IEC 63267-2-1

Edition 1.0 2024-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Fibre optic interconnecting devices and passive components – Connector optical interfaces for enhanced macro bend multimode fibres – Part 2-1: Connection parameters of physically contacting 50 µm core diameter fibres – Non-angled

Dispositifs d'interconnexion et composants passifs fibroniques – Interfaces optiques de connecteurs pour fibres multimodales améliorées en macrocourbures – Partie 2-1 : Paramètres de connexion des fibres d'un diamètre de cœur de 50 µm en contact physique – Sans angle

IEC 63267-2-1:2024-03(en-fr)

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Part 2-1: Connection parameters of physically contacting 50 µm core diameter fibres – Non-angled

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IEC 63267-2-1 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.

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

Draft	Report on voting
86B/4858/FDIS	86B/4877/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 of the IEC 63267 series, under the general title *Fibre optic interconnecting devices and passive components – Connector optical interfaces for enhanced macro bend multimode fibre*, 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.

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

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – CONNECTOR OPTICAL INTERFACES FOR ENHANCED MACRO BEND MULTIMODE FIBRES –

Part 2-1: Connection parameters of physically contacting 50 µm core diameter fibres – Non-angled

1 Scope

This part of IEC 63267 defines a set of specified conditions for an enhanced macro bend of 50/125 µm, graded index multimode fibre optic connection that is maintained in order to satisfy the requirements of attenuation and return loss performance in a randomly mated pair of polished physically contacting (PC) fibres.

An encircled flux (EF) compliant launch condition in accordance with IEC 61300-1, at an operational wavelength of 850 nm, is used for determination of performance grades, based on lateral fibre core offset, numerical aperture (NA) mismatch, and fibre core diameter (CD) variation. Fibre core angular offset is considered insignificant given the state-of-the-art and is excluded as a factor for attenuation estimation.

Attenuation and return loss performance grades are defined in IEC 63267-1.

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 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 63267-1, *Fibre optic interconnecting devices and passive components – Fibre optic connector optical interfaces – Part 1: Enhanced macro bend loss multimode 50 µm core diameter fibres – General and guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 63267-1 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

4 Attenuation and return loss grades

Proposed attenuation and return loss grades for PC polished connections are given in Table 1 and Table 2.

Table 1 – Multimode random mate attenuation grades at 850 nm

Attenuation grade	Attenuation mean dB	Attenuation[a] ≥ 97 %[b] dB	Notes
Am			Reserved for future application
Bm	≤ 0,30	≤ 0,60	
Cm	≤ 0,50	≤ 1,00	
Dm			Not specified at this time

[a] Attenuation shall be measured by IEC 61300-3-34 for single-fibre connectors and IEC 61300-3-45 for multi-fibre connectors.

[b] The probability of a random mated connection set to meet the specified attenuation requirement will be ≥ 97 %. This performance is reached considering a statistical distribution of the connection's parameters (optical fibre core diameter, numerical aperture, and lateral offset) and using an encircled flux (EF) compliant launch at the source operating at a nominal value for wavelength of 850 nm.

Table 2 – Multimode return loss grades at 850 nm

Return loss grade	Return loss (mated) [a] dB	Notes
1		Grade 1 is defined as ≥ 45 dB (mated) and reserved for use with angled, physically contacting fibres
2	≥ 20	

[a] The test shall be carried out in accordance with IEC 61300-3-6.

5 Criteria for a fit within attenuation and return loss grades

5.1 General

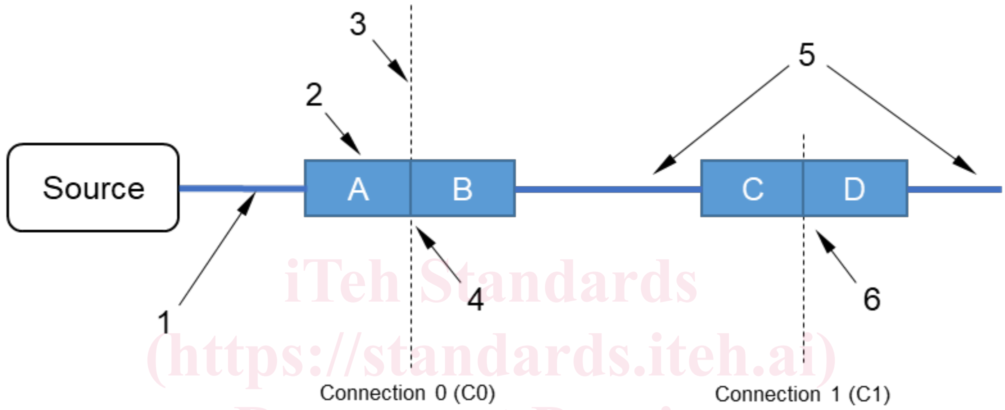
The criteria for meeting the attenuation and return loss grades listed in Table 1 and Table 2 are given in Figure 1 to Figure 3 and Table 3 and Table 4. The parameters chosen for the criteria definition are based on the degree of significance in affecting the performance under test. The criteria selected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

IEC TR 62614-2, which is a Technical Report, provides further background on EF in conjunction with attenuation and return loss of graded index multimode fibre products.

5.2 Attenuation grades and criteria

When launched into multimode optical fibre, light emitting diode (LED) and laser sources can exhibit varying modal power distributions. These differing modal power distributions, combined with the differential mode attenuation (DMA) inherent in most multimode components, commonly cause variations when measuring attenuation. EF is used to provide quantitative requirements based on near-field intensity, measured in accordance with IEC 61300-1 so that the maximum expected variation in attenuation is known. An EF flux template is constructed from a set of three EF curves, defined at critical values of radius, using the lower and upper limits to establish an envelope, and a target condition. Requirements are tabulated for a particular combination of optical fibre size and wavelength in IEC 61300-1.

The theory leading to the EF limits is based on assumptions that include optical fibre core refractive index dimension and shape, spectral width, and Hermite-Gauss or Laguerre-Gauss models for mode fields. A mode group power coupling matrix associated with lateral offset of a connection can be generated by overlap integrals of the different mode fields, having the input fields displaced relative to the receiving fibre mode fields. This allows the attenuation of a connection to be computed for a given encircled flux launch condition based on lateral misalignment, optical fibre core diameter, and numerical aperture, which are the most significant parameters influencing performance under test.



Key

1 nominal fibre

2 reference connector interface

3 EF compliant launch condition

4 random displacement, (x_B, y_B)

5 random NA and CD

6 random relative displacement, $(x_D - x_C, y_D - y_C)$

Figure 1 – Schematic illustration showing connection zero and connection one

Characterization of the requisite EF launch condition is described at the end of an equipment launch cord, generally with reference grade fibre and interface geometry. When a random cord is concatenated to the launch cord, the first interface is referred to as connection zero (C0). This connection tends to alter the launch condition through mode coupling and differential mode attenuation. However, the second connection, defined as connection one (C1), is used for estimation of a given attenuation performance grade. Therefore, the estimated loss at C1 is dependent on the connection at C0 with respect to how much the power intensity distribution is modified and shall be considered in the determination of a performance grade. A schematic of the test setup illustrates the connections in Figure 1.

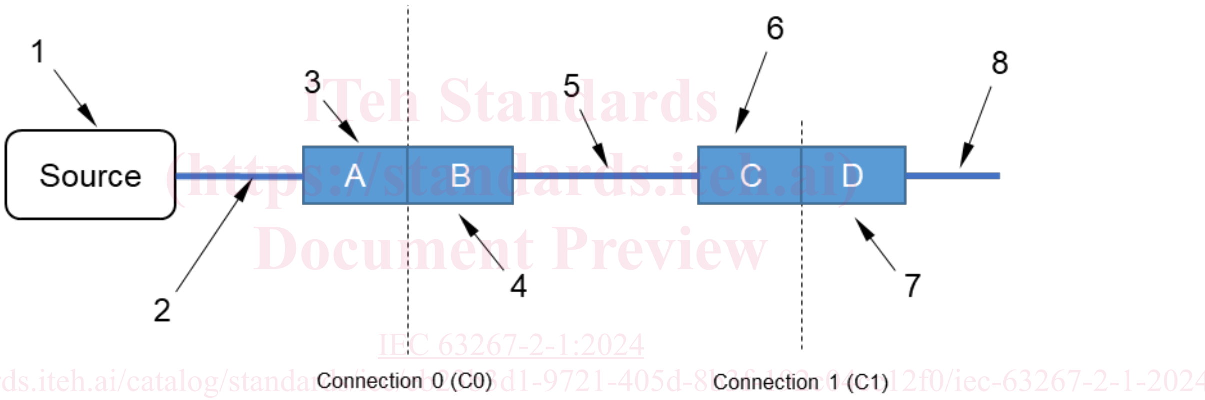
The attenuation grades are based on a statistical approach defining parameter values of connection populations to reach the given random attenuation (or below) in 97 % of the connections. This performance assumes a nominal wavelength of 850 nm with multimode optical fibre defined in IEC 60793-2-10 category A1-OMxb (x = 2, 3, 4, or 5) as highlighted by the properties listed in Table 3.

Table 3 – Multimode optical fibre properties

Fibre type	Nominal wavelength nm	Fibre core diameter µm		Numerical aperture		Effective group index of refraction
		Minimum	Maximum	Minimum	Maximum	
IEC 60793-2-10 category A1-OMxb (x = 2, 3, 4, or 5) fibres	850	47,5	52,5	0,185	0,215	1,483 5

Populations of lateral fibre core offset, NA mismatch, and CD of the randomly mated connections are assumed to be statistically distributed for the purpose of simulation. Assuming an optimally centred reference fibre at connection zero, it should be noted that offset distribution at connection, C1, is $\sqrt{2}$ times broader than connection, C0.

The attenuation at C1 is estimated using the lookup table result for a given combination of parameters. The underlying statistical assumptions for these inputs are used to generate the expected loss distribution. A graphical representation which provides parameter limits and probability density functions for the theoretical analysis is shown in Figure 2.



Key

1 EF at upper boundary of launch condition template

2 reference fibre with CD from 49,5 µm to 50,5 µm (uniform) and NA from 0,198 to 0,202 (uniform)

3 reference interface with displacement from 0 µm to 4,5 µm

4 bi-variate Gaussian displacement, (x_B, y_B)

5 cord 1 fibre with CD from 47,5 µm to 52,5 µm (Gaussian) and NA from 0,185 to 0,215 (Gaussian)

6 bi-variate Gaussian displacement, (x_C, y_C)

7 bi-variate Gaussian displacement, (x_D, y_D)

8 cord 2 fibre with CD from 47,5 µm to 52,5 µm (Gaussian) and NA from 0,185 to 0,215 (Gaussian)

NOTE 1 Gaussian distribution is based on a +3σ variance within the limits.

NOTE 2 Bi-variate Gaussian displacement variation is alternatively defined as a radial offset with a Rayleigh distribution in polar coordinates.

NOTE 3 Refer to IEC 63267-2-2 for detail on reference connection parameter.

Figure 2 – Graphical representation showing parameter limits and distribution information for the purpose of attenuation modelling

Simulation of the parameters yields characteristic curves for the mean and ≥ 97 % attenuation levels as a function of lateral offset limit for the mating interfaces, as shown in Figure 3. The offset limit is defined by a Raleigh probability distribution, where the tail is truncated at a value of 99,97 %. From the plot, the maximum allowable misalignment between mating fibre cores can be determined for performance grades Bm and Cm, which are approximately 3 µm and

6 µm, respectively, as illustrated. Alternatively, response surfaces that give the maximum allowable combination of lateral offset, core diameter, and numerical aperture to not exceed attenuations of 0,6 dB and 1,0 dB are shown in Annex A. These provide a qualitative representation of the influence that each factor has on a given performance level.

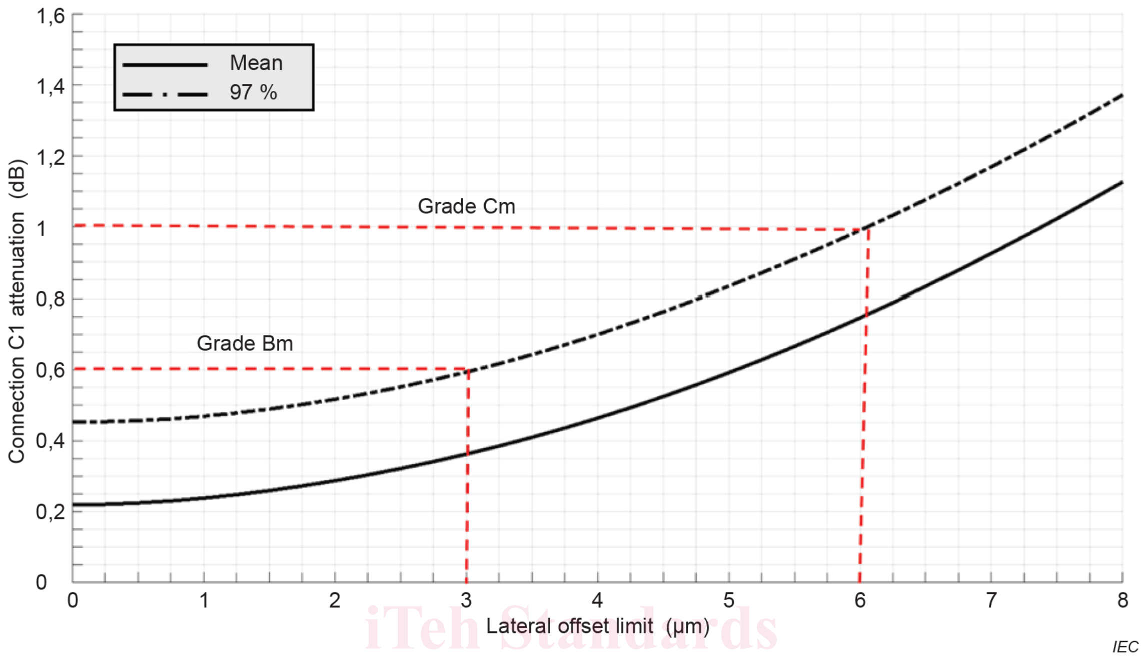


Figure 3 – Connection C1 attenuation as a function of lateral offset limit

5.3 Return loss grades and criteria

Without considering any contamination or defect on the end face, the intrinsic return loss on physical contacting fibres is governed by the refractive index profiles of the mating fibre core. Assuming a proper polishing method is applied to ensure the return loss grades listed in Table 2, the quality of the end face shall be inspected in accordance with IEC 61300-3-35 to determine if it is suitable for use. The visual requirements for multimode PC polished end faces in fibre core zone (zone A), and fibre cladding zone (zone B) are shown in Table 4.

Table 4 – Visual requirements for multimode PC polished end faces return loss grade 2 (RL ≥ 20 dB)

Zone (diameter)	**Defects** (diameter)	**Scratches** (width)
A: core zone 65 µm	< 2 µm: no limit ≥ 2 µm and ≤ 5 µm: maximum 4 > 5 µm: none	< 3 µm: no limit ≥ 3 µm and ≤ 4 µm: maximum 4 > 4 µm: none
B: cladding zone 65 µm to 110 µm	≤ 25 µm: no limit > 25 µm: none	No limit