

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Optical fibres –

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

Fibres optiques –

Partie 2-10: Spécifications de produits – Spécification intermédiaire pour les fibres multimodales de catégorie A1



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Optical fibres –

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

Fibres optiques –

**Partie 2-10: Spécifications de produits – Spécification intermédiaire pour les
fibres multimodales de catégorie A1**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.180.10

ISBN 978-2-8322-6920-6

Warning! Make sure that you obtained this publication from an authorized distributor.

Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	8
3 Terms and definitions	9
4 Abbreviated terms	10
5 Specifications	10
5.1 General	10
5.2 Dimensional requirements	10
5.3 Mechanical requirements	12
5.4 Transmission requirements	12
5.5 Environmental requirements	14
5.5.1 General	14
5.5.2 Mechanical environmental requirements (common to all fibres in category A1)	15
5.5.3 Transmission environmental requirements	16
Annex A (normative) Specifications for sub-categories A1-OM2, A1-OM3, A1-OM4 and A1-OM5 multimode fibres	17
A.1 General	17
A.2 Dimensional requirements	17
A.3 Mechanical requirements	18
A.4 Transmission requirements	18
A.5 Environmental requirements	20
Annex B (normative) Specifications for sub-category A1-OM1 multimode fibres	21
B.1 General	21
B.2 Dimensional requirements	21
B.3 Mechanical requirements	21
B.4 Transmission requirements	22
B.5 Environmental requirements	22
Annex C (normative) Specifications for sub-category A1d multimode fibres	23
C.1 General	23
C.2 Dimensional requirements	23
C.3 Mechanical requirements	23
C.4 Transmission requirements	24
C.5 Environmental requirements	24
Annex D (normative) Fibre differential mode delay (DMD), calculated effective modal bandwidth (EMB _c) and calculated overfilled modal bandwidth (OMB _c) requirements	25
D.1 A1-OM3 fibre DMD requirements	25
D.1.1 General	25
D.1.2 DMD templates	25
D.1.3 DMD interval masks	26
D.2 A1-OM3 fibre EMB _c requirements	27
D.2.1 General	27
D.2.2 Calculated effective bandwidth	27
D.3 A1-OM4 DMD requirements	29
D.3.1 General	29

D.3.2	DMD templates	29
D.3.3	DMD interval masks	30
D.4	A1-OM4 fibre EMB _C requirements	30
D.4.1	General	30
D.4.2	Calculated effective bandwidth	30
D.5	A1-OM5 fibre modal bandwidth requirements	30
D.5.1	General	30
D.5.2	Calculated effective modal bandwidth	31
D.6	A1-OM2, A1-OM3, A1-OM4 and A1-OM5 calculated overfilled modal bandwidth	31
Annex E (informative)	System, modal bandwidth, and transmitter considerations	33
E.1	Background	33
E.2	System considerations	33
E.2.1	A1-OM3 and A1-OM4 fibres	33
E.2.2	A1-OM5 fibre	33
E.3	Effective modal bandwidth (EMB)	34
E.4	Transmitter encircled flux (EF) and centre wavelength requirements	37
E.4.1	Encircled flux	37
E.4.2	Centre wavelength for A1-OM3 and A1-OM4 fibres	38
E.4.3	Centre wavelength for A1-OM5 fibre	38
Annex F (informative)	Bandwidth nomenclature explanation	40
Annex G (informative)	Preliminary indications for items needing further study	41
G.1	Effective modal bandwidth (EMB) at 1 300 nm	41
G.2	Scaling of EMB with DMD	41
Annex H (informative)	Applications and cabling categories supported by A1 fibres	43
Annex I (informative)	1-Gigabit, 10-Gigabit, 25-Gigabit, 40-Gigabit and 100-Gigabit Ethernet applications	44
Bibliography		50
Figure 1	– Relation between bandwidths at 850 nm and 1 300 nm	14
Figure D.1	– DMD template requirements	26
Figure E.1	– Estimated minimum wide band EMB versus wavelength for A1-OM3	35
Figure E.2	– Estimated minimum wide band EMB versus wavelength for A1-OM4	36
Figure E.3	– Estimated minimum wide band EMB versus wavelength for A1-OM5	37
Figure E.4	– Approximate position of DMD weightings relative to the EF boundaries of Equations (E.10) and (E.11)	38
Table 1	– Cross reference IEC A1 multimode fibre designations to IEC 60793-2-10:2017	8
Table 2	– Dimensional attributes and measurement methods	11
Table 3	– Dimensional requirements common to category A1 fibres	11
Table 4	– Additional dimensional attributes required in sub-category specifications	11
Table 5	– Mechanical attributes and measurement methods	12
Table 6	– Mechanical requirements common to category A1 fibres	12
Table 7	– Transmission attributes and measurement methods	13
Table 8	– Additional transmission attributes required in sub-category specifications	13
Table 9	– Environmental exposure tests	15

Table 10 – Attributes measured for environmental tests	15
Table 11 – Strip force for environmental tests	15
Table 12 – Tensile strength for environmental tests	16
Table 13 – Stress corrosion susceptibility for environmental tests	16
Table 14 – Change in attenuation for environmental tests	16
Table A.1 – Dimensional requirements specific to A1-OM2, A1-OM3, A1-OM4 and A1-OM5 fibres	18
Table A.2 – Mechanical requirements specific to A1-OM2, A1-OM3, A1-OM4 and A1-OM5 fibres	18
Table A.3 – Transmission requirements specific to A1-OM2, A1-OM3, A1-OM4 and A1-OM5 fibres	19
Table B.1 – Dimensional requirements specific to A1-OM1 fibres	21
Table B.2 – Mechanical requirements specific to A1-OM1 fibres	21
Table B.3 – Transmission requirements specific to A1-OM1 fibres	22
Table C.1 – Dimensional requirements specific to A1d fibres	23
Table C.2 – Mechanical requirements specific to A1d fibres	23
Table C.3 – Transmission requirements specific to A1d fibres	24
Table D.1 – DMD templates for A1-OM3 fibres	25
Table D.2 – DMD interval masks for A1-OM3 fibres	27
Table D.3 – DMD weightings	28
Table D.4 – DMD templates for A1-OM4 fibres	30
Table D.5 – DMD interval masks for A1-OM4 fibres	30
Table D.6 – DMD weighting for OMB _C	32
Table F.1 – Bandwidth nomenclature explanation	40
Table H.1 – Some standardised applications supported by A1-OM2, A1-OM3, A1-OM4, A1-OM5 fibres and in some cases A1-OM1 fibres	43
Table I.1 – Summary of 1 Gb/s, 10 Gb/s, 25 Gb/s, 40 Gb/s and 100 Gb/s Ethernet requirements and capabilities	45

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRES –

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60793-2-10 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This seventh edition cancels and replaces the sixth edition published in 2017. This edition constitutes a technical revision.

This edition includes the following significant change with respect to the previous edition: revision of the naming convention for A1 multimode fibres, which better matches with those found in ISO/IEC standards. These changes are outlined in the scope of this document along with a cross reference table for the new names.

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

FDIS	Report on voting
86A/1932/FDIS	86A/1939/RVD

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.

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

1 Scope

This part of IEC 60793 is applicable to optical fibre sub-categories A1-OM1, A1-OM2, A1-OM3, A1-OM4, A1-OM5, and A1d. These fibres are used or can be incorporated in information transmission equipment and optical fibre cables.

Sub-categories A1-OM2, A1-OM3, A1-OM4 and A1-OM5 apply to 50/125 μm graded index fibre in four bandwidth grades. Each of these bandwidth grades is defined for two levels of macrobend loss performance that are distinguished by "a" or "b" suffix. Those sub-categories with suffix "a" are specified to meet traditional macrobend loss performance levels. Those sub-categories with suffix "b" are specified to meet enhanced macrobend loss (i.e. lower loss) performance levels.

Sub-category A1-OM5 is specified to support single wavelength or multi-wavelength transmission systems in the vicinity of 850 nm to 950 nm. Although not normatively specified, bandwidth information covering this wavelength range is also included for A1-OM3 and A1-OM4.

Sub-category A1-OM1 applies to 62,5/125 μm graded index fibre and sub-category 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, local area networks (LANs), storage area networks (SANs), private branch exchanges (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 document and which are given in Clause 5;
- particular requirements applicable to individual fibre sub-categories and models, or specific applications, which are defined in the normative specification Annexes A to D.

Table 1 shows the cross reference between the IEC A1 multimode optical fibre designations used in this document compared to those used in IEC 60793-2-10:2017. The table also refers to the normative annexes A, B and C for the A1 sub-category multimode fibres in this document that contains the detailed specification.

Table 1 – Cross reference IEC A1 multimode fibre designations to IEC 60793-2-10:2017

Annex	Sub-category	Sub-category/Model	Core diameter (nominal)	ISO/IEC 11801-1:2017
	This document designations	IEC 60793-2-10:2017 designations		Usage of cabled OMx fibres
A	A1-OM2	A1a.1	50 µm ^a	OM2 ^b
	A1-OM3	A1a.2	50 µm	OM3
	A1-OM4	A1a.3	50 µm	OM4
	A1-OM5	A1a.4	50 µm	OM5
B	A1-OM1	A1b	62,5 µm ^c	OM1 ^d
C	A1d	A1d	100 µm	-
^a Historically, ISO/IEC 11801:2002 also defined OM2 cables made with 62,5/125 µm fibres having a minimum overfilled launch bandwidth of 500 MHz·km at 850 nm and 500 MHz·km at 1 300 nm. This specific bandwidth combination of 62,5/125 µm fibre is not part of this document. ^b OM2 cables are not supported for new installations within ISO/IEC 11801-1:2017. ^c Historically, ISO/IEC 11801:2002 also defined OM1 cables made with 50/125 µm fibres having a minimum overfilled launch bandwidth of 200 MHz·km at 850 nm and 500 MHz·km at 1 300 nm. This specific bandwidth combination of 50/125 µm fibre is not part of this document. ^d OM1 cables are not supported for new installations within ISO/IEC 11801-1:2017.				

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 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 60793-1-40, *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 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, *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) 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 60793-1-53, *Optical fibres – Part 1-53: Measurement methods and test procedures – Water immersion tests*

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

IEC 61280-4-1:2009, *Fibre-optic communication subsystem test procedures – Part 4-1: Installed cable plant – Multimode attenuation measurement*

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>