IEC 60793-2-50

Edition 4.0 2012-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Optical fibres –
Part 2-50: Product specifications – Sectional specification for class B single-mode fibres

Fibres optiques –
Partie 2-50: Spécifications de produits – Spécification intermédiaire pour les fibres unimodales de classe B

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FOREWORD

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International Standard IEC 60793-2-50 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This fourth edition cancels and replaces the third edition, published in 2008, and constitutes a technical revision.

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

– aligns the requirements with the relevant ITU-T Recommendations;
– adds another option to the list of alternative primary coating diameter constructions in Table 2 and subsequent family specifications; related modification of coating strip force in Tables 4 and 11;
– removes the jumper cut-off wavelength in Table 5;
– modifies B6 sub-categories;

– aligns B6-b MFD on B1.3 MFD.

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

FDIS	Report on voting
86A/1481/FDIS	86A/1490/RVD

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 can be found, under the general title *Optical Fibres*, on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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

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- withdrawn,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

The contents of the corrigendum of January 2014 have been included in this copy.

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OPTICAL FIBRES –

Part 2-50: Product specifications – Sectional specification for class B single-mode fibres

1 Scope

This part of IEC 60793 is applicable to optical fibre categories B1.1, B1.2, B1.3, B2, B4, B5 and B6. A map illustrating the connection of IEC designations to ITU-T designations is shown in Annex I. These fibres are used or can be incorporated in information transmission equipment and optical fibre cables.

Three types of requirements apply to these fibres:

– general requirements, as defined in IEC 60793-2;

– specific requirements common to the class B single-mode fibres covered in this standard and which are given in Clause 3;

– particular requirements applicable to individual fibre categories or specific applications, which are defined in Annexes A to G.

For some fibre categories (shown in the relevant family specifications), there are sub-categories that are distinguished on the basis of difference in transmission attribute specifications. The designations for these sub-categories are documented in the individual family specifications.

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 1), *Optical fibres – Measurement methods and test procedures*

IEC 60793-1-1, *Optical fibres – Measurement methods and test procedures – Part 1-1: 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 60793-1-40:2011, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

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

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

IEC 60793-1-45, *Optical fibres – Part 1-45: Measurement methods and test procedures – Mode field diameter*

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 60793-1-48, *Optical fibres – Part 1-48: Measurement methods and test procedures – Polarization mode dispersion*

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, *Optical fibres – Part 2: Product specifications – General*

3 Terms and definitions

For the purposes of this document, a number of definitions apply. General definitions for fibres are provided in IEC 60793-2. The definitions of the specified attributes are contained in the relevant test methods standard of the IEC 60793-1 series, while general definitions for testing are provided in IEC 60793-1-1.

4 Abbreviations and symbols

The following abbreviations and symbols apply:

λ_0 zero dispersion wavelength
F_{avg} average strip force
F_{peak} peak strip force
MFD mode field diameter
n_d stress corrosion parameter – dynamic
PMD polarization mode dispersion
PMD_Q PMD link design value

5 Specifications

5.1 General

The fibre shall consist of a glass core and glass cladding in accordance with the construction of optical fibre category B – single mode fibre – as given in IEC 60793-2.

The term “glass” usually refers to material consisting of non-metallic oxides. The composition of some fibres may be all glass, or glass and glass/hard polymeric composites.

5.2 Dimensional requirements

Relevant dimensional attributes and measurement methods are given in Table 1.

Requirements common to all categories of class B single-mode fibres are given in Table 2.

Table 1 – Dimensional attributes and measurement methods

Attributes	Measurement methods
Cladding diameter	IEC 60793-1-20
Cladding 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 all category B fibres

Attributes	Unit	Limits
Primary coating diameter – uncoloured	µm	235 to 255 [a]
Primary coating diameter – coloured	µm	235 to 265 [a]
Primary coating-cladding concentricity error	µm	≤ 12,5
Fibre length	km	[b]
NOTE 1 The primary coating cladding concentricity error should be limited to a maximum 10 um for 200 um. NOTE 2 Alternate coating diameters may impact fibre connectivity such as ribbons, multi-fibre connectors, mechanical splices, and fusion splice protectors. NOTE 3 Alternate coating diameters may need adjustments to connectivity tools.		
[a] The above limits on primary coating diameter are most commonly used in telecommunications cables. There are other applications, such as fibre for use within optical sub-systems, pigtails, or specialty applications such as for submarines cables or for compact FTTH cables, which use other primary coating diameters, several of which are listed below. Alternative nominal primary coating diameters and ranges: 200 µm ± 10 µm (uncoloured; 190 to 220 µm coloured) 400 µm ± 40 µm 500 µm ± 30 µm 700 µm ± 100 µm 900 µm ± 100 µm [b] Length requirements vary and should be agreed between supplier and customer.		

5.3 Mechanical requirements

Relevant mechanical attributes and test methods are given in Table 3. The relationship of these attributes and requirements to mechanical reliability are described in IEC/TR 62048.

Requirements common to all categories of class B single-mode fibres are given in Table 4.

Table 3 – Mechanical attributes and test methods

Attributes	Test methods
Proof test	IEC 60793-1-30
Tensile strength	IEC 60793-1-31
Coating strippability	IEC 60793-1-32
Stress corrosion susceptibility	IEC 60793-1-33
Fibre curl	IEC 60793-1-34

Table 4 – Requirements common to all category B fibres

Attributes	Unit	Limits
Proof stress level	GPa	≥0,69 [a]
Coating strip force (average) [b, c]	N	$1,0 \leq F_{ave} \leq 5,0$
Coating strip force (peak) [b, c]	N	$1,0 \leq F_{peak} \leq 8,9$
Fibre curl radius	m	≥2 [d]
Tensile strength (median) for 0,5 m specimen length	GPa	≥ 3,8
Stress corrosion susceptibility parameter, n_d	–	≥ 18

[a] The proof test value of 0,69 GPa equals about 1 % strain or about 8,8 N force. For the relation between these different units, see Clause 4 of IEC/TR 62048.

[b] Either average strip force or peak strip force, which are defined in the test procedure, may be specified with agreement between supplier and customer.

[c] In case of alternative nominal primary coating diameters (see Table 2), associated alternative coating strip force values need to be agreed between supplier and customer.

[d] Depending on splicing methods, a minimum of 4 m may be specified for fibre intended to be used in some cable constructions – such as ribbon cable.

5.4 Transmission requirements

Relevant transmission attributes and measurement methods are given in Table 5.

Requirements common to all categories of class B single-mode fibres are shown in Table 6.

Requirements that shall be specified in the family specifications are listed in Table 7.

Table 5 – Transmission attributes and measurement methods

Attributes	Measurement methods
Attenuation coefficient	IEC 60793-1-40 [a]
Chromatic dispersion	IEC 60793-1-42
Cut-off wavelength [b]	IEC 60793-1-44
Mode field diameter	IEC 60793-1-45
Change of optical transmission	IEC 60793-1-46
Macrobending loss	IEC 60793-1-47
Polarization mode dispersion	IEC 60793-1-48

NOTE The indicated maximum attenuation values apply to uncabled optical fibres; for the maximum cabled attenuation values, reference is made to IEC 60794-2, which can be used in conjunction with this standard.

[a] The attenuation coefficient at various wavelengths can be calculated using the measured values at a few wavelengths using a spectral model such as that given in IEC 60793-1-40. For example, the attenuation at 1 480 nm can be calculated and used for design of systems that employ remote pumping of optical amplifiers. When using Method C, OTDR, additional guidance information in IEC/TR 62316 should be taken into account.

[b] There are two ways to measure cut-off wavelength, leading to: fibre cut-off wavelength λ_c and to cable cut-off wavelength λ_{cc}, respectively. The correlation of the measured values of λ_c and λ_{cc} depends on the specific fibre and cable design and the test conditions. While in general $\lambda_{cc} < \lambda_c$ a general quantitative relationship cannot be easily established, the importance of ensuring single-mode transmission in the minimum cable length between joints at the minimum operating wavelength is paramount. This may be performed by recommending the maximum cable cut-off wavelength λ_{cc} of a cabled single-mode fibre to be 1 260 nm or for worst case length and bends by recommending a maximum fibre cut-off wavelength λ_c to be 1 250 nm.

Table 6 – Requirements common to all category B fibres

Attributes	Unit	Limits
Polarization mode dispersion (PMD) coefficient link design value (PMD_Q)	ps/√km	[a]
[a] A maximum value of PMD_Q on uncabled fibre shall be agreed between supplier and customer to satisfy the primary requirement of cable PMD, given in IEC 60794-3.		

Table 7 – Additional attributes required in the family specifications

Attributes
Attenuation coefficient and wavelengths
Chromatic dispersion characteristics
Nominal mode field diameter (MFD) range and wavelength
Mode field diameter tolerance
Cable cut-off wavelength
Macrobending loss including: wavelength, mandrel size, and number of turns
Cladding diameter
Cladding non-circularity
Core concentricity error

For category B4 fibre, information for system design is given in Annex H.

5.5 Environmental requirements

5.5.1 General

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

– relevant environmental attributes and test methods are given in Table 8;

– measurements of a particular mechanical or transmission attributes that may change on the application of the environment are listed in Table 9.

Table 8 – Environmental exposure tests

Attributes	Test methods
Damp heat tests	IEC 60793-1-50
Dry heat tests	IEC 60793-1-51
Change of temperature tests	IEC 60793-1-52
Water immersion tests	IEC 60793-1-53

Table 9 – Attributes measured

Attribute	Test methods
Change in optical transmission	IEC 60793-1-46
Attenuation	IEC 60793-1-40
Coating 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.

5.5.2 Optical environmental requirements – Attenuation

Change in attenuation from the initial value shall be less than the values in Table 10. Attenuation shall be measured periodically during the entire exposure to each environment and after removal.

Table 10 – Change in attenuation for environmental tests

Environment	Wavelength nm	Maximum attenuation increase dB/km
Damp heat	1 550, 1 625	≤ 0,05
Dry heat	1 550, 1 625	≤ 0,05
Change of temperature	1 550, 1 625	≤ 0,05
Water Immersion	1 550, 1 625	≤ 0,05
NOTE Attenuation changes at wavelengths lower than the test wavelength are smaller than the attenuation change at the test wavelength.		

5.5.3 Mechanical environmental requirements

5.5.3.1 General

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

5.5.3.2 Coating strip force

The attributes given in Table 11 shall be verified following removal of the fibre from the particular environment.

Table 11 – Coating 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	$1{,}0 \leq F_{avg} \leq 5{,}0$	$1{,}0 \leq F_{peak} \leq 8{,}9$
NOTE In case of alternative nominal primary coating diameters (see Table 2), associated alternative coating strip force values need to be agreed between supplier and customer.		

5.5.3.3 Tensile strength

The attributes given in Table 12 shall be verified following removal of the fibre from the environment indicated.

Table 12 – Tensile strength for environmental tests

Environment	Median tensile strength (GPa), specimen length: 0,5 m	15 percentile of the tensile strength distribution (GPa), specimen length: 0,5 m
Damp heat	≥ 3,03	≥ 2,76
NOTE These requirements do not apply to hermetically coated fibre. (An hermetic coating is a protective layer that completely segregates the glass fibre from moisture, thereby ensuring a high level of stress corrosion resistance. Typical hermetic coating is a carbon layer of several microns thickness applied on the glass surface.)		

5.5.3.4 Stress corrosion susceptibility

The attribute given in Table 13 shall be verified following removal of the fibre from the environment indicated.

Table 13 – Stress corrosion susceptibility for environmental tests

Environment	Stress corrosion susceptibility parameter, n_d
Damp heat	≥ 18
NOTE This requirement does not apply to hermetically coated fibre (see definition for hermetic coating in Table 12).	