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INTERNATIONAL STANDARD

Fibre optic interconnecting devices and passive components – Performance standard –
Part 021-3: Single-mode fibre optic connectors for category U – Uncontrolled environment

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International Standard IEC 61753-021-3 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

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

FDIS	Report on voting
86B/3495/FDIS	86B/3542/RVD

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 of the IEC 61753 series, published under the general title *Fibre optic interconnecting devices and passive components – Performance standard,* 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

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – PERFORMANCE STANDARD –

Part 021-3: Single-mode fibre optic connectors for category U – Uncontrolled environment

1 Scope

This part of IEC 61753 defines minimum initial test and measurement requirements and severities which a single-mode connector, either part of a pigtail, or part of a cord, must satisfy in order to be categorized as meeting the IEC standard category U (uncontrolled environment).

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 60793-2-50:2008, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 61300-2-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*

IEC 61300-2-2, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-2: Tests – Mating durability*

IEC 61300-2-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retention*

IEC 61300-2-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-6: Tests – Tensile strength of coupling mechanism*

IEC 61300-2-12:2009, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-12: Tests – Impact*

IEC 61300-2-17, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-17: Tests – Cold*

IEC 61300-2-18, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-18: Tests – Dry heat – High temperature endurance*

IEC 61300-2-22, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*

IEC 61300-2-42, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-42: Tests – Static side load for connectors*

IEC 61300-2-44, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-44: Tests – Flexing of the strain relief of fibre optic devices*

IEC 61300-3-3, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-3: Examinations and measurements – Active monitoring of changes in attenuation and return loss*

IEC 61300-3-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examinations and measurements – Attenuation*

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 61300-3-28, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-28: Examinations and measurements – Transient 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 61753-1:2007*, Fibre optic interconnecting devices and passive components performance standard – Part 1: General and guidance for performance standards*

IEC 61754 (all parts), *Fibre optic connector interfaces*

IEC 61755 (all parts), *Fibre optic connector optical interfaces*

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1
change in attenuation
peak-to-peak variation of attenuation

3.2
sample
complete set of connector components required to provide demountable coupling between one or more pairs of optical fibres

3.3
pigtail
a cabled fibre or a secondary coated fibre terminated with a connector on one end

3.4
cord
general term for terminated cable assembly

4 Tests

All test methods are in accordance with the relevant parts of IEC 61300 as defined in 7.6 and 7.7.

The connectors under test shall be terminated onto single-mode fibre category B1.1, B1.3 or B6_a of IEC 60793-2-50:2008, depending upon the design of the connector, it will be terminated with a cabled fibre or a secondary coated fibre. The connector interface standard shall meet the dimensions of IEC 61754 series and the connector optical interface standard shall meet the relevant requirements of IEC 61755 series.

Each test defines the number of samples to be evaluated. The sample set used for the first test is to be composed of randomly selected and previously unstressed new samples.

The optical criteria for each test shall be as defined in 7.6.

5 Test report

Fully documented test reports and supporting evidence shall be prepared and available for inspection as evidence that the tests have been carried out and the results are satisfactory.

6 Reference components

No reference components are required to perform the tests in this standard.

7 Performance requirements

7.1 Dimensions

Dimensions shall comply with the appropriate IEC interface standard as defined in the IEC 61754 series.

7.2 Sample size

For the purposes of this standard, a sample is composed of pigtail assemblies and cord assemblies (see Clause 3). The sample sizes to be used for the tests shall be as defined in Annex A. There is no defined sequence or grouping in which the tests shall be run. Samples for the first test (attenuation) are to be randomly selected and randomly mated new products. Samples for the second test (return loss) are the same plugs selected and mated for the first test. Samples for subsequent tests may be randomly selected and randomly mated new products or the same plugs.

7.3 Connector set sample test configuration

Two connector plugs mated with an adaptor with pigtailed leads, as shown in Figure 1.

Each of the pigtailed leads shall be at least 3 m long so that when the sample is located inside an environmental test chamber the connections may be located outside the chamber.

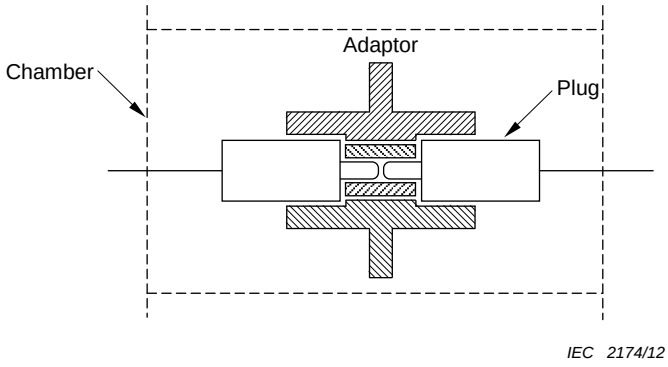

Figure 1 – Pigtail assembly

7.4 Cord sample test configuration

Cord connected with adaptors to two additional connector plugs with pigtailed leads on either end, as shown in Figure 2. The cord shall be 3 m to 5 m. Each of the pigtailed leads shall be long enough so that the splices may be located outside of the environmental test chamber.

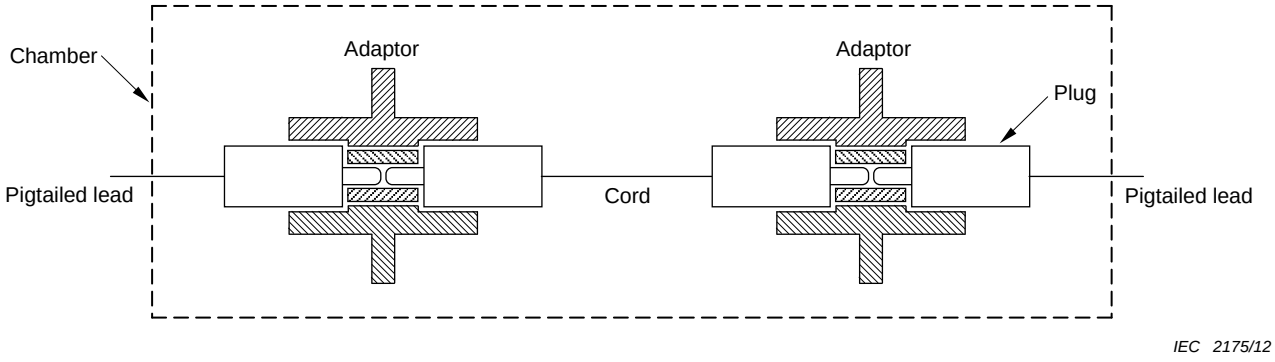

Figure 2 – Cord assembly

7.5 Optical Interface requirements

The connector endface shall comply with the endface geometry requirements of the applicable IEC optical interface standard as defined in the 61755-3 series. Compliance with the appropriate optical interface standard shall be confirmed on all samples before the start of testing and after all of the tests have been completed. Non-compliance with the endface geometry requirements of the applicable optical interface standard on any connector tested results in a failure of this performance standard.

7.6 Performance criteria

The optical performance levels shall meet the requirements as defined in Table A.12 of IEC 61753-1:2007 (see Table 1).

Table 1 – Requirements for different performance levels

Performance level	Test name	Initial	During/after test
B[a]/1	Attenuation IEC 61300-3-34	≤ 0,12 dB mean (see Note) ≤ 0,25 dB max. for ≥ 97 % of samples	

Performance level	Test name	Initial	During/after test
	Return loss IEC 61300-3-6	≥ 60 dB	
	Monitoring change in attenuation and in return loss (multiple path IEC 61300-3-3)		Maximum attenuation variation ≤ 0,2 dB during and after test for pigtails. Maximum attenuation variation ≤ 0,5 dB during and ≤ 0,4 dB after test for cords. Return loss ≥ 60 dB during and after test
B[a]/2	Attenuation IEC 61300-3-34	≤0,12 dB mean (see Note) ≤0,25 dB max. for ≥97 % of samples	
	Return loss IEC 61300-3-6	≥45 dB	
	Monitoring change in attenuation and in return loss (multiple path IEC 61300-3-3)		Maximum attenuation variation ≤ 0,2 dB during and after test for pigtails. Maximum attenuation variation ≤ 0,5 dB during and ≤ 0,4 dB after test for cords. Return loss ≥ 45 dB during and after test
C/1	Attenuation IEC 61300-3-34	≤ 0,25 dB mean (see Note) ≤ 0,50 dB max. for ≥ 97 % of samples	
	Return loss IEC 61300-3-6	≥ 60 dB	
	Monitoring change in attenuation and in return loss (multiple path IEC 61300-3-3)		Maximum attenuation variation ≤ 0,2 dB during and after test for pigtails. Maximum attenuation variation ≤ 0,5 dB during and ≤ 0,4 dB after test for cords. Return loss ≥ 60 dB during and after test
C/2	Attenuation IEC 61300-3-34	≤ 0,25 dB mean (see Note) ≤ 0,50 dB max. for ≥97 % of samples	
	Return loss IEC 61300-3-6	≥ 45 dB	
	Monitoring change in attenuation and in return loss (multiple path IEC 61300-3-3)		Maximum attenuation variation ≤ 0,2 dB during and after test for pigtails. Maximum attenuation variation ≤ 0,5 dB during and ≤ 0,4 dB after test for cords Return loss ≥ 45 dB during and after test

[a] Grade B connector attenuation is specified at mode field diameter range 9,2 μm ± 0,4 μm for B1.1 and B1.3 fibres. When connectors terminated with these fibres are intermated with connectors terminated with B6_a fibres the average attenuation value is expected to increase due to mode field diameter mismatch. The expected average increase is less than 0,05 dB.

NOTE Initial attenuation requirements of each test in Table 1 are per connection.

7.7 Performance details

Performance details are specified in Table 2.

Table 2 – Performance details

No	Test	Requirements	Details
1	Attenuation (Method C)	See Table 1 for the requirements for the different performance levels Test wavelengths: 1 310 nm ± 30 nm and 1 550 nm ± 30 nm (launch condition S4 and S5)	IEC 61300-3-4 Device under test (DUT) type 5, Insertion method (C) Launch mode conditions: only the fundamental mode shall propagate at the connector interface and at the detector. Source characteristics reference to IEC 61300-3-4 (attenuation). Specimen shall be optically functioning. Preconditioning procedure: clean plug and according to manufacturer's instructions
2	Return loss	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 310 nm ± 30 nm and 1 550 nm ± 30 nm	IEC 61300-3-6: Method branching devices Launch fibre length: $L > 2$ m Source stability: ± 0,20 dB over the measuring period or at least 1 h. Detector linearity: within 5 % of the power levels to be measured. Directivity: > 65 dB Specimen shall be optically functioning. Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions. Alternative method: IEC 61300-3-6: Method OTDR Launch fibre length: $L1 \geq 500$ m, $L2 \geq 6$ m, $L3 \geq 6$ m. Pulse duration: ≤10 ns. Specimen shall be optically functioning. Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions
3	Vibration (sinusoidal)	See Table 1 for the requirements for the different performance levels Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-1 Frequency range: 10 Hz to 55 Hz Change in frequency: 1 oct/min Number of axes: three orthogonal Number of sweeps (10-55-10 Hz) per axis: 15 Vibration amplitude: 0,75 mm Sampling rate: before, during and after each axis. The measurement interval during the test shall be < 2 ms and transient monitoring shall be performed according to IEC 61300-3-28. Sampling rate note: Attenuation and return loss decrease is the difference between any measurement and the initial measurement, and applies to all measurements. Maximum attenuation and return loss criteria apply to all measurements. Method of mounting: an adaptor shall be mounted rigidly to the mounting fixture. Specimen shall be optically functioning. Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions. The connector samples shall not be uncoupled or cleaned at any time during the test

Table 2 (*2 of 7*)

No	Test	Requirements	Details
4	Cold	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-17 Temperature: –25 °C ± 2 °C Duration of exposure: 96 h Length of the cable on each side of the connector inside the chamber: 1,5 m minimum. Sampling rate: before and after test and at a maximum interval of 1 h during the test. Preconditioning procedure: before test, specimens shall be maintained in room temperature condition for 2 h. Clean plug and adaptor according to manufacturer's instructions. Recovery procedure: after test, specimens shall be maintained in room temperature condition for 2 h. The connector samples shall not be uncoupled or cleaned at any time during the test
5	Dry heat – high temperature endurance	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-18 Temperature: +70 °C ± 2 °C Duration of exposure: 96 h Length of the cable on each side of the connector inside the chamber: 1,5 m minimum. Sampling rate: before and after test and at a maximum interval of 1 h during the test. Preconditioning procedure: before test, specimens shall be maintained in room temperature condition for 2 h. Clean plug and adaptor according to manufacturer's instructions. Recovery procedure: after test, specimens shall be maintained in room temperature condition for 2 h. The connector samples shall not be uncoupled or cleaned at any time during the test
6	Damp heat (cyclic)	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-46 Temperature: +25 °C ± 2 °C to +55 °C ± 2 °C Relative humidity: > 95 % RH (Variant 1) Duration of exposure: 96 h Length of the cable on each side of the connector inside the chamber: 1,5 m minimum. Sampling rate: before and after test and at a maximum interval of 1 h during the test. Preconditioning procedure: before test, specimens shall be maintained in room temperature condition for 2 h. Clean plug and adaptor according to manufacturer's instructions. Recovery procedure: after test, specimens shall be maintained in room temperature condition for 2 h. The connector samples shall not be uncoupled or cleaned at any time during the test

Table 2 (*3 of 7*)

No	Test	Requirements	Details
7	Change of temperature	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-22 High temperature dwell: +70 °C ± 2 °C Low temperature dwell: –25 °C ± 2 °C Duration at each dwell temperature: 1 h Ramp time = 1 °C/min Number of cycles: 12 Length of the cable on each side of the connector inside the chamber: 1,5 m minimum. Specimen shall be optically functioning. Sampling rate: initially at room ambient, after 0,5 h during each dwell (measurements to be completed during dwell) and at the end of the test at room ambient. Preconditioning procedure: before test, specimens shall be maintained in room temperature condition for 2 h. Recovery procedure: after test, specimens shall be maintained in room temperature condition for 2 h. The connector samples shall not be uncoupled or cleaned at any time during the test
8	Flexing of the strain relief of fibre optic devices	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 310 nm ± 30 nm and 1 550 nm ± 30 nm NOTE This test only applies to connectors assembled on reinforced cable.	IEC 61300-2-44 Magnitude of the tensile load: 5 N for connectors with reinforced cable. Cycle: ± 90° Number of cycles: 100 Rate of application of the tensile load: 1 N/s for reinforced cable. Point of application of tensile load: 220 mm to 280 mm from cable entrance to plug. Sampling rate: initially, during and at the end of the test. Measurement interval during the test shall be < 2 ms and transient monitoring shall be performed according to IEC 61300-3-28. Method of mounting: an adaptor shall be mounted rigidly to the test fixture. Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions. The connector samples shall not be uncoupled or cleaned at any time during the test

Table 2 (*4 of 7*)

No	Test	Requirements	Details
9	Fibre cable retention	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-4 Magnitude and rate of application of the load for reinforced cables with diameter > 2 mm: 100 N ± 2 N at 5 N/s Magnitude and rate of application of the load for reinforced cables with diameter ≤ 2 mm: 70 N ± 2 N at 5 N/s Duration for reinforced cables: 120 s at 70 N or 100 N Magnitude and rate of application of the load for secondary coated fibres: 5,0 N ± 0,5 N at 0,5 N/s Magnitude and rate of application of the load for primary coated fibres: 2,0 N ± 0,2 N at 0,5 N/s. Duration for buffered fibres: 60 s at 2 N or 5 N. Point of application of tensile load: 0,3 m from the end face of the connector. Sampling rate: Initially and after the load has reached its maximum level and been maintained for a minimum of 30 s. Specimen shall be optically functioning. Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions
10	Impact	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-12:2009: Method A Number of drops: 5 for each plug Drop height: 1,5 m Sampling rate: Initially and after the last drop. Specimen shall be unmated during drop cycles. Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions. Place a dust cap over the ferrule to protect the fibre endface. Recovery procedure: the connector may be cleaned after each drop before measurement
11	Tensile strength of coupling mechanism	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-6 Magnitude and rate of application of the load: 40 N at 2 N/s Duration: 120 s Sampling rate: Initially and after the load has reached its maximum level and been maintained for a minimum of 30 s Specimen shall be optically functioning. Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions

Table 2 (*5 of 7*)

No	Test	Requirements	Details
12	Static side load	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-42 Magnitude of the load for reinforced cables: 1 N Duration for reinforced cables: 1 h Magnitude of the load for buffered fibres: 0,2 N Duration for buffered fibres: 5 min Static side load shall be applied in two mutually perpendicular directions Sampling rate: Initially and 3 min maximum intervals Specimen shall be optically functioning Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions
13	Mating durability	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm In the event that the attenuation increases above the allowable limit, the connector may be cleaned as necessary but not more than 25 times during the course of the test. (The measurements at which the cleaning takes place shall be discounted from the test results)	IEC 61300-2-2 Coupling mechanism to be cycled: plug-adaptor Cycling rate: not less than 3 s between each engagement and separation Number of cycles: 500 minimum Specimen shall be optically functioning Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions. Recovery procedure: the mechanical and optical alignment parts of the specimen may be cleaned according to manufacturer's instructions up to 2 times after the final mating cycle
14	Dust	Allowable change in attenuation: ≤ 0,20 dB at 1 550 nm ± 30 nm Return loss shall be measured before and after the test at normal ambient conditions and shall satisfy the requirements for the specified class. Attenuation shall be measured before and after the test at normal ambient conditions. The change in attenuation measurement shall be made against randomly selected plugs. The initial attenuation shall satisfy the requirements for the specified attenuation grade	IEC 61300-2-27 Dust particle size: $d < 150$ μm Dust type: talc Dust concentration: 10,6 g/m^3 ± 7,1 g/m^3 Temperature: +35 °C Relative humidity: 60 % Duration of test: 10 min Configuration: The configuration shall be a mated pair of connectors which once mated for the initial measurements shall not be disconnected until after the completion of the test. Specimen shall be optically functioning. Preconditioning procedure. Clean the mechanical and optical alignment parts of the specimen according to the manufacturer's instructions, prior to initial measurement

Table 2 (*6 of 7*)

No	Test	Requirements	Details
15	Torsion	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-5 Magnitude and rate of application of the tensile load: 15 N at a speed of 1 N/s for reinforced cable 2 N at a speed of 0,1 N/s for coated fibre Point of application of tensile load: 0,2 m from the endface of the connector Duration of the test: 25 cycles ± 180° Sampling rate: Losses shall be measured at least once after the load has reached maximum level. Specimen shall be optically functioning. Preconditioning procedure: Clean the mechanical and optical alignment parts of the specimen according to the manufacturer's instructions. Recovery procedure: Clean the mechanical and optical alignment parts of the specimen according to the manufacturer's instructions before final measurement
16	Bending moment	See Table 1 for the requirements for the different performance levels. Test wavelengths: 1 550 nm ± 30 nm	IEC 61300-2-7 Load: 10 N smoothly applied Point of application: 25 mm from centre line of load defined by the optical interface. Sampling rate: Losses shall be measured at least once after the load has reached its maximum level and been maintained for a minimum period of 30 s. Specimen shall be optically functioning. Preconditioning procedure: Clean the mechanical and optical alignment parts of the specimen according to the manufacturer's instructions. Recovery procedure: The connector may be cleaned after the test before final measurement

Table 2 (*7 of 7*)

No	Test	Requirements	Details
17	Salt mist	Allowable change in attenuation: ≤ 0,20 dB at 1 550 nm ± 30 nm Return loss shall be measured before and after the test at normal ambient conditions and shall satisfy the requirements for the specified class. Attenuation shall be measured before and after the test at normal ambient conditions. The change in attenuation measurement shall be made against randomly selected plugs. The initial attenuation shall satisfy the requirements for the specified performance grade	IEC 61300-2-26 Salt concentration 5 % NaCl (pH 6,5 to 7,2) Temperature: +35 °C Relative humidity: > 85 % Duration of test: 96 h Configuration: The configuration shall be a mated pair of connectors which once mated for the initial measurements shall not be disconnected until after the completion of the test. Specimen shall be optically functioning. Preconditioning procedure. Clean the mechanical and optical alignment parts of the specimen according to the manufacturer's instructions, prior to initial measurement

Annex A
(normative)

Sample size

The tests in Table A.1 are intended to be performed individually on products selected as defined in 7.2, although products from a previous test may be used if desired. The tests may also be performed in any order providing the product is selected as defined.

Table A.1 – Sample size

	Test	Sample size		Source
Test no.		**Pigtail assembly**	**Cord assembly**	
1	Attenuation (random mate)	20	5	New
2	Return loss (random mate)	20	5	Test 1
3	Vibration	5	–	Test 2
4	Cold	5	5	Test 2
5	Dry heat – high temperature endurance	5	5	Test 2
6	Damp heat (steady state)	5	5	Test 2
7	Change of temperature	5	5	Test 2
8	Flexing of the strain relief of fibre optic devices	5	5	Test 2
9	Fibre cable retention	5	–	Test 2
10	Impact	5	–	Test 2
11	Tensile strength of coupling	5	–	Test 2
12	Static side load	5	–	Test 2
13	Mating durability	5	–	Test 2
14	Dust	5	–	Test 2
15	Torsion	5	–	Test 2
16	Bending moment	5	–	Test 2
17	Salt mist	5	–	Test 2

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