

Optical fibres —

Part 1-22: Measurement methods and test procedures — Length measurement

The European Standard EN 60793-1-22:2002 has the status of a
British Standard

ICS 33.180.10

National foreword

This British Standard is the official English language version of EN 60793-1-22:2002. It is identical with IEC 60793-1-22:2001. It partly supersedes BS EN 188000:1994 which will be withdrawn upon completion of the full BS EN 60793-1 series.

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.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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Part 1-22: Measurement methods and test procedures –
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(IEC 60793-1-22:2001)

Fibres optiques
Partie 1-22: Méthodes de mesure
et procédures d'essai –
Mesure de la longueur
(CEI 60793-1-22:2001)

Lichtwellenleiter
Teil 1-22: Messmethoden
und Prüfverfahren –
Längenmessung
(IEC 60793-1-22:2001)

This European Standard was approved by CENELEC on 2002-03-05. 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.

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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/687/FDIS, future edition 1 of IEC 60793-1-22, 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 60793-1-22 on 2002-03-05.

This European Standard supersedes subclause 2.10 (test method 105), subclause 2.11 (test method 106) 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) 2002-12-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2005-03-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annexes A, B, C, D, E 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 60793-1-2X consists of the following parts, under the general title: Optical fibres:

- Part 1-20: Measurement methods and test procedures – Fibre geometry
- Part 1-21: Measurement methods and test procedures – Coating geometry
- Part 1-22: Measurement methods and test procedures – Length measurement

Endorsement notice

The text of the International Standard IEC 60793-1-22:2001 was approved by CENELEC as a European Standard without any modification.

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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 1-22: Measurement methods and test procedures – Length measurement

1 Scope

This part of IEC 60793 establishes uniform requirements for measuring the length and elongation of optical fibre (typically within cable).

The length of an optical fibre is one of the most fundamental values and shall be known for the evaluation of transmission characteristics such as losses and bandwidths.

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

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

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

3 Overview of method

This standard gives five methods for measuring length, which are presented in the following table 1.

Table 1 – Measurement methods

Method	Characteristics covered	Fibre category(ies) covered	Former designation
A Delay measuring	Length	All A1 and all B	IEC 60793-1-A6
B Backscattering	Length	All A1 and all B	IEC 60793-1-C1C
C Fibre elongation ^a	Fibre elongation	A1 and B1 ^b	IEC 60793-1-A7
D Mechanical	Length	All	IEC 60793-1-A5
E Phase shift	Length	All A1 and all B	IEC 60793-1-A8
^a The measurement of fibre elongation, method C, is part of several measurement methods for fibres and fibre optic cables, such as those in IEC 60794-1-1. ^b This measurement is applicable unreservedly to type B single-mode fibres. For type A1 multimode fibres, take particular care when interpreting the results because the results of this measurement may be influenced by interfering modal effects, for example, due to the occurrence of non-longitudinal stresses on the fibre. Application of the measurement to A2 to A4 multimode fibres is under consideration.			

Information common to all measurements is contained in clauses 2 to 8. Information on specific application appears in annexes A, B, C, D, and E for methods A, B, C, D and E, respectively.

3.1 Method A – Delay measuring

The delay measuring method applies to measurements of the fibre length by the measurement of the propagation time of an optical pulse or a pulse train on the basis of a known value of the group index of the fibre.

Alternatively, this method is suitable for measuring the group index of a fibre of known length. Therefore, in practice this fibre length measurement method is calibrated against a known length of fibre of the same type.

3.2 Method B – Backscattering

The backscattering method, which is a single-sided measurement, uses an optical time domain reflectometer (OTDR), and measures the optical power backscattered from different points in the fibre to the beginning of the fibre.

3.3 Method C – Fibre elongation

This measurement method describes a procedure for determining the fibre elongation. It does not measure absolute strain, but instead measures the changes in strain from one loading condition to another.

3.4 Method D – Mechanical length

This measurement method describes a procedure for determining the fibre length by winding a fibre around a fixed diameter calibrated wheel that rotates. The length is determined by the number of revolutions of the wheel.

3.5 Method E – Phase shift

The phase shift method describes a procedure for determining the fibre length. The length is determined from the phase shift that occurs when a predetermined modulation frequency $f_{\max}$ is applied.

3.6 Reference test method

The reference test method (RTM), which shall be the one used to settle disputes, varies depending on whether the fibre is cabled or not, such as

- uncabled fibre: method D;
- length of fibre within cable: method B;
- elongation of fibre within cable: method C;
- elongation of uncabled fibre: method C.

4 Apparatus

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

5 Sampling and specimens

See the appropriate annex A, B, C, D or E for specific requirements. General requirements follow.

Prepare a flat end face, perpendicular to the fibre axis, at the input and output ends of each specimen for measurements based on optical delay measurements.

6 Procedure

See the appropriate annex A, B, C, D or E for specific requirements.

7 Calculations

See the appropriate annex A, B, C, D or E for specific requirements.

8 Results

The following information shall be provided with each measurement:

- date and title of measurement;
- identification and description of specimen, including whether fibre or cable;
- specimen length, or elongation;
- measurement method used: A, B, C, D or E;
- other results, as required by the appropriate annex, A, B, C, D or E.

The following information shall be available upon request:

- description of measurement apparatus arrangement;
- type and wavelength of measurement source;
- launch conditions;
- details of computation technique;
- date of latest calibration of equipment.

See annexes A, B, C, D and E for any additional information that shall be available upon request.

9 Specification information

The detail specification shall specify the following information:

- type of fibre (or cable) to be measured;
- failure or acceptance criteria;
- information to be reported;
- deviations to the procedure that apply.

Annex A (normative)

Requirements specific to method A – Delay measuring

A.1 General

Use this method to measure the length of optical fibre by itself, or installed in cable. If the specimen is a fibre in a cable, determine the value of group index N under conditions applicable to the specimen under measurement (for example, tension, temperature). This is done by inverting equation (A.1) and the measurements on a specimen with a known length.

A.2 Principle

An optical pulse travelling through an optical fibre with length L and average group index N experiences a travelling/delay time, Δt :

$$\Delta t = \frac{NL}{C} \quad (\text{A.1})$$

where

- Δt is the time delay;
- N is the average group index;
- C is the velocity of light in vacuum.

If N is known, the measurement of Δt gives L . On the other hand, the measurement of Δt gives the value of N when L is known.

A.3 Apparatus

A.3.1 Two techniques

There are two techniques for measuring the propagation time of an optical pulse:

- time measurement of the transmitted pulse (Δt measured);
- time measurement of the reflected pulse ($2\Delta t$ measured).

See figures A.1 and A.2 for two different arrangements corresponding to the two techniques applying a sampling oscilloscope.

Instead of the sampling oscilloscope, backscattering equipment, or a counter with separate start/stop gate and averaging capability (for example, at least 10^4 counts), can be used.