

# PUBLICLY AVAILABLE SPECIFICATION

## PRE-STANDARD

**Fibre optic interconnecting devices and passive components performance standard –  
Part 1-3: General and guidance for performance standards – Single-mode fibre  
optic connector performance for harsh industrial operating conditions**

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Part 1-3: General and guidance for performance standards – Single-mode fibre  
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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC INTERCONNECTING DEVICES  
AND PASSIVE COMPONENTS PERFORMANCE STANDARD –**

**Part 1-3: General and guidance for performance standards –  
Single-mode fibre optic connector performance for harsh industrial  
operating conditions**

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IEC-PAS 61753-1-3 has been processed by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
86B/2895/PAS	86B/2931/RVD

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## FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS PERFORMANCE STANDARD –

### Part 1-3: General and guidance for performance standards – Single-mode fibre optic connector performance for harsh industrial operating conditions

#### 1 Scope

This Publicly Available Specification (PAS) defines the minimum initial performance, test and measurement requirements and severities which a single-mode connector or cable assembly must satisfy in order to be categorized as meeting IEC Category I (industrial environment). Category I is an addition to environmental categories C, U, O, E described in IEC 61753-1 and the MICE methodology described in ISO/IEC 24702.

#### 2 Normative references

The following referenced documents are indispensable for the application 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 60068-2-60, *Environmental testing – Part 2: Tests – Test Ke: Flowing mixed gas corrosion test*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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

IEC 61300 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures*

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

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 61300-2-5, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-5: Tests – Torsion*

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 61300-2-7, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-7: Tests – Bending moment*<sup>1</sup>

IEC 61300-2-9, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: tests – Shock*

IEC 61300-2-10, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-10: Tests – Crush resistance*<sup>2</sup>

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

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

IEC 61300-2-26, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-26 : Tests – Salt mist*

IEC 61300-2-34, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-34: Tests – Resistance to solvents and contaminating fluids of interconnecting components and closures*

61300-2-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-35: Tests – Cable nutation*<sup>3</sup>

IEC 61300-2-46, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-46: Tests – Damp heat, cyclic*

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 61300-3-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-35: Examinations and measurements – Fibre optic connector endface visual and automated inspection*<sup>4</sup>

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1 Publication withdrawn and not replaced.

2 Publication withdrawn and not replaced.

3 Publication withdrawn and not replaced.

4 To be published.

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*

IEC 61755-1, *Fibre optic connector optical interfaces – Part 1: Optical interfaces for single mode non-dispersion shifted fibres – General and guidance*

IEC 61755-3 (all parts 3), *Fibre optic connector optical interfaces*

ISO/IEC 24702, *Information technology – Generic cabling – Industrial premises*

ISO/IEC TR 29106, *Information technology – Generic cabling – Introduction to the MICE environmental classification*

### 3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

#### 3.1

##### **change in attenuation**

peak-to-peak variation (see Table A-12, IEC 61753-1)

#### 3.2

##### **sample**

a complete set of passive connector components consisting of a free plug and a socket. The socket may be mounted in an enclosure. This allow demountable coupling between pairs of optical fibres

#### 3.3

##### **patch cord assembly**

two connector plugs mated consisting of a free plug and a socket with each socket mechanically mounted in an enclosure. Each of the non terminated leads from the socket should be at least 3 m long so that the splices may be located outside of the environmental test chamber (see also Figure 1)

### 4 Industrial environment

#### 4.1 General

Fibre optic components are frequently used in industrial environments, like control stations, power rooms or inside switch cabinets. The special environmental conditions such as temperature, dust, moisture, vibration, chemicals, etc. in industrial deployment require more rugged components than found in standard environments.

#### 4.2 Cross-reference with MICE

The MICE methodology from ISO/IEC/TR 29106 classifies the environment local to a cabling system in terms of mechanical, ingress, climatic and chemical and electromagnetic characteristics. The tests and severities in Clause 9 of this PAS are intended to reflect the M<sub>3</sub> and I<sub>3</sub> environment. The climatic conditions and chemical substances used are selected from the C<sub>3</sub> environment. The defined tests and severities are according to IEC 60068-2-60

NOTE Not all chemical substances are used.

## 5 Tests

### 5.1 General

The defined performance test procedures should:

- evaluate the product for two basic acceptance criteria: mechanical integrity and optical transmission requirements;
- simulate the effects of exposure to the environment in which it will be installed;
- simulate installation and intervention conditions;
- evaluate all specified features of the product.

The defined performance test procedures should simulate the situation in a mated condition under use in a harsh industrial environment. It is not the intention to simulate the situation:

- when being mated or demated;
- during the assembling of the connector;
- during transportation and storage of the connector.

All test methods are in accordance with IEC 61300 series as defined in Table 3.

Each test defines the number of samples to be evaluated as described in Annex A. The samples used for each test should be composed of randomly selected and previously unstressed new samples but may also be selected from previously used samples if desired.

The connectors under test shall be terminated onto single-mode fibre per IEC 60793-2-50, type B1.1 or B1.3. 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.

Unless otherwise specified, tests should be carried out under standard atmospheric conditions according to IEC 61300-1. The optical criteria for each test shall be as defined in Clause 9, (see also notes to Table 1).

### 5.2 Sample size

As a minimum requirement and if not otherwise mentioned, the tests can be run individually on five samples per test only. It is intended that new samples should be used for each test however samples may be reused at the manufacturer's own risk. In the event that this reuse causes a failure, the test may be rerun with new samples.

Samples for the attenuation test are to be randomly selected and randomly mated as new product, starting with 10 DUT, see Figure 1 (e.g. as duplex version, see also Annex A).

## 6 Test report

Fully documented test reports and supporting evidence shall be prepared and available for inspection to show that the tests have been carried out and the results are satisfactory; the requested performances (see Table 1 for the grades) should be defined before starting the tests.

## 7 Reference component

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

## 8 Performance requirements

### 8.1 General

The protection level of the connector according to IEC 60529 shall be defined before performing the tests. The minimum protection level shall be IP x5 and IP x7 for immersion and IP 6x for dust, so the resulting level will be IP65 and IP67.

### 8.2 Dimensions

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

### 8.3 Sample definition and size

Default sample sizes for the tests are defined in 5.1.

Reliability tests for life time expectations are not covered by this standard.

For the purposes of this standard, a sample (DUT) is a mated connector set. Products under test shall be mounted and cleaned according to the manufacturer's instructions.

Where the connector arrangement is a plug and a bulkhead flange, Figure 1 shows a proposed sample.

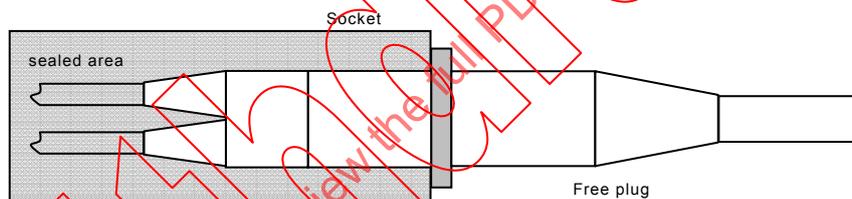


Figure 1 – Example of a duplex sample (mated), DUT

### 8.4 Test preparation and accomplishment

Before the tests are made, the sample shall be preconditioned under standard atmospheric conditions for testing as specified in IEC 61300-1 for a period of 24 h unless otherwise specified by the manufacturer.

When mounting is required in a test, unless otherwise specified, the adaptors shall be rigidly mounted on a specified accessory, whichever is applicable, using the specified connection methods, fixing devices and panel cut-outs.

When un-mating is required in a test, the end faces of the sample shall be cleaned according to the manufacturer's instructions. A particular combination of connectors shall be maintained during the complete test sequence, normally without un-mating the sample.

### 8.5 Performance criteria

Compliance with the following requirements shall be confirmed on all samples before the test has been started and after the test have been completed.

- All performed tests according to the chosen performance category and performance requirements shall be passed with all tested samples.

- The connector end face shall comply with the end face geometry requirements of the applicable optical interface standard as defined in IEC 61755-3 series.
- The optical performance levels shall meet the requirements of the designated grade as defined in Table 1.
- The mechanical performance shall meet the requirements of the defined protection level according to IEC 60529.
- A visual examination of the unmated connectors with protective housings shall show no mechanical damage.

## 9 Performance tests

a) Optical performance requirements, see also IEC 61755-1.

**Table 1 – Single mode<sup>a</sup> attenuation grades at 1310 nm and 1550 nm (dB)**

Attenuation grade	Attenuation random mated IEC 61300-3-34	Monitoring change in attenuation and in return loss (multiple path) IEC 61300-3-3
Grade A	Not defined yet	Not defined yet
Grade B	≤ 0,12 dB mean ≤ 0,25 dB max. for > 97 % of samples	IL ≤ 0,2 dB during and after test for pigtails IL ≤ 0,5 dB during and ≤ 0,4 dB after test for patchcords
Grade C	≤ 0,25 dB mean ≤ 0,50 dB max. for > 97 % of samples	IL ≤ 0,2 dB during and after test for pigtails IL ≤ 0,5 dB during and ≤ 0,4 dB after test for patchcords
Grade D	≤ 0,50 dB mean ≤ 1,0 dB max. for > 97 % of samples	IL ≤ 0,2 dB during and after test for pigtails IL ≤ 0,5 dB during and ≤ 0,4 dB after test for patchcords
Return loss grade	Return loss random mated IEC 61300-3-6	Monitoring change in attenuation and in return loss (Multiple path) IEC 61300-3-3
Grade 1	≥ 60 dB (mated) and ≥ 55 dB (unmated)	RL ≥ 60 dB (mated) and ≥ 55 dB (unmated) during and after test
Grade 2	≥ 45 dB	RL ≥ 45 dB during and after test
Grade 3	≥ 35 dB	RL ≥ 35 dB during and after test
Grade 4	≥ 26 dB	RL ≥ 26 dB during and after test
<sup>a</sup> Multi-mode performance criteria are under consideration.		
NOTE 1 Table 1 is a copy from IEC 61753-1:2007, Table A.12.		
NOTE 2 (for achieved RL-values): From a technical point of view, where not specified in more detail, at least > 35 dB (= Grade 3) should be achieved in case of 0° polishing angle, exception for Grade 4 connectors. Otherwise, the RL grades in IEC 61753-1 have to be defined before starting the tests.		
NOTE 3 For Grade 1 performance level (APC-version), the RL values depend of the connecting situation: Minimum ≥ 60 dB (mated) and ≥ 55 dB (unmated), during and after test.		

b) Required tests and severities, reflecting an industrial environment.

**Table 2 – Test description**

Test number No.	Test	Requirements	Details
1	Visual inspection	<p>The connector plugs and adapters shall be inspected for damage that might impair the performance. This inspection shall include:</p> <p>Distortion of housing parts, as indicated by difficulty in insertion, improper snap-fits, etc.</p> <p>Distortion of ferrules and sleeves, as indicated by change in mating force, changes in end face geometry, etc.</p> <p>Housing cracks</p> <p>Presence of debris, shavings, etc.</p> <p>Corrosion or residue</p> <p>Ferrule end-face cracks chips or scratches @ 100x</p> <p>Other potentially service-affecting damage</p>	IEC 61300-3-1 and IEC 61300-3-35
2	<p>Attenuation (random mate, IEC 61300-3-34)</p> <p>10 randomly mated duplex plugs. For plug / adaptor / plug connector sets, 10 adaptors, randomly selected shall be used (100 randomly mated connector sets). Total number of measurements <math>10 \times 10 \times 10</math> times the number of fibres in each plug. For duplex connectors, there are 2 fibres.--&gt; resulting in 2000 measuring points (See also Annex A)</p>	As specified before the test, following the grades in Table 1	<p>IEC 61300-3-34 for random mate and 61300-3-4, method C, for IL measurement</p> <p>Test wavelengths: 1 310 nm <math>\pm</math> 30 nm and 1 550 nm <math>\pm</math> 30 nm (launch condition S4 and S5)</p> <p>Launch mode conditions: only the fundamental mode shall propagate at the connector interface and at the detector</p> <p>Source characteristics reference to IEC 61300-3-4 (attenuation)</p> <p>Sample shall be optically functioning</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions</p>

Test number No.	Test	Requirements	Details
3	<p>Return loss (IEC 61300-3-6, method 1 or 2)</p> <p>(Random mate)</p> <p>10 randomly mated duplex plugs. For plug / adaptor / plug connector sets, 10 adaptors, randomly selected shall be used (100 randomly mated connector sets). Total number of measurements <math>10 \times 10 \times 10</math> times the number of fibres in each plug. For duplex, there are 2 fibres.--&gt; resulting in 2 000 measuring points</p> <p>(See also Annex A)</p>	<p>As specified before the test, see Table 2 for grades</p>	<p>Test wavelengths: 1 310 nm <math>\pm</math> 20 nm and 1 550 nm <math>\pm</math> 20 nm</p> <p>Launch fibre length: <math>L &gt; 2</math> m</p> <p>Source stability: <math>\pm 0,20</math> dB over the measuring period or at least 1 h</p> <p>Detector linearity: within 5 % of the power levels to be measured</p> <p>Directivity: <math>&gt;65</math> dB</p> <p>Sample shall be optically functioning</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions</p> <p>Alternative method: IEC 61300-3-6 Method OTDR</p> <p>Launch fibre length: <math>L1 \geq 500</math> m, <math>L2 \geq 6</math> m, <math>L3 \geq 6</math> m</p> <p>Pulse duration: <math>\leq 10</math> ns</p> <p>Sample shall be optically functioning</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions</p>
4	<p>Impact (IEC 61300-2-12, method B)</p>	<p>Before and after test: Initial and final attenuation should meet the grade.</p> <p>RL grade shall be met</p> <p>The sample shall not have any mechanical damage</p>	<p>IEC 61300-2-12, method B</p> <p>Test wavelengths: 1 550 nm <math>\pm</math> 20 nm</p> <p>Number of drops: 4 per location</p> <p>Impact severity: 20 Nm</p> <p>4x at 90° rotated locations</p> <p>Sampling rate: Initially and after the last drop</p> <p>Sample shall be unmated during drop cycles. Dust cap fitted</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions. Place a dust cap over the ferrule to protect the fibre end face</p> <p>Recovery procedure: the connector may be cleaned after each drop before measurement</p>

Test number No.	Test	Requirements	Details
5	Fibre cable retention	<p>During test</p> <p><math>\Delta</math> Atten.: <math>\leq 0,2</math> dB</p> <p>Initial and final attenuation should meet the required grade</p> <p>RL grade shall be met</p> <p>The sample shall not have any mechanical damage</p>	<p>IEC 61300-2-4</p> <p>Test wavelengths: 1 550 nm <math>\pm</math> 20 nm</p> <p>Magnitude and rate of application of the load for reinforced cables: 100 N <math>\pm</math> 2 N at 5 N/s</p> <p>The connector shall be rigidly mounted such that the load is applied to the cable retention mechanism and not to the coupling mechanism</p> <p>Duration for reinforced cables: 120 s</p> <p>Magnitude and rate of application of the load for secondary coated fibres: 5,0 N <math>\pm</math> 0,5 N at 5 N/s</p> <p>Duration for buffered fibres: 60 s</p> <p>Magnitude and rate of application of the load for primary coated fibres: 2,0 N <math>\pm</math> 0,5 N at 5 N/s</p> <p>Point of application of tensile load: 0,3 m from the end face of the connector</p> <p>Sampling rate: Initially and after the load has reached its maximum level and been maintained for a minimum of 30 s</p> <p>Sample shall be optically functioning</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions</p>
6	Cable nutation	<p>During test:</p> <p><math>\Delta</math>Atten.: <math>\leq 0,5</math> dB</p> <p>Initial and final attenuation should meet the grade</p> <p>RL grade shall be met</p> <p>The sample shall not have any mechanical damage</p>	<p>IEC 61300-2-35</p> <p>Test wavelengths: 1 550 nm <math>\pm</math> 20 nm</p> <p>Number of cycles: 100 for each plug</p> <p>Force: 10 N</p> <p>Rotation angle: 360°</p> <p>Sampling rate: continuously according to IEC 61300-3-28</p> <p>Point of application of the load: 0,2 m from rear of plug body</p> <p>Sample shall be mated during nutation cycles</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions</p> <p>Recovery procedure: the connector may be cleaned after each cycle before measurement</p>

Test number No.	Test	Requirements	Details
7	Mating durability	During test: $\Delta$ Atten.: $\leq 0,2$ dB Initial and final attenuation should meet the grade RL grade shall be met  The sample shall not have any mechanical damage	IEC 61300-2-2 Test wavelengths: 1 550 nm $\pm$ 20 nm  Coupling mechanism to be cycled: plug-adapter Cycling rate: not less than 3 s between each engagement and separation  Number of cycles:500 minimum (only one industrial plug is subjected to successive engagement and separation) Sample shall be optically functioning. Preconditioning procedure: clean plug and adapter according to manufacturer's instructions Recovery procedure: the mechanical and optical alignment parts of the sample may be cleaned according to manufacturer instructions up to 2 times after the final mating cycle  In the event that the attenuation increases the allowable limit, the connector may be cleaned as necessary as 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)
8	Durability by water immersion	No water inside the connector Initial and final attenuation should meet the grade RL grade shall be met	IEC 60529 IP x7, with 30 min at 1 m, below the surface of water (IP67) and IPx5 intermittent jet, 12,5 l/min, 6,3 mm, > 2,5 mm distance, duration 30 min 25 °C $\pm$ 2 °C  Preconditioning procedure: clean plug and adapter according to manufacturer's instructions Recovery procedure: 2 h at normal ambient conditions

Test number No.	Test	Requirements	Details
9	Strength of coupling mechanism	<p>With IL/RL monitoring: <math>\Delta</math> Atten.: <math>\leq 0,2</math> dB</p> <p>Initial and final attenuation should meet the grade</p> <p>RL grade shall be met</p>	<p>IEC 61300-2-6</p> <p>Test wavelengths: 1 550 nm <math>\pm</math> 20 nm</p> <p>IEC 61300-2-6</p> <p>Magnitude and rate of application of the load: 60 N <math>\pm</math> 1 N at 2 N/s<sup>1</sup></p> <p>Duration: 60 s</p> <p>Point of application of the load: 0,3 m from rear of plug</p> <p>Sample shall be optically functioning</p> <p>Sampling rate: initially and after the load has reached its maximum level and been maintained for at least 30 s</p> <p>Preconditioning procedure clean plug and adapter according to manufacturer's instructions. Place a dust cap over the ferrule to protect the fibre end face</p> <p>Recovery procedure: 5 min recovery period</p>
10	Vibration (sinusoidal)	<p><math>\Delta</math>Atten.: <math>\leq 0,2</math> dB</p> <p>Initial and final attenuation should meet the grade</p> <p>RL grade shall be met</p> <p>The sample shall not have any mechanical damage</p>	<p>IEC 61300-2-1</p> <p>Test wavelength: 1 550 nm <math>\pm</math> 20 nm</p> <p>Displacement 15 mm, 2-9 Hz</p> <p>Acceleration 5g, 9 Hz to 200 Hz</p> <p>Change in frequency: 1 oct/min</p> <p>Number of axes: three orthogonal</p> <p>Number of sweeps per axis: 15</p> <p>Additionally transient monitoring according to IEC 61300-3-28</p> <p>Sampling rate note: attenuation and return loss decrease is the difference between any measurement and the initial measurement, and applies to all measurements: before, during and after each axis. Maximum and mean attenuation and minimum return loss criteria apply to all measurements</p> <p>Method of mounting: an adapter shall be mounted rigidly to the mounting fixture</p> <p>Sample shall be optically functioning</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions</p> <p>The connector samples may not be uncoupled or cleaned anytime during the test</p>

Test number No.	Test	Requirements	Details
11	Shock	<p>During</p> <p><math>\Delta</math> Atten.: <math>\leq 0,2</math> dB</p> <p>Initial and final attenuation should meet the grade</p> <p>RL grade shall be met</p> <p>Sampling rate:</p> <p>Measurements shall be made after the load has been maintained at its maximum level for at least 3 s</p> <p>The sample shall not have any mechanical damage</p>	<p>IEC 61300-2-9</p> <p>Test wavelength: <math>1\ 550\ \text{nm} \pm 20\ \text{nm}</math></p> <p><math>250\ \text{m/s}^2</math>, 6 ms duration, 5 shocks in each of the 6 directions</p> <p>Additionally transient monitoring according to IEC 61300-3-28</p> <p>Sampling rate: before, during and after shock</p> <p>Sampling rate note: attenuation and return loss decrease is the difference between any measurement and the initial measurement, and applies to all measurements. Maximum and mean attenuation and return loss criteria apply to all measurements</p> <p>Method of mounting: an adapter shall be mounted rigidly to the mounting fixture</p> <p>Sample shall be optically functioning</p> <p>Preconditioning procedure: clean plug and adapter according to manufacturer's instructions</p> <p>The connector samples may not be uncoupled or cleaned anytime during the test</p>
12	Torsion	<p>During</p> <p><math>\Delta</math>Atten.: <math>\leq 0,2</math> dB</p> <p>Initial and final attenuation should meet the grade</p> <p>RL grade shall be met</p> <p>The sample shall not have any mechanical damage</p>	<p>IEC 61300-2-5</p> <p>Test wavelength: <math>1\ 550\ \text{nm} \pm 20\ \text{nm}</math></p> <p>Cycles: 25 (<math>\pm 180^\circ</math>)</p> <p>Force: 10 N at 300 mm from rear of plug body, at 1N/s</p> <p>Sampling rate: before, during and after torsion</p> <p>Sampling rate note: Attenuation and return loss decrease is the difference between any measurement and the initial measurement, and applies to all measurements. Maximum and mean attenuation and return loss criteria apply to all measurements</p> <p>Method of mounting: an adapter shall be mounted rigidly to the mounting fixture</p> <p>Sample shall be optically functioning</p> <p>Preconditioning procedure: Clean plug and adapter according to manufacturer's instructions</p> <p>The connector samples may not be uncoupled or cleaned anytime during the test</p>

Test number No.	Test	Requirements	Details
13	Bending moment	During $\Delta$ Atten.: $\leq 0,2$ dB Initial and final attenuation should meet the grade RL grade shall be met The sample shall not have any mechanical damage	IEC 61300-2-7 Test wavelengths: 1 550 nm $\pm$ 20 nm Force 10 N Point of application of bending load: The end of the connector plug with the moment being about the centre of the adaptor The load shall be applied in 2 perpendicular axes with reference to the connector latching orientation, 55 mm from the outer front surface of the adaptor 30 s per axis Sampling rate: initially and after the load has reached its maximum level and been maintained for a minimum of 30 s Sample shall be optically functioning Preconditioning procedure: clean plug and adapter according to manufacturer's instructions. Place a dust cap over the ferrule to protect the fibre end face
14	Dust	No dust inside Initial and final attenuation should meet the grade RL grade shall be met	IEC 60529 (IEC 61300-2-46) IP 6x, Test 6 (Table VII) Sample not optically functioning Testing only in a mated condition Particle size: 150 $\mu$ m, talc powder, 10 min duration Concentration: 10,6 g/m <sup>3</sup>
15	Industrial atmosphere	After test: as described in test number 1, Visual Inspection Initial and final attenuation should meet the grade RL grade shall be met, before and after the test The sample shall not have any mechanical damage	Industrial atmosphere IEC 60068-2-60, chapter 3, Severities, page 11: Method 1: H <sub>2</sub> S: 100 ppb $\pm$ 20 ppb SO <sub>2</sub> : 500 ppb $\pm$ 100 ppb Stability of concentration: Volume changes per hour: 3-10 ppb Time of exposure: 96h, Maximum allowed duration of stabilization and adjustment is 24h, before the test. Temp. level: Method 1: 25 °C Humidity level RH: 75 %

Test number No.	Test	Requirements	Details
16	Change of temperature	During $\Delta$ Atten.: $\leq 0,2$ dB Initial and final attenuation should meet the grade RL grade shall be met	IEC 61300-2-22 Test wavelength: $1\ 550\ \text{nm} \pm 20\ \text{nm}$ High temperature dwell: $+70\ ^\circ\text{C} \pm 2\ ^\circ\text{C}$ Low temperature dwell: $-40\ ^\circ\text{C} \pm 2\ ^\circ\text{C}$ Duration at each dwell temperature: 3 h Ramp time: $1\ ^\circ\text{C}/\text{min}$ Number of cycles: 4 cycles, 3 h Length of the cable on each side of the connector inside the chamber: 1,5 m minimum Sample shall be optically functioning Sampling rate: initially at room ambient, after 1/2 h during each dwell (measurements to be completed during dwell) and at the end of the test at room ambient Sampling rate note: attenuation and return loss decrease is the difference between any measurement and the initial measurement made at room temperature, and applies to all measurements. Maximum and mean attenuation and return loss criteria apply to all measurements Preconditioning procedure: before test, samples shall be maintained in room temperature condition for 2 h Recovery procedure: after test, samples shall be maintained in room temperature condition for 2 h The connector samples may not be uncoupled or cleaned anytime during the test
17	Damp heat cyclic	During $\Delta$ Atten.: $\leq 0,2$ dB Initial and final attenuation should meet the grade RL grade shall be met The sample shall not have any mechanical damage	IEC 61300-2-46 Minimum temperature: $25\ ^\circ\text{C}$ Maximum temperature: $55\ ^\circ\text{C}$ Humidity: 90 %, no condensing 6 cycles, 24 h per cycle Preconditioning procedure: clean plug and adapter according to manufacturer's instructions The connector samples may not be uncoupled or cleaned anytime during the test