IEC 61300-2-43

Edition 2.0 2014-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 2-43: Tests – Screen testing of return loss of single-mode PC optical fibre connectors

Dispositifs d'interconnexion et composants passifs à fibres optiques – Procédures fondamentales d'essais et de mesures –
Partie 2-43: Essais – Sélection des connecteurs PC pour fibres optiques unimodales en fonction de leur affaiblissement de réflexion

IEC 61300-2-43:2014-06(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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CONTENTS

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 2-43: Tests – Screen testing of return loss of single-mode PC optical fibre connectors

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International Standard IEC 61300-3-43 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This second edition of IEC 61300-3-43 cancels and replaces the first edition published in 1999 and constitutes a technical revision.

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

a) revision of the scope;

b) revision of the procedure;

c) addition of measurement uncertainty into the 'Details to be specified';

d) addition of a bibliography.

The text of this standard is based on the following documents:

CDV	Report on voting
86B/3669/CDV	86B/3755/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61300 series, published under the general title, *Fibre optic interconnecting and passive components – Basic test and measurement procedures*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,
- replaced by a revised edition, or
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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 2-43: Tests – Screen testing of return loss of single-mode PC optical fibre connectors

1 Scope

This part of IEC 61300 aims at screening single-mode physical contact (PC) optical fibre connectors of an optical fibre cord or an optical fibre pigtail in terms of return loss, thus ensuring minimum return loss when the connectors, which have been screen tested by this method, are randomly mated with each other in the field.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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*

3 General description

The domed ferrule end faces of PC connectors (not angled) are produced by a polishing process. This polishing process results in a thin damaged layer at the fibre end face of the connector. In silica fibres, the refractive index of the damaged layer is slightly higher than that of original fibre. This high refractive index layer generates optical reflection. When PC connectors are mated, return loss occurs as a result of multiple reflections at the two damaged layers of the butted connectors.

This test procedure ensures that a designed minimum return loss is achieved when PC connectors are randomly mated. It screens cords or pigtails by using a pair of reflection standard plug (RP) cords. The pair of reflection standard plugs is selected on the condition that the return loss when the plugs are mated is several decibels better than the designed minimum return loss. Cords which pass this test will achieve the designed minimum return loss in over 99 % of cases when randomly mated (see Annex A).

4 Apparatus

The equipment listed below shall be chosen according to the method used to measure the connector return loss, in accordance with IEC 61300-3-6. The reflection standard plug shall be prepared according to the procedure given in 5.1.

- Sources S
- Excitation unit E
- Detector D
- Temporary joint TJ
- Terminator T
- Branching device BD
- Reflection standard cord

The reflection standard cord has a reflection standard plug (RP) at one end. The other end of the reflection standard cord is an end or a plug whose return loss is better than the designed minimum return loss L_{rs} (in decibels).

5 Procedure

5.1 Selection of the reflection standard cord

The reflection standard plug (RP) shall be selected by the following procedure.

a) Set up an objective reflection standard cord as shown in Figure 1.

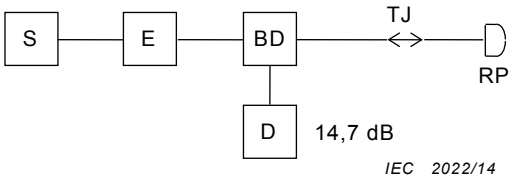

Figure 1 – Measurement set-up for open plug reflection standard

b) Set the detector to 14,7 dB as the Fresnel reflection between the air and the silica fibre core as shown in Figure 1. The refractive index of air is 1,0, and the one of silica fibre is 1,452 for single-mode fibre on condition Δ = 0,3 %, λ = 1,31 μm.

NOTE Measurement accuracy can be improved by using the actual parameters of fibres which have been employed.

c) Connect another objective reflection standard cord as shown in Figure 2, then measure the return loss.

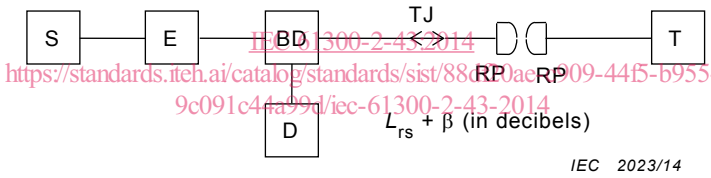

Figure 2 – Measurement set-up for mated reflection standard cords

d) Take the pair of objective reflection standard cords as reflection standard cords on condition that their return loss from the mating point is L_{rs} + β (in decibels), where L_{rs} is a designed minimum return loss. The value of β shall be set at above 2 dB.

5.2 Cord screen testing

a) Connect the device under test (DUT) (cord) between the reflection standard plugs as shown in Figure 3.

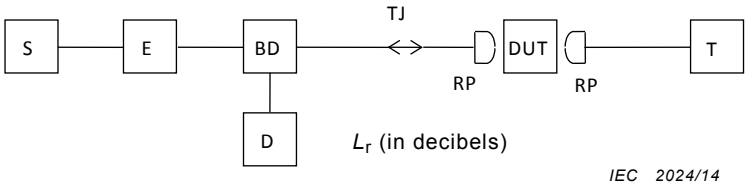

Figure 3 – Measurement set-up for cord screen testing

b) Measure the return loss L_r (in decibels) from the two PC mating points.

c) Consider the objective cord as a screen tested cord when L_r is greater than L_{rs}.

5.3 Pigtail cord screen testing

a) Connect the objective PC connector of DUT (pigtail cord) to one reflection standard plug as shown in Figure 4, and terminate pigtail fibre end.

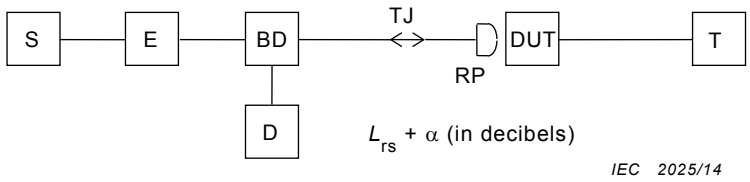

Figure 4 – Measurement set-up for pigtail cord screen testing

b) Measure the return loss L_r (in decibels) from the mating point.

c) Pass the objective pigtail cord as a screen tested cord when L_r is greater than L_{rs} + α (in decibels). The value of α shall be set at above 0,6 dB and at less than 5 dB.

6 Details to be specified

The following details, as applicable, shall be specified in the relevant specification:

– minimum return loss L_{rs} (in decibels);

– condition of standard reflection plugs (the value of β in decibels);

– screening condition for pigtail cords (the value of α in decibels);

– attenuation of mating points between the reflection standard connectors and the objective connectors;

– measurement uncertainty.

Annex A
(informative)

Screen testing of return loss of pigtails having PC fibre optic connector

This annex describes the theoretical background of the screen testing of return loss for pigtails. The basic idea is the same as the screen testing of return loss of cords having PC fibre optic connectors: select a pair of reference connectors, and a measurement pigtail is screen tested using the reference connector under a condition which is determined by simulation, where the distribution of high refractive index layer caused by polishing process is considered.

Two parameters β and α are introduced into this method. Parameter β is used for the selection of a pair of reference connectors. Parameter α is used as a criterion for screen testing measurement connectors. These two parameters β and α are carefully determined by simulation so that return loss of mating point exceeds certain specified return loss L_{rs} with high probability when the screen tested connectors are randomly connected.

The method assumes:

– refractive index of fibre core n_1 is 1,452;

– refractive index of air n_2 is 1,0.

The set-up of the measurement and test procedures will be shown first. Figure A.1 shows the set-up with the reference cords 1 and 2; 1a and 2a represent reference connectors. Points 3a and 3b are the connectors of the cord under test and 4a is the connector of the pigtail under test. The connectors represented by 1b and 2b and 5b are angled connectors with high return loss. S is the optical source, D is the optical detector and BD represents the optical coupler. T is a fibre termination which shall have a high return loss; it should be made by the application of an index matching material to the fibre end or introducing an high attenuation in the fibre, for example, with a mandrel wrap.

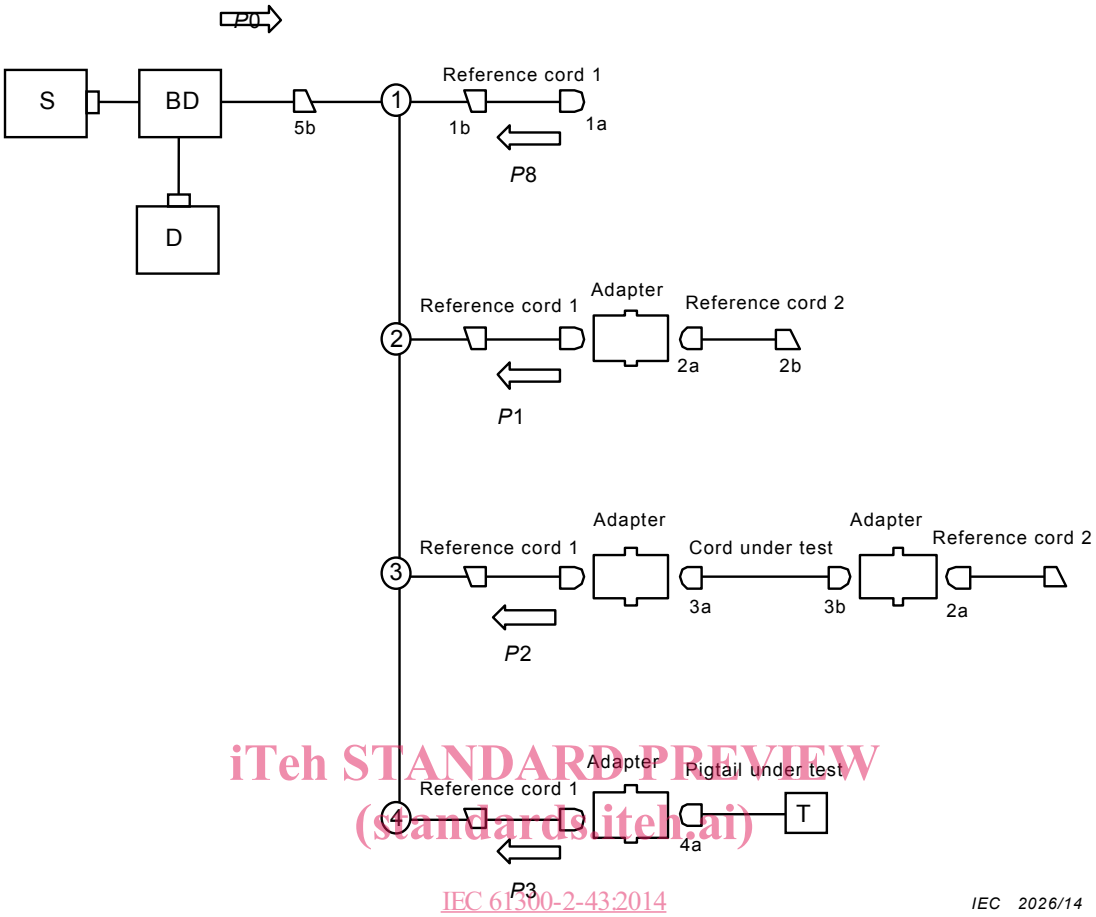

Figure A.1 – Measurement set-up of the screen test method

*P*0 is the input power and *P*8, *P*1, *P*2 and *P*3 are the reflected powers. The symbols ①, ②, ③, ④ indicate connection conditions.

The procedure of the screen test method is as follows:

a) A pair of reference plugs is selected.

– Connect the connector 1b to the connector 5b, then measure the power *P*8 (see ① in Figure A.1).

– Connect the reference connector 2a to the reference connector 1a, then measure the power *P*1 (see ② in Figure A.1).

The condition of selection is given by:

$$L_{rs} < -10 \log P1/P0 \leq L_{rs} + \beta \ \text{(dB)} \quad \text{(A.1)}$$

The measured power *P*0 can be described using *P*8, n_1 and n_2 as follows:

$$-10 \log 1/P0 = -10 \log 1/P8 - 20 \log (n_1 - n_2) / (n_1 + n_2) \quad \text{(A.2)}$$

The second term of the right side represents Fresnel reflection of air, and equals 14,7 dB. Therefore Equation (A.1) can be rewritten as:

$$0 < -10 \log P1/P8 + 14{,}7 - L_{rs} \leq \beta \quad \text{(A.3)}$$

b) The cord under test is screen tested using the pair of reference connectors.

– Connect the cord under test 3 between the reference connectors 1a and 2a, then measure the power *P*2 (see ③ in Figure A.1).

The criteria for the screen test of the measurement connectors are given by:

$$-10 \log P2/P8 + 14{,}7 \geq L_{rs} + \alpha \text{ (dB)} \quad \text{(A.4)}$$

c) The pigtail under test is screen tested using one of the pair reference connectors.

– Remove the reference connector 2a from reference connector 1a.

– Connect measurement connector 4a to the reference connector 1a, then measure the power $P3$ (see ④ in Figure A.1).

The criteria for the screen test of the measurement connectors is given by:

$$-10 \log P3/P8 + 14{,}7 \geq L_{rs} + \alpha \text{ (dB)} \quad \text{(A.5)}$$

The parameters β and α are determined by simulation so that the return loss of mating point exceeds the specified return loss L_{rs} with high probability when the screen tested connectors are randomly connected.

Figure A.2 shows the relation between β and α derived by the condition that the return loss at the mating point exceeds a specified value L_{rs} with a probability of 99 %. The white circles represent the simulation results for pigtails. The black circles represent those for cords. The lines indicate first-order regression lines. The figure indicates that the return loss of randomly concatenated cords exceeds L_{rs} (in decibels) with a probability of 99 % under the condition of $\alpha \geq 0{,}4\beta - 2{,}0$. The parameters β and α shall be determined according to this condition.

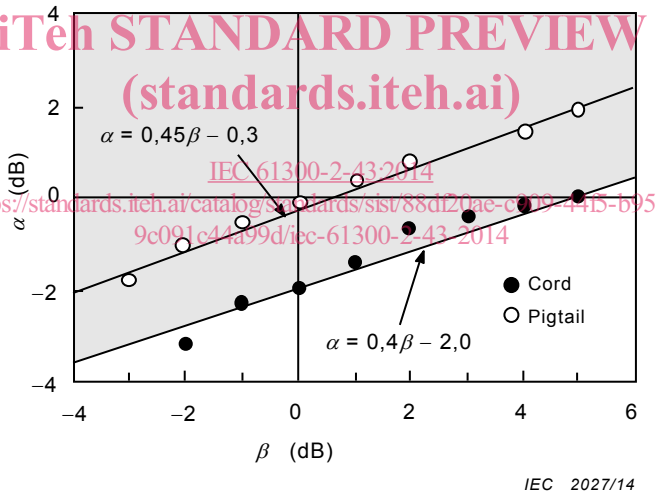

Figure A.2 – Relationship between β and α

Figure A.3 shows the cumulative probability of return loss before screen testing. Figure A.4 shows the cumulative probability of return loss when pigtails were screen tested under the condition of Equation (A.5) using the reference cord selected in accordance with Equation (A.1). The parameters L_{rs}, β and α are set at 45 dB, 5 dB and 2 dB, respectively. For pigtails, the probability exceeds 99 % when the return loss L_{rs} is greater than 45 dB.