

Optical fibres —

Part 1-40: Measurement methods and test procedures — Attenuation

The European Standard EN 60793-1-40:2003 has the status of a
British Standard

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National foreword

This British Standard is the official English language version of EN 60793-1-40:2003. It was derived by CENELEC from IEC 60793-1-40:2001. It partially supersedes BS EN 188000:1994 which will be withdrawn on publication of the full BS EN 60793-1 series.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by tags (C) (C).

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/1, Optical fibres and cables, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Part 1-40: Measurement methods and test procedures –
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Fibres optiques
Partie 1-40: Méthodes de mesure
et procédures d'essai –
Affaiblissement
(CEI 60793-1-40:2001, modifiée)

Lichtwellenleiter
Teil 1-40: Messmethoden und
Prüfverfahren –
Dämpfung
(IEC 60793-1-40:2001, modifiziert)

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/669/FDIS, future edition 1 of IEC 60793-1-40, 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 60793-1-40 on 2001-10-01.

A draft amendment, prepared by the Technical Committee CENELEC TC 86A, Optical fibres and optical fibre cables, was submitted to the Unique Acceptance Procedure and was approved by CENELEC for inclusion into EN 60793-1-40 on 2003-11-01.

This European Standard supersedes subclause 4.5 (test method 301), subclause 4.6 (test method 302) and subclause 4.7 (test method 303) of EN 188000:1992.

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) 2004-11-01
- 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.

In this standard, Annexes A, B, C, D and ZA are normative.

Annex ZA has been added by CENELEC.

Compared to IEC 60793-1:1989 and IEC 60793-2:1992, IEC/SC 86A has adopted a revised structure of the new IEC 60793 series: The individual measurement methods and test procedures for optical fibres are published as "Part 1-XX"; the product standards are published as "Part 2-XX".

The general relationship between the new series of EN 60793 and the superseded European Standards of the EN 188000 series is as follows:

EN	Title	supersedes
EN 60793-1-XX	Optical fibres -- Part 1-XX: Measurement methods and test procedures	Individual subclauses of EN 188000:1992
EN 60793-2-XX	Optical fibres -- Part 2-XX: Product specifications	EN 188100:1995 EN 188101:1995 EN 188102:1995 EN 188200:1995 EN 188201:1995 EN 188202:1995

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 60793-1-40:2001 was approved by CENELEC as a European Standard with agreed common modifications.

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INTRODUCTION

Publications in the IEC 60793-1 series concern measurement methods and test procedures as they apply to optical fibres.

Within the same series several different areas are grouped, as follows:

- parts 1-10 to 1-19: General
- parts 1-20 to 1-29: Measurement methods and test procedures for dimensions
- parts 1-30 to 1-39: Measurement methods and test procedures for mechanical characteristics
- parts 1-40 to 1-49: Measurement methods and test procedures for transmission and optical characteristics
- parts 1-50 to 1-59: Measurement methods and test procedures for environmental characteristics.

OPTICAL FIBRES –

Part 1-40: Measurement methods and test procedures – Attenuation

1 Scope

This part of IEC 60793 establishes uniform requirements for measuring the attenuation of optical fibre, thereby assisting in the inspection of fibres and cables for commercial purposes.

Four methods are described for measuring attenuation, one of which being that for modelling spectral attenuation:

- method A: cut-back;
- method B: insertion loss;
- method C: backscattering;
- method D: modelling spectral attenuation.

Methods A to C apply to the measurement of attenuation for all categories of the following fibres:

- class A multimode fibres;
- class B single-mode fibres.

Method C, backscattering, also covers the location, losses and characterization of point discontinuities.

To date, method D has been demonstrated only on class B fibres.

Information common to all three measurements, and to the modelling method, appears in clauses 1 to 8, and information pertaining to each individual method appears in annexes A, B, C, and D, respectively.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60793. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60793 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60793-1-22, *Optical fibres – Part 1-22: Measurement methods and test procedures – Length*

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

3 Definitions

For the purpose of this part of IEC 60793, the following definitions apply.

NOTE Attenuation is a measure of the decreasing optical power in a fibre at a given wavelength. It depends on the nature and length of the fibre and is also affected by measurement conditions.

Uncontrolled launching conditions normally excite higher order lossy modes that produce transient losses and result in attenuation that is not proportional to the length of the fibre. A controlled, steady-state launching condition yields attenuation that is proportional to the fibre's length. Under steady-state conditions, an attenuation coefficient of a fibre can be determined and the attenuation of concatenated fibres added linearly.

3.1

attenuation

attenuation of a fibre at wavelength λ between two cross-sections, 1 and 2, separated by a distance and defined as

$$A(\lambda) = \left| 10 \log_{10} \frac{P_1(\lambda)}{P_2(\lambda)} \right| \quad (1)$$

where

$A(\lambda)$ is the attenuation, in dB, at wavelength λ ;

$P_1(\lambda)$ is the optical power traversing cross-section 1;

$P_2(\lambda)$ is the optical power traversing cross-section 2.

3.2

attenuation coefficient

attenuation per unit length

for a uniform fibre under steady state conditions, it is possible to define the attenuation per unit length or the attenuation coefficient as follows:

$$\alpha(\lambda) = \frac{A(\lambda)}{L} \quad (2)$$

which is independent of the chosen length of the fibre;

where

$\alpha(\lambda)$ is the attenuation coefficient;

$A(\lambda)$ is the attenuation at wavelength λ ;

L is the length, in kilometres.

3.3

spectral attenuation modelling

technique that predicts the attenuation coefficients across a spectrum of wavelengths from a small number (three to five) of discrete values measured directly

3.4

point discontinuities

temporary or permanent local deviation of the continuous OTDR signal in the upward or downward direction

NOTE The nature of the deviation can vary with test conditions (e.g. pulse duration, wavelength, and direction of the OTDR signal). Although a point discontinuity can have a length greater than the corresponding displayed pulse duration (including transmitter and receiver effects), the length is usually about equal to the pulse duration. For a correct interpretation, the guidelines in IEC 60793-1-22 should be followed for measuring length.

4 Calibration requirements

Under consideration.

5 Reference test method

Method A, cut-back, is the reference test method (RTM), which shall be the one used to settle disputes.

6 Apparatus

Annexes A, B, C, and D include layout drawings and other equipment requirements for each of the methods, respectively.

7 Sampling and specimens

7.1 Specimen length

The specimen shall be a known length of fibre on a reel, or within a cable, as specified in the detail specification.

7.2 Specimen end face

Prepare a flat end face, orthogonal to the fibre axis, at the input and output ends of each specimen.

8 Procedure

See annexes A, B, C and D for methods A, B, C and D, respectively.

9 Calculations

9.1 Methods A and B

Methods A and B, cut-back and insertion loss, respectively, use equations (1) and (2), which appear in 3.1 and 3.2.