

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Fibre optic interconnecting devices and passive components – Connector optical interfaces for single-mode fibres – Part 2-2: Connection parameters of dispersion unshifted physically contacting fibres – Angled**

IEC 61755-2-2:2022

**Dispositifs d'interconnexion et composants passifs fibroniques – Interfaces optiques des connecteurs pour fibres unimodales – Partie 2-2: Paramètres de connexion des fibres en contact physique à dispersion non décalée – avec angle**



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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**FIBRE OPTIC INTERCONNECTING  
DEVICES AND PASSIVE COMPONENTS –  
CONNECTOR OPTICAL INTERFACES FOR SINGLE-MODE FIBRES –****Part 2-2: Connection parameters of dispersion  
unshifted physically contacting fibres – Angled**

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IEC 61755-2-2 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is an International Standard.

This second edition cancels and replaces the first edition published in 2006. This edition constitutes a technical revision.

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

- a) addition of normative references and visual requirements;
- b) reconsideration of the whole parts of the text to avoid misuse of the standard.

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

Draft	Report on voting
86B/4640/FDIS	86B/4661/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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

A list of all parts in the IEC 61755 series, published under the general title *Fibre optic interconnecting devices and passive components – Connector optical interfaces for single-mode fibres*, can be found on the IEC website.

Future documents in this series will carry the new general title as cited above. Titles of existing documents in this series will be updated at the time of the next edition.

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# FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – CONNECTOR OPTICAL INTERFACES FOR SINGLE-MODE FIBRES –

## Part 2-2: Connection parameters of dispersion unshifted physically contacting fibres – Angled

### 1 Scope

This part of IEC 61755 defines a set of prescribed conditions for a single-mode fibre optic connection that is maintained in order to satisfy the requirements of attenuation and return loss (RL) performance in a randomly mated pair of angled polished physically contacting (APC) fibres. The model uses a Gaussian distribution of light intensity over the specified mode field diameter (MFD) for determination of attenuation performance grades, based on MFD mismatch and the amount of lateral and angular fibre core offsets. Attenuation and RL performance grades are defined in IEC 61755-1.

### 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 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

IEC 61300-3-34, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-34: Examinations and measurements – Attenuation of random mated connectors*

IEC 61300-3-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-35: Examinations and measurements – Visual inspection of fibre optic connectors and fibre-stub transceivers*

IEC 61300-3-45, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-45: Examinations and measurements – Attenuation of random mated multi-fibre connectors*

IEC 61755-1, *Fibre optic interconnecting devices and passive components – Connector optical interfaces for single-mode fibres – Part 1: Optical interfaces for dispersion unshifted fibres – General and guidance*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61755-1 and the following apply.

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>

**3.1 defect size**

diameter of the smallest circle that can encompass the entire defect

**4 Attenuation and return loss grades**

Attenuation and return loss grades for APC polished connections are given in Table 1 and Table 2 according to IEC 61755-1. The return loss grade is for angled contacting fibres only. The grades that shall be used for non-angled polished PC connections are given separately in IEC 61755-2-1.

**Table 1 – Single-mode random mate attenuation grades**

Attenuation grade	Attenuation mean dB	Attenuation <sup>a</sup> ≥ 97 % <sup>b</sup> dB	Notes
A			Reserved for future application
B	≤ 0,12	≤ 0,25	
C	≤ 0,25	≤ 0,50	
D	≤ 0,50	≤ 1,0	

<sup>a</sup> Attenuation shall be measured by IEC 61300-3-34 for single-fibre connectors and IEC 61300-3-45 for multi-fibre connectors.

<sup>b</sup> The probability of a randomly mated connection set meeting the specified attenuation requirement will be ≥ 97 %. This performance is reached by means of a statistical distribution of connection parameters (MFD mismatch, lateral offset and angular offset) using a nominal value for wavelength of 1 310 nm.

**Table 2 – Single-mode return loss grades for APC (8°)**

Return loss grade	Return loss (mated) <sup>a</sup> dB	Return loss (unmated) dB
1	≥ 60	≥ 55

<sup>a</sup> The test shall be carried out according to IEC 61300-3-6.

Single-mode attenuation and return loss grades are applicable for the wavelengths from 1 310 nm to 1 625 nm.

**5 Criteria for a fit within attenuation and return loss grades**

**5.1 General**

Figure 1, Table 3 and Table 4 give the criteria for meeting the attenuation and return loss grades listed in Table 1 and Table 2. The parameters chosen for the criteria definition are based on the degree of significance by which they affect the performance under test. The criteria selected are based on the theoretical model in 5.2 and 5.3 as well as experimental results.



## 5.2 Attenuation grades and criteria

Using a Gaussian distribution for the incident light, the attenuation of the joint between two dispersion unshifted single-mode optical fibres defined by IEC 60793-2-50 category B is given by Formula (1). Attenuation is also referred to as insertion loss (IL), or coupling efficiency of the fibres.

The range of the nominal MFD and index of refraction ( $n_0$ ) of the fibre cores are given in Table 3.

**Table 3 – MFD and fibre core nominal index of refraction**

Fibre sub-category	Nominal wavelength nm	Nominal MFD $\mu\text{m}$	$n_0$ (core)
IEC 60793-2-50 fibres	1 310	8,6 to 9,2	1,452 0

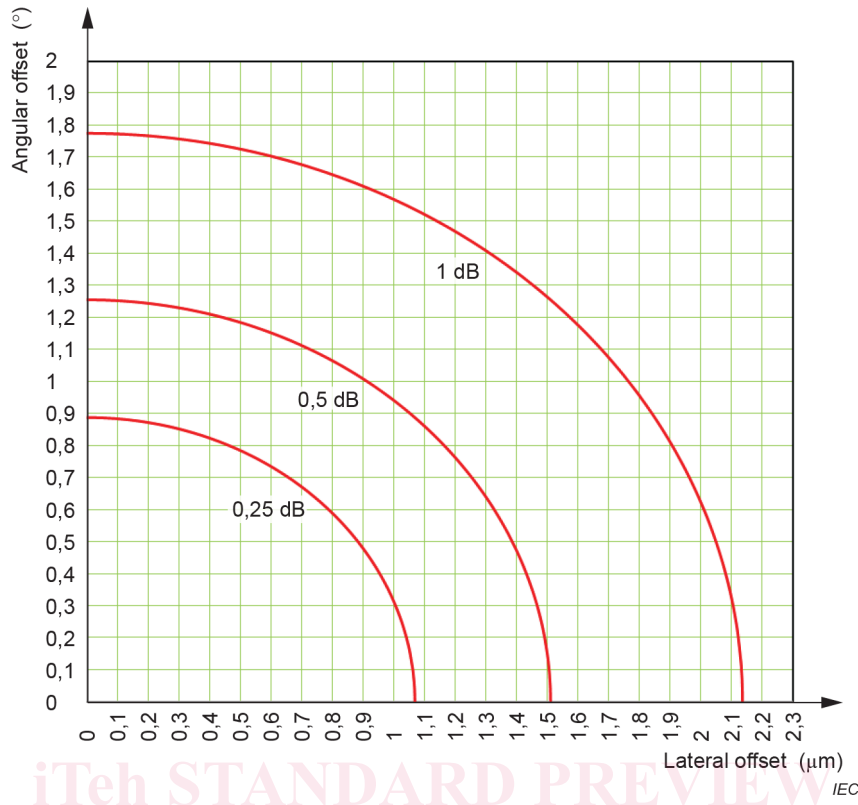
These attenuation grades are based on a statistical approach defining parameter values of connection populations to reach the attenuation to be less than or equal to the given value in 97 % of the connections. This performance is assumed at the nominal wavelength with fibre MFD in the range defined in IEC 60793-2-50 family specification for single-mode dispersion unshifted fibres category B.

Populations of lateral and angular offset of the random mated connections are assumed to be statistically distributed within the specific ranges of parameter values  $d$  and  $\theta$  in Formula (1).

Each curve given in Figure 1 represents maximum allowable combinations of lateral offset and angular offset so as not to exceed the specified attenuation of any single connection, without the contribution from fibre MFD mismatch. Additional attenuation due to mismatch of the MFD from the randomly selected fibres is included in Formula (1).

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Formula (1) is applicable to wavelengths from the range between 1 310 nm and 1 625 nm, using the parameters for these wavelengths. The curves in Figure 1 are only shown at 1 310 nm wavelength.



**Figure 1 – Lateral offset and angular offset versus attenuation,  $\eta_{combined}$ , for single-mode fibre with 8,9 μm MFD at 1 310 nm**

Attenuation  $\eta_{combined}$  is expressed in Formula (1) below:

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$$\eta_{combined} = -10 \log_{10} \left[ \frac{(2\omega_2\omega_1)^2}{(\omega_2^2 + \omega_1^2)^2} \exp \left[ \frac{-2 \cdot d^2}{\omega_2^2 + \omega_1^2} - 2\pi^2 \frac{n_0^2}{\lambda^2} \frac{(\omega_2^2\omega_1^2)}{(\omega_2^2 + \omega_1^2)} \sin^2(\theta) \right] \right] \quad (1)$$

where

- $d$  is the total lateral offset between two fibres;
- $\theta$  is the angular offset between fibre core axes;
- $\lambda$  is the wavelength of transmitted light in vacuum;
- $n_0$  is the index of refraction of the fibre core;
- $\omega_1$  is the transmit fibre mode field radius;
- $\omega_2$  is the receive fibre mode field radius.

### 5.3 Visual requirements for return loss grades

Without considering any contamination or defect on the end face, the intrinsic return loss for angled polished physical contacting fibres is primarily governed by the polishing angle (see Annex A). The appropriate polishing method shall be applied to obtain the return loss grade in Table 2. The quality of the end face shall be inspected using IEC 61300-3-35. The visual requirements for single-mode APC polished end faces in fibre core zone (zone A), and fibre cladding zone (zone B) based on defect size, scratch width, and their respective quantities are shown in Table 4.

**Table 4 – Visual requirements for single-mode angle polished (APC) fibres SM APC (RL ≥ 60 dB)**

<b>Zone</b> (diameter)	<b>Defects</b> (diameter)	<b>Scratches</b> (width)
A: core 25 µm	No limit < 2 µm Maximum 1 ≥ 2 µm and ≤ 3 µm None > 3 µm	No limit < 3 µm Maximum 4 ≥ 3 µm and ≤ 4 µm None > 4 µm
B: cladding 25 µm to 110 µm	No limit ≤ 25 µm None > 25 µm	No limit

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