BS EN 60793-2:2016

BSI Standards Publication

Optical fibres

Part 2: Product specifications — General

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National foreword

This British Standard is the UK implementation of EN 60793-2:2016. It is identical to IEC 60793-2:2015. It supersedes BS EN 60793-2:2012 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/1, Optical fibres and cables.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Optical fibres - Part 2: Product specifications - General (IEC 60793-2:2015)

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(IEC 60793-2:2015)

Lichtwellenleiter - Teil 2: Produktspezifikationen - Allgemeines
(IEC 60793-2:2015)

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European foreword

The text of document 86A/1645/CDV, future edition 8 of IEC 60793-2, prepared by SC 86A "Fibres and cables" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60793-2:2016.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-12-17
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2019-06-17

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Annex ZA
(normative)
Normative references to international publications with their corresponding European publications

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NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60304	-	Standard colours for insulation for low-frequency cables and wires	HD 402 S2	-
IEC 60793-1	series	Optical fibres	EN 60793-1	series
IEC 60793-2-10	-		EN 60793-2-10	-
IEC 60793-2-20	-		EN 60793-2-20	-
IEC 60793-2-30	-		EN 60793-2-30	-
IEC 60793-2-40	-	Optical fibres -- Part 40: Product specifications - Sectional specification for category A4 multimode fibres	EN 60793-2-40	-
IEC 60793-2-50	-	Optical fibres -- Part 2-50: Product specifications - Sectional specification for class B single-mode fibres	EN 60793-2-50	-
IEC 60793-2-60	-	Optical fibres -- Part 2-60: Product specifications - Sectional specification for category C single-mode intraconnection fibres	EN 60793-2-60	-

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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OPTICAL FIBRES –

Part 2: Product specifications – General

FOREWORD

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

This eighth edition cancels and replaces the seventh edition published in 2011. This edition constitutes a technical revision which was necessary due to the addition of new fibre models to the A1 category in IEC 60793-2-10.

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

a) addition of two new sub-categories A3f and A3g indicated "under consideration" as they have not yet been fully standardized at the moment of finalizing this document;
b) modification of the Numerical aperture heading in Table 3 in line with recent modifications in all A1, A2, A3 and A4 multimode product specifications (NA_{ff} only).

This standard is to be read in conjunction with the IEC 60793-1 series.

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

CDV	Report on voting
86A/1645/CDV	86A/1663/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.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

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OPTICAL FIBRES –

Part 2: Product specifications – General

1 Scope

This part of IEC 60793 contains the general specifications for both multimode and single-mode optical fibres.

Sectional specifications for each of the four categories multimode fibres: A1, A2, A3, and A4 (part of the multimode fibre class A) contain requirements specific to each category.

Sectional specifications for each of the two single-mode fibre classes, B and C, contain requirements common to each class.

Each sectional specification includes family specifications (in normative annexes) that contain requirements for the applicable category or sub-categories. These sub-categories are distinguished on the basis of different fibre types or applications.

The requirements of this standard apply to all classes.

Each sectional specification contains the requirements that are common to all the family specifications that are within it. These common requirements are copied to the family specification for ease of reference.

Tests or measurement methods are defined for each specified attribute. Where possible, these definitions are by reference to an IEC standard – otherwise the test or measurement method is outlined in the relevant sectional specification.

Table 1 defines the sectional specifications. The relevant family specifications are defined within the sectional specifications as normative annexes (see Tables 2 to 5).

Annexes A and B summarize the existing fibre specifications.

Table 1 – Sectional specifications

Document ID	Fibre category / class	Cladding material	Core material	Index profile
IEC 60793-2-10	A1 multimode	Glass	Glass	Graded
IEC 60793-2-20	A2 multimode	Glass	Glass	Quasi-step or step
IEC 60793-2-30	A3 multimode	Plastic	Glass	Step or graded (under consideration)
IEC 60793-2-40	A4 multimode	Plastic	Plastic	Step, multi-step or graded
IEC 60793-2-50	B single-mode	Glass	Glass	Not applicable
IEC 60793-2-60	C single-mode	Glass	Glass	Not applicable

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 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60793-1 (all parts), *Optical fibres – Part 1: Measurement methods and test procedures*

IEC 60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

IEC 60793-2-20, *Optical fibres – Part 2-20: Product specifications – Sectional specification for category A2 multimode fibres*

IEC 60793-2-30, *Optical fibres – Part 2-30: Product specifications – Sectional specification for category A3 multimode fibres*

IEC 60793-2-40, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 60793-2-60, *Optical fibres – Part 2-60: Product specifications – Sectional specification for category C single-mode intraconnection fibres*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
multimode fibre
optical fibre in the core of which the radiation of two or more bound modes can propagate at the wavelength of interest

[SOURCE: IEC 60050-731:1991, 731-02-03]

3.2
single-mode fibre
optical fibre in which the radiation of only one bound mode can propagate at the wavelength of interest

[SOURCE: IEC 60050-731:1991, 731-02-02, modified — Note deleted]

3.3
core
central region of an optical fibre through which most of the optical power is transmitted

[SOURCE: IEC 60050-731:1991, 731-02-04]

3.4
cladding
dielectric material of an optical fibre surrounding the core

[SOURCE: IEC 60050-731:1991, 731-02-05]

3.5
primary coating
thin coating applied directly to the cladding, usually at the time of the fibre drawing, in one or more layers, to preserve integrity of the cladding surface

Note 1 to entry: A secondary coating may be applied directly to the primary coating, of one or more fibres, to reinforce the protection of the optical fibre during handling and cabling.

[SOURCE: IEC 60050-731:1991, 731-02-57, modified — the phrase "usually at the time . ...more layers" and the note 1 to entry have been added]

3.6
fibre buffer
material or assembly of materials used to protect the optical fibre against physical damage

[SOURCE: IEC 60050-731:1991, 731-02-56]

3.7
coloured coating and/or buffer
thin coating and/or buffer applied on the primary coating and/or buffer or on the secondary coating in order to make each fibre distinguishable by its colour

4 Quality assurance

It is the responsibility of the supplier to establish quality assurance by quality control procedures which ensures that the product meets the requirements of this standard and the related sectional specifications and family specifications. It is not intended that a complete testing programme be carried out on every length of fibre. When the customer wishes to specify acceptance tests or other quality procedures, it is essential that an agreement be reached between the supplier and the customer at the time of ordering.

5 Construction of optical fibres

5.1 Class A – Multimode fibres

The main fibre categories are based on g, the refractive index profile parameter, see Table 2.

The normalized index profile is expressed as:

$$\delta(x) = 1 - \mathrm{x}^{g} \tag{1}$$

where

$$\delta(x) = \frac{n(x) - n(1)}{n(0) - n(1)} \tag{2}$$

$$x = \frac{r}{a} \quad (0 \le r \le a) \text{ is the normalized radial position;} \tag{3}$$

a is the core radius;
$n(x)$ is the refractive index at normalized position x.

Table 2 – Main categories of multimode fibres

Category	Material	Type	Limits
A1	Glass core/glass cladding	Graded index fibre	$1 \leq g < 3$
A2	Glass core/glass cladding	Step and quasi-step index fibre	$3 \leq g < \infty$
A3	Glass core/plastic cladding	Step index fibre or graded index fibre (under consideration)	$10 \leq g < \infty$ $1 \leq g \leq 3$
A4	Plastic core/plastic cladding	Step, multi-step, or graded index fibre	$1 \leq g < \infty$

NOTE Attention is drawn to the index profile as stated in the detail specification. The fibre category is determined on the basis of the material type and the g value which best fits the normalized refractive index profile, falling within the category defined above.

A further differentiation of sub-categories inside the main categories is given in Table 3.

Table 3 – Sub-categories of multimode fibres

Category	Sub-categories/Models	Nominal core diameter µm	Nominal cladding diameter µm	Nominal coating diameter µm	Nominal numerical aperture (NA_{ff})
A1					
	A1a With models: A1a.1a (traditional macrobend loss) A1a.1b (enhanced macrobend loss) A1a.2a (traditional macrobend loss) A1a.2b (enhanced macrobend loss) A1a.3a (traditional macrobend loss) A1a.3b (enhanced macrobend loss)	50	125	245	0,20
	A1b	62,5	125	245	0,275
	A1d	100	140	245	0,26 or 0,29
A2					
	A2a	100	140	NS	0,23 or 0,26
	A2b	200	240	NS	0,23 or 0,26
	A2c	200	280	NS	0,23 or 0,26
A3					
	A3a	200	300	900	0,40
	A3b	200	380	600	0,40
	A3c	200	230	500	0,40
	A3d	200	230	500	0,35
	A3e	200	230	500	0,37
	A3f (Under consideration)	50	230	500	0,20
	A3g (Under consideration)	62,5	230	500	0,275
A4					
	A4a (With models A4a.1 and A4a.2)	NS	1 000	NA	(A4a.1): 0,50 (A4a.2): 0,485
	A4b	NS	750	NA	0,50
	A4c	NS	500	NA	0,50
	A4d	NS	1 000	NA	0,30

Category	Sub-categories/Models	Nominal core diameter µm	Nominal cladding diameter µm	Nominal coating diameter µm	Nominal numerical aperture (NA_{ff})
	A4e	≥500	750	NA	0,25
	A4f	200	490	NA	0,19
	A4g	120	490	NA	0,19
	A4h	62,5	245	NA	0,19
NOTE 1 NA = not applicable; NS = not specified. NOTE 2 All three A1a models indicated in Table 3 differ in bandwidth (or DMD) requirements.					

5.2 Class B – Single-mode fibres

The categories of single-mode fibres currently in use are given in Table 4.

Table 4 – Categories of glass core/glass clad single-mode fibres

Category	Type	Description
B1.1	Dispersion unshifted	This dispersion unshifted single-mode fibre is optimised for use in the 1 310 nm region but can be used in the 1 550 nm and 1 625 nm regions. Depending on link length and bit rates, dispersion may need accommodation in the 1 550 nm region.
B1.2	Cut-off shifted	This category of dispersion unshifted single-mode fibre is optimised for low loss in the 1 550 nm region.
B1.3	Extended band	This dispersion unshifted single-mode fibre can be used from 1 260 nm up to 1 625 nm. Chromatic dispersion in this band may impose requirements either on the maximum link length, or the need for accommodation.
B2	Dispersion shifted	This dispersion-shifted single-mode fibre is optimised for single-channel transmission in the 1 550 nm region. Multiple channels can only be transmitted if care is taken to avoid the effects of four-wave mixing by, for example, moderating the power levels or appropriate spacing or placement of the channels. Two sub-categories are recognized (B2_a and B2_b) differing in chromatic dispersion characteristics.
B4	Non-zero dispersion-shifted	This dispersion-shifted single-mode fibre is optimised for multiple channel transmission in the 1 550 nm region. The dispersion coefficient is required to be non-zero throughout the band from 1 530 nm to 1 565 nm, but may be either positive or negative. Depending on the dispersion characteristics, multiple channel transmission may be possible at bands either above or below the normal 1 550 nm region. Three sub-categories are recognized (B4_c, B4_d and B4_e), differing in chromatic dispersion characteristics.
B5	Wideband non-zero dispersion-shifted	This wideband non-zero dispersion-shifted single-mode fibre is optimised for multiple channel transmission in the wavelength range of 1 460 nm to 1 625 nm with the positive value of the chromatic dispersion coefficient that is greater than some non-zero value. This fibre can be used for both CWDM and DWDM systems throughout the wavelength region between 1 460 nm and 1 625 nm.

Category	Type	Description
B6	Bending loss insensitive	This category of single-mode fibre is optimised for improved bending loss. Four sub-categories are recognized: B6_a1 and B6_a2 fibres are a subset of category B1.3 fibres and therefore are compliant with B1.3 fibres and have the same transmission properties. Sub-category B6_a1 fibres are appropriate for a minimum bend radius of 10 mm; sub-category B6_a2 fibres for a minimum bend radius of 7,5 mm. B6_b2 and B6_b3 fibres are intended to be used for restricted distances (less than 1 000 m) at the end of Access networks, in particular inside buildings or near buildings (e.g. outside building riser cabling). Application length of B6_b fibre, however, depends on the deployment strategy of each network operator. Sub-category B6_b fibres are not necessarily compliant with category B1.3 fibres in terms of chromatic dispersion coefficient specifications. These fibres, however, are system compatible with B6_a (and B1.3) fibres in Access networks. Sub-category B6_b2 fibres are appropriate for a minimum bend radius of 7,5 mm; sub category B6_b3 fibres for a minimum bend radius of 5 mm.

5.3 Class C – Single-mode fibres for intraconnection

The categories of single-mode fibres for intraconnection currently in use are given in Table 5.

Table 5 – Categories of glass core/glass clad single-mode fibres for intraconnection

Category	Type	Description
C1	Single-mode intraconnection fibre suitable for use with any class B single-mode fibre at wavelengths from 1 260 nm to 1 625 nm.	This category of single-mode fibre is optimised for precision glass geometry and improved macrobending, and generally having lower fibre cut-off wavelength compared to that of B1.1 fibres.
C2	Single-mode intraconnection fibre suitable for use from 1 260 nm to 1 360 nm	This category of single-mode fibre with reduced mode field diameter is optimised for loss performance in the 1 310 nm region.
C3	Single-mode intraconnection fibre suitable for use from 1 530 nm to 1 625 nm	This category of single-mode fibre with reduced mode field diameter is optimised for loss performance in the 1 550 nm region.
C4	Single-mode intraconnection fibre suitable for use at 980 nm	This single-mode intraconnection fibre is intended to support 980 nm transmissions.
NOTE All four categories indicated in Table 5 have sub-categories based on 125 μm and 80 μm cladding diameter.		

6 General requirements

6.1 Coating

Fibres with glass cladding shall be coated with a material suitable for protecting the cladding material from damage. For fibres with coatings:

a) the coating shall be in close contact with the cladding material to preserve the initial integrity of the surface;

b) the coating consists of one or more layers of the same or different materials;

c) the coating shall be removable for connecting purposes, except where it is used as a reference surface. The method of removal shall be agreed between the supplier and the customer.

6.2 Interface with the coating

The interstices between the coated fibre (when the fibre is coated) and loose buffer can be filled with a suitable fluid or easily deformable materials.

6.3 Colours of the coating

When fibre is coloured:

a) colours shall correspond reasonably with IEC 60304, of which the following are examples: natural or white, red, yellow, blue, green, etc.;

b) a marking over the colour may be used. If used, the marking shall consist of distinctive coloured rings, lines, or helices. Printed markings shall adhere satisfactorily. Marking shall be easily identifiable with a constant repeated distance.

Annex A
(normative)

Existing multimode fibres

Table A.1 lists existing categories of multimode fibres.

Table A.1 – Existing multimode fibres

Class	Category	Sub-category	Model	Document
A: Multimode fibres				
	A1 – Graded index (Glass core/glass cladding)			IEC 60793-2-10
		A1a		Annex A
			A1a.1a and A1a.1b	
			A1a.2a and A1a.2b	
			A1a.3a and A1a.3b	
		A1b		Annex B
		A1d		Annex C
	A2 – Step index (Glass core/glass cladding)			IEC 60793-2-20
		A2a		Annex A
		A2b		Annex B
		A2c		Annex C
	A3 – Step or graded index (Glass core/plastic cladding)			IEC 60793-2-30
		A3a		Annex A
		A3b		Annex B
		A3c		Annex C
		A3d		Annex D
		A3e		Annex E
		A3f		Under consideration
		A3g		Under consideration
	A4 – Step or graded index plastic optical fibre			IEC 60793-2-40
		A4a		Annex A
			A4a.1	
			A4a.2	
		A4b		Annex B
		A4c		Annex C
		A4d		Annex D
		A4e		Annex E
		A4f		Annex F
		A4g		Annex G
		A4h		Annex H

Annex B
(normative)

Existing single-mode fibres

B.1 Existing single-mode fibres

Table B.1 lists existing categories of single-mode fibres.

Table B.1 – Existing single-mode fibres

Class	Category	Sub-category	Model	Document
B: Single-mode fibres				IEC 60793-2-50
	B1.1 – Dispersion unshifted			Annex A
	B1.2 – Cut-off shifted			Annex B
		B1.2_b		
		B1.2_c		
	B1.3 – Extended band			Annex C
	B2 – Dispersion shifted			Annex D
		B2_a		
		B2_b		
	B4 – Non-zero dispersion shifted			Annex E
		B4_c		
		B4_d		
		B4_e		
	B5 – Wideband non-zero dispersion shifted			Annex F
	B6 – Bending loss insensitive			Annex G
		B6_a		
			B6_a1	
			B6_a2	
		B6_b		
			B6_b2	
			B6_b3	

B.2 Existing fibres for intraconnection

Table B.2 lists existing fibres for intraconnection.

Table B.2 – Existing fibres for intraconnection

Class	Category	Sub-category		Document
C: Single-mode fibres for Intraconnection,				IEC 60793-2-60
	C1 – Applicable 1 280 nm to 1625 nm			Annex A
		C1_125		
		C1_80		
	C2 – Applicable 1 310 nm region			Annex B
		C2_125_a and C2_125_b		
		C2_80_a and C2_80_b		
	C3 – Applicable 1 550 nm region			Annex C
		C3_125_a and C3_125_b		
		C3_80_a and C3_80_b		
	C4 – Applicable 980 nm region			Annex D
		C4_125_a and C4_125_b		
		C4_80_a and C4_80_b		

Bibliography

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication* (available at http://www.electropedia.org)

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