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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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

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FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60793-2-40:2015. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60793-2-40 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 2015. This edition constitutes a technical revision.

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

a) revision of NA range of A4a.2;

b) addition of a new subcategory A4i;

c) deletion of the subcategory A4f and of Annex F.

The text of this International Standard is based on the following documents:

CDV	Report on voting
86A/1943/CDV	86A/1981/RVC

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

This document 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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OPTICAL FIBRES –

Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres

1 Scope

This part of IEC 60793 is applicable to category A4 optical multimode fibres and the related subcategories A4a, A4b, A4c, A4d, A4e~~, A4f~~, A4g, A4h and A4i. These fibres have a plastic core and plastic cladding and may have step-index, multi-step index or graded-index profiles. The fibres are used in information transmission equipment and other applications employing similar light transmitting techniques, and ~~finally~~ in fibre optic cables. Table 1 summarizes some of the salient characteristics and applications of these fibres.

Table 1 – Characteristics and applications of category A4 fibres

~~Sub-category~~	~~A4a~~	~~A4b~~	~~A4c~~	~~A4d~~	~~A4e~~	~~A4f~~	~~A4g~~	~~A4h~~
~~Core diameter (µm)~~	~~See Note 1~~	~~See Note 1~~	~~See Note 1~~	~~See Note 1~~	~~≥ 500~~	~~200~~	~~120~~	~~62,5~~
~~Cladding diameter (µm)~~	~~1 000~~	~~750~~	~~500~~	~~1 000~~	~~750~~	~~490~~	~~490~~	~~245~~
~~Numerical aperture Na_{ff}~~	~~0,50~~	~~0,50~~	~~0,50~~	~~0,30~~	~~0,25~~	~~0,190~~	~~0,190~~	~~0,190~~
~~Operating wave-length (s) (nm)~~	~~650 See Note 2~~	~~650~~	~~650~~	~~650~~	~~650~~	~~650 850 1 300~~	~~650 850 1 300~~	~~850 1 300~~
~~Applications~~	~~Digital audio interface, automobile, industrial, sensor and data transmission~~	~~Industrial and sensor~~	~~Sensor~~	~~Digital audiovisual interface and data transmission~~	~~Digital audiovisual interface and data transmission~~	~~Industrial and mobile; compatible with A3 transmission equipment~~	~~Data transmission~~	~~Data transmission; primarily used in ribbon structures~~
~~NOTE 1 Typically 15 µm to 35 µm smaller than the cladding diameter.~~ ~~NOTE 2 Other potential wavelengths for A4a fibre are described in Annex J.~~								

Sub-category	A4a		A4b	A4c	A4d	A4e	A4f	A4g	A4h	A4i
	A4a.1	A4a.2								
Core diameter (µm)	[a]		[a]	[a]	[a]	≥ 500	[c]	120	62,5	55
Cladding diameter (µm)	1 000		750	500	1 000	750	[c]	490	245[d]	490
Numerical aperture Na_{ff} [e]	0,50	0,53	0,50	0,50	0,30	0,25	[c]	0,190	0,190	0,24
Operating wave-length(s) (nm)	650[b]		650	650	650	650	[c]	650 850 1 300	850 1 300	850
Applications	Digital audio interface, automobile, industrial, sensor and data transmission		Industrial and sensor	Sensor	Digital audio-visual interface and data trans-mission	Digital audio-visual interface and data trans-mission	[c]	Data trans-mission	Data trans-mission; primarily used in ribbon structures	Industrial data trans-mission

[a] Typically 15 µm to 35 µm smaller than the cladding diameter.

[b] Other potential wavelengths for A4a fibre are described in Annex K.

[c] This sub-category is outdated and therefore no more specified.

[d] Cladding diameters of 490 µm and 750 µm are also possible.

[e] Na_{ff} is numerical aperture measured by far field pattern method.

In addition to the applications shown in Table 1, other applications for A4 fibres include, but are not restricted to, the following: support for short reach, high bit-rate systems in telephony, distribution and local networks, carrying data, voice and/or video services and on-premises intrabuilding and interbuilding fibre installations, including local area networks (LANs), private branch exchanges (PBXs), video, various multiplexing uses and miscellaneous related uses, such as consumer electronics and industrial and mobile networks.

Three types of requirements apply to A4 fibres:

- general requirements, as defined in IEC 60793-2;
- specific requirements common to category A4 multimode fibres covered in this document and which are given in Clause 4;
- particular requirements applicable to individual fibre sub-categories and implementations or specific applications which are defined in this document, in the normative family specification annexes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60793-1-20~~:2001~~, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

IEC 60793-1-22, *Optical fibres – Part 1-22: Measurement methods and test procedures – Length measurement*

IEC 60793-1-40:~~2001~~2019, *Optical fibres – Part 1-40: Attenuation 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~~:2009~~, *Optical fibres – Part 1-47: Measurement methods and test procedures – Macrobending loss*

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*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Specifications

4.1 Dimensional requirements

Relevant dimensional attributes and measurement methods are given in Table 2.

Requirements common to all category A4 fibres are indicated in Table 3.

Additional attributes that shall be specified in the family specifications for subcategories ~~A4f~~ A4g through ~~A4h~~ A4i are given in Table 4.

Table 2 – Dimensional attributes and measurement methods

Attribute	Measurement method
Cladding diameter	IEC 60793-1-20 [a]
Cladding non-circularity	IEC 60793-1-20 [a]
Core diameter [b]	IEC 60793-1-20
Fibre length	IEC 60793-1-22
Core-cladding concentricity error	IEC 60793-1-20
Core non-circularity	IEC 60793-1-20

[a] Mechanical methods are also applicable to cladding diameter and cladding non-circularity measurements if they provide the same measurement uncertainty.

[b] Core diameter is specified at 650 nm ± 10 nm with a test specimen length of 2,0 m ± 0,2 m and a threshold value k_{CORE} of 2,5 % (IEC 60793-1-20~~:2001~~, method B) for A4 fibres.

Table 3 – Requirements common to all category A4 fibres

Attribute	Unit	Limit
Cladding diameter	µm	[a]
Cladding non-circularity	%	≤ 6 [b]
Core diameter	µm	[c]
Fibre length	km	[d]

[a] The cladding diameter varies and is listed in the family specification.

[b] Unless otherwise specified in the family specification.

[c] For A4a, A4b, A4c and A4d fibre, the core diameter is typically 15 µm to 35 µm smaller than the cladding diameter. For A4e, ~~A4f,~~ A4g, A4h and A4i fibre, the core diameter varies and is listed in the relevant family specification (in the annexes to this document).

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

Table 4 – Additional attributes required in ~~A4f~~ A4g through ~~A4h~~ A4i family specifications

Attribute
Core non-circularity
Core-cladding concentricity error

4.2 Mechanical requirements

4.2.1 General

Mechanical attributes, test methods, and requirements for buffered fibres can be found in IEC 60794-2-41.

Relevant mechanical attributes and test methods are given in Table 5.

Requirements common to all category A4 fibres are indicated in Table 6.

Additional attributes that shall be specified in the family specifications for subcategories ~~A4f~~ A4g through ~~A4h~~ A4i are given in Table 7.

Table 5 – Mechanical attributes and test methods

Attribute	Test method
Tensile performance	4.2.2

Table 6 – Requirements common to category A4 fibres

Attribute	Unit	Limit
Elongation at yield peak	%	≥ 4,0
Tensile load at yield peak	N	[a]

[a] Tensile load at yield peak varies and is listed in the family specification (see annexes to this document).

Table 7 – Additional attributes required in family specification for subcategory ~~A4f~~ A4g through ~~A4h~~ A4i fibres

Attribute
Tensile load to induce 4 % elongation

4.2.2 Tensile load test

4.2.2.1 Object

The purpose of this test is to characterize the ability of the fibre to support a load during handling. Its purpose is to obtain values of the fibre's tensile strength.

~~The fibre samples are subjected to a mechanical environment as specified below.~~ The test shall be carried out at the standard test conditions in compliance with IEC 60068-1.

4.2.2.2 Definition of yield peak

Figure 1 shows a typical load versus elongation curve for a plastic optical fibre. The curve exhibits an initial monotonic increase in tensile load with applied elongation that goes through a load peak. The peak is followed by a decrease in load as the sample begins to undergo a ductile, irreversible elongation. Localized necking and drawing of the sample may accompany the process. This phenomenon is known as yielding and the peak is termed a yield peak.

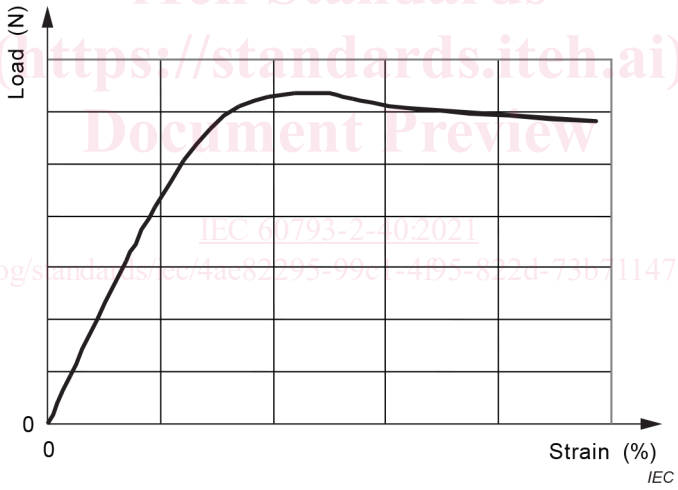

Figure 1 – Tensile load versus elongation for a plastic optical fibre

4.2.2.3 Test apparatus

The length of the sample between two clamping devices shall be between 100 mm and 200 mm.

The tensile strength measuring apparatus shall be a device, for example a vertical tensile tester, which provides relative motion to the test fibre. The apparatus shall be capable of imparting constant motion without jerking the fibre under test. The apparatus shall have the ability to simultaneously measure and record the resulting tensile force or load. To prevent fibre breakage, the means used to secure the fibre ends at the clamping points shall not stress the fibre excessively.

4.2.2.4 Procedure

The tensile speed shall be 100 mm/min ± 10 %. Yield strength and yield elongation are obtained from the load-elongation curve described in 4.2.2.2. Unless otherwise specified, tensile load at the yield peak and tensile load to induce 4 % elongation shall be recorded.