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2007-06

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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CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Specifications.....	7
3.1 Dimensional requirements	7
3.2 Mechanical requirements.....	9
3.3 Transmission requirements	9
3.4 Environmental requirements.....	11
3.4.1 Mechanical environmental requirements (common to all fibres in category A1).....	12
3.4.2 Transmission environmental requirements.....	12
Annex A (normative) Family specifications for A1a multimode fibres.....	14
Annex B (normative) Family specifications for A1b multimode fibres.....	16
Annex C (normative) Family specifications for A1d multimode fibres.....	18
Annex D (normative) Transmitter centre wavelength and encircled flux (EF), fibre differential mode delay (DMD) and calculated effective modal bandwidth (EMBc) requirements.....	20
Annex E (informative) Applications supported by A1 fibres.....	25
Annex F (informative) 1-Gigabit and 10-Gigabit Ethernet applications.....	29
Annex G (informative) Preliminary indications for items needing further study.....	31
Bibliography.....	33
Figure 1 – Relation between bandwidths at 850 nm and 1 300 nm	11
Figure D.1 – DMD requirements.....	21
Table 1 – Dimensional attributes and measurement methods.....	8
Table 2 – Requirements common to category A1 fibres.....	8
Table 3 – Additional attributes required in the family specifications.....	8
Table 4 – Mechanical attributes and measurement methods	9
Table 5 – Requirements common to category A1 fibres.....	9
Table 6 – Transmission attributes and measurement methods	9
Table 7 – Additional attributes required in family specifications.....	10
Table 8 – Environmental exposure tests	11
Table 9 – Attributes measured	11
Table 10 – Strip force for environmental tests.....	12
Table 11 – Tensile strength for environmental tests	12
Table 12 – Stress corrosion susceptibility for environmental tests.....	12
Table 13 – Change in attenuation for environmental tests.....	13
Table A.1 – Dimensional requirements specific to A1a fibres	14

Table A.2 – Mechanical requirements specific to A1a fibres.....	14
Table A.3 – Transmission requirements specific to A1a fibres.....	15
Table B.1 – Dimensional requirements specific to A1b fibres	16
Table B.2 – Mechanical requirements specific to A1b fibres.....	16
Table B.3 – Transmission requirements specific to A1b fibres.....	17
Table C.1 – Dimensional requirements specific to A1d fibres	18
Table C.2 – Mechanical requirements specific to A1d fibres.....	18
Table C.3 – Transmission requirements specific to A1d fibres	19
Table D.1 – DMD templates	21
Table D.2 – DMD interval masks.....	22
Table D.3 – DMD weightings.....	24
Table E.1 – Some internationally standardised applications supported by A1a and A1b fibres	25
Table E.2 – Typically used commercial bandwidth specifications for A1a and A1b graded-index multimode fibres.....	26
Table E.3 – Cross reference of fibre types and bandwidth cells for this standard and ISO/IEC 11801.....	27
Table F.1 – Summary of 1 Gb/s and 10 Gb/s Ethernet requirements and capabilities.....	30

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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 third edition cancels and replaces the second edition published in 2004, of which it constitutes a technical revision. Temporarily included text of the DMD test method has been removed and modifications have been included on the A1a.1 and A1d chromatic dispersion specifications, and A1a.1 numerical aperture has been limited to one class only.

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

CDV	Report on voting
86A/1046/CDV	86A/1079/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 of 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 publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication 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 types A1a, A1b, and A1d. These fibres are used or can be incorporated in information transmission equipment and optical fibre cables.

Type A1a fibre is a 50/125 μm graded index fibre. Type A1a.1 applies to 50/125 μm fibre, while A1a.2 applies to 850 nm laser-optimised 50/125 μm fibre. 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 LANs, 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 referenced documents are indispensable for the application 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 60793-1-1:2002, *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance*

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*

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)*

IEC 60793-1-51, *Optical fibres – Part 1-51: Measurement methods and test procedures – Dry heat*

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

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

IEC 60793-2:2003, *Optical fibres – Part 2: Product specifications – General*

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 61280-1-4, *Fibre optic communication subsystem test procedures – Part 1-4: General communication subsystems – Collection and reduction of two-dimensional nearfield data for multimode fibre laser transmitters*

<https://www.intel.com/iee/60793-2-10-2007>

IEC/TR 62048, *Optical fibres – Reliability – Power law theory*

3 Specifications

The fibre shall consist of a glass core with a graded index profile and a glass cladding in accordance with 5.1 in IEC 60793-2.

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

3.1 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

Attributes	Measurement methods
Cladding diameter	IEC 60793-1-20
Core diameter	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

Table 2 – Requirements common to category A1 fibres

Attributes	Unit	Limits
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 attributes required in the family specifications

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

3.2 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

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 – Requirements common to category A1 fibres

Attributes	Unit	Limits
Proof stress level	GPa	$\geq 0,69$ ^a
Strip force (average) ^b	N	$1,0 \leq F_{\text{ave.strip}} \leq 5,0$
Strip force (peak) ^b	N	$1,0 \leq F_{\text{peak.strip}} \leq 8,9$
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 A1a and A1b fibres. For the relation between these different units, see 4.4 of IEC/TR 62048.

^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.

3.3 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

Attributes	Measurement methods
Attenuation coefficient ^a	IEC 60793-1-40
Modal bandwidth ^a	IEC 60793-1-41
Numerical aperture	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	IEC 60793-1-49

^a When measuring attenuation and modal bandwidth, the appropriate launching conditions should be applied. These may differ from those prescribed in the test methods to which reference is made.

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

Table 7 – Additional attributes required in family specifications

Attributes
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 E.1 shows a number of internationally standardised applications supported by A1 fibres, and Table E.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 in Figure 1, depending on the refractive index parameter, g , (see 8.1 of IEC 60793-1-1) 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 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. For example, it is practically impossible to produce a fibre with the maximum of both indicated bandwidth ranges (e.g. 800 MHz·km/1 000 MHz·km for A1b multimode fibres).

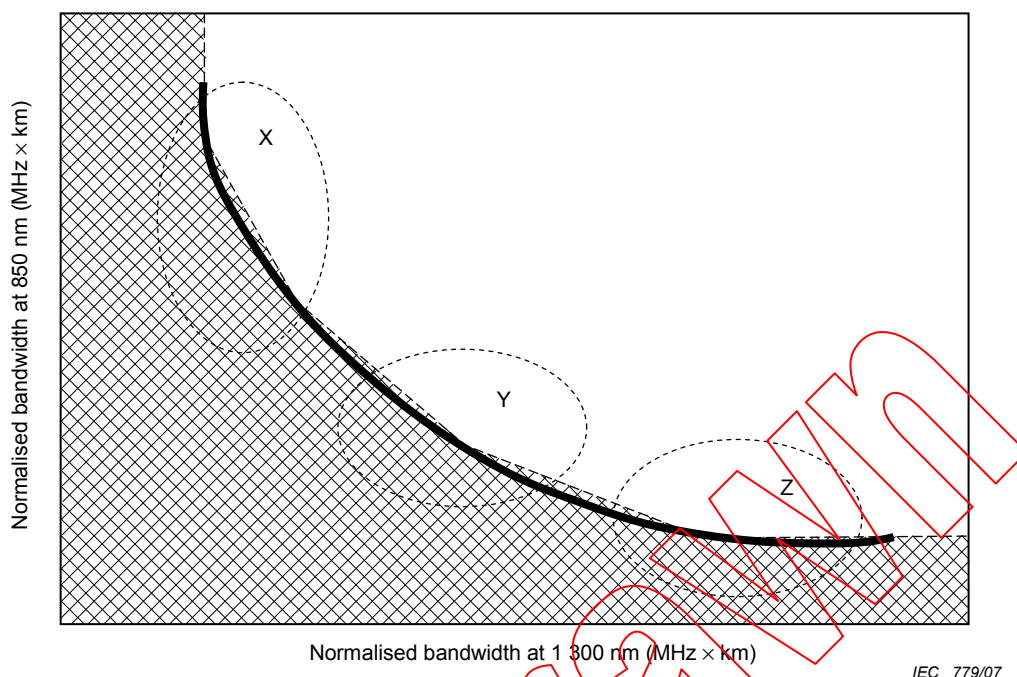


Figure 1 – Relation between bandwidths at 850 nm and 1 300 nm

3.4 Environmental requirements

Environmental exposure tests and measurement methods are documented in two forms:

- relevant environmental attributes and test procedures are given in Table 8;
- measurements of a particular mechanical or transmission attribute that may change on the application of the environment are listed in Table 9.

Table 8 – Environmental exposure tests

Environmental exposure	Test
Damp heat	IEC 60793-1-50
Dry heat	IEC 60793-1-51
Change of temperature	IEC 60793-1-52
Water immersion	IEC 60793-1-53

Table 9 – Attributes measured

Attribute	Measurement method
Change in optical transmission	IEC 60793-1-46
Attenuation	IEC 60793-1-40
Strip force	IEC 60793-1-32
Tensile strength	IEC 60793-1-31
Stress corrosion susceptibility	IEC 60793-1-33

These tests are normally conducted periodically as type-tests for a fibre and coating design. Unless otherwise indicated, the recovery period allowed between the completion of the environmental exposure and performing the attribute measurements shall be as stated in the particular environmental test method.

3.4.1 Mechanical environmental requirements (common to all fibres in category A1)

These tests are, in practice, the most severe requirements amongst the environments defined in Table 8.

Tables 10, 11, and 12 give the prescriptions for strip force, tensile strength and stress corrosion susceptibility respectively.

3.4.1.1 Strip force

The following attributes shall be verified following removal of the fibre from the particular environment.

Table 10 – Strip force for environmental tests

Environment	Average strip force N	Peak strip force N
Damp heat	$1,0 \leq F_{avg} \leq 5,0$	$1,0 \leq F_{peak} \leq 8,9$
Water immersion	$1,0 \leq F_{avg} \leq 5,0$	$1,0 \leq F_{peak} \leq 8,9$

3.4.1.2 Tensile strength

The following attribute shall be verified following removal of the fibre from the environment.

Table 11 – Tensile strength for environmental tests

Environment	Median tensile strength specimen length: 0,5 m GPa	15th percentile tensile strength Specimen length 0,5 m GPa
Damp heat	$\geq 3,03$	$\geq 2,76$
NOTE These requirements do not apply to hermetically coated fibre.		

3.4.1.3 Stress corrosion susceptibility

The following attribute shall be verified following removal of the fibre from the environment.

Table 12 – Stress corrosion susceptibility for environmental tests

Environment	Stress corrosion susceptibility constant, n_d
Damp heat	≥ 18
NOTE This requirement does not apply to hermetically coated fibre.	

3.4.2 Transmission environmental requirements

Change in attenuation from the initial value shall be less than the values in Table 13. Attenuation shall be measured periodically during the entire exposure to each environment and after removal.