IEC 61280-4-1

Edition 3.0 2019-05

INTERNATIONAL STANDARD

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colour inside

Fibre-optic communication subsystem test procedures – Part 4-1: Installed cabling plant – Multimode attenuation measurement

Procédures d'essai des sous-systèmes de télécommunication fibroniques – Partie 4-1: Installation câblée – Mesure de l'affaiblissement en multimodal

IEC 61280-4-1:2019-05(en-fr)

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FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 4-1: Installed cabling plant – Multimode attenuation measurement

FOREWORD

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International Standard IEC 61280-4-1 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition, published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) changes to Annex F on encircled flux to harmonise with IEC TR 62614-2, but keeping the encircled flux limits defined in Tables F.2 to F.5 unchanged;
b) addition of an equipment cord method in Annex D;
c) inclusion of testing bend insensitive multimode optical fibre;
d) updates to measurement uncertainty;
e) definition of additional cabling configurations;
f) changes to Table 5 on spectral requirements.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
86C/1575/FDIS	86C/1592/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61280 series, published under the general title *Fibre optic communication subsystem test procedures*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –

Part 4-1: Installed cabling plant – Multimode attenuation measurement

1 Scope

This part of IEC 61280 is applicable to the measurement of attenuation of installed optical fibre cabling plant using multimode optical fibre. This cabling plant can include multimode optical fibres, connectors, adapters, splices, and other passive devices. The cabling can be installed in a variety of environments including residential, commercial, industrial, and data centre premises, as well as outside plant environments. The test equipment used in this document has one single fibre connector interface or two single fibre connector interfaces.

In this document, the optical fibres that are addressed include sub-categories A1-OMx, where x = 2, 3, 4 and 5 (50/125 µm) and A1-OM1 (62,5/125 µm) multimode optical fibres, as specified in IEC 60793-2-10. The attenuation measurements of the other multimode categories can be made using the approaches of this document, but the source conditions for the other categories have not been defined.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 61280-1-3, *Fibre optic communication subsystem test procedures – Part 1-3: General communication subsystems – Central wavelength and spectral width measurement*

IEC 61280-1-4, *Fibre optic communication subsystem test procedures – Part 1-4: General communication subsystems – Light source encircled flux measurement method*

IEC 61300-3-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-35: Examinations and measurements – Visual inspection of fibre optic connectors and fibre-stub transceivers*

IEC 61315, *Calibration of fibre-optic power meters*

IEC 61746-2, *Calibration of optical time-domain reflectometers (OTDR) – Part 2: OTDR for multimode fibres*

3 Terms, definitions, graphical symbols and abbreviated terms

For the purposes of this document, the following terms, definitions, graphical symbols and abbreviated terms apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and definitions

3.1.1
attenuation
A
reduction of optical power induced by transmission through a medium such as cabling

$$A = 10 \log(P_{in}/P_{out})$$

where

P_{in} and P_{out} are the power, typically measured in mW, into and out of the cabling

Note 1 to entry: Attenuation is expressed in dB.

3.1.2
light source power meter
LSPM
test system consisting of a light source (LS) and power meter (PM) used to measure the attenuation of installed cabling plant

3.1.3
optical time domain reflectometer
OTDR
test system consisting of an optical time-domain reflectometer instrument used to characterize and measure the attenuation of installed cabling plant and specific elements within that cabling plant

Note 1 to entry: This note applies to the French language only.

3.1.4
test cord
terminated optical fibre cord used to connect the optical source or detector to the cabling, or to provide suitable interfaces to the cabling under test

Note 1 to entry: There are five types of test cords:

– launch cord: used to connect the light source to the cabling;
– receive cord: used to connect the cabling to the power meter (LSPM only);
– tail cord: attached to the far end of the cabling when an OTDR is used at the near end. This provides a means of evaluating attenuation of the whole of the cabling including the far end connection;
– adapter cord: used to transition between sockets or other incompatible connectors in a required test configuration;
– substitution cord: a test cord used within a reference measurement which is replaced during the measurement of the attenuation of the cabling under test.

3.1.5
bi-directional measurement
two measurements of the same optical fibre, made by launching light into opposite ends of that fibre

3.1.6
configuration
form or arrangements of parts or elements such as terminations, connections and splices

3.1.7
encircled flux
EF
fraction of cumulative near-field power to the total output power as a function of radial distance from the optical centre of the core

[SOURCE: IEC 62614:2010, 3.2]

3.1.8
reference-grade termination
connector and plug with tightened tolerances terminated onto an optical fibre with tightened tolerances such that the expected attenuation of a connection formed by mating two such assemblies is lower and more repeatable than a standard-grade termination

Note 1 to entry: An adapter, required to assure the reduced attenuation, may be considered as part of the reference-grade termination where required by the test configuration.

Note 2 to entry: IEC 61755-6-2 defines reference-grade terminations for 50/125 µm fibre.

3.1.9
connector
component normally attached to an optical cable or piece of apparatus for the purpose of providing frequent optical interconnection/disconnection of optical fibres or cables

[SOURCE: IEC TR 61931:1998, 2.6.1, modified – The words in brackets, "optical" and "fibre", have been omitted from the term.]

3.1.10
plug
male-type part of a connector

[SOURCE: IEC TR 61931:1998, 2.6.2]

3.1.11
adapter
female-type part of a connector in which one or two plugs are inserted and aligned

[SOURCE: IEC TR 61931:1998, 2.6.4]

3.1.12
socket-style connector
connector for which the adapter, including any alignment device, is integrated with and permanently attached to the connector plug on one side of the connection

Note 1 to entry: Examples include many harsh environment connectors.

3.1.13
reference test method
RTM
test method for measuring a given characteristic strictly according to the definition of this characteristic, and giving results which are accurate, reproducible and relatable to practical use

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC TR 61931:1998, 2.8.1, modified – The words in brackets, "for optical fibres", have been omitted from the term.]

3.1.14
alternative test method
ATM
test method for measuring a given characteristic in a manner consistent with the definition of this characteristic and giving results which are reproducible and relatable to the reference test method and to practical use

[SOURCE: IEC TR 61931:1998, 2.8.2, modified – The alternative term, "practical test method (for optical fibres)" has been omitted from the term.]

3.1.15
measurement bias
estimate of a systematic measurement error

Note 1 to entry: A systematic error is a component of measurement error that in repeated measurements remains constant or varies in a predictable manner.

[SOURCE: ISO/IEC Guide 99:2007, 2.18, modified – Note 1 to entry has been added.]

3.1.16
reference plane
theoretical plane without thickness or tolerances

Note 1 to entry: The reference plane is used to define spaces in mechanical structures.

[SOURCE: IEC 60050-581:2008, 581-25-30]

3.1.17
channel
end-to-end transmission path connecting any two pieces of application-specific equipment

[SOURCE: ISO/IEC 11801-1:2017, 3.1.26]

3.2 Graphical symbols

The graphic symbols showed in Figure 1 and Figure 2 for different connection options have been adapted from IEC TR 61930.

NOTE 1 In Figure 1b and elsewhere in this document, the plugs are shown with different sizes to indicate directionality where the cabling has adapters pre-attached and the test cord does not, or vice versa. In Figure 1b, the plug on the left has the adapter pre-attached.

NOTE 2 Where used in all figures in this document, including those in the annexes, reference-grade terminations and adapters are shaded with grey.

NOTE 3 A simplified two-block connection used in Annex G is shown in Figure 1e.

NOTE 4 A simplified connection for pinned to unpinned and socketed connections used in Annex H is shown in Figure 1f.

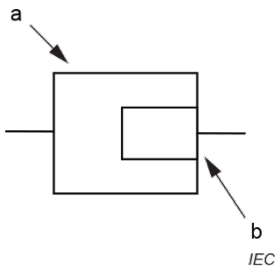


Figure 1a – Socket and plug assembly

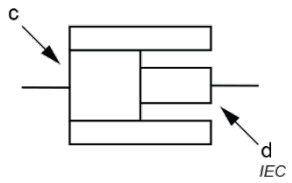


Figure 1b – Connector set (plug, adapter, plug)

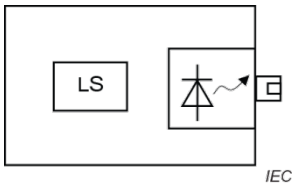


Figure 1c – Light source

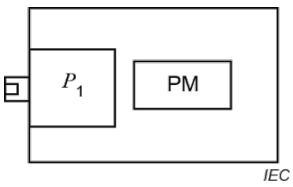


Figure 1d – Power meter

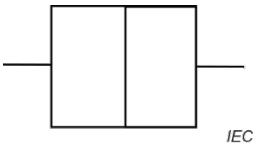


Figure 1e – Generic connection

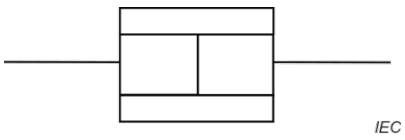


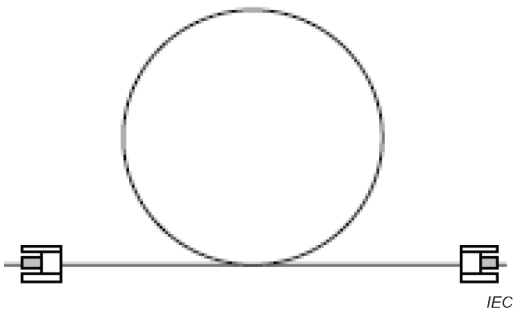
Figure 1f – Pinned/unpinned connection

Key

a	socket	d	plug inserted into plug-adapter assembly
b	plug	LS	light source
c	plug-adapter assembly	PM	power meter

Figure 1 – Connector symbols

In the figures that illustrate the measurement configurations in Annexes A through D and in Annex I, the cabling under test, illustrated by the loop, may contain splices, connectors or other passive components. Note that for purposes of measuring the attenuation of this cabling, the attenuation associated with the terminal connectors is considered separately from that of the cabling itself.



NOTE Cabling is shown with adapters pre-attached, and the plugs going into them are associated with reference-grade test cord plugs.

Figure 2 – Symbol for cabling under test

3.3 Abbreviated terms

ATM	alternative test method
BIMMF	bend-insensitive multimode optical fibre
EF	encircled flux
LSA	least squares approximation
LSPM	light source power meter
OTDR	optical time domain reflectometer
PM	power meter
RTM	reference test method

4 Test methods

4.1 General

Five test methods are designated. The five test methods use test cords to interface to the cabling plant and are designated as follows:

- one-cord method (Annex A);
- three-cord method (Annex B);
- two-cord method (Annex C);
- equipment cord method (Annex D);
- optical time domain reflectometer (OTDR) method (Annex E).

The first four methods use an optical light source and power meter (LSPM) to measure input and output power levels of the cabling under test to determine the attenuation. The main functional difference between these methods is the way the input power level, known as the reference power level, is measured and hence the inclusion or exclusion of the attenuation associated with the connections to the cabling under test, and the associated uncertainties of these connections. The process of measuring the input power level is commonly referred to as "taking the reference power level", or "normalization".

The one-cord method includes the attenuation associated with connections at both ends of the cabling under test. The three-cord method is designed to exclude the attenuation of the connections of both ends of the cabling under test. The two-cord method includes the attenuation associated with one of the connections of the cabling under test.

The equipment cord method includes the attenuation associated with the connections between the equipment cords and the fixed cabling, but excludes the attenuation associated with the connectors that will be connected into the equipment.

The maximum allowed cabling attenuation specified (e.g., optical power budget or channel attenuation) for a transmission system normally excludes the connections made to the transmission equipment. It is, therefore, appropriate to use the equipment cord method (if possible) where the cabling under test is intended to be connected directly to transmission equipment.

The OTDR method emits short light impulses into the cabling and measures the backscattered power as a function of propagation time delay or length along the optical fibre. This method allows the measurement of the attenuation of both installed cabling plant and the attenuation of individual cabling components such as connectors and lengths of optical fibre cable. It does not require a separate reference measurement to be completed. Requirements for the launch cord and tail cord are defined in Annex E. In addition to commissioning new cabling plant, the OTDR method is useful for optical fibre cabling testing during trouble-shooting and maintenance, since the cabling plant can be characterized by a detailed mapping (the OTDR trace) that can be analysed to highlight any changes.