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INTERNATIONAL STANDARD

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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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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

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61300-2-43:2014. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61300-2-43 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 third edition cancels and replaces the second edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition: addition of Clause 3 containing terms, definitions, and abbreviated terms.

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

Draft	Report on voting
86B/4628/FDIS	86B/4652/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/standardsdev/publications.

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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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~~ connector plugs of an optical fibre patch cord or an optical fibre pigtail in terms of return loss, thus ensuring minimum return loss when the ~~connectors~~ connector plugs~~, which have been screen tested by this method~~ are randomly mated with each other in the field. This document is intended to apply to cylindrical ferrule connector plugs.

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*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databased for use in standardization at the following addresses:

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

3.2 Abbreviated terms

BD branching device
D detector
DUT device under test
PC physical contact
PDL polarization dependent loss
RSC reflection standard cord
RSP reflection standard plug
S source
T termination
TJ temporary joint

4 General description

The domed ferrule end faces of PC ~~connectors~~ connector plugs (not angled) are produced by a polishing process. This polishing process results in a thin, damaged surface layer at the fibre end face of the connector plug. In silica fibres, the refractive index of the damaged layer is slightly higher than that of the original fibre. This high ~~refractive~~ index layer generates optical reflection. When PC ~~connectors~~ connector plugs are mated, return loss occurs as a result of multiple reflections at the two ~~damaged~~ high index layers of ~~the butted connectors~~ the physically contacting fibre end faces. This phenomenon and its effect on return loss is further explained in IEC 61755-2-1.

This test procedure ensures that a designed minimum return loss is achieved when PC ~~connectors~~ connector plugs are randomly mated. It screens patch cords or pigtails by using a pair of ~~reflection standard plug (RP) cords~~ reflection standard cords (RSCs). The reflection standard cord has a reflection standard plug (RSP) at one end. The pair of ~~reflection standard plugs is~~ RSCs are selected on the condition that the return loss when the plugs are mated is several decibels ~~better~~ higher than the designed minimum return loss. Patch cords which pass this test ~~will~~ achieves the designed minimum return loss in over 99 % of cases when randomly mated (see Annex A).

5 Apparatus

5.1 General

The equipment ~~listed below~~ used 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.~~ For the sake of simplicity, the procedure and figures in this document reflect that of a measurement with an optical continuous wave reflectometer (OCWR). The procedure can be adapted to any of the other measurement methods as deemed fit.

- ~~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).~~

5.2 Source (S)

The source consists of an optical emitter, associated drive electronics, an excitation unit, and a fibre connector or fibre pigtail.

5.3 Detector (D)

The detector used consists of an optical detector, the associated electronics, and a means of connecting to an optical fibre. The optical connection may be a receptacle for an optical connector plug, a fibre pigtail, or a bare fibre adapter.

5.4 Temporary joint (TJ)

A TJ is a joint that is made to connect the device under test (DUT) into the measurement circuit. Examples of TJs are a connector, splice, vacuum chuck or micro-manipulator. The loss of the TJ shall be stable, and the TJ shall have a return loss of at least 10 dB greater than the maximum return loss to be measured.

Where a return loss greater than 50 dB is to be measured, a fusion splice is recommended in order to guarantee the prescribed measurement uncertainty.

5.5 Termination (T)

Fibre terminations, T, shall have a high return loss. Three types of terminations are suggested:

– angled fibre ends: the value of the angle depends on the fibre type. A minimum angle of 12° is necessary to achieve the desired high return loss;

– the application of an index matching material to the fibre end;

– attenuation in the fibre, for example, with a mandrel wrap.

Where attenuation is used as a termination, it may be applied between components.

The fibre termination shall have a return loss of at least 20 dB greater than the maximum return loss to be measured.

Where a return loss greater than 50 dB is to be measured, the "attenuation in the fibre" termination technique is advised in order to guarantee the prescribed measurement uncertainty.

5.6 Branching device (BD)

The BD splits light power from the source to the signal and reference ports and couples light power from those ports into the detector.

The splitting ratio of the BD shall be stable and be insensitive to polarization. The PDL is recommended to be less than 0,1 dB. The directivity shall be at least 10 dB higher than the maximum return loss to be measured.

5.7 Reflection standard plug (RSP)

The RSP is a plug connector whose return loss is better than the designed minimum return loss RL_{rs} (in decibels).

5.8 Reflection standard cord (RSC)

The RSC has a RSP at one end. The other end of the RSC is an end or a plug whose return loss is better than the designed minimum return loss RL_{rs} (in decibels).

6 Procedure

6.1 Selection of the RSC

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

a) Set up an objective RSC as shown in Figure 1.

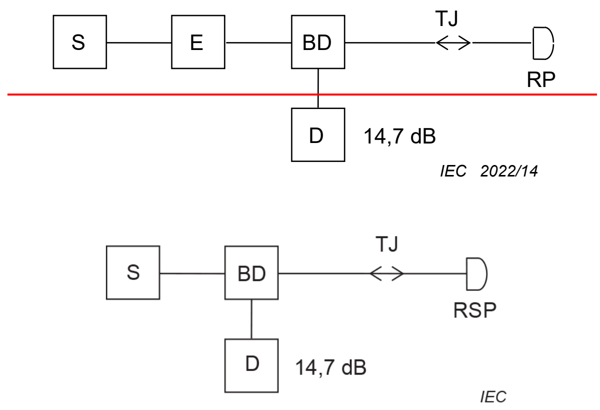


Figure 1 – Measurement set-up for open plug reflection standard

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 refractive index constant, Δ = 0,3 %, and wavelength, λ = 1,31 µm.

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

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

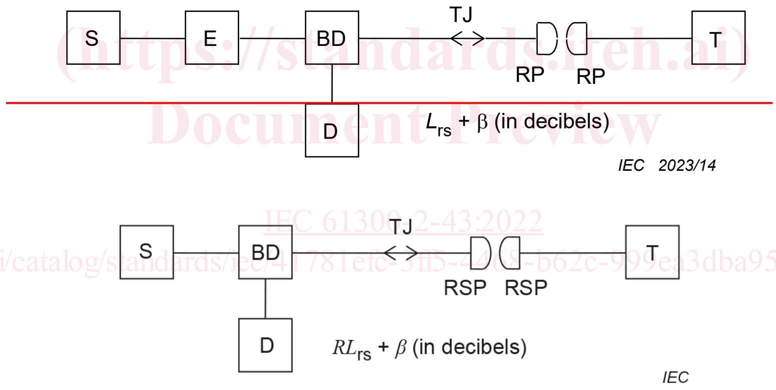


Figure 2 – Measurement set-up for mated RSCs

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

6.2 Patch cord screen testing

Optical fibre patch cords shall be screen tested according to the following procedure.

a) Connect the device under test (DUT) (patch cord) between the RSPs as shown in Figure 3.

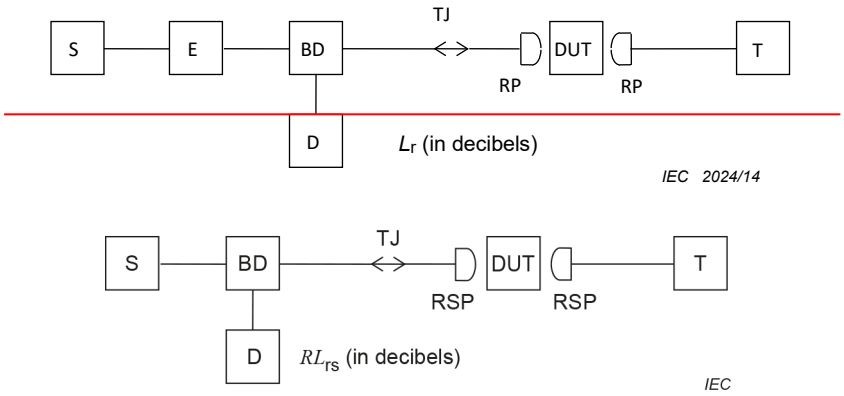


Figure 3 – Measurement set-up for patch cord screen testing

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

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

6.3 Pigtail ~~cord~~ screen testing

Optical fibre pigtails shall be screen tested according to the following procedure.

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

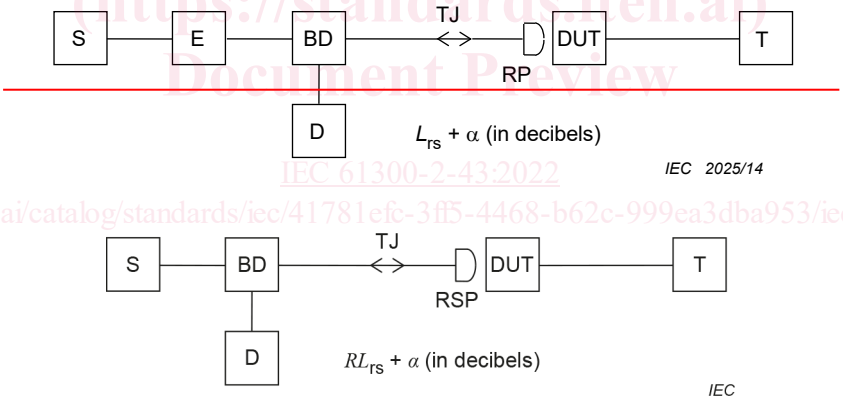


Figure 4 – Measurement set-up for pigtail ~~cord~~ screen testing

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

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

7 Details to be specified and reported

The following details, as applicable, shall be specified in the relevant specification and reported in the test report:

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

– condition of RSPs (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~~ RSPs and the objective ~~connectors~~ connector plugs;

– attenuation and return loss of temporary joint;
– types of termination;
– return loss of termination;
– measurement uncertainty.

Annex A
(informative)

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

Annex A 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 patch cords having PC fibre optic ~~connectors~~ connector plugs: 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.

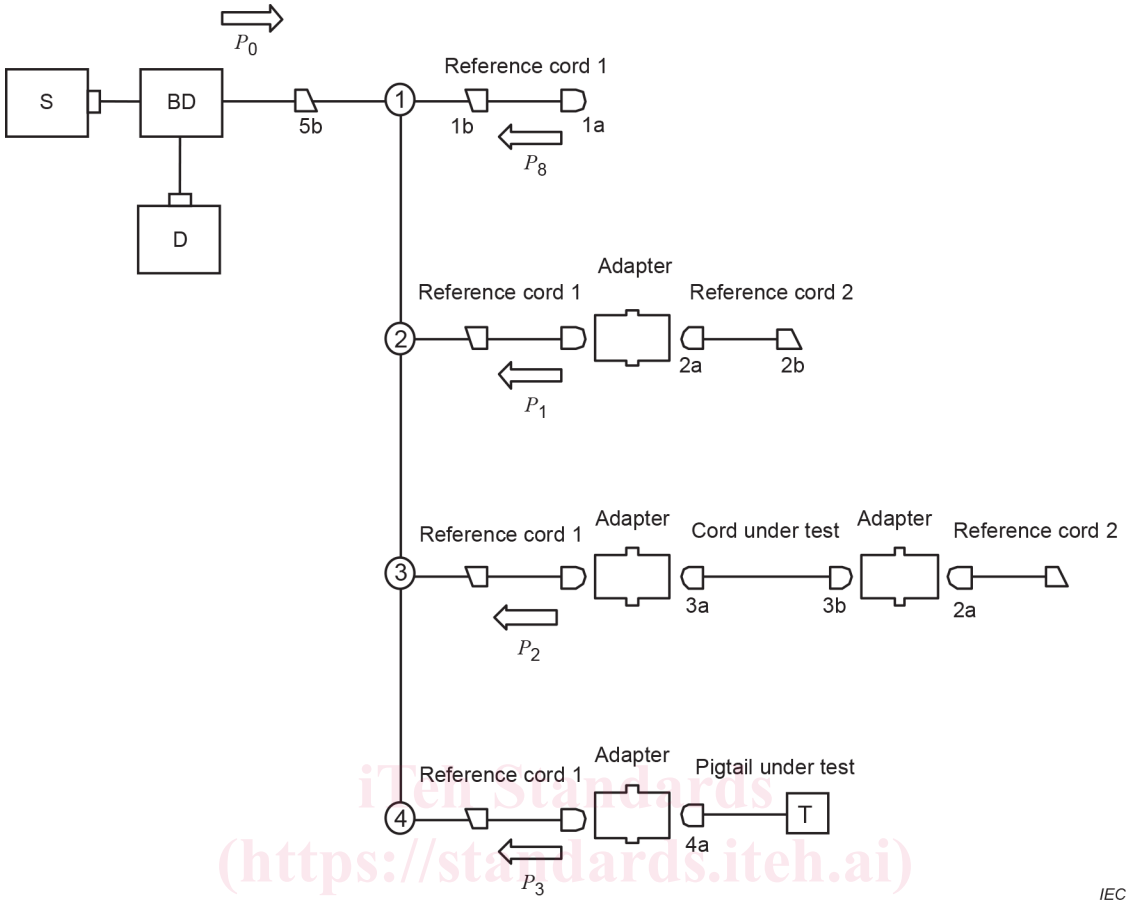
Two parameters β and α are introduced into this method. Parameter β is used for the selection of a pair of reference connectors. Parameter α is used as a criterion for screen testing measurement connectors. These two parameters β and α are carefully determined by simulation so that return loss of mating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

The method assumes the following:

– 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 patch cords 1 and 2; 1a and 2a represent reference ~~connectors~~ connector plugs. Points 3a and 3b are the ~~connectors~~ connector plugs of the patch cord under test and 4a is the connector plug of the pigtail under test. The ~~connectors~~ connector plugs represented by 1b, 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~~ branching device. T is a fibre termination which ~~shall have~~ has a high return loss; it should be made by the application of an index matching material to the fibre end or introducing a high attenuation in the fibre, for example, with a mandrel wrap.



Key

P_0	input power
P_1, P_2, P_3 and P_8	reflected power
①…④	connection conditions
and	angled connections with high return loss
	non-angled PC plugs

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

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:

~~$L_{rs-} < -10 \log P1/P0 \leq L_{rs-} + \beta$ (dB)~~

$$RL_{rs} < -10 \log P_1/P_0 \leq RL_{rs} + \beta \text{ (dB)} \quad \text{(A.1)}$$

   The measured power P_0 can be described using P_8, n_1 and n_2 as follows:

~~$-10 \log 1/P0 = -10 \log 1/P8 - 20 \log (n_{1-} - n_2) / (n_{1-} + n_2)$~~