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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 –

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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.

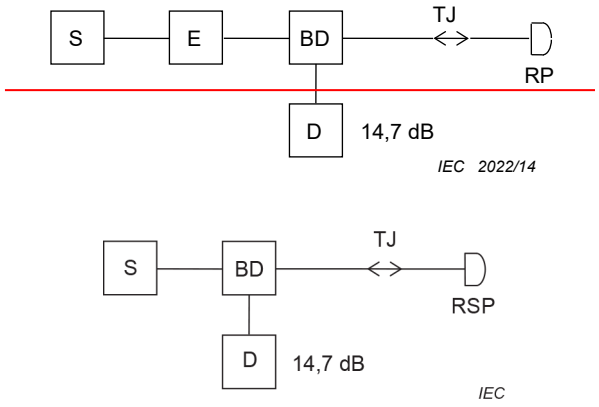


Figure 1 – Measurement set-up for open plug reflection standard

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.

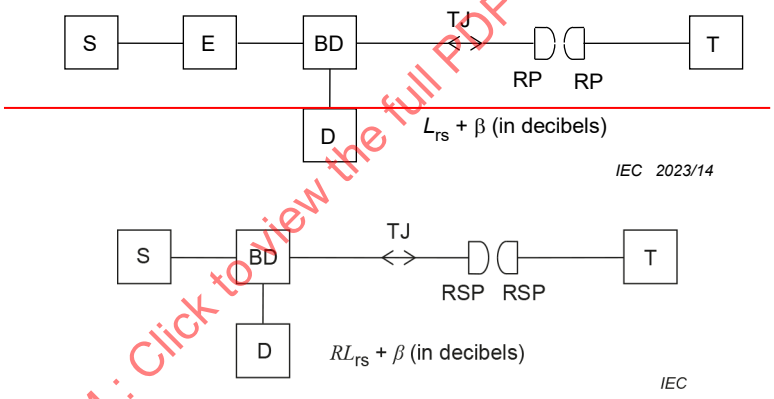


Figure 2 – Measurement set-up for mated RSCs

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.

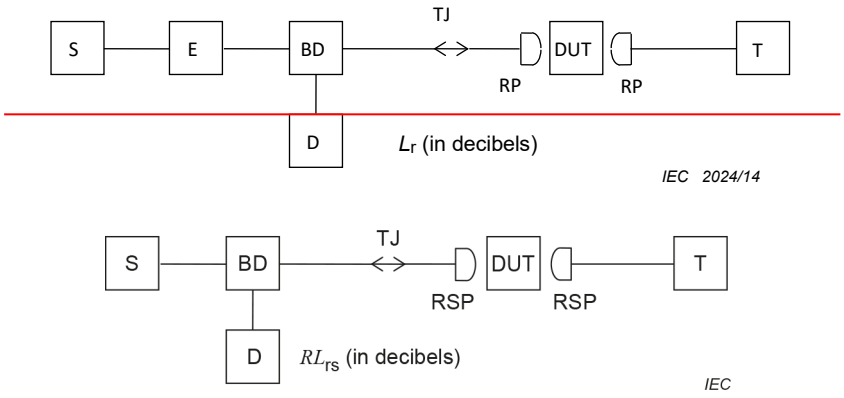


Figure 3 – Measurement set-up for patch cord screen testing

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.

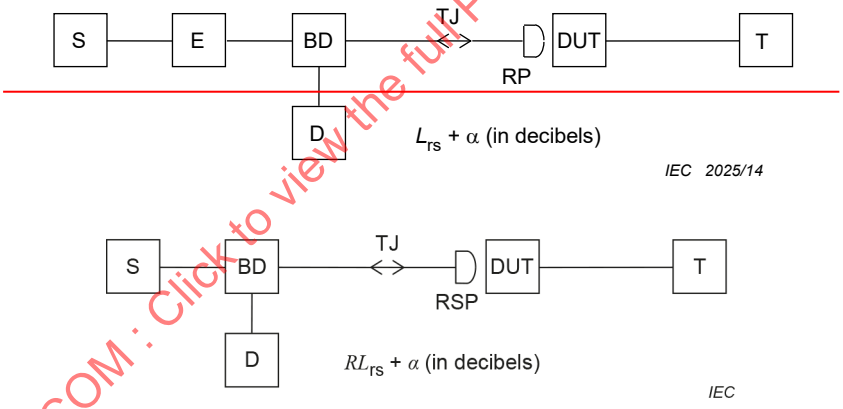


Figure 4 – Measurement set-up for pigtail ~~cord~~ screen testing

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.

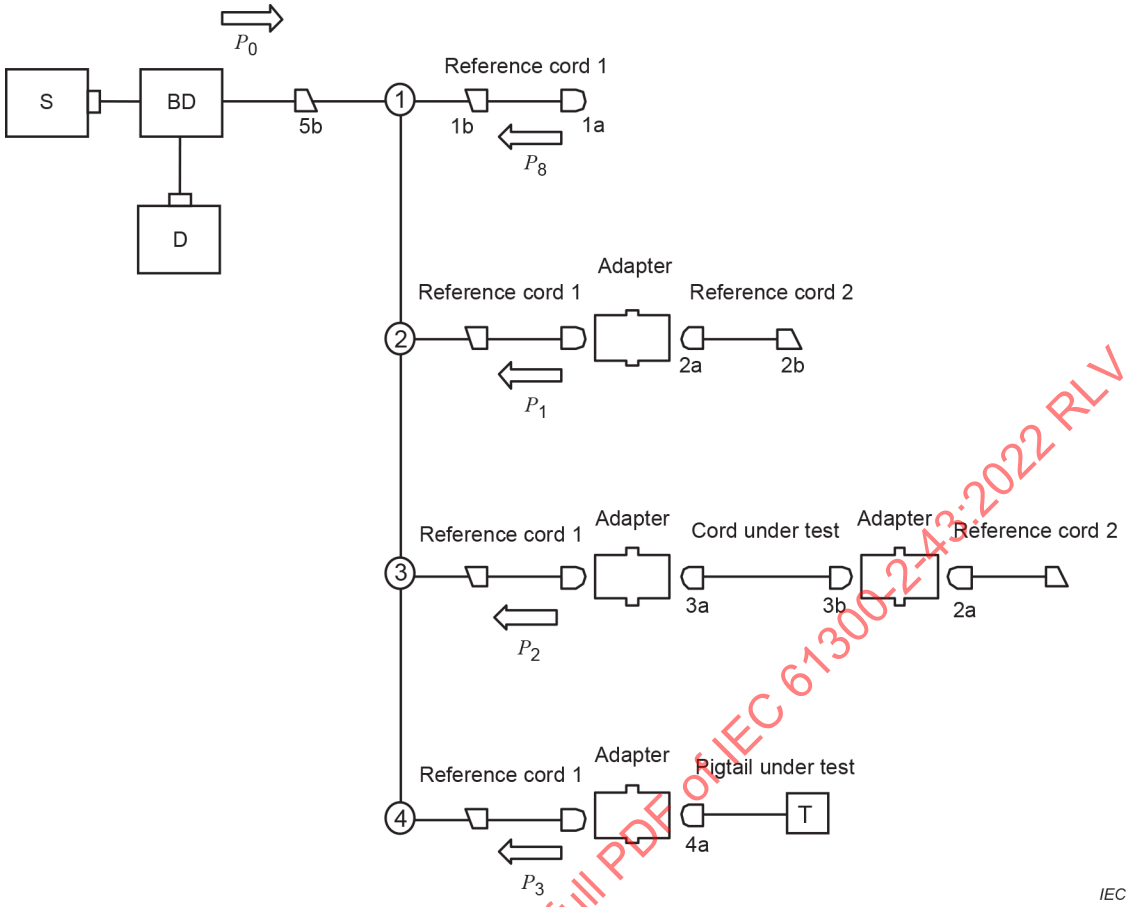
Two parameters β and α are introduced into this method. Parameter β is used for the selection of a pair of reference connectors. Parameter α is used as a criterion for screen testing measurement connectors. These two parameters β and α are carefully determined by simulation so that return loss of mating 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:

~~$-10 \log 1/P0 = -10 \log 1/P8 - 20 \log (n_1 - n_2) / (n_1 + n_2)$~~

$$-10 \log 1/P_0 = -10 \log 1/P_8 - 20 \log (n_1 - n_2) / (n_1 + n_2) \quad \text{(A.2)}$$

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

~~$0 < -10 \log P1/P8 + 14{,}7 - L_{rs} \leq \beta$~~

$$0 < -10 \log P_1/P_8 + 14{,}7 - RL_{rs} \leq \beta \quad \text{(A.3)}$$

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

– Connect the patch cord under test 3 between the reference connectors 1a and 2a, then measure the power P_2 (see ③ Figure A.1).

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

~~$-10 \log P2/P8 + 14{,}7 \geq L_{rs} + \alpha$ (dB)~~

$$-10 \log P_2/P_8 + 14{,}7 \geq RL_{rs} + \alpha \text{ (dB)} \quad \text{(A.4)}$$

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 P_3 (see ④ in Figure A.1).

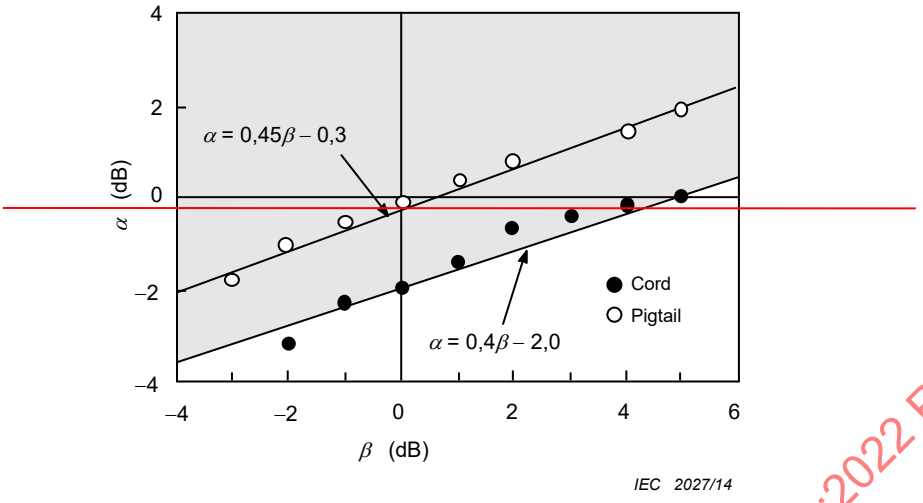
The criteria for the screen test of the measurement connectors is given by:

~~$-10 \log P3/P8 + 14{,}7 \geq L_{rs} + \alpha$ (dB)~~

$$-10 \log P_3/P_8 + 14{,}7 \geq RL_{rs} + \alpha \text{ (dB)} \quad \text{(A.5)}$$

The parameters β and α are determined by simulation so that the return loss of mating point exceeds the specified return loss ~~L_{rs}~~ RL_{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}~~ RL_{rs} with a probability of 99 %. The white circles represent the simulation results for pigtails. The black circles represent those for patch cords. The lines indicate first-order regression lines. Figure A.2 indicates that the return loss of randomly concatenated patch cords exceeds ~~L_{rs}~~ RL_{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~~ are determined according to this condition.



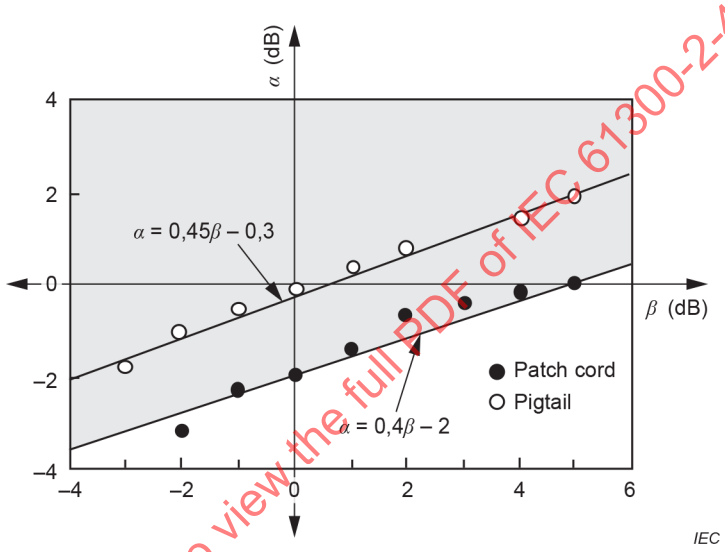


Figure A.2 – Relationship between β and α

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 Formula (A.5) using the reference cord selected in accordance with Formula (A.1). The parameters ~~L_{rs}~~ RL_{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}~~ RL_{rs} is greater than 45 dB.

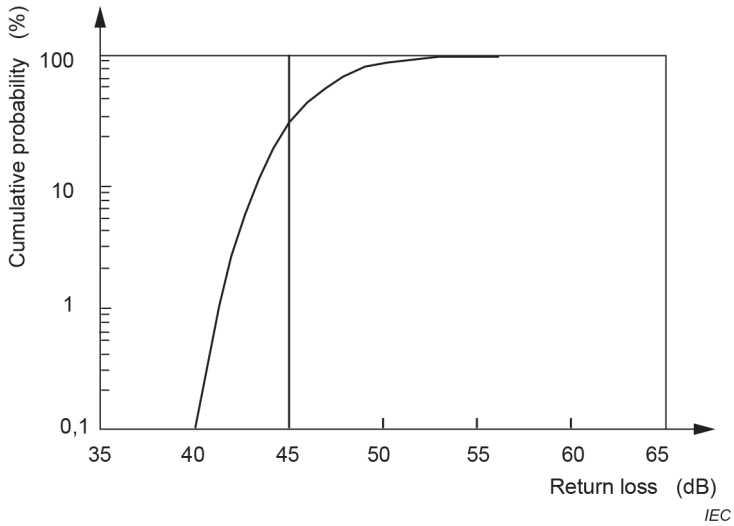


Figure A.3 – Cumulative probability of return loss before test

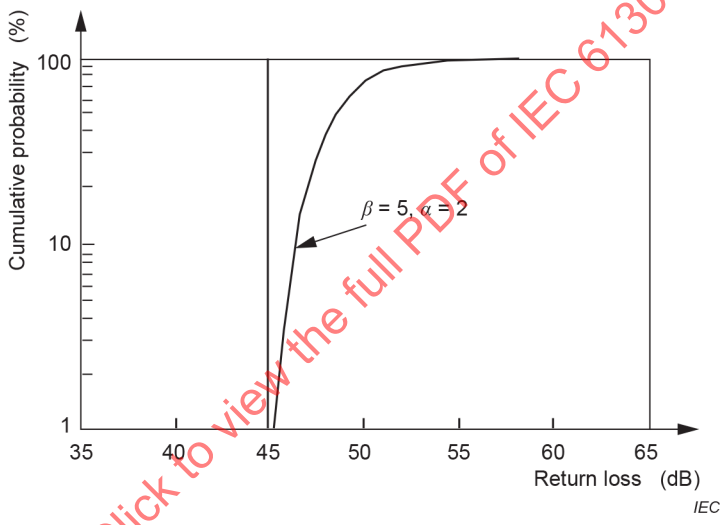


Figure A.4 – Cumulative probability of return loss after test

It is also important for the screen testing of pigtails that the fibre surface condition of one of the paired reference connectors is almost equal to that of the other reference connector. Figure A.5 shows the relation of the difference of P_4 and P_5 and difference of α_a and α_b. P_4 and P_5 are the reflected power of the paired reference connectors. The power is measured in the way described in Figure A.6 where the meaning of the symbols is the same as in Figure A.1. The parameters α_a and α_b are individual criteria which mean that the return loss of randomly concatenated connectors selected using the individual reference connector exceeds a specified value ~~L_{rs}~~ RL_{rs} with a probability of 99 % under following condition:

~~–10 log $P2/P8$ + 14,7 ≥ L_{rs} + α_a (dB); or~~

~~–10 log $P2/P8$ + 14,7 ≥ L_{rs} + α_b (dB).~~

- –10 log P_2/P_8 + 14,7 ≥ RL_{rs} + α_a (dB); or
- –10 log P_2/P_8 + 14,7 ≥ RL_{rs} + α_b (dB).

Figure A.5 shows that the fibre surface condition of the reference connector 1a is almost equal to that of the reference connector 2a when the difference between the measured power P_4 and

P_5 is small. The power P_4 and P_5 ~~shall~~ should satisfy the following condition to obtain the small difference between α_a and α_b within 1,0 dB:

$$2{,}0\ (\text{dB}) \geq |-10 \log P_4/P_5| \quad (A.6)$$

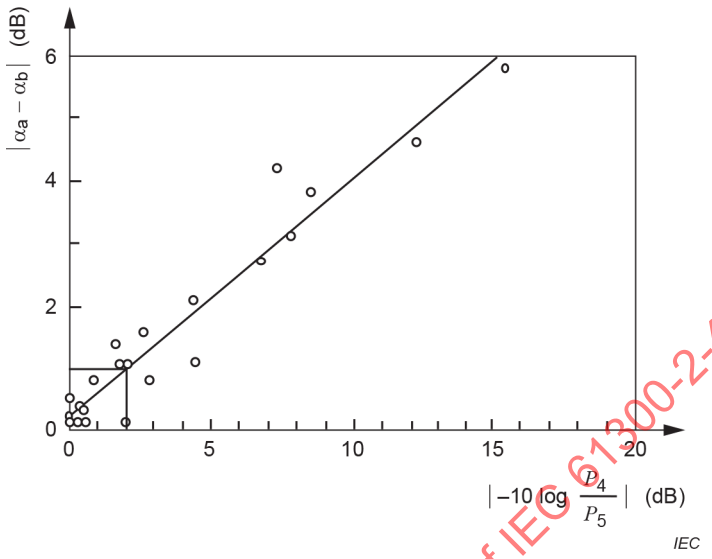


Figure A.5 – Relationship between power and α

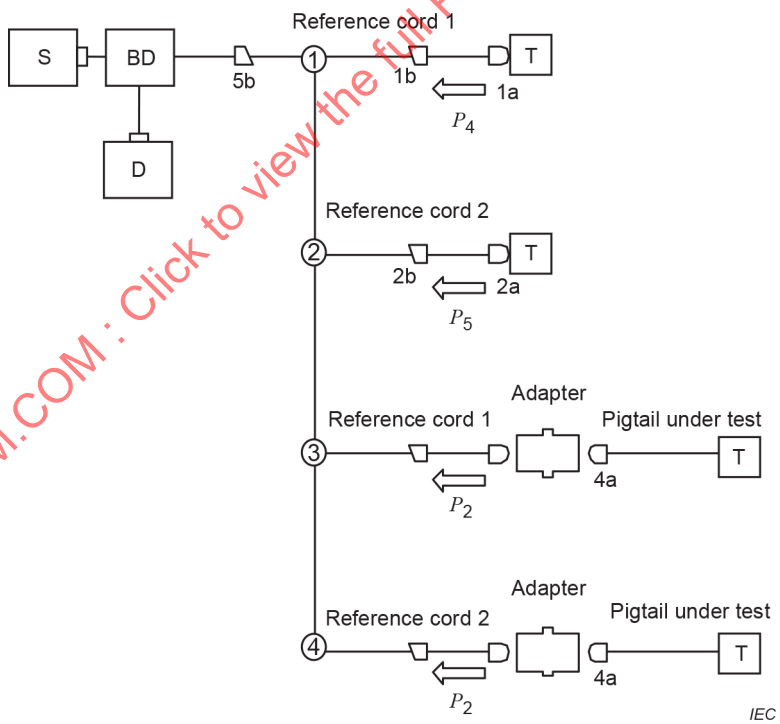


Figure A.6 – Measurement set-up of the reflected powers

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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

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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 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 connector plugs 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 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 index layer generates optical reflection. When PC connector plugs are mated, return loss occurs as a result of multiple reflections at the two high index layers of 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 connector plugs are randomly mated. It screens patch cords or pigtails by using a pair of reflection standard cords (RSCs). The reflection standard cord has a reflection standard plug (RSP) at one end. The pair of RSCs are selected on the condition that the return loss when the plugs are mated is several decibels higher than the designed minimum return loss. Patch cords which pass this test achieves the designed minimum return loss in over 99 % of cases when randomly mated (see Annex A).

5 Apparatus

5.1 General

The equipment used shall be chosen according to the method used to measure the connector return loss, in accordance with IEC 61300-3-6. 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.

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 RSC shall be selected by the following procedure.

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

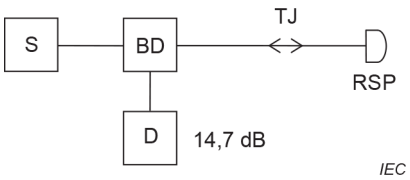


Figure 1 – Measurement set-up for open plug reflection standard

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 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.

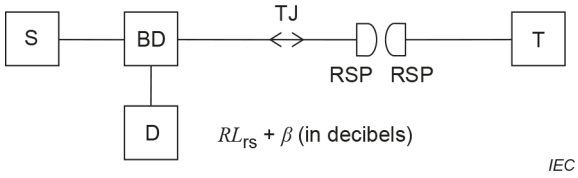


Figure 2 – Measurement set-up for mated RSCs

d) Take the pair of objective RSC's as RSC's on condition that their return loss from the mating point is RL_{rs} + β (in decibels), where 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.

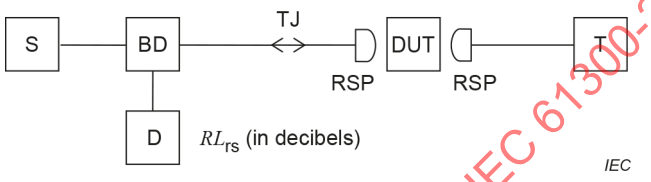


Figure 3 – Measurement set-up for patch cord screen testing

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

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

6.3 Pigtail screen testing

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

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

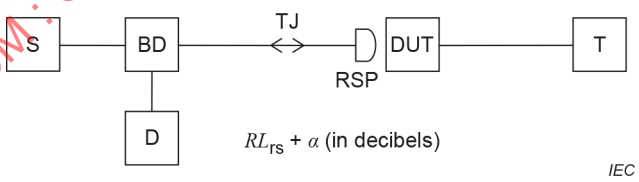


Figure 4 – Measurement set-up for pigtail screen testing

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

c) Pass the objective pigtail as a screen tested pigtail when RL_r is greater than 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 RL_{rs} (in decibels);

– condition of RSPs (the value of β in decibels);

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

– attenuation of mating points between the RSPs and the objective 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 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.

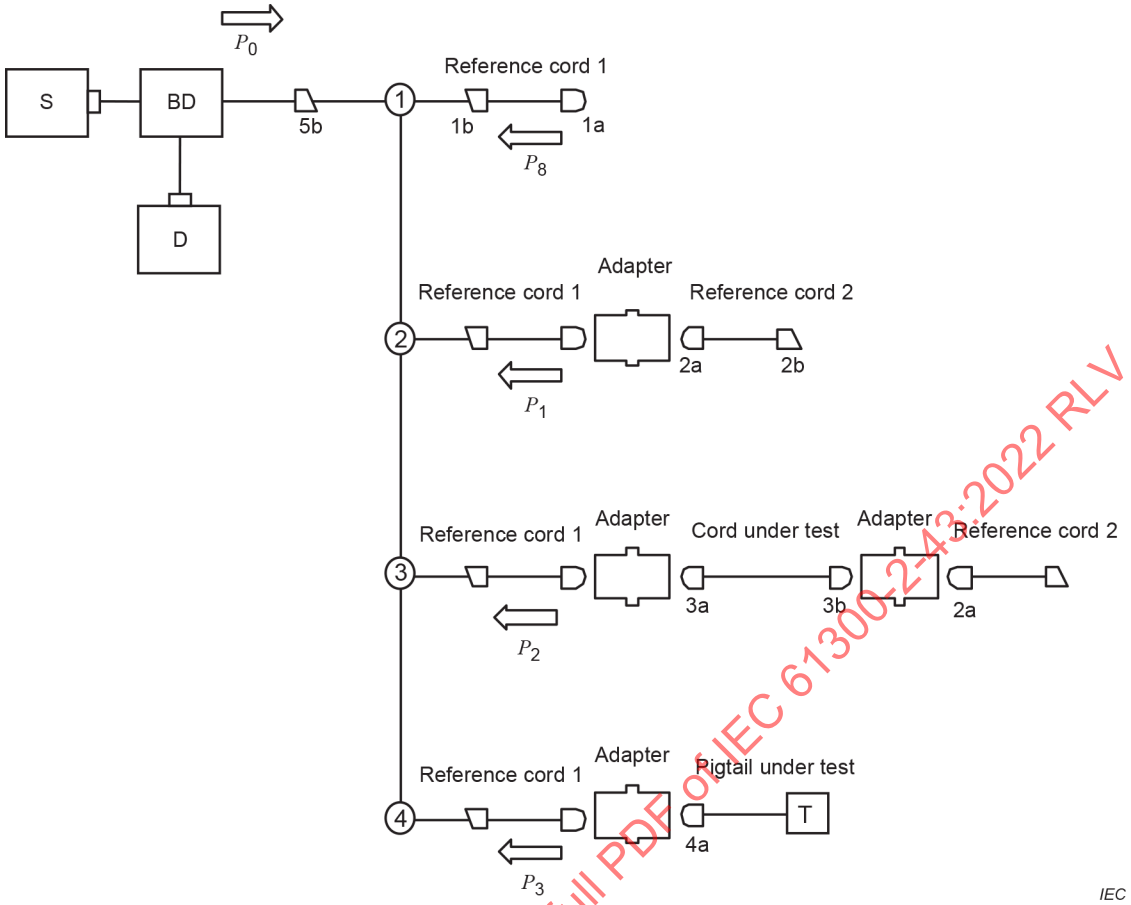
Two parameters β and α are introduced into this method. Parameter β is used for the selection of a pair of reference connectors. Parameter α is used as a criterion for screen testing measurement connectors. These two parameters β and α are carefully determined by simulation so that return loss of mating 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 connector plugs. Points 3a and 3b are the connector plugs of the patch cord under test and 4a is the connector plug of the pigtail under test. The 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 branching device. T is a fibre termination which 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:

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

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

$$-10 \log 1/P_0 = -10 \log 1/P_8 - 20 \log (n_1 - n_2) / (n_1 + n_2) \quad \text{(A.2)}$$

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

$$0 < -10 \log P_1/P_8 + 14{,}7 - RL_{rs} \leq \beta \quad \text{(A.3)}$$

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

– Connect the patch cord under test 3 between the reference connectors 1a and 2a, then measure the power P_2 (see ③ Figure A.1).

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

$$-10 \log P_2/P_8 + 14{,}7 \geq RL_{rs} + \alpha \text{ (dB)} \quad \text{(A.4)}$$

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 P_3 (see ④ in Figure A.1).

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

$$-10 \log P_3/P_8 + 14{,}7 \geq RL_{rs} + \alpha \text{ (dB)} \quad \text{(A.5)}$$

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

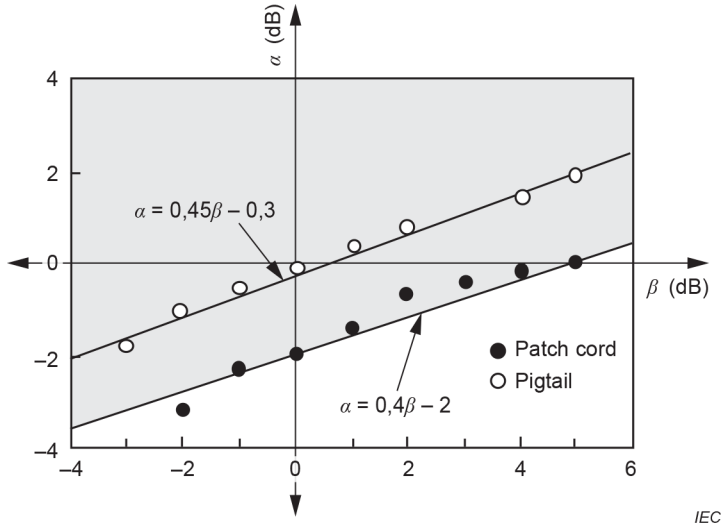


Figure A.2 – Relationship between β and α

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 Formula (A.5) using the reference cord selected in accordance with Formula (A.1). The parameters RL_{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 RL_{rs} is greater than 45 dB.

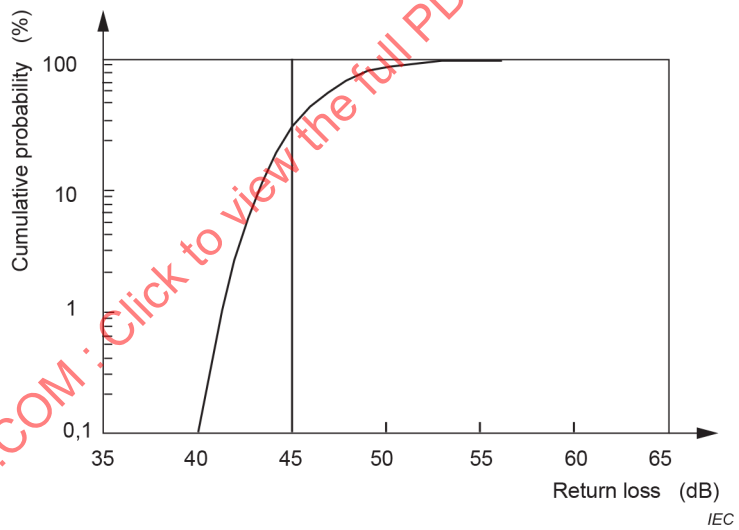


Figure A.3 – Cumulative probability of return loss before test

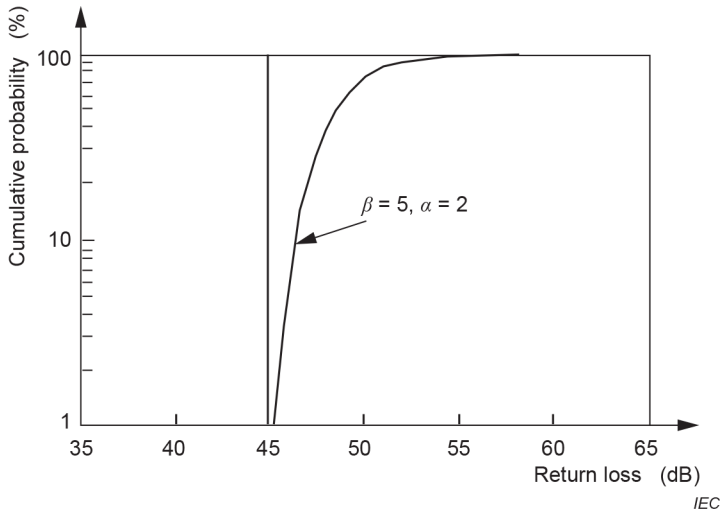


Figure A.4 – Cumulative probability of return loss after test

It is also important for the screen testing of pigtails that the fibre surface condition of one of the paired reference connectors is almost equal to that of the other reference connector. Figure A.5 shows the relation of the difference of P_4 and P_5 and difference of α_a and α_b. P_4 and P_5 are the reflected power of the paired reference connectors. The power is measured in the way described in Figure A.6 where the meaning of the symbols is the same as in Figure A.1. The parameters α_a and α_b are individual criteria which mean that the return loss of randomly concatenated connectors selected using the individual reference connector exceeds a specified value RL_{rs} with a probability of 99 % under following condition:

- $-10 \log P_2/P_8 + 14{,}7 \geq RL_{rs} + \alpha_a$ (dB); or
- $-10 \log P_2/P_8 + 14{,}7 \geq RL_{rs} + \alpha_b$ (dB).

Figure A.5 shows that the fibre surface condition of the reference connector 1a is almost equal to that of the reference connector 2a when the difference between the measured power P_4 and P_5 is small. The power P_4 and P_5 should satisfy the following condition to obtain the small difference between α_a and α_b within 1,0 dB:

$$2{,}0 \text{ (dB)} \geq |-10 \log P_4/P_5| \quad \text{(A.6)}$$

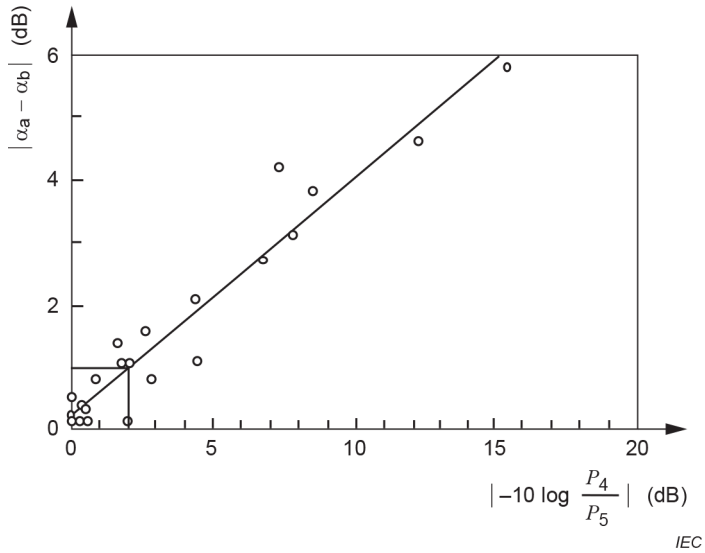


Figure A.5 – Relationship between power and α

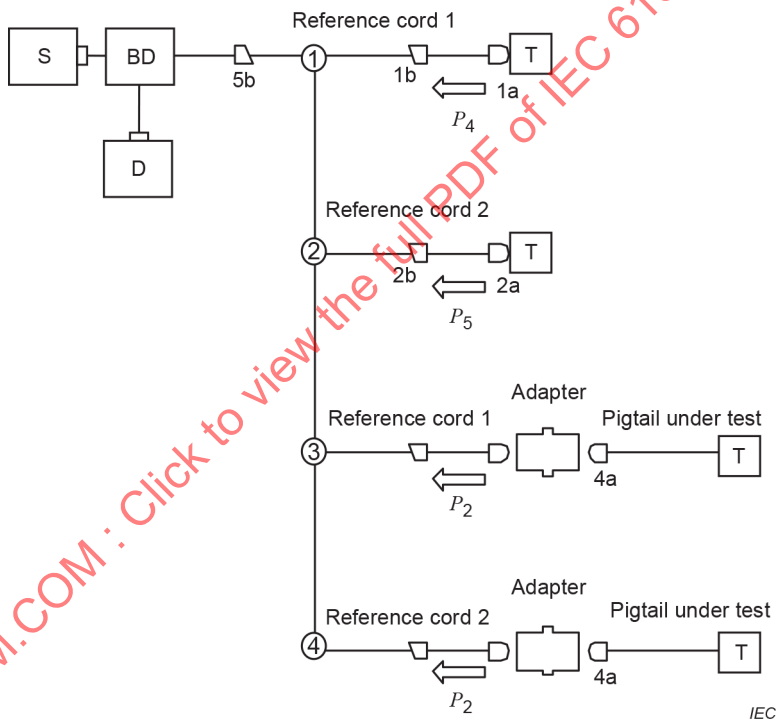


Figure A.6 – Measurement set-up of the reflected powers

Bibliography

IEC 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61755-2-1, *Fibre optic connector optical interfaces – Part 2-1: Optical interface standard single mode non-angled physically contacting fibres*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – 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

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L'IEC 61300-2-43 a été établie par le sous-comité 86B: Dispositifs d'interconnexion et composants passifs à fibres optiques, du comité d'études 86 de l'IEC: Fibres optiques. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition parue en 2014. Cette édition constitue une révision technique.

La présente édition inclut la modification technique majeure suivante par rapport à l'édition précédente: ajout de l'Article 3 contenant les termes, définitions et abréviations.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
86B/4628/FDIS	86B/4652/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Une liste de toutes les parties de la série IEC 61300, publiées sous le titre général *Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures*, est disponible sur le site web de l'IEC.

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DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – 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

1 Domaine d'application

La présente partie de l'IEC 61300 a pour objet de procéder à une sélection des fiches de connexion pour fibres optiques unimodales à contact physique (PC, *physical contact*) montées sur un cordon de brassage à fibre optique ou une fibre optique amorce, en fonction de leur affaiblissement de réflexion, pour garantir ainsi un affaiblissement de réflexion minimal lorsque les fiches de connexion sont accouplées sans choix préalable dans le terrain. Le présent document est destiné à s'appliquer aux fiches de connexion équipées de férules cylindriques.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61300-3-6, *Dispositifs d'interconnexion et composants passifs à fibres optiques – Méthodes fondamentales d'essais et de mesures – Partie 3-6: Examens et mesures – Affaiblissement de réflexion*

3 Termes, définitions et abréviations

3.1 Termes et définitions

Aucun terme n'est défini dans le présent document.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp
- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/

3.2 Abréviations

BD dispositif de couplage (*branching device*)

D détecteur

DUT dispositif en essai (*device under test*)

PC contact physique (*physical contact*)

PDL perte dépendant de la polarisation (*polarization dependent loss*)

RSC cordon de réflexion de référence (*reflection standard cord*)

RSP fiche de réflexion de référence (*reflection standard plug*)

S source

T terminaison

TJ jonction temporaire (*temporary joint*)

4 Description générale

Les extrémités bombées des férules des fiches de connexion PC (sans angle) sont obtenues par polissage. Ce procédé de polissage donne lieu à une fine couche endommagée à l'extrémité de la fibre de la fiche de connexion. Dans les fibres en silice, l'indice de réfraction de la couche endommagée est légèrement supérieur à celui de la fibre originale. Cette couche à indice élevé produit une réflexion optique. Lorsque des fiches de connexion PC sont accouplées, il apparaît un affaiblissement de réflexion qui est le résultat de réflexions multiples au niveau des deux couches à indice élevé des extrémités des fibres en contact physique. Ce phénomène et son effet sur l'affaiblissement de réflexion sont expliqués plus en détail dans l'IEC 61755-2-1.

La présente procédure d'essai garantit un affaiblissement de réflexion minimal prédéfini, lorsque des fiches de connexion PC sont accouplées sans choix préalable. Elle permet une sélection des cordons de brassage ou des fibres amorces par utilisation d'une paire de cordons de réflexion de référence (RSC). Le cordon de réflexion de référence est équipé d'une fiche de réflexion de référence (RSP) à une extrémité. La paire de cordons de réflexion de référence est choisie de manière telle que l'affaiblissement de réflexion, lorsque les fiches sont accouplées, soit supérieur de plusieurs décibels à l'affaiblissement de réflexion minimal prédéfini. Les cordons de brassage satisfaisant à cet essai atteignent l'affaiblissement de réflexion minimal prédéfini dans plus de 99 % des cas lorsqu'ils sont accouplés sans choix préalable (voir Annexe A).

5 Appareillage

5.1 Généralités

Le matériel utilisé doit être choisi selon la méthode utilisée pour mesurer l'affaiblissement de réflexion du connecteur, conformément à l'IEC 61300-3-6. À des fins de simplicité, la procédure et les figures du présent document représentent un mesurage avec un réflectomètre optique à ondes entretenues (OCWR, *optical continuous wave reflectometer*). La procédure peut être adaptée à toute autre méthode de mesure si cela est jugé nécessaire.

5.2 Source (S)

La source est constituée d'un émetteur optique, d'une électronique de commande associée, d'une unité d'excitation et d'un connecteur de fibre ou d'une fibre amorce.

5.3 Détecteur (D)

Le détecteur utilisé est constitué d'un détecteur optique, de l'électronique associée et d'un moyen de connexion à une fibre optique. La connexion optique peut être un réceptacle pour une fiche de connecteur optique, une fibre amorce ou un adaptateur de fibre nue.

5.4 Jonction temporaire (TJ)

Une jonction temporaire est une jonction faite pour connecter le dispositif en essai (DUT) dans le circuit de mesure. Les liaisons temporaires peuvent être, par exemple, un connecteur, une épissure, un plateau de maintien par dépression ou un micromanipulateur L'affaiblissement de la liaison temporaire doit être stable, et elle doit avoir un affaiblissement de réflexion supérieur d'au moins 10 dB à l'affaiblissement de réflexion maximal à mesurer.

Lorsqu'un affaiblissement de réflexion supérieur à 50 dB doit être mesuré, une épissure par fusion est recommandée afin de garantir l'incertitude de mesure prescrite.

5.5 Terminaison (T)

Les terminaisons de fibres, marquées T, doivent avoir un affaiblissement de réflexion élevé. Trois types de terminaisons sont suggérés:

– extrémités de fibre avec angle: la valeur de l'angle dépend du type de fibre. Un angle minimal de 12° est nécessaire pour obtenir l'affaiblissement de réflexion élevé souhaité;
– application d'un matériau adaptateur d'indice à l'extrémité de la fibre;
– affaiblissement dans la fibre, par exemple, avec un enroulement sur mandrin.

Lorsque l'affaiblissement est utilisé comme terminaison, il peut être appliqué entre les composants.

La terminaison de la fibre doit avoir un affaiblissement de réflexion supérieur d'au moins 20 dB à l'affaiblissement de réflexion maximal à mesurer.

Lorsqu'un affaiblissement de réflexion supérieur à 50 dB doit être mesuré, la technique de terminaison de l'"affaiblissement dans la fibre" est recommandée afin de garantir l'incertitude de mesure prescrite.

5.6 Dispositif de couplage (BD)

Le dispositif de couplage sépare la puissance lumineuse de la source vers les ports de signal et de référence et couple la puissance lumineuse de ces ports dans le détecteur.

Le rapport de division du dispositif de couplage doit être stable et insensible à la polarisation. Il est recommandé que la PDL soit inférieure à 0,1 dB. La directivité doit être supérieure d'au moins 10 dB à l'affaiblissement de réflexion maximal à mesurer.

5.7 Fiche de réflexion de référence (RSP)

La fiche de réflexion de référence est une fiche de connexion dont l'affaiblissement de réflexion est meilleur que l'affaiblissement de réflexion minimal prédéfini RL_{rs} (en décibels).

5.8 Cordon de réflexion de référence (RSC)

Le cordon de réflexion de référence est équipé d'une fiche de réflexion de référence (RSP) à une extrémité. L'autre extrémité du cordon de réflexion de référence est une extrémité ou une fiche dont l'affaiblissement de réflexion est meilleur que l'affaiblissement de réflexion minimal prédéfini RL_{rs} (en décibels).

6 Procédure

6.1 Sélection du RSC

Le RSC doit être choisi par la procédure suivante.

a) Disposer un RSC objectif comme cela est représenté à la Figure 1.

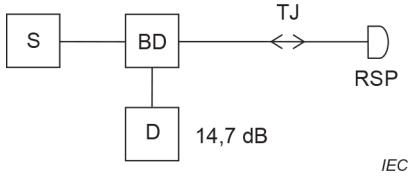

Figure 1 – Montage de mesure pour fiche de réflexion de référence en position ouverte