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INTERNATIONAL STANDARD

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

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OPTICAL FIBRE CABLES –

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

FOREWORD

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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

- 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 24702 (Industrial premises) [11]~~[1] 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*

~~[1] 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, *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 60794-3:2001~~ 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 ± 5) °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 × 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.