IEC 60793-1-22

Edition 2.0 2024-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Fibres optiques –
Partie 1-22: Méthodes de mesure et procédures d'essai – Mesure de la longueur

IEC 60793-1-22:2024-06(en-fr)

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FOREWORD

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IEC 60793-1-22 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

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) Inclusion of category C single mode fibres in Table 1;
b) Inclusion of a new informative Annex F on Brillouin frequency shift test method to determine the tensile strain applied to a fibre.

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

Draft	Report on voting
86A/2456/FDIS	86A/2474/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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:

- IEC 60793-1-20 to IEC 60793-1-29: *Measurement methods and test procedures for dimensions*
- IEC 60793-1-30 to IEC 60793-1-39: *Measurement methods and test procedures for mechanical characteristics*
- IEC 60793-1-40 to IEC 60793-1-49: *Measurement methods and test procedures for transmission and optical characteristics*
- IEC 60793-1-50 to IEC 60793-1-59: *Measurement methods and test procedures for environmental characteristics*.
- IEC 60793-1-60 to IEC 60793-1-69: *Measurement methods and test procedures for polarization-maintaining fibres*.

IEC 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

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 a fundamental value for the evaluation of transmission characteristics such as losses and bandwidths.

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 60793-1-40, *Optical fibres – Part 1-40: Attenuation measurement methods*

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

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

BOTDA	Brillouin optical time domain analysis
BOTDR	Brillouin optical time domain reflectometry
FWHM	full-width half-maximum
OTDR	optical time domain reflectometer
RMSW	root-mean-squared width
RTM	reference test method

4 Overview of method

4.1 General

This document gives five methods for measuring length, which are presented in Table 1.

Table 1 – Measurement methods

Method		Characteristics covered	Fibre categories covered
A	Delay measuring	Length	All A1, B, and C
B	Backscattering	Length	All A1, B, and C
C	Fibre elongation [a]	Fibre elongation [c]	A1, B1 [b], and C
D	Mechanical	Length	All
E	Phase shift	Length	All A1, B, and C

[a] The measurement of fibre elongation is used 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 can 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.

[c] Informative Annex F has been added to determine the tensile strain applied to a fibre. It uses Brillouin reflectometry (BOTDR) or so-called Brillouin analysis (BOTDA), which are single-sided and double-sided methods respectively.

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

4.2 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 based on 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.

4.3 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.

4.4 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.

4.5 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.

4.6 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.

4.7 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.

5 Apparatus

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

6 Sampling

See the appropriate Annex A, Annex B, Annex C, Annex D or Annex 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 sample for measurements based on optical delay measurements.

7 Procedure

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

8 Calculations

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

9 Results

The following information shall be provided with each measurement:

– date and title of measurement;
– identification and description of sample, including whether fibre or cable;
– sample length, or elongation;
– measurement method used: A, B, C, D or E;
– other results, as required by the appropriate Annex A, Annex B, Annex C, Annex D or Annex 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 Annex A, Annex B, Annex C, Annex D and Annex E for any additional information that shall be available upon request.

10 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 sample is a fibre in a cable, determine the value of group index N under conditions applicable to the sample under measurement (for example, tension, temperature). This is done by inverting Formula (A.1) and the measurements on a sample 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 time delay, Δt:

$$\Delta t = \frac{NL}{C} \tag{A.1}$$

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 Figure A.1 and Figure 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 (e.g. at least 10^4 counts), can be used.