

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

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## Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM), and is now submitted for the ETSI standards Membership Approval Procedure.

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## Introduction

The present document covers mechanical splices for single mode optical fibres and cables. The optical fibres are those described in EN 188100 [9] (sectional specification) and EN 188101 [10] (family specification). 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 [8].

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

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# 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.

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.

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# 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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

- [1] IEC 61073-1 (1994): "Splices for optical fibres and cables; Part 1: Generic specification; Hardware and accessories".
- [2] ETS 300 019: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".
- [3] IEC 61300-3-6: "Fibre optic interconnecting devices and passive components; Basic test and measurement procedures; Part 3-6: Examinations and measurements; Return loss".
- [4] IEC 61300-2-12: "Fibre optic interconnecting devices and passive components; Basic test and measurement procedures; Part 2-12: Tests; Impact".
- [5] IEC 61300-2-21: "Fibre optic interconnecting devices and passive components; Basic test and measurement procedures; Part 2-21: Tests; Condensation".
- [6] IEC 61300-2-45: "Fibre optic interconnecting devices and passive components; Basic test and measurement procedures; Part 2-45: Test; Durability by water immersion".
- [7] IEC 60068-2-30: "Environmental testing; Part 2: Tests. Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)".
- [8] ITU-T Recommendation L.12: "Optical fibre joints".
- [9] EN 188100: "Sectional Specification: Single-Mode (SM) Optical Fibre".
- [10] EN 188101: "Family Specification: Single-Mode Dispersion Unshifted (B1.1) Optical Fibre".

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## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the following definition applies:

**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 abbreviation applies:

OTDR:            Optical Time Domain Reflectometer

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## 4 Details, measurements and performance requirements

All tests shall be carried out in accordance with the prescribed IEC standard tests.

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  $1\,310\text{ nm} \pm 30\text{ nm}$  and  $1\,550\text{ nm} \pm 30\text{ nm}$  shall be used.

### 4.1 Visual inspection

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

NOTE: Attenuation is referred to as "insertion loss" in IEC 61073-1 [1]. For the purpose of this test the two terms may be considered to have the same meaning.

#### Details:

In accordance with IEC 61073-1 [1] subclause 4.4.4, method 1 or 2.2.

- Fibre lengths Method 1 (L, L1, L2):    > 4m, > 2m, > 2m.
- Fibre lengths Method 2.2 (L1, L2):    > 1km, > 1km.

**Requirements:**

- Allowable attenuation:  $\leq 0,20$  dB (average value);  
 $\leq 0,50$  dB (maximum value for 95 %) single fibres splices;  
 $\leq 0,80$  dB (maximum value for 95 %) multiple fibres splices.

## 4.3 Return loss

**Details:**

In accordance with IEC 61073-1 [1] subclause 4.5.5, method 1.

- Launch fibre length for IEC 61073-1 [1] Method 1: between 2 m and 3 m.

Alternatively, the return loss may be measured using an OTDR in accordance with IEC 61300-3-6 [3] Method 2. If this method is used, the OTDR pulse length shall be selected to give a return loss measurement equivalent to that which would be given by the coupler based technique.

- Launch fibre length for IEC 61300-3-6 [3] Method 2:  $> 1$ km.

**Requirements:**

- Allowable return loss: Grade V  $\geq 55$  dB;  
Grade T  $\geq 35$  dB.

## 4.4 Vibration (sinusoidal)

**Details:**

In accordance with IEC 61073-1 [1] subclause 4.5.1

- 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  $1\,550\text{ nm} \pm 30\text{ nm}$  before, during and after the test. The maximum sampling interval during the tests shall be 2 seconds.

## 4.5 Pulling

### Details:

In accordance with IEC 61073-1 [1] subclause 4.5.2.

- Magnitude and rate of application of the tensile load: 5 N  $\pm$  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 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 1 550 nm  $\pm$  30 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 61073-1 [1] subclause 4.5.31. 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 1 550 nm  $\pm$  30 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 [4] method A (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 1 550 nm  $\pm$  30 nm.



## 4.8 Cold

### Details:

In accordance with IEC 61073-1 [1] subclause 4.5.11.

- Temperature: -25 °C.
- Duration of exposure: 16 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  $1\,550\text{ nm} \pm 30\text{ nm}$  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 61073-1 [1] subclause 4.5.12.

- 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  $\leq 0,20$  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  $1\,550\text{ nm} \pm 30\text{ nm}$  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 61073-1 [1] subclause 4.5.13.

- 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  $\leq 0,20$  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  $1\,550\text{ nm} \pm 30\text{ nm}$  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 [2] subclasses 3.3, 3.4 or 3.5.

**Details:**

In accordance with IEC 60068-2-30 [7].

- 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  $1\,550\text{ nm} \pm 30\text{ nm}$  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 61073-1 [1] subclause 4.5.16.

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

## 4.13 Dust

This test shall be carried out on splices which are to be used in weather protected environments corresponding to ETS 300 019 [2] subclasses 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to ETS 300 019 [2] subclass 4.1.

**Details:**

In accordance with IEC 61073-1 [1] subclause 4.5.18.

- Dust particle size:  $d < 150\ \mu\text{m}$ .
- Dust type: talc.
- Temperature:  $35\ ^\circ\text{C}$ .
- Relative humidity: 60 %.
- Duration of test: 10 minutes.

**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  $1\ 550\ \text{nm} \pm 30\ \text{nm}$ .

## 4.14 Condensation

This test shall be carried out on splices which are to be used in non-weather protected environments corresponding to ETS 300 019 [2] subclass 4.1.

**Details:**

In accordance with IEC 61300-2-21 [6].

- High temperature:  $65\ ^\circ\text{C}$ .
- Low temperature:  $-10\ ^\circ\text{C}$ .
- Duration at  $65\ ^\circ\text{C}$ : 4 hours + 4 hours.
- Duration at  $-10\ ^\circ\text{C}$ : 4 hours.
- Maximal relative humidity: 93 %.
- Duration of the cycle: 24 hours.
- Number of cycles: Under consideration.
- 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  $1\,550\text{ nm} \pm 30\text{ nm}$  before, during and after the test. During the test the attenuation shall be measured at a maximum interval of 10 minutes.

## 4.15 Water immersion

This test shall be carried out on splices which are to be used in weather protected environments corresponding to ETS 300 019 [2] subclasses 3.3, 3.4 or 3.5 or in non-weather protected environments corresponding to ETS 300 019 [2] subclass 4.1.

**Details:**

In accordance with IEC 61300-2-45 [6].

- Height of water: 150 mm.
- Temperature: 43 °C.
- Duration: 168 hours.

**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  $1\,550\text{ nm} \pm 30\text{ nm}$  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

#### 5.1.1 Qualification to minimum uniform requirements

- Visual inspection (subclause 4.1): 50 splices.
- Attenuation (subclause 4.2): 50 splices.
- Return loss (subclause 4.3): 50 splices.
- Vibration (subclause 4.4): 4 splices.
- Pulling (subclause 4.5): 4 splices.

- Torsion (subclause 4.6): 4 splices.
- Impact (subclause 4.7): 4 splices.
- Cold (subclause 4.8): 4 splices.
- Dry heat (subclause 4.9): 4 splices.
- Damp heat (steady state) (subclause 4.10): 4 splices.
- Change of temperature (subclause 4.12): 4 splices.

### 5.1.2 Qualification for ETS 300 019 environment subclasses 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 ETS 300 019 [2] subclasses 3.3, 3.4, or 3.5.

- Damp heat (cyclic) (subclause 4.11): 4 splices.
- Dust (subclause 4.13): 4 splices.
- Water immersion (subclause 4.15): 4 splices.

### 5.1.3 Qualification for ETS 300 019 environment subclass 4.1

In addition to the tests included in subclauses 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 ETS 300 019 [2] subclass 4.1.

Condensation (subclause 4.14): 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.

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## History

<b>Document history</b>		
V1.1.1	March 1999	Membership Approval Procedure MV 9922: 1999-03-30 to 1999-05-28