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Technical Specification

**Transmission and Multiplexing (TM);
Passive optical components;
Fibre optic fusion splices for
single-mode optical fibre transmission systems for
indoor and outdoor applications;
Common requirements and conformance testing**



Reference

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The present document is a revision of I-ETS 300 783.

1 Scope

The present document specifies requirements for fusion splices to be used in single mode optical fibre telecommunications land-based (not submarine) systems. The scope covers the establishment of minimum uniform requirements for the following aspects:

- optical, environmental and mechanical properties;
- test conditions;
- acceptance criteria.

The splices are considered to be between single fibres, between ribbon fibres and between ribbon and multiple fibres. The optical fibres which are spliced are intended to conform to IEC 60793-2-50 [4]. These requirements cover splices with the same single mode fibre type.

In order to obtain the required functional behaviour of the fusion splices, it is necessary to follow a number of procedures for fibre preparation, fibre alignment, jointing and protection as described in ITU-T Recommendation L.12 [3].

All the following requirements refer to protected splices measured in a laboratory. This ES is intended to provide criteria for the assessment of splicing equipment and techniques, including the splice protector.

Some users may have additional specific requirements, such as the need to verify performance at lower temperatures. These users should specify splices conforming to the basic ETSI performance standard plus the additional tests or more severe test conditions.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

- [1] ETSI EN 300 019 (all parts): "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".
- [2] IEC 61300 (all parts): "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures".
- [3] ITU-T Recommendation L.12: "Optical fibre joints".
- [4] ETSI I-ETS 300 783: "Transmission and Multiplexing (TM); Passive optical components; Fibre optic fusion splices for single-mode optical fibre transmission systems; Common requirements and conformance testing".

3 Definition and abbreviations

3.1 Definition

For the purposes of the present document, the following terms and definitions apply:

fusion splice: fusion spliced fibres protected by a splice protector with fibre tails of 1,5 metres on each side of the splice protector

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

RL	Return Loss
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4 Details, measurements and performance requirements

The performance requirements shall fulfil the ETSI environmental classes 3.1, 3.2, 3.3 as well as environmental category U from IEC 61753-1.

All measurements shall be carried out under normal room conditions, unless otherwise stated. Before the insertion and return loss measurement, careful cleaning in accordance with manufacturers instructions is necessary.

All optical tests shall be carried out in both the 1 310 nm window and the 1 550 nm window unless otherwise stated. Light sources with peak wavelengths of $1\ 310 \pm 30$ nm and $1\ 550 \pm 30$ nm shall be used.

The length of fibre or cable on each side of the connector set shall be 1,5 m (minimum). A minimum length of 1,5 m on each side of the test set shall be exposed to the test conditions of all climatic and environmental tests.

4.1 Visual inspection

Details

In accordance with IEC 61300-3-1 [2]. The splice shall be examined for defects using a magnifying glass giving a magnification of between 3 and 8 times.

Requirements

The fused region and the stripped fibre on each side of the fused region shall be fully enclosed within the splice protector. The splice protector shall be seen to be gripping the fibre coating at each end of the splice. The fibre shall emerge from the protector without any visible sign of bending or kinking. The splice protector shall show no sign of damage. Heat shrink splice protectors shall have no bulges since these would suggest that air had become trapped during the shrink down process.

4.2 Attenuation

Details

In accordance with IEC 61300-3-4 [2].

Requirements

The requirements specified in the following table apply to both the 1 310 nm and 1 550 nm windows.

Table 1

Category	Mean attenuation	Maximum attenuation
Single fibres:		
Class I	$\leq 0,08$ dB	$\leq 0,15$ dB
Class II	$\leq 0,20$ dB	$\leq 0,50$ dB
Ribbon and multiple fibres:		
Class III	$\leq 0,20$ dB	$\leq 0,80$ dB

4.3 Return Loss (RL)

Details

In accordance with IEC 61300-3-6 [2].

Requirements

allowable return loss: > 60 dB.

Throughout all the environmental and climatic tests, the return loss shall be >60 dB.

4.4 Vibration (sinusoidal)

Details

In accordance with IEC 61300-2-1 (Second edition - 2003-01) [2]:

frequency range: 10 Hz to 55 Hz;

endurance duration per axis: 0,5 hour;

number of axes: three, orthogonal;

number of cycles (10-55-10): 15;

vibration amplitude: 0,75 mm.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 310\ \text{nm} \pm 30\ \text{nm}$ and $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. The maximum sampling interval during the test shall be 2 ms.

4.5 Fibre retention

Details

In accordance with IEC 61300-2-4 [2]:

magnitude and rate of application of the tensile load: $5 \pm 0,5$ N applied at 0,5 N/s;

duration of the test (maintaining the load): 60 s;

point of application of the tensile load: 0,3 m from the splice.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$ before, during and after the test. During the test the attenuation shall be measured at least once while the load is at the maximum level.

4.6 Torsion

Details

In accordance with IEC 61300-2-5 [2]:

magnitude of tensile load	2 N;
point of application of the tensile load:	0,3 m from the splice;
maximum torsion angle	$\pm 180^\circ$;
duration of the test:	50 cycles (not to exceed the fibre specification).

Requirements

During the test the attenuation variation shall be $\leq 0,20$ dB. On completion of the test the difference between the final and the initial attenuation shall be $\leq 0,10$ dB.

The return loss during and on completion of the test shall not fall below the minimum for the grade.

The attenuation and the return loss shall be measured at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$ before, during and after the test. During the test the attenuation and return loss shall be measured at least once every time when the torsion angle is at the maximum value.

4.7 Drop test (Impact method A)

Details

In accordance with IEC 61300-2-12 method A (drop test) [2]:

number of drops:	5;
Drop height:	1,5 m.

Requirements

On completion of the test the difference between the initial and the final attenuation shall be $\leq 0,10$ dB and the return loss shall not fall below the minimum for the grade.

The measurements shall be carried out at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$.

4.8 Cold

Details

In accordance with IEC 61300-2-17 [2]:

temperature:	-25°C ;
duration of exposure:	96 hours;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.9 Dry heat

Details

In accordance with IEC 61300-2-18 [2]:

temperature:	+70°C;
duration of exposure:	96 hours;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.10 Damp heat (steady state)

Details

In accordance with IEC 61300-2-19 [2]:

temperature:	+40°C;
relative humidity:	$93 \pm 2\%$;
duration of exposure:	96 hours;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.11 Damp heat (cyclic)

Details

This test shall be carried out on splices which are to be used in weather protected environments corresponding to EN 300 019 [1], classes 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to EN 300 019 [1] class 4.1.

This test should be carried out in accordance with IEC 61300-2-46 [2]:

high temperature:	+55°C;
low temperature:	+25°C;
duration of each cycle:	24 hours;
number of cycles:	6;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	16 hours at normal ambient conditions.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 1 hour.

4.12 Change of temperature

Details

In accordance with IEC 61300-2-22 [2]:

high temperature:	+70°C;
low temperature:	-25°C;
duration at extreme temperatures:	1 hour;
rate of change of temperature:	1°C/minute;
number of cycles:	12;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\,310\text{ nm} \pm 30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 10 minutes.

4.13 Corrosive atmosphere (salt mist)

Details

This test shall be carried out on splices which are to be used in weather protected environments corresponding to EN 300 019 [1] classes 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to EN 300 019 [1] class 4.1.

In accordance with IEC 61300-2-26 [2]:

atmosphere:	salt solution 5 % NaCl, pH 6,5 to 7,2;
temperature:	+35°C;
duration of test:	96 hours;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements

The attenuation shall be measured at $1\ 310\ \text{nm} \pm 30\ \text{nm}$ and $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before and after the test at normal ambient conditions. On completion of the test there shall be no difference between the initial and final attenuation.

4.14 Industrial atmosphere

Details

This test shall be carried out on splices which are to be used in weather protected environments corresponding to EN 300 019 [1] classes 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to EN 300 019 [1] class 4.1.

In accordance with IEC 61300-2-28 [2]:

atmosphere:	sulphur dioxide (SO ₂) 25 ppm;
temperature:	+25°C;
relative humidity	75 %;
duration of test:	96 hours;
Pre-conditioning procedure:	2 hours at normal ambient conditions;
Recovery procedure:	2 hours at normal ambient conditions.

Requirements

The attenuation shall be measured at $1\ 310\ \text{nm} \pm 30\ \text{nm}$ and $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before and after the test at normal ambient conditions. On completion of the test there shall be no difference between the initial and final attenuation.

4.15 Condensation

Details

This test shall be carried out on splices which are to be used in non-weather protected environments corresponding to EN 300 019 [1], class 4.1.

In accordance with IEC 61300-2-21 [2]:

high temperature:	65°C;
low temperature:	-10°C;
duration at 65°C:	4 hours;
duration at -10°C:	4 hours;
maximal relative humidity:	93 %;
duration of the cycle:	24 hours;
number of cycles:	12;
pre-conditioning procedure:	2 hours at normal ambient conditions;
recovery procedure:	2 hours at normal ambient conditions.

Requirements

During the test the attenuation shall be within $\pm 0,10$ dB of the initial value. On completion of the test there shall be no difference between the initial and final attenuation.

The attenuation shall be measured at $1\ 310\ \text{nm} \pm 30\ \text{nm}$ and $1\ 550\ \text{nm} \pm 30\ \text{nm}$ before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 10 minutes.

4.16 Water immersion

This test shall be carried out on splices which are to be used in weather protected environments corresponding to EN 300 019 [1], classes 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to EN 300 019 [1], class 4.1.

At present there are several different user requirements. ETSI is attempting to harmonize these requirements. Until this is achieved, water immersion testing should be carried out in accordance with specific user test methods and requirements.

5 Acceptance criteria

Fusion splicing machines used to produce splices conforming to the performance requirements of the present document are required to demonstrate conformance by means of the following qualification procedure. The splice definition given in clause 3.1 of the present document shall apply to the test samples.

The requirements for each test are given in the relevant clauses of the present document. Any parallel or serial sequence of environmental and mechanical tests can be used provided that each test or serial group of tests is followed by the change of temperature test. No deviation from the specified test methods is allowed. This clause specifies the minimum sample sizes required for qualification and defines the pass/fail criteria.

5.1 Minimum sample size for qualification

5.1.1 Qualification to minimum uniform requirements

- Visual inspection (clause 4.1): 50 splices.
- Attenuation (clause 4.2): 50 splices.
- Return loss (clause 4.3): 50 splices.
- Vibration (sinusoidal) (clause 4.4): 4 splices.
- Fibre retention (clause 4.5): 4 splices.
- Torsion (clause 4.6): 4 splices.
- Drop test (clause 4.7): 4 splices.
- Cold (clause 4.8): 4 splices.
- Dry heat (clause 4.9): 4 splices.
- Damp heat (steady state) (clause 4.10): 4 splices.
- Change of temperature (clause 4.12): 4 splices.

5.1.2 Qualification for EN 300 019 environment classes 3.3, 3.4 and 3.5

In addition to the tests included in 5.1.1 the following tests shall be carried out on splices which are to be used in weather protected environments corresponding to EN 300 019 [1] classes 3.3, 3.4 or 3.5.

- Damp heat (cyclic) (clause 4.11): 4 splices.
- Water immersion (clause 4.16): 4 splices.

5.1.3 Qualification for EN 300 019 environment class 4.1

In addition to the tests included in clauses 5.1.1 and 5.1.2, the following test shall be carried out on splices which are to be used in non-weather protected environments corresponding to EN 300 019 [1] class 4.1.

- Corrosive atmosphere (salt mist) (clause 4.13): 4 splices.
- Industrial atmosphere (clause 4.14): 4 splices.
- Condensation (clause 4.15): splices.

5.2 Attenuation

A minimum of 100 splices shall be made using randomly oriented fibre conforming to the standards quoted in the introduction of the present document. The attenuation requirements are applicable to both the 1 310 nm and 1 550 nm windows. The following table shows the acceptance limits for the mean and maximum attenuation values.

Table 2

Category	Mean attenuation	Maximum attenuation
Single fibres:		
Class I	≤ 0,08 dB	≤ 0,15 dB (≥ 99 % of splices)
Class II	≤ 0,20 dB	≤ 0,50 dB (≥ 95 % of splices)
Ribbon and multiple fibres:		
Class III	≤ 0,20 dB	≤ 0,80 dB (≥ 95 % of splices)

5.3 Pass/fail criteria

To satisfy the qualification approval requirements of the present document performance specification there shall be no failures of any in the sample groups for any test parameter. If a failure does occur this shall be investigated and the cause of failure identified and corrected. The test which is affected shall then be repeated using the minimum sample size stated in the present document.

A fully documented test report and supporting data shall be prepared and shall be available for inspection. Failures and the corrective action taken to eliminate failures shall be documented and evidence shall be presented to show that the corrective action will have no detrimental effect on the performance in any of the other tests. Design changes, as opposed to improvements in quality control, will usually be deemed to necessitate a repeat of the full qualification programme.

History

Document history		
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