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Generic Specification: Optical fibres

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Fachgrundspezifikation: Lichtwellenleiter

Spécification générique: Fibres optiques

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Fachgrundspezifikation:
Lichtwellenleiter

This European Standard was approved by the CENELEC Electronic Components Committee (CECC) on 21 August 1992. CENELEC members are bound to comply with 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 General Secretariat of the CECC 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 CECC General Secretariat has the same status as the official versions.

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CECC

CENELEC Electronic Components Committee

Comité des Composants Electroniques du CENELEC

CENELEC- Komitee für Bauelemente der Elektronik

General Secretariat: Gartenstr. 179, W- 6000 Frankfurt/Main 70

FOREWORD

The CENELEC Electronic Components Committee (CECC) is composed of those member countries of the European Committee for Electrotechnical Standardization (CENELEC) who wish to take part in a harmonized System for electronic components of assessed quality.

The object of the System is to facilitate international trade by the harmonization of the specifications and quality assessment procedures for electronic components, and by the grant of an internationally recognized Mark, or Certificate, of Conformity. The components produced under the System are thereby acceptable in all member countries without further testing.

This European Standard was prepared by CECC WG 28, Optical Fibres and Optical Fibre Cables.

The text of the draft based on document CECC (Secretariat)3021 was submitted to the formal vote; together with the voting report, circulated as document CECC(Secretariat)3168, it was approved by CECC as EN 188 000 on 21 August 1992.

The following dates were fixed:

- latest date of announcement of the EN at national level	(doa)	**1993-09-28**
- latest date of publication of an identical national standard	(dop)	**1994-03-28**
- latest date of declaration of national standards obsolescence		**1994-03-28**
- latest date of withdrawal of conflicting national standards	(dow)	**2003-09-28**

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(For future consideration)

OPTICAL FIBRES
Generic specification

SECTION ONE - GENERAL

1.1 Scope

This standard applies to primary coated or buffered optical fibres for use in telecommunication equipment and in devices employing similar techniques.

1.2 Object

To establish uniform requirements for the geometrical, optical, transmission, mechanical and environmental properties of optical fibre.

1.3 Definitions

Under consideration.

1.4 Categories of optical fibres

1.4.1 *Class A — Multimode fibres*

Fibre categories are based on g, the refractive index profile parameter.

The normalized index profile is expressed as :

$$\delta(x) = 1 - x^g$$

where : $\delta(x) = \dfrac{n(x) - n(1)}{n(o) - n(1)}$

and : $n(x)$ = refractive index at x

$x = \frac{r}{a} \left(o \leq r \leq a \right)$

a = core radius

TABLE I A

Categories of multimode fibres

Category	Material	Type	Limits
A1	Glass core/glass cladding	Graded* index fibre	$1 \leq g < 3$
A2.1 A2.2	Glass core/glass cladding Glass core/glass cladding	Quasi step* index fibre Step* index fibre	$3 \leq g < 10$ $10 \leq g < \infty$
A3	Glass core/plastic cladding	Step* index fibre	$10 \leq g < \infty$
A4	Plastic fibre		

* Attention is drawn to the index profile as stated in the detail specification. For some applications, g may be specified as a function of x.

The fibre category is determined on the basis of the g value which best fits the normalized refractive index profile, falling within the category defined above.

1.4.2 *Class B - single-mode fibres*

Single-mode fibres are characterized by the following parameters.

1.4.2.1 *Mode field diameter,*
see clause 4.23

1.4.2.2 *Cut-off wavelength*

The cut-off wavelength is the wavelength greater than which the ratio between the total power, including launched higher order modes, and the fundamental mode power has decreased to less than a specified value, the modes being substantially uniformly excited.

Note 1. - By definition, the specified value is chosen as 0,1 dB for a substantially straight 2 m length of fibre including one single loop of radius 140 mm.

1.4.2.3 *Total dispersion*

Total dispersion is the dependence of the propagation parameter on wavelength. Where the source has a finite line width, dispersion will result in distortion.

Total dispersion can arise as a result of :

- material dispersion ;
- waveguide dispersion.

- profile dispersion   polarization dispersion does not produce an appreciable effect in nominally circular fibre.

The maximum magnitude of the total dispersion coefficient and, if applicable, the wavelength of zero dispersion in a particular wavelength region shall be specified in the product specification.

1.4.2.4 *Categories of single-mode fibres*

The categories of single-mode fibres currently in use are given in the table below :

TABLE I B

Categories of glass core/glass clad single-mode fibres

Category	Material	Zero dispersion wavelength Nominal value (nm)	Operating wavelength Nominal value (nm)
B1.1	Dispersion unshifted	1 310	1 310
B1.2	Loss minimized	1 310	1 550
B2	Dispersion shifted	1 550	1 550
B3	Dispersion flattened	see note 3	1 310 and 1 550

Notes 1. Care may be needed in splicing fibres of different types. Provisional results indicate that adequate splice loss and mechanical strength can be achieved when splicing different types within a single category.

2. Fibre category B1.2 is not single-mode in the 1310 nm region.

3. Catégory B3 single-mode fibres are characterized by a low dispersion over a large wavelength range.

1.4.3 *Other classes of fibre*

For future consideration

1.5 Optical fibre properties

The construction, dimensions and mechanical, optical, transmission, material and environmental properties of each type of optical fibre shall be as specified in the relevant detail specification.

1.6 Preparation of samples

Fibre ends shall be substantially clean, smooth and perpendicular to the fibre axis.

Note : Fibres coated by UV-curable acrylic resin can be cleaned (e.g. from cable filling compounds), without causing damage to the coating, using any cleaning agent recommended by the manufacturer of the fibres. However, the use of chlorine-based cleaning agents should be absolutely avoided, since they can attack the coating even after their use and in vapour phase.

1.7 Categories of test and measuring methods

a) Parameter measurements.
b) Performance measurement.
c) Compliance tests.

SECTION TWO - MEASURING METHODS FOR DIMENSIONS

2.1 Object

The measuring methods apply to the practical measurement of the length and the cross-sectional dimensions of an optical fibre. The methods are to be used for inspection of fibres for commercial purposes.

The dimensions of the optical fibres shall be determined by subjecting samples to tests selected from table II. The tests applied, acceptance criteria and number of samples shall be as specified in the detail specification. It should be clear that this table encompasses all categories of fibres, but not all tests are applicable to any one fibre category.

TABLE II

Dimensions of optical fibres

Test method	Test	Characteristics covered by test method
101	Refracted near field	Diameter of core Diameter of cladding Non-circularities Concentricity errors
102	Near field light distribution	Diameter of core Diameter of cladding Diameter of primary coating Diameter of buffer Non-circularities Concentricity errors
103	Four concentric circles	Diameter of core Diameter of cladding Non-circularities Concentricity errors
104	Mechanical diameter measurement	Diameter of cladding Diameter of primary coating Diameter of buffer Non-circularities
105	Mechanical length measurement (under consideration)	Length of fibre
106	Delay of transmitted and/or reflected pulse	Length of fibre
303	Backscattering technique	Length of fibre

Notes 1. - The refracted near field technique is a direct application of core definition based on the refractive index profile. This method gives the refractive index profile from which the dimensions and numerical aperture can be calculated.

2. - With the near field light distribution the dimensions obtained are correlated to the refractive index profile, but are not strictly in accordance with the definition of core diameter.

3. - The four concentric circles method is a compliance test normally based on near field light distribution. It is not valid for measuring the actual values of fibre dimensions.

4. - For dimensions linked to transmission part of single-mode fibres (i.e. diameter of mode field, concentricity of mode field) make reference to Section four : Measuring methods for optical and transmission characteristics.

5. - For practical reasons, the core diameter of single-mode fibres is not normally specified.

6. - A definition of the core diameter of single-mode fibres is on study.

2.2 Reference surface

The reference surface will be defined in the detail specification and may be either the core, cladding, primary coating, or buffer surface.

2.3 Concentricity error

The concentricity error may be specified between any two of the above mentioned diameters, and can be specified in the detail specification.

2.4 Tolerances

Tolerances on diameters can be specified in the detail specification.

Reference can also be made to test method 103 : Four concentric circles (as a compliance test).

2.5 Operational definitions

2.5.1 Definition of Multimode Fibre Diameter

The core diameter of a multimode optical fibre is defined from the refractive index profile as that diameter passing throught the core center and intersecting the index profile at the points n_3 such that :

$$n_3 = n_2 + k\,(n_1 - n_2)$$

where :

n_2 - the refractive index of the homogeneous cladding
n_1 - the maximum refractive index, and
k - a constant commonly called the "k factor"

The refractive index profile can be measured by profiling techniques such as the refracted nearfield measurement (RNF) or transverse interferometry (TI), and by measurement of the near field of a fully illuminated core such as the transmitted near field measurement (TNF).
It is recommended that curve fitting be used with both the index profiling and the TNF techniques to improve the measurement precision of the core diameter.

Note 1 :
Typically, k = 0,025 for either the fitted profiling methods or the unfitted TNF method is equivalent to k = 0 for the fitted TNF method.

Note 2 :
For fibres with refractive index profiles that have gradual transition region at their core / cladding boundary, a value of k = 0,05 for the unfitted TNF method is equivalent to k = 0 for the fitted TNF method.

2.6 Method 101 — Refracted near field

2.6.1 *Object*

The refracted near-field measurement is straightforward, accurate and measures directly the refractive index variation across the fibre (core and cladding). The measurement is capable of good resolution and can be calibrated to give absolute values of refractive indexes. It can be used to obtain profiles of both single-mode and multimode fibres.

2.6.2 *Test apparatus*

A schematic diagram of the test apparatus is shown in figures 1 and 2.

2.6.2.1 *Source*

A stable laser giving a few milliwatts of power in the TEM_{00} mode is required.

A HeNe laser, which has a wavelength of 633 nm, may be used, but a correction factor must be applied to the results for extrapolation at different wavelengths. It shall be noted that measurement at 633 nm may not give complete information at longer wavelengths, in particular non-uniform fibre doping can affect the correction.

A quarter-wave plate is introduced to change the beam from linear to circular polarization because the reflectivity of light at an air-glass interface is strongly angle and polarization dependent.

A pinhole placed at the focus of lens 1 acts as a spatial filter.

2.6.2.2 *Launch optics*

The launch optics, which are arranged to overfill the NA of the fibre, brings a beam of light to a focus on the flat end of the fibre. The optical axis of the beam of light should be within 1° of the axis of the fibre. The resolution of the equipment is determined by the size of the focused spot, which should be as small as possible in order to maximize the resolution, for example less than 1,5 µm. The equipment enables the focused spot to be scanned across the fibre diameter.

2.6.2.3 *Liquid cell*

The liquid in the liquid cell shall have a refractive index slightly higher than that of the fibre cladding.

2.6.2.4 *Sensing*

The refracted light is collected and brought to the detector in any convenient manner provided that all the refracted light is collected. By calculation, the required size of disc and its position along the central axis can be determined.