.5 Transmission requirements

5.5.1 General

The transmission requirements shall be ~~verified~~ in accordance with one of the sectional specifications defined in IEC 60793-2-10 or IEC 60793-2-50 ~~and shall be agreed between customer and supplier~~. Maximum cabled fibre attenuation shall comply with ~~values stated in the relevant detail specification~~ this document.

5.5.2 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	$\leq 0,10$ dB	IEC 60793-1-40	

5.5.3 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	According to the Detail Specification	IEC 60793-1-40	
at 1 310 nm at 1 550 nm at 1 625 nm		$\leq 1,0$ dB/km $\leq 1,0$ dB/km $\leq 1,0$ dB/km		

5.5.4 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	According to the Detail Specification	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		

5.5.5 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	According to the Detail Specification	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		

5.5.6 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	According to the Detail Specification	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		

5.5.7 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	

5.5.8 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	According to the Detail Specification	IEC 60793-1-40	
at 850 nm at 1 300 nm		3,0 dB/km 1,5 dB/km		

5.6 Fire performance

IEC TR 62222 provides guidance and recommendations for the requirements and test methods ~~to be specified~~ 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.

~~The recommendations relate to typical applications and installation practices and also take into account legislation and regulation applicable to the fire performance of cables that govern the tests to be performed.~~

~~Tests to be performed shall be agreed between the customer and the supplier.~~

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.

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Annex A (informative)

Examples of cable constructions

Figure A.1 to ~~Figure A.9~~ Figure A.10 provide examples of cable constructions.

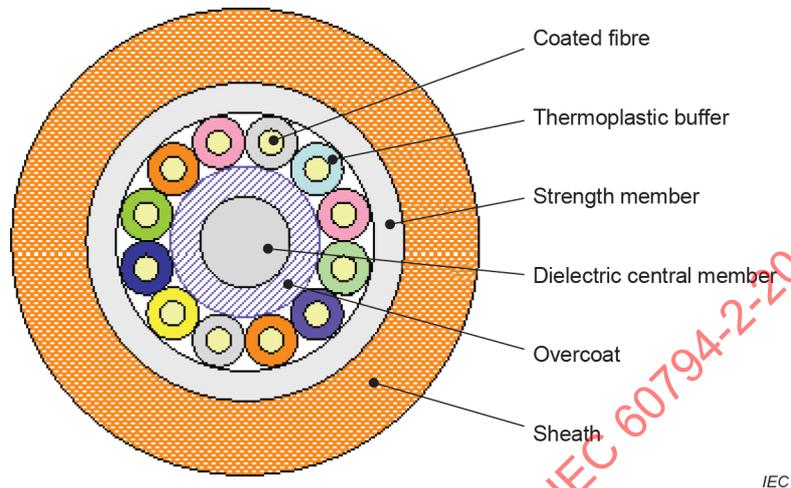


Figure A.1 – Example of cross-section of a 12-fibre cable

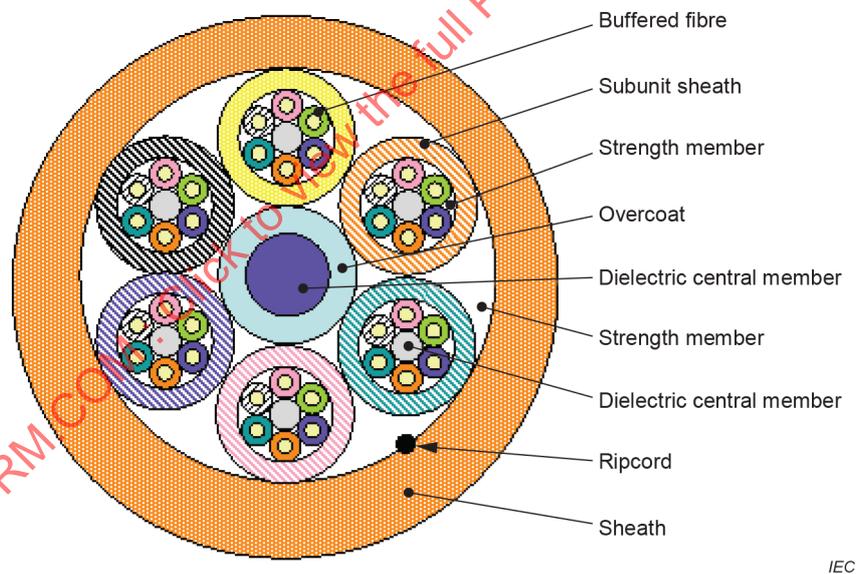
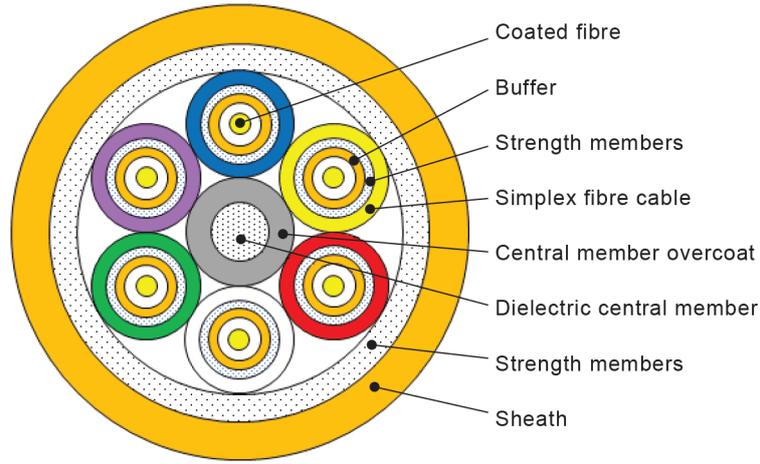
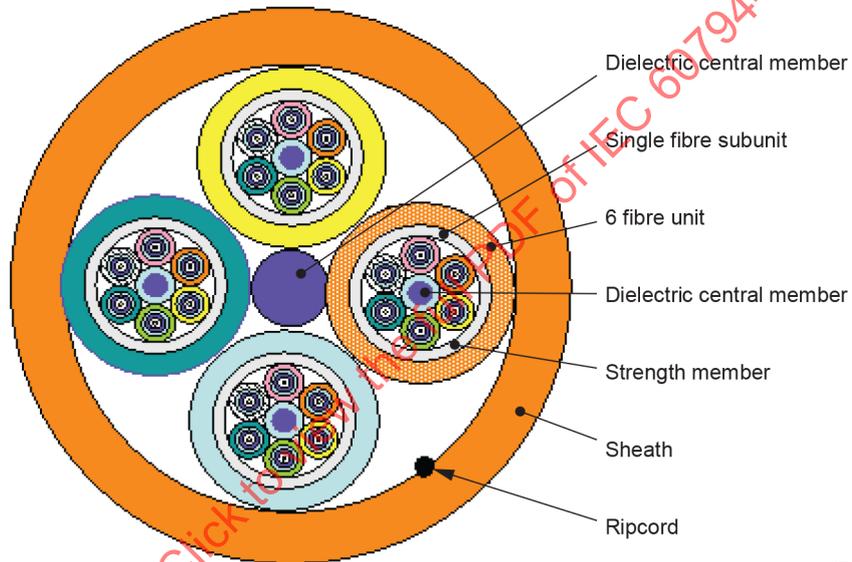


Figure A.2 – Example of cross-section of a 36-fibre cable



IEC

Figure A.3 – Example of cross-section of a 6-fibre break-out cable



IEC

Figure A.4 – Example of cross-section of a 24-fibre break-out cable

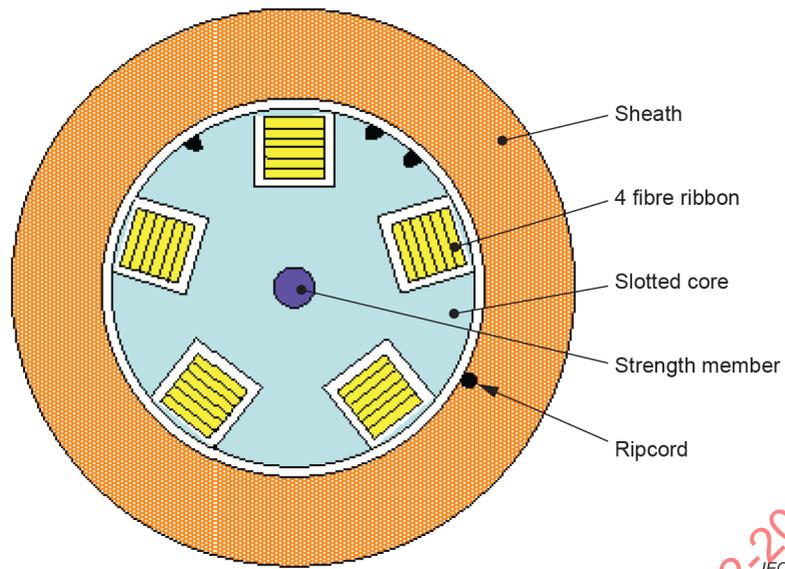


Figure A.5 – Example of cross-section of a slotted core type indoor cable with 4-fibre ribbons

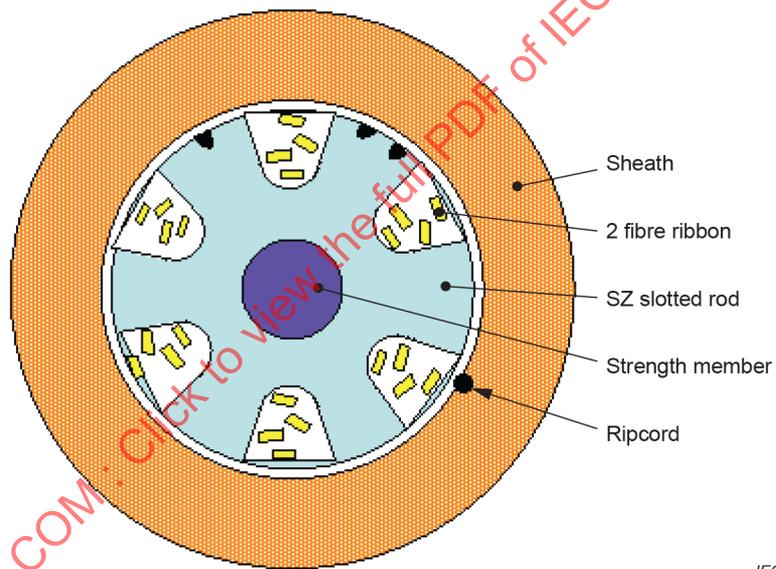


Figure A.6 – Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 2-fibre ribbons

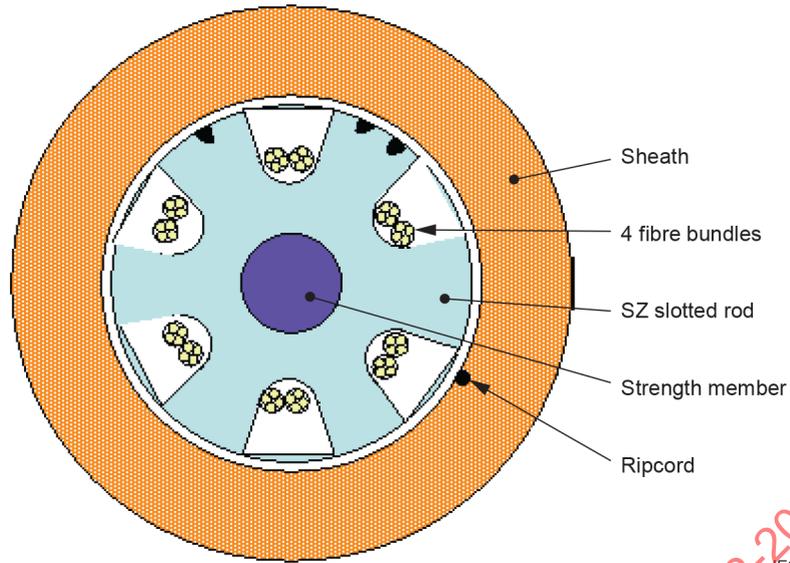


Figure A.7 – Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 4-fibre bundles

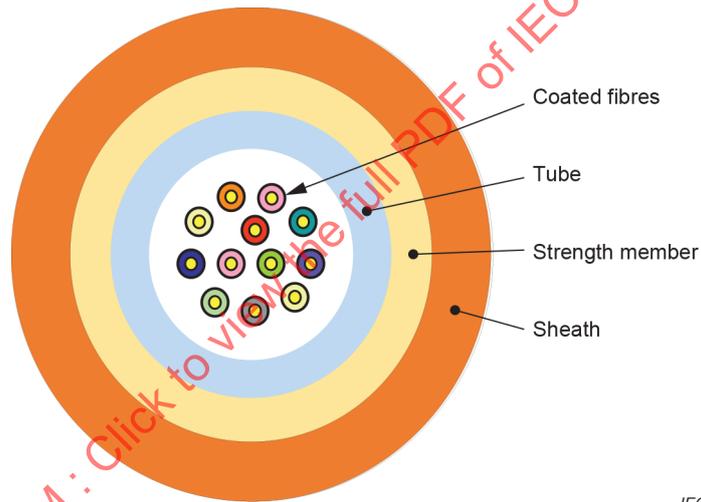


Figure A.8 – Example of multi-fibre unitube cable

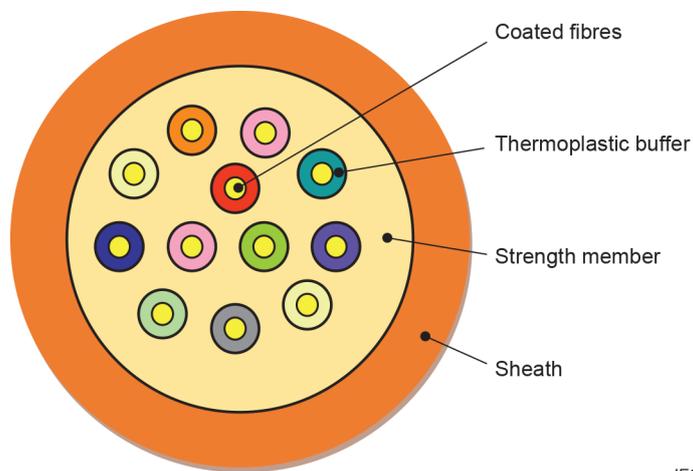


Figure A.9 – Example of multi-fibre cable

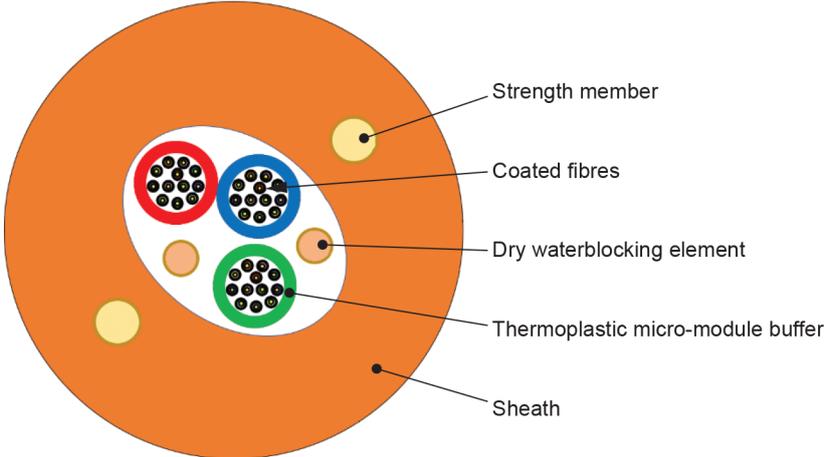


Figure A.10 – Example of a retractable (micro-module) cable

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Annex B
(informative)

**Family specification for multi-fibre optical cables –
Blank detail specification and minimum requirements**

B.1 Blank detail specification

B.1.1 General

See Table B.1 to Table B.5 for blank detail specifications and minimum requirements.

B.1.2 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 11801-1 if required		
(6) Cable description:		
(7) Cable construction:		
Optical fibres		
Range of fibre count		
Modularity		
Construction <ul style="list-style-type: none"> – single coloured fibre – tube – filled – tube – unfilled – slotted core – filled – slotted core – unfilled – tight, semi-tight or loose buffer – ribbon in slotted core – ribbon in tube – strength elements – non metallic – strength elements – metallic 		Additional remarks
Lay-up <ul style="list-style-type: none"> – stranding (helical or reverse oscillating/SZ) – single unit – hybrid configuration – other 		
<u>Insulated copper conductors</u> <ul style="list-style-type: none"> — AWG — solid/stranded — insulation material 		

Inner sheath	
– material	
– minimum wall thickness	
Peripheral strength member	
– metallic	
– non-metallic	
Outer sheath	
– material	
– minimum wall thickness	
<u>Additional armouring</u>	
– non-metallic armouring	
– metallic armouring	
Marking identification	
– customer requirement	
– identification of supplier	
(8) Application information:	
Application	
Maximum outer diameter (<i>d</i>)	mm
Rated maximum tensile load	N
Minimum bending radius for operation	mm or nxd
Minimum bending radius under load	mm or nxd
Temperature range:	
– transport and storage	°C
– installation	°C
– operation	°C
Manufacturing cable length	
– typical	m
– nominal/tolerances:	+1 0 %

B.1.3 Cable element

Table B.2 – Cable element

Characteristics (9)	IEC 60794-2:2017 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Cable element				
Tight, semi-tight or loose buffer				
Slotted core				
Tube				
Compound flow and evaporation				
Outer diameter				
Ribbon				
Filler				
Insulated copper conductor				

Central strength member				
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B.1.4 Cable construction

Table B.3 – Cable construction

Characteristics (9)	IEC 60794-2:2017, clause/ subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Lay-up	6.25.9	According to the Detail Specification a	Visual inspection	
Cable core	6.35.11	According to the Detail Specification		
Strength member – central – peripheral	6.45.7	According to the Detail Specification	Visual inspection	
Outer cable sheath Material Minimum sheath thickness Outer diameter Optional protection	6.65.11	IEC 60794-2:2002 2017, 6.6.3 According to the Detail Specification According to the Detail Specification According to the Detail Specification	IEC 60811-202 IEC 60811-203	
Sheath marking Configuration, dimensions Abrasion resistance	6.75.12	According to the Detail Specification According to the Detail Specification	Visual inspection IEC 60794-1-21, method E2B, method 1 Or IEC 60794-1-21, method E2B, method 2	
Sheath abrasion	8.105.12	According to the Detail Specification	IEC 60794-1-21, method E2A	
Cable length				
a Detail specification.				

B.1.5 Installation and operating conditions**Table B.4 – Installation and operating conditions**

Characteristics (9)	IEC 60794-2:2017 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
General requirements				
Bend of cable element			IEC 60794-1- 24 23, method G1	
Tube kinking			IEC 60794-1- 24 23, method G7	
Ribbons:				
– dimensions			IEC 60794-1-23, methods G2, G3 or G4	
– separability of individual fibres from ribbon			IEC 60794-1- 24 23, method G5 or acc. DS	
– ribbon stripping				
– torsion			IEC 60794-1-21, method G6	

B.1.6 Mechanical and environmental tests**Table B.5 – Tests applicable**

Characteristics (9)	IEC 60794-2:2017 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Tensile performance			IEC 60794-1-2, Method E1A and E1B IEC 60794-1-21, method E1	
Installation capability selection from the following:				
– bending under tension			IEC 60794-1-21, method E18A	
– repeated bending			IEC 60794-1-21, method E6	
– impact			IEC 60794-1-21, method E4	
– kink			IEC 60794-1-21, method E10	
– torsion			IEC 60794-1-21, method E7	
Cable bend			IEC 60794-1-21, method E11	
Crush			IEC 60794-1-21, method E3	
Temperature cycling			IEC 60794-1-22, method F1	
Ageing				
– coating adhesion stability			IEC 60794-1- 22 21, method E5	
– finished cable				

B.2 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 may require the specification of additional tests to ensure their suitability in the applicable environments defined by the mechanical, ingress, climatic and chemical, and electromagnetic (MICE) classification. Such tests are outside of the scope of IEC 60794 cable specifications, and MICE criteria are not part of the requirements for IEC 60794 specifications. The MICE tests may be the same as, similar to, or substantially different from, the tests required by IEC 60794 specifications. It is possible that cables manufactured per IEC 60794 specifications will meet MICE criteria, but it is also possible that they will not. For supplemental guidance, see IEC TR 62362.

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Bibliography

IEC 60654 (all parts), *Industrial-process measurement and control equipment – Operating conditions*

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 weather protected locations*

IEC 60794-1-3, *Optical fibre cables – Part 1-3: Generic specification – Optical cable elements*

IEC 60794-1-21, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical tests methods³*

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 61326 (all parts), *Electrical equipment for measurement, control and laboratory use – EMC requirements*~~

IEC 61753-1, *Fibre optic interconnecting devices and passive components – Performance standard – Part 1: General and guidance*

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*

IEC 60794-2 (all parts), *Optical fibre cables – Part 2: Indoor cables*

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

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

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

³ ~~Under consideration as a Committee Draft.~~

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INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Optical fibre cables –
Part 2-20: Indoor cables – Family specification for multi-fibre optical cables**

**Câbles à fibres optiques –
Partie 2-20: Câbles intérieurs – Spécification de famille pour les câbles optiques
multifibres**

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CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	7
4 Construction	7
4.1 General.....	7
4.2 Optical fibres	7
4.3 Buffer.....	8
4.4 Ruggedized fibre.....	8
4.5 Slotted core	8
4.6 Tube	8
4.7 Stranded tube	8
4.8 Ribbon structure	8
4.9 Strength and anti-buckling members	9
4.10 Ripcord.....	9
4.11 Sheath.....	9
4.12 Sheath marking.....	9
4.13 Identification	9
4.14 Examples of cable constructions	9
5 Tests	9
5.1 General.....	9
5.2 Dimensions	10
5.3 Mechanical requirements	10
5.3.1 Tensile performance	10
5.3.2 Crush	10
5.3.3 Impact	10
5.3.4 Bending	11
5.3.5 Repeated bending	11
5.3.6 Bending under tension.....	11
5.3.7 Bending at low temperature	11
5.3.8 Flexing	11
5.3.9 Torsion	12
5.3.10 Cable kink	12
5.4 Environmental requirements – Temperature cycling	12
5.5 Transmission requirements	13
5.5.1 General	13
5.5.2 Single-mode optical fibres	13
5.5.3 Single-mode dispersion unshifted (B-652.B) optical fibre	13
5.5.4 Single-mode dispersion unshifted (B-652.D) optical fibre	13
5.5.5 Single-mode (B-657.A) optical fibre	14
5.5.6 Single-mode (B-657.B) optical fibre	14
5.5.7 Multimode optical fibres	14
5.5.8 Multimode (A1-OM1 to A1-OM5) optical fibres	15
5.6 Fire performance	15
Annex A (informative) Examples of cable constructions	16
Annex B (informative) Family specification for multi-fibre optical cables – Blank detail specification and minimum requirements.....	21

B.1	Blank detail specification	21
B.1.1	General	21
B.1.2	Cable description.....	21
B.1.3	Cable element	22
B.1.4	Cable construction.....	23
B.1.5	Installation and operating conditions.....	24
B.1.6	Mechanical and environmental tests	24
B.2	Cables subject to the MICE environmental classification (ISO/IEC 11801-1 and related standards)	25
Bibliography.....		26
Figure A.1	– Example of cross-section of a 12-fibre cable.....	16
Figure A.2	– Example of cross-section of a 36-fibre cable.....	16
Figure A.3	– Example of cross-section of a 6-fibre break-out cable	17
Figure A.4	– Example of cross-section of a 24-fibre break-out cable.....	17
Figure A.5	– Example of cross-section of a slotted core type indoor cable with 4-fibre ribbons	18
Figure A.6	– Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 2-fibre ribbons.....	18
Figure A.7	– Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 4-fibre bundles.....	19
Figure A.8	– Example of multi-fibre unitube cable.....	19
Figure A.9	– Example of multi-fibre cable.....	19
Figure A.10	– Example of a retractable (micro-module) cable	20
Table 1	– Dimensions of buffered fibres.....	8
Table 2	– Typical values for temperature cycling.....	12
Table 3	– Common single-mode optical fibre requirements	13
Table 4	– Cabled fibre attenuation requirements for B-652.B optical fibre	13
Table 5	– Cabled fibre attenuation requirements for B-652.D optical fibre	14
Table 6	– Cabled fibre attenuation requirements for B-657.A optical fibre	14
Table 7	– Cabled fibre attenuation requirements for B-657.B optical fibre	14
Table 8	– Common multimode optical fibre requirements	14
Table 9	– Cabled fibre attenuation requirements for A1-OM1 to A1-OM5 optical fibres.....	15
Table B.1	– Cable description	21
Table B.2	– Cable element.....	22
Table B.3	– Cable construction	23
Table B.4	– Installation and operating conditions	24
Table B.5	– Tests applicable.....	24

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRE CABLES –

**Part 2-20: Indoor cables –
Family specification for multi-fibre optical cables**

FOREWORD

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IEC 60794-2-20 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2013. This edition constitutes a technical revision.

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

- a) update of the normative references;
- b) review update of parameters and requirements for mechanical tests and environmental tests, maintaining alignment with additional relevant standards in the IEC 60794-2 series;
- c) addition of cabled fibre attenuation requirements;

d) addition of cable design examples.

This document is to be used in conjunction with IEC 60794-1-1:2023, IEC 60794-1-2:2021, IEC 60794-1-21:2015 and IEC 60794-1-21:2015/AMD: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/2431/FDIS	86A/2520/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, or
- revised.

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OPTICAL FIBRE CABLES –

Part 2-20: Indoor cables – Family specification for multi-fibre optical cables

1 Scope

This part of IEC 60794 is a family specification covering multi-fibre optical cables for indoor use. The requirements of the sectional specification IEC 60794-2 are applicable to cables covered by this document. Annex B contains a blank detail specification and general guidance in case the cables are intended to be used in installations governed by the MICE table of ISO/IEC 11801-1.

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 60793-1-46, *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 60794-1-1:2023, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-2:2021, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance*

IEC 60794-1-21:2015, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods*

IEC 60794-1-21:2015/AMD1:2020

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IEC 60794-1-31, *Optical fibre cables – Part 1-31: Generic specification – Optical cable elements – Optical fibre ribbon*

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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 apply.

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 considerations apply to multi-fibre indoor cables.

The cable shall be designed and manufactured for an expected operating lifetime of at least 15 years. In this context, the attenuation at the operational wavelength(s) of the optical fibres contained in the installed cable shall not exceed values specified in 5.5. The materials in the cable shall not present a health or environmental hazard within its intended use.

Optical elements may comprise any of the cable elements described in 4.3 to 4.8 or in IEC 60794-1-3.

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

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

4.2 Optical fibres

Multimode or single-mode optical fibres meeting the requirements of IEC 60793-2-10 sub-categories A1-OM1 to A1-OM5 or IEC 60793-2-50 categories B-652 and B-657 shall be used. The linear coefficient of optical fibre attenuation and attenuation point discontinuity may be affected by the cable manufacturing process. Maximum values for these optical characteristics shall be as specified in 5.5.

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 Ruggedized fibre

Further protection can be provided to tight or semi-tight buffered fibres by surrounding them with non-metallic strength members within a sheath of suitable material.

4.5 Slotted core

The slotted core is obtained by extruding a suitable material with a defined number of slots, providing helical or SZ (reverse-oscillating lay) configuration along the core. One or more primary coated fibres or optical elements such as ribbons or fibre bundles are located in each slot.

4.6 Tube

One or more primary coated or buffered fibres or ribbons 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, to provide some crush protection to the fibre bundle or soft to enable easy stripability of the tube without specialized tools.

4.7 Stranded tube

Multiple tubes, containing one or more primary coated or buffered fibres or ribbons, may be:

- stranded around a central member,
- non-stranded, or
- homogeneous optical tubes stranded using helical or SZ configurations.

For the sake of preserving cable geometry, some tubes may be "filler" or "empty" elements not containing optical fibres.

4.8 Ribbon structure

Ribbon structures shall conform to IEC 60794-1-31. Fibres shall be arranged to be parallel and formed into ribbons so that the fibres remain parallel and do not cross over.

Partially bonded ribbon structures enable the optical fibre ribbon to be rolled up easily and accommodated very tightly in cables. Unless otherwise specified, each ribbon shall be uniquely identified with a printed legend or by uniquely colouring the reference fibre and/or by colouring the matrix material of the ribbon.

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 specified in 5.3.1.

The strength and anti-buckling members 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

If required, a ripcord may be provided beneath the sheath.

4.11 Sheath

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

4.12 Sheath marking

If required, the cable shall be marked as agreed between customer and supplier. The marking can include identifying marks regarding the manufacturer, fire resistance ratings, jacket length, date of manufacture, etc.

4.13 Identification

Optical fibres, buffers and sub-unit sheaths shall be easily and uniquely identifiable through the use of a suitable colour code according to IEC 60304 and/or an easily visible numbering scheme to be agreed between customer and supplier.

4.14 Examples of cable constructions

Examples of some types of cable construction are shown in Annex A. Other configurations (e.g. multi-layer constructions) are not precluded if they meet the mechanical, environmental and transmission requirements given in this document.

5 Tests

5.1 General

Compliance with relevant detail specification requirements shall be verified by carrying out tests selected from 5.2 to 5.6. It is not intended that all tests be carried out; the frequency of testing shall be agreed between customer and supplier.

Unless otherwise specified, all tests shall be carried out at standard atmospheric conditions according to IEC 60794-1-2. These tests are not intended to define end-of-life performance.

The attenuation of cabled fibres shall be as specified in 5.5.

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 fibre sub-categories A1-OM3 and A1-OM4 is 850 nm and for A1-OM5 fibre, the targeted operational wavelength(s) is between 850 nm and 950 nm.

5.2 Dimensions

The fibre dimensions and tolerances shall be checked in accordance with the test method as specified in 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.

5.3 Mechanical requirements

5.3.1 Tensile performance

Method:	IEC 60794-1-21, method E1
Diameter of chuck drums and transfer devices:	not smaller than the minimum bending diameter specified for the cable under load
Velocity of transfer device:	either 100 mm/min or 100 N/min
Load and duration:	400 N or $9,8 \times$ the mass of 1 km of cable, whichever is greater, and for a minimum period of 10 min
Length of sample:	≥ 50 m and sufficient to achieve the desired accuracy of measurement of attenuation change
Requirements:	there shall be no change in attenuation after the test; there shall be no visible damage to the cable elements

The fibre strain shall be less than 60 % of the proof test level of the fibre.

For certain applications specifying MICE classification of ISO/IEC 11801-1 and related standards, different load and duration values may be agreed between customer and supplier.

For exceptionally high fibre count cables, different load values may be agreed between customer and supplier.

5.3.2 Crush

Method:	IEC 60794-1-21, method E3A
Total force applied (short term):	500 N
Duration of application of the force:	1 min
Number of tests:	3
Spacing between test places:	500 mm
Requirements:	no change in attenuation during the operational test and after the installation test; there shall be no visible damage to the cable elements

NOTE For certain applications specifying MICE classification of ISO/IEC 11801-1 and related standards, different force values can be agreed between customer and supplier.

5.3.3 Impact

Method:	IEC 60794-1-21, method E4
Radius of striking surface:	300 mm
Impact energy:	1,0 J
Number of impacts:	at least 3, each separated at least 500 mm
Requirements:	no fibre breakage

NOTE For certain applications specifying MICE classification of ISO/IEC 11801-1 and related standards, impact energy values can be agreed between customer and supplier.

5.3.4 Bending

Method:	IEC 60794-1-21, method E11A
Mandrel diameter:	20 times cable diameter
Number of turns:	6
Number of cycles:	10
Requirements:	no fibre breakage

NOTE For certain applications specifying MICE classification of ISO/IEC 11801-1 and related standards, different mandrel diameter values can be agreed between customer and supplier.

5.3.5 Repeated bending

Method:	IEC 60794-1-21, method E6
Bending radius:	20 times cable diameter
Number of cycles:	25
Mass of weights:	sufficient to minimize specimen sag or bend – typically 4 kg
Requirements:	under visual examination without magnification, there shall be no damage to the sheath and to the cable elements

5.3.6 Bending under tension

Method:	IEC 60794-1-21, method E18A
Bending radius:	20 times cable diameter
Load:	400 N or weight of 1 km of cable, whichever is greater
Requirements:	no change in attenuation after the test, and there shall be no visible damage to the cable elements

5.3.7 Bending at low temperature

Method:	IEC 60794-1-21, method E11A
Bending radius:	10 times cable diameter
Test temperature:	0 °C, -10 °C or -15 °C depending on application and customer requirements
Number of turns:	4
Number of cycles:	2
Requirements:	no visible damage to cable sheath, and no fibre shall break during the test

5.3.8 Flexing

Method:	IEC 60794-1-21, method E8
Number of cycles:	100
Pulley diameter:	20 times cable diameter
Mass of weights:	2 kg (minimum)
Requirements:	no fibre breakage

NOTE For certain applications specifying MICE classification of ISO/IEC 11801-1 and related standards, different pulley diameter values can be agreed between customer and supplier.

5.3.9 Torsion

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

NOTE For certain applications specifying MICE classification of ISO/IEC 11801-1 and related standards, different values for the number of cycles can be agreed between customer and supplier.

5.3.10 Cable kink

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

5.4 Environmental requirements – Temperature cycling

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

Table 2 – Typical values for temperature cycling

Low temperature TA2 °C	High temperature TB2 °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 _x I _x C1E _x
-25	+70	OP	M _x I _x C2E _x
-40	+70	I	M _x I _x C3E _x

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 60794-1-1:2023.

^a Included in IEC 61753-1. The abbreviations represent:

- 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 represents: mechanical, ingress, climatic, electromagnetic.

Method:	IEC 60794-1-22, method F1
Period:	t1 = sufficient time such that the cable has reached thermal stability throughout its entire length at the specified temperature (for additional information, see IEC 60794-1-22:2017, Table 1 in method F1)
Number of cycles:	2
Length of sample:	sufficient to achieve the desired accuracy of measurement of attenuation
Requirements:	the maximum change in attenuation during the test shall be specified in the relevant detail specification; there shall be no change in attenuation after the test.

5.5 Transmission requirements

5.5.1 General

The transmission requirements shall be in accordance with one of the sectional specifications defined in IEC 60793-2-10 or IEC 60793-2-50. Maximum cabled fibre attenuation shall comply with this document.

5.5.2 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	$\lambda_{cc} < \lambda_{\text{operational}}$	IEC 60793-1-44	
Point discontinuities at 1 550 nm	4.2	$\leq 0,10$ dB	IEC 60793-1-40	

5.5.3 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	According to the Detail Specification	IEC 60793-1-40	
at 1 310 nm at 1 550 nm at 1 625 nm		$\leq 1,0$ dB/km $\leq 1,0$ dB/km $\leq 1,0$ dB/km		

5.5.4 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	According to the Detail Specification	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		

5.5.5 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	According to the Detail Specification	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		

5.5.6 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	According to the Detail Specification	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		

5.5.7 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	

5.5.8 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	According to the Detail Specification	IEC 60793-1-40	
at 850 nm at 1 300 nm		3,0 dB/km 1,5 dB/km		

5.6 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.

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Annex A (informative)

Examples of cable constructions

Figure A.1 to Figure A.10 provide examples of cable constructions.

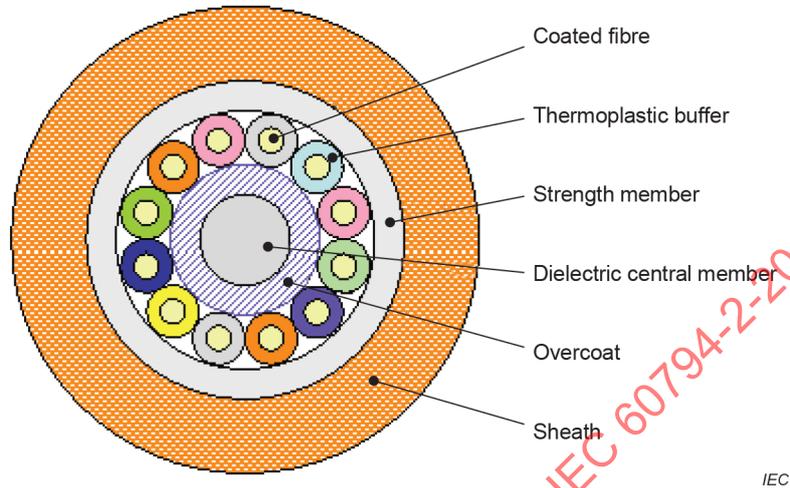


Figure A.1 – Example of cross-section of a 12-fibre cable

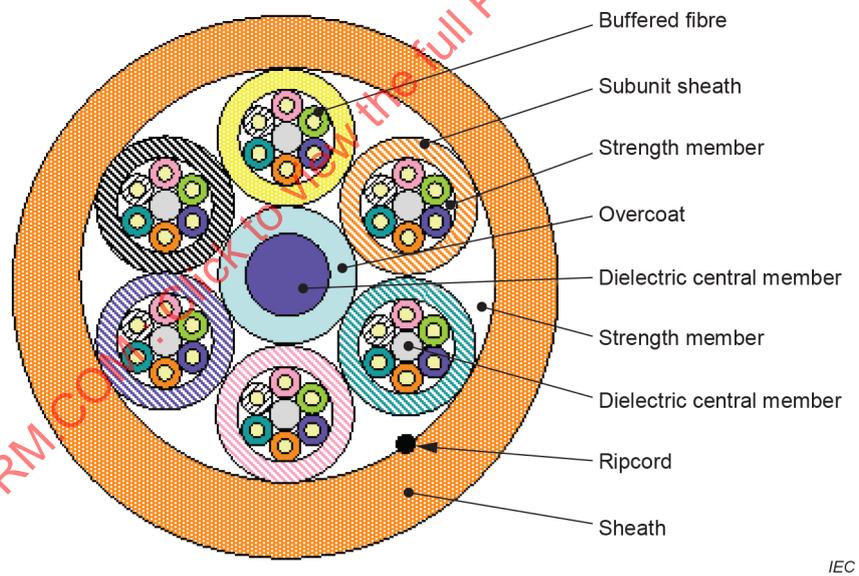
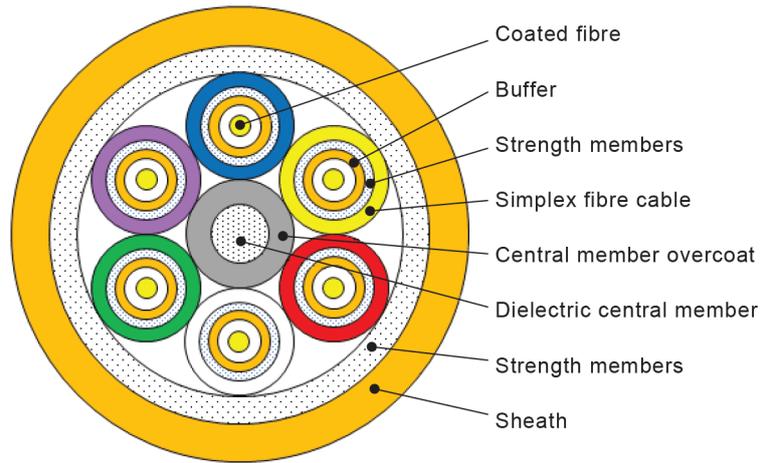
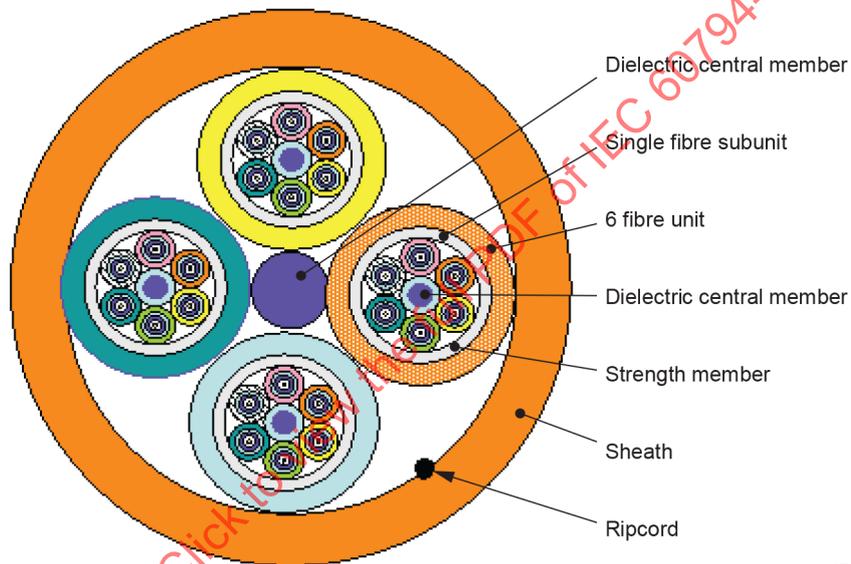


Figure A.2 – Example of cross-section of a 36-fibre cable



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Figure A.3 – Example of cross-section of a 6-fibre break-out cable



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Figure A.4 – Example of cross-section of a 24-fibre break-out cable

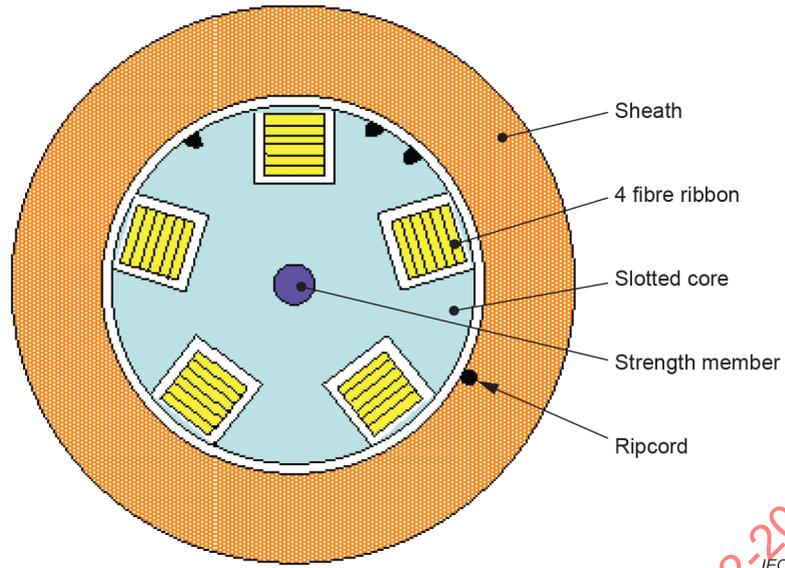


Figure A.5 – Example of cross-section of a slotted core type indoor cable with 4-fibre ribbons

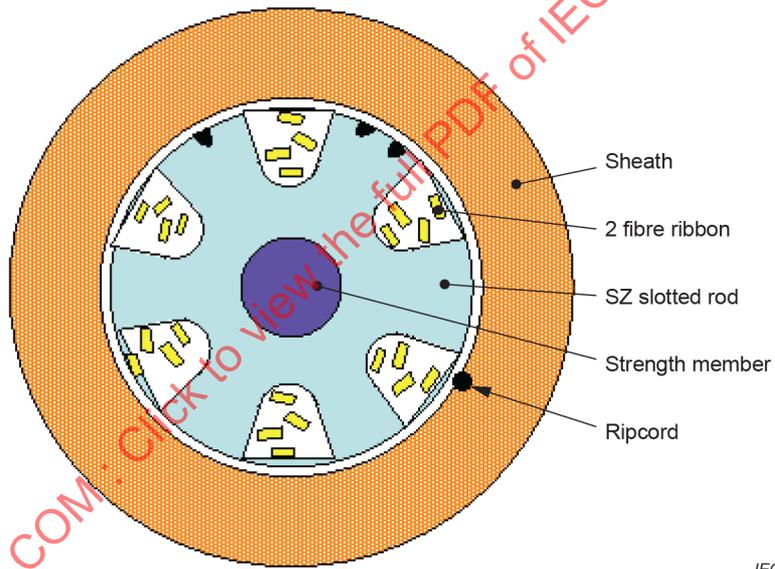


Figure A.6 – Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 2-fibre ribbons

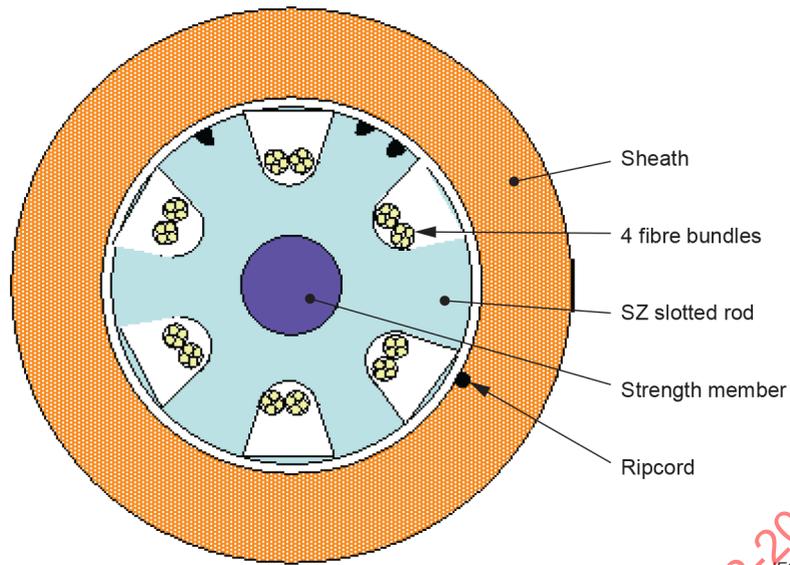


Figure A.7 – Example of cross-section of an SZ (reverse oscillating lay) slotted core type indoor cable with 4-fibre bundles

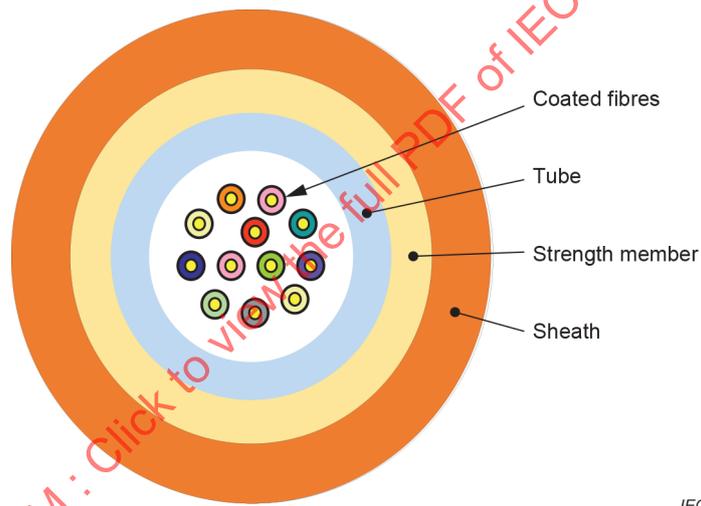


Figure A.8 – Example of multi-fibre unitube cable

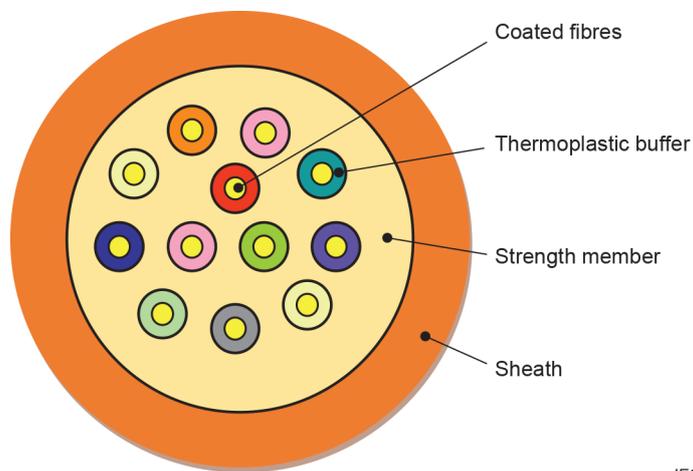


Figure A.9 – Example of multi-fibre cable

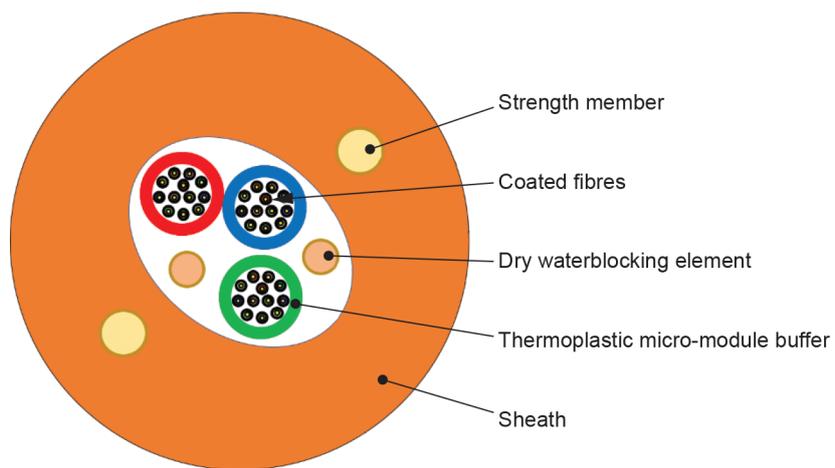


Figure A.10 – Example of a retractable (micro-module) cable

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Annex B (informative)

Family specification for multi-fibre optical cables – Blank detail specification and minimum requirements

B.1 Blank detail specification

B.1.1 General

See Table B.1 to Table B.5 for blank detail specifications and minimum requirements.

B.1.2 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		Additional remarks
<ul style="list-style-type: none"> – single coloured fibre – tube – filled – tube – unfilled – slotted core – filled – slotted core – unfilled – tight, semi-tight or loose buffer – ribbon in slotted core – ribbon in tube – strength elements – non metallic – strength elements – metallic 		
Lay-up		
<ul style="list-style-type: none"> – stranding (helical or reverse oscillating/SZ) – single unit – hybrid configuration – other 		
Inner sheath		
<ul style="list-style-type: none"> – material – minimum wall thickness 		
Peripheral strength member		
<ul style="list-style-type: none"> – metallic – non-metallic 		

Outer sheath – material – minimum wall thickness	
Marking identification – customer requirement – identification of supplier	
(8) Application information:	
Application	
Maximum outer diameter (<i>d</i>)	mm
Rated maximum tensile load	N
Minimum bending radius for operation	mm or nxd
Minimum bending radius under load	mm or nxd
Temperature range:	
– transport and storage	°C
– installation	°C
– operation	°C
Manufacturing cable length	
– typical	m
– nominal/tolerances:	+1 0 %

B.1.3 Cable element

Table B.2 – Cable element

Characteristics (9)	IEC 60794-2:2017 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Cable element				
Tight, semi-tight or loose buffer				
Slotted core				
Tube				
Compound flow and evaporation				
Outer diameter				
Ribbon				
Filler				
Insulated copper conductor				
Central strength member				

B.1.4 Cable construction**Table B.3 – Cable construction**

Characteristics (9)	IEC 60794-2:2017, clause/ subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Lay-up	5.9	According to the Detail Specification ^a	Visual inspection	
Cable core	5.11	According to the Detail Specification		
Strength member – central – peripheral	5.7	According to the Detail Specification	Visual inspection	
Outer cable sheath Material Minimum sheath thickness Outer diameter Optional protection	5.11	IEC 60794-2:2017, 6.6.3 According to the Detail Specification According to the Detail Specification According to the Detail Specification	IEC 60811-202 IEC 60811-203	
Sheath marking Configuration, dimensions Abrasion resistance	5.12	According to the Detail Specification According to the Detail Specification	Visual inspection IEC 60794-1-21, method E2B, method 1 Or IEC 60794-1-21, method E2B, method 2	
Sheath abrasion	5.12	According to the Detail Specification	IEC 60794-1-21, method E2A	
Cable length				
^a Detail specification.				

B.1.5 Installation and operating conditions

Table B.4 – Installation and operating conditions

Characteristics (9)	IEC 60794-2:2017 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
General requirements				
Bend of cable element			IEC 60794-1-23, method G1	
Tube kinking			IEC 60794-1-23, method G7	
Ribbons:				
– dimensions			IEC 60794-1-23, methods G2, G3 or G4	
– separability of individual fibres from ribbon			IEC 60794-1-23, method G5 or acc. DS	
– ribbon stripping				
– torsion			IEC 60794-1-21, method G6	

B.1.6 Mechanical and environmental tests

Table B.5 – Tests applicable

Characteristics (9)	IEC 60794-2:2017 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Tensile performance			IEC 60794-1-21, method E1	
Installation capability selection from the following:				
– bending under tension			IEC 60794-1-21, method E18A	
– repeated bending			IEC 60794-1-21, method E6	
– impact			IEC 60794-1-21, method E4	
– kink			IEC 60794-1-21, method E10	
– torsion			IEC 60794-1-21, method E7	
Cable bend			IEC 60794-1-21, method E11	
Crush			IEC 60794-1-21, method E3	
Temperature cycling			IEC 60794-1-22, method F1	
Ageing				
– coating adhesion stability			IEC 60794-1-21, method E5	
– finished cable				

B.2 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 may require the specification of additional tests to ensure their suitability in the applicable environments defined by the mechanical, ingress, climatic and chemical, and electromagnetic (MICE) classification. Such tests are outside of the scope of IEC 60794 cable specifications, and MICE criteria are not part of the requirements for IEC 60794 specifications. The MICE tests may be the same as, similar to, or substantially different from, the tests required by IEC 60794 specifications. It is possible that cables manufactured per IEC 60794 specifications will meet MICE criteria, but it is also possible that they will not. For supplemental guidance, see IEC TR 62362.

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SOMMAIRE

AVANT-PROPOS	30
1 Domaine d'application	32
2 Références normatives	32
3 Termes et définitions	33
4 Construction	33
4.1 Généralités	33
4.2 Fibres optiques	34
4.3 Revêtement protecteur	34
4.4 Fibre renforcée	34
4.5 Jonc rainuré	34
4.6 Tube	34
4.7 Tube câblé	35
4.8 Structure en ruban	35
4.9 Renforts de traction et d'antiflambage	35
4.10 Fil de déchirement	35
4.11 Gaine	35
4.12 Marquage de la gaine	35
4.13 Identification	35
4.14 Exemples de construction de câble	36
5 Essais	36
5.1 Généralités	36
5.2 Dimensions	36
5.3 Exigences mécaniques	36
5.3.1 Performance en traction	36
5.3.2 Écrasement	37
5.3.3 Chocs	37
5.3.4 Pliage	37
5.3.5 Courbures répétées	37
5.3.6 Courbure sous traction	38
5.3.7 Courbure à basse température	38
5.3.8 Flexions	38
5.3.9 Torsion	38
5.3.10 Pliure du câble	38
5.4 Exigences environnementales – Cycles de température	38
5.5 Exigences de transmission	39
5.5.1 Généralités	39
5.5.2 Fibres optiques unimodales	39
5.5.3 Fibre optique unimodale à dispersion non décalée (B-652.B)	40
5.5.4 Fibre optique unimodale à dispersion non décalée (B-652.D)	40
5.5.5 Fibre optique unimodale (B-657.A)	40
5.5.6 Fibre optique unimodale (B-657.B)	41
5.5.7 Fibres optiques multimodales	41
5.5.8 Fibres optiques multimodales (A1-OM1 à A1-OM5)	41
5.6 Comportement au feu	41
Annexe A (informative) Exemples de construction de câble	42
Annexe B (informative) Spécification de famille pour câbles optiques multifibres – Spécification particulière-cadre et exigences minimales	46

B.1	Spécification particulière-cadre	46
B.1.1	Généralités	46
B.1.2	Description du câble	46
B.1.3	Élément de câble	47
B.1.4	Construction du câble	48
B.1.5	Conditions d'installation et d'exploitation	49
B.1.6	Essais mécaniques et environnementaux	49
B.2	Câbles soumis à la classification environnementale MICE (ISO/IEC 11801-1 et normes connexes).....	50
	Bibliographie.....	51
	Figure A.1 – Exemple de coupe transversale d'un câble composé de 12 fibres	42
	Figure A.2 – Exemple de coupe transversale d'un câble composé de 36 fibres	42
	Figure A.3 – Exemple de coupe transversale d'un câble d'éclatement composé de 6 fibres	43
	Figure A.4 – Exemple de coupe transversale d'un câble d'éclatement composé de 24 fibres	43
	Figure A.5 – Exemple de coupe transversale d'un câble intérieur de type à jonc rainuré avec rubans à 4 fibres	44
	Figure A.6 – Exemple de coupe transversale d'un câble intérieur de type à jonc rainuré SZ (disposition en hélices croisées) avec rubans à 2 fibres	44
	Figure A.7 – Exemple de coupe transversale d'un câble intérieur de type à jonc rainuré SZ (disposition en hélices croisées) avec faisceaux à 4 fibres	44
	Figure A.8 – Exemple de câble à tube unique multifibre	45
	Figure A.9 – Exemple de câble multifibre	45
	Figure A.10 – Exemple de câble (à micromodules) à gaine rétractable.....	45
	Tableau 1 – Dimensions des fibres avec revêtement protecteur	34
	Tableau 2 – Valeurs types pour les cycles de température.....	39
	Tableau 3 – Exigences communes aux fibres optiques unimodales.....	40
	Tableau 4 – Exigences d'affaiblissement des fibres câblées pour les fibres optiques B-652.B	40
	Tableau 5 – Exigences d'affaiblissement des fibres câblées pour les fibres optiques B-652.D	40
	Tableau 6 – Exigences d'affaiblissement des fibres câblées pour les fibres optiques B-657.A	40
	Tableau 7 – Exigences d'affaiblissement des fibres câblées pour les fibres optiques B-657.B	41
	Tableau 8 – Exigences communes aux fibres optiques multimodales	41
	Tableau 9 – Exigences d'affaiblissement des fibres câblées pour les fibres optiques A1-OM1 à A1-OM5	41
	Tableau B.1 – Description du câble.....	46
	Tableau B.2 – Élément de câble	47
	Tableau B.3 – Construction du câble	48
	Tableau B.4 – Conditions d'installation et conditions de fonctionnement	49
	Tableau B.5 – Essais applicables.....	49

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

CÂBLES À FIBRES OPTIQUES –

**Partie 2-20: Câbles intérieurs –
Spécification de famille pour les câbles optiques multifibres**

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L'IEC 60794-2-20 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 quatrième édition annule et remplace la troisième édition parue en 2013. 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) révision-mise à jour des paramètres et des exigences pour les essais mécaniques et les essais d'environnement, en conservant l'alignement avec les normes pertinentes supplémentaires de la série IEC 60794-2;
- c) ajout des exigences relatives à l'affaiblissement des fibres câblées;
- d) ajout d'exemples de conceptions de câble.

Le présent document est à utiliser conjointement avec l'IEC 60794-1-1:2023, l'IEC 60794-1-2:2021, l'IEC 60794-1-21:2015 associée à l'IEC 60794-1-21:2015/AMD: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/2431/FDIS	86A/2520/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*, se trouve sur le site Web de l'IEC.

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CÂBLES À FIBRES OPTIQUES –

Partie 2-20: Câbles intérieurs – Spécification de famille pour les câbles optiques multifibres

1 Domaine d'application

La présente partie de l'IEC 60794 est une spécification de famille qui couvre les câbles optiques multifibres pour utilisation intérieure. Les exigences de la spécification intermédiaire IEC 60794-2 sont applicables aux câbles couverts par le présent document. L'Annexe B contient une spécification particulière-cadre et des recommandations générales dans le cas où les câbles sont destinés à être utilisés dans des installations régies par la matrice MICE de l'ISO/IEC 11801-1.

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 60793-1-46, *Fibres optiques – Partie 1-46: Méthodes de mesure et procédures d'essai – Contrôle des variations du facteur de transmission optique*

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 60794-1-1:2023, *Câbles à fibres optiques – Partie 1-1: Spécification générique – Généralités*

IEC 60794-1-2:2021, *Câbles à fibres optiques – Partie 1-2: Spécification générique – Procédures fondamentales d'essais des câbles optiques – Recommandations générales*

IEC 60794-1-21:2015, *Câbles à fibres optiques – Partie 1-21: Spécification générique – Procédures fondamentales d'essais des câbles optiques – Méthodes d'essai mécanique*
IEC 60794-1-21:2015/AMD1:2020

IEC 60794-1-22:2017, *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 60794-1-23:2019, *Câbles à fibres optiques – Partie 1-23: Spécification générique – Procédures fondamentales d'essai des câbles optiques – Méthodes d'essai des éléments de câble*

IEC 60794-1-31, *Câbles à fibres optiques – Partie 1-31: Spécification générique – Éléments de câbles optiques – Rubans de fibres optiques*

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

IEC 60811-202, *Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux non-métalliques – Partie 202: Essais généraux – Mesure de l'épaisseur des gaines non métalliques*

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

Pour les besoins du présent document, les termes et les définitions de l'IEC 60794-1-1 s'appliquent.

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 considérations suivantes s'appliquent aux câbles multifibres intérieurs.

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 à la ou aux longueurs d'onde de fonctionnement des fibres optiques contenues dans le câble installé ne doit pas dépasser les valeurs spécifiées en 5.5. 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.

Les éléments optiques peuvent comprendre l'un des éléments de câble décrits de 4.3 à 4.8 ou dans l'IEC 60794-1-3.

Il ne doit pas y avoir d'épissures de fibre sur une longueur de livraison, sauf accord préalable 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

Des fibres optiques multimodales ou unimodales répondant aux exigences de l'IEC 60793-2-10, sous-catégories A1-OM1 à A1-OM5 ou de l'IEC 60793-2-50, catégories B-652 et B-657 doivent être utilisées. Le coefficient linéaire d'affaiblissement de la fibre optique et une discontinuité ponctuelle d'affaiblissement peut être affecté par le processus de fabrication du câble. Les valeurs maximales de ces caractéristiques optiques doivent être telles que spécifiées en 5.5.

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 avec 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 avec revêtement protecteur serré ou semi-serré en les entourant d'éléments de renforts non métalliques à l'intérieur d'une gaine en matériau approprié.

4.5 Jonc rainuré

Le jonc rainuré est obtenu en extrudant un matériau approprié avec un nombre défini d'encoches longitudinales, donnant lieu à une configuration en hélice ou une configuration SZ (disposition en hélices croisées) le long du cœur. Une ou plusieurs fibres avec revêtement primaire, ou des éléments optiques tels que des rubans ou des modules de fibres sont placés dans chaque encoche.

4.6 Tube

Une ou plusieurs fibres avec revêtement primaire ou revêtement protecteur, ou des rubans, sont conditionnés (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 pour fournir au module de fibres une certaine protection contre l'écrasement, ou bien souple, afin de faciliter la dénudabilité du tube sans outils spécialisés.

4.7 Tube câblé

Plusieurs tubes, contenant une ou plusieurs fibres avec revêtement primaire ou revêtement protecteur, ou des rubans, peuvent être:

- câblés autour d'un élément central;
- non câblés; ou
- des tubes optiques homogènes câblés utilisant des configurations en hélice ou en hélices croisées/SZ.

Dans le but de préserver la géométrie du câble, certains tubes peuvent être des éléments "de remplissage" ou "vides" ne contenant pas de fibres optiques.

4.8 Structure en ruban

Les structures en ruban doivent être conformes à l'IEC 60794-1-31. Les fibres doivent être disposées de manière à être parallèles et à former des rubans, les fibres restant parallèles sans se croiser.

Les structures en ruban collé partiellement permettent au ruban de fibres optiques d'être enroulé facilement et de s'insérer parfaitement dans les câbles. Sauf spécification contraire, chaque ruban doit être identifié de manière unique par un marquage imprimé ou une coloration de la fibre de référence et/ou du matériau matriciel du ruban.

4.9 Renforts de traction et d'antiflambage

Le câble doit être conçu avec des renforts de traction 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 spécifiées en 5.3.1.

Les renforts de traction et d'antiflambage peuvent être métalliques ou non métalliques, et peuvent être situés dans l'âme du câble, sous la gaine ou dans la gaine.

4.10 Fil de déchirement

Si cela est exigé, un filin de déchirement peut être placé sous la gaine.

4.11 Gaine

Le câble doit comporter une gaine de protection extérieure. Le diamètre du câble doit être stipulé dans la spécification particulière-cadre (ou la spécification de produit) applicable.

4.12 Marquage de la gaine

Si cela est exigé, le câble doit comporter le marquage comme convenu entre le client et le fournisseur. Le marquage peut comprendre des marques d'identification concernant le fabricant, les indices de résistance au feu, la longueur de la gaine, la date de fabrication, etc.

4.13 Identification

Les fibres optiques, les revêtements protecteurs et les gaines des sous-unités doivent être facilement identifiables; leur identification doit être unique et utiliser un code de couleur approprié conformément à l'IEC 60304 et/ou un système de numérotation facilement visible qui doit faire l'objet d'un accord entre le client et le fournisseur.

4.14 Exemples de construction de câble

Des exemples de certains types de constructions de câbles sont représentés à l'Annexe A. D'autres configurations (par exemple les constructions multicouches) ne sont pas exclues si elles satisfont aux exigences mécaniques, d'environnement et de transmission du présent document.

5 Essais

5.1 Généralités

La conformité aux exigences de la spécification particulière applicable doit être vérifiée en effectuant les essais choisis de 5.2 à 5.6. Il n'est pas prévu de réaliser tous les essais; 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 les performances en fin de vie.

L'affaiblissement des fibres câblées doit être tel que spécifié en 5.5.

Les mesures d'affaiblissement doivent être effectuées conformément à l'IEC 60793-1-40. Les mesures de variation d'affaiblissement doivent être effectuées conformément à l'IEC 60793-1-46.

NOTE La longueur d'onde optimisée pour les sous-catégories de fibres multimodales A1-OM3 et A1-OM4 est 850 nm et pour les fibres A1-OM5, la ou les longueurs d'onde opérationnelles cibles sont comprises entre 850 nm et 950 nm.

5.2 Dimensions

Les dimensions et tolérances des fibres doivent être vérifiées conformément à la méthode d'essai spécifiée dans l'IEC 60793-1-20 ou de l'IEC 60793-1-21. Le diamètre du revêtement protecteur et du câble, ainsi que l'épaisseur de la gaine, doivent être mesurés conformément aux méthodes de l'IEC 60811-202 et l'IEC 60811-203.

5.3 Exigences mécaniques

5.3.1 Performance en traction

Méthode:	IEC 60794-1-21, Méthode E1
Diamètre des tambours de blocage et des dispositifs de transfert:	pas inférieur au diamètre minimal de courbure spécifié pour le câble sous charge
Vitesse du dispositif de transfert:	100 mm/min ou 100 N/min
Charge et durée:	400 N ou $9,8 \times$ la masse de 1 km de câble, en retenant la valeur la plus élevée, et pendant au moins 10 min
Longueur de l'échantillon:	≥ 50 m et suffisante pour obtenir la précision désirée pour la mesure de la variation de l'affaiblissement
Exigences:	il ne doit y avoir aucune variation d'affaiblissement après l'essai, les éléments du câble ne doivent présenter aucun dommage visible

La contrainte sur la fibre doit être inférieure à 60 % du niveau de l'essai de sélection de la fibre.

Pour certaines applications spécifiant la classification MICE de l'ISO/IEC 11801-1 et des normes connexes, des valeurs de charge et de durée différentes peuvent faire l'objet d'un accord entre le client et le fournisseur.

Pour les câbles à nombre de fibres exceptionnellement élevé, des valeurs de charge différentes peuvent faire l'objet d'un accord entre le client et le fournisseur.

5.3.2 Écrasement

Méthode:	IEC 60794-1-21, Méthode E3A
Force appliquée totale (court terme):	500 N
Durée d'application de la force:	1 min
Nombre d'essais:	3
Espacement entre les emplacements d'essai:	500 mm
Exigences:	il ne doit y avoir aucune variation d'affaiblissement pendant l'essai en fonctionnement et après l'essai d'installation; les éléments du câble ne doivent présenter aucun dommage visible

NOTE Pour certaines applications spécifiant la classification MICE de l'ISO/IEC 11801-1 et des normes connexes, des valeurs de force différentes peuvent faire l'objet d'un accord entre le client et le fournisseur.

5.3.3 Chocs

Méthode:	IEC 60794-1-21, Méthode E4
Rayon de la surface de frappe:	300 mm
Énergie 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 Pour certaines applications spécifiant la classification MICE de l'ISO/IEC 11801-1 et des normes connexes, les valeurs d'énergie de choc peuvent faire l'objet d'un accord entre le client et le fournisseur.

5.3.4 Pliage

Méthode:	IEC 60794-1-21, Méthode E11A
Diamètre du mandrin:	20 fois le diamètre du câble
Nombre de tours:	6
Nombre de cycles:	10
Exigences:	pas de rupture de fibre

NOTE Pour certaines applications spécifiant la classification MICE de l'ISO/IEC 11801-1 et des normes connexes, des valeurs de diamètre de mandrin différentes peuvent faire l'objet d'un accord entre le client et le fournisseur.

5.3.5 Courbures répétées

Méthode:	IEC 60794-1-21, Méthode E6
Rayon de courbure:	20 fois le diamètre du câble
Nombre de cycles:	25
Masse des poids:	suffisante pour réduire le plus possible la flèche ou la courbure de l'échantillon, généralement 4 kg
Exigences:	un examen visuel sans agrandissement ne doit révéler aucun dommage sur la gaine et sur les éléments du câble