

Optical fibres —

Part 1-49: Measurement methods and test procedures — Differential mode delay

The European Standard EN 60793-1-49:2003 has the status of a
British Standard

ICS 33.180.10

National foreword

This British Standard is the official English language version of EN 60793-1-49:2003. It is identical with IEC 60793-1-49:2003. It supersedes DD IEC/PAS 60793-1-49:2002 which is withdrawn.

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:

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- 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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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, the EN foreword page, pages 3 to 17, the Annex ZA page, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 15 December 2003

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ISBN 0 580 43076 6

Optical fibres
Part 1-49: Measurement methods and test procedures –
Differential mode delay
(IEC 60793-1-49:2003)

Fibres optiques
Partie 1-49: Méthodes de mesure
et procédures d'essai –
Retard différentiel de mode
(CEI 60793-1-49:2003)

Lichtwellenleiter
Teil 1-49: Messmethoden
und Prüfverfahren –
Gruppenlaufzeitdifferenz
(IEC 60793-1-49:2003)

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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.

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CENELEC

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

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Foreword

The text of document 86A/842/FDIS, future edition 1 of IEC 60793-1-49, 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 60793-1-49 on 2003-11-01.

This European 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 B and ZA are normative and annexes A and C 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 60793-1-49:2003 was approved by CENELEC as a European Standard without any modification.

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OPTICAL FIBRES –

PART 1-49: Measurement methods and test procedures – Differential mode delay

1 Scope

This part of IEC 60793 describes a method for characterizing the modal structure of a graded-index multimode fibre. This information is useful for assessing the bandwidth performance of a fibre when used with laser sources.

With this method, the output from a fibre that is single-mode at the test wavelength excites the multimode fibre under test. The probe spot is scanned across the endface of the fibre under test, and the optical pulse delay is determined at specified offset positions. The difference in optical pulse delay time between the fastest and slowest modes of the fibre under test is determined. The user specifies the upper and lower limits of radial offset positions over which the probe fibre is scanned in order to specify desired limits of modal structure.

This standard applies only to multimode, graded-index glass-core (category A1) fibres. The test method is commonly used in production and research facilities, but is 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 60793-1-1, *Optical fibres – Part 1: Generic specification – Section 1: General*

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

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

IEC 60793-1-45, *Optical fibres – Part 1-45: Measurement methods and test procedures – Mode field diameter*

3 Terms and definitions

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

3.1

inner limit

R_{inner}

outer limit

R_{outer}

limits of radial offset positions on the endface of the fibre under test over which the probe spot is scanned

3.2

Differential Mode Delay DMD

estimated difference in optical pulse delay time between the fastest and slowest modes excited for all radial offset positions between and including R_{INNER} and R_{OUTER}

4 Apparatus

4.1 Optical source

Use an optical source that introduces short duration, narrow spectral width pulses into the probe fiber.

The temporal duration of the optical pulse shall be short enough to measure the intended differential delay time. The maximum duration allowed for the optical pulse, characterized as full width at 25 % of maximum amplitude, will depend both on the value of DMD to be determined and the sample length. For example, if the desired length-normalized DMD limit is 0,20 ps/m over a sample of length 500 m, the DMD to be measured is 100 ps, and a pulse of duration less than ~110 ps is needed. Testing to the same DMD limit in a 10 000 m length of fiber requires measuring a DMD of 2 000 ps, and a pulse as wide as ~2 200 ps may be used. Detailed limits are given in 6.1, and may depend on the source spectral width.

Chromatic dispersion induced broadening resulting from source spectral width shall be within the limits indicated in Annex B. The requirement on spectral width may be met either by using a spectrally narrow source, or alternatively by the use of appropriate optical filtering at either the source or detection end.

The centre wavelength shall be within ± 10 nm of the nominal specified wavelength.

A mode locked titanium-sapphire laser is an example of a source usable for this application.

4.2 Stability

Devices shall be available to position the input and output ends of the test specimen with sufficient stability and reproducibility to meet the conditions of 4.3 and 4.4.

4.3 Launch system

The probe fibre between the light source and test sample shall propagate only a single mode at the measurement wavelength. The mode field diameter of the probe fibre at λ shall be $(8,7\lambda - 2,39) \pm 0,5 \mu\text{m}$, where λ is the measurement wavelength in micrometers, and the mode field diameter is determined using IEC 60793-1-45. This equation produces a mode field diameter of 5 μm at 850 nm and 9 μm at 1310 nm, which corresponds to commercially available single-mode fibres.

Ensure that the output of the probe fibre is single-mode. One method to do this is to strip higher order modes by wrapping the probe fibre three turns around a 25 mm diameter mandrel.

The output spot of the probe fibre shall be scanned across the endface of the test sample with a positional accuracy less than or equal to $\pm 0,5 \mu\text{m}$.