BRITISH STANDARD

BS EN 60793-1-21:2002

Optical fibres —

Part 1-21: Measurement methods and test procedures — Coating geometry

The European Standard EN 60793-1-21:2002 has the status of a British Standard

ICS 33.180.10

National foreword

This British Standard is the official English language version of EN 60793-1-21:2002. It is identical with IEC 60793-1-21:2001.

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 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

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This British Standard, having been prepared under the direction of the Electrotechnical Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 17 May 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 15 , and a back cover.

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EUROPEAN STANDARD **EN 60793-1-21**

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English version

Optical fibres
Part 1-21: Measurement methods and test procedures – Coating geometry
(IEC 60793-1-21:2001)

Fibres optiques
Partie 1-21: Méthodes de mesures et procédures d'essai –
Géométrie du revêtement
(CEI 60793-1-21:2001)

Lichtwellenleiter
Teil 1-21: Messmethoden und Prüfverfahren -
Beschichtungsgeometrie
(IEC 60793-1-21:2001)

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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.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 60793-1-21:2002 E

Foreword

The text of document 86A/686/FDIS, future edition 1 of IEC 60793-1-21, 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 60793-1-21 on 2002-03-05.

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 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

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Endorsement notice

The text of the International Standard IEC 60793-1-21:2001 was approved by CENELEC as a European Standard without any modification.

CONTENTS

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 1-21: Measurement methods and test procedures – Coating geometry

1 Scope

This part of IEC 60793 establishes uniform requirements for measuring the coating geometry of optical fibre. Coating geometry measurements are fundamental values that need to be known for subsequent procedures such as cabling, connectorization, splicing, handling and for making other measurements.

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

3 Overview of method

This standard gives four methods for measuring fibre geometry characteristics which are given in terms of the following parameters:

- coating diameter;
- coating non-circularity;
- coating-cladding concentricity error.

Table 1 – Measurement methods

Method	Characteristics covered	Fibre category(ies) covered	Former designation
A Side-view [a]	All	All [b]	IEC 60793-1-A3
B Mechanical	Coating diameter and non-circularity	All	IEC 60793-1-A4

[a] For certain coating parameters evaluation, the cladding diameter should be measured using this procedure. However, due to the relatively poor accuracy of the method, this value of cladding diameter cannot be considered as an alternative to the values obtained by the already established test methods for glass geometry, for which reference should be made to IEC 60793-1-20.

[b] Coating-cladding concentricity error is not defined for category A4 fibre.

Both methods are conducted off-line during inspection. Neither of them is suitable for on-line, in-process measurements.

Information common to both measurements appears in clauses 2 to 10. See also annexes A and B, for methods A and B, respectively.

4 Definitions

For the purpose of this part of IEC 60793, the following definitions apply.

4.1
primary coating
one or more layers of protective coating material applied to the fibre cladding surface during or after the drawing to preserve the cladding surface and to give a minimum amount of required protection (e.g. a 250 µm protective coating)

4.2
secondary or "buffer" coating
one or more layers of coating material applied over one or more layers of primary coated fibres in order to give additional required protection or to arrange fibres together in a particular structure (e.g. a 900 µm "buffer" coating, "tight jacket" or "ribbon coating")

5 Reference test method

Method A is the reference test method (RTM), which is the one used to settle disputes.

6 Apparatus

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

7 Sampling and specimens

7.1 Specimen length

The specimen shall be a short length of fibre, or as specified in the detail specification.

7.2 Specimen end face

Because the end faces of the specimen are not involved in the measurement itself, it is not necessary to have tight end-face requirements.

8 Procedure

See annexes A and B for methods A and B, respectively.

9 Calculations

See annexes A and B for methods A and B, respectively.

10 Results

The following information shall be provided with each measurement:

- date and title of measurement;
- identification and description of specimen;
- measurement results as required by the detail specification.

The following information shall be available upon request:

- length of specimen;
- measurement method used: A or B;
- description of measurement apparatus arrangement;
- details of computation technique;
- date and details of the latest calibration.

11 Specification information

The detail specification shall specify the following information:

- type of fibre 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 – Side-view light distribution

A.1 Apparatus

The apparatus may consist of an optical microscope or a laser gauge.

A.1.1 Optical microscope

See figure A.1 for a schematic diagram of typical test equipment.

A.1.1.1 Lens objective

Use a high-quality microscope lens objective, with transmitted light illumination.

A.1.1.2 Fibre holding arrangement

Provide a fixture to hold the fibre in the focal plane of the microscope, with the fibre axis perpendicular to the optical axis of the objective. Immerse the specimen in a suitable index-matching fluid, and retain it by means of a cell made with a transparent material. If necessary, fix this cell on a rotating table, in order to position the specimen parallel to the cursor. Hold the cell assembly as a whole, or the fibre within the cell, by the fibre clamp in such a way that it may be rotated through at least 180°, and be capable of being fixed in a sufficient number of positions for the purpose of measuring coating dimensions. The mechanical tolerances should be such that minimal repositioning and refocusing is required when the fibre is moved from one rotational position to another.

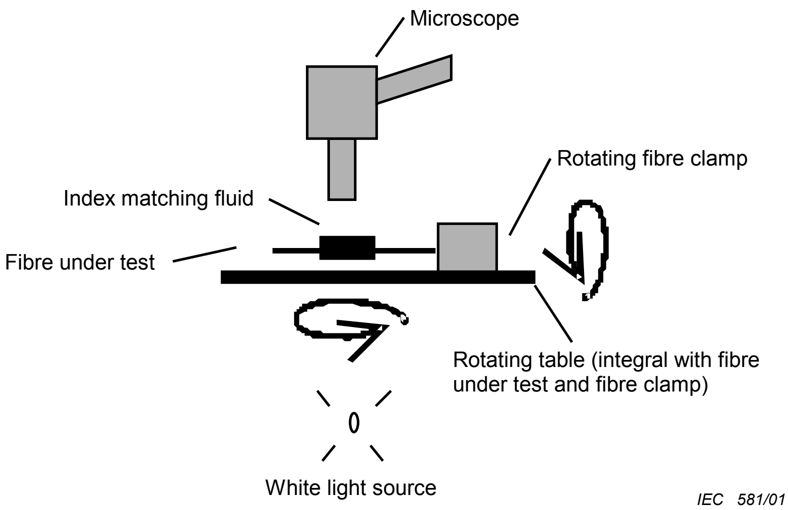

Figure A1 – Schematic diagram of typical test equipment

A.1.1.3 Image viewing

The image may be viewed directly using a filar eyepiece or projected onto a charge-coupled device (CCD) camera and displayed on a monitor. A typical system magnification for the visual method is ×100 to ×200, and for the camera method is typically ×20; in the latter case the image is formed directly onto the CCD. Determine the dimensions of the fibre image by using the filar eyepiece with the visual method and by positioning an electronic cursor on the monitor, or by computer data analysis of a stored image with the camera method.

A.1.2 Laser gauge

See figure A.2 for a schematic diagram of typical test equipment.

A.1.2.1 General components

The apparatus shall consist of a laser source operating at a suitable wavelength (e.g. 633 nm), a scanning device and a detector. If necessary, a system of lenses may be used to collimate the beam onto the specimen.

A.1.2.2 Fibre holding arrangement

Hold the specimen by means of a suitable rotating fibre clamp so that it is capable of rotating through at least 180° and being fixed in a sufficient number of positions while maintaining the fibre axis perpendicular to the optical axis of the apparatus.

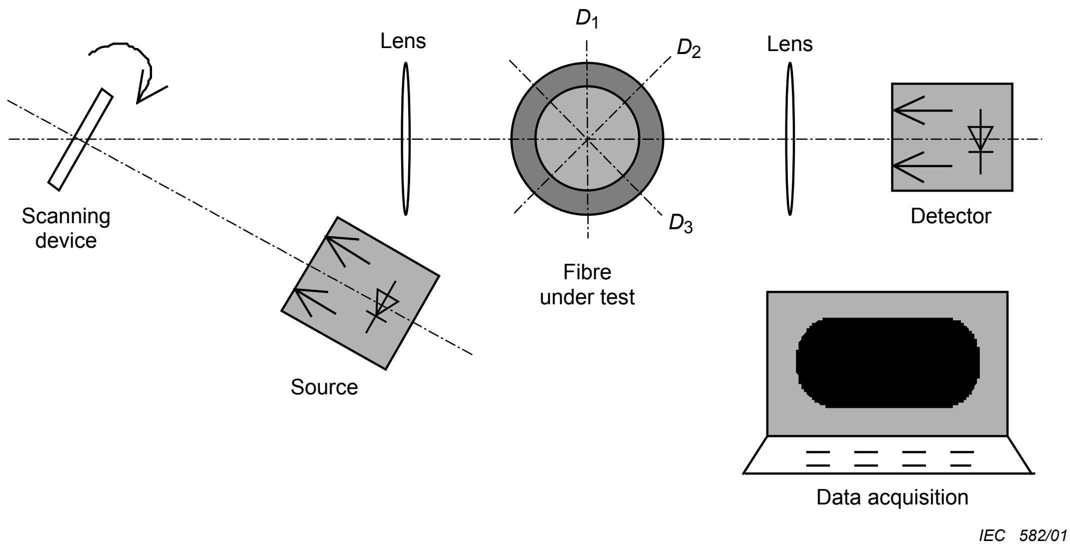

Figure A.2 – Side view of measurement set-up

A.2 Procedure

A.2.1 Calibration

Calibrate the apparatus by measuring an object of known dimensions (calibration sample). However, since the accuracy of this test method is typically 1 μm, the dimensions of the calibration specimen need only be known to within an accuracy of 0,5 μm or better.

A.2.2 Analyzing the image

Determine the dimensions of the coating(s) under different rotation angles by the analysis of the image of the fibre. Using the laser gauge, the dimensions may be measured by evaluating the deflection function of the laser beam across the fibre.

A.2.3 Analyzing the data

After data acquisition, two different approaches may be followed: plane analysis or ellipse-fitting analysis. Proceed with the analysis only when there are sufficient data available to achieve the required accuracy and repeatability.

A.2.3.1 Plane analysis

Measure the minimum and maximum diameters by rotating the specimen, using a suitable fibre clamp. Rotate the fibre to find the angular position where the size of the image is at maximum or minimum. Then measure the cladding diameter and the thicknesses of the primary coating layers in such angular positions; follow the same procedure after rotating the fibre; then compute the maximum and minimum values (respectively A and B) of the diameters measured at the different angular positions.

A.2.3.2 Ellipse-fitting analysis

Analyze a magnified image of the side view of the fibre to obtain data on the outer coating diameter. Provided enough data points are available, fit ellipses to the coating data using a “least sum of squares (LSS)" technique to determine the major axis (A) and the minor axis (B).

A.3 Calculations

A.3.1 For plane analysis

A.3.1.1 Coating diameter, in μm : $\frac{A+B}{2}$

A.3.1.2 Coating non-circularity, in %: $\frac{A-B}{\text{Coating diameter}}\times 100$

A.3.1.3 Thickness ratio, in %: $\frac{\text{Min.}}{\text{Max.}}\times 100$

where

A and B, respectively, are the maximum and minimum diameters;

Min. and Max., respectively, are the minimum and maximum measured thicknesses of the primary coating.

A.3.2 For ellipse-fitting analysis

A.3.2.1 Coating diameter, in µm: $\frac{A+B}{2}$

A.3.2.2 Coating non-circularity, in %: $\frac{A-B}{\text{Coating diameter}} \times 100$

A.3.2.3 Coating-cladding concentricity error, in µm: $\left[(X_{pc}-X_{gl})^2+(Y_{pc}-Y_{gl})^2\right]^{1/2}$

where

A and *B,* respectively, are the major and minor axes of the best-fit ellipse in µm;

X_{pc} and Y_{pc} are the outer coating/inner coating-centre coordinates;

X_{gl} and Y_{gl} are the cladding-centre coordinates.

Annex B
(normative)

Requirements specific to method B – Mechanical measurement

This is a mechanical measurement technique for determining the diameter of primary coating and buffer, and also non-circularities. Both sides of the specimen are made to come into contact with a flat, parallel surface and the separation of the surfaces is measured.

B.1 Apparatus

The measurement uses two anvils with very flat surfaces in order to make contact with each side of the fibre under test. The faces of the anvils shall be flat and parallel, and the applied force shall be small enough to ensure that the coating or buffer, or both, is not physically distorted by the anvils. Alternatively, if either or both of the anvils are not flat, and if the coating or buffer is distorted by the anvils, then a correction shall be made for compression. See figure B.1 for a schematic diagram of the apparatus.

B.1.1 Anvils

There are two anvils, one fixed and the other movable. The movable anvil shall be mounted on a micromanipulator, or it may move freely, as on an air bearing. The movable anvil shall be held against the fixed anvil or the fibre by springs, or by a force developed by a hanging weight, or by any other reproducible means.

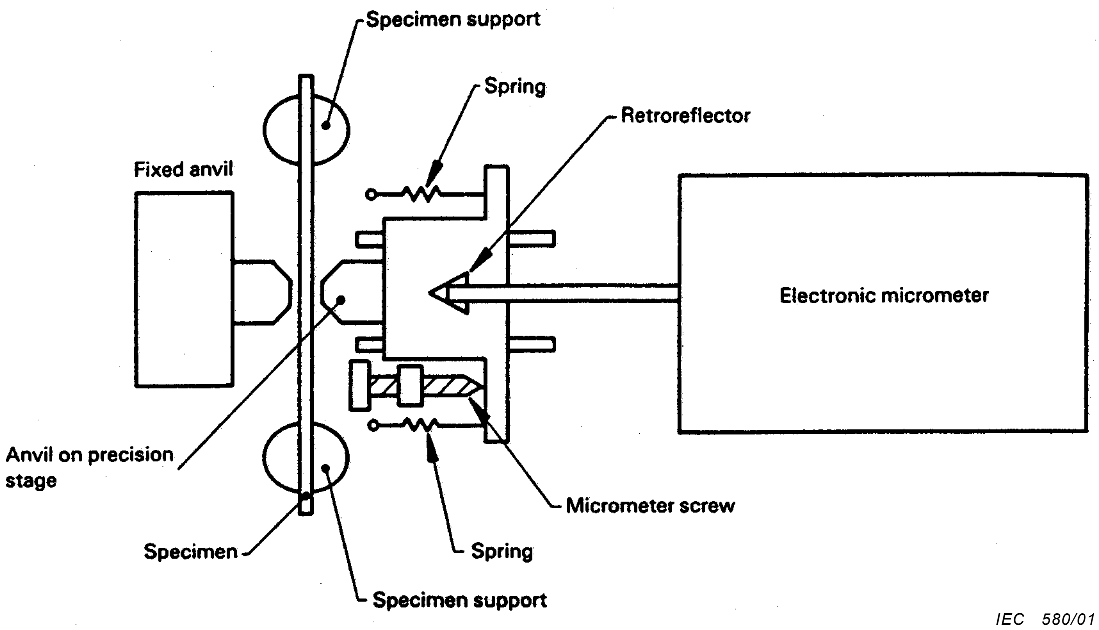

Figure B1 – Top view of a typical electronic micrometer system

B.1.2 Electronic micrometer system

An electronic micrometer system, such as a double-pass Michelson interferometer, may be used with a retroreflector or a plane mirror to measure accurately the movement of the stage, and thus the movable anvil.

B.1.3 Specimen support

Support the specimen between the faces of the anvils. Short specimens may protrude from a ferrule, or a V-block, or other similar fixture.

B.2 Procedure

B.2.1 Principle of the measurement

The diameter of the specimen is measured by contacting opposite sides with the anvils [1][1)]. The contact force may be adjusted so that there is negligible distortion of the specimen and the anvils. The actual force used shall be agreed upon by the supplier and the user, and may depend on the materials of the specimen, or the anvils.

Accurately measure the separation of the anvils with the electronic micrometer.If distortion is not negligible, make a mathematical correction of the measured separation.

B.2.2 Measurement

Clean the anvil faces and turn the micrometer screw in order to bring the anvil faces into contact with each other. Further turn the micrometer screw so that the anvils are held together by the spring tension only. Record the electronic micrometer distance reading.

Next, adjust the micrometer so that the gap between the anvil faces is larger than the specimen. Making sure that the specimen surfaces are clean and representative of the fibre under test, place the specimen on the supports between the anvil faces. Turn the micrometer screw slowly in order to bring the anvil faces into contact with the fibre so that the anvils are held against the fibre by the spring tension only. Record the electronic micrometer distance reading. The difference between the readings, plus any corrections due to compression, is the specimen diameter. Repeat this after rotating the fibre when coating non-circularity is desired.

B.3 Calculations

Record the average diameter of the individual measured diameters of the primary coating or buffer as the coating diameter.

The coating non-circularity (%) is calculated as the difference between the maximum and minimum individual diameters, divided by the average, and multiplied by 100.

B.4 Results

In addition to the results listed in clause 10, and depending on the specification requirements, the following information shall be provided on request: the correction factor, if used.

[1)] Figures in square brackets refer to the bibliography.

Bibliography

[1] YOUNG, M., HALE, P.D., MECHELS, S.E. Optical Fiber Geometry: Accurate Measurement of Cladding Diameter. *Journal of Research of the National Institute of Standards and Technology*, March-April 1993, vol 98, no 2, p.203-216.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60793-1-20	- [1]	Optical fibres Part 1-20: Measurement methods and test procedures - Fibre geometry	EN 60793-1-20	2002 [2]

[1] Undated reference.

[2] Valid edition at date of issue.

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