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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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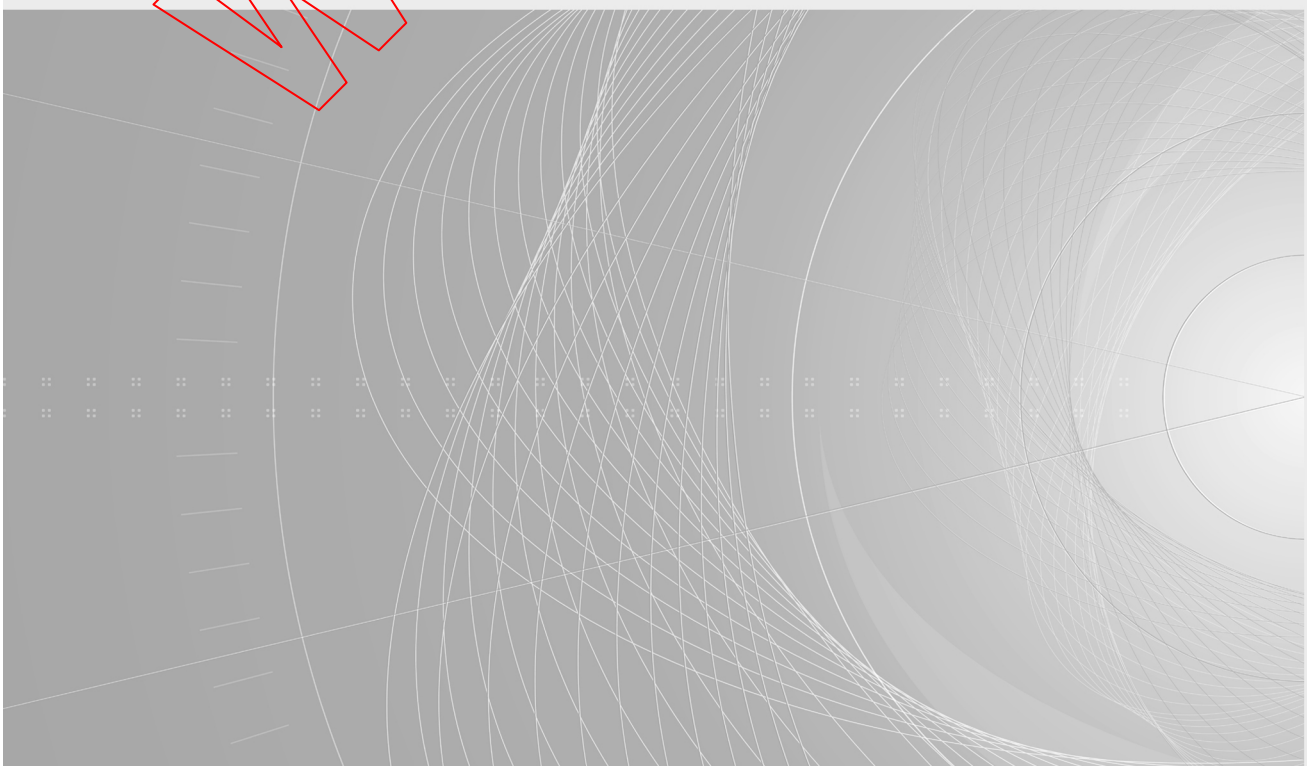

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OPTICAL FIBRES –

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

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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 third edition cancels and replaces the second edition published in 2004 and constitutes a technical revision which:

- aligns the requirements with the relevant ITU-T Recommendations, including tightening the tolerances of many parameters;
- provides a means for defining the requirements of sub-categories;
- for B1.2 fibres now includes two sub-categories;
- for B4 fibres now includes three sub-categories ;
- for B4 fibres, replaces the traditional method of specifying chromatic dispersion coefficient by limiting curves vs. wavelength for two of the sub-categories;
- adds a new category, B5, which corresponds to the fibres defined in ITU-T Recommendation G.656;

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- adds a new category, B6, which corresponds to the fibres defined in ITU-T Recommendation G.657;
- adds an informative annex that maps the nomenclature of the IEC fibre specifications to that of the ITU-T fibre recommendations;
- adds a clause for definitions;
- adds a clause for abbreviations;
- removes the dates from the normative references.

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

CDV	Report on voting
86A/1164/CDV	86A/1170/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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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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 types B1.1, B1.2, B1.3, and categories 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 types or specific applications, which are defined in Annexes A to G.
- For some 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 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, *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*

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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 60793-1-42, *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*

IEC 60794-2, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

3 Terms and definitions

For the purposes of this document, the terms and definitions of the specified attributes are contained in the test methods. IEC 60793-1-1 provides general definitions for testing. IEC 60793-2 provides general definitions for fibres.

4 Abbreviations and symbols

The following abbreviations and symbols are used in this document:

λ_0 zero dispersion wavelength

F_{avg} average strip force

F_{peak} peak strip force

MFD mode field diameter

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n_d stress corrosion parameter – dynamic

PMD polarization mode dispersion

PMD_Q 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 fibres in class B are 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

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Table 2 – Requirements common to class B fibres

Attributes	Unit	Limits
Cladding diameter	µm	125 ± 1
Cladding non-circularity	%	≤2,0[a]
Core concentricity error	µm	≤0,8[a]
Primary coating diameter – uncoloured	µm	235 to 255[b]
Primary coating diameter – coloured	µm	235 to 265
Primary coating-cladding concentricity error	µm	≤12,5
Fibre length	km	[c]

[a] Some family specifications have tighter tolerances.

[b] 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 speciality applications such as for submarines, which use other primary coating diameters, several of which are listed below.

Alternative nominal primary coating diameters and ranges (µm):

400 ± 40

700 ± 100

900 ± 100

[c] Length requirements vary and should be agreed between supplier and customer.

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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 fibres in class B are 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 class B fibres

Attributes	Unit	Limits
Proof stress level	GPa	≥0,69 [a]
Coating strip force (average) [b]	N	$1,0 \le F_{ave} \le 5,0$
Coating strip force (peak) [b]	N	$1,0 \le F_{peak} \le 8,9$
Fibre curl radius	m	≥2 [c]
Tensile strength (median) for 0,5 m specimen length	GPa	≥ 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 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] 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.

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5.4 Transmission requirements

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

Requirements common to all fibres in class B are indicated in Table 6.

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

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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

[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 three ways to measure cut-off wavelength: fibre cut-off wavelength, λ_c, cable cut-off wavelength, λ_{cc}, and jumper cut-off wavelength, λ_{cj}. The correlation of the measured values of λ_c, λ_{cc} and λ_{cj} depends on the specific fibre and cable design and the test conditions. While in general $\lambda_{cc} < \lambda_{cj} < \lambda_c$ 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 typical jumpers, by recommending a maximum jumper cable cut-off λ_{cj} to be 1 250 nm, or for worst case length and bends by recommending a maximum fibre cut-off wavelength λ_c to be 1 250 nm.

The indicated maximum attenuation values apply to uncabled optical fibres; for the maximum cabled attenuation values, reference is made to IEC 60794-2:2002, which can be used in conjunction with this standard.

Table 6 – Requirements common to class 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 specified 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

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

5.5 Environmental requirements

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.

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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.

5.5.1 Optical environmental requirements

5.5.1.1 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	≤0,05
Dry heat	1 550	≤0,05
Change of temperature	1 550	≤0,05
Water Immersion	1 550	≤0,05
NOTE Attenuation changes at wavelengths lower than the test wavelength are smaller than the attenuation change at the test wavelength. NOTE Performance at 1625 nm is optional and should be agreed between customer and supplier.		

5.5.2 Mechanical environmental requirements

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

5.5.2.1 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	$1,0 \leq F_{avg} \leq 5,0$	$F_{peak} \leq 8,9$
Water Immersion	$1,0 \leq F_{avg} \leq 5,0$	$F_{peak} \leq 8,9$

5.5.2.2 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.		

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