Reviewing ITU-T SG15 Q5 Recommendations used in the Access Network

Jing Li - Editor, Question 5 of ITU-T SG15

ITU-T SG15 Q5 Characteristics and test methods of optical fibres and cables, and installation guidance

- The following major Recommendations and Supplements, in force at the time of approval of this Question, fall under its responsibility:
  - **Optical fibres:**

    G.650.1, G.650.2, G.650.3, G.651.1, G.652, G.653, G.654, G.655, G.656, G.657, G Suppl.40, G Suppl.47 and G Suppl.59.

  - **Optical fibre cables:**

    L.100/L.10, L.102/L.26, L.101/L.43, L.106/L.58, L.103/L.59, L.109/L.60, L.104/ L.67, L.107/L.78, L.108/L.79, L.105/L.87, L.110 for cable structure and characteristics, o L.126/L.27 for cable evaluation,

    and L.151/L.34, L.150/L.35, L.152/L.38, L.161/L.46, L.153/L.48, L.154/L.49, L.158/ L.56, L.156/L.57, L.157/L.61, L.159/L.77, L.160/L.82, L.155/L.83, L.162, L.163 for guidance and installation technique.

Area	Standard	Title	Key Areas
Optical Fibre	ITU-T G650.1 ITU-T G.652 ITU-T G.657	Transmission media and optical systems characteristics – Optical fibre cables Characteristics of a Single-mode Optical Fibre and Cable Characteristics of a Bending-loss Insensitive Single-mode Optical Fibre and Cable	• Fibre attributes
Cable (Feeder + Distribution)	L.101-110	Cable attributes	• L.101: Optical fibre cables for buried application • L.102: Optical fibre cables for aerial application • L.106: Optical fibre cables: Special needs for access network • L.107: Optical fibre cable construction for sewer duct applications • L.108: Optical fibre cable elements for microduct blowing-installation application • L.109: Construction of optical/metallic hybrid cables • L.110: Optical fibre cables for direct surface application
Drop Cable	ITU-T L. 105	Optical fibre cables for drop applications	• Characteristics, construction and test methods of optical fibre cables for drop applications
Indoor Cable	ITU-T L. 103 ITU-T L. 104	Cable attributes	• L.103: Optical fibre cables for indoor applications • L.104: Small count optical fibre cables for indoor applications
In-Home	ITU-TL.oha	Optical fibre cables for in-home applications	• SFU/ MDU cable

Additional fibre attribute specifications covered by IEC 60793-2-50 (type B)

Attribute	ITU	IEC
Cabled Attenuation Coefficient	ITU G650.1	IEC 60793-1-40
Mode-field Diameter (MFD)	ITU G650.1	IEC 60793-1-45
Fibre Geometry (Glass-only)		IEC 60793-1-20
Cable Cut-off wavelength	ITU G650.1	IEC 60793-1-44
Macrobending Loss	ITU G650.1	IEC 60793-1-47
Chromatic Dispersion	ITU G650.1	IEC 60793-1-42
Polarization Mode Dispersion (PMD)	ITU G650.1	IEC 60793-1-48
Mechanical proof test	ITU G650.1	IEC 60793-1-30

Additional detail fibre parameters not covered by ITU-T

IEC 60793-1/-2 forms the basis of Industry Standardization for fibre specification and testing

Attribute	Details and/or Test Method
Coating Geometry; ▪ **Outer Diameter of un-colored fibre** ▪ **Outer Diameter of Colored fibre** ▪ **Coating Concentricity Error**	IEC 60793-1-21
Coating Strip Force ▪ **(average value)** ▪ **(peak value)**	IEC 60793-1-32
Fibre curl radius	IEC 60793-1-34
Tensile strength	IEC 60793-1-31
Stress corrosion susceptibility; n_d	IEC 60793-1-33
Environmental Exposure Tests; ▪ Temperature Cycling ▪ Damp Heat ▪ Dry Heat ▪ Water Immersion	▪ IEC 60793-1-50 ▪ IEC 60793-1-51 ▪ IEC 60793-1-52 ▪ IEC 60793-1-53 Verification Testing; ▪ Attenuation Change (IEC60793-1-46), ▪ Coating strip force, ▪ Tensile Strength
Fibre Length	IEC 60793-1-22
Hydrogen Aging Test	IEC 60793-2-50 A5, 60793-1-40

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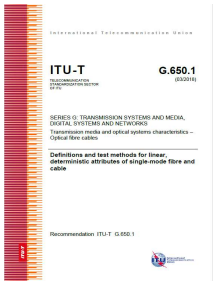
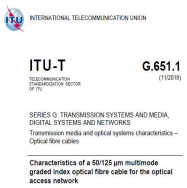
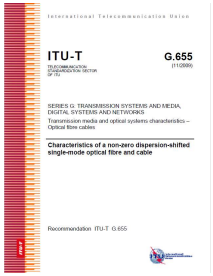
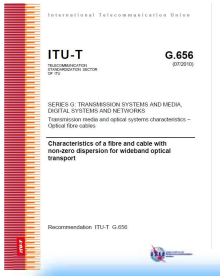
G.650.1 | G.651.1 | G.652 | G.653 | G.654 | G.655 | G.656 | G.657

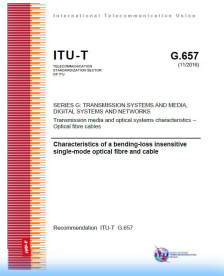




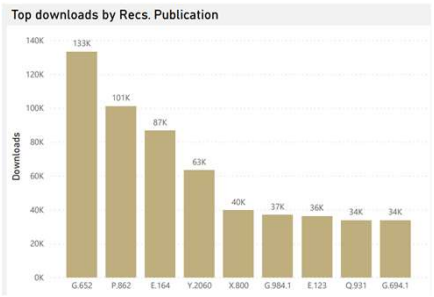
Multimode

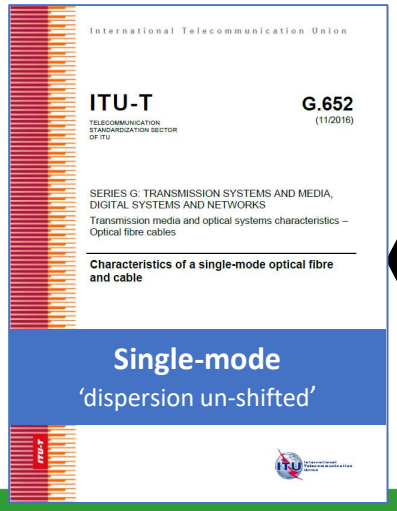


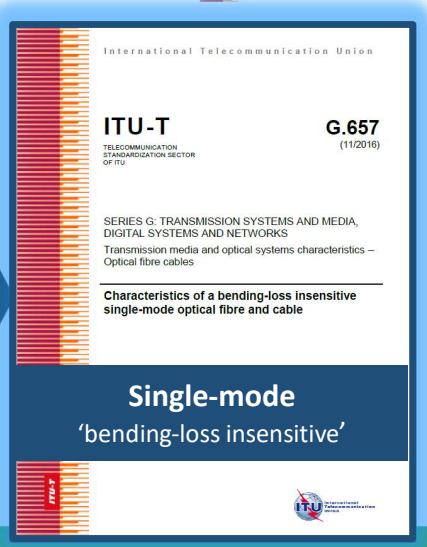




ITU-T G.652 is the most downloaded ITU-T Recommendation







Bending Resilience (Optical)

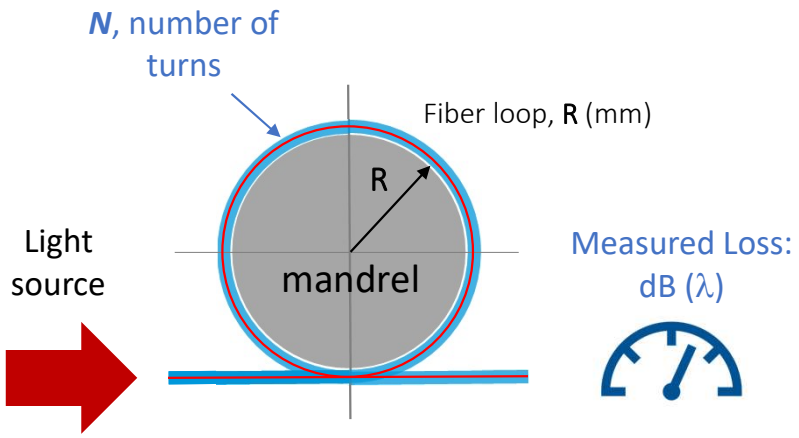


Table – Macrobend Requirements of ITU-T G.652 & G.657

Note: Specifications apply to un-cabled fiber

Fiber bend	G.652.D	G.657.A1		G.657.A2 & B2			G.657.B3		
Radius (mm)	30	15	10	15	10	7.5	10	7.5	5
Num. of turns	100	10	1	10	1	1	10	1	1
1550 nm	-	0.25	0.75	0.03	0.01	0.5	0.03	0.08	0.15
1625 nm	0.1	1.0	1.5	0.1	0.2	1.0	0.1	0.25	0.45

.Ax = Full Compliance to **G.652.D is Required**

.Bx = Full Compliance to **G.652.D is Optional**

ITU-T SG15 Q5 Characteristics and test methods of optical fibres and cables, and installation guidance

- Hot Topics and latest discussions during ITU-T SG15 Q5 meeting
  - TSDR-SDM, published in September 2022. (Optical fibre, cable, and components for space-division multiplexing (SDM) transmission)
  - L.109.1, published in November 2022. (Type II optical/electrical hybrid cables for access points and other terminal equipment)
  - Revision of L.109, L.100, G.652, G.654, G.657, G.650.1, G.Sup.40, and G.Sup.47

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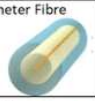
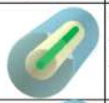
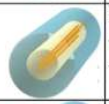
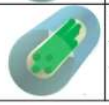
TSDR-SDM Space-division multiplexing (SDM) transmission for expanding optical network capacity

- Today's optical networks are approaching their Shannon limit – the estimated maximum rate at which they can transmit data reliably.
- SDM, key to the next major phase in optical network technology evolution.
- Key topics considered in the report TSDR-SDM include:
  - High-potential SDM applications
  - Technical and commercial aspects of SDM technology
  - The current state of SDM technical maturity, with a focus on optical fibres, cables, and related components for SDM transmission.

TSDR-SDM Optical fibre, cable, and components for space-division multiplexing (SDM) transmission

Type		General features
Single-core design	Reduced Coating Diameter Fibre 	Coating diameter is reduced while maintaining a cladding diameter of 125 µm - Higher count optical fibre cable is achieved - Microbending sensitivity may be elevated - Puncture and abrasion resistance may be reduced
	Reduced Cladding Fibre 	Cladding diameter is reduced to less than 125 µm - Higher count optical fibre cable and/or higher density connection is achieved - Microbending sensitivity may be elevated - Puncture, abrasion resistance and tensile strength may be reduce
	Few Mode Fibre 	A core is designed to support multiple-mode propagation - Higher spatial multiplicity is achieved with a standard cladding diameter - Multiple input and multiple output digital signal processing (MIMO-DSP) may be needed
Multicore design	Weakly coupled Multicore Fibre 	Multiple cores are allocated within a cladding so that each core supports an individual spatial path - Each core design can be compatible with conventional SMFs - The number of cores in the standard cladding diameter is limited by inter-core crosstalk and loss
	Randomly coupled Multicore Fibre 	Multiple cores are allocated within a cladding so that sufficient signal coupling among the cores is achieved - Higher core multiplicity is achieved than with a weakly coupled multicore fibre - MIMO-DSP is required
	Few Mode Multicore Fibre 	Multiple few-mode cores are allocated within one cladding so that each core has sufficiently low crosstalk - Higher spatial channels are achieved thanks to the multiplication of core and mode numbers - MIMO-DSP may be needed

- **Single-core SDM optical fibre designs**

  reduced coating diameter fibre (RCDF)

  reduced cladding diameter fibre (RCF)

  few-mode fibre (FMF).

- **Multi-core designs**

  weakly coupled multicore fibre (WC-MCF)

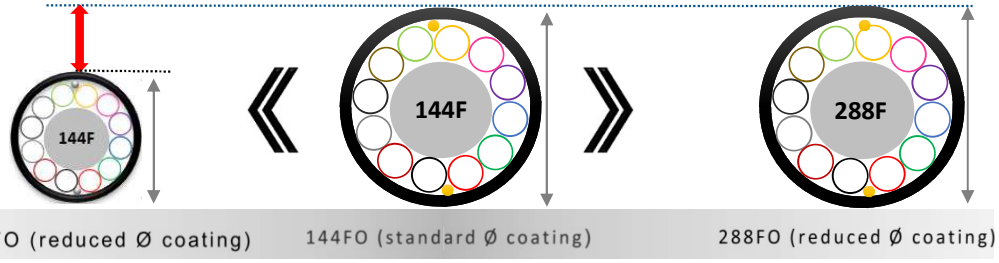
  randomly coupled MCF (RC-MCF)

  few-mode MCF (FM-MCF)

Optimize the infrastructure by maximizing the usable space

Fibre density in cable = Number of fibres / Cable section in mm²

Smaller cable diameter



Higher fibre count in cable

Duct diameter reduction

Reference cable

Fibre count increase

- Smaller and lighter cables,
- Easier handling, smaller and lighter delivery spools

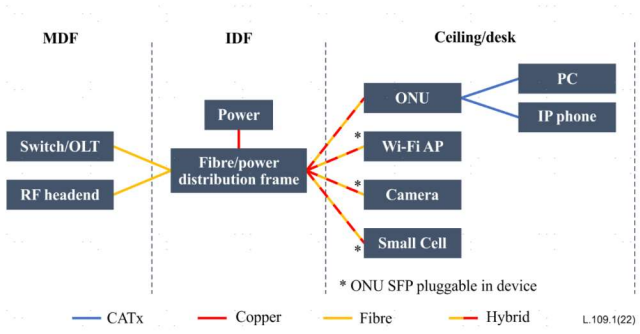
- Installation by blowing in micro-ducts
- Faster installation and with reduced teams

Smaller environmental footprint

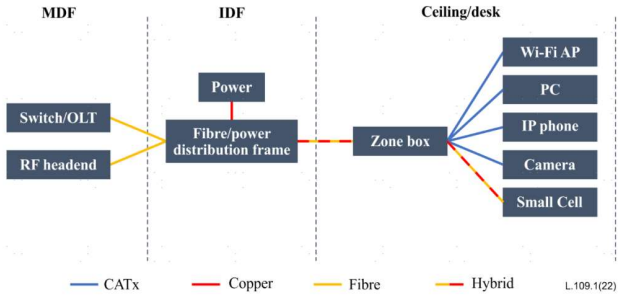
L.109 & L.109.1 Optical/metallic hybrid cables

- **L.109 Construction of optical/metallic hybrid cables**
  - Recommendation ITU-T L.109 describes cable construction and provides guidance for the use of optical/metallic hybrid cable, which contains both optical fibres and metallic wires for telecommunication and/or power feeding. Technical requirements may differ according to the installation environment.
- **L.109.1 (L.oehc) Type II optical/electrical hybrid cables for access points and other terminal equipment**
  - Recommendation ITU-T L.109.1 explains the type II optical/electrical hybrid cable (OEHC) in which a copper pair is used for power delivery (not for telecommunications) and an optical fibre can support data transmission up to and beyond 1 Gbit/s. The current application scenarios for remote powering and data transmission of access points and other equipment require a type of hybrid cable that has a small footprint, is lightweight, and is convenient for installation.

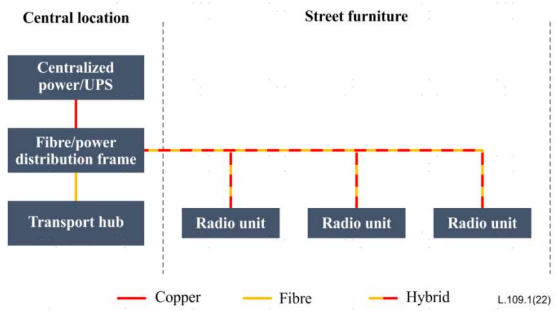
L.109.1 Type II optical/electrical hybrid cables for access points and other terminal equipment



Power and data delivery networking based on OEHC



OEHC application on the fibre and power to the zone and the small cell scenario



Centralised fibre connectivity and power delivery network based on multi fibre OEHC


thank you
danke
謝謝
ngiyabonga
متشكرم
рахмат
teşekkür ederim
gracias
obrigado
merci
dziękuję
bedankt
sukriya
go raibh maith agat
kop khun krap
terima kasih
dakujem
arigatō
grazie
mochchakkeram
tapadh leat
спасибо
Баярлалаа
faafetai lava
dank je
misaotra
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хвала
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