# IEC 60793-1-40

Edition 2.0 2019-03
REDLINE VERSION

# INTERNATIONAL STANDARD

colour inside

**Optical fibres –**
**Part 1-40: ~~Measurement methods and test procedures~~ – Attenuation measurement methods**



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# OPTICAL FIBRES –

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

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International Standard IEC 60793-1-40 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) Improvement of the calibration requirements for A4 fibre;
c) Introduction of Annex E describing examples of short cable test results on A1 multimode fibres.

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

| FDIS | Report on voting |
|---|---|
| 86A/1909/FDIS | 86A/1927/RVD |

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- withdrawn,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.



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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 measurement methods

## 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 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.~~



Method D is applicable only to class B fibres.

Information common to all ~~three measurements, and to the modelling method~~ four methods appears in Clauses 1 to ~~8~~ 11, and information pertaining to each individual method appears in Annexes A, B, C, and D, respectively.

## 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 60793-1-1, *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance*

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

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

IEC 61746-1, *Calibration of optical time-domain reflectometers (OTDR) – Part 1: OTDR for single mode fibres*

IEC 61746-2, *Calibration of optical time-domain reflectometers (OTDR) – Part 2: OTDR for multimode fibres*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60793-1-1 and the following apply.

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

**3.1**
**attenuation**
attenuation of a fibre at wavelength $\lambda$ 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 $\lambda$;

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

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



Note 1 to entry: 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.

**3.2**
**attenuation coefficient**
~~**attenuation per unit length**~~
attenuation per unit length for a uniform fibre under steady state conditions

Note 1 to entry: 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 $\lambda$;

$L$ is the length, in kilometres.

Note 2 to entry: 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.

**3.3**
**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 at different wavelengths

**3.4**
**point discontinuity**
temporary or permanent local deviation of the continuous optical time-domain reflectometer (OTDR) signal in the upward or downward direction

Note 1 to entry: 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.~~

See Annexes A, B, and C for methods A, B, and C, respectively.

## 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 use Equations (1) and (2) respectively, which appear in 3.1 and 3.2.

### 9.2 Method C

See Annex C.

### 9.3 Method D

See Annex D.

## 10 Results

### 10.1 Information available with each measurement

Report the following information with each measurement:

– date and title of measurement;
– identification of specimen;
– optical source wavelength;
– specimen length;
– spectral attenuation, in dB, or attenuation coefficient, in dB/km, versus wavelength or at specific wavelength(s), as required by the detail specification.

### 10.2 Information available upon request

The following information shall be available upon request:

– measurement method used: A, B, C, or D;
– type of optical source used: ~~central~~ centroidal wavelength(s) and spectral width(s);
– launching technique and conditions used;
– indication if a dead-zone fibre was used (for method C only);
– description of all key equipment;
– for type B fibres – dimensions and number of turns of the mode filter or mode scrambler;
– pulse duration(s), scale range(s), and signal-averaging details;
– details of computation technique (calculation method);
– any deviations to the procedure that were made;
– date of latest calibration of measurement equipment.



### 10.3 Method-specific additional information

For methods C and D, see the additional requirements in Clauses C.6 and D.6, respectively. This particularly applies when using method C for measuring point discontinuities.

## 11 Specification information

The detail specification shall specify the following information:

– type of fibre (or cable) to be measured;
– failure or acceptance criteria at the wavelength or wavelength range;
– any deviations to the procedure that apply;
– information to be reported.

# Annex A
(normative)

# Requirements specific to method A – Cut-back

## A.1 General

The cut-back technique is the only method directly derived from the definition of fibre attenuation, in which the power levels, $P_1(\lambda)$ and $P_2(\lambda)$, are measured at two points of the fibre without change of input conditions. $P_2(\lambda)$ is the power emerging from the end of the fibre, and $P_1(\lambda)$ is the power emerging from a point near the input after cutting the fibre. This explains its wide acceptance as the reference test method for attenuation.

This measurement principle does not permit information to be obtained on the attenuation behaviour over the length of the fibre, nor is it easy to measure the change of attenuation under changing conditions. In some situations, its destructive nature is a disadvantage.

## A.2 Apparatus

### A.2.1 General apparatus for all fibres

#### A.2.1.1 General



See Figures A.1 and A.2 for diagrams of suitable test set-ups.



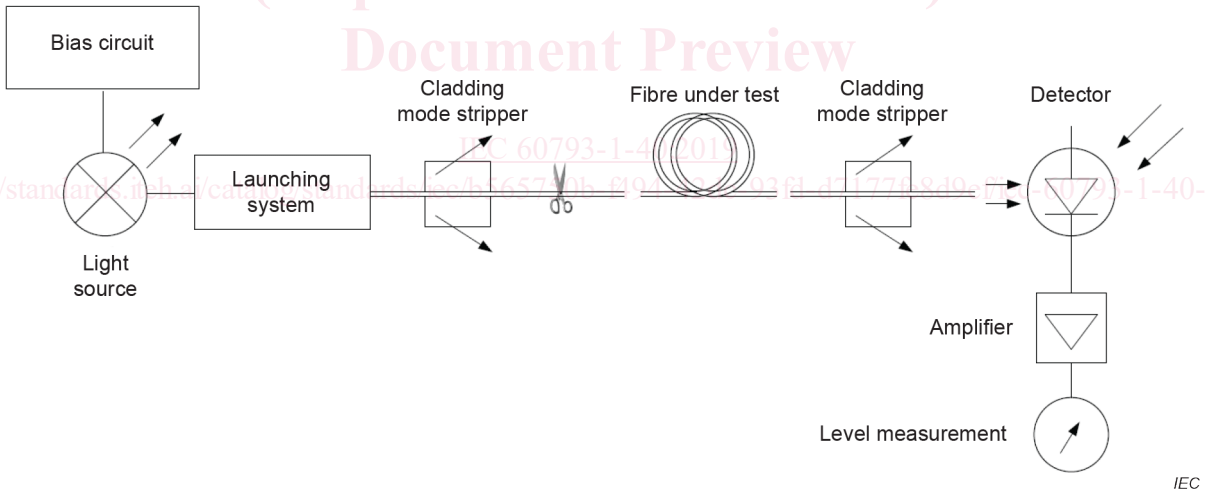


**Figure A.1 – Arrangement of equipment ~~to make~~ for loss measurement at ~~one~~ a specified wavelength**