

BS EN 60793-2-10:2011



BSI Standards Publication

Optical fibres

Part 2-10: Product specifications —
Sectional specification for category A1
multimode fibres

bsi.

...making excellence a habit.
AVA Documents™
Document Sharing Hub

National foreword

This British Standard is the UK implementation of EN 60793-2-10:2011. It is identical to IEC 60793-2-10:2011. It supersedes BS EN 60793-2-10:2007 which is withdrawn.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.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© BSI 2011

ISBN 978 0 580 67447 1

ICS 33.180.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2011.

Amendments issued since publication

Amd. No.	Date	Text affected
----------	------	---------------

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60793-2-10

May 2011

ICS 33.180.10

Supersedes EN 60793-2-10:2007

English version

**Optical fibres -
Part 2-10: Product specifications -
Sectional specification for category A1 multimode fibres
(IEC 60793-2-10:2011)**

Fibres optiques -
Partie 2-10: Spécifications de produits -
Spécification intermédiaire pour les fibres
multimodales de catégorie A1
(CEI 60793-2-10:2011)

Lichtwellenleiter -
Teil 2-10: Produktspezifikationen -
Rahmenspezifikation für
Mehrmodenfasern der Kategorie A1
(IEC 60793-2-10:2011)

This European Standard was approved by CENELEC on 2011-04-18. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

© 2011 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Ref. No. EN 60793-2-10:2011 E

 **Documents**
Document Sharing Hub

Foreword

The text of document 86A/1295/CDV, future edition 4 of IEC 60793-2-10, prepared by SC 86A, Fibres and cables, of IEC TC 86, Fibre optics, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60793-2-10 on 2011-04-18.

This European Standard supersedes EN 60793-2-10:2007.

The major changes with respect to EN 60793-2-10:2007 are listed below:

- addition of type A1a.3 fibre;
- reduction of core diameter tolerance from 3,0 to 2,5 mm for A1a fibres.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2012-01-18 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2014-04-18 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60793-2-10:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

- | | | | |
|------|---------------|------|-----------------------------|
| [15] | IEC 61280-1-4 | NOTE | Harmonized as EN 61280-1-4. |
| [16] | IEC 61280-1-3 | NOTE | Harmonized as EN 61280-1-3. |
-

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

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

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-1-1	-	Optical fibres - Part 1-1: Measurement methods and test procedures - General and guidance	EN 60793-1-1	-
IEC 60793-1-20	-	Optical fibres - Part 1-20: Measurement methods and test procedures - Fibre geometry	EN 60793-1-20	-
IEC 60793-1-21	-	Optical fibres - Part 1-21: Measurement methods and test procedures - Coating geometry	EN 60793-1-21	-
IEC 60793-1-22	-	Optical fibres - Part 1-22: Measurement methods and test procedures - Length measurement	EN 60793-1-22	-
IEC 60793-1-30	-	Optical fibres - Part 1-30: Measurement methods and test procedures - Fibre proof test	EN 60793-1-30	-
IEC 60793-1-31	-	Optical fibres - Part 1-31: Measurement methods and test procedures - Tensile strength	EN 60793-1-31	-
IEC 60793-1-32	-	Optical fibres - Part 1-32: Measurement methods and test procedures - Coating strippability	EN 60793-1-32	-
IEC 60793-1-33	-	Optical fibres - Part 1-33: Measurement methods and test procedures - Stress corrosion susceptibility	EN 60793-1-33	-
IEC 60793-1-34	-	Optical fibres - Part 1-34: Measurement methods and test procedures - Fibre curl	EN 60793-1-34	-
IEC 60793-1-40	-	Optical fibres - Part 1-40: Measurement methods and test procedures - Attenuation	EN 60793-1-40	-
IEC 60793-1-41	-	Optical fibres - Part 1-41: Measurement methods and test procedures - Bandwidth	EN 60793-1-41	-
IEC 60793-1-42	-	Optical fibres - Part 1-42: Measurement methods and test procedures - Chromatic dispersion	EN 60793-1-42	-
IEC 60793-1-43	-	Optical fibres - Part 1-43: Measurement methods and test procedures - Numerical aperture	EN 60793-1-43	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-1-46	-	Optical fibres - Part 1-46: Measurement methods and test procedures - Monitoring of changes in optical transmittance	EN 60793-1-46	-
IEC 60793-1-47	-	Optical fibres - Part 1-47: Measurement methods and test procedures - Macrobending loss	EN 60793-1-47	-
IEC 60793-1-49	-	Optical fibres - Part 1-49: Measurement methods and test procedures - Differential mode delay	EN 60793-1-49	-
IEC 60793-1-50	-	Optical fibres - Part 1-50: Measurement methods and test procedures - Damp heat (steady state)	EN 60793-1-50	-
IEC 60793-1-51	-	Optical fibres - Part 1-51: Measurement methods and test procedures - Dry heat	EN 60793-1-51	-
IEC 60793-1-52	-	Optical fibres - Part 1-52: Measurement methods and test procedures - Change of temperature	EN 60793-1-52	-
IEC 60793-1-53	-	Optical fibres - Part 1-53: Measurement methods and test procedures - Water immersion	EN 60793-1-53	-
IEC 60793-2	2007	Optical fibres - Part 2: Product specifications - General	EN 60793-2	2008
IEC 60794-1-1	-	Optical fibre cables - Part 1-1: Generic specification - General	EN 60794-1-1	-
IEC/TR 62048	2002	Optical fibres - Reliability - Power law theory	-	-
ISO/IEC 11801	2002	Information technology - Generic cabling for customer premises	-	-

CONTENTS

1	Scope	6
2	Normative references	6
3	Specifications	7
3.1	General requirements	7
3.2	Dimensional requirements	8
3.3	Mechanical requirements	9
3.4	Transmission requirements	9
3.5	Environmental requirements	11
3.5.1	Overview	11
3.5.2	Mechanical environmental requirements (common to all fibres in category A1)	12
3.5.3	Transmission environmental requirements	13
Annex A (normative)	Family specifications for A1a multimode fibres	14
Annex B (normative)	Family specifications for A1b multimode fibres	16
Annex C (normative)	Family specifications for A1d multimode fibres	18
Annex D (normative)	Fibre differential mode delay (DMD) and calculated effective modal bandwidth (EMB_C) requirements	20
Annex E (informative)	Modal bandwidth considerations and transmitter requirements	25
Annex F (informative)	Bandwidth nomenclature explanation	27
Annex G (informative)	Preliminary indications for items needing further study	28
Annex H (informative)	Applications supported by A1 fibres	30
Annex I (informative)	1-Gbit, 10-Gbit, 40-Gbit and 100-Gbit Ethernet applications	34
Bibliography		38
Figure 1	– Relation between bandwidths at 850 nm and 1 300 nm	11
Figure D.1	– DMD template requirements	21
Table 1	– Dimensional attributes and measurement methods	8
Table 2	– Dimensional requirements common to category A1 fibres	8
Table 3	– Additional dimensional attributes required in the family specifications	8
Table 4	– Mechanical attributes and measurement methods	9
Table 5	– Mechanical requirements common to category A1 fibres	9
Table 6	– Transmission attributes and measurement methods	9
Table 7	– Additional transmission attributes required in family specifications	10
Table 8	– Environmental exposure tests	11
Table 9	– Attributes measured for environmental tests	11
Table 10	– Strip force for environmental tests	12
Table 11	– Tensile strength for environmental tests	12
Table 12	– Stress corrosion susceptibility for environmental tests	12
Table 13	– Change in attenuation for environmental tests	13
Table A.1	– Dimensional requirements specific to A1a fibres	14
Table A.2	– Mechanical requirements specific to A1a fibres	14

Table A.3 – Transmission requirements specific to A1a fibres .	15
Table B.1 – Dimensional requirements specific to A1b fibres .	16
Table B.2 – Mechanical requirements specific to A1b fibres .	16
Table B.3 – Transmission requirements specific to A1b fibres .	17
Table C.1 – Dimensional requirements specific to A1d fibres .	18
Table C.2 – Mechanical requirements specific to A1d fibres .	18
Table C.3 – Transmission requirements specific to A1d fibres .	19
Table D.1 – DMD templates for A1a.2 fibres .	20
Table D.2 – DMD interval masks for A1a.2 fibres .	22
Table D.3 – DMD Weightings .	23
Table D.4 – DMD templates for A1a.3 fibres .	24
Table D.5 – DMD interval masks for A1a.3 fibres .	24
Table F.1 – Bandwidth nomenclature explanation .	27
Table H.1 – Some internationally standardised applications supported by A1a and/or A1b fibres .	30
Table H.2 – Typically used commercial bandwidth specifications for A1a and A1b graded-index multimode fibres .	31
Table H.3 – Cross reference of fibre types and bandwidth cells for this standard and ISO/IEC 11801 .	32
Table I.1 – Summary of 1 Gbit/s , 10 Gbit/s , 40 Gbit/s and 100 Gbit/s Ethernet requirements and capabilities for A1b fibres .	35
Table I.2 – Summary of 1 Gbit/s , 10 Gbit/s , 40 Gbit/s and 100 Gbit/s Ethernet requirements and capabilities for A1a.1 fibres .	36
Table I.3 – Summary of 1 Gbit/s , 10 Gbit/s , 40 Gbit/s and 100 Gbit/s Ethernet requirements and capabilities for A1a.2 and A1a.3 fibres .	37

OPTICAL FIBRES –

Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres

1 Scope

This part of IEC 60793 is applicable to optical fibre types A1a, A1b, and A1d. These fibres are used or can be incorporated in information transmission equipment and optical fibre cables.

Type A1a fibre is a 50/125 μm graded index fibre. Type A1a.1 applies to 50/125 μm fibre, while A1a.2 and A1a.3 apply to two bandwidth grades of 850 nm laser-optimised 50/125 μm fibre. Type A1b applies to 62,5/125 μm graded index fibre and A1d applies to 100/140 μm graded index fibre.

Other applications include, but are not restricted to, the following: short reach, high bit-rate systems in telephony, distribution and local networks carrying data, voice and/or video services; on-premises intra-building and inter-building fibre installations including Data Centres, LANs, Storage Area Networks, PBXs, video, various multiplexing uses, outside telephone cable plant use, and miscellaneous related uses.

Three types of requirements apply to these fibres:

- general requirements, as defined in IEC 60793-2;
- specific requirements common to the category A1 multimode 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 the normative family specification annexes.

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 – Part 1-1: Measurement methods and test procedures – 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, *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 60793-1-42, *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*

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 60793-1-49, *Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay*

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 60793-2:2007, *Optical fibres – Part 2: Product specifications - General*

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification - General*

IEC/TR 62048:2002, *Optical fibres – Reliability – Power law theory*

ISO/IEC 11801:2002, *Information technology – Generic cabling for customer premises*

3 Specifications

3.1 General requirements

The fibre shall consist of a glass core with a graded index profile and a glass cladding in accordance with 5.1 in IEC 60793-2.

The term “glass” usually refers to material consisting of non-metallic oxides.

3.2 Dimensional requirements

Dimensional attributes and measurement methods are given in Table 1.

Requirements common to all fibres in category A1 are indicated in Table 2.

Table 3 lists additional attributes that shall be specified by each family specification.

Table 1 – Dimensional attributes and measurement methods

Attributes	Measurement methods
Cladding diameter	IEC 60793-1-20
Core diameter	IEC 60793-1-20
Cladding non-circularity	IEC 60793-1-20
Core 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 – Dimensional requirements common to category A1 fibres

Attributes	Unit	Limits
Core non-circularity	%	≤6
Primary coating diameter – uncoloured ^a	μm	245 ± 10
Primary coating diameter – coloured ^a	μm	250 ± 15
Primary coating-cladding concentricity error	μm	≤12,5
Fibre length	km	^b
^a The above limits on primary coating diameter are most commonly used in telecommunications cables. There are other applications, which use other primary coating diameters, several of which are listed below. Alternative nominal primary coating diameters and tolerance (μm): 400 ± 40 500 ± 50 700 ± 100 900 ± 100		
^b Length requirements vary and should be agreed between the supplier and the customer.		

Table 3 – Additional dimensional attributes required in the family specifications

Attributes
Cladding diameter
Cladding non-circularity
Core diameter
Core-cladding concentricity error

3.3 Mechanical requirements

Mechanical attributes and measurement methods are given in Table 4.

Requirements common to all fibres in category A1 are in Table 5.

Table 4 – Mechanical attributes and measurement methods

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

Table 5 – Mechanical requirements common to category A1 fibres

Attributes	Unit	Limits
Proof stress level	GPa	$\geq 0,69$ ^a
Strip force (average) ^b	N	$1,0 \leq F_{\text{ave.strip}} \leq 5,0$
Strip force (peak) ^b	N	$1,0 \leq F_{\text{peak.strip}} \leq 8,9$
Tensile strength (median) for 0,5 m specimen length	GPa	$\geq 3,8$
Stress corrosion susceptibility constant	n _d	≥ 18
^a The proof stress of 0,69 GPa equals about 1 % strain or about 8,8 N force, for A1a and A1b fibres. For the relation between these different units, see 7.4 of IEC/TR 62048. ^b Either average strip force or peak strip force, which are defined in the test procedure, may be specified by agreement between the supplier and the customer.		

3.4 Transmission requirements

Transmission attributes and measurement methods are given in Table 6.

Table 7 lists additional attributes that shall be specified by each family specification.

Table 6 – Transmission attributes and measurement methods

Attributes	Measurement methods
Attenuation coefficient ^a	IEC 60793-1-40
Modal bandwidth ^a	IEC 60793-1-41
Numerical aperture	IEC 60793-1-43
Chromatic dispersion ^b	IEC 60793-1-42
Change of optical transmission	IEC 60793-1-46
Macrobending loss	IEC 60793-1-47
Differential mode delay	IEC 60793-1-49
^a When measuring attenuation and modal bandwidth, the appropriate launching conditions should be applied. These may differ from those prescribed in the test methods to which reference is made. ^b Specification compliance of chromatic dispersion can be assured by compliance to the numerical aperture specification.	

**Table 7 – Additional transmission attributes required
in family specifications**

Attributes
Attenuation coefficient
Modal bandwidth
Chromatic dispersion
Numerical aperture
Macrobending loss

For attenuation coefficient and modal bandwidth, the family specification contains ranges of specifiable values instead of fixed limits. The actual values of the maximum attenuation coefficient and minimum modal bandwidth, at both 850 nm and 1 300 nm (or just at one of these wavelengths) are to be agreed between the supplier and the customer. For commercial purposes, the modal bandwidth is linearly normalized to 1 km.

For guidance purposes on bandwidth, Table H.1 shows a number of internationally standardised applications supported by A1 fibres, and Table H.2 gives a (limited) number of frequently used commercial bandwidth specifications for A1a and A1b fibres.

The indicated maximum attenuation values apply to uncabled optical fibres; for the maximum cabled attenuation values, reference is made to IEC 60794-1-1, which can be used in conjunction with this standard.

Remarks on the specification of modal bandwidth:

Care should be taken in writing dual wavelength bandwidth specifications. For category A1 fibres, the bandwidth at 850 nm may be related to the bandwidth at 1 300 nm in a way shown in Figure 1, depending on the refractive index parameter, g , (see 5.1 of IEC 60793-2). The shaded region under the curve of Figure 1 can be defined as the dual window area. In this area, regions X, Y, and Z are examples of where a fibre manufacturer may choose to optimise the process. That is, centre the production at 850 nm, 1 300 nm, or between these two wavelengths.

Due to this optimisation of the manufacturing process, there will be combinations of bandwidth that are not possible. For example, it is practically impossible to produce a fibre with the maximum of both indicated bandwidth ranges (e.g. 800 MHz·km / 1 000 MHz·km for A1b multimode fibres).

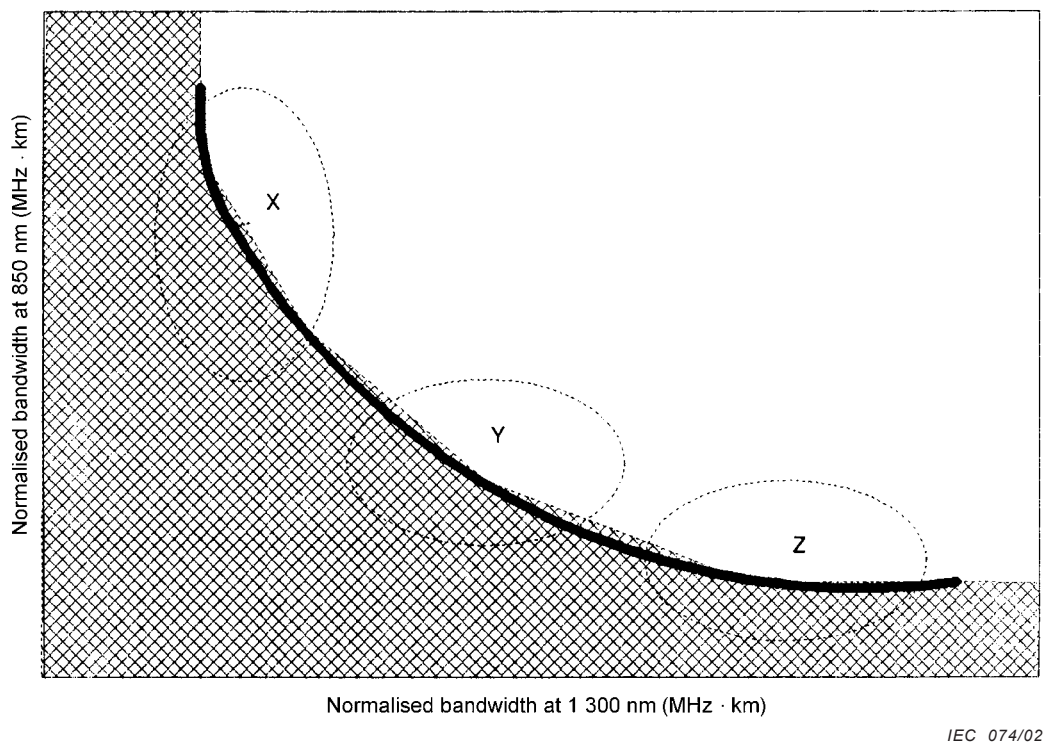


Figure 1 – Relation between bandwidths at 850 nm and 1 300 nm

3.5 Environmental requirements

3.5.1 Overview

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

- Relevant environmental attributes and test procedures are given in Table 8.
- Measurements of a particular mechanical or transmission attribute that may change on the application of the environment are listed in Table 9.

Table 8 – Environmental exposure tests

Environmental exposure	Test
Damp heat	IEC 60793-1-50
Dry heat	IEC 60793-1-51
Change of temperature	IEC 60793-1-52
Water immersion	IEC 60793-1-53

Table 9 – Attributes measured for environmental tests

Attribute	Measurement method
Change in optical transmission	IEC 60793-1-46
Attenuation	IEC 60793-1-40
Strip force	IEC 60793-1-32
Tensile strength	IEC 60793-1-31
Stress corrosion susceptibility	IEC 60793-1-33