

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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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.180.10

ISBN 978-2-8322-3006-0

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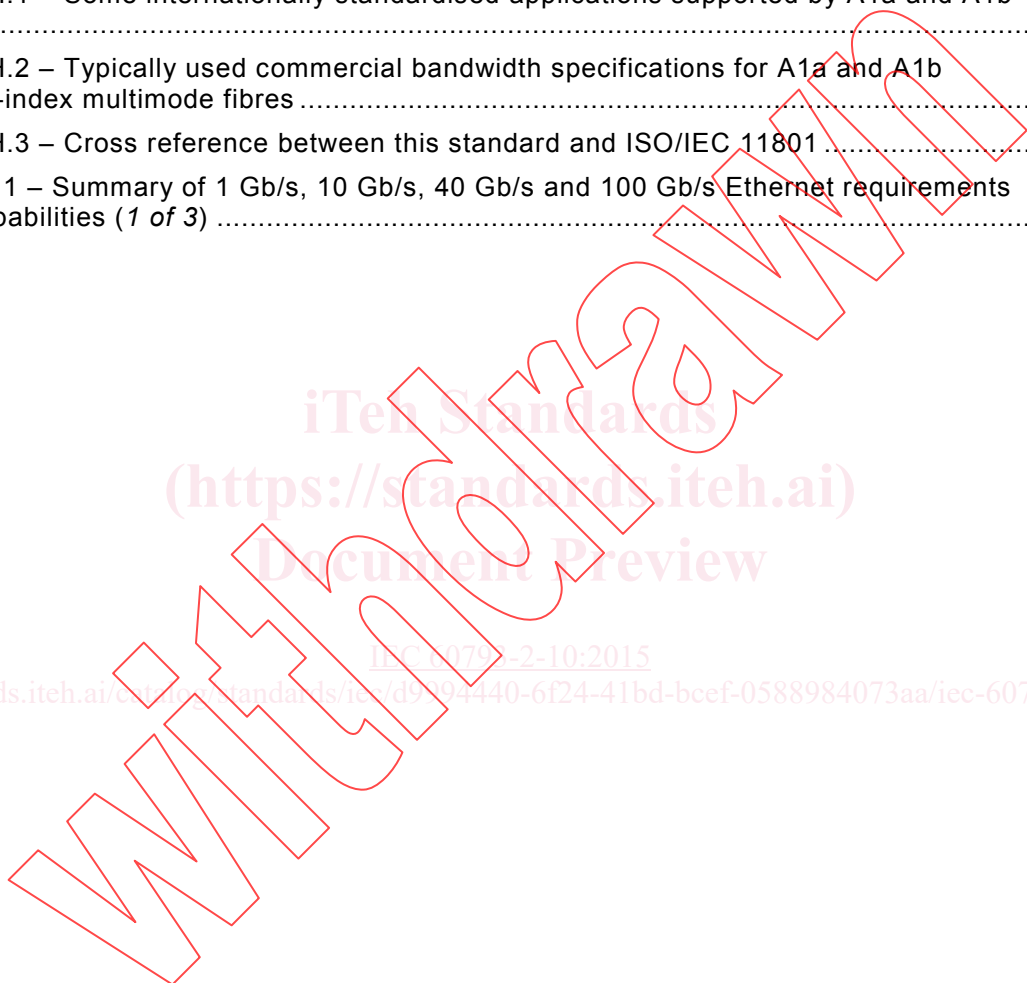
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OPTICAL FIBRES –

**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 fifth edition cancels and replaces the fourth edition published in 2011. This edition constitutes a technical revision.

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

- a) addition of enhanced macrobending multimode fibres A1a.1b, A1a.2b and A1a.3b;
- b) inclusion of the specified test wavelength and specimen length for core diameter (CD), numerical aperture (NA), differential mode delay (DMD) and threshold values for CD and NA;
- c) addition of a specimen length for 850 nm bandwidth of A1a and A1b fibres.

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

CDV	Report on voting
86A/1631/CDV	86A/1664/RVC

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

This publication 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.

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

Type A1a applies to 50/125 μm graded index fibre. Three bandwidth grades are defined as A1a.1, A1a.2 and A1a.3. Each of these bandwidth grades is defined for two levels of macrobend loss performance that are distinguished by “a” or “b” suffix. Those with suffix “a” are specified to meet traditional macrobend loss performance levels. Those with suffix “b” are specified to meet enhanced macrobend loss (i.e. lower loss) performance levels.

Type A1b applies to 62,5/125 μm graded index fibre and 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 standard and which are given in Clause 3;
- particular requirements applicable to individual fibre types or specific applications, which are defined in the normative family specification annexes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 (all parts), *Optical fibres – Part 1: Measurement methods and test procedures*

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 60793-2:2011, *Optical fibres – Part 2: Product specifications – General*

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

IEC TR 61931, *Fibre optic – Terminology*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60793-2, the IEC 60793-1 series and IEC 61931 apply.

3.2 Abbreviations

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

4 Specifications

NOTE 1 The fibre consists of a glass core with a graded index profile and a glass cladding in accordance with IEC 60793-2:2011, 5.1.

NOTE 2 The term “glass” usually refers to material consisting of non-metallic oxides.

4.1 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 family specification.

Table 1 – Dimensional attributes and measurement methods

Attribute	Measurement method
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 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 fibres.	

Table 2 – Dimensional requirements common to category A1 fibres

Attribute	Unit	Limit
Core non-circularity	%	≤ 6
Primary coating diameter – uncoloured ^b	µm	245 ± 10
Primary coating diameter – coloured ^b	µm	250 ± 15
Primary coating-cladding concentricity error	µm	≤ 12,5
Fibre length	km	^a
^a Length requirements vary and should be agreed between supplier and customer. ^b The above 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		

Table 3 – Additional dimensional attributes required in family specifications

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

4.2 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

Attribute	Test method
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

Attribute	Unit	Limit
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 0,5m 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>		

4.3 Transmission requirements

Transmission attributes and measurement methods are given in Table 6.

Table 7 lists additional attributes that shall be specified by each family specification.

Table 6 – Transmission attributes and measurement methods

Attribute	Measurement method
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 (OMBc) can be used. OMBc is the reference test method for A1a fibres at 850 nm.</p> <p>^b 850 nm modal bandwidth is specified at 850 nm ± 10 nm with a test specimen length of 1 000 m ± 5 % for A1a fibres.</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 A1a.1b/2b/3b 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 A1a.1b/2b/3b fibres.</p> <p>^e Differential mode delay is specified at 850 nm ± 10 nm with a test specimen length of 1 000 m ± 5 % for A1a fibres.</p>	

Specification compliance of chromatic dispersion can be assured by compliance to the numerical aperture specification.

Table 7 – Additional transmission attributes required in family specifications

Attribute
Attenuation coefficient
Modal bandwidth
Chromatic dispersion
Numerical aperture
Macrobending loss

For attenuation coefficient and modal bandwidth, the family specification contains ranges of specifiable values instead of fixed limits. 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 on bandwidth, Table H.1 shows a number of internationally standardised applications supported by A1 fibres, and Table H.2 gives a (limited) number of frequently used commercial bandwidth specifications for A1a and A1b fibres.

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 standard.

Remarks on the specification of modal bandwidth:

Care should be taken in writing dual wavelength bandwidth specifications. For category A1 fibres, the bandwidth at 850 nm may be related to the bandwidth at 1 300 nm in a way shown