

**Transmission and Multiplexing (TM);
Passive optical components and cables;
Optical fibre cables to be used for patchcord applications for
single-mode optical fibre communication 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).

1 Scope

The present document specifies requirements of simplex and duplex cables for use in patchcord applications to be used in single mode optical fibre telecommunication 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 cables for use in patchcords 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 connectors conforming to the basic ETSI performance standard, plus additional tests or more severe test conditions.

Test methods are in accordance with relevant parts of IEC series.

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] IEC 60068-1: "Environmental testing. Part 1: General and guidance".
- [2] IEC 60189-1: "Low-frequency cables and wires with PVC insulation and PVC sheath. Part 1: General test and measuring methods".
- [3] IEC 60304: "Standard colours for insulation for low-frequency cables and wires".
- [4] IEC 60793-2: "Optical fibres - Part 2: Product specifications - General".
- [5] IEC 60793-2-50: "Optical fibres - Part 2-50: Product specifications - Sectional specification for class B single-mode fibres".
- [6] IEC 60794-1-2: "Optical fibre cables - Part 1-2: Generic specification - Basic optical cable test procedures".
- [7] IEC 60794-2-50: "Optical fibre Cables- Part 2-50: Indoor optical fibre cables - Family specification for simplex and duplex cables for use in patch cords".
- [8] IEC 60811-1-3: "Common test methods for insulating and sheathing materials of electric and optical cables - Part 1-3: General application - Methods for determining the density - Water absorption tests - Shrinkage test".
- [9] IEC 60794-1: "Optical fibre cables".
- [10] IEC 60793-1-40: "Optical fibres - Part 1-40: Measurement methods and test procedures - Attenuation".

3 Definitions and symbols

3.1 Definitions

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

buffer: tight or semi-tight (loosely applied) protection of the fibre consisting of one or more layers of inert material

NOTE: The semi-tight buffer may be filled.

cable assembly or patchcord: combination of cable(s) and connector(s) with specified performance, used as a single unit intended to be a part of an optical cabling link

sheath: overall protection of the cable

strength members: tensile and/or anti-buckling protection of the fibre

NOTE: This member may be either metallic or non-metallic and may be located in the cable core and/or under the sheath and/or in the sheath.

3.2 Symbols

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

°C	Celsius
dB	decibel
h	hour
J	joule
kg	kilogramme
km	kilometre
m	meter
mm	millimetre
N	Newton
nm	nanometre

4 Details, measurements and performance requirements

Generally optical cables comprise several elements or individual constituents, depending on the cable design which takes into account the cable application, operating environment and assembling processes, and the need to protect the fibre during terminating with connectors and handling.

Mechanical and ageing tests are to ensure stability of optical performance, therefore optical tests shall be performed before, during and after the mechanical and ageing tests as applicable.

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

The measured results shall be reported in graphical or table format with the limits specified in the standard distinctly shown in the table at the same wavelengths as specified in the present document.

All optical tests shall be carried out in the 1 310 nm, 1 550 nm and the 1 625 nm window unless otherwise stated. Light sources with peak wavelengths of 1 310 nm ± 30 nm, 1 550 nm ± 30 nm and 1 625 nm ± 30 nm shall be used.

4.1 Optical fibres and primary coating

The optical fibre and fibre primary coating shall conform to the requirements of IEC 60793-2 [4].

4.2 Material

The material(s) used for a cable shall be selected to be compatible with the other elements in contact or in function with it.

The materials in the optical fibre cable shall not present a health hazard within its intended use.

Polymeric materials that are used shall not support fungus growth.

A complete set of documentation shall be available from the manufacturer upon request and shall provide all related information to describe materials used for the cable.

Test report issued under the terms of the present document shall include the information about the base materials used in the cable as well as instructions for disposal.

4.3 Colour coding

The coated fibre or buffer shall be distinguishable by means of colour coding. Standard colours shall be used, as near as possible (reasonable match) to IEC 60304 [3].

The cable sheath shall be colour coded or alternatively, a printing in the sheath indicates the fibre. The colours for sheaths are given in table 1.

Table 1: Colours for sheath

Cables with fibre type	Colour of sheath
Standard single mode dispersion unshifted fibre	yellow
Single mode non-zero dispersion shifted fibre	red

4.4 Dimensions

The diameter of the buffer and of the cable, as well as the thickness of the sheath, shall be measured in accordance with the methods of IEC 60189-1 [2].

Buffer dimensions are shown in table 2.

Table 2: Dimensions of buffered fibres

Buffer type	Semi-tight buffer	Tight buffer
Nominal diameter (mm)	0,9	0,9
Tolerances (mm)	±0,1	±0,1

The cable shall have an overall protective sheath. The proposed cable diameter for the present document shall be between 1,7 mm and 2,4 mm.

For the other buffer and cable dimensions tests and requirements in the tests may be changed.

4.5 Visual inspection

Visual inspection of cables for patchcords is performed by observing with normal or corrected vision without any additional magnification:

- the condition, workmanship and finish are satisfactory;
- the marking is legible;
- mechanical damage is absent;
- the sheath of the cable shall be homogeneous.

4.6 Attenuation

4.6.1 Cabled attenuation

Details:

The transmission requirements shall be verified in accordance with IEC 60793-2 [4]. Maximum cable attenuation shall comply with IEC 60794-1 [9].

Test method: IEC 60793-1-40 [10]

Requirements:

Table 3: Single-mode maximum cable attenuation coefficient (dB/km)

Fibre category	Attenuation coefficient at 1 310 nm	Attenuation coefficient at 1 550 nm	Attenuation coefficient at 1 625 nm
IEC 60793-2-50 [5], clause B1.1	1,0	1,0	1,2
IEC 60793-2-50 [5], clause B4	n.a	1,0	1,2

5 Cable performance test

Unless otherwise specified, tests should be carried out under standard atmospheric conditions according to clause 5.3.1 of IEC 60068-1 [1].

5.1 Cable tensile performance

Method: IEC 60794-1-2 [6] E1A

Diameter of chuck drums and transfer devices: 250 mm to 300 mm

Rate of transfer device: Either 100 mm/min or 100 N/min

Load:

- 100 N for simplex cables, 200 N for duplex cables for outer sheath > 1,7 mm;
- 70 N for simplex cables, 140 N for duplex cables for outer sheath 1,7 mm;
- duration of the force application 5 min;
- sample length 25 m;
- Wavelength: 1 625 nm.

Requirements:

- 0,1 dB change of attenuation after the test, and there shall be no damage to the cable elements;
- 0,2 dB during the force application.

5.2 Cable crush

To determine the ability of a cable assembly to withstand a transverse load (or a force) applied to any part of the cable. This test is normally performed on the cable before assembly. Where the cable was not tested for crushing, the cable assembly shall be tested.

Method: IEC 60794-1-2 [6] E3

Force: 500 N

Duration: 1 min

Wavelength: 1 625 nm

Length between test locations: 500 mm

Requirements:

- 0,1 dB change of attenuation after the test, and there shall be no damage to the cable elements;
- 0,2 dB during the force application.

NOTE: In the case of flat cables the force shall be applied on the flat sides of the cable.

5.3 Cable impact

Method: IEC 60794-1-2 [6] E4

Radius of striking surface: 12,5 mm

Impact energy: 1,0 joules

Number of impacts: at least 3, each separated at least 500 mm

Wavelength: 1 625 nm

Requirements:

- 0,1 dB change of attenuation after the test.

NOTE: In the case of flat cables the force shall be applied on the flat sides of the cable.

5.4 Cable repeated bending

Method: IEC 60794-1-2 [6] E6

Bending radius: 30 mm only reinforced cable (for flat cables, the diameter is the minor dimension)

Number of cycles: 200

Mass of weights: 2 kg

Wavelength: 1 625 nm

Requirements:

- 0,1 dB change of attenuation after the test, and there shall be no damage to the cable elements;
- 0,2 dB during the test.

NOTE: In the case of flat cables the sample shall be fixed to the apparatus so that bending is perpendicular to the flat surface of the cable.

5.5 Cable torsion

Method: IEC 60794-1-2 [6] E7

Number of cycles:	20
Distance between fixed and rotating clamp:	250 mm
Tension load:	15 N
Wavelength:	1 625 nm

Requirements:

- 0,1 dB change of attenuation after the test, and there shall be no damage to the cable elements;
- 0,2 dB during the test.

5.6 Cable kink

Method: IEC 60794-1-2 [6] E10

NOTE: Only buffered cables shall be tested.

Minimum loop diameter: 20 times cable diameter.

Requirement:

- no kink shall occur.

5.7 Cable bend

Method: IEC 60794-1-2 [6] E11A

NOTE: All cable members shall be fixed together at the both ends to preserve from any relative movement of the member ends to each other.

Mandrel diameter:	50 mm
Length of specimen:	4,5 m
Number of turns per helix:	10
Number of cycles:	3
Wavelength:	1 625 nm

Requirements:

- 0,1 dB change of attenuation after the test, and there shall be no damage to the cable elements;
- 0,2 dB during the test.

5.8 Buffer movement under compression

Method: IEC 60794-2-50 [7] E21

NOTE 1: Strength members shall be fixed and only buffer shall be moved.

NOTE 2: Force shall be measured.

NOTE 3: Buckling of the buffer shall be avoided.

Compression distance: 10 mm
 Velocity of movement: ≤ 200 mm/min
 Movement length: 1 mm
 Number of movements: 5

Requirement:

- compression force at 0,4 mm movement ≤ 1 N.

5.9 Cable sheath pull-off force

Method: IEC 60794-2-50 [7] E20

Rate of separation: ≤ 200 mm/min
 Strip length: 50 mm

Requirement:

- the force to strip the sheath shall not be greater than 15 N.

5.10 Cable shrinkage test

Method: IEC 60811-1-3 [8], clause 10: Shrinkage test for insulation.

Length of specimen: 1 m
 High temperature: 70°C
 Duration: 1 h

Requirement:

- Shrinkage $\leq 0,5$ %.

5.11 Temperature cycling

Method: IEC 60794-1-2 [6] F1

NOTE: All cable members shall be fixed together at the both ends to preserve from any relative movement of the member ends to each other and shall be inside the climatic chamber.

Length of sample: 10 m
 Number of fibres: 1 or 2
 Type of winding: free, supported horizontally in an climatic chamber
 Winding radius: 150 mm
 Low temperature: -25°C
 High temperature: 70°C

Duration at extreme temperatures:	1 h
Rate of change of temperature:	1 C/min
Number of cycles:	6
Wavelength:	1 625 nm
Pre-conditioning procedure:	2 h at normal ambient conditions
Recovery procedure:	2 h at normal ambient conditions

Requirements:

- 0,1 dB change of attenuation after the test, and there shall be no damage to the cable elements.
- 0,4 dB during the test.

6 Acceptance criteria

The requirements for each test are given in the relevant clauses of the present document. There is no defined sequence in which the tests shall be run. No deviations from the specified test methods are allowed. This clause specifies the minimum sample sizes required for qualification and defines the pass/fail criteria.

Cable tensile performance:	4 samples
Cable crush:	4 samples
Cable impact:	4 samples
Cable repeated bending:	4 samples
Cable torsion:	4 samples
Cable kink:	4 samples
Cable bend:	4 samples
Buffer movement under compression:	4 samples
Cable sheath pull-off force:	4 samples
Cable shrinkage test:	4 samples
Temperature cycling:	4 samples

6.1 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.

Annex A (informative): Bibliography

- IEC 61300 (all relevant parts): "Fibre optic interconnecting devices and passive components - Basic test and measurement procedures".
- ETSI EN 300 019 (all parts): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".
- CENELEC EN 50377 series: "Product specification for connector set to be used in single mode optical fibre communication systems".
- ETSI ES 201 792: " Transmission and Multiplexing (TM); Passive optical components; Fibre optic patchcords for single mode optical fibre communication systems; Common requirements and conformance testing".

History

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