



PRE-RELEASE VERSION (FDIS)

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.10

Warning! Make sure that you obtained this publication from an authorized distributor.



FINAL DRAFT INTERNATIONAL STANDARD (FDIS)

PROJECT NUMBER:

IEC 60793-1-22 ED2

DATE OF CIRCULATION:

2024-04-12

CLOSING DATE FOR VOTING:

2024-05-24

SUPERSEDES DOCUMENTS:

86A/2335/CDV, 86A/2425/RVC

IEC SC 86A : FIBRES AND CABLES	
SECRETARIAT: France	SECRETARY: Mr Laurent Gasca
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL STANDARD: <input type="checkbox"/>
FUNCTIONS CONCERNED: <input type="checkbox"/> EMC <input type="checkbox"/> ENVIRONMENT <input type="checkbox"/> QUALITY ASSURANCE <input type="checkbox"/> SAFETY	
<input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING Attention IEC-CENELEC parallel voting The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Final Draft International Standard (FDIS) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	<input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING

This document is a draft distributed for approval. It may not be referred to as an International Standard until published as such.

In addition to their evaluation as being acceptable for industrial, technological, commercial and user purposes, Final Draft International Standards may on occasion have to be considered in the light of their potential to become standards to which reference may be made in national regulations.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to consider for future work to include relevant "In Some Countries" clauses. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (SEE [AC/22/2007](#) OR NEW [GUIDANCE DOC](#)).

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

PROPOSED STABILITY DATE: 2028

NOTE FROM TC/SC OFFICERS:

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	8
3 Terms, definitions, and abbreviated terms	8
3.1 Terms and definitions	8
3.2 Abbreviated terms	8
4 Overview of method	9
4.1 General	9
4.2 Method A – Delay measuring	9
4.3 Method B – Backscattering	9
4.4 Method C – Fibre elongation	9
4.5 Method D – Mechanical length	9
4.6 Method E – Phase shift	10
4.7 Reference test method	10
5 Apparatus	10
6 Sampling	10
7 Procedure	10
8 Calculations	10
9 Results	10
10 Specification information	11
Annex A (normative) Requirements specific to method A – Delay measuring	12
A.1 General	12
A.2 Principle	12
A.3 Apparatus	12
A.3.1 Two techniques	12
A.3.2 Optical source	13
A.3.3 Optical detector	14
A.4 Procedure	14
A.4.1 Calibration	14
A.4.2 Average group index value	14
A.4.3 Length measurement	14
A.5 Calculations	15
A.5.1 General	15
A.5.2 Transmitted-pulse technique	15
A.5.3 Reflected-pulse technique	16
A.6 Results	16
Annex B (normative) Requirements specific to method B – Backscattering	17
B.1 General	17
B.2 Apparatus	17
B.2.1 General	17
B.2.2 Optical transmitter	17
B.2.3 Launch conditions	17
B.2.4 Optical coupler or splitter	18

B.2.5	Optical receiver	18
B.2.6	Pulse duration and repetition rate	18
B.2.7	Signal processor.....	18
B.2.8	Display	18
B.2.9	Data interface (optional)	18
B.2.10	Reflection controller (optional)	18
B.2.11	Splices and connectors.....	19
B.3	Sampling.....	19
B.4	Procedure	19
B.4.1	Three techniques.....	19
B.4.2	Procedure common to all three techniques	19
B.4.3	Procedures specific to each technique.....	20
B.4.4	Determination of group index.....	22
B.5	Results	23
Annex C (normative)	Requirements specific to method C – Fibre elongation.....	24
C.1	Principle	24
C.2	Apparatus	24
C.2.1	General requirements	24
C.2.2	Optical measurement equipment.....	25
C.2.3	Instrument resolution	25
C.3	Procedure	26
C.3.1	Calibration.....	26
C.3.2	Sample measurement.....	26
C.4	Results	27
Annex D (normative)	Requirements specific to method D – Mechanical length.....	28
D.1	Principle	28
D.2	Apparatus	28
D.3	Procedure	28
D.3.1	Calibration.....	28
D.3.2	Operation	28
Annex E (normative)	Requirements specific to method E – Phase shift.....	29
E.1	General.....	29
E.2	Apparatus	29
E.2.1	General	29
E.2.2	Light source.....	29
E.2.3	Modulator	29
E.2.4	Launch optics	30
E.2.5	Signal detector and signal detection electronics	30
E.2.6	Reference signal.....	30
E.2.7	Computation equipment.....	31
E.3	Sampling.....	31
E.4	Procedure	31
E.4.1	Selection of starting frequency.....	31
E.4.2	Selection of maximum frequency	31
E.4.3	Phase measurement performance	31
E.4.4	Measurement of length of test fibre.....	32
E.5	Calculation and interpretation of results	32
E.6	Group index	33
E.6.1	General	33

E.6.2	Cut-back method	33
E.6.3	Substitution method	33
Annex F (informative)	Brillouin frequency shift test method	35
F.1	General.....	35
F.2	Principle	35
F.3	Apparatus	36
F.3.1	General requirements	36
F.3.2	Optical measurement equipment.....	36
F.3.3	Instrument resolution	37
F.4	Procedure	38
F.4.1	Calibration	38
F.4.2	Sample measurement	38
F.5	Results	40
Bibliography	41
Figure A.1	– Time measurement of the transmitted pulse	13
Figure A.2	– Time measurement of the reflected pulse.....	13
Figure A.3	– Principle of fibre-length measurement	15
Figure B.1	– Block diagram of an OTDR	17
Figure B.2	– Schematic OTDR trace of a sample (z_1 to z_0) with a section of unknown length, z_1 , preceding it and without a reflection pulse from the fibre joint point (two-point technique (B.4.3.1)).....	21
Figure B.3	– Schematic OTDR trace of sample (z_1 to z_2) with a section of unknown length, z_1 , preceding it and with a reflection pulse from the fibre joint point (two-point technique (B.4.3.1))	21
Figure B.4	– Schematic trace of a sample (0 to z_2) with no section preceding it (single-point technique 0 (B.4.3.2)).....	22
Figure B.5	– Schematic OTDR trace of a sample (z_D to z_2) with a section of known length, z_D , preceding it (single-point technique 1 (B.4.3.3))	22
Figure C.1	– Equipment set-up for phase-shift technique (C.2.2.2)	25
Figure C.2	– Equipment set-up for differential pulse-delay technique (C.2.2.3)	26
Figure E.1	– Apparatus for fibre length measurement	34
Figure F.1	– Equipment setup for BOTDR technique	37
Figure F.2	– Equipment setup for BOTDR technique	37
Figure F.3	– Differential strain recorded during a pulling test over a 100 m of cable.....	39
Figure F.4	– Absolute strain profile recorded during a pulling test over a 100 m of cable	39
Table 1	– Measurement methods	9

INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRES –

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

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/XX/FDIS	86A/XX/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*