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INTERNATIONAL STANDARD

colour inside

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

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FOREWORD

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International Standard IEC 60793-2-30 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 2012 and constitutes a technical revision.

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

– specified test specimen length and measurement details for core diameter and NA_{ff} measurements have been added.
– two new sub-categories have been added
– NA_{th} is replaced by NA_{ff}

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

FDIS	Report on voting
86A/1661/FDIS	86A/1662/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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

OPTICAL FIBRES –

Part 2-30: Product specifications – Sectional specification for category A3 multimode fibres

1 Scope

This part of IEC 60793-2 is applicable to sub-categories A3a, A3b, A3c, A3d, A3e, A3f and A3g. These fibres are used or can be incorporated in different information transmission equipment, other applications employing similar light transmitting techniques as well as fibre optic cables.

Three types of requirements apply to these fibres:

- general requirements, as defined in IEC 60793-2;
- specific requirements common to the category A3 multimode fibres covered in this standard and which are given in Clause 3;
- particular requirements applicable to the individual sub-categories or specific applications (e.g. automotive or industrial applications), which are defined in the normative sub-category annexes.

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 60793-1-20, *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 60793-1-40, *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 60793-1-43, *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 60793-1-50, *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*

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

IEC TR 62048:2014, *Optical fibres – Reliability – Power law theory*

3 Specifications

3.1 General

The fibre shall consist of a glass core and a plastic cladding in accordance with the definition in IEC 60793-2. For sub-categories A3f and A3g, a glass inner cladding between core and cladding is present.

3.2 Dimensional requirements

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

Dimensional requirements common to all sub-categories are indicated in Table 2.

Table 3 lists additional dimensional attributes that shall be specified for each sub-category.

Table 1 – Relevant dimensional attributes and measurement methods

Attributes	Measurement methods
Core diameter[a]	IEC 60793-1-20
Core non-circularity	IEC 60793-1-20
Inner glass cladding[b]	IEC 60793-1-20
Cladding diameter	IEC 60793-1-20
Core-cladding concentricity error	IEC 60793-1-20
Coating diameter	IEC 60793-1-21
Fibre length	IEC 60793-1-22

[a] Core diameter is specified at 850 nm ± 10 nm with a test specimen length of 2,0 m ± 0,2 m and a threshold value k_{CORE} which is defined in each sub-category (see IEC 60793-1-20:2001, Method B).

[b] Only relevant for sub-categories A3f and A3g

Table 2 – Dimensional requirements common to all category A3 fibres

Attributes	Unit	Limits
Fibre length	km	[a]
[a] Length requirements vary and should be agreed between supplier and customer.		

Table 3 – Additional dimensional attributes required for each sub-category

Attributes
Core diameter
Core non-circularity
Inner glass cladding[a]
Cladding diameter
Core-cladding concentricity error
Coating diameter
[a] Only relevant for sub-categories A3f and A3g

3.3 Mechanical requirements

Relevant mechanical attributes and test methods are given in Table 4.

Requirements to be specified for each sub-category are listed in Table 5.

Table 4 – Relevant mechanical attributes and test methods

Attributes	Test methods
Tensile strength	IEC 60793-1-31 (0,5 m specimen length) Strain rate 3 %/min to 5 %/min
Proof test	IEC 60793-1-30

Table 5 – Mechanical requirements to be specified for each sub-category

Attribute	Unit
Proof stress level	GPa

3.4 Transmission requirements

Relevant transmission attributes and measurement methods are given in Table 6.

Additional attributes required in the sub-categories are listed in Table 7.

Table 6 – Relevant transmission attributes and measurement methods

Attributes	Measurement methods
Attenuation coefficient [a]	IEC 60793-1-40
Modal bandwidth [a]	IEC 60793-1-41
Numerical aperture (NA_{ff}) [a,b]	IEC 60793-1-43
Change of optical transmission	IEC 60793-1-46

[a] When measuring attenuation, modal bandwidth and numerical aperture, the appropriate launching conditions should be applied as specified in the corresponding measurement methods (IEC 60793-1-40, IEC 60793-1-41 and IEC 60793-1-43).

[b] Numerical aperture (NA_{ff}) is specified at 850 nm with a test specimen length of 2,0 m ± 0,2 m, and a threshold value, k_{NA} defined in each sub-category.

Table 7 – Additional transmission attributes required for each sub-category

Attributes
Attenuation coefficient
Modal bandwidth
Numerical aperture

3.5 Environmental requirements

Relevant environmental attributes and test methods are given in Table 8.

Table 8 – Relevant environmental attributes and test methods

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

Annex A
(normative)

Specifications for sub-category A3a multimode fibres

A.1 General

Clauses A.2 to A.5 contain particular requirements applicable to A3a fibres. Common requirements, repeated here for ease of reference from the sectional specification, are noted by an entry in the “Reference” column.

A.2 Dimensional requirements

Table A.1 contains dimensional requirements specific to A3a fibres.

Table A.1 – Dimensional requirements specific to A3a fibres

Attributes	Unit	Limits	Reference
Core diameter[a]	µm	200 ± 8	3.2 Table 1
Core non-circularity	%	≤ 6	3.2
Cladding diameter	µm	300 ± 30	3.2
Core-cladding concentricity error	µm	≤ 20	3.2
Coating diameter	µm	900 ± 50	3.2
Fibre length	km	See 3.2	3.2
[a] Using k_{CORE} of 0,5			

A.3 Mechanical requirements

Table A.2 contains mechanical requirements specific to A3a fibres.

Table A.2 – Mechanical requirements specific to A3a fibres

Attribute	Unit	Limit	Reference
Proof stress level	GPa	≥ 0,345	3.3
NOTE The normative proof test stress value of 0,345 GPa equals about 0,5 % strain or about 11,7 N force (for the largest allowed core diameter). For the relation between these different units, see IEC TR 62048:2014, 7.4.			

A.4 Transmission requirements

Table A.3 contains transmission requirements specific to A3a fibres.

Table A.3 – Transmission requirements specific to A3a fibres

Attributes	Unit	Limits	Reference
Attenuation coefficient at 850 nm	dB/km	≤10	3.4
Modal bandwidth at 850 nm	MHz × km	≥5	3.4
Numerical aperture (NA_{ff})[a]	Unitless	0,40 ± 0,04	3.4 Table 6
[a] Using k_{NA} of 0,5			

A.5 Environmental requirements

None.

Annex B
(normative)

Specifications for sub-category A3b multimode fibres

B.1 General

Clauses B.2 to B.5 contain particular requirements applicable to A3b fibres. Common requirements, repeated here for ease of reference from the sectional specification, are noted by an entry in the “Reference” column.

B.2 Dimensional requirements

Table B.1 contains dimensional requirements specific to A3b fibres.

Table B.1 – Dimensional requirements specific to A3b fibres

Attributes	Unit	Limits	Reference
Core diameter[a]	µm	200 ± 8	3.2 Table 1
Core non-circularity	%	≤ 6	3.2
Cladding diameter	µm	380 ±30	3.2
Core-cladding concentricity error	µm	≤ 20	3.2
Coating diameter	µm	600 ± 50	3.2
Fibre length	km	See 3.2	3.2
[a] Using k_{CORE} of 0,5			

B.3 Mechanical requirements

Table B.2 contains mechanical requirements specific to A3b fibres.

Table B.2 – Mechanical requirements specific to A3b fibres

Attributes	Unit	Limits	Reference
Proof stress level	GPa	≥ 0,345	3.3
NOTE The normative proof test stress value of 0,345 GPa equals about 0,5 % strain or about 11,7 N force (for the largest allowed core diameter). For the relation between these different units, see IEC TR 62048:2014, 7.4.			

B.4 Transmission requirements

Table B.3 contains transmission requirements specific to A3b fibres.

Table B.3 –Transmission requirements specific to A3b fibres

Attributes	Unit	Limits	Reference
Attenuation coefficient at 850 nm	dB/km	≤ 10	3.4
Modal bandwidth at 850 nm	MHz × km	≥ 5	3.4
Numerical aperture (NA_{ff})[a]	Unitless	0,40 ± 0,04	3.4 Table 6
[a] Using k_{NA} of 0,5			

B.5 Environmental requirements

None.

Annex C
(normative)

Specifications for sub-category A3c multimode fibres

C.1 General

Clauses C.2 to C.5 contain particular requirements applicable to A3c fibres. Common requirements, repeated here for ease of reference from the sectional specification, are noted by an entry in the “Reference” column.

C.2 Dimensional requirements

Table C.1 contains dimensional requirements specific to A3c fibres.

Table C.1 – Dimensional requirements specific to A3c fibres

Attributes	Unit	Limits	Reference
Core diameter[a]	µm	200 ± 8	3.2 Table 1
Core non-circularity	%	≤ 6	3.2
Cladding diameter	µm	230 ± 10	3.2
Core-cladding concentricity error	µm	≤ 20	3.2
Coating diameter	µm	500 ± 50	3.2
Fibre length	km	See 3.2	3.2
[a] Using k_{CORE} of 0,5			

C.3 Mechanical requirements

Table C.2 contains mechanical requirements specific to A3c fibres.

Table C.2 – Mechanical requirements specific to A3c fibres

Attributes	Unit	Limits	Reference
Proof stress level	GPa	≥ 0,345	3.3
NOTE The normative proof test stress value of 0,345 GPa equals about 0,5 % strain or about 11,7 N force (for the largest allowed core diameter). For the relation between these different units, see IEC TR 62048:2014, 7.4			

C.4 Transmission requirements

Table C.3 contains transmission requirements specific to A3c fibres.

Table C.3 –Transmission requirements specific to A3c fibres

Attributes	Unit	Limits	Reference
Attenuation coefficient at 850 nm	dB/km	≤ 10	3.4
Modal bandwidth at 850 nm	MHz × km	≥ 5	3.4
Numerical aperture (NA_{ff})[a]	Unitless	0,40 ± 0,04	3.4 Table 6
[a] Using k_{NA} of 0,5			

C.5 Environmental requirements

Table C.4 and Table C.5 contain environmental exposure tests and measurement methods specific to A3c fibres. Test and measurements shall be documented in two forms:

– relevant environmental attributes, test methods and test conditions are given in Table C.4;

– measurements of a particular mechanical and transmission attribute that may change during exposure to the environmental test are listed in Table C.5.

Table C.4 – Environmental exposure tests

Test condition	Environment	Test method	Test condition
A	Damp heat	IEC 60793-1-50	+85 °C, 85 % RH, long term: 125 days; short term: 10 days
	Dry heat	IEC 60793-1-51	+125 °C, long term: 125 days; short term: 10 days
	Change of temperature	IEC 60793-1-52	T_a: –40 °C, T_b:+125 °C
B	Damp heat	IEC 60793-1-50	+75 °C, 85 % RH, long term: 125 days; short term: 10 days
	Dry heat	IEC 60793-1-51	+85 °C, long term: 125 days; short term: 10 days
	Change of temperature	IEC 60793-1-52	T_a: –40 °C, T_b:+85 °C
C	Damp heat	IEC 60793-1-50	+70 °C, 85 % RH, 30 days
	Dry heat	IEC 60793-1-51	+70 °C, 30 days
	Change of temperature	IEC 60793-1-52	T_a: –20 °C, T_b:+70 °C
Test condition A, B, or C and short-term or long-term test conditions should be agreed between supplier and customer. Test conditions A and B are typical conditions for automotive applications.			

Table C.5 – Attributes measured

Attributes	Unit	Limits	Reference
Change in optical transmission at 850 nm	dB/km	≤ 1,5	
Tensile strength	GPa at 15 % and 50 % Weibull probability levels	1,08 at 15 % 1,18 at 50 %	

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

Annex D
(normative)

Specifications for sub-category A3d multimode fibres

D.1 General

Clauses D.2 to D.5 contain particular requirements applicable to A3d fibres. Common requirements, repeated here for ease of reference from the sectional specification, are noted by an entry in the “Reference” column.

D.2 Dimensional requirements

Table D.1 contains dimensional requirements specific to A3d fibres.

Table D.1 – Dimensional requirements specific to A3d fibres

Attributes	Unit	Limits	Reference
Core diameter[a]	µm	200 ± 8	3.2 Table 1
Core non-circularity	%	≤ 6	3.2
Cladding diameter	µm	230 ± 10	3.2
Core-cladding concentricity error	µm	≤ 20	3.2
Coating diameter	µm	500 ± 50	3.2
Fibre length	km	See 3.2	3.2
[a] Using k_{CORE} of 0,5			

D.3 Mechanical requirements

Table D.2 contains mechanical requirements specific to A3d fibres.

Table D.2 – Mechanical requirements specific to A3d fibres

Attribute	Unit	Limit	Reference
Proof stress level	GPa	≥ 0,345	3.3
NOTE The normative proof test stress value of 0,345 GPa equals about 0,5 % strain or about 11,7 N force (for the largest allowed core diameter). For the relation between these different units, see IEC TR 62048:2014,7.4.			

D.4 Transmission requirements

Table D.3 contains transmission requirements specific to A3d fibres.

Table D.3 – Transmission requirements specific to A3d fibres

Attributes	Unit	Limits	Reference
Attenuation coefficient at 850 nm	dB/km	≤ 10	3.4
Modal bandwidth at 850 nm	MHz over 100 m	≥ 100	3.4
Numerical aperture (NA_{ff})[a]	Unitless	0,35 ± 0,02	3.4 Table 6
[a] Using k_{NA} of 0,5			

D.5 Environmental requirements

Table D.4 and Table D.5 contain environmental exposure tests and measurement methods specific to A3d fibres. Test and measurements shall be documented in two forms:

– relevant environmental attributes, test methods and test conditions are given in Table D.4;

– measurements of a particular mechanical and transmission attribute that may change during exposure to the environmental test are listed in Table D.5.

Table D.4 – Environmental exposure tests

Test condition	Environment	Test method	Test condition
A	Damp heat	IEC 60793-1-50	+85 °C, 85 % RH, long term: 125 days; short term: 10 days
	Dry heat	IEC 60793-1-51	+125 °C, long term: 125 days; short term: 10 days
	Change of temperature	IEC 60793-1-52	T_a: –40 °C, T_b:+125 °C
B	Damp heat	IEC 60793-1-50	+75 °C, 85 % RH, long term: 125 days; short term: 10 days
	Dry heat	IEC 60793-1-51	+85 °C, long term: 125 days; short term: 10 days
	Change of temperature	IEC 60793-1-52	T_a: −40 °C, T_b:+85 °C
C	Damp heat	IEC 60793-1-50	+70 °C, 85 % RH, 30 days
	Dry heat	IEC 60793-1-51	+70 °C, 30 days
	Change of temperature	IEC 60793-1-52	T_a: –20 °C, T_b:+70 °C
Test condition A, B, or C and short term or long term test conditions should be agreed between supplier and customer. Test conditions A and B are typical conditions for automotive applications.			

Table D.5 – Attributes measured

Attributes	Unit	Limits	Reference
Change in optical transmission at 850 nm	dB/km	≤ 1,5	
Tensile strength	GPa at 15 % and 50 % Weibull probability levels	1,08 at 15 % 1,18 at 50 %	

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

Annex E
(normative)

Specifications for sub-category A3e multimode fibres

E.1 General

Clauses E.2 to E.5 contain particular requirements applicable to A3e fibres. Common requirements, repeated here for ease of reference from the sectional specification, are noted by an entry in the “Reference” column.

E.2 Dimensional requirements

Table E.1 contains dimensional requirements specific to A3e fibres.

Table E.1 – Dimensional requirements specific to A3e fibres

Attributes	Unit	Limits	Reference
Core diameter[a]	µm	200 ± 4	3.2 Table 1
Core non-circularity	%	≤ 3	3.2
Cladding diameter	µm	230	3.2
Core-cladding concentricity error	µm	≤ 5	3.2
Coating diameter	µm	500 ± 30	3.2
Fibre length	km	See 3.2	3.2
[a] Using k_{CORE} of 0,5			

E.3 Mechanical requirements

Table E.2 contains mechanical requirements specific to A3e fibres.

Table E.2 – Mechanical requirements specific to A3e fibres

Attribute	Unit	Limit	Reference
Proof stress level	GPa	≥ 0,69	3.3
NOTE The normative proof test stress value of 0,69 GPa equals about 1,0 % strain or about 22,6 N force (for the largest allowed core diameter). For the relation between these different units, see IEC TR 62048:2014, 7.4.			

E.4 Transmission requirements

Table E.3 contains transmission requirements specific to A3e fibres.

Table E.3 – Transmission requirements specific to A3e fibres

Attributes	Unit	Limits	Reference
Attenuation coefficient at 850 nm	dB/km	≤ 8	3.4
Modal bandwidth at 850 nm	MHz × km	≥ 5	3.4
Numerical aperture (NA_{ff})[a]	Unitless	0,37 ± 0,02	3.4 Table 6
[a] Using k_{NA} of 0,5			

E.5 Environmental requirements

Table E.4. and Table E.5 contain environmental exposure tests and measurement methods specific to A3e fibres. Test and measurements shall be documented in two forms:

– relevant environmental attributes, test methods and test conditions are given in Table E.4;

– measurements of a particular mechanical and transmission attribute that may change during exposure to the environmental test are listed in Table E.5.

Table E.4 – Environmental exposure tests

Test condition	Environment	Test method	Test condition
A	Damp heat	IEC 60793-1-50	+85 °C, 85 % RH, Long term: 125 days; Short term: 10 days
	Dry heat	IEC 60793-1-51	+125 °C, Long term: 125 days; Short term: 10 days
	Change of temperature	IEC 60793-1-52	T_a: –40 °C, T_b:+125 °C
B	Damp heat	IEC 60793-1-50	+75 °C, 85 % RH, Long term: 125 days; Short term: 10 days
	Dry heat	IEC 60793-1-51	+85 °C, Long term: 125 days; Short term: 10 days
	Change of temperature	IEC 60793-1-52	T_a: –40 °C, T_b:+85 °C
C	Damp heat	IEC 60793-1-50	+70 °C, 85 % RH, 30 days
	Dry heat	IEC 60793-1-51	+70 °C, 30 days
	Change of temperature	IEC 60793-1-52	T_a: –20 °C, T_b:+70 °C
Test condition A, B, or C and short-term or long-term test conditions should be agreed between supplier and customer. Test conditions A and B are typical conditions for automotive applications.			

Table E.5 – Attributes measured

Attributes	Unit	Limits	Reference
Change in optical transmission at 850 nm	dB/km	≤ 1,5	
Tensile strength	GPa at 15 % and 50 % Weibull probability levels	1,08 at 15 % 1,18 at 50 %	

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

Annex F
(normative)

Specifications for sub-category A3f multimode fibres

F.1 General

Clauses F.2 to F.5 contain particular requirements applicable to A3f fibres. Common requirements, repeated here for ease of reference from the sectional specification, are noted by an entry in the “Reference” column.

F.2 Dimensional requirements

Table F.1 contains dimensional requirements specific to A3f fibres.

Table F.1 – Dimensional requirements specific to A3f fibres

Attributes	Unit	Limits	Reference
Core diameter[a]	µm	50 ± 3	3.2 Table 1
Core non-circularity	%	≤ 5	3.2
Inner glass cladding	µm	200 ± 4	3.2
Cladding diameter	µm	230 ± 5	3.2
Core-cladding concentricity error	µm	≤ 3	3.2
Coating diameter	µm	500 ± 30	3.2
Fibre length	km	See 3.2	3.2
[a] Using k_{CORE} of 0,025			

F.3 Mechanical requirements

Table F.2 contains mechanical requirements specific to A3f fibres.

Table F.2 – Mechanical requirements specific to A3f fibres

Attribute	Unit	Limit	Reference
Proof stress level	GPa	≥ 1,03	3.3
NOTE The normative proof test stress value of 1,03 GPa equals about 1,5 % strain or about 33,7 N force (for the largest allowed inner cladding diameter). For the relation between these different units, see IEC TR 62048:2014, 7.4.			

F.4 Transmission requirements

Table F.3 contains transmission requirements specific to A3f fibres.