

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

L.59

(01/2008)

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

Optical fibre cables for indoor applications

Recommendation ITU-T L.59

Recommendation ITU-T L.59

Optical fibre cables for indoor applications

Summary

Recommendation ITU-T L.59 describes characteristics, construction and test methods for optical fibre cables for indoor applications. In order for an optical fibre to perform appropriately, characteristics that a cable should have are described. Also, the method of determining whether or not the cable has the required characteristics is described. Required conditions may differ according to the installation environment; detailed test conditions need to be agreed upon between a user and a manufacturer for the environment where a cable is to be used.

Source

Recommendation ITU-T L.59 was approved on 8 January 2008 by ITU-T Study Group 6 (2005-2008) under Recommendation ITU-T A.8 procedure.

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/>.

© ITU 2009

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

CONTENTS

Page

1	Scope	1
2	References.....	1
3	Terms and definitions	3
4	Abbreviations and acronyms	3
5	Characteristics of optical fibres and cables	3
5.1	Optical fibre characteristics.....	3
5.2	Mechanical characteristics.....	4
5.3	Environmental conditions.....	5
5.4	Fire safety	6
6	Cable construction	6
6.1	Fibre coatings	6
6.2	Cable element	7
6.3	Sheath	8
6.4	Identification of cable.....	8
7	Test methods.....	8
7.1	Test methods for cable element.....	8
7.2	Test methods for mechanical characteristics of the cable	9
7.3	Test methods for environmental characteristics	11
7.4	Test methods for fire safety	11
	Appendix I – Overview on IEC specifications for indoor optical fibre cable	12
	Appendix II – Indoor cable pathway (Japanese experience) Indoor pathway systems for optical fibre cables.....	13
II.1	General	13
II.2	Vertical cable pathway systems.....	13
II.3	Horizontal cable pathway systems	14
II.4	Pathway systems facilities.....	16
	Appendix III – Indoor cable specification (Chinese experience)	23
III.1	Fibre attenuation.....	23
III.2	Mechanical characteristics.....	23
III.3	Environmental conditions.....	24
III.4	Test methods for mechanical characteristics of the cable	24
III.5	Test methods for environmental characteristics	25
	Bibliography.....	26

Copyright © 2008 ITU-T. All rights reserved.

Recommendation ITU-T L.59

Optical fibre cables for indoor applications

1 Scope

This Recommendation:

- refers to multimode graded index and single-mode optical fibre cables to be used for telecommunication networks within buildings;
- deals with mechanical and environmental characteristics of the optical fibre cables concerned. The optical fibre dimensional and transmission characteristics, together with their test methods, should comply with [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], which describe single-mode optical fibres, and [ITU-T G.651.1] and [IEC 60793-2-10], which describe multimode graded index optical fibres;
- deals with fundamental considerations related to optical fibre cable from mechanical and environmental aspects;
- acknowledges that some optical fibre cables may contain metallic elements, for which reference should be made to [b-ITU-T handbook] (see [ITU-T L.1]), and other ITU-T 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;
- recommends that pulling devices may be fitted to the end of the cable if required.

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] Recommendation ITU-T G.650.1 (2004), *Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable*.
- [ITU-T G.650.2] Recommendation ITU-T G.650.2 (2007), *Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable*.
- [ITU-T G.651.1] Recommendation ITU-T G.651.1 (2007), *Characteristics of a 50/125 μm multimode graded index optical fibre cable for the optical access network*.
- [ITU-T G.652] Recommendation ITU-T G.652 (2005), *Characteristics of a single-mode optical fibre and cable*.
- [ITU-T G.653] Recommendation ITU-T G.653 (2006), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.
- [ITU-T G.654] Recommendation ITU-T G.654 (2006), *Characteristics of a cut-off shifted single-mode optical fibre and cable*.

- [ITU-T G.655] Recommendation ITU-T G.655 (2006), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable.*
- [ITU-T G.656] Recommendation ITU-T G.656 (2006), *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport.*
- [ITU-T G.657] Recommendation ITU-T G.657 (2006), *Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network.*
- [ITU-T L.1] Recommendation ITU-T L.1 (1988), *Construction, installation and protection of telecommunication cables in public networks.*
- [ITU-T L.46] Recommendation ITU-T 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 method.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/038026>>
- [IEC 60189-2] IEC 60189-2 (2007), *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 2: Cables in pairs, triples, quads and quintuples for inside installations.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/038025>>
- [IEC 60189-3] IEC 60189-3 (2007), *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 3: Equipment wires with solid or stranded conductor wires, PVC insulated, in singles, pairs and triples.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/038024>>
- [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.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/032773>>
- [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.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/026437>>
- [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.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/019243>>
- [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.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/017216>>
- [IEC 60793-1-1] IEC 60793-1-1 (2002), *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/039212>>
- [IEC 60793-1-21] IEC 60793-1-21 (2001), *Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/027868>>
- [IEC 60793-1-32] IEC 60793-1-32 (2001), *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability.*
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/027456>>

- [IEC 60793-2-10] IEC 60793-2-10 (2007), *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/038047>>
- [IEC 60794-1-1] IEC 60794-1-1 (2001), *Optical fibre cables – Part 1-1: Generic specification – General*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/027459>>
- [IEC 60794-1-2] IEC 60794-1-2 (2003), *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/030610>>
- [IEC 60794-2] IEC 60794-2 (2002), *Optical fibre cables – Part 2: Indoor cables – Sectional specification*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/029611>>
- [IEC 60794-2-20] IEC 60794-2-20 (2003), *Optical fibre cables – Part 2-20: Indoor cables – Family specification for multi-fibre optical distribution cables*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/029688>>
- [IEC 60794-3] IEC 60794-3 (2001), *Optical fibre cables – Part 3: Sectional specification – Outdoor cables*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/027900>>
- [IEC 61034-1] IEC 61034-1 (2005), *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/034053>>
- [IEC 61034-2] IEC 61034-2 (2005), *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*.
<<http://webstore.iec.ch/webstore/webstore.nsf/artnum/034054>>

3 Terms and definitions

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

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

D	Used to denote the diameter of the cable
H	Used to denote the height of the cable
SZ	Reverse oscillating stranding
T _A	Lower bound for temperature range
T _B	Upper bound for temperature range
UV	Ultraviolet ray

5 Characteristics of optical fibres and cables

5.1 Optical fibre characteristics

Optical fibres described in [ITU-T G.651.1], [ITU-T G.652], [ITU-T G.653], [ITU-T G.654], [ITU-T G.655], [ITU-T G.656], [ITU-T G.657] or [IEC 60793-2-10] should be used depending upon users' environmental conditions and technical requirements.

5.1.1 Transmission characteristics

The typical transmission characteristics are described in the appropriate Recommendations on optical fibres.

5.1.2 Fibre microbending

Severe 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 by manufacturing and installation strains and also dimensional variations of cable materials due to temperature changes during its lifetime.

Microbending can cause an increase in optical loss. In order to reduce microbending loss, stresses applied to a fibre randomly and longitudinally should be eliminated when manufacturing, installing and utilizing the cable.

5.1.3 Fibre macrobending

Macrobending is the resulting curvature of an optical fibre after cable manufacture and installation.

Macrobending may cause an increase in optical loss. The optical loss increases if the bending radius is lower than a minimum established limit.

5.1.4 Fibre attenuation

Maximum allowable attenuations are described in each Recommendation of optical fibres. However, if there is a different agreement between a manufacturer and a user, higher values can be allowed.

5.2 Mechanical characteristics

5.2.1 Tensile strength

Optical fibre cable is subject to short-term load during manufacture and installation, and may be affected by continuous static loading and/or cyclic load during operation (e.g., temperature variation). Changes in the tension of the cable due to the variety of factors encountered during the service life of the cable can cause differential movement of the cable components. This effect needs to be considered in the cable design. Excessive cable tensile load may increase 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 the design of the strength member, should not be exceeded.

Therefore, when designing a tensile member, an agreement between a manufacturer and a user on maximum tensile load during storage, installation and operation is required.

NOTE – Where a cable is subject to permanent load during its operational life, it is preferable that the fibre does not experience additional strain.

5.2.2 Bending

Under the dynamic conditions encountered during installation, optical fibre is subject to strain from both cable tension and bending. The strength elements in the cable and the installation bend radius must be selected to limit this combined dynamic strain. Any fibre bend radius remaining after cable installation shall be large enough to limit the macrobending loss or long-term strain reducing the lifetime of the fibre.

The bending test should be performed according to clause 7.2.2. After the test, there shall be no fibre breakage.

5.2.3 Crush

The cable may be subject to crush during both installation and operational life.

The crush may increase the optical loss (permanently, or for the time of application of the stress) and excessive stress may lead to fibre fracture.

Allowable crush load depends strongly upon the cable structure. Therefore, crush load for this test should be agreed between a manufacturer and a user.

The crush test should be performed according to clause 7.2.4. During and after the test, the fibre attenuation coefficient should not change under permanent load. After the test, there shall be no damage to the fibre or the cable elements.

5.2.4 Bending under tension (flexing)

Under dynamic conditions encountered during installation and operation, the cable may be subject to bending under tension (flexing). The bending under tension test should be performed according to clause 7.2.3. After the test, there shall be no fibre breakage.

5.2.5 Torsion

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

Torsion test should be performed according to clause 7.2.5. There shall be no fibre breakage after the test.

5.2.6 Impact

The cable may be subject to impact during both installation and operational life.

The impact may increase the optical loss (permanently, or for the time of application of the stress) and excessive stress may lead to fibre fracture.

The impact test should be performed according to clause 7.2.6. There shall be no fibre breakage and no damage to the cable elements.

5.2.7 Kink

The cable may be subject to kink during installation.

The kink test should be performed according to clause 7.2.7. There shall be no damage to the cable elements after the test.

5.2.8 Repeated bending

The cable may be subject to repeated bending during installation.

The repeated bending test should be performed according to clause 7.2.8. There shall be no fibre breakage after test.

5.3 Environmental conditions

Environmental conditions for indoor cables may not be as severe as those for outdoor cables. Therefore, if environmental conditions are not defined, it is recommended that the same requirements which are used for outdoor cables apply.

5.3.1 Temperature variations

During their operational lifetime, cables may be subject to severe temperature variations. In these conditions, the increase of attenuation of the fibres shall not exceed the specified limits.