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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Small count optical fibre cables for indoor applications

ITU-T Recommendation L.67

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Small count optical fibre cables for indoor applications

Summary

This Recommendation describes the characteristics, construction and test methods of small count optical fibre cables for indoor applications. Indoor optical fibre cables that contain three or more fibres have been described in ITU-T Recommendation L.59. This Recommendation deals with small count optical fibre cable that contains one or two optical fibre(s). First, we describe the cable characteristics that are required if an optical fibre is to demonstrate sufficient levels of performance. Then, a method is described for examining whether a cable has the required characteristics. The required conditions may differ according to the installation environment. Therefore, detailed test conditions of experiments must be agreed between a user and a supplier on the basis of the environment in which a cable is to be used.

Source

ITU-T Recommendation L.67 was approved on 29 October 2006 by ITU-T Study Group 6 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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NOTE

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

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Small count optical fibre cables for indoor applications

1 Scope

This Recommendation:

– refers to small count (one or two) optical fibre cables to be used for telecommunications networks in buildings and houses;

– deals with mechanical and environmental characteristics of these small count optical fibre cables. The optical fibre dimensional and transmission characteristics, together with their test methods, should comply with [IEC 60793-2-10], [ITU-T G.652], [ITU-T G.653], [ITU-T G.654], [ITU-T G.655] and [ITU-T G.656], which deal with a multi-mode graded index optical fibre and single-mode optical fibres respectively;

– deals with fundamental considerations related to optical fibre cable from mechanical and environmental points of view;

– acknowledges that some optical fibre cables may contain metallic elements, for which reference should be made to the manual *Outside plant technologies for public networks* (see [ITU-T L.1]), and other L-series Recommendations;

– recommends that an optical fibre cable should be provided with cable end-sealing and protection during cable delivery and storage, as is common for metallic cables. If splicing components have been factory installed they should be adequately protected.

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; 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.650.1] ITU-T Recommendation G.650.1 (2004), *Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable*.

[ITU-T G.651] ITU-T Recommendation G.651 (1998), *Characteristics of a 50/125 µm multimode graded index optical fibre cable*.

[ITU-T G.652] ITU-T Recommendation G.652 (2005), *Characteristics of a single-mode optical fibre and cable.*

[ITU-T G.653] ITU-T Recommendation G.653 (2006), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.

[ITU-T G.654] ITU-T Recommendation G.654 (2006), *Characteristics of a cut-off shifted single-mode optical fibre and cable*.

[ITU-T G.655] ITU-T Recommendation G.655 (2006), *Characteristics of a non-zero dipersion-shifted single-mode optical fibre and cable*.

[ITU-T G.656] ITU-T Recommendation G.656 (2006), *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport.*

[ITU-T L.1] ITU-T Recommendation L.1 (1988), *Construction, installation and protection of telecommunication cables in public networks*.

[ITU-T L.46] ITU-T Recommendation L.46 (2000), *Protection of telecommunication cables and plant from biological attack*.

[IEC 60189-1] IEC 60189-1 (2007), *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*.

[IEC 60332-1-1] IEC 60332-1-1 (2004), *Tests on electric and optical fibre cables under fire conditions – Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus*.

[IEC 60332-3-24] IEC 60332-3-24 (2000), *Tests on electric cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C*.

[IEC 60754-1] IEC 60754-1 (1994), *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the amount of halogen acid gas*.

[IEC 60754-2] IEC 60754-2 (1991), *Test on gases evolved during combustion of electric cables – Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*.

[IEC 60793-1-1] IEC 60793-1-1 (2002), *Optical fibres – Part 1-1: General and guidance*.

[IEC 60793-1-32] IEC 60793-1-32 (2001), *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*.

[IEC 60793-2-10] IEC 60793-2-10 (2007), *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*.

[IEC 60794-1-1] IEC 60794-1-1 (2001), *Optical fibre cables – Part 1-1: Generic specification – General*.

[IEC 60794-1-2] IEC 60794-1-2 (2003), *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*.

[IEC 60794-2] IEC 60794-2 (2002), *Optical fibre cables – Part 2: Indoor cables – Sectional specification*.

[IEC 60794-2-10] IEC 60794-2-10 (2003), *Optical fibre cables – Part 2-10: Indoor cables – Family specification for simplex and duplex cables*.

[IEC 61034-1] IEC 61034-1 (2005), *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*.

[IEC 61034-2] IEC 61034-2 (2005), *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*.

3 Definitions

For the purpose of this Recommendation, the definitions given in [ITU-T G.650.1], [ITU-T G.650.2] and [ITU-T G.651] apply.

4 Abbreviations and acronyms

None.

5 Characteristics of optical fibres and cables

5.1 Optical fibres

Optical fibres described in [IEC 60793-2-10], [ITU-T G.652], [ITU-T G.653], [ITU-T G.654], [ITU-T G.655] and [ITU-T G.656] should be used.

5.2 Mechanical characteristics

If mechanical forces (e.g., expanding, buckling, bending, torsion, crush and kink) are applied, they may affect the performance of a fibre and a cable. This clause describes the relations between typical mechanical forces and cable performance.

5.2.1 Bending

Cable bending during installation and operation may impose strain on fibres and this may affect fibre strength. Bending also causes a loss increase. Therefore, when designing a tensile member or limiting the installation conditions, the cable bending radius must be kept large enough to avoid any loss increase or fibre lifetime degradation.

5.2.2 Tensile strength

Optical fibre cable is subjected to short-term loading during manufacture and installation and may be affected by continuous static loading and/or cyclic loading during operation (e.g., temperature variation). Changes to the cable tension as a result of the various factors encountered by a cable during its service life can cause the differential movement of the cable components. This effect needs to be considered in the cable design. Excessive cable tensile loading increases the optical loss and may cause increased residual strain in the fibre if the cable cannot relax. To avoid this, the maximum tensile strength determined by the cable construction, especially as regards the design of the strength member, should not be exceeded.

NOTE – Where a cable is subjected to permanent loading during its operational life, the fibre should preferably not experience additional strain.

5.2.3 Crushing and impact

The cable may be subjected to crushing and impact both during its installation and operational life.

This crushing and impact may increase the optical loss (permanently or during the time the stress is applied) and excessive stress may lead to fibre fracture.

5.2.4 Torsion

Under the dynamic conditions encountered during installation and operation, the cable may be subjected to torsion, resulting in residual strain in the fibres and/or sheath damage. Should this be the case, the cable design should allow a specified number of cable twists per unit length without any increase in fibre loss and/or sheath damage.

5.3 Environmental conditions

The environmental conditions experienced by indoor cables may be less severe than those encountered by outdoor cables. However, the conditions may differ depending on the building. Therefore, if the environmental conditions are not clear, it is recommended that the same requirements be applied as those used for outdoor cables.

5.3.1 Temperature variations

During their operational lifetime, cables may be subjected to severe temperature variations. Under such conditions, the increase in fibre attenuation shall not exceed the specified limits.

5.3.2 Biotic damage

The small size of an optical fibre cable makes it vulnerable to rodent attack. Where rodents cannot be excluded, suitable and effective protection should be used. Further information is provided in [ITU-T L.46].

Effective protection can be provided by metallic barriers (steel tape or wire armouring), or non-metallic barriers (e.g., fibreglass rods, glass yarns/tapes).

5.3.3 Vibration

In buildings, it is assumed that there are various kinds of vibrations caused by such factors as construction, generators and elevators. Usually, cable elements are held in place by friction. Vibrations may cause this friction to decrease. This in turn may cause cable elements to move, thus affecting the transmission or mechanical characteristics of the cables. The effects may be harsher when optical fibre cables are installed on a vertical pathway. Therefore, cables should be able to withstand these vibrations without failure or signal degradation. Care should be exercised, however, in the choice of installation method.

5.4 Fire safety

Fire safety is an important problem in buildings and houses. There are two major issues. The first is that the cables and cable elements should have flame retardant characteristics. The second is that the cables and cable elements should not generate toxic gases or smoke when burning. Fire performance requirements may differ from country to country. Optical cables for indoor applications should comply with the fire safety regulations of each country or telecommunication carrier.

6 Cable construction

6.1 Fibre protection

6.1.1 Fibre primary coating

Primary coated fibres must comply with relevant G.650-series of ITU-T Recommendations.

6.1.2 Buffered fibre

When using a tight or semi-tight buffer (loosely applied), the following items should be requested:

– A tight buffer should be easily removable over a length of 15 to 25 mm for fibre splicing.

– A semi-tight buffer should be easily removable over a length of 300 to 2000 mm for fibre splicing.

– With a tight buffer, the nominal diameter should be between 300 and 1000 µm, based on an agreement between the user and supplier. The tolerance should be ±100 µm.

– With a semi-tight buffer, the nominal diameter should be between 300 and 1300 µm, based on an agreement between the user and supplier. The tolerance should be ±100 µm.

6.1.3 Further protection

When a buffered fibre requires further protection, a sheath that includes one or two non-metallic strength members can be used. The sheath should be made of a suitable material.

6.2 Cable element

The make-up of the cable, in particular the number of fibres, the methods used for their protection and identification and the location of strength members should be clearly defined.

6.2.1 Tube

A tube construction is used for packaging one or two optical fibre(s). The tube may contain filling material. A composite wall can be used for reinforcement.

6.2.2 Strength and anti-buckling member

The strength member should be designed so that it does not exceed fibre strain levels under installation and service conditions agreed between the customer and supplier. An anti-buckling member can be used to prevent a cable from buckling as a result of changes in environmental conditions (mainly temperature). The strength and anti-buckling members may be either metallic or non-metallic.

6.3 Sheath

The cable core shall be covered with a sheath or sheaths suitable for the relevant environmental and mechanical conditions associated with storage, installation and operation. The sheath may be of a composite construction and may include strength members.

Considerations as regards the sheaths for optical fibre cables are generally the same as for metallic conductor cables. Consideration should also be given to the amount of hydrogen generated from a metallic moisture barrier. The minimum acceptable thickness of the sheath should be stated, together with any maximum and minimum allowable overall diameter for the cable.

The selection of the sheath material is an important issue in terms of satisfying fire safety requirements. Polyethylene is widely used as a cable sheath material. However, it may not be suitable for indoor cables from the viewpoint of fire safety.

6.4 Cable identification

Embossing, sintering, imprinting, hot foil or surface printing can be used to identify cables by agreement between the user and supplier.

7 Test methods

NOTE – In this clause, if the word (optional) follows the test title, it means that those tests are not mandatory.

7.1 Test methods for cable elements

7.1.1 Tests applicable to optical fibres

This clause describes optical fibre test methods related to splicing. Methods for testing the mechanical and optical characteristics of optical fibres are described in [ITU-T G.650.1] and [ITU-T G.651] and in the IEC 60793-1 series.

7.1.1.1 Dimensions

[IEC 60189-1] shall be used for measuring buffered fibres, tubes and cable diameters. This method can be employed to measure the thickness of a cable sheath.

7.1.1.2 Coating strippability

[IEC 60793-1-32] shall be used for measuring the strippability of primary or secondary fibre coatings.

7.1.1.3 Compatibility with filling material

When fibres contact a filling material, the stability of the fibre coating and the filling material should be examined by tests after accelerated aging.

The stability of the coating stripping force shall be tested in accordance with method IEC 60794-1-2 E5.

Dimension stability and coating transmissivity should be examined by using a test method agreed upon by the user and supplier.

7.1.2 Tests applicable to tubes

7.1.2.1 Tube kink

IEC 60794-1-2 G7 shall be used for measuring the kink characteristics of a tube.

7.2 Test methods for mechanical characteristics of cable

This clause recommends appropriate tests and test methods for verifying the mechanical characteristics of optical fibre cables. For test methods, reference shall be made to the IEC 60794-1 series.

7.2.1 Tensile strength (optional)

This test method applies to optical fibre cables installed under all environmental conditions.

Measurements are made to examine the behaviour of the fibre attenuation as a function of the load on a cable during installation.

The test should be carried out in accordance with method IEC 60794-1-2 E1A.

The amount of mechanical decoupling of the fibre and cable can be determined by measuring the fibre elongation with optical phase shift test equipment, together with cable elongation.

This method may be non-destructive if the tension applied is within the operational values.

Test conditions should be identical to those of IEC 60794-2-10.

7.2.2 Bending

This test method applies to optical fibre cables installed under all environmental conditions.

The purpose of this test is to determine the ability of optical fibre cables to withstand bending around a pulley, simulated by a test mandrel.

This test shall be carried out in accordance with method IEC 60794-1-2 E11A.

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.3 Flexing (optional)

This test method applies to optical fibre cables installed under all environmental conditions.

This test should be carried out in accordance with method IEC 60794-1-2 E8.

The test conditions should be identical to those of [IEC 60794-2-10].

7.2.4 Crushing

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with method IEC 60794-1-2 E3.

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.5 Torsion (optional)

This test method applies to optical fibre cables installed under all environmental conditions.

This test should be carried out in accordance with method IEC 60794-1-2 E7.

The test conditions should be identical to those of [IEC 60794-2-10].

7.2.6 Impact

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with method IEC 60794-1-2 E4.

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.7 Kink (optional)

This test method applies to optical fibre cables installed under all environmental conditions.

This test should be carried out in accordance with method IEC 60794-1-2 E10.

The test conditions should be identical to those of [IEC 60794-2-10].

7.2.8 Repeated bending

This test shall be carried out in accordance with method IEC 60794-1-2 E6.

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.9 Repeated bending at low temperature (optional)

This test should be carried out in accordance with method IEC 60794-1-2 E11A.

The test conditions should be identical to those of [IEC 60794-2-10].

7.3 Test methods for environmental characteristics

This clause recommends appropriate tests and test methods for verifying the environmental characteristics of optical fibre cables.

7.3.1 Temperature cycling

This test method applies to optical fibre cables installed under all environmental conditions.

Testing involves temperature cycling to determine the stability of the attenuation of a cable in the presence of ambient temperature changes that may occur during storage, transportation and operation.

This test shall be carried out in accordance with method IEC 60794-1-2 F1.

7.3.2 Vibration (optional)

This subject needs further study.

7.4 Test methods for fire safety

This clause recommends appropriate tests and test methods for verifying the fire safety characteristics of optical fibre cables.

7.4.1 Flame retardant characteristics

This test shall be carried out in accordance with method IEC 60332-1-1 or IEC 60332-3-24, unless there is an agreement between the manufacturer and user.

7.4.2 Toxic gases characteristics

This test shall be carried out in accordance with method IEC 60754-1 or IEC 60754-2, unless there is an agreement between the manufacturer and user.

7.4.3 Smoke characteristics

This test shall be carried out in accordance with method IEC 61034-1 or IEC 61034-2, unless there is an agreement between the manufacturer and user.

Appendix I

Japanese experience – Construction of small count optical fibre cables for indoor applications

(This appendix does not form an integral part of this Recommendation)

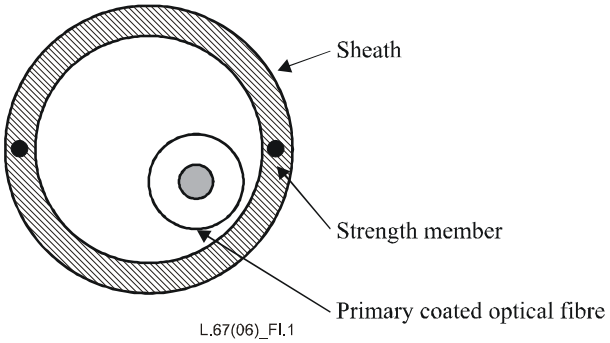

Figure I.1 – Simplex loose non-buffered optical fibre cable

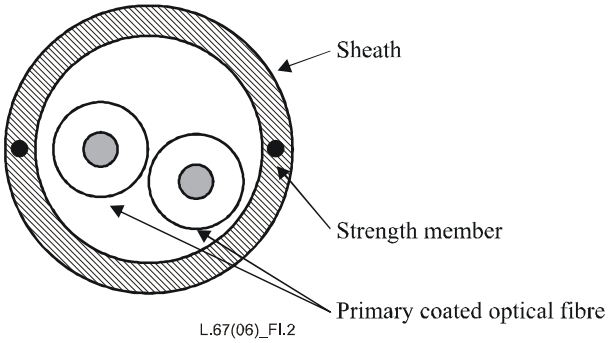

Figure I.2 – Duplex loose non-buffered optical fibre cable

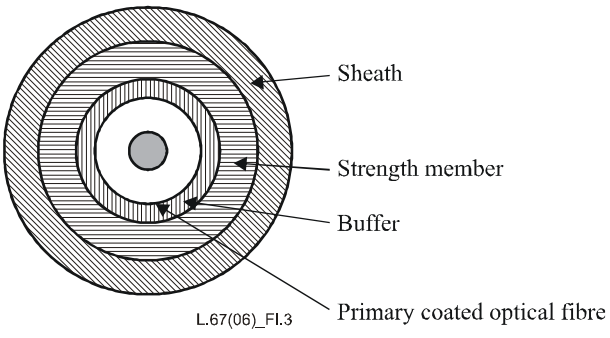

Figure I.3 – Simplex ruggedized optical fibre cable

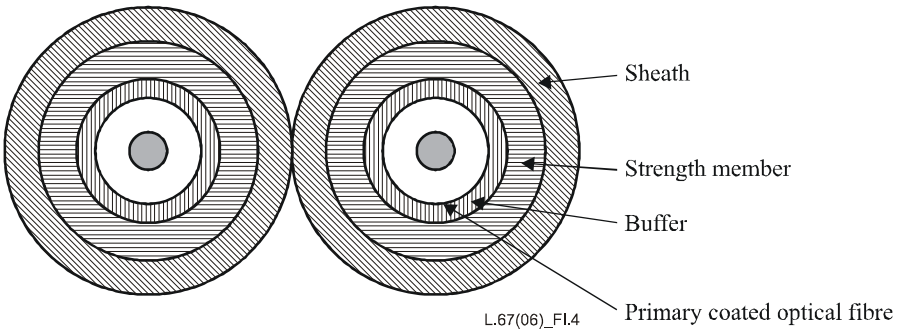

Figure I.4 – Duplex ruggedized optical fibre cable

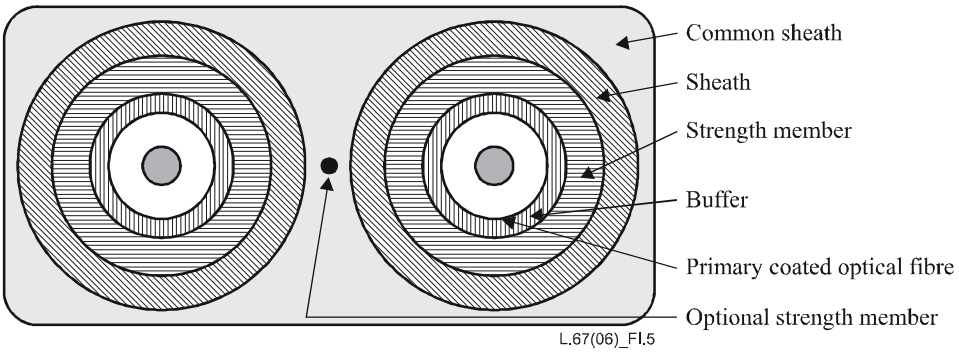

Figure I.5 – Duplex flat optical fibre cable

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[b-ITU-T Handbook] ITU-T Handbook (1994), *Construction, installation, jointing and protection of optical fibre cables*.

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