

# Overview of optical fibres standardization



**This document is a synthesis of optical fibre standardization. It provides direct links to standards and relevant technical reports.**

## 1. Introduction

The optical fibres on which optical access and transport networks are structured are standardized at international level.

The purpose of this newsletter is to present the main organizations, the associated documents as well as the technical characteristics and attributes addressed within these documents. This newsletter also refers to major international technical reports.

This newsletter is part of a suite of newsletters published by EUROPACABLE

## 2. Historic

Optical fibres used in telecommunications and data transport networks are standardized internationally under the guidance of several organizations.

This situation is the result of the standardization effort initiated in the early 1980s to promote wide adoption and prevent any obstacles regarding interoperability and compatibility between manufacturers. This work materialized through the development of good practices, procedures and specifications documents, reflecting a certain state of the art at a given time, and the result of a consensus of all stakeholders (operators, system manufacturers, fibre and optical cable manufacturers, etc.).

Collaboration between these different stakeholders still remain essential to ensure technical consistency and to guarantee the interoperability of telecommunications systems and equipment.

Different families of optical fibres are available today: multimode step-index or gradient-index and single-mode fibres. They can be made from pure or doped silica or from plastic, and have various opto-geometrical dimensions (core, cladding and outer coating diameters). The fields of application now extend well beyond the fields of telecommunications.



For single-mode optical fibres, two organizations are responsible for the specifications:

- The International Telecommunications Union (ITU) provides recommendations on telecommunications systems and infrastructures. The ITU-T G.65x series of recommendations covers the specification of optical fibres **in cables** and associated characterization methods. For each recommendation, several types of fibres (subcategories) are offered. These documents are available free of charge on the organization's website, **[Annex A table A1 provides direct access to ITU specifications](#)**.
- The International Electrotechnical Commission (IEC), publishes a set of standards (IEC 60793 series) relating to technical specifications for measurements and tests of optical single mode fibres. **[Annex A table A2 provides direct access to IEC standards webstore](#)**.

For multimode optical fibres, standards are managed by:

- The IEC as part of the IEC 60793-2-10 / 20/30/40 standard series covering all fibres intended for telecommunications or industrial systems. **[Annex A table A2 provides direct access to IEC standards webstore](#)**.
- The International Organization for Standardization (ISO) whose ISO / IEC 11801 document series covers structured cabling systems for telecommunications. It is in these documents that OMx type multimode optical fibre cables are specified.

**IEC and ITU optical fiber specifications are aligned.** IEC standards complement those of ITU-T by adding mechanical and environmental performance to the fibre and its coating. The applicable standards for attribute test methods are grouped together in the IEC 60793-1 series of documents.

The main documents published by ITU-T and IEC relating to optical fibres are reported in Annex A:

- The specification of single-mode fibres is thus based on a series of 6 ITU-T G.65x recommendations (G.652, G.653, G.654, G.655, G.656 and G.657) defining a set of 17 fibre subcategories. The sub-categories were created to introduce different levels of performance on certain attributes such as attenuation coefficient, resistance to macro-bending loss induced attenuation, etc. we thus find fibres G.652.B, G.652D, G.657A2, G.657B3 ... These ITU-T recommendations are also mirrored in IEC 60793-2-50 document.
- For multimode fibres, IEC 60793-2-20, -30 and -40 standards cover all fibres for data transport applications and industrial systems aggregating 28 fibre subcategories

**To date, the use of G.652 and G.657 are the dominant fibres, with G.657 fibres widely used for FTTH and other optical distribution networks.**

**Europacable recommends G.657.Ax fibres for any parts of the FTTH network.**



The other types of single-mode fibres according to recommendations G.653, G.655 and G.656 are more discretionary and typically reserved when extension or maintenance of existing systems networks are needed.

The ITU documents describe applicable specifications relating to a set of attributes:

- Geometry: diameters, non-circularities, concentricity errors which are key to address connection losses,
- Mechanical properties: tensile strength, stress corrosion susceptibility,
- Parameters related to transmission properties: mode diameters, chromatic dispersion, cut-off wavelengths and macro-bending induced losses. These parameters can be significantly different from one recommendation to another.
- The properties of the fibre in its cabled form: attenuation coefficients, polarization modal dispersion

The creation of new recommendations or the revision of existing recommendations must be justified either by the development of new transmission technologies, or by the identification of new applications with demonstrated commercial opportunities or more simply motivated by the improvement of manufacturing methods. More specifically, we can highlight technological interests (e.g. such as support for transmission speed or capacity increase), economic interests (e.g. a commercial outlet is identified), analysis of implementation costs within the framework of industrial mass production without forgetting the availability of suitable measuring equipment.

Beside the above mentioned documents ITU-T and IEC are publishing guidance documents, called Technical Reports in IEC. A selection is proposed in Annex C.

### 3. Conclusion

Optical fibres are characterized by many parameters, some of which are subject to standardization, as well as the associated characterization methods. Compliance with this normative system is essential to guarantee the interoperability of networks and equipment while providing a high level of confidence for future-proof systems and overall product quality. Standardization has undoubtedly enabled the expansion of fibre optic networks which now form the baseline of any modern telecommunications networks. Europacable recommends G.657.Ax fibres for the FTTH networks.

#### **For further information please contact:**

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## Annex A :

# Main ITU recommendation and IEC standards on Optical fibre

Recommendation	Title	# of Subcategories	1st publication	Last revision	Link
<b>G.652</b>	Characteristics of a single-mode optical fibre and cable	2	1984	2016	<a href="#">lien</a>
<b>G.653</b>	Characteristics of a dispersion-shifted, single-mode optical fibre and cable	2	1988	2010	<a href="#">lien</a>
<b>G.654</b>	Characteristics of a cut-off shifted single-mode optical fibre and cable	5	1988	2020	<a href="#">lien</a>
<b>G.655</b>	Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable	3	1996	2009	<a href="#">lien</a>
<b>G.656</b>	Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport	1	2004	2010	<a href="#">lien</a>
<b>G.657</b>	Characteristics of a bending-loss insensitive single-mode optical fibre and cable	4	2006	2016	<a href="#">lien</a>

Table A-1 - Main recommendations published by ITU on optical fibres.

Document	Title	# of Subcategories	1st publication	Last revision
<b>60793-2-10</b>	Part 2-10: Product specifications - Sectional specification for category A1 multimode fibres	10	2019	<a href="#">lien</a>
<b>60793-2-20</b>	Part 2-20: Product specifications - Sectional specification for category A2 multimode fibres	3	2015	<a href="#">lien</a>
<b>60793-2-30</b>	Part 2-30: Product specifications - Sectional specification for category A3 multimode fibres	7	2015	<a href="#">lien</a>
<b>60793-2-40</b>	Part 2-40: Product specifications - Sectional specification for category A4 multimode fibres	8	2021	<a href="#">lien</a>
<b>60793-2-50</b>	Part 2-50: Product specifications - Sectional specification for class B single-mode fibres	17	2018	<a href="#">lien</a>
<b>60793-2-60</b>	Part 2-60: Product specifications - Sectional specification for category C single-mode intra-connection fibres	4	2008	<a href="#">lien</a>
<b>60793-2-70</b>	Part 2-70: Product specifications - Sectional specification for polarization-maintaining fibres	3	2017	<a href="#">lien</a>

Table A-2 - Main standards published by the IEC on optical fibres.

**Annex B :**

**Overview of the attributes required by IEC 60793-2-50 and ITU-T G.65x**

	<b>Multimode fibres</b>	<b>Singlemode fibres</b>
<b>transmission</b>	Intrinsic attenuation Macro-bending induced attenuation Inter-modal dispersion } Bandwidth Intra-modal dispersion }	Intrinsic attenuation Macro-bending induced attenuation Chromatic dispersion coefficients Polarization-mode dispersion coefficient Hydrogen ageing
<b>dimensional</b>	Length Core } Diametre Cladding } Non-circularity Coating } Concentricity error	Length Core <sup>1</sup> } Diametre Cladding } Non-circularity Coating } Concentricity error
<b>optical</b>	Numerical Aperture	Mode-field diametres Cabled Cut-off wavelength
<b>mechanical</b>	Fibre Curl Tensile strength Stress corrosion susceptibility Coating strip force	Fibre Curl Tensile strength Stress corrosion susceptibility Coating strip force
<b>environmental</b>	Temperature cycle test Dry heat test Damp heat test Water immersion test	Temperature cycle test Dry heat test Damp heat test Water immersion test

<sup>1</sup>: Core diameter and core non circularity are not standardized for singlemode fibres.

Table B-1 - List of standard characteristics for multimode and single-mode optical fibres.

## Annex C :

# Main ITU and IEC guidance documents on Optical fibre

Recommendation	Title	1st publication	Last revision	Link
<b>G.Sup59</b>	Guidance on optical fibre and cable reliability	2016	2018	<a href="#">lien</a>

Table C-1 - Main Guidance documents published by ITU on optical fibres.

Document	Title	Last edition	Link
<b>TR 62000</b>	Guidelines for combining different single-mode fibre sub-categories	2021	<a href="#">lien</a>
<b>TR 62048</b>	Optical fibres - Reliability - Power law theory	2014	<a href="#">lien</a>
<b>TR 62221</b>	Optical fibres - Measurement methods - Microbending sensitivity	2012	<a href="#">lien</a>
<b>TR 62316</b>	Guidance for the interpretation of OTDR backscattering traces for single-mode fibres	2017	<a href="#">lien</a>

Table C-2 - Main Technical Reports published by the IEC on optical fibres.



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*The information provided in this document reflects the best knowledge of Europacable experts at the moment of its publication and is provided as an informative tool to assist the readers in the assessment and use of Optical fibre cables and components. The content of the document is not legally binding and is not intended as a substitute for user's or manufacturer's own assessment and decision-making.*

*Readers of this document are encouraged to seek information on specific matters regarding Optical cables and components from the manufacturer or provider and to consider the Technical Standards relating to the selected products.*

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