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Technical Specification

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



Reference

RTS/TM-01105

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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 ES 201 263 [4].

Introduction

The present document covers mechanical splices for single mode optical fibres and cables. The optical fibres are those described in IEC 60793-2-50 [3]. To minimize reflection loss caused by an air gap between the fibre ends, index-matching material can be used. Mechanical splices can be used both as temporary or permanent splices. The considered splices are between single fibres, between ribbon fibres and between ribbon and multiple single fibres.

Mechanical splices are field-mountable passive optical components; therefore they will be assembled by users. The manufacturer should give instructions for assembly.

In order to obtain the required functional behaviour of mechanical 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 [2].

All the following requirements are referred to protected splices measured in laboratory.

1 Scope

The present document specifies requirements for mechanical splices to be used in single-mode optical fibre telecommunication 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.

Reliability aspects of connector sets are not covered by the present document.

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

Two grades of mechanical splices have been established in the present document regarding their performance in environmental tests. These are referred to as grades V and T.

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 ETS 300 019 (all parts): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".
- [2] ITU-T Recommendation L.12 (2000): "Optical fibre joints".
- [3] IEC 60793-2-50 (2004): "Optical fibres - Part 2-50: Product specifications - Sectional specification for class B single-mode fibres".
- [4] ETSI ES 201 263 (V1.1.1): "Transmission and Multiplexing (TM); Passive optical components; Fibre optic mechanical splices for single-mode optical fibre communications systems; Common requirements and conformance testing".
- [5] IEC 61300-3-1: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-1: Examinations and measurements - Visual examination".
- [6] IEC 61300-3-4: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-4: Examinations and measurements - Attenuation".
- [7] IEC 61300-3-6: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-6: Examinations and measurements - Return loss".
- [8] IEC 61300-2-1: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-1: Tests - Vibration".
- [9] IEC 61300-3-28: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-28: Examinations and measurements - Transient loss".

- [10] IEC 61300-2-4: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-4: Tests - Fibre/cable retention".
- [11] IEC 61300-2-5: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-5: Tests - Torsion/twist".
- [12] IEC 61300-2-12: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-12: Tests - Impact".
- [13] IEC 61300-2-17: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-17: Tests - Cold".
- [14] 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".
- [15] IEC 61300-2-19: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-19: Tests - Damp heat".
- [16] IEC 61300-2-46: "Basic test and measurement procedures - Part 2-46: Tests - Damp heat cyclic".
- [17] IEC 61300-2-22: "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-22: Tests - Change of temperature".

3 Definitions and abbreviations

3.1 Definitions

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

mechanical splices: splices that carry out the alignment and fixing of fibres by mechanical means

splice: mechanical spliced fibres, properly protected, with fibre tails of at least 1,5 m on each side of the splice protector

3.2 Abbreviations

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

OTDR Optical Time Domain Reflectometer

4 Details, measurements and performance requirements for ETSI environmental classes 3.1, 3.2, 3.3 and IEC environmental category U

All tests shall be carried out in accordance with the prescribed IEC standard tests. All measurements shall be carried out under normal room conditions, unless otherwise stated.

A minimum length of 1,5 m on each side of the splice protector shall be exposed to the test conditions of all climatic and environmental tests. In most cases mechanical splice assemblies will contain both the alignment and the protection features.

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 nm \pm 30 nm and 1 550 nm \pm 30 nm shall be used.

4.1 Visual inspection

Details:

In accordance with IEC 61300-3-1 [5].

The mechanical splice shall be examined for defects using a magnifying glass giving a magnification of between 3 and 8 times.

Requirements:

Each mechanical splice shall be properly packed. The package shall be marked with the name of the manufacturer and the production date.

The mechanical splice itself shall be legibly and durably marked with the identity mark of the manufacturer and the manufacturing date code.

4.2 Attenuation

Details:

In accordance with IEC 61300-3-4 [6].

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	$\leq 0,15$ dB	$\leq 0,30$ dB (≥ 95 % of splices)
Class II	$\leq 0,20$ dB	$\leq 0,50$ dB (≥ 95 % of splices)
Multiple splices:		
Class III	$\leq 0,30$ dB	$\leq 0,80$ dB (≥ 95 % of splices)

4.3 Return loss

Details:

In accordance with IEC 61300-3-6 [7] method 2 (coupler method).

Alternatively, the return loss may be measured using an Optical Time Domain Reflectometer (OTDR) in accordance with IEC 61300-3-6 [7] method 2. It is recommended to calibrate OTDR against coupler based measurements or reference reflector.

launch fibre length $2\text{m} \leq L \leq 4\text{ m}$.

source stability: better than $\pm 0,20$ dB over the measurement period.

Requirements:

Allowable return loss: Grade 1 ≥ 60 dB;

Grade 3 ≥ 35 dB.

4.4 Vibration (sinusoidal)

Details:

In accordance with IEC 61300-2-1 [8]:

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 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. The maximum sampling interval during the tests shall be 2 s.

The transient loss should be measured in accordance with IEC 61300-3-28 [9].

4.5 Fibre/cable retention

Details:

In accordance with IEC 61300-2-4 [10]:

magnitude and rate of application of the tensile load:	$5\ \text{N} \pm 0,5\ \text{N}$ applied at $0,5\ \text{N/s}$;
duration of the test (maintaining the load):	60 s;
point of application of the tensile load:	0,3 m from the fibre-fibre interface.

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 while the load is at the maximum level.

4.6 Torsion

Details:

In accordance with IEC 61300-2-5 [11]:

This test shall only be carried out for single fibre splices.

Tensile load:	2 N;
point of application:	0,3 m from the end face of the splice;
maximum torsion angle:	$\pm 180^\circ$;
number of cycles:	50.

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 Impact

Details:

In accordance with IEC 61300-2-12 [12] method A2 (drop test):

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 $1\,310\text{ nm} \pm 0,30\text{ nm}$ and $1\,550\text{ nm} \pm 30\text{ nm}$.

4.8 Cold

Details:

In accordance with IEC 61300-2-17 [13]:

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 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 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 shall be measured at a maximum interval of 1 hour.

4.9 Dry heat

Details:

In accordance with IEC 61300-2-18 [14]:

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

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

The attenuation and 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 shall be measured at a maximum interval of 1 hour.

4.10 Damp heat (steady state)

Details:

In accordance with IEC 61300-2-19 [15]:

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

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

The attenuation and 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 shall be measured at a maximum interval of 1 hour.

4.11 Damp heat (cyclic)

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

Details:

This test should be carried out in accordance with IEC 61300-2-46 [16]:

high temperature:	55°C;
low temperature:	25°C;
duration of one cycle:	24 hours;
number of cycles:	6.

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 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 shall be measured at a maximum interval of 10 minutes.

4.12 Change of temperature

Details:

In accordance with IEC 61300-2-22 [17]:

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 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 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 shall be measured at a maximum interval of 10 minutes.

5 Acceptance criteria

Mechanical splices used to produce splices conforming to the performance requirements of the present document are required to demonstrate conformance by means of the following test procedure.

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 section specifies the minimum sample sizes required for qualification and defines the pass/fail criteria.

5.1 Minimum sample size for qualification

- Visual inspection (clause 4.1): 50 splices.
- Attenuation (clause 4.2): 50 splices.
- Return loss (clause 4.3): 50 splices.
- Vibration (clause 4.4): 4 splices.
- Fibre/cable retention (clause 4.5): 4 splices.
- Torsion (clause 4.6): 4 splices.
- Impact (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.
- Damp heat (cyclic) (clause 4.12): 4 splices.
- Change of temperature (clause 4.12): 4 splices.

5.2 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 that 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		
V1.1.1	June 1999	Publication as ES 201 263
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