

INTERNATIONAL STANDARD

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

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

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OPTICAL FIBRES –

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

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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 sixth edition cancels and replaces the fifth edition published in 2015. This edition constitutes a technical revision.

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

- a) addition of model A1a.4 fibre which supports single wavelength or multi-wavelength transmission systems in the vicinity of 850 nm to 950 nm.

The text of this standard is based on the following documents:

CDV	Report on voting
86A/1771/CDV	86A/1794/RVC

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

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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 A1a, A1b, and A1d. These fibres are used or can be incorporated in information transmission equipment and optical fibre cables.

Sub-category A1a applies to 50/125 μm graded index fibre. Four bandwidth grades are defined as models A1a.1, A1a.2, A1a.3 and A1a.4. Each of these bandwidth grades is defined for two levels of macrobend loss performance that are distinguished by "a" or "b" suffix. Those models with suffix "a" are specified to meet traditional macrobend loss performance levels. Those models with suffix "b" are specified to meet enhanced macrobend loss (i.e. lower loss) performance levels. Model A1a.4 supports single wavelength or multi-wavelength transmission systems in the vicinity of 850 nm to 950 nm.

Sub-category A1b 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.

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 60793-1-34, *Optical fibres – Part 1-34: Measurement methods and test procedures – Fibre curl*

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 60793-2:2015, *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, 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 60793-2:2015, 5.1.

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 1.

Requirements common to all fibres in category A1 are indicated in Table 2.

Table 3 lists additional attributes that shall be specified by each sub-category specification.

Table 1 – 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 nm ± 10 nm with a test specimen length of 2,0 m ± 0,2 m and a threshold value, k_{CORE} , of 0,025 for A1 fibres except A1a.1b/2b/3b/4b fibres.	
^b Core diameter is specified at 850 nm ± 10 nm with a test specimen length of 100 m ± 5 % and a threshold value, k_{CORE} , of 0,025 for A1a.1b/2b/3b/4b fibres.	

Table 2 – 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	≤ 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 3 – 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 4.

Requirements common to all fibres in category A1 are in Table 5.

Table 4 – 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
Fibre curl	IEC 60793-1-34

Table 5 – Mechanical requirements common to category A1 fibres

Attributes	Unit	Limits
Proof stress level	GPa	$\geq 0,69^a$
Average strip force ^b	N	$1,0 \leq F_{avg} \leq 5,0$
Peak strip force ^b	N	$1,0 \leq F_{peak} \leq 8,9$
Tensile strength (median) for 0,5 m specimen length	GPa	$\geq 3,8$
Stress corrosion susceptibility constant	n_d	≥ 18
<p>^a The proof test value of 0,69 GPa equals about 1 % strain or about 8,8 N force, for A1a and A1b fibres. For the relation between these different units, see IEC TR 62048.</p> <p>^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.</p>		

5.4 Transmission requirements

Transmission attributes and measurement methods are given in Table 6.

Table 7 lists additional attributes that shall be specified by each sub-category specification.

Table 6 – 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 A1a.1/2/3 fibres at 850 nm and is the required method for A1a.4 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 \pm 5 % for A1a.2/3/4 fibres. For A1a.2 fibres, the 850 nm modal bandwidth is measured at 850 nm \pm 10 nm. For A1a.3 and A1a.4 fibres, the 850 nm modal bandwidth is measured at 850 nm \pm 2 nm. For A1a.4 fibre, the modal bandwidth is also measured at 953 nm \pm 6 nm.</p> <p>^c Numerical aperture is specified at 850 nm \pm 10 nm with a test specimen length of 2 m \pm 0,2 m and a threshold value, k_{NA}, of 0,05 for A1 fibres except A1a.1b/2b/3b/4b fibres.</p> <p>^d Numerical aperture is specified at 850 nm \pm 10 nm with a test specimen length of 100 m \pm 5 % and a threshold value, k_{NA}, of 0,05 for A1a.1b/2b/3b/4b fibres.</p> <p>^e Differential mode delay is specified with a test specimen length of 1 000 m \pm 5 % for A1a.2/3/4 fibres. For A1a.2 fibres, the DMD is measured at 850 nm \pm 10 nm. For A1a.3 and A1a.4 fibres, the DMD is measured at 850 nm \pm 2 nm. For A1a.4 fibre, the DMD is also measured at 953 nm \pm 6 nm.</p>	

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

Table 7 – 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) are to be agreed between supplier and customer. For commercial purposes, the modal bandwidth is linearly normalized to 1 km.

For guidance purposes, Table H.1 shows a number of standardised applications supported by A1 fibres, and Table H.2 provides a cross reference between the cabled optical fibre categories of ISO/IEC 11801-1¹ and fibre sub-categories A1a and A1b of this document.

The indicated maximum attenuation values apply to uncabled optical fibres; for the maximum cabled attenuation values, reference is made to IEC 60794-1-1, which can be used in conjunction with this document.

Remarks on the specification of modal bandwidth.

Care should be taken in writing dual wavelength bandwidth specifications. It is understood that for category A1 fibres, the bandwidth at 850 nm may be related to the bandwidth at 1 300 nm in a way shown in Figure 1, depending on the refractive index parameter, g , (see IEC 60793-2:2015, 5.1). See [26]², page 50, and [27], page 255, for similar figures. The shaded region under the curve of Figure 1 can be defined as the dual window area. In this area, regions X, Y, and Z are examples of where a fibre manufacturer may choose to optimise the process. That is, centre the production bandwidth peak at 850 nm, 1 300 nm, or between these two wavelengths.

Due to this optimisation of the manufacturing process, there will be combinations of bandwidth that are not possible (i.e., outside the shaded region).

¹ Under preparation. Stage at the time of publication: ISO/IEC RFDIS 11801-1:2017.

² Numbers in square brackets refer to the Bibliography.