

---

---

**Optična vlakna – 1-41. del: Metode merjenja in preskusni postopki Pasovna širina (IEC 60793-1-41:2003)\***

Optical fibres - Part 1-41: Measurement methods and test procedures - Bandwidth (IEC 60793-1-41:2003)

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN 60793-1-41:2004](https://standards.iteh.ai/catalog/standards/sist/f84603aa-8199-46bd-a71a-16af5fe4e55b/sist-en-60793-1-41-2004)

<https://standards.iteh.ai/catalog/standards/sist/f84603aa-8199-46bd-a71a-16af5fe4e55b/sist-en-60793-1-41-2004>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

SIST EN 60793-1-41:2004

<https://standards.iteh.ai/catalog/standards/sist/f84603aa-8199-46bd-a71a-16af5fe4e55b/sist-en-60793-1-41-2004>

EUROPEAN STANDARD

**EN 60793-1-41**

NORME EUROPÉENNE

EUROPÄISCHE NORM

December 2003

ICS 33.180.10

Supersedes EN 60793-1-41:2002

English version

**Optical fibres**  
**Part 1-41: Measurement methods and test procedures –**  
**Bandwidth**  
(IEC 60793-1-41:2003)

Fibres optiques  
Partie 1-41: Méthodes de mesure  
et procédures d'essai –  
Largeur de bande  
(CEI 60793-1-41:2003)

Lichtwellenleiter  
Teil 1-41: Messmethoden  
und Prüfverfahren –  
Bandbreite  
(IEC 60793-1-41:2003)

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN 60793-1-41:2004](https://standards.iteh.ai/catalog/standards/sist/84603aa-8199-46bd-a71a-10411e239134/en-60793-1-41-2003)

This European Standard was approved by CENELEC on 2003-11-01. 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, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

**CENELEC**

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

**Central Secretariat: rue de Stassart 35, B - 1050 Brussels**

## Foreword

The text of document 86A/841/FDIS, future edition 2 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 was approved by CENELEC as EN 60793-1-41 on 2003-11-01.

This European Standard supersedes EN 60793-1-41:2002. It updates and completes the 2002 edition in particular by the restricted mode launch intended for the laser launch transmission system.

This standard is to be read in conjunction with EN 60793-1-1:2003.

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) 2004-08-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2006-11-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B, C and ZA are normative and annexes D and E are informative.

Annex ZA has been added by CENELEC.

EN 60793-1-4X consists of the following parts, under the general title: Optical fibres:

- Part 1-40: Measurement methods and test procedures – Attenuation
- Part 1-41: Measurement methods and test procedures – Bandwidth
- Part 1-42: Measurement methods and test procedures – Chromatic dispersion
- Part 1-43: Measurement methods and test procedures – Numerical aperture
- Part 1-44: Measurement methods and test procedures – Cut-off wavelength
- Part 1-45: Measurement methods and test procedures – Mode field diameter
- Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance
- Part 1-47: Measurement methods and test procedures – Macrobending loss
- Part 1-48: Measurement methods and test procedures – Polarization mode dispersion
- Part 1-49: Measurement methods and test procedures – Differential mode delay

---

## Endorsement notice

The text of the International Standard IEC 60793-1-41:2003 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60793-1-40 NOTE Harmonized as EN 60793-1-40:2003 (modified).

---

## Annex ZA (normative)

### Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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 60793-1-20	2001	Optical fibres Part 1-20: Measurement methods and test procedures - Fibre geometry	EN 60793-1-20	2002
IEC 60793-1-42	2001	Part 1-42: Measurement methods and test procedures - Chromatic dispersion	EN 60793-1-42	2002
IEC 60793-1-43	2001	Part 1-43: Measurement methods and test procedures - Numerical aperture	EN 60793-1-43	2002
IEC 60793-2-10	2002	Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres	EN 60793-2-10	2002
IEC 60793-2-30	2002	Part 2-30: Product specifications - Sectional specification for category A3 multimode fibres	EN 60793-2-30	2002
IEC 60793-2-40	2002	Part 2-40: Product specifications - Sectional specification for category A4 multimode fibres	EN 60793-2-40	2002

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

SIST EN 60793-1-41:2004

<https://standards.iteh.ai/catalog/standards/sist/f84603aa-8199-46bd-a71a-16af5fe4e55b/sist-en-60793-1-41-2004>

NORME  
INTERNATIONALE  
INTERNATIONAL  
STANDARD

CEI  
IEC

60793-1-41

Deuxième édition  
Second edition  
2003-04

---

---

**Fibres optiques –**

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

iTech STANDARD PREVIEW

**Optical fibres –**

**Part 1-41:** SIST EN 60793-1-41:2004

**Measurement methods and test procedures –  
Bandwidth**

© IEC 2003 Droits de reproduction réservés — Copyright - all rights reserved

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'éditeur.

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 the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland  
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale  
International Electrotechnical Commission  
Международная Электротехническая Комиссия

CODE PRIX  
PRICE CODE

U

Pour prix, voir catalogue en vigueur  
For price, see current catalogue

## CONTENTS

FOREWORD .....	5
1 Scope .....	9
2 Normative references .....	9
3 Definition .....	11
4 Apparatus .....	11
4.1 Radiation source .....	11
4.2 Launch system .....	13
4.3 Detection system .....	15
4.4 Recording system .....	17
4.5 Computational equipment .....	17
4.6 Overall system performance .....	17
5 Sampling and specimens .....	17
5.1 Test sample .....	17
5.2 Reference sample .....	19
5.3 End preparation .....	19
5.4 Test sample packaging .....	19
5.5 Test sample positioning .....	19
6 Procedure .....	19
6.1 Method A – Pulse distortion method (optical time domain) input pulse measurement .....	19
6.2 Method B – Frequency domain measurement method .....	21
7 Calculations or interpretation of results .....	23
7.1 –3 dB frequency, $f_{3\text{ dB}}$ .....	23
7.2 Calculations for optional reporting methods .....	23
8 Length normalization .....	23
9 Results .....	23
9.1 Information to be provided with each measurement .....	23
9.2 Informations available upon request .....	25
10 Specification information .....	25
Annex A (normative) Intramodal dispersion factor and the normalized intermodal dispersion limit .....	27
Annex B (normative) Fibre transfer function, $H(f)$ .....	35
Annex C (normative) Calculations for other reporting methods .....	37
Annex D (informative) Comparison between this test method and ITU requirements .....	39
Annex E (informative) Mode scrambler requirements for overfilled launching conditions to multimode fibres .....	41
Bibliography .....	53



## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## OPTICAL FIBRES –

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

## FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60793-1-41 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 new edition updates and completes the earlier edition in particular by the restricted mode launch intended for the laser launch transmission system.

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

FDIS	Report on voting
86A/841/FDIS	86A/853/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This standard is to be read in conjunction with IEC 60793-1-1.

IEC 60793-1-4X consists of the following parts, under the general title *Optical fibres*:

- Part 1-40: Measurement methods and test procedures – Attenuation
- Part 1-41: Measurement methods and test procedures – Bandwidth
- Part 1-42: Measurement methods and test procedures – Chromatic dispersion
- Part 1-43: Measurement methods and test procedures – Numerical aperture
- Part 1-44: Measurement methods and test procedures – Cut-off wavelength
- Part 1-45: Measurement methods and test procedures – Mode field diameter
- Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance
- Part 1-47: Measurement methods and test procedures – Macrobending loss
- Part 1-48: Measurement methods and test procedures – Polarisation mode dispersion <sup>1)</sup>
- Part 1-49: Measurement methods and test procedures – Differential mode delay <sup>2)</sup>

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN 60793-1-41:2004](https://standards.iteh.ai/catalog/standards/sist/f84603aa-8199-46bd-a71a-16af5fe4e55b/sist-en-60793-1-41-2004)

<https://standards.iteh.ai/catalog/standards/sist/f84603aa-8199-46bd-a71a-16af5fe4e55b/sist-en-60793-1-41-2004>

---

1) To be published.

2) To be published.

## OPTICAL FIBRES –

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

#### 1 Scope

This part of IEC 60793 describes two methods for determining and measuring the modal bandwidth of multi-mode optical fibres (see IEC 60793-2-10, IEC 60793-2-30 and IEC 60793-2-40). 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 two methods are the following:

Method A – Optical time domain measurement method (pulse distortion)

Method B – Frequency domain measurement method

Each method can be performed using one of two launches: an overfilled launch (OFL) condition or a restricted mode launch (RML) condition.

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

#### 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 60793-1-20:2001, *Optical Fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

IEC 60793-1-42:2001, *Optical fibres – Part 1-42: Measurement methods and test procedures – Chromatic dispersion*

IEC 60793-1-43:2001, *Optical fibres – Part 1-43: Measurement methods and test procedures – Numerical aperture*

IEC 60793-2-10:2001, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

IEC 60793-2-30:2002, *Optical fibres – Part 2-30: Product specifications – Sectional specification for category A3 multimode fibres*

IEC 60793-2-40:2002, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

### 3 Definitions

For the purposes of this part of IEC 60793, the following definition applies.

#### **bandwidth (–3 dB)**

the value numerically equal to the lowest modulation frequency at which the magnitude of the baseband transfer function of an optical fibre decreases to a specified fraction, generally to one half, of the zero frequency value.

NOTE Various methods of reporting the results are described in the annexes, but the results shall be expressed in terms of the –3 dB (optical power) frequency unless otherwise specified by the detail specification.

### 4 Apparatus

#### 4.1 Radiation source

##### 4.1.1 Optical time domain measurement method (pulse distortion measurement) (Method A)

Use a radiation source such as an injection laser diode that produces short duration, narrow spectral width pulses for the purposes of the measurement. The pulse distortion measurement method requires the capability to switch the energy of the light sources electrically, optically or mechanically.

##### 4.1.2 Frequency domain measurement method (Method B)

Use a radiation source such as a continuous wave (CW) injection laser diode for the purposes of the measurement. The frequency domain measurement method requires the capability to modulate the energy of the light sources electrically, optically or mechanically.

##### 4.1.3 For both methods

- a) Use a radiation source with a center wavelength that is known and within  $\pm 10$  nm of the nominal specified wavelength. For injection laser diodes, laser emission coupled into the fibre must exceed spontaneous emission by a minimum of 15 dB (optical).
- b) Use a source with sufficiently narrow linewidth to assure the measured bandwidth is at least 90 % of the intermodal bandwidth. This is accomplished by calculating the normalized intermodal dispersion limit, NIDL (refer to Annex A). For A4 fibre, the linewidth of the laser diode is narrow enough to neglect its contribution to bandwidth measurement.
- c) For A1 and A3 fibres, calculate the normalized intermodal dispersion limit (NIDL, see Annex A) for each measurement wavelength from the optical source spectral width for that wavelength as follows:

$$NIDL = IDF/\Delta\lambda$$

where:

*NIDL* is the normalized intermodal dispersion limit in GHz·km;

$\Delta\lambda$  is the source full width half maximum (FWHM) spectral width in nm;

*IDF* is the intramodal dispersion factor (GHz·km·nm) from Annex A according to the wavelength of the source.

*NIDL* is not defined for wavelengths from 1 200 nm to 1 400 nm. The source spectral width for these wavelengths shall be less than or equal to 10 nm, FWHM.