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# ITU-T

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# Series G

**Supplement 40**

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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

## Optical fibre and cable Recommendations and standards guideline

ITU-T G-series Recommendations – Supplement 40

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# Supplement 40 to ITU-T G-series Recommendations

## Optical fibre and cable Recommendations and standards guideline


**Summary**

This Supplement provides information on the background and specifications used in the development of optical fibre and cable ITU-T Recommendations such as [ITU-T G.651], [ITU-T G.652], [ITU-T G.653], [ITU-T G.654], [ITU-T G.655], [ITU-T G.656], [ITU-T G.657] and L series. It also contains information used in the development of test method Recommendations such as [ITU-T G.650.1] and [ITU-T G.650.2]. Moreover, this Supplement maps ITU-T documents to optical fibre and cable standards developed under IEC.



**Source**

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## FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. 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.

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# Supplement 40 to ITU-T G-series Recommendations

## Optical fibre and cable Recommendations and standards guideline

### 1 Scope

This fibre guideline aims at providing a road map with regard to the specifications of various kinds of fibres and their test methods, as well as the most important fibre optics hardware which will be very useful for engineers reading the ITU-T Recommendations and other documents to design an optical fibre network. This guideline should also make it easier for readers to correlate the specifications found in the fibre, component, terrestrial system interface, and submarine system Recommendations currently being developed in Questions 5, 7, 6 and 8 of ITU-T Study Group 15, respectively. Moreover, this guideline provides important information for system designs and optical fibre cable installations in relation to, for example, high power limitations and reliability, which is available to optical fibre cable installation suppliers and system designers. This guideline contains:

– Definitions of fibre parameters not specified in current ITU-T fibre Recommendations but very important for practical use.

– Features of existing optical fibre categories and their application areas.

– The relationship between fibre parameters and interface parameters.

– Optical fibre properties for operation and maintenance.

In the appendices, the following items are described for reference:

– Standardization criteria for optical fibres in ITU-T Study Group 15.

– Optical fibre cable structures and constructions.

– Fibre optics hardware and passive components mostly used in the construction of an optical network.

– Comparison of ITU-T Recommendations and IEC documents related to optical fibre specifications and test methods.

In particular, this guideline is prepared concisely by quoting document numbers so as to avoid any overlap with existing ITU-T Recommendations and Handbooks or IEC documents. This guideline would be a very useful desk book for engineers dealing with optical transmission systems.

### 2 References

[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.650.2] ITU-T Recommendation G.650.2 (2005), *Definitions and test methods for statistical and non-linear related 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 dispersion-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 G.657] ITU-T Recommendation G.657 (2006), *Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network*.

[ITU-T G.663] ITU-T Recommendation G.663 (2000), *Application related aspects of optical amplifier devices and subsystems*.

[ITU-T G.664] ITU-T Recommendation G.664 (2006), *Optical safety procedures and requirements for optical transport systems*.

[ITU-T G.671] ITU-T Recommendation G.671 (2005), *Transmission characteristics of optical components and subsystems*.

[ITU-T G.695] ITU-T Recommendation G.695 (2006), *Optical interfaces for coarse wavelength division multiplexing applications*.

[ITU-T G.978] ITU-T Recommendation G.978 (2006), *Characteristics of optical fibre submarine cables*.

[ITU-T G-Sup.39] ITU-T G-series Recommendations – Supplement 39 (2006), *Optical system design and engineering considerations*.

[ITU-T L.10] ITU-T Recommendation L.10 (2002), *Optical fibre cables for duct and tunnel application*.

[ITU-T L.12] ITU-T Recommendation L.12 (2000), *Optical fibre joints*.

[ITU-T L.13] ITU-T Recommendation L.13 (2003), *Performance requirements for passive optical nodes: Sealed closures for outdoor environments*.

[ITU-T L.14] ITU-T Recommendation L.14 (1992), *Measurement method to determine the tensile performance of optical fibre cables under load*.

[ITU-T L.25] ITU-T Recommendation L.25 (1996), *Optical fibre cable network maintenance*.

[ITU-T L.26] ITU-T Recommendation L.26 (2002), *Optical fibre cables for aerial application*.

[ITU-T L.27] ITU-T Recommendation L.27 (1996), *Method for estimating the concentration of hydrogen in optical fibre cables*.

[ITU-T L.28] ITU-T Recommendation L.28 (2002), *External additional protection for marinized terrestrial cables*.

[ITU-T L.29] ITU-T Recommendation L.29 (2002), *As-laid report and maintenance/repair log for marinized terrestrial cable installation*.

[ITU-T L.30] ITU-T Recommendation L.30 (1996), *Markers on marinized terrestrial cables*.

[ITU-T L.31] ITU-T Recommendation L.31 (1996), *Optical fibre attenuators*.

[ITU-T L.36] ITU-T Recommendation L.36 (1998), *Single mode fibre optic connectors*.

[ITU-T L.37] ITU-T Recommendation L.37 (2007), *Optical branching components (non-wavelength selective)*.

[ITU-T L.38] ITU-T Recommendation L.38 (1999), *Use of trenchless techniques for the construction of underground infrastructures for telecommunication cable installation*.

[ITU-T L.40] ITU-T Recommendation L.40 (2000), *Optical fibre outside plant maintenance support, monitoring and testing system*.

[ITU-T L.41] ITU-T Recommendation L.41 (2000), *Maintenance wavelength on fibres carrying signals*.

[ITU-T L.43] ITU-T Recommendation L.43 (2002), *Optical fibre cables for buried application*.

[ITU-T L.45] ITU-T Recommendation L.45 (2000), *Minimizing the effect on the environment from the outside plant in telecommunication networks*.

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

[ITU-T L.48] ITU-T Recommendation L.48 (2003), *Mini-trench installation technique*.

[ITU-T L.49] ITU-T Recommendation L.49 (2003), *Micro-trench installation technique*.

[ITU-T L.50] ITU-T Recommendation L.50 (2003), *Requirements for passive optical nodes: Optical distribution frames for central office environments*.

[ITU-T L.51] ITU-T Recommendation L.51 (2003), *Passive node elements for fibre optic networks – General principles and definitions for characterization and performance evaluation*.

[ITU-T L.52] ITU-T Recommendation L.52 (2003), *Deployment of Passive Optical Networks (PON)*.

[ITU-T L.53] ITU-T Recommendation L.53 (2003), *Optical fibre maintenance criteria for access networks*.

[ITU-T L.54] ITU-T Recommendation L.54 (2004), *Splice closure for marinized terrestrial cables (MTC)*.

[ITU-T L.55] ITU-T Recommendation L.55 (2003), *Digital database for marine cables and pipelines*.

[ITU-T L.56] ITU-T Recommendation L.56 (2003), *Installation of optical fibre cables along railways*.

[ITU-T L.57] ITU-T Recommendation L.57 (2003), *Air-assisted installation of optical fibre cables*.

[ITU-T L.58] ITU-T Recommendation L.58 (2004), *Optical fibre cables: Special needs for access network*.

[ITU-T L.59] ITU-T Recommendation L.59 (2004), *Optical fibre cables for indoor applications*.

[ITU-T L.60] ITU-T Recommendation L.60 (2004), *Construction of optical/metallic hybrid cables*.

[ITU-T L.61] ITU-T Recommendation L.61 (2004), *Optical fibre cable installation by floating technique*.

[ITU-T Handbook] ITU-T Handbook (1994), *Outside plant: construction, installation, jointing and protection of optical fibre cables*.

A lot of IEC documents concerning optical fibre cables and test methods are quoted in this Supplement. The detailed information is omitted in this clause.

## 3 Definitions

### 3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

**3.1.1 alternative test method (ATM)** [ITU-T G.650.1].

**3.1.2 attenuation coefficient** [ITU-T G.651].

**3.1.3 attenuation** [ITU-T G.650.1].

**3.1.4 bandwidth** [ITU-T G.651].

**3.1.5 baseband response** [ITU-T G.651].

**3.1.6 cable cut-off wavelength** [ITU-T G.650.1].

**3.1.7 chromatic dispersion coefficient** [ITU-T G.650.1].

**3.1.8 chromatic dispersion** [ITU-T G.650.1].

**3.1.9 chromatic dispersion slope** [ITU-T G.650.1].

**3.1.10 cladding centre** [ITU-T G.650.1].

**3.1.11 cladding** [ITU-T G.650.1] and [ITU-T G.651].

**3.1.12 cladding diameter** [ITU-T G.650.1].

**3.1.13 cladding diameter deviation** [ITU-T G.650.1].

**3.1.14 cladding mode stripper** [ITU-T G.650.1] and [ITU-T G.651].

**3.1.15 cladding non-circularity** [ITU-T G.650.1].

**3.1.16 cladding tolerance field** [ITU-T G.650.1].

**3.1.17 core (cladding) centre** [ITU-T G.651].

**3.1.18 core (cladding) diameter** [ITU-T G.651].

**3.1.19 core (cladding) non-circularity** [ITU-T G.651].

**3.1.20 core (cladding) tolerance field** [ITU-T G.651].

**3.1.21 core area** [ITU-T G.651].

**3.1.22 core centre** [ITU-T G.650.1].

**3.1.23 core concentricity error** [ITU-T G.650.1].

**3.1.24 core** [ITU-T G.651].

**3.1.25 (core/cladding) concentricity error** [ITU-T G.651].

**3.1.26 cut-off wavelength** [ITU-T G.650.1].

**3.1.27 differential group delay (DGD)** [ITU-T G.650.2].

**3.1.28 dispersion offset** [ITU-T G.650.1].

**3.1.29 elementary cable sections** [ITU-T G.651].

**3.1.30 fibre cut-off wavelength** [ITU-T G.650.1].

**3.1.31 fibre materials** [ITU-T G.651].

**3.1.32 jumper cable cut-off wavelength** [ITU-T G.650.1].

**3.1.33 maximum theoretical numerical aperture** [ITU-T G.651].

**3.1.34 modal distortion bandwidth** [ITU-T G.651].

**3.1.35 mode field centre** [ITU-T G.650.1].

**3.1.36 mode field concentricity error** [ITU-T G.650.1].

**3.1.37 mode field** [ITU-T G.650.1].

**3.1.38 mode field diameter** [ITU-T G.650.1].

**3.1.39 mode field non-circularity** [ITU-T G.650.1].

**3.1.40 mode filter** [ITU-T G.650.1] and [ITU-T G.650].

**3.1.41 mode scrambler** [ITU-T G.651].

**3.1.42 numerical aperture** [ITU-T G.651].

**3.1.43 PMD coefficient** [ITU-T G.650.2].

**3.1.44 PMD delay** [ITU-T G.650.2].

**3.1.45 polarization mode dispersion (PMD)** [ITU-T G.650.2].

**3.1.46 $PMD_Q$** [ITU-T G.650.2].

**3.1.47 primary coating** [ITU-T G.650.1].

**3.1.48 principal states of polarization (PSP)** [ITU-T G.650.2].

**3.1.49 prooftest level** [ITU-T G.650.1].

**3.1.50 protective materials** [ITU-T G.651].

**3.1.51 reference surface** [ITU-T G.651].

**3.1.52 reference test method (RTM)** [ITU-T G.650.1].

**3.1.53 (refractive) index profile** [ITU-T G.651].

**3.1.54 secondary coating** [ITU-T G.650.1].

**3.1.55 source wavelength offset** [ITU-T G.650.1].

**3.1.56 stress corrosion parameter** [ITU-T G.650.1].

**3.1.57 zero-dispersion slope** [ITU-T G.650.1].

**3.1.58 zero-dispersion wavelength** [ITU-T G.650.1].

## 3.2 Terms defined in this Supplement

This Supplement defines the following terms:

**3.2.1 passive (chromatic) dispersion compensator**: A passive component used to compensate the chromatic dispersion of an optical path.

**3.2.2 dispersion compensating fibre (DCF)**: A fibre used to compensate the chromatic dispersion of an optical path.

**3.2.3 dispersion curvature (DC)**: The dispersion curvature is defined as $C(\lambda) = dS(\lambda)/d\lambda$. $S(\lambda)$ denotes the dispersion slope at the wavelength $\lambda$.

**3.2.4 relative dispersion slope (RDS)**: The relative dispersion slope is defined as $RDS = S(\lambda)/D(\lambda)$. $D(\lambda)$ denotes the chromatic dispersion at the wavelength $\lambda$.

**3.2.5 relative dispersion curvature (RDC)**: The relative dispersion curvature is defined as $RDC = C(\lambda)/D(\lambda)$.

## 4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

ATM Alternative Test Method

DC Dispersion Curvature

DCF Dispersion Compensating Fibre

DGD Differential Group Delay

PMD Polarization Mode Dispersion

PSP Principal States of Polarization

RDC Relative Dispersion Curvature

RDS Relative Dispersion Slope

RTM Reference Test Method

SBS Stimulated Brillouin Scattering

## 5 Conventions

None.

## 6 Features of existing optical fibre categories and their application areas

### 6.1 Attenuation properties

Typical attenuation spectrum of G.652 fibre with and without OH absorption loss is given in Appendix I of [ITU-T G.695]. Attenuation uniformity is given in IEC/TS 62033 (Attenuation uniformity in optical fibres).

### 6.2 Dispersion properties

The chromatic dispersion property of G.655 fibre is given in Appendix I of [ITU-T G.655]. The dispersion properties of G.652 and G.655 fibres are given in clause 10.3 of [ITU-T G-Sup.39]. Statistical calculation of chromatic dispersion is given in IEC/TR 61282-7 (Fibre optic communication system design guides – Part 7: Statistical calculation of chromatic dispersion).

### 6.3 Bending properties

For further study.

## 7 Relationship between fibre parameters and interface parameters

### 7.1 Relationship between PMD and DGD

Relationship between $PMD_Q$ and $DGD_{max}$ is given in Appendix I of [ITU-T G.652], [ITU-T G.653], [ITU-T G.654], [ITU-T G.655] and [ITU-T G.656]. The definition of $PMD_Q$ and the calculations of $PMD_Q$ and $DGD_{max}$ are given in Appendix IV of [ITU-T G.650.2]. Relationship between PMD and DGD is given in IEC/TR 61282-3 (Fibre optic communication system design guides – Part 3: Calculation of link polarization mode dispersion).

### 7.2 Transmission limitation due to dispersion properties

Transmission limitation due to dispersion properties is given in clauses 9.2 and 10.3 of [ITU-T G-Sup.39].

## 8 Unspecified fibre parameters and their test methods

The unspecified fibre parameters are defined in Appendix II of [ITU-T G.650.2] and Appendix II of [ITU-T G.663].

### 8.1 Non-linear coefficient

Information of non-linear coefficient is given in Appendix II of [ITU-T G.650.2] and IEC/TR 62285 (Application guide for non-linear coefficient measuring methods).

### 8.2 Effective area $A_{eff}$

Information on effective area is given in Appendix III of [ITU-T G.650.2] (Test methods) and IEC/TR 62284 (Effective area measurements of single-mode optical fibres – Guidance).

### 8.3 Stimulated brillouin scattering (SBS) threshold

Information on stimulated brillouin scattering threshold is given in Appendix II of [ITU-T G.650.2] and Appendix II of [ITU-T G.663].

### 8.4 Raman gain coefficient

Information on Raman gain coefficient is given in Appendix II of [ITU-T G.663] and IEC/TR 62324 (Single-mode optical fibres – Raman gain efficiency measurement using continuous wave method – Guidance).

### 8.5 Microbending loss

Measurement methods of microbending loss are given in IEC 62221 (Optical fibres – Measurement methods – Microbending sensitivity).

## 9 Optical fibre properties for operation and maintenance

See IEC/TR 62000 (Single-mode fibre compatibility guidelines).

### 9.1 Properties of cut-off wavelength under the deployment conditions

This clause contains length dependence of cut-off wavelength and loop diameter dependence of cut-off wavelength.

### 9.2 Properties of chromatic dispersion and polarization mode dispersion

The statistical design of chromatic dispersion is given in clause 10.3 of [ITU-T G-Sup.39].

NOTE – This clause contains the temperature dependence of chromatic and polarization mode dispersions.

### 9.3 Splice loss

Information on splice loss is given in [ITU-T G.651] (Specification of splice loss and connector loss), [ITU-T L.36] (Single mode fibre optic connectors) and [ITU-T L.12] (Optical fibre joints).

### 9.4 Input power limitation and safety aspects

The following documents describe input power limitation and safety aspects.

[ITU-T G.664]: Optical safety procedures and requirements for optical transport systems.

IEC/TR 61292-4: Optical amplifiers – Part 4: Maximum permissible optical power for the damage-free and safe use of optical amplifiers, including Raman amplifiers.

IEC 60825-2: Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS).

## 9.5 Reliability of optical fibre cable

Reliability issues of optical fibre cable are given in [ITU-T L.14] (Measurement method to determine the tensile performance of optical fibre cables under load), [ITU-T L.45] (Minimizing the effect on the environment from the outside plant in telecommunication networks), [ITU-T L.46] (Protection of telecommunication cables and plant from biological attack) and IEC/TR 62048 (Optical fibres – Reliability – Power law theory).

## 9.6 Optical loss properties due to hydrogen

Information on optical loss properties due to hydrogen is given in [ITU-T L.27] (Method for estimating the concentration of hydrogen in optical fibre cables developed under Study Group 15) and IEC 60793-2-50 (Addresses loss increase with time).

## 9.7 Environmental test conditions for fibres

The following documents describe the environmental test conditions for fibres.

IEC 60793-1-50: Optical fibres – Part 1-50: Measurement methods and test procedures – Damp heat (steady state).

IEC 60793-1-51: Optical fibres – Part 1-51: Measurement methods and test procedures – Dry heat.

IEC 60793-1-52: Optical fibres – Part 1-52: Measurement methods and test procedures – Change of temperature.

IEC 60793-1-53: Optical fibres – Part 1-53: Measurement methods and test procedures – Water immersion.

IEC 60793-1-54: Optical fibres – Part 1-54: Measurement methods and test procedures – Gamma irradiation.

## 9.8 Optical fibre cable network maintenance

The following ITU-T Recommendations describe the optical fibre cable network maintenance.

[ITU-T L.25]: Optical fibre cable network maintenance.

[ITU-T L.29]: As-laid report and maintenance/repair log for marinized terrestrial cable installation.

[ITU-T L.40]: Optical fibre outside plant maintenance support, monitoring and testing system.

[ITU-T L.41]: Maintenance wavelength on fibres carrying signals.

[ITU-T L.53]: Optical fibre maintenance criteria for access networks.

# Appendix I

# Standardized criteria

## I.1 Criteria for revising the optical fibre Recommendations

A Recommendation covers a group of fibres which are *approximately* the same in both of the following respects:

1) Primary wavelength region of intended operation.

2) Chromatic dispersion value in the primary wavelength region of intended operation.

Within each Recommendation, the base category should be described in Table 1, while other categories may be described in subsequent tables, including at least two attribute types (fibre and cable) for each table. A third attribute type (links) remains under study.

The fibre Recommendation may include the main parameters of mode field diameter, cut-off wavelength, and chromatic dispersion. The values of these parameters must be broad enough to encompass all of the fibre categories in the Recommendation.

The *base category* (for which the Recommendation was originally created, and which serves as the default category), is described in Table 1. Minor changes in the parameter values of Table 1 may be made from time to time to keep Table 1 aligned with current industry practice.

Further categories, typically based on new fibre parameters, may be created, providing they distinguish implementation variations that support different transmission strategies. The categories shall be designated in the order of their adoption. Several examples, which differ in one or more parameter values, may be given to illustrate each category of fibre. It is expected that there will be a few fibre Recommendations, each containing at most a few categories, with a few examples within each category, all arrived at by consensus on the part of the experts. A brief descriptor must be provided for each category and example, as well as the history of the modification of specification values and revised dates.

## I.2 Guideline for conducting measurement round robins in Question 5 of ITU-T Study Group 15 (Q.5/15)

a) ***Objectives***: ITU-T Q.5/15 round robins should be carried out for completing the content of the test method or fibre parameters described in the G.65x series of ITU-T Recommendations. For example, when determining the RTM and ATM for test methods of a parameter, or when a parameter value is specified in the Recommendation, the round robin is needed. This round robin activity is different from an academic one.

b) ***Coordinators***: In principle, the editor of each Recommendation should coordinate the round robin activity. The responsible editor may appoint a substitute coordinator from ITU-T Q.5/15 members.

c) ***Participants***: The round robin participants are fundamentally limited to only ITU-T Members. Non ITU-T members may participate only when ITU-T Q.5/15 members accept the necessity of their participation.

d) ***Round robin results handling***: Round robin results should be utilized for revising the Recommendation. The coordinator can present the round robin results only when all ITU-T Q.5/15 members, or all participants in the round robin, accept the necessity of disclosure of the round robin results.

# Appendix II

## Optical fibre cable structures

The following ITU-T Recommendations describe the optical fibre cable structures.

[ITU-T G.978]: Characteristics of optical fibre submarine cables.

[ITU-T L.10]: Optical fibre cables for duct and tunnel application.

[ITU-T L.26]: Optical fibre cables for aerial application.

[ITU-T L.28]: External additional protection for marinized terrestrial cables.

[ITU-T L.43]: Optical fibre cables for buried application.

[ITU-T L.58]: Optical fibre cables: Special needs for access network.

[ITU-T L.59]: Optical fibre cables for indoor applications.

[ITU-T L.60]: Construction of optical/metallic hybrid cables.

# Appendix III

## Fibre optics hardware and passive components

The following ITU-T Recommendations are related to fibre optics hardware and passive components.

[ITU-T L.13]: Performance requirements for passive optical nodes: Sealed closures for outdoor environments.

[ITU-T L.30]: Markers on marinized terrestrial cables.

[ITU-T L.31]: Optical fibre attenuators.

[ITU-T L.36]: Single mode fibre optic connectors.

[ITU-T L.37]: Optical branching components (non-wavelength selective).

[ITU-T L.50]: Requirements for passive optical nodes: Optical distribution frames for central office environments.

[ITU-T L.51]: Passive node elements for fibre optic networks – General principles and definitions for characterization and performance evaluation.

[ITU-T L.54]: Splice closure for marinized terrestrial cables (MTC).

# Appendix IV

## Construction and installation practices

The construction issues are given in ITU-T Handbooks entitled "Construction, Installation, Jointing and Protection of Optical Fibre Cables" and "Marinized terrestrial cables" developed under Study Group 6. The following ITU-T Recommendations are related to construction and installation practices.

[ITU-T L.38]: Use of trenchless techniques for the construction of underground infrastructures for telecommunication cable installation.

[ITU-T L.48]: Mini-trench installation technique.

[ITU-T L.49]: Micro-trench installation technique.

[ITU-T L.52]: Deployment of Passive Optical Networks (PON).

[ITU-T L.56]: Installation of optical fibre cables along railways.

[ITU-T L.57]: Air-assisted installation of optical fibre cables.

[ITU-T L.61]: Optical fibre cable installation by floating technique.

# Appendix V

# Status of optical fibre and cable specifications in ITU-T and IEC

## V.1 Fibre specifications

The status of optical fibre specifications in ITU-T and IEC is listed in Table V.1

**Table V.1 – Status of optical fibre specifications in ITU-T and IEC**

| Optical fibre specification | | | |
|---|---|---|---|
| **ITU-T** | | **IEC** | |
| **Fibre category** | **Recommendation** | **Fibre category** | **Document** |
| 50/125 µm multimode graded index optical fibre | G.651 | A1 a multimode fibre | IEC 60793-2-10 |
| Single-mode optical fibre | G.652 | B1.1 single-mode fibre<br>B1.3 single-mode fibre | IEC 60793-2-50 |
| Dispersion-shifted single-mode optical fibre | G.653 | B2 single-mode fibre | |
| Cut-off shifted single-mode optical fibre | G.654 | B1.2 single-mode fibre | |
| Non-zero dispersion shifted single-mode optical fibre | G.655 | B4 single-mode fibre | |
| Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport | G.656 | B5 single-mode fibre (in next edition, presently in ballot) | |
| Characteristics of a bending loss insensitive single-mode optical fibre and cable for the access network | G.657 | | |

## V.2 Fibre cable specifications

The status of IEC 60794 regarding optical cables is shown in Figure V.1.

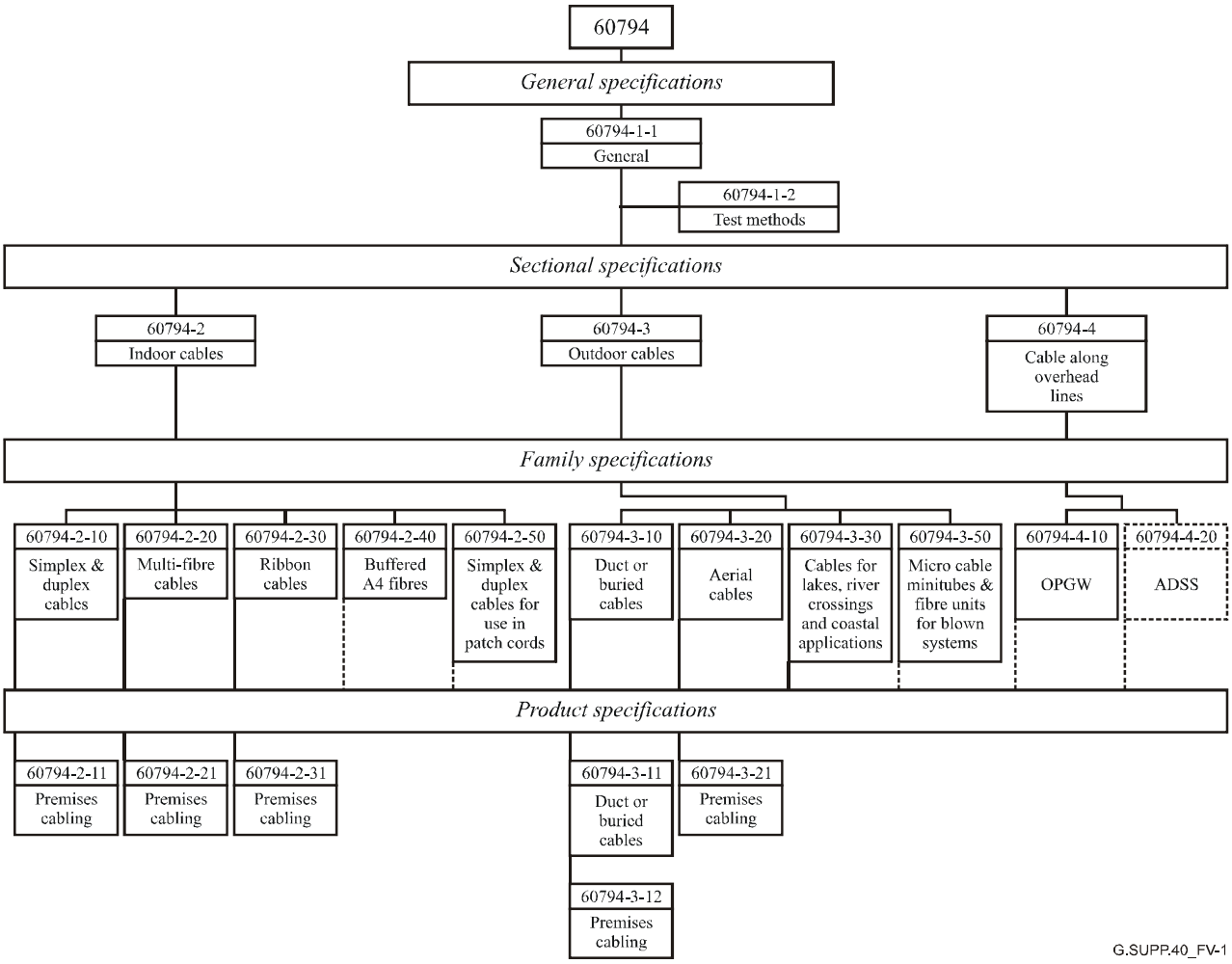


**Figure V.1 – Status of IEC 60794 regarding optical cables**

# Appendix VI

## Comparison of ITU-T Recommendations and IEC documents concerning test methods

### VI.1 Test methods for single-mode fibres

#### VI.1.1 Documents are available in both ITU-T and IEC

| ITU-T Recs | Test methods | | IEC documents | Test methods |
|---|---|---|---|---|
| G.650.1 | | | IEC 60793 | |
| 5.1 | Test methods for the mode field diameter | ⟺ | IEC 60793-1-45 | Optical fibres – Part 1-45: Measurement methods and test procedures – Mode field diameter |
| 5.1.1 | Reference test method: The far-field scan | | Annex A | Far field scan |
| 5.1.2 | First alternative test method: The variable aperture technique | | Annex B | Variable aperture |
| 5.1.3 | Second alternative test method: The near-field scan | | Annex C | Near-field scan |
| 5.1.4 | Third alternative test method: Bidirectional backscatter difference | | Annex D | Bidirectional backscatter difference |
| G.650.1 | | | IEC 60793 | |
| 5.2 | Test methods for the cladding diameter, core concentricity error and cladding non-circularity | ⟺ | IEC 60793-1-20 | Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry |
| 5.2.1 | Reference test method: The near-field image technique | | Annex C | Near-field light (Gray-scale technique) |
| 5.2.2 | First alternative test method: The refracted near-field technique | | Annex A | Refracted near-field |
| 5.2.3 | Second alternative test method: The side-view technique | | None | |
| 5.2.4 | Third alternative test method: The transmitted near-field technique | | Annex C | Near-field light (Single near-field scan technique) |

| G.650.1 | | | IEC 60793 | |
|---|---|---|---|---|
| 5.3 | Test methods for the cut-off wavelength | ⟺ | IEC 60793-1-44 | Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength |
| 5.3.1 | Reference test method for the cut-off wavelength ($\lambda_c$) of the primary coated fibre and reference test method for the cut-off wavelength ($\lambda_{cj}$) of jumper cables: The transmitted power technique | | Annex C | Fibre cut-off wavelength $\lambda_c$ |
| 5.3.2 | Alternative test method for $\lambda_c$: The split-mandrel technique | | Annex C | Fibre cut-off wavelength $\lambda_c$ |
| 5.3.3 | Reference test method for the cut-off wavelength ($\lambda_{cc}$) of the cabled fibre: The transmitted power technique | | Annex B | Cabled cut-off wavelength, $\lambda_{cc}$, using cabled fibre |
| 5.3.4 | Alternative test method for the cut-off wavelength ($\lambda_{cc}$) of the cabled fibre | | Annex A | Cabled cut-off wavelength, $\lambda_{cc}$, using uncabled fibre |

| G.650.1 | | | IEC 60793 | |
|---|---|---|---|---|
| 5.4 | Test methods for the attenuation | ⟺ | IEC 60793-1-40 | Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation |
| 5.4.1 | Reference test method: The cut-back technique | | Annex A | Cut-back |
| 5.4.2 | First alternative test method: The backscattering technique | | Annex C | Backscattering |
| 5.4.3 | Second alternative test method: The insertion loss technique | | Annex B | Insertion loss |

| G.650.1 | | | IEC 60793 | |
|---|---|---|---|---|
| 5.5 | Test methods for the chromatic dispersion | ⟺ | IEC 60793-1-42 | Optical fibres – Part 1-42: Measurement methods and test procedures – Chromatic dispersion |
| 5.5.1 | Reference test method: The phase-shift technique | | Annex A | Phase shift (Annex C: Differential phase shift) |
| 5.5.2 | First alternative test method: The interferometric technique | | Annex D | Interferometry |
| 5.5.3 | Second alternative test method: The pulse delay technique | | Annex B | Spectral group delay in time domain |

| G.650.1 | | | IEC 60793 | |
|---|---|---|---|---|
| 5.6 | Test methods for prooftesting | ⟺ | IEC 60793-1-30 | Optical fibres – Part 1-30: Measurement methods and test procedures – Fibre prooftest |
| 5.6.1 | Reference test method: Longitudinal tension | | | Fibre prooftest |

| G.650.1 | | | |
|---|---|---|---|
| Appendix II | Test method for measuring chromatic dispersion uniformity based on the backscattering technique | ⟺ | None |

| G.650.2 | | | IEC 60793 | |
|---|---|---|---|---|
| 5.1 | Test methods for polarization mode dispersion | ⟺ | IEC 60793-1-48 | Optical fibres – Part 1-48: Measurement methods and test procedures – Polarization mode dispersion |
| 5.1.1 | Reference test method: The Stokes parameter evaluation technique | | Annex B | Stokes evaluation method |
| | | | | Jones matrix eigenanalysis (JME) |
| | | | | Poincare's sphere analysis (PSA) |
| 5.1.2 | First alternative test method: State of polarization (SOP) method | | Annex B | State of polarization (SOP) |
| 5.1.3 | Second alternative test method: Interferometric method | | Annex C | Interferometric method |
| | | | | Weak mode coupling |
| | | | | Strong mode coupling |
| 5.1.4 | The fixed analyser technique | | Annex A | Fixed analyser measurement method |
| | | | | Extrema counting (EC) |
| | | | | Fourier transform (FT) |

| G.650.2 | | | IEC/TR 62284 | |
|---|---|---|---|---|
| Appendix III | Test methods for effective area ($A_{eff}$) | ⟺ | IEC/TR 62284 | Effective area measurements of single-mode optical fibres – Guidance |
| III.1 | The far-field scan (FFS) technique | | Annex A | Direct far-field method measurement specifics |
| III.2 | The variable aperture (VA) technique | | Annex B | Variable aperture in the far-field method measurement specifics |
| III.3 | The near-field scan (NFS) technique | | Annex C | Near-field method measurement specifics |

## VI.2 Test methods for multimode fibres

### VI.2.1 Documents available in both ITU-T and IEC

| ITU-T Recs | Test methods | | IEC documents | Test methods |
|---|---|---|---|---|
| G.651 | | | IEC 60793 | |
| 6.1 | Reference test method and alternative test method for geometrical and optical parameters measurements | ⟺ | IEC 60793-1-20 | Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry |
| 6.2 | Reference test method for geometrical and alternative test method for numerical aperture: The refracted near-field technique | | Annex A | Refracted near-field |
| 6.3 | Alternative test method for geometrical parameters: The near-field technique | | Annex C | Near-field light distribution (Single near-field scan technique) |
| G.651 | | | | |
| 6.4 | Reference test method for the numerical aperture: Far-field light distribution | ⟺ | IEC 60793-1-43 | Optical fibres – Part 1-43: Measurement methods and test procedures – Numerical aperture |
| G.651 | | | | |
| 6.5 | Reference test method and alternative test methods for attenuation measurements | ⟺ | IEC 60793-1-40 | Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation |
| 6.6 | The reference test method: The cutback technique | | Annex A | Cut-back |
| 6.7 | First alternative test method: The insertion loss technique | | Annex B | Insertion loss |
| 6.8 | Second alternative test method: The backscattering technique | | Annex C | Backscattering |
| G.651 | | | | |
| 6.9 | Reference test method for baseband response measurements | ⟺ | IEC 60793-1-41 | Optical fibres – Part 1-41: Measurement methods and test procedures – Bandwidth |
| 6.10 | Reference test method | | Annex A | Impulse response |
| | | | Annex B | Frequency response |

## VI.3 Documents available only in IEC and not in ITU-T

| | |
|---|---|
| IEC 60793-1-21 | Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry |
| IEC 60793-1-22 | Optical fibres – Part 1-22: Measurement methods and test procedures – Length measurement |
| IEC 60793-1-31 | Optical fibres – Part 1-31: Measurement methods and test procedures – Tensile strength |
| IEC 60793-1-32 | Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability |
| IEC 60793-1-33 | Optical fibres – Part 1-33: Measurement methods and test procedures – Stress corrosion susceptibility |
| IEC 60793-1-34 | Optical fibres – Part 1-34: Measurement methods and test procedures – Fibre curl |
| IEC 60793-1-47 | Optical fibres – Part 1-47: Measurement methods and test procedures – Macrobending loss |
| IEC 60793-1-49 | Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay |
| IEC 60793-1-50 | Optical fibres – Part 1-50: Measurement methods and test procedures – Damp heat (steady state) |
| IEC 60793-1-51 | Optical fibres – Part 1-51: Measurement methods and test procedures – Dry heat |
| IEC 60793-1-52 | Optical fibres – Part 1-52: Measurement methods and test procedures – Change of temperature |
| IEC 60793-1-53 | Optical fibres – Part 1-53: Measurement methods and test procedures – Water immersion |
| IEC 60793-1-54 | Optical fibres – Part 1-54: Measurement methods and test procedures – Gamma irradiation |
| IEC 60794-1-2 | Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures |
| IEC 62221 | Optical fibres – Measurement methods – Microbending sensitivity |
| IEC/TR 62000 | Single-mode fibre compatibility guidelines |
| IEC/TS 62033 | Attenuation uniformity in optical fibres |
| IEC/TR 62283 | Nuclear radiation – Fibre optic guidance |
| IEC/TR 62284 | Effective area measurements of single-mode optical fibres – Guidance |
| IEC/TR 62285 | Application guide for non-linear coefficient measuring methods |
| IEC/TR 62316 | Guidance for the integration of OTDR backscattering traces |
| IEC/TR 62324 | Single-mode optical fibres – Raman gain efficiency measurement using continuous wave method – Guidance |
| IEC/TR 62349 | Guideline for polarization crosstalk measurement of optical fibre |

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