

INTERNATIONAL STANDARD



Optical fibres –

Part 1-1: Measurement methods and test procedures – General and guidance

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INTERNATIONAL STANDARD



Optical fibres –

Part 1-1: Measurement methods and test procedures – General and guidance

INTERNATIONAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRES –

**Part 1-1: Measurement methods and test procedures –
General and guidance**

FOREWORD

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- 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.
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- 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) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60793-1-1:2017. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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

This fifth edition cancels and replaces the fourth edition published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) changes in normative references;
- b) renamed Clause 10 and added documentation-related requirements in a new subclause 10.2.

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

Draft	Report on voting
86A/2166/CDV	86A/2203/RVC

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,
- 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.~~

The documents are categorized as follows:

- Measurement methods and test procedures for dimensions
- Measurement methods and test procedures for mechanical characteristics
- Measurement methods and test procedures for transmission and optical characteristics
- Measurement methods and test procedures for environmental characteristics
- Measurement methods and test procedures for polarization-maintaining fibres

OPTICAL FIBRES –

Part 1-1: Measurement methods and test procedures – General and guidance

1 Scope

This part of IEC 60793 lists and gives guidance on the use of documents giving uniform requirements for measuring and testing optical fibres, thereby assisting in the inspection of fibres and cables for commercial (mostly telecommunications) purposes.

The individual measurement and test methods are contained in the different parts of the IEC 60793 series. They are identified as IEC 60793-1-X, where "X" is an assigned sub-part number, indicating its affiliation to the IEC 60793-1 series.

In general, measurements and tests methods apply to all class A multimode fibres and class B and class C single-mode optical fibres covered by the IEC 60793-2 series relating to product specifications, although there can be exceptions. Clause 1 of each part of the IEC 60793 series contains the scope for each particular attribute.

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 60793-1-20, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

IEC 60793-1-21, *Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry*

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

IEC 60793-1-30, *Optical fibres – Part 1-30: Measurement methods and test procedures – Fibre proof test*

IEC 60793-1-31, *Optical fibres – Part 1-31: Measurement methods and test procedures – Tensile strength*

IEC 60793-1-32, *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*

IEC 60793-1-33, *Optical fibres – Part 1-33: Measurement methods and test procedures – Stress corrosion susceptibility*

IEC 60793-1-34, *Optical fibres – Part 1-34: Measurement methods and test procedures – Fibre curl*

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

IEC 60793-1-41, *Optical fibres – Part 1-41: Measurement methods and test procedures – Bandwidth*

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

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

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

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

IEC 60793-1-46, *Optical fibres – Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance*

IEC 60793-1-47, *Optical fibres – Part 1-47: Measurement methods and test procedures – Macrobending loss*

IEC 60793-1-48, *Optical fibres – Part 1-48: Measurement methods and test procedures – Polarization mode dispersion*

IEC 60793-1-49, *Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay*

IEC 60793-1-50, *Optical fibres – Part 1-50: Measurement methods and test procedures – Damp heat (steady state) tests*

IEC 60793-1-51, *Optical fibres – Part 1-51: Measurement methods and test procedures – Dry heat (steady state) tests*

IEC 60793-1-52, *Optical fibres – Part 1-52: Measurement methods and test procedures – Change of temperature tests*

IEC 60793-1-53, *Optical fibres – Part 1-53: Measurement methods and test procedures – Water immersion tests*

IEC 60793-1-54, *Optical fibres – Part 1-54: Measurement methods and test procedures – Gamma irradiation*

IEC 60793-1-60, *Optical fibres – Part 1-60: Measurement methods and test procedures – Beat length*

IEC 60793-1-61, *Optical fibres – Part 1-61: Measurement methods and test procedures – Polarization crosstalk*

IEC 60793-2, *Optical fibres – Product specifications – General*

~~IEC TR 61931:1998, Fibre optic Terminology~~

3 Terms and definitions

~~For the purposes of this document, the terms and definitions given in IEC TR 61931 apply.~~

No terms and definitions are listed in this document.

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>

4 Rounding rules

All reported test results shall follow the conventional rounding rule¹ of "rounding half away from zero" when the results recorded display more than the number of significant digits required in the acceptance criteria. Only the first digit beyond the number of significant digits is used in determining the rounding.

EXAMPLE 1 Against a requirement of 0,22 dB/km maximum attenuation, values up to 0,224 dB/km conform, while values of 0,225 dB/km and above are failures.

EXAMPLE 2 Against a requirement of $\pm 0,05$ dB, values between $-0,054$ dB and $+0,054$ dB are deemed acceptable.

EXAMPLE 3 Against a requirement of $0,6 \mu\text{m}$ maximum core concentricity error, values up to $0,64 \mu\text{m}$ are acceptable.

5 Measurement and test categories

The categories include

- parameter measurements,
- performance measurements, and
- compliance tests.

According to several different areas, the tests are grouped as follows:

~~Parts 1-10 to 1-19:~~

~~General~~

IEC 60793-1-20 to
IEC 60793-1-29:

Measurement methods and test procedures for dimensions

IEC 60793-1-20
IEC 60793-1-21
IEC 60793-1-22

¹ See ISO 80000-1:2009, Annex B, Rule B.

IEC 60793-1-30 to IEC 60793-1-39:	Measurement methods and test procedures for mechanical characteristics
	IEC 60793-1-30
	IEC 60793-1-31
	IEC 60793-1-32
	IEC 60793-1-33
	IEC 60793-1-34
IEC 60793-1-40 to IEC 60793-1-49:	Measurement methods and test procedures for transmission and optical characteristics
	IEC 60793-1-40
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IEC 60793-1-50 to IEC 60793-1-59:	Measurement methods and test procedures for environmental characteristics
	IEC 60793-1-50
	IEC 60793-1-51
	IEC 60793-1-52
	IEC 60793-1-53
	IEC 60793-1-54
IEC 60793-1-60 to IEC 60793-1-69:	Measurement methods and test procedures for polarization-maintaining fibres
	IEC 60793-1-60
	IEC 60793-1-61

6 Standard atmospheric measurement and test conditions

It is necessary to control standard atmospheric conditions ~~need to be controlled~~ within ~~some~~ a certain range to ensure proper correlation ~~of~~ between data obtained from measurements and tests conducted in various facilities. Conduct measurement and test conditions under the following atmospheric conditions (see Table 1), unless otherwise specified. In some cases, special ambient conditions ~~may~~ can be ~~needed~~ necessary and can be specified in the detail specification.

Table 1 gives the standard range of atmospheric conditions for carrying out measurements and tests.

Table 1 – Standard range of atmospheric conditions

Condition	Standard
Temperature	23 °C ± 5 °C
Relative humidity	45 % ± 25 %
Atmospheric pressure (limits are inclusive)	Site ambient

Keep variations in ambient temperature and humidity to a minimum during a series of measurements.

7 Calibration guidance

The process of calibration can be defined as the set of operations which establish, under specified conditions, the relationship between values indicated by a measuring system and the known values of a reference material. Once established, this relationship may be used to adjust the measuring system to correct for measurement bias. Adjustment of the system ~~may~~ can, for example, take the form of hardware or a software adjustment.

Follow the instructions given in the test procedure documents as can be necessary for calibration and adjustment of the apparatus to ensure successful application of the documents. If suitable reference materials do not exist, then consideration should be given to an appropriate strategy to minimise measurement uncertainty.

Record relevant information of the calibration process, such as the calibrated value and uncertainty of the reference material or test equipment used.

8 Reference test methods

Several attributes have an agreed-upon reference test method (RTM). This is the method that shall be used to settle disputes.

9 Categories of optical fibres

The measurement methods and test procedures indicated in this document apply to fibre categories described in IEC 60793-2 as appropriate.

10 Packaging and documentation

10.1 Packaging

For handling and shipping of optical fibres, the packaging device shall meet the following requirements:

- winding techniques shall enable the optical fibre to withstand transport and specified environmental conditions;
- the possibility of measuring the dimensions, transmission and optical characteristics of the optical fibre without removal of the fibre from the packaging device shall be indicated;
- reel dimensions shall be provided to the customer.

~~d) on request, optical fibre reel handling guidelines can be provided;~~

~~e) material safety and disposal related information can be provided upon request.~~

10.2 Documentation

For handling, shipping and inspection of optical fibres, the information listed below shall be provided on request. The information can be provided either by physical or electronic or digital means (e.g. barcode, quick response code):

- a) optical fibre reel handling guidelines;
- b) material safety and disposal related information as agreed between the supplier and the customer;
- c) the nominal effective group refractive indices at 850 nm for multimode fibres, at 1 550 nm for single-mode fibre and at other wavelengths where data is available;
- d) the physical length of the fibre on the shipping reel which shall meet or exceed the stated supplied length.

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Bibliography

IEC 60793-2 (all parts), *Optical fibres – Part 2-X: Product specifications*

IEC TR 61931:1998, *Fibre optic – Terminology*

ISO 80000-1:2009, *Quantities and units – Part 1: General*

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

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IEC 60793-1-48, *Optical fibres – Part 1-48: Measurement methods and test procedures – Polarization mode dispersion*

IEC 60793-1-49, *Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay*

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IEC 60793-1-60, *Optical fibres – Part 1-60: Measurement methods and test procedures – Beat length*

IEC 60793-1-61, *Optical fibres – Part 1-61: Measurement methods and test procedures – Polarization crosstalk*

IEC 60793-2, *Optical fibres – Product specifications – General*

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EXAMPLE 2 Against a requirement of $\pm 0,05$ dB, values between $-0,054$ dB and $+0,054$ dB are deemed acceptable.

EXAMPLE 3 Against a requirement of 0,6 μm maximum core concentricity error, values up to 0,64 μm are acceptable.

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- parameter measurements,
- performance measurements, and
- compliance tests.

According to several different areas, the tests are grouped as follows:

IEC 60793-1-20 to IEC 60793-1-29:	Measurement methods and test procedures for dimensions
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IEC 60793-1-20

IEC 60793-1-21

IEC 60793-1-22

IEC 60793-1-30 to IEC 60793-1-39:	Measurement methods and test procedures for mechanical characteristics
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IEC 60793-1-30

IEC 60793-1-31

IEC 60793-1-32

IEC 60793-1-33

IEC 60793-1-34

¹ See ISO 80000-1:2009, Annex B, Rule B.