



BSI Standards Publication

Optical fibres

Part 2-10: Product specifications — Sectional
specification for category A1 multimode fibres

National foreword

This British Standard is the UK implementation of EN IEC 60793-2-10:2019+A1:2022. It is identical to IEC 60793-2-10:2019, incorporating amendment 1:2022. It supersedes BS EN IEC 60793-2-10:2019, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted to Technical Committee GEL/86/1, Optical fibres and cables.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

Optical fibres - Part 2-10: Product specifications - Sectional
specification for category A1 multimode fibres
(IEC 60793-2-10:2019)

Fibres optiques - Partie 2-10: Spécifications de produits -
Spécification intermédiaire pour les fibres multimodales de
catégorie A1
(IEC 60793-2-10:2019)

Lichtwellenleiter - Teil 2-10: Produktspezifikationen -
Rahmenspezifikation für Mehrmodenfasern der Kategorie
A1
(IEC 60793-2-10:2019)

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Comité Européen de Normalisation Electrotechnique
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European foreword

The text of document 86A/1932/FDIS, future edition 7 of IEC 60793-2-10, prepared by SC 86A "Fibres and cables" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60793-2-10:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-03-26
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-06-26

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61280-1-3	NOTE	Harmonized as EN 61280-1-3
IEC 61280-1-4	NOTE	Harmonized as EN 61280-1-4
IEC 60793-2-10:2017	NOTE	Harmonized as EN 60793-2-10:2017 (not modified)
IEC 60794-1-1	NOTE	Harmonized as EN 60794-1-1

European foreword to amendment A1

The text of document 86A/2121/CDV, future IEC 60793-2-10/AMD1, prepared by SC 86A "Fibres and cables" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60793-2-10:2019/A1:2022.

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-03-03

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Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-1-20	-	Optical fibres - Part 1-20: Measurement methods and test procedures - Fibre geometry	EN 60793-1-20	-
IEC 60793-1-21	-	Optical fibres - Part 1-21: Measurement methods and test procedures - Coating geometry	EN 60793-1-21	-
IEC 60793-1-22	-	Optical fibres - Part 1-22: Measurement methods and test procedures - Length measurement	EN 60793-1-22	-
IEC 60793-1-30	-	Optical fibres - Part 1-30: Measurement methods and test procedures - Fibre proof test	EN 60793-1-30	-
IEC 60793-1-31	-	Optical fibres - Part 1-31: Measurement methods and test procedures - Tensile strength	EN IEC 60793-1-31	-
IEC 60793-1-32	-	Optical fibres - Part 1-32: Measurement methods and test procedures - Coating strippability	EN IEC 60793-1-32	-
IEC 60793-1-33	-	Optical fibres - Part 1-33: Measurement methods and test procedures - Stress corrosion susceptibility	EN 60793-1-33	-
IEC 60793-1-40	-	Optical fibres - Part 1-40: Attenuation measurement methods	EN IEC 60793-1-40	-
IEC 60793-1-41	-	Optical fibres - Part 1-41: Measurement methods and test procedures - Bandwidth	EN 60793-1-41	-
IEC 60793-1-42	-	Optical fibres - Part 1-42: Measurement methods and test procedures - Chromatic dispersion	EN 60793-1-42	-
IEC 60793-1-43	-	Optical fibres - Part 1-43: Measurement methods and test procedures - Numerical aperture measurement	EN 60793-1-43	-
IEC 60793-1-46	-	Optical fibres - Part 1-46: Measurement methods and test procedures - Monitoring of changes in optical transmittance	EN 60793-1-46	-
IEC 60793-1-47	-	Optical fibres - Part 1-47: Measurement methods and test procedures - Macrobending loss	EN IEC 60793-1-47	-

EN IEC 60793-2-10:2019+A1:2022 (E)

IEC 60793-1-49	-	Optical fibres - Part 1-49: Measurement methods and test procedures - Differential mode delay	EN IEC 60793-1-49	-
IEC 60793-1-50	-	Optical fibres - Part 1-50: Measurement methods and test procedures - Damp heat (steady state) tests	EN 60793-1-50	-
IEC 60793-1-51	-	Optical fibres - Part 1-51: Measurement methods and test procedures - Dry heat (steady state) tests	EN 60793-1-51	-
IEC 60793-1-52	-	Optical fibres - Part 1-52: Measurement methods and test procedures - Change of temperature tests	EN 60793-1-52	-
IEC 60793-1-53	-	Optical fibres - Part 1-53: Measurement methods and test procedures - Water immersion tests	EN 60793-1-53	-
IEC 60793-2	-	Optical fibres - Part 2: Product specifications - General	EN 60793-2	-
IEC 61280-4-1	2009	Fibre-optic communication subsystem test procedures - Part 4-1: Installed cable plant - Multimode attenuation measurement	EN 61280-4-1	2009

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRES –

Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres

FOREWORD

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International Standard IEC 60793-2-10 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This seventh edition cancels and replaces the sixth edition published in 2017. This edition constitutes a technical revision.

This edition includes the following significant change with respect to the previous edition: revision of the naming convention for A1 multimode fibres, which better matches with those found in ISO/IEC standards. These changes are outlined in the scope of this document along with a cross reference table for the new names.

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

FDIS	Report on voting
86A/1932/FDIS	86A/1939/RVD

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

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

A list of all parts in the IEC 60793 series, published under the general title *Optical fibres*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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OPTICAL FIBRES –

Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres

1 Scope

This part of IEC 60793 is applicable to optical fibre sub-categories A1-OM1, A1-OM2, A1-OM3, A1-OM4, A1-OM5, and A1d. These fibres are used or can be incorporated in information transmission equipment and optical fibre cables.

Sub-categories A1-OM2, A1-OM3, A1-OM4 and A1-OM5 apply to 50/125 μm graded index fibre in four bandwidth grades. Each of these bandwidth grades is defined for two levels of macrobend loss performance that are distinguished by "a" or "b" suffix. Those sub-categories with suffix "a" are specified to meet traditional macrobend loss performance levels. Those sub-categories with suffix "b" are specified to meet enhanced macrobend loss (i.e. lower loss) performance levels.

Sub-category A1-OM5 is specified to support single wavelength or multi-wavelength transmission systems in the vicinity of 850 nm to 950 nm. Although not normatively specified, bandwidth information covering this wavelength range is also included for A1-OM3 and A1-OM4.

Sub-category A1-OM1 applies to 62,5/125 μm graded index fibre and sub-category A1d applies to 100/140 μm graded index fibre.

Other applications include, but are not restricted to, the following: short reach, high bit-rate systems in telephony, distribution and local networks carrying data, voice and/or video services; on-premises intra-building and inter-building fibre installations including data centres, local area networks (LANs), storage area networks (SANs), private branch exchanges (PBXs), video, various multiplexing uses, outside telephone cable plant use, and miscellaneous related uses.

Three types of requirements apply to these fibres:

- general requirements, as defined in IEC 60793-2;
- specific requirements common to the category A1 multimode fibres covered in this document and which are given in Clause 5;
- particular requirements applicable to individual fibre sub-categories and models, or specific applications, which are defined in the normative specification Annexes A to D.

Table 1 shows the cross reference between the IEC A1 multimode optical fibre designations used in this document compared to those used in IEC 60793-2-10:2017. The table also refers to the normative annexes A, B and C for the A1 sub-category multimode fibres in this document that contains the detailed specification.

Table 1 – Cross reference IEC A1 multimode fibre designations to IEC 60793-2-10:2017

Annex	Sub-category	Sub-category/Model	Core diameter (nominal)	ISO/IEC 11801-1:2017
	This document designations	IEC 60793-2-10:2017 designations		Usage of cabled OMx fibres
A	A1-OM2	A1a.1	50 µm ^a	OM2 ^b
	A1-OM3	A1a.2	50 µm	OM3
	A1-OM4	A1a.3	50 µm	OM4
	A1-OM5	A1a.4	50 µm	OM5
B	A1-OM1	A1b	62,5 µm ^c	OM1 ^d
C	A1d	A1d	100 µm	-
^a Historically, ISO/IEC 11801:2002 also defined OM2 cables made with 62,5/125 µm fibres having a minimum overfilled launch bandwidth of 500 MHz·km at 850 nm and 500 MHz·km at 1 300 nm. This specific bandwidth combination of 62,5/125 µm fibre is not part of this document. ^b OM2 cables are not supported for new installations within ISO/IEC 11801-1:2017. ^c Historically, ISO/IEC 11801:2002 also defined OM1 cables made with 50/125 µm fibres having a minimum overfilled launch bandwidth of 200 MHz·km at 850 nm and 500 MHz·km at 1 300 nm. This specific bandwidth combination of 50/125 µm fibre is not part of this document. ^d OM1 cables are not supported for new installations within ISO/IEC 11801-1:2017.				

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

IEC 60793-1-22, *Optical fibres – Part 1-22: Measurement methods and test procedures – Length measurement*

IEC 60793-1-30, *Optical fibres – Part 1-30: Measurement methods and test procedures – Fibre proof test*

IEC 60793-1-31, *Optical fibres – Part 1-31: Measurement methods and test procedures – Tensile strength*

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

IEC 60793-1-33, *Optical fibres – Part 1-33: Measurement methods and test procedures – Stress corrosion susceptibility*

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

IEC 60793-1-41, *Optical fibres – Part 1-41: Measurement methods and test procedures – Bandwidth*

IEC 60793-1-42, *Optical fibres – Part 1-42: Measurement methods and test procedures – Chromatic dispersion*

IEC 60793-1-43, *Optical fibres – Part 1-43: Measurement methods and test procedures – Numerical aperture measurement*

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

IEC 60793-1-47, *Optical fibres – Part 1-47: Measurement methods and test procedures – Macrobending loss*

IEC 60793-1-49, *Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay*

IEC 60793-1-50, *Optical fibres – Part 1-50: Measurement methods and test procedures – Damp heat (steady state) tests*

IEC 60793-1-51, *Optical fibres – Part 1-51: Measurement methods and test procedures – Dry heat (steady state) tests*

IEC 60793-1-52, *Optical fibres – Part 1-52: Measurement methods and test procedures – Change of temperature tests*

IEC 60793-1-53, *Optical fibres – Part 1-53: Measurement methods and test procedures – Water immersion tests*

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

IEC 61280-4-1:2009, *Fibre-optic communication subsystem test procedures – Part 4-1: Installed cable plant – Multimode attenuation measurement*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

4 Abbreviated terms

CPR	coupled power ratio
DMD	differential mode delay
EF	encircled flux
EMB	effective modal bandwidth
EMB _c	calculated effective modal bandwidth
LAN	local area network
MMF	multimode fibre
NA	numerical aperture
OFL	overfilled launch
OMB _c	overfilled launch modal bandwidth calculated from differential mode delay (also known as OFL _c)
PBX	private branch exchange
PMD	physical medium dependent
ROFL	radial overfilled launch
SAN	storage area network

5 Specifications

5.1 General

The fibre consists of a glass core with a graded index profile and a glass cladding in accordance with IEC 60793-2.

The term "glass" usually refers to material consisting of non-metallic oxides.

5.2 Dimensional requirements

Dimensional attributes and measurement methods are given in Table 2.

Requirements common to all fibres in category A1 are indicated in Table 3.

Table 4 lists additional attributes that shall be specified by each sub-category specification.

Table 2 – Dimensional attributes and measurement methods

Attributes	Measurement methods
Cladding diameter	IEC 60793-1-20
Core diameter ^{a, b}	IEC 60793-1-20
Cladding non-circularity	IEC 60793-1-20
Core non-circularity	IEC 60793-1-20
Core-cladding concentricity error	IEC 60793-1-20
Primary coating diameter	IEC 60793-1-21
Primary coating non-circularity	IEC 60793-1-21
Primary coating-cladding concentricity error	IEC 60793-1-21
Fibre length	IEC 60793-1-22
^a Core diameter is specified at $850 \text{ nm} \pm 10 \text{ nm}$ with a test specimen length of $2,0 \text{ m} \pm 0,2 \text{ m}$ and a threshold value, k_{CORE} , of 0,025 for A1 fibres except A1-OM2b, A1-OM3b, A1-OM4b, A1-OM5b fibres. ^b Core diameter is specified at $850 \text{ nm} \pm 10 \text{ nm}$ with a test specimen length of $100 \text{ m} \pm 5 \%$ and a threshold value, k_{CORE} , of 0,025 for A1-OM2b, A1-OM3b, A1-OM4b, A1-OM5b fibres.	

Table 3 – Dimensional requirements common to category A1 fibres

Attributes	Unit	Limits
Core non-circularity	%	≤ 6
Primary coating diameter – uncoloured ^a	μm	245 ± 10
Primary coating diameter – coloured ^a	μm	250 ± 15
Primary coating-cladding concentricity error	μm	$\leq 12,5$
Fibre length	km	^b
^a The limits on primary coating diameter are most commonly used in telecommunications cables. There are other applications, which use other primary coating diameters, several of which are listed below. Alternative nominal primary coating diameters and tolerance (μm): 400 ± 40 500 ± 50 700 ± 100 900 ± 100 ^b Length requirements vary and should be agreed between supplier and customer.		

Table 4 – Additional dimensional attributes required in sub-category specifications

Attributes
Cladding diameter
Cladding non-circularity
Core diameter
Core-cladding concentricity error

5.3 Mechanical requirements

Mechanical attributes and measurement methods are given in Table 5.

Requirements common to all fibres in category A1 are in Table 6.

Table 5 – Mechanical attributes and measurement methods

Attributes	Test methods
Proof test	IEC 60793-1-30
Tensile strength	IEC 60793-1-31
Primary coating strippability	IEC 60793-1-32
Stress corrosion susceptibility	IEC 60793-1-33

Table 6 – Mechanical requirements common to category A1 fibres

Attributes	Unit	Limits
Proof stress level	GPa	$\geq 0,69^a$
Average strip force ^b	N	$1,0 \leq F_{\text{avg}} \leq 5,0$
Peak strip force ^b	N	$1,0 \leq F_{\text{peak}} \leq 8,9$
Tensile strength (median) for 0,5 m specimen length	GPa	$\geq 3,8$
Stress corrosion susceptibility constant, n_d	-	≥ 18
^a The proof test value of 0,69 GPa equals about 1 % strain or about 8,8 N force, for A1-OM1 to A1-OM5 fibres. For the relation between these different units, see IEC TR 62048:2014, 8.4. ^b Either average strip force or peak strip force, which are defined in the test procedure, may be specified by agreement between supplier and customer.		

5.4 Transmission requirements

Transmission attributes and measurement methods are given in Table 7.

Table 8 lists additional attributes that shall be specified by each sub-category specification.

Table 7 – Transmission attributes and measurement methods

Attributes	Measurement methods
Attenuation coefficient	IEC 60793-1-40
Modal bandwidth ^{a,b}	IEC 60793-1-41
Numerical aperture ^{c,d}	IEC 60793-1-43
Chromatic dispersion	IEC 60793-1-42
Change of optical transmission	IEC 60793-1-46
Macrobending loss	IEC 60793-1-47
Differential mode delay ^e	IEC 60793-1-49
<p>^a For modal bandwidth, either overfilled launch (OFL) or overfilled launch modal bandwidth calculated from differential mode delay (OMB_c) can be used. OMB_c is the reference test method for A1-OM2, A1-OM3 and A1-OM4 fibres at 850 nm and is the required method for A1-OM5 fibres at 850 nm and 953 nm.</p> <p>^b 850 nm modal bandwidth is specified with a test specimen length of 1 000 m ± 5 % for A1-OM3 to A1-OM5 fibres. For A1-OM3 fibres, the 850 nm modal bandwidth is measured at 850 nm ± 10 nm. For A1-OM4 and A1-OM5 fibres, the 850 nm modal bandwidth is measured at 850 nm ± 2 nm. For A1-OM5 fibre, the modal bandwidth is also measured at 953 nm ± 6 nm.</p> <p>^c Numerical aperture is specified at 850 nm ± 10 nm with a test specimen length of 2 m ± 0,2 m and a threshold value, k_{NA}, of 0,05 for A1 fibres except A1-OM2b, A1-OM3b, A1-OM4b, A1-OM5b fibres.</p> <p>^d Numerical aperture is specified at 850 nm ± 10 nm with a test specimen length of 100 m ± 5 % and a threshold value, k_{NA}, of 0,05 for A1-OM2b, A1-OM3b, A1-OM4b and A1-OM5b fibres.</p> <p>^e Differential mode delay is specified with a test specimen length of 1 000 m ± 5 % for A1-OM3, A1-OM4 and A1-OM5 fibres. For A1-OM3 fibres, the DMD is measured at 850 nm ± 10 nm. For A1-OM4 and A1-OM5 fibres, the DMD is measured at 850 nm ± 2 nm. For A1-OM5 fibre, the DMD is also measured at 953 nm ± 6 nm.</p>	

Specification compliance of chromatic dispersion can be assured by compliance to the numerical aperture (NA) specification for A1 fibre.

Table 8 – Additional transmission attributes required in sub-category specifications

Attributes
Attenuation coefficient
Modal bandwidth
Chromatic dispersion
Numerical aperture
Macrobending loss

For attenuation coefficient and modal bandwidth, the sub-category specifications may contain ranges of specifiable values instead of fixed limits. In this case, the actual values of the maximum attenuation coefficient and minimum modal bandwidth, at both 850 nm and 1 300 nm (or just at one of these wavelengths) shall be agreed between supplier and customer. For commercial purposes, the modal bandwidth is linearly normalized to 1 km.

For guidance purposes, Annex H shows a number of standardised applications supported by A1 fibres and Annex I shows transmission capabilities for these fibres.

The indicated maximum attenuation coefficients apply to uncabled optical fibres; for the maximum cabled attenuation coefficients, reference is made to IEC 60794-1-1, which can be used in conjunction with this document. Tighter specifications for the fibre may be requested to account for added attenuation in the cabling process.

Remarks on the specification of modal bandwidth: