

Recommendation

ITU-T L.109 (01/2024)

SERIES L: Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant

Optical fibre cables – Cable structure and characteristics

Construction of optical/metallic hybrid cables

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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.109

Construction of optical/metallic hybrid cables

Summary

Recommendation ITU-T L.109 describes cable construction and provides guidance for the use of optical/metallic hybrid cables, which contains both optical fibres and metallic wires for telecommunication and/or power feeding. Technical requirements may differ according to the installation environment. Environmental issues and test methods for cable characteristics are described in other L-series Recommendations.

History *

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Recommendation ITU-T L.109

Construction of optical/metallic hybrid cables

1 Scope

This Recommendation describes cables containing both optical fibres and metallic wires and covers the following aspects.

- Optical/metallic hybrid cables for communications systems;
- Construction of optical/metallic hybrid cables. The optical fibre dimensional and transmission characteristics should comply with [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 [IEC 60793-2-10]. Dimensional and transmission characteristics of metallic wires and coaxial units for telecommunication applications and systems should comply with [ITU-T TR-OFCs];
- Cables designed for outdoor, indoor, or indoor-outdoor use: fibre-to-the-antenna (FTTA) or distributed antenna systems (DAS) cables are examples of such hybrid cables;
- Cables for limited powering applications found in communications systems.
- A recommendation that an optical/metallic hybrid cable should be provided with cable-end sealing and protection during cable delivery and storage, as is usual for metallic or optical cables. If splicing components have been factory installed, they should be adequately protected;
- A recommendation that pulling devices can be fitted to the end of the cable if required.

Three types of optical/metallic hybrid cable are considered in this Recommendation according to the usage of the metallic wires, such as Type I: communication only, Type II: power feeding only, and Type III: both power feeding and communication.

Individual requirements for Type II optical/metallic hybrid cable which supports a bit rate up to 1 Gb/s or beyond can be found in [ITU-T L.109.1].

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.

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| [ITU-T G.650.1] | Recommendation ITU-T G.650.1 (2024), <i>Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable.</i> |
| [ITU-T G.650.2] | Recommendation ITU-T G.650.2 (2015), <i>Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable.</i> |
| [ITU-T G.652] | Recommendation ITU-T G.652 (2016), <i>Characteristics of a single-mode optical fibre and cable.</i> |
| [ITU-T G.653] | Recommendation ITU-T G.653 (2010), <i>Characteristics of a dispersion-shifted, single-mode optical fibre and cable.</i> |
| [ITU-T G.654] | Recommendation ITU-T G.654 (2020), <i>Characteristics of a cut-off shifted single-mode optical fibre and cable.</i> |

[ITU-T G.655]	Recommendation ITU-T G.655 (2009), <i>Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable.</i>
[ITU-T G.656]	Recommendation ITU-T G.656 (2010), <i>Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport.</i>
[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.100]	Recommendation ITU-T L.100/L.10 (2024), <i>Optical fibre cables for duct and tunnel application.</i>
[ITU-T L.101]	Recommendation ITU-T L.101/L.43 (2015), <i>Optical fibre cables for buried application.</i>
[ITU-T L.102]	Recommendation ITU-T L.102/L.26 (2015), <i>Optical fibre cables for aerial application.</i>
[ITU-T L.103]	Recommendation ITU-T L.103 (2016), <i>Optical fibre cables for indoor applications.</i>
[ITU-T L.109.1]	Recommendation ITU-T L.109.1 (2022), <i>Type II optical/electrical hybrid cables for access points and other terminal equipment.</i>
[IEC 60227-1]	IEC 60227-1 (2024), <i>Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 1: General requirements.</i>
[IEC 60228]	IEC 60228:2004, <i>Conductors of insulated cables.</i>
[IEC 60502-1]	IEC 60502-1:2021, <i>Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV) – Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV).</i>
[IEC 60793-2-10]	IEC 60793-2-10:2019+AMD1:2022 CSV Consolidated version, <i>Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres.</i>
[IEC 60794-1-21]	IEC 60794-1-21:2015+AMD1:2020 CSV Consolidated version, <i>Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test 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 60794-1-23]	IEC 60794-1-23:2019, <i>Optical fibre cables – Part 1-23: Generic specification – Basic optical cable test procedures – Cable element test methods.</i>
[IEC 60794-2]	IEC 60794-2:2017, <i>Optical fibre cables – Part 2: Indoor cables – Sectional specification.</i>
[IEC 60794-3]	IEC 60794-3:2022, <i>Optical fibre cables – Part 3: Outdoor cables – Sectional specification.</i>
[IEC 61156-1]	IEC 61156-1:2023, <i>Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification.</i>
[IEC 61196-1-10x]	IEC 61196-1-10x-series (2022), <i>Coaxial communication cables – Parts 1-100 to 1- 109: Electrical test methods series.</i>
[IEC 61156-2-1]	IEC 61156-2-1:2010, <i>Multicore and symmetrical pair/quad cables for digital communications – Part 2-1: Horizontal floor wiring – Blank detail specification.</i>

[IEC 62807-1]	IEC 62807-1:2017, Hybrid <i>telecommunication cables – Part 1: Generic specification</i> .
[IEC TR 62222]	IEC TR 62222:2021, <i>Fire performance of communication cables installed in buildings</i> .

3 Definitions

3.1 Terms defined elsewhere

For the purposes of this Recommendation, the definitions given in [ITU-T G.650.1], [ITU-T G.650.2], and [ITU-T L.102] apply.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BBU	Baseband Unit
DAS	Distributed Antenna Systems
DBS	Distributed Base Station
ELFEXT	Equal Level of Far-End crosstalk
FEXT	Far-End Crosstalk
FRP	Fibre-Reinforced Plastic
FTTA	Fibre-To-The-Antenna
NEXT	Near-End Crosstalk
PE	Polyethylene
PSNEXT	Power Sum Of Near-End Crosstalk
PVC	Polyvinyl Chloride
RRH	Remote Radio Head
RRU	Remote Radio Unit

5 Conventions

None.

6 Optical/metallic hybrid cable construction

This Recommendation deals with three types of optical/metallic hybrid cables as shown in Table 1.

Table 1 – Contents of each cable type

Cable type	Optical fibres	Metallic wires for telecommunication	Metallic wires for power feeding
Type I	Contained	Contained	Not contained
Type II	Contained	Not contained	Contained
Type III	Contained	Contained	Contained

Type I can be used for optical transmission and electric transmission carrying analogue or digital signals. Type II can be used for optical transmission and power feeding. Type III can be used for optical transmission, electric transmission carrying analogue or digital signals and power feeding.

There are several methods to contain the media in a cable. One is to strand each medium fabricated cylindrically (with or without other materials) around a central member. Second is to arrange all media in a round way (without a central member) and put a round sheath over it. Third is to insert media into slots of a slotted core as described in clause 6.2.7. Alternatively, flat or oval configurations meeting this intent may be used.

NOTE – Individual requirements for Type II optical/metallic hybrid cable which supports a bit rate up to 1 Gb/s or beyond can be found in [ITU-T L.109.1].

6.1 Characteristics of each medium

6.1.1 Optical fibre

Optical fibres described in [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 [IEC 60793-2-10] should be used, depending on the circumstances and technical requirements.

Optical fibre cable elements described in [IEC 60794-2] and [IEC 60794-3] should be used, depending on the circumstances and technical requirements.

6.1.2 Metallic wires for telecommunication

6.1.2.1 Symmetrical metallic pair

The electrical and transmission characteristics of a symmetrical pair or pairs for communication should comply with those agreed between the manufacturer and the user. The following items should be agreed upon:

- maximum conductor direct current resistance;
- maximum conductor direct current resistance unbalance of the pair;
- mutual capacitance;
- capacitance unbalance;
- attenuation (insertion loss);
- near-end crosstalk (NEXT);
- power sum of near-end crosstalk (PSNEXT);
- far-end crosstalk (FEXT);
- equal level of far-end crosstalk (ELFEXT);
- impedance;
- return loss;
- insulation resistance;
- any other parameter to be agreed between the manufacturer and the user.

The mechanical and the environmental characteristics should comply with [IEC 61156-2-1] unless there is a different agreement between the manufacturer and the user.

6.1.2.2 Coaxial conductors

The electrical and transmission characteristics of coaxial conductors for communication should comply with those agreed between the manufacturer and the user. The following items should be agreed upon:

- characteristic impedance;
- conductor resistance;
- attenuation;
- velocity ratio;
- return loss;
- insulation resistance;
- withstand voltage of dielectric;
- any other parameter to be agreed between the manufacturer and the user.

The mechanical and the environmental characteristics should be agreed upon between the manufacturer and the user.

6.1.3 Power-feeding wires

The conductor characteristics of the copper wire should comply with [IEC 60228] unless there is a different agreement between the manufacturer and the user. The insulation characteristic of the copper wire should comply with [IEC 60502-1] or [IEC 60227-1] standard requirements, unless there is a different agreement between the manufacturer and the user.

The cross-section of the metallic wire should be designed according to the transmission voltage, transmission distance and the power consumption. Under extreme operating conditions, the heat generated by the conductors should not make the cable temperature exceed the maximum allowed temperature in detailed specifications of the cable element materials.

Conductors and insulation materials for power-feeding wires should be specified in detail.

6.2 Cable element

The make-up of the cable core in particular the number of fibres, the method of protection and identification, the location of strength members and metallic wires or pairs, if required, should be clearly specified. Designs other than those described in clauses 6.2.1 to 6.2.16 may be used, provided that they comply with the aims of this Recommendation.

6.2.1 Tight secondary coating or buffer

If a tight secondary coating is required, it should consist of one or more layers of polymeric material. The coating should be easily removable for fibre splicing. For tight buffers, the buffer and fibre primary coating should be removable in one operation over a length depending on the customer's requirements. The nominal overall diameter of the tight secondary coating is typically 800/900 µm.

In fibre-to-the-antenna (FTTA) applications, tight buffered fibres can be used. Spiral stainless steel tubes can be used to protect and gather those buffered fibres.

6.2.2 Loose tube

A loose tube construction or a loose tube cable is frequently used to protect and gather optical fibres or fibre ribbons. Water blocking material may be contained in the tube if required for the application.