International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

L.404

(08/2017)

SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Passive optical devices

Field mountable single-mode optical fibre connectors

Recommendation ITU-T L.404

ITU-T

ITU International Telecommunication Union

ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

OPTICAL FIBRE CABLES	
Cable structure and characteristics	L.100–L.124
Cable evaluation	L.125–L.149
Guidance and installation technique	L.150–L.199
OPTICAL INFRASTRUCTURES	
Infrastructure including node element (except cables)	L.200–L.249
General aspects and network design	L.250–L.299
MAINTENANCE AND OPERATION	
Optical fibre cable maintenance	L.300–L.329
Infrastructure maintenance	L.330–L.349
Operation support and infrastructure management	L.350–L.379
Disaster management	L.380–L.399
PASSIVE OPTICAL DEVICES	**L.400–L.429**
MARINIZED TERRESTRIAL CABLES	L.430–L.449

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T L.404

Field mountable single-mode optical fibre connectors

Summary

Recommendation ITU-T L.404 describes the main features of field mountable single-mode optical fibre connectors, defines requirements for their optical, mechanical and environmental characteristics and lists the main test methods. Further, this Recommendation gives a general description of the basic principles of operation and of technologies of fabrication of field mountable single-mode optical fibre connectors.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L.404	2017-08-13	15	11.1002/1000/13297

Keywords

Field mountable, optical fibre connector, single-mode.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T L.404

Field mountable single-mode optical fibre connectors

1 Scope

This Recommendation covers field mountable single-mode connectors without an external fibre tail that are applied directly to the fibre by an installer in the field. The attachment of the fibre to this type of connector is fully inside the connector assembly (including the boot if present).

Connectors that include a fibre tail are covered by [ITU-T L.402].

This version of the Recommendation covers connectors with one fibre per ferrule or one fibre per connection.

This Recommendation:

– gives classification and information on types of field mountable single-mode optical fibre connectors, and the main requirements for their optical, mechanical and environmental characteristics;

– lists the main test methods of field mountable single-mode optical fibre connectors;

– gives a general description of the basic principles of operation and of technologies of fabrication of field mountable single-mode optical fibre connectors.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.652] Recommendation ITU-T G.652 (2016), *Characteristics of a single-mode optical fibre and cable*.

[ITU-T G.653] Recommendation ITU-T G.653 (2010), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.

[ITU-T G.654] Recommendation ITU-T G.654 (2016), *Characteristics of a cut-off shifted single-mode optical fibre and cable*.

[ITU-T G.655] Recommendation ITU-T G.655 (2009), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable*.

[ITU-T G.656] Recommendation ITU-T G.656 (2010), *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport*.

[ITU-T G.657] Recommendation ITU-T G.657 (2016), *Characteristics of a bending-loss insensitive single-mode optical fibre and cable*.

[ITU-T G.671] Recommendation ITU-T G.671 (2012), *Transmission characteristics of optical components and subsystems*.

[ITU-T L.402] Recommendation ITU-T L.402/L.36 (2015), *Single-mode fibre optic connectors*.

[IEC 60794-2-50] IEC 60794-2-50 (2008), *Optical fibre cables – Part 2-50: Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies*.

[IEC 61300-2-1] IEC 61300-2-1 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal).*

[IEC 61300-2-2] IEC 61300-2-2 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-2: Tests – Mating durability*.

[IEC 61300-2-4] IEC 61300-2-4 (1995), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retention.*

[IEC 61300-2-5] IEC 61300-2-5 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-5: Tests – Torsion*.

[IEC 61300-2-6] IEC 61300-2-6 (2010), *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] IEC 61300-2-7 (2013), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-7: Tests – Bending moment*.

[IEC 61300-2-12] IEC 61300-2-12 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-12: Tests – Impact*.

[IEC 61300-2-17] IEC 61300-2-17 (2010), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-17: Tests – Cold*.

[IEC 61300-2-18] IEC 61300-2-18 (2005), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-18: Tests – Dry heat – High temperature endurance*.

[IEC 61300-2-19] IEC 61300-2-19 (2012), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Damp heat (steady state)*.

[IEC 61300-2-22] IEC 61300-2-22 (2007), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*.

[IEC 61300-2-26] IEC 61300-2-26 (2006), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-26: Tests – Salt mist*.

[IEC 61300-2-27] IEC 61300-2-27 (1995), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-27: Tests – Dust - Laminar flow*.

[IEC 61300-2-33] IEC 61300-2-33 (2012), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-33: Tests – Assembly and disassembly of fibre optic mechanical splices, fibre management systems and closures*.

[IEC 61300-2-46] IEC 61300-2-46 (2006), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-46: Tests – Damp heat, cyclic*.

[IEC 61300-2-50] IEC 61300-2-50 (2007), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-50: Tests – Fibre optic connector proof test with static load - Singlemode and multimode*.

[IEC 61300-3-3] IEC 61300-3-3 (2009), *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 61300-3-6] IEC 61300-3-6 (2008), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*.

[IEC 61300-3-7] IEC 61300-3-7 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-7: Examinations and measurements – Wavelength dependence of attenuation and return loss of single mode components*.

[IEC 61300-3-28] IEC 61300-3-28 (2012), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-28: Examinations and measurements – Transient loss*.

[IEC 61300-3-34] IEC 61300-3-34 (2009), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-34: Examinations and measurements – Attenuation of random mated connectors*.

[IEC 61754-1] IEC 61754-1 (2013), *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 1: General and guidance*.

[IEC 61755-2-1] IEC 61755-2-1 (2006), *Fibre optic connector optical interfaces – Part 2-1: Optical interface standard single mode non-angled physically contacting fibres*.

[IEC 61755-2-2] IEC 61755-2-2 (2006), *Fibre optic connector optical interfaces – Part 2-2: Optical interface standard single mode angled physically contacting fibres*.

[IEC 61755-3-1] IEC 61755-3-1 (2006), *Fibre optic connector optical interfaces – Part 3-1: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia PC ferrule, single mode fibre*.

[IEC 61755-3-2] IEC 61755-3-2 (2006), *Fibre optic connector optical interfaces – Part 3-2: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia ferrules for 8 degrees angled-PC single mode fibres*.

[IEC 61755-3-5] IEC 61755-3-5 (2006), *Fibre optic connector optical interfaces – Part 3-5: Optical interface – 2,5 mm and 1,25 mm diameter cylindrical PC composite ferrule using Cu-Ni-alloy as fibre surrounding material, single mode fibre*.

[IEC 61755-3-6] IEC 61755-3-6 (2006), *Fibre optic connector optical interfaces – Part 3-6: Optical interface – 2,5 mm and 1,25 mm diameter cylindrical 8 degrees angled-PC composite ferrule using Cu-Ni-alloy as fibre surrounding material, single mode fibre*.

[IEC 61755-3-7] IEC 61755-3-7 (2009), *Fibre optic connector optical interfaces – Part 3-7: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical PC composite ferrule using titanium as fibre surrounding material, single mode fibre*.

[IEC 61755-3-8] IEC 61755-3-8 (2009), *Fibre optic connector optical interfaces – Part 3-8: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical 8 degrees angled-APC composite ferrule using titanium as fibre surrounding material, single mode fibre*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 fusion splice [ITU-T G.671].

3.1.2 mechanical splice [ITU-T G.671].

3.1.3 optical connector [ITU-T G.671].

3.1.4 optical splice [ITU-T G.671].

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 direct-mount FMC: This type of FMC is mounted using tools for clamping or gluing (hot or cold), cleaving and polishing. There is no optical splice inside the connector body.

3.2.2 ferrule: Mechanical fixture, generally a rigid tube, used to confine the stripped end of an optical fibre. See [IEC 61754-1].

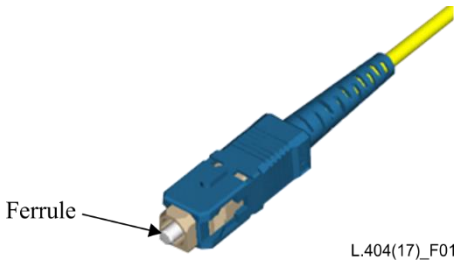

Figure 1 – Ferrule based connector

3.2.3 ferrule-less FMC: This type of FMC does not have a ferrule to align the fibres. The fibres are aligned by an alignment mechanism inside the adapter.

3.2.4 field mountable optical fibre connector (FMC): A type of optical fibre connector that can be mounted to the end of fibre and/or cable in field conditions.

3.2.5 fusion splice FMC: This type of ferrule based pre-polished fibre stub FMC is assembled with some tools and a fusion splicing machine. The fibres are fusion spliced and the splice is protected inside the connector body.

3.2.6 mechanical splice FMC: This type of ferrule based pre-polished fibre stub FMC contains a mechanical splice mechanism inside the connector body. The mechanical splice contains the following pre-assembled elements:

– an alignment device;
– a sealing and index matching material;
– a fibre alignment activation device such as a spring, wedge or plunger;
– a fibre clamp or fixing able to withstand axial fibre loads.

The mechanical splice FMC can be assembled with some simple tools not including a fusion splicing machine.

3.2.7 patch cord: Optical fibre cable with connectors on both ends.

Figure 2 – Patch cord

3.2.8 pigtail: Buffered or cabled fibre terminated with a connector on one end.

Figure 3 – Pigtail

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

APC Angled Physical Contact

FMC Field Mountable optical fibre Connector

FTTH Fibre to the Home

PC Physical Contact

5 Conventions

None.

6 General information

As fibre to the home (FTTH) is growing rapidly, the termination of optical cables at the wall outlet is becoming very important in deployment of the new optical access network.

A field mountable optical fibre connector (FMC) is a type of optical fibre connector (plug or socket) that can be installed directly on the fibre in the field and mated/demated many times.

7 Classification

An FMC can be classified on the basis of:

– the type of assembly;
– the type of fibre on which they are mounted;
– the type of cable on which they are mounted;
– the fibre alignment system;
– when applicable, the kind of fibre present in the ferrule and the end-face finish;
– the number of jointed fibres;
– the type of coupling mechanism;
– when applicable, the outer diameter of the ferrule (2.5 mm or 1.25 mm);
– the connector mating layout ("plug and socket" or "plug-adapter-plug").

7.1 Assembly types

According to the installation method, the FMC can be classified into four types:

1) mechanical splice type;
2) fusion splice type;
3) ferrule-less type;
4) direct-mount type.

7.2 Fibre types

The fibres of the cable to be terminated considered in this Recommendation are those specified in: [ITU-T G.652], [ITU-T G.653], [ITU-T G.654], [ITU-T G.655], [ITU-T G.656] and [ITU-T G.657].

7.3 Cable types

The connector can be assembled with:

– primary coated fibre (typically 200 µm or 250 µm);
– secondary coated fibre (900 µm);
– aramid yarn reinforced fibre cable (typically from 0.9 mm to 4.5 mm);
– rectangular cable (typically 2.0 mm × 1.6 mm or 3.1 mm × 2.0 mm).

One FMC product does not necessarily cover all fibre/cable types mentioned above. For example, several different FMCs products may be required depending on cable diameter/shape.

7.4 Fibre alignment system

– *direct alignment*: The bare fibre is directly aligned by V-groove or capillary tube;
– *secondary alignment*: The fibre is fixed in a structure. These structures are usually cylindrical ferrules. These structures are aligned by means of sleeves, pins or other systems.

7.5 Fibre and ferrule end-face finish

For cylindrical ferrule-based pre-polished fibre stub connectors, the end face of the fibre and the ferrule are prepared in the factory to ensure physical contact between the fibres either with the end faces perpendicular to the fibre axis or with a small angle to the perpendicular. For direct termination the termination process controls the shape of the end of the ferrule to ensure physical contact. For the shape of the end of the ferrules two common cases are found:

1) *physical contact (PC)*: The ferrule end face is polished to a spherical shape in order to obtain a physical contact between the two fibre cores and to improve the transmission performance of the connector. The end-face geometry should meet [IEC 61755-2-1] and the relevant [IEC 61755-3-1], [IEC 61755-3-5] or [IEC 61755-3-7] requirements. The spherical radius is in the range of 5-30 mm and the dome offset should be maximum 50 µm;
2) *angled physical contact (APC)*: This finish is similar to the PC, but in this case the polished end surface of the ferrule is angled with respect to the fibre axis. This solution gives low values of reflected power. Typical angles are 8 or 9 degrees. The end-face geometry should meet [IEC 61755-2-2] and the relevant [IEC 61755-3-2], [IEC 61755-3-6] or [IEC 61755-3-8] requirements. End surface radius is in the range of 5-12 mm and the dome offset should be maximum 50 µm.

Direct alignment connectors do not generally contain a fusion or mechanical splice. The fibre is fixed in the connector plug and the fibre ends are field prepared (normally by cleaving, polishing or using any other surface shaping procedure). Fibres are aligned by means of sleeves, pins or other systems and index matching gel is often applied between the fibres.

7.6 Coupling mechanism

The most common systems for mating together two plugs (or the plug and the socket) are:

– push-pull mechanism;

– screw mechanism;

– bayonet mechanism.

7.7 Compatibility

The FMC should be mechanically interconnectable with the relevant connector specified by [ITU-T L.402], either by an adapter and/or with the use of a convertor.

8 Performance criteria and test methods

The operating temperature ranges in which the connector performance should be guaranteed are from −25°C to +70°C for outdoor applications ("outdoor protected environment") and −10°C to +60°C for indoor applications ("controlled environment").

Although an FMC can be installed on any kind of fibre, in this Recommendation the performance requirements for the single-mode FMC are stated for single-mode fibres, having a mode field diameter in the range from 8.2 µm to 9.6 µm at 1310 nm.

Unless otherwise stated in the individual test details, all single-mode measurements are done at room temperature and should be performed at 1310 nm ± 30 nm, 1550 nm ± 30 nm and 1625 nm ± 25 nm.

NOTE – For some applications, testing at 1625 nm may not be required.

Before starting each test, plugs and adaptors should be cleaned according to manufacturers' instructions.

8.1 Optical performance requirements

8.1.1 Attenuation

Table 8-1 – Attenuation grades

Attenuation grade	Attenuation random mated [IEC 61300-3-34]
Grade A_f	Reserved for future application
Grade B_f	≤ 0.35 dB mean ≤ 0.55 dB max. for > 97% of samples
Grade C_f	≤ 0.4 dB mean ≤ 0.75 dB max. for > 97% of samples

These values are referred to random mating between two randomly selected FMCs of the same type.

8.1.2 Return loss

Table 8-2 – Return loss grades

Return loss grade	Return loss random mated [IEC 61300-3-6]
Grade 1	≥ 60 dB (mated) and ≥ 55 dB (unmated)
Grade 2	≥ 45 dB
Grade 3	≥ 35 dB
Grade 4	≥ 26 dB

These values are referred to random mating between two randomly selected FMCs of the same type.

8.1.3 Wavelength dependence of attenuation [IEC 61300-3-7], method A

The attenuation of a connection with two field installable connectors will be measured:

– light source: broadband light source;
– wavelength range: 1260 nm to 1360 nm (unpolarized light);
– line width: ≤ 0.2 nm;
– wavelength step: ≤ 0.5 nm.

The peak-to-peak variation of the attenuation depends on the attenuation grade and should not exceed the values measured over the wavelength range from 1260 nm to 1360 nm as listed in Table 8-3.

Table 8-3 – Wavelength dependence of attenuation

Attenuation grade	Peak-to-peak variation of attenuation [IEC 61300-3-7]
Grade B_f	≤ 0.3 dB
Grade C_f	≤ 0.5 dB

8.1.4 Change in attenuation [IEC 61300-3-3]

The maximum allowed change in attenuation during the environmental and mechanical tests is given in Tables 8-4 and 8-5. All connections under test are made between FMC connectors.

Table 8-4 – Change in attenuation for pigtails

Max. change in attenuation [IEC 61300-3-3]		
Wavelength (nm)	**During test (dB)**	**After test (dB)**
1310 and 1550	≤ 0.2	≤ 0.2
1625	≤ 0.3	≤ 0.2

Table 8-5 – Change in attenuation for patch cords

Max. change in attenuation [IEC 61300-3-3]		
Wavelength (nm)	**During test (dB)**	**After test (dB)**
1310	≤ 0.5	≤ 0.4
1550	≤ 0.7	≤ 0.4
1625	≤ 1.0	≤ 0.4

8.2 Mechanical and environmental performance requirements

8.2.1 Environmental performance tests

For the environmental performance tests, the FMC should be tested in accordance with Table 8-6. The test assemblies are placed in the climatic test chamber and the test configurations should be clearly stated.

The patch cord test assembly contains two FMC connections plus the necessary cable: two to five metres of cable between connections plus the leads to connect the patch cord to the measurement equipment outside the climatic test chamber.

The pigtail test assembly contains one FMC connection plus a portion of cable: one FMC connection and a portion of the attached cable and leads are inside the chamber. The connector type (FMC or factory-assembled) on the leads also should be reported.

Table 8-6 – Test sample construction for environmental performance tests

	Test sample construction	
	Pigtail and patch cord	**Pigtail**
Cable type used	Aramid yarn reinforced fibre cables according to simplex circular cable in [IEC 60794-2-50]	Primary and secondary coated fibre Aramid yarn reinforced fibre cables Rectangular cables

8.2.1.1 Dry heat [IEC 61300-2-18]

– temperature: 60°C (for indoor applications) or 70°C (for outdoor applications);

– duration: 96 hours;

– preconditioning and recovery: 2 hours in room temperature condition.

Attenuation and return loss should be monitored before, during with a maximum measurement interval of one hour and after the test. The maximum change in attenuation for pigtails should meet the values listed in Table 8-4. The maximum allowed change in attenuation for patch cords is listed in Table 8-5. The return loss should satisfy the requirement for the specified grade during and after the test.

8.2.1.2 Cold [IEC 61300-2-17]

– temperature: −10°C (for indoor applications) or −25°C (for outdoor applications);

– duration: 96 hours.

– preconditioning and recovery: 2 hours in room temperature condition.

Attenuation and return loss should be monitored before, during with a maximum measurement interval of one hour and after the test. The maximum change in attenuation for pigtails should meet the values listed in Table 8-4. The maximum allowed change in attenuation for patch cords is listed in Table 8-5. The return loss should satisfy the requirement for the specified grade during and after the test.

8.2.1.3 Change of temperature [IEC 61300-2-22]

– high temperature: 60°C (for indoor applications) or 70°C (for outdoor applications);

– low temperature: −10°C (for indoor applications) or −25°C (for outdoor applications);

– duration at extreme temperature: 1 hour;

– temperature rate of change: 1ºC/min;

– number of cycles: 5 (indoor application), 12 (outdoor application);

– preconditioning and recovery: 2 hours in room temperature condition.

Attenuation and return loss should be monitored before, during with a maximum measurement interval of 10 minutes and after the test. The maximum change in attenuation for pigtails should meet the values listed in Table 8-4. The maximum allowed change in attenuation for patch cords is listed in Table 8-5. The return loss should satisfy the requirement for the specified grade during and after the test.

8.2.1.4 Damp heat (steady state) [IEC 61300-2-19]

– high humidity exposure (for indoor applications only);
– temperature: 40°C ± 2°C;
– relative humidity: 93% ± 3%;
– duration: 96 hours;
– preconditioning and recovery: 2 hours in room temperature condition.

Attenuation and return loss should be monitored before, during with a maximum measurement interval of one hour and after the test. The maximum change in attenuation for pigtails should meet the values listed in Table 8-4. The maximum allowed change in attenuation for patch cords is listed in Table 8-5. The return loss should satisfy the requirement for the specified grade during and after the test.

8.2.1.5 Damp heat cyclic test [IEC 61300-2-46]

Change of temperature and humidity cycle profile (for outdoor applications only):

– temperature extremes: +25°C ± 2°C to +55°C ± 2°C;
– relative humidity: > 90% RH;
– duration one cycle: 24 hours;
– number of cycles: 6 cycles.

Attenuation and return loss should be monitored before, during with a maximum measurement interval of 10 minutes and after the test. The maximum change in attenuation for pigtails should meet the values listed in Table 8-4. The maximum allowed change in attenuation for patch cords is listed in Table 8-5. The return loss should satisfy the requirement for the specified grade during and after the test.

8.2.1.6 Dust [IEC 61300-2-27]

Exposure to dust (for outdoor applications only):

– dust type: talc;
– dust particle size: d < 150 µm;
– dust concentration: 10.6 g/m^3± 7.0 g/m^3;
– temperature: 35°C;
– duration: 10 minutes.

The test should be done with mated pairs of connectors which once mated for the initial measurements should not be disconnected until after the completion of the test.

Attenuation and return loss should be measured before and after the test and should meet the requirements in Tables 8-1 and 8-2.

8.2.1.7 Salt mist [IEC 61300-2-26]

Exposure to corrosive atmosphere (for outdoor applications only):

– solution: 5% NaCl with pH between 6.5 and 7.2;
– temperature: 35°C;
– duration: 96 hours.

The test should be done with mated pairs of connectors which once mated for the initial measurements should not be disconnected until after the completion of the test.

Attenuation and return loss should be measured before and after the test and should meet the requirements in Tables 8-1 and 8-2.

8.2.2 Mechanical performance tests

For mechanical performance tests, the FMC should be tested as pigtail.

8.2.2.1 Vibration [IEC 61300-2-1]

The vibration test has the following characteristics:

– frequency range: sweep 10 to 55 to 10 Hz at 1 octave/minute;

– number of cycles (10 to 55 to 10) per axis: 15;

– number of axes: 3, orthogonal;

– vibration amplitude: 0.75 mm (or 1.5 mm peak-to-peak).

The change in attenuation during and after the test should be measured by means of transient loss monitoring at 1550 nm ± 30 nm for single-mode FMC according to [IEC 61300-3-28]. During the test the maximum allowed change in attenuation should be ≤ 0.5 dB. After the test, the maximum allowed change in attenuation should be ≤ 0.2 dB. The return loss should meet the specified grade after the vibration test.

8.2.2.2 Impact [IEC 61300-2-12] method A

The impact test is performed with the following characteristics:

– height: 1.5 m;

– drop surface: concrete floor;

– number of cycles: 5.

The connector will be protected with a dust cap during the test.

Attenuation and return loss should be measured before and after the test and should meet the requirements in Tables 8-1 and 8-2.

8.2.2.3 Strength of the coupling mechanism [IEC 61300-2-6]

The test is performed applying a specified axial load between the plug and the adapter.

The value of the load and the duration of the test are specified according to the specific coupling mechanism and the manufacturer's rating for the specific connector design. The recommended minimum load value is 40 N during 60 seconds.

Attenuation and return loss should be monitored before, during and after the test. During and after the test, the maximum allowed change in attenuation should meet the values listed in Table 8-4 and the return loss should satisfy the requirement for the specified grade.

8.2.2.4 Fibre/cable retention [IEC 61300-2-4]

The test is performed applying an axial load between the cable and the plug.

The load should be:

– 2 N for primary coated fibre;

– 5 N for secondary coated fibre;

– 50 N (indoor) or 70 N (outdoor) for aramid reinforced cables;

– 10 N for cables or tubes without aramid reinforcement.

The load should be applied smoothly and kept constant for a duration of 60 seconds.

Attenuation and return loss should be monitored before, during and after the test. During and after the test, the maximum allowed change in attenuation should meet the values listed in Table 8-4 and the return loss should satisfy the requirement for the specified grade.

8.2.2.5 Torsion [IEC 61300-2-5]

The test is performed applying a torque on the cable at the distance of 25 cm ± 5 cm from the connector; the cable is kept taut by a load of 10 N. In total, 25 torsion cycles of ±180° should be applied.

Attenuation and return loss should be monitored before, during and after the test. During and after the test, the maximum allowed change in attenuation should meet the values listed in Table 8-4 and the return loss should satisfy the requirement for the specified grade.

8.2.2.6 Mechanical endurance [IEC 61300-2-2] measurement conditions B

The test is carried out by connecting 200 times a plug and an adapter (one side of the connector set only in the case of a plug-adapter-plug configuration).

In the event that the change in attenuation increases above or the return loss below the allowable limit, the connector may be cleaned as necessary but not more than 25 times during the course of the test. The measurement at which the cleaning takes place should be discounted from the test results.

Attenuation and return loss should be monitored before, during and after the test. During and after the test, the maximum allowed change in attenuation should meet the values listed in Table 8-4 and the return loss should satisfy the requirement for the specified grade.

8.2.2.7 Bending moment [IEC 61300-2-7]

The test is performed applying a load of 10 N for 10 seconds in the middle of a connection.

Attenuation and return loss should be monitored before, during and after the test. During and after the test, the maximum allowed change in attenuation should meet the values listed in Table 8-4 and the return loss should satisfy the requirement for the specified grade.

8.2.2.8 Fibre optic connector proof test 90° [IEC 61300-2-50]

This test is not applicable for FMC without a strain relief boot.

The test is performed by applying a load on the fibre or cable at the distance of 20 cm from the connector. The load should be:

– 5 N for secondary coated fibre;

– 5 N for cables or tubes without aramid reinforcement;

– 25 N for aramid yarn reinforced cable.

The load should be applied smoothly at 90° to the connector axis and kept constant for a duration of 5 seconds.

Attenuation and return loss should be monitored before and after the test. After the test, the maximum allowed change in attenuation should be ≤ 0.2 dB and the return loss should satisfy the requirement for the specified grade.

8.2.2.9 Assembly and disassembly [IEC 61300-2-33]

This requirement is only applicable to FMC that can be disassembled and re-assembled. The test is carried out by assembling and disassembling a plug or socket to the cable for at least three times.

The connector may be cleaned and the cable may be cut at each installation. No ageing cycle is done between the installations.

Attenuation and return loss should be measured after each installation and should meet the requirements in Tables 8-1 and 8-2.

9 Connector identification

It is important to be able to distinguish cable assemblies by their characteristics such as assembly type, fibre and cable type, polishing type, attenuation and return loss grades.

While no complete international standard is approved at this time, the general trend is to colour code the plastic body connectors to distinguish the PC type from the APC type independently of the attenuation and return loss performance.

A blue colour is used for single-mode FMC (PC type).

A green colour is used for single-mode FMC (APC type).

As an alternative means, labels may be applied for connector type/class/grade identification, as it is independent on regional differences in colour code conventions. Especially for metallic body connectors, this may be a good alternative.

In any case, an appropriate identification system is to be agreed between the customer and the supplier.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	**Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant**
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2017