

INTERNATIONAL STANDARD

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**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**



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CONTENTS

FOREWORD.....	7
1 Scope.....	9
2 Normative references	9
3 Terms, definitions, graphical symbols and abbreviated terms.....	9
3.1 Terms and definitions.....	10
3.2 Graphical symbols	12
3.3 Abbreviated terms.....	14
4 Test methods.....	14
4.1 General.....	14
4.2 Cabling configurations and applicable test methods	15
5 Overview of uncertainties	17
5.1 General.....	17
5.2 Sources of significant uncertainties.....	17
5.3 Consideration of the PM.....	18
5.4 Consideration of test cord connector grade	18
5.5 Typical uncertainty values.....	18
6 Apparatus.....	19
6.1 General.....	19
6.2 Light source	19
6.2.1 Stability	19
6.2.2 Spectral characteristics (LSPM measurement).....	19
6.3 Launch cord	20
6.4 Receive or tail cord.....	20
6.5 Substitution cord.....	21
6.6 Power meter – LSPM methods only.....	21
6.7 OTDR apparatus.....	21
6.8 Connector end face cleaning and inspection equipment.....	22
6.9 Adapters	22
7 Procedures.....	22
7.1 General.....	22
7.2 Common procedures.....	22
7.2.1 Care of the test cords	22
7.2.2 Make reference measurements (LSPM methods only).....	22
7.2.3 Inspect and clean the ends of the optical fibres in the cabling.....	22
7.2.4 Make the measurements.....	23
7.2.5 Make the calculations	23
7.2.6 Duplex and bi-directional testing.....	23
7.3 Calibration	23
7.4 Safety	23
8 Calculations.....	23
9 Documentation	23
9.1 Information for each test	23
9.2 Information to be available.....	24
Annex A (normative) One-cord method	25
A.1 Applicability of test method	25

A.2	Apparatus	25
A.3	Procedure	25
A.4	Calculation	26
A.5	Components of reported attenuation	26
Annex B (normative)	Three-cord method	27
B.1	Applicability of test method	27
B.2	Apparatus	27
B.3	Procedure	27
B.4	Calculations	28
B.5	Components of reported attenuation	28
Annex C (normative)	Two-cord method	29
C.1	Applicability of test method	29
C.2	Apparatus	29
C.3	Procedure	29
C.4	Calculations	30
C.5	Components of reported attenuation	30
Annex D (normative)	Equipment cord method	32
D.1	Applicability of the test method	32
D.2	Apparatus	32
D.3	Procedure	32
D.4	Calculation	33
D.5	Components of reported attenuation	33
D.6	Typical uncertainty values	34
Annex E (normative)	Optical time domain reflectometer	35
E.1	Applicability of the test method	35
E.2	Apparatus	35
E.2.1	General	35
E.2.2	OTDR	35
E.2.3	Test cords	35
E.3	Procedure (test method)	36
E.4	Calculation	37
E.4.1	General	37
E.4.2	Connection location	37
E.4.3	Definition of power levels F_1 and F_2	38
E.4.4	Alternative calculation	38
E.5	OTDR uncertainties	40
Annex F (normative)	Requirements for the source characteristics	42
F.1	Encircled flux	42
F.2	Assumptions and limitations	42
F.3	Encircled flux templates	42
F.3.1	General	42
F.3.2	Uncertainties expectations	43
F.3.3	Templates	43
F.4	Graphical representation of templates	44
Annex G (informative)	OTDR configuration information	46
G.1	General	46
G.2	Fundamental parameters that define the operational capability of an OTDR	47
G.2.1	Dynamic range	47

G.2.2	Pulse width	47
G.2.3	Averaging time	47
G.2.4	Dead zone	47
G.3	Other parameters	47
G.3.1	Index of refraction.....	47
G.3.2	Measurement range	48
G.3.3	Distance sampling	48
G.4	Other measurement configurations	48
G.4.1	General	48
G.4.2	Macrobend or splice attenuation measurement	48
G.4.3	Splice attenuation measurement.....	49
G.4.4	Measurement with high reflection connectors or short length cabling	49
G.4.5	Ghost	51
G.5	More on the measurement method	52
G.6	Bi-directional measurement.....	53
G.7	Non-recommended practices.....	54
G.7.1	Measurement without tail test cord	54
G.7.2	Cursor measurement	54
Annex H (informative)	Test cord attenuation verification	55
H.1	General.....	55
H.2	Apparatus	55
H.3	Procedure	55
H.3.1	General	55
H.3.2	Test cord verification for the one-cord and two-cord methods when using non-pinned/unpinned and non-plug/socket style connectors	56
H.3.3	Test cord verification for the one-cord and two-cord methods when using pinned/unpinned or plug/socket style connectors.....	57
H.3.4	Test cord verification for the three-cord method when using non-pinned/unpinned and non-plug/socket style connectors	59
H.3.5	Test cord verification for the three-cord method when using pinned/unpinned or plug/socket style connectors	61
Annex I (normative)	On the use of reference-grade test cords.....	63
I.1	General.....	63
I.2	Practical configurations and assumptions.....	63
I.2.1	Component specifications	63
I.2.2	Conventions	64
I.2.3	Reference planes	64
I.3	Impact of using reference grade test cords for recommended LSPM methods	64
I.4	Examples for LSPM measurements.....	65
I.4.1	Example 1 (configuration A, 1-C method – Annex A).....	65
I.4.2	Example 2 (configuration D, EC method – Annex D)	65
I.5	Impact of using reference-grade test cords for different configurations using the OTDR test method	66
I.5.1	Cabling configurations A, B and C	66
I.5.2	Cabling configuration D	67
Annex J (informative)	Launch cord output near-field verification.....	69
J.1	Direct verification	69
J.2	Test equipment manufacturer verification.....	69
J.3	Field check with physical artefact.....	69
J.3.1	General	69

J.3.2	Procedure for attenuation characterization of artefacts	71
J.3.3	Construction details	71
J.3.4	Example results	72
Bibliography.....		76
Figure 1	– Connector symbols	13
Figure 2	– Symbol for cabling under test.....	13
Figure 3	– Reference plane for configuration A tested with the 1-cord method	16
Figure 4	– Reference plane for configuration B tested with the 3-cord method	16
Figure 5	– Reference plane for configuration C tested with the 2-cord method	17
Figure 6	– Reference plane for configuration D tested with the EC method	17
Figure 7	– OTDR schematic.....	21
Figure A.1	– Reference measurement.....	26
Figure A.2	– Test measurement	26
Figure B.1	– Reference measurement.....	27
Figure B.2	– Test measurement	28
Figure C.1	– Reference measurement.....	29
Figure C.2	– Test measurement.....	30
Figure C.3	– Test measurement for plug-socket style connectors.....	30
Figure D.1	– Reference measurement.....	33
Figure D.2	– Test measurement.....	33
Figure E.1	– OTDR method.....	36
Figure E.2	– Location of the ports of the cabling under test.....	37
Figure E.3	– Graphic construction of F_1 and F_2	38
Figure E.4	– Graphic construction of F_1 , F_{11} , F_{12} and F_2	40
Figure F.1	– Encircled flux example	45
Figure G.1	– Splice and macrobend attenuation measurement.....	49
Figure G.2	– Attenuation measurement with high reflection connectors.....	50
Figure G.3	– Attenuation measurement of a short length cabling.....	51
Figure G.4	– OTDR trace with ghost	52
Figure G.5	– Cursor positioning	53
Figure H.1	– Obtaining reference power level P_0	57
Figure H.2	– Obtaining power level P_1	57
Figure H.3	– Obtaining reference power level P_0	58
Figure H.4	– Obtaining power level P_1	58
Figure H.5	– Obtaining reference power level P_0	59
Figure H.6	– Obtaining power level	59
Figure H.7	– Obtaining reference power level P_0	60
Figure H.8	– Obtaining power level P_1	60
Figure H.9	– Obtaining power level P_5	61
Figure H.10	– Obtaining reference power level P_0	62

Figure H.11 – Obtaining power level P_1	62
Figure I.1 – Cabling configurations A, B and C tested with the OTDR method	66
Figure I.2 – Cabling configuration D tested with the OTDR method	68
Figure J.1 – Initial power measurement.....	70
Figure J.2 – Verification of reference-grade connection	70
Figure J.3 – Two offset splices.....	70
Figure J.4 – Five offset splices	71
Figure J.5 – EF centred	72
Figure J.6 – EF underfilling	73
Figure J.7 – EF overfilling	73
Figure J.8 – L1 attenuation with mandrel.....	74
Figure J.9 – L1 attenuation with mandrel and mode conditioner	74
Figure J.10 – L2 attenuation with mandrel.....	74
Figure J.11 – L2 attenuation with mandrel and mode conditioning.....	75
Figure J.12 – L3 attenuation with mandrel.....	75
Figure J.13 – L3 attenuation with mandrel and mode conditioning.....	75
Table 1 – Cabling configurations.....	15
Table 2 – Test methods and configurations.....	15
Table 3 – Measurements bias related to test cord connector grade	18
Table 4 – Uncertainty for a given attenuation at 850 nm.....	19
Table 5 – Spectral requirements	19
Table D.1 – Uncertainty for a given attenuation at 850 nm	34
Table F.1 – Attenuation, threshold tolerance and confidence level	43
Table F.2 – EF requirements for 50 µm core optical fibre cabling at 850 nm	43
Table F.3 – EF requirements for 50 µm core optical fibre cabling at 1 300 nm.....	44
Table F.4 – EF requirements for 62,5 µm core optical fibre cabling at 850 nm.....	44
Table F.5 – EF requirements for 62,5 µm core optical fibre cabling at 1 300 nm.....	44
Table G.1 – Default effective group index of refraction values.....	48
Table I.1 – Measurement bias when using reference-grade test cords	65
Table I.2 – Measurement bias when using reference grade test cords – OTDR test method	67

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIBRE-OPTIC COMMUNICATION SUBSYSTEM TEST PROCEDURES –**Part 4-1: Installed cabling plant – Multimode attenuation measurement**

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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

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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-OM_x, 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.

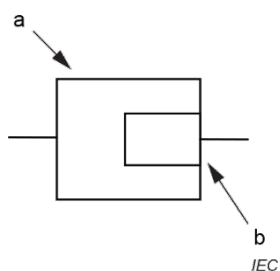


Figure 1a – Socket and plug assembly

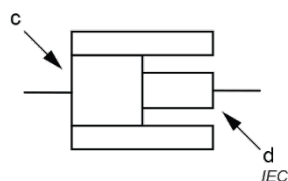


Figure 1b – Connector set (plug, adapter, plug)

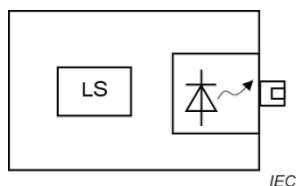


Figure 1c – Light source

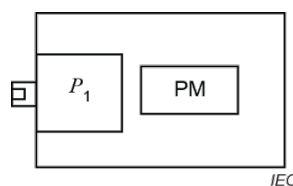


Figure 1d – Power meter

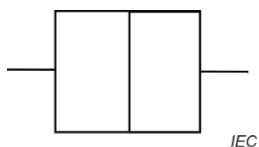


Figure 1e – Generic connection

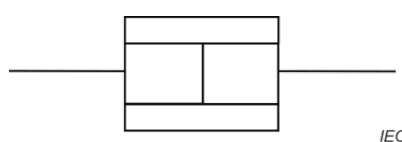


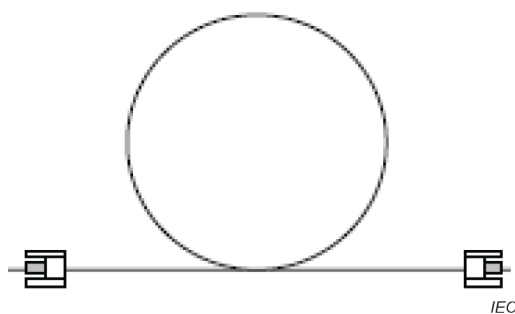
Figure 1f – Pinned/unpinned connection

Key

a	socket	d	plug inserted into plug-adaptor assembly
b	plug	LS	light source
c	plug-adaptor 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.