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CONSTRUCTION, INSTALLATION AND PROTECTION
OF CABLES AND OTHER ELEMENTS OF OUTSIDE
PLANT

Optical fibre cables – Cable structure and characteristics

Optical fibre cables for in-home applications

Recommendation ITU-T L.111

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**

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Recommendation ITU-T L.111

Optical fibre cables for in-home applications

Summary

Recommendation ITU-T L.111 aims to provide the requirements of optical fibre cables for in-home applications. Compared to requirements of optical fibre cables in traditional "indoor" applications, the requirements of cables in "in-home" applications have their own specialized characteristics. This Recommendation describes characteristics, cable construction and test methods of optical cables with minimum visibility for in-home applications.

History

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Introduction

In recent years, fibre to the home (FTTH) has been developing rapidly in many areas of the world. More and more homes have been accessed by the optical network instead of the copper wire network. With this background, a new type of optical fibre cable application environment, which can be called "in-home applications" has emerged. The "in-home" applications particularly refer to optical fibre cable applications inside household living spaces that are also referred to as "indoor living units" (ILU). These new applications are significant for the further development of FTTH, fibre to the room (FTTR) and fibre to the desk (FTTD).

Recommendation ITU-T L.111

Optical fibre cables for in-home applications

1 Scope

This Recommendation:

- refers to optical fibre cables with minimum visibility to be used for telecommunications access networks in the household living spaces of end users;
- covers mechanical and environmental characteristics of optical fibre cable for in-home applications;
- focuses on characteristics of the optical fibre cables that are related to in-home environment harmonization.

The optical fibre cables described in [ITU-T L.103], [ITU-T L.104] and [ITU-T L.105] may also be used in relevant environments, which are not included in this Recommendation.

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.657] | Recommendation ITU-T G.657 (2016), <i>Characteristics of a bending-loss insensitive single-mode optical fibre and cable.</i> |
| [ITU-T L.103] | Recommendation ITU-T L.103 (2016), <i>Optical fibre cables for indoor applications.</i> |
| [ITU-T L.104] | Recommendation ITU-T L.104/L.67 (2006), <i>Small count optical fibre cables for indoor applications.</i> |
| [ITU-T L.105] | Recommendation ITU-T L.105/L.87 (2010), <i>Optical fibre cables for drop applications.</i> |
| [ITU-T L.404] | Recommendation ITU-T L.404 (2017), <i>Field mountable single-mode optical fibre connectors.</i> |
| [IEC 60793-1-1] | IEC 60793-1-1:2017, <i>Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance.</i> |
| [IEC 60793-1-21] | IEC 60793-1-21:2001, <i>Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry.</i> |
| [IEC 60793-1-31] | IEC 60793-1-31:2019, <i>Optical fibres – Part 1-31: Measurement methods and test procedures – Tensile strength.</i> |
| [IEC 60793-1-32] | IEC 60793-1-32:2018, <i>Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability.</i> |
| [IEC 60793-2-50] | IEC 60793-2-50:2018, <i>Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres.</i> |

[IEC 60794-1-1]	IEC 60794-1-1:2015, <i>Optical fibre cables – Part 1-1: Generic specification – General.</i>
[IEC 60794-1-2]	IEC 60794-1-2:2017, <i>Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance.</i>
[IEC 60794-1-21]	IEC 60794-1-21:2015, <i>Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical tests methods.</i>
[IEC 60794-1-22]	IEC 60794-1-22:2017, <i>Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental test methods.</i>
[IEC 60794-2]	IEC 60794-2:2017, <i>Optical fibre cables – Part 2: Indoor cables – Sectional specification.</i>

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FDH	Fibre Distribution Hub
FR	Flame Retardant
FTTD	Fibre to The Desk
FTTH	Fibre to The Home
FTTR	Fibre to The Room
ILU	Indoor Living Unit
LSZH	Low Smoke Zero Halogen
MDU	Multi-dwelling Unit
NID	Network Interface Device
POE	Point Of Entry
SFU	Single Family Unit

5 Conventions

None.

6 Characteristics of optical fibres and cables

6.1 Optical characteristics

6.1.1 Transmission characteristics

The typical transmission characteristics are described in the appropriate Recommendations. Unless specified otherwise by the users of the Recommendations, optical fibres and transmission characteristics should comply with [ITU-T G.657].

6.1.2 Fibre microbending

Extreme bending of an optical fibre, involving local axial displacement of a few micrometres over short distances caused by localized lateral forces along its length, is called microbending. This may be caused in cabled fibres by manufacturing and installation strains, as well as dimensional variations of cable materials due to temperature changes during operation. Microbending can cause an increase in optical loss. In order to reduce microbending loss, stresses randomly applied to a fibre along its axis should be minimized during the incorporation of the fibres into the cable, as well as during and after cable installation.

6.1.3 Fibre macrobending

Macrobending is the curvature of an optical fibre resulting after cable manufacturing and installation. Macrobending may cause an increase in optical loss. Optical loss increases if the bending radius is too small.

6.2 Mechanical characteristics

6.2.1 Bending

Cable bending during installation and operation may impose strain on fibres. This may affect fibres strength and lifetime and cause increased losses. Therefore, when designing cables and accessories for installation, the cable bending radius should be kept large enough to avoid damage to the fibre and excessive losses. When installed in and into household living spaces, the cables may have numerous bends with small radius. The minimum cable bending radius and the number of turns should be designed to minimize cable loss and maintain mechanical fibre reliability, which is ensured in accordance with operators' policy, see [b-ITU-T G-Sup.59] for further information.

The bending test should be performed according to Annex A.

6.2.2 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). Proper installation methods should be used to reduce tensile forces on optical fibre cables during installation and operation. With proper installations, the tensile forces applied on cables for in-home applications can be sufficiently small, and the cables may need not to have intentional strength members. In this condition, the fibres may temporarily bear most of the applied forces during the installation, and care should be taken to avoid fibre damage during installation. Fibre reliability should also be considered, see [b-ITU-T G-Sup.59] for further information.

The tensile strength test should be performed according to Annex A.

6.2.3 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. The cable design should allow a specified number of cable twists per unit length without exceeding a level of specific limits for loss increase and/or any damage to the cable.

The torsion test should be performed according to Annex A.

6.2.4 Crush

The cable may be subjected to crush during its installation and operational life. This crush may increase optical loss (permanently or for the duration of crush applied) and excessive stress may break the fibre. The optical fibre cables for in-home applications may not have a sufficient protection layer for minimum visibility.

Proper pathways in the living space should be chosen to install the optical cable to reduce the chance of crush during its lifetime.

The crush test should be performed according to Annex A.

6.2.5 Impact

The cable may be subjected to impact during its installation and operational life. This impact may increase optical loss (permanently or for the duration of the impact applied) and excessive stress may break the fibre. Optical fibre cables for in-home applications may not have a sufficient protection layer for minimum visibility.

Proper pathways in the living space should be chosen to install the optical cable to reduce the chance of impact during its lifetime. A small impact may leave an imprint in the cable sheath without causing excess loss. However, the integrity of the cable sheath should not be compromised.

The impact test should be performed according to Annex A.

6.2.6 Kink

The cable may be subjected to kink during installation. The kink test should be performed according to Annex A.

6.2.7 Vibration

The possibility of vibration for the in-home environment may be neglected. If the vibration is considered, cables should be able to withstand these vibrations without failure or signal degradation. Care should be exercised in the choice of installation method.

6.3 Environmental characteristics

6.3.1 Temperature variations

When the cable is subjected to temperature variations for operation, the increase in fibre attenuation should not exceed the specified limits. The environmental conditions experienced by optical fibre cables for in-home applications are weather-protected, and partly temperature-controlled. The normal temperature range shown in Table 1 should be considered.

The conditions may differ depending on the users' environment. The locations of connections between in-home cables and other cables may be placed in uncontrolled environments such as corridors and outside passages. In such cases, the extended temperature range should be agreed between the customers and manufacturers.

Testing of the response to temperature variations should be performed according to Annex A.

Table 1 – Temperature variations of optical fibre cable for in-home applications

Temperature range (°C)	
Lower temperature (T _A)	Higher temperature (T _B)
–10	+60

6.3.2 Biotic damage

The cable may be subjected to rodent attack during operational life. Rodent attack may cause fibre fracture. The optical fibre cables for in-home applications may not have a sufficient anti-rodent protection layer for minimum visibility. Proper pathways in the living space should be chosen to install the optical cable and reduce the chance of rodent attack during its lifetime.

6.3.3 Fire safety

Fire safety is an important problem in homes. There are two major issues. The first is that the cables and cable elements should be difficult to burn. In other words, 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 in-home applications should meet fire safety regulations in each country and in accordance with each telecommunication carrier.

7 Cable construction

7.1 Fibre coatings

7.1.1 Primary coating

For harmonization with in-home environments, the primary coating is recommended to be colourless (transparent).

Primary-coated fibres should comply with relevant optical fibre specifications in [IEC 60793-2-50].

7.1.2 Secondary coating

If a secondary coating is used, it should comply with the requirements given in [IEC 60794-2]. For in-home applications, the secondary coating can be the outmost protection layer of the optical fibre cable. For harmonization with in-home environments, the secondary coating is recommended to be uncoloured or a colour which is neutral in order to blend into the building interior.

NOTE – The mechanical characteristics should be considered under the conditions of fibre splicing, installation and assembling field mountable connectors [ITU-T L.404] using secondary coating to avoid high fibre stress.

7.2 Cable element

The optical fibre cables for in-home applications may or may not have cable elements such as tubes, strength members and sheaths for minimum visibility. If cable elements are used for their protection and for packaging more than one fibre, the cable construction and materials should be agreed between the customer and manufacturer.

7.3 Limitation of hazardous substances in materials

Cable materials for in-home applications as well as cable attaching materials to the wall should be non-noxious and harmless to human health. Restriction on hazardous substances may differ from country to country. Optical cables for in-home applications should meet hazardous substances regulations in each country and in accordance with each telecommunication carrier.