

STN	Optické vlákna Časť 1-41: Metódy merania a skúšobné postupy Šírka pásma	STN EN IEC 60793-1-41 35 9213
------------	--	---

Optical fibres - Part 1-41: Measurement methods and test procedures - Bandwidth

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 08/24

Obsahuje: EN IEC 60793-1-41:2024, IEC 60793-1-41:2024

Oznámením tejto normy sa od 24.05.2027 ruší
STN EN 60793-1-41 (35 9213) z júla 2011

139094



EUROPEAN STANDARD

EN IEC 60793-1-41

NORME EUROPÉENNE

EUROPÄISCHE NORM

May 2024

ICS 33.180.10

Supersedes EN 60793-1-41:2010

English Version

**Optical fibres - Part 1-41: Measurement methods and test
procedures - Bandwidth
(IEC 60793-1-41:2024)**

Fibres optiques - Partie 1-41: Méthodes de mesure et
procédures d'essai - Largeur de bande
(IEC 60793-1-41:2024)

Lichtwellenleiter - Teil 1-41: Messmethoden und
Prüfverfahren - Bandbreite
(IEC 60793-1-41:2024)

This European Standard was approved by CENELEC on 2024-05-24. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 60793-1-41:2024 (E)**European foreword**

The text of document 86A/2302/CDV, future edition 4 of IEC 60793-1-41, prepared by SC 86A "Fibres and cables" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60793-1-41:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2025-02-24 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-05-24 document have to be withdrawn

This document supersedes EN 60793-1-41:2010 and all of its amendments and corrigenda (if any).

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

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 60793-1-41:2024 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 standard indicated:

IEC 60793-2-10	NOTE	Approved as EN IEC 60793-2-10
IEC 60793-2-30	NOTE	Approved as EN 60793-2-30
IEC 60793-2-40	NOTE	Approved as EN IEC 60793-2-40
IEC 61280-4-1	NOTE	Approved as EN IEC 61280-4-1
IEC 60793-1-42	NOTE	Approved as EN 60793-1-42
IEC 60793-1-1	NOTE	Approved as EN IEC 60793-1-1
IEC 60793-1-22	NOTE	Approved as EN 60793-1-22

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cencenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-1-20	-	Optical fibres - Part 1-20: Measurement methods and test procedures - Fibre geometry	EN 60793-1-20	-
IEC 60793-1-43	-	Optical fibres - Part 1-43: Measurement methods and test procedures - Numerical aperture measurement	EN 60793-1-43	-
IEC 60793-1-49	-	Optical fibres - Part 1-49: Measurement methods and test procedures - Differential mode delay	EN IEC 60793-1-49	-



IEC 60793-1-41

Edition 4.0 2024-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Optical fibres –
Part 1-41: Measurement methods and test procedures – Bandwidth**

**Fibres optiques –
Partie 1-41: Méthodes de mesure et procédures d'essai – Largeur de bande**





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2024 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 Secretariat
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.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 60793-1-41

Edition 4.0 2024-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Optical fibres –

Part 1-41: Measurement methods and test procedures – Bandwidth

Fibres optiques –

Partie 1-41: Méthodes de mesure et procédures d'essai – Largeur de bande

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.180.10

ISBN 978-2-8322-8636-4

**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.....	4
1 Scope.....	6
2 Normative references	6
3 Terms, definitions and abbreviated terms	7
3.1 Terms and definitions.....	7
3.2 Abbreviated terms.....	8
4 Apparatus.....	8
4.1 Radiation source.....	8
4.1.1 Method A – Time domain (pulse distortion) measurement.....	8
4.1.2 Method B – Frequency domain measurement	8
4.1.3 Method C – Overfilled launch modal bandwidth calculated from differential mode delay (OMBc).....	8
4.1.4 For method A and method B	8
4.2 Launch system.....	9
4.2.1 Overfilled launch (OFL).....	9
4.2.2 Restricted mode launch (RML).....	10
4.2.3 Differential mode delay (DMD) launch.....	11
4.3 Detection system	11
4.4 Recording system	11
4.5 Computational equipment	11
4.6 Overall system performance.....	11
5 Sampling and specimens	12
5.1 Test sample	12
5.2 Reference sample.....	12
5.3 End face preparation.....	12
5.4 Test sample packaging	12
5.5 Test sample positioning	12
6 Procedure.....	13
6.1 Method A – Time domain (pulse distortion) measurement	13
6.1.1 Output pulse measurement.....	13
6.1.2 Input pulse measurement method A-1: reference sample from test sample.....	13
6.1.3 Input pulse measurement method A-2: periodic reference sample.....	13
6.1.4 Input pulse measurement method A-3: direct reference	13
6.2 Method B – Frequency domain measurement.....	14
6.2.1 Output frequency response.....	14
6.2.2 Method B-1: Reference length from test specimen	14
6.2.3 Method B-2: Reference length from similar fibre	14
6.2.4 Method B-3: Reference from direct coupling	14
6.3 Method C – Overfilled launch modal bandwidth calculated from differential mode delay (OMBc)	15
7 Calculations or interpretation of results.....	16
7.1 Bandwidth (–3 dB), $f_{3\text{ dB}}$	16
7.2 Calculations for optional reporting methods	16
8 Length normalization	16
9 Results	16

9.1	Information to be provided with each measurement.....	16
9.2	Information available upon request	17
10	Specification information	17
Annex A (normative) Intramodal dispersion factor and the normalized intermodal dispersion limit.....		
		18
A.1	Intramodal dispersion factor, IDF	18
A.2	Normalized intermodal dispersion limit, NIDL	19
A.3	Derivation of the IDF	19
Annex B (normative) Fibre transfer function, $H(f)$, power spectrum, $ H(f) $, and f_3 dB.....		
		21
B.1	Fibre transfer function.....	21
B.1.1	Method A – Time domain (pulse distortion) measurement.....	21
B.1.2	Method B – Frequency-domain measurement	21
B.2	Power spectrum.....	22
B.2.1	Method A – Time domain (pulse distortion) measurement.....	22
B.2.2	Method B – Frequency-domain measurement	22
B.2.3	Bandwidth (–3 dB), f_3 dB.....	22
Annex C (normative) Calculations for other reporting methods.....		
		23
C.1	Fibre impulse response, $h(t)$	23
C.2	RMS impulse response, exact method	23
C.3	RMS impulse response, difference of squares approximation.....	24
Annex D (normative) Mode scrambler requirements for overfilled launching conditions to multimode fibres		
		25
D.1	General.....	25
D.2	Apparatus	25
D.2.1	Light source.....	25
D.2.2	Mode scrambler.....	25
D.2.3	Cladding mode strippers	26
D.3	Sampling and specimens	27
D.4	Procedure	27
D.4.1	Qualification of mode scrambler.....	27
D.4.2	Alignment of test fibre in mode scrambler output	28
D.4.3	Measurement test	28
D.5	Calculations or interpretation of results	28
D.6	Results	29
D.6.1	Information to be provided with each measurement	29
D.6.2	Information available upon request	29
Bibliography.....		
		30
Figure 1 – Mandrel wrapped mode filter		
		10
Figure D.1 – Two examples of optical fibre scramblers		
		26
Table 1 – Abbreviated terms		
		8
Table 2 – DMD weights for calculating overfilled modal bandwidth (OMBc) from DMD data for 850 nm only		
		15
Table A.1 – Highest expected dispersion for commercially available A1 fibres		
		18

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRES –

Part 1-41: Measurement methods and test procedures – Bandwidth

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60793-1-41 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2010. This edition constitutes a technical revision.

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

- a) the addition of a direct reference for method A and method B.

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

Draft	Report on voting
86A/2302/CDV	86A/2365/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 60793 series, published under the general title *Optical fibres – Measurement methods and test procedures*, 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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 1-41: Measurement methods and test procedures – Bandwidth

1 Scope

This part of IEC 60793 describes three methods for determining and measuring the modal bandwidth of multimode optical fibres (see IEC 60793-2-10, IEC 60793-2-30, and the IEC 60793-2-40 series). The baseband frequency response is directly measured in the frequency domain by determining the fibre response to a sinusoidally modulated light source. The baseband response can also be measured by observing the broadening of a narrow pulse of light. The calculated response is determined using differential mode delay (DMD) data. The three methods are:

- Method A – Time domain (pulse distortion) measurement
- Method B – Frequency-domain measurement
- Method C – Overfilled launch modal bandwidth calculated from differential mode delay (OMBc)

Method A and method B can be performed using one of two launches: an overfilled launch (OFL) condition or a restricted mode launch (RML) condition. Method C is only defined for A1-OM3 to A1-OM5 multimode fibres and uses a weighted summation of DMD launch responses with the weights corresponding to an overfilled launch condition. The relevant test method and launch condition is chosen according to the type of fibre.

NOTE 1 These test methods are commonly used in production and research facilities and are not easily accomplished in the field.

NOTE 2 OFL has been used for the modal bandwidth value for LED-based applications for many years. However, no single launch condition is representative of the laser (e.g. VCSEL) sources that are used for gigabit and higher rate transmission. This fact drove the development of IEC 60793-1-49 for determining the effective modal bandwidth of laser optimized 50 μm fibres. See IEC 60793-2-10 and IEC 61280-4-1 for more information.

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 60793-1-43, *Optical fibres – Part 1-43: Measurement methods and test procedures – Numerical aperture*

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

koniec náhľadu – text ďalej pokračuje v platenej verzii STN