



BSI Standards Publication

Optical fibres

Part 1-45: Measurement methods and test procedures –
Mode field diameter (IEC 60793-1-45:2017)

National foreword

This British Standard is the UK implementation of EN IEC 60793-1-45:2018. It is identical to IEC 60793-1-45:2017. It supersedes BS EN 60793-1-45:2003, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee 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.

© The British Standards Institution 2018
Published by BSI Standards Limited 2018

ISBN 978 0 580 92160 5

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 28 February 2018.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

English Version

**Optical fibres - Part 1-45: Measurement methods and test
procedures - Mode field diameter
(IEC 60793-1-45:2017)**

Fibre optiques - Partie 1-45: Méthodes de mesure et
procédures d'essai - Diamètre du champ de mode
(IEC 60793-1-45:2017)

Lichtwellenleiter - Teil 1-45: Messmethoden - Messung des
Modenfelddurchmessers
(IEC 60793-1-45:2017)

This European Standard was approved by CENELEC on 2017-12-14. 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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey 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

European foreword

The text of document 86A/1758/CDV, future edition 2 of IEC 60793-1-45, prepared by IEC/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 60793-1-45:2018.

The following dates are fixed:

- latest date by which the document has to be (dop) 2018-09-14
implemented at national level by
publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2020-12-14
standards conflicting with the
document have to be withdrawn

This document supersedes EN 60793-1-45:2003.

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.

Endorsement notice

The text of the International Standard IEC 60793-1-45:2017 was approved by CENELEC as a European Standard without any modification.

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.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60793-1-40 (mod)	2001	Optical fibres -- Part 1-40: Measurement methods and test procedures - Attenuation	EN 60793-1-40	2003
IEC 60793-2	-	Optical fibres -- Part 2: Product specifications.	-	-

CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	7
3 Terms and definitions	7
4 General consideration about mode field diameter	7
5 Reference test method	8
6 Apparatus	8
6.1 General	8
6.2 Light source	8
6.3 Input optics	9
6.4 Input positioner	9
6.5 Cladding mode stripper	9
6.6 High-order mode filter	9
6.7 Output positioner	9
6.8 Output optics	9
6.9 Detector	9
6.10 Computer	9
7 Sampling and specimens	10
7.1 Specimen length	10
7.2 Specimen end face	10
8 Procedure	10
9 Calculations	10
9.1 Basic equations	10
9.2 Method A – Direct far-field scan	10
9.3 Method B – Variable aperture in the far field	11
9.4 Method C – Near-field scan	11
10 Results	12
10.1 Information available with each measurement	12
10.2 Information available upon request	12
11 Specification information	12
Annex A (normative) Requirements specific to method A – Mode field diameter by direct far-field scan	14
A.1 Apparatus	14
A.1.1 General	14
A.1.2 Scanning detector assembly – Signal detection electronics	14
A.1.3 Computer	14
A.2 Procedure	15
A.3 Calculations	15
A.3.1 Determine folded power curve	15
A.3.2 Compute the top (T) and bottom (B) integrals of Equation (1)	15
A.3.3 Complete the calculation	15
A.4 Sample data	16
Annex B (normative) Requirements specific to method B – Mode field diameter by variable aperture in the far field	17
B.1 Apparatus	17

B.1.1	General	17
B.1.2	Output variable aperture assembly	17
B.1.3	Output optics system	18
B.1.4	Detector assembly and signal detection electronics	18
B.2	Procedure	18
B.3	Calculations	18
B.3.1	Determine complementary aperture function	18
B.3.2	Complete the integration	19
B.3.3	Complete the calculation	19
B.4	Sample data	19
Annex C (normative)	Requirements specific to method C – Mode field diameter by near-field scan	20
C.1	Apparatus	20
C.1.1	General	20
C.1.2	Magnifying output optics	20
C.1.3	Scanning detector	20
C.1.4	Detection electronics	21
C.2	Procedure	21
C.3	Calculations	21
C.3.1	Calculate the centroid	21
C.3.2	Fold the intensity profile	22
C.3.3	Compute the integrals	22
C.3.4	Complete the calculation	22
C.4	Sample data	23
Annex D (normative)	Requirements specific to method D – Mode field diameter by optical time domain reflectometer (OTDR)	24
D.1	General	24
D.2	Apparatus	24
D.2.1	OTDR	24
D.2.2	Optional auxiliary switches	24
D.2.3	Optional computer	25
D.2.4	Test sample	25
D.2.5	Reference sample	25
D.3	Procedure	25
D.3.1	Orientation and notation	25
D.4	Calculations	26
D.4.1	Reference fibre mode field diameter	26
D.4.2	Computation of the specimen mode field diameter	27
D.4.3	Validation	27
Annex E (informative)	Sample data sets and calculated values	29
E.1	General	29
E.2	Method A – Mode field diameter by direct far-field scan	29
E.3	Method B – Mode field diameter by variable aperture in the far field	30
E.4	Method C – Mode field diameter by near-field scan	30
Figure 1	– Transform relationships between measurement results	8
Figure A.1	– Far-field measurement set	14
Figure B.1	– Variable aperture by far-field measurement set	17

Figure C.1 – Near-field measurement set-ups	20
Figure D.1 – Optical switch arrangement	25
Figure D.2 – View from reference fibre A	26
Figure D.3 – View from reference fibre B	26
Figure D.4 – Validation example – Comparison of methods.....	27
Table E.1 – Sample data, method A – Mode field diameter by direct far-field scan	29
Table E.2 – Sample data set, method B – Mode field diameter by variable aperture in the far field	30
Table E.3 – Sample data set, method C – Mode field diameter by near-field scan	30

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**OPTICAL FIBRES –
Part 1-45: Measurement methods and test procedures –
Mode field diameter****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 60793-1-45 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2001. This edition constitutes a technical revision.

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

- a) improvement of the description of measurement details for B6 fibre;
- b) correction of Equations (1), (2), (5) and (6);
- c) correction of Table E.1, Table E.2 and Table E.3.

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

CDV	Report on voting
86A/1758/CDV	86A/1802/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.

OPTICAL FIBRES –

Part 1-45: Measurement methods and test procedures – Mode field diameter

1 Scope

This part of IEC 60793 establishes uniform requirements for measuring the mode field diameter (MFD) of single-mode optical fibre, thereby assisting in the inspection of fibres and cables for commercial purposes.

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 60793-1-40:2001, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

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

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>

4 General consideration about mode field diameter

The mode field diameter measurement represents a measure of the transverse extent of the electromagnetic field intensity of the guided mode in a fibre cross section, and it is defined from the far-field intensity distribution as a ratio of integrals known as the Petermann II definition. See Equation (1).

The definitions of mode field diameter are strictly related to the measurement configurations. The mathematical equivalence of these definitions results from transform relationships between measurement results obtained by different implementations summarized in Figure 1 as follows.