

# 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 © 2017 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  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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 corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions 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](http://std.iec.ch/glossary)

65 000 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.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://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: [csc@iec.ch](mailto:csc@iec.ch).

#### 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.

#### Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### Recherche de publications IEC - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions 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](http://std.iec.ch/glossary)

65 000 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.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).

# 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 978-2-8322-4627-6

**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 .....	7
3 Terms, definitions .....	8
4 Abbreviated terms .....	8
5 Specifications .....	9
5.1 General.....	9
5.2 Dimensional requirements.....	9
5.3 Mechanical requirements .....	10
5.4 Transmission requirements .....	11
5.5 Environmental requirements .....	13
5.5.1 General .....	13
5.5.2 Mechanical environmental requirements (common to all fibres in category A1).....	14
5.5.3 Transmission environmental requirements.....	14
Annex A (normative) Specifications for sub-category A1a multimode fibres.....	16
A.1 General.....	16
A.2 Dimensional requirements.....	16
A.3 Mechanical requirements .....	17
A.4 Transmission requirements .....	17
A.5 Environmental requirements .....	18
Annex B (normative) Specifications for sub-category A1b multimode fibres.....	19
B.1 General.....	19
B.2 Dimensional requirements.....	19
B.3 Mechanical requirements .....	19
B.4 Transmission requirements .....	19
B.5 Environmental requirements .....	20
Annex C (normative) Specifications for sub-category A1d multimode fibres .....	21
C.1 General.....	21
C.2 Dimensional requirements.....	21
C.3 Mechanical requirements .....	21
C.4 Transmission requirements .....	21
C.5 Environmental requirements .....	22
Annex D (normative) Fibre differential mode delay (DMD), calculated effective modal bandwidth (EMB <sub>C</sub> ) and calculated overfilled modal bandwidth (OMB <sub>C</sub> ) requirements .....	23
D.1 A1a.2 fibre DMD requirements .....	23
D.1.1 General .....	23
D.1.2 DMD templates.....	23
D.1.3 DMD interval masks.....	24
D.2 A1a.2 fibre EMB <sub>C</sub> requirements.....	25
D.2.1 General .....	25
D.2.2 Calculated effective bandwidth .....	25
D.3 A1a.3 DMD requirements .....	27
D.3.1 General .....	27

D.3.2	DMD templates .....	27
D.3.3	DMD interval masks .....	28
D.4	A1a.3 fibre EMB <sub>C</sub> requirements .....	28
D.4.1	General .....	28
D.4.2	Calculated effective bandwidth .....	28
D.5	A1a.4 fibre modal bandwidth requirements .....	28
D.5.1	General .....	28
D.5.2	Calculated effective modal bandwidth .....	28
D.5.3	Calculated overfilled modal bandwidth .....	29
Annex E (informative)	System, modal bandwidth, and transmitter considerations .....	30
E.1	Background .....	30
E.2	System considerations .....	30
E.2.1	A1a.2 and A1a.3 fibres .....	30
E.2.2	A1a.4 fibre .....	30
E.3	Effective modal bandwidth (EMB) .....	31
E.4	Transmitter encircled flux (EF) and centre wavelength requirements .....	32
E.4.1	Encircled flux .....	32
E.4.2	Centre wavelength for A1a.2 and A1a.3 fibres .....	33
E.4.3	Centre wavelength for A1a.4 fibre .....	33
Annex F (informative)	Bandwidth nomenclature explanation .....	34
Annex G (informative)	Preliminary indications for items needing further study .....	35
G.1	Effective modal bandwidth (EMB) at 1 300 nm .....	35
G.2	Scaling of EMB with DMD .....	35
Annex H (informative)	Applications and cabling categories supported by A1 fibres .....	37
H.1	Standardised applications .....	37
H.2	Cross reference of cabled optical fibre performance categories in ISO/IEC 11801-1 to fibres of this document .....	37
Annex I (informative)	1-Gigabit, 10-Gigabit, 25-Gigabit, 40-Gigabit and 100-Gigabit Ethernet applications .....	39
Bibliography	.....	44
Figure 1	– Relation between bandwidths at 850 nm and 1 300 nm .....	13
Figure D.1	– DMD template requirements .....	24
Figure E.1	– Estimated minimum wide band EMB versus wavelength .....	32
Figure E.2	– Approximate position of DMD weightings relative to the EF boundaries of Equations (E.6), and (E.7) .....	33
Table 1	– Dimensional attributes and measurement methods .....	9
Table 2	– Dimensional requirements common to category A1 fibres .....	10
Table 3	– Additional dimensional attributes required in sub-category specifications .....	10
Table 4	– Mechanical attributes and measurement methods .....	10
Table 5	– Mechanical requirements common to category A1 fibres .....	11
Table 6	– Transmission attributes and measurement methods .....	11
Table 7	– Additional transmission attributes required in sub-category specifications .....	12
Table 8	– Environmental exposure tests .....	13
Table 9	– Attributes measured for environmental tests .....	13
Table 10	– Strip force for environmental tests .....	14

Table 11 – Tensile strength for environmental tests .....	14
Table 12 – Stress corrosion susceptibility for environmental tests .....	14
Table 13 – Change in attenuation for environmental tests .....	15
Table A.1 – Dimensional requirements specific to A1a fibres .....	16
Table A.2 – Mechanical requirements specific to A1a fibres .....	17
Table A.3 – Transmission requirements specific to A1a fibres .....	18
Table B.1 – Dimensional requirements specific to A1b fibres .....	19
Table B.2 – Mechanical requirements specific to A1b fibres .....	19
Table B.3 – Transmission requirements specific to A1b fibres .....	20
Table C.1 – Dimensional requirements specific to A1d fibres .....	21
Table C.2 – Mechanical requirements specific to A1d fibres .....	21
Table C.3 – Transmission requirements specific to A1d fibres .....	22
Table D.1 – DMD templates for A1a.2 fibres .....	23
Table D.2 – DMD interval masks for A1a.2 fibres .....	25
Table D.3 – DMD weightings .....	26
Table D.4 – DMD templates for A1a.3 fibres .....	28
Table D.5 – DMD interval masks for A1a.3 fibres .....	28
Table D.6 – DMD weighting for $OMB_c$ .....	29
Table F.1 – Bandwidth nomenclature explanation .....	34
Table H.1 – Some standardised applications supported by A1a fibres and in some cases A1b fibres .....	37
Table H.2 – Cross reference between ISO/IEC 11801-1 and this document .....	38
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 .....	40

## 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, accept 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 sixth edition cancels and replaces the fifth 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) addition of model A1a.4 fibre which supports single wavelength or multi-wavelength transmission systems in the vicinity of 850 nm to 950 nm.

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

CDV	Report on voting
86A/1771/CDV	86A/1794/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.

**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 A1a, A1b, and A1d. These fibres are used or can be incorporated in information transmission equipment and optical fibre cables.

Sub-category A1a applies to 50/125  $\mu\text{m}$  graded index fibre. Four bandwidth grades are defined as models A1a.1, A1a.2, A1a.3 and A1a.4. Each of these bandwidth grades is defined for two levels of macrobend loss performance that are distinguished by "a" or "b" suffix. Those models with suffix "a" are specified to meet traditional macrobend loss performance levels. Those models with suffix "b" are specified to meet enhanced macrobend loss (i.e. lower loss) performance levels. Model A1a.4 supports single wavelength or multi-wavelength transmission systems in the vicinity of 850 nm to 950 nm.

Sub-category A1b applies to 62,5/125  $\mu\text{m}$  graded index fibre and sub-category A1d applies to 100/140  $\mu\text{m}$  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.

#### 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 – Core 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*