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INTERNATIONAL STANDARD

colour inside

AMENDMENT 1

Information technology – Implementation and operation of customer premises cabling –
Part 3: Testing of optical fibre cabling

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ISO/IEC 14763-3:2006/A1:2009(E)

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AMENDMENT 1

Information technology – Implementation and operation of customer premises cabling –
Part 3: Testing of optical fibre cabling

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FOREWORD

Amendment 1 to International Standard ISO/IEC 14763-3 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

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2 Normative references

Delete the following references:

IEC 60793-1-20, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

IEC/PAS 61300-3-43, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-43: Examination and measurements – Mode Transfer Function Measurement for fibre optic sources*

Add the following new references:

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

IEC 61280-4-1, *Fibre optic communication subsystem test procedures – Part 4-1: Cable plant and links – Multimode fibre-optic cable plant attenuation measurement*

IEC/PAS 62614, *Fibre optics – Launch condition requirements for measuring multimode attenuation*

3.1 Definitions

Replace the existing term and definition 3.1.7 by the following:

3.1.7
field calibration cord
test cord used for referencing when using the three test cord reference test method

Delete the following terms and definitions:

3.1.5
coupled power ratio (CPR)

3.1.14
relative power distribution

Add, after 3.1.19, the following new terms and definitions:

3.1.20

attenuation

reduction of optical power induced by transmission though a medium such as optical fibre; this is sometimes called insertion loss, L, and is given in dB as $L = 10 \log_{10}(P_{in}/P_{out})$, where P_{in} and P_{out} are the power, typically measured in mW, into and out of the cabling

3.1.21
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

3.1.22
OTDR dead zone

distance in which an OTDR cannot detect an event following a reflective event

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3.2 Abbreviations

Add, in the existing list, the following:

EF Encircled flux

Remove, from the existing list, the following:

CPR, MPD and RPD

5.4 Documentation

Replace the existing item d) by the following:

d) optical fibre cabling details (fibre core size/MFD; fibre type, e.g. A1a, A1b, A1a.2, B1.1, B1.3)

6.1.3 Power meters

Add, after the first paragraph, the following new paragraphs and NOTE:

When the test set-up (LSPM) is used for a link or channel attenuation, the measurement uncertainty shall not be greater than ±0,02 dB.

When the test set-up (LSPM) is used for a field check of the reference connectors by measuring the attenuation, the measurement uncertainty should be <0,02 dB.

NOTE It is therefore recommended to use a power meter with a power resolution of at least 2 decimal places.

6.3.2 Reference connector requirements

Add, after Table 3, the following new paragraphs and NOTE:

When the test set-up (LSPM) is also used for a link or channel attenuation the measurement uncertainty should be <0,2 dB.

When the test set-up (LSPM) is used for a field check of the reference connectors by measuring the attenuation, the measurement uncertainty should be <0,02 dB.

NOTE It is therefore recommended to use a power meter with a power resolution of at least 2 decimal places.

6.3.3.6 OTDR launch cord

Replace the second paragraph by the following new text:

The launch cord shall be

- longer than the attenuation dead zone of the OTDR (see Annex C for further details),
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C1 to C2 in Figure 11) so that reliable insertion loss measurements may be carried out. For example, in multimode fibre installations the length of the launch cord should be at least 75 m,
- terminated at one end with one or more connectors suitable for attachment to the OTDR,
- terminated at the other end with one or more reference connectors compatible with the interface to the installed cabling.

6.3.3.7 OTDR tail cord

Replace the first paragraph by the following new text:

The tail cord shall be

- of a different length than the corresponding launch cord (but longer than the attenuation dead zone of the OTDR, see Annex C or further details),
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C3 to C4 in Figure 11), so that reliable insertion loss measurements may be made). For example, in multimode installations the length of the tail cord should be at least 75 m,
- terminated at one end with one or more reference connectors compatible with the interface to the installed cabling.

6.3.4.6 OTDR launch cord

Replace the first paragraph by the following new text:

The launch cord shall be

- longer than the attenuation dead zone of the OTDR,
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C1 to C2 in Figure 11), so that reliable insertion loss measurements may be carried out. For example, in single-mode installations the length of the launch cord should be at least 150 m,
- terminated at one end with one or more connectors suitable for attachment to the OTDR, see Annex C for further details,
- terminated at the other end with one or more single-mode reference connectors compatible with the interface to the installed cabling.

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6.3.4.7 OTDR tail cord

Replace the first paragraph by the following new text:

The tail cord shall be

- of a different length than the corresponding launch cord (but longer than the attenuation dead zone of the OTDR, see Annex C for further details),
- long enough for a reliable straight-line fit to be made to the backscatter trace following the dead zone (C3 to C4 in Figure 11), so that reliable insertion loss measurements may be carried out. For example, in single-mode installations the length of the tail cord should be at least 150 m,
- terminated at one end with one or more reference connectors compatible with the interface to the installed cabling.

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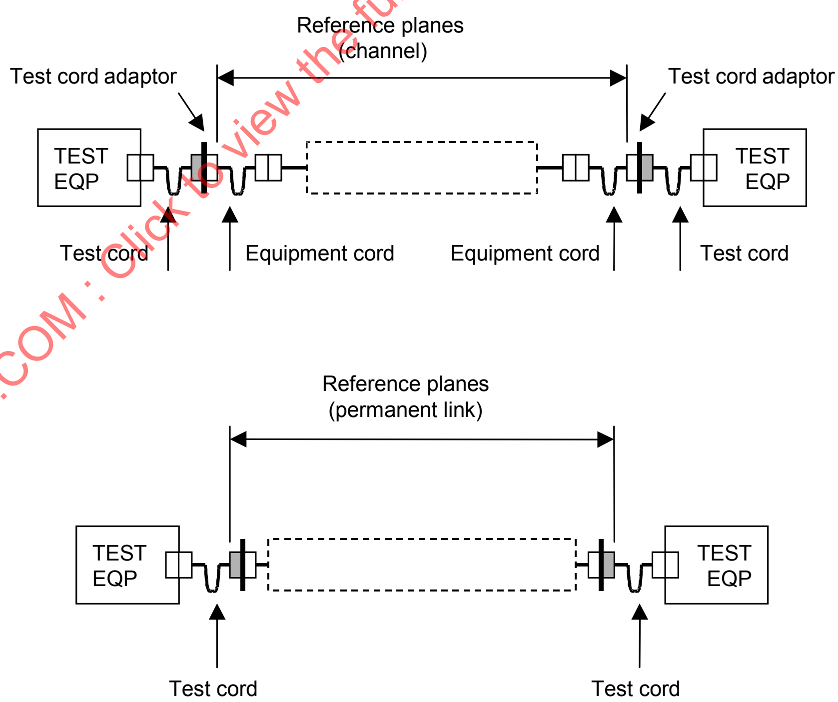
8.1.2 Reference planes

Replace the third paragraph by the following new text:

The test configuration reference planes of a channel are within the equipment cords next to, but excluding, the connections of the equipment cords into the test cords (see Figure 8). The test configuration reference planes of a permanent link are within the test cords next to, and including, the test cord connections which mate to the termination points of the permanent link under test (see Figure 8).

Replace the existing Figure 8 by the following new Figure 8:



NOTE The dotted area contains cable and may contain splices and additional connections.

Figure 8 – Channel and permanent link test configuration

In the second bullet point after Figure 8 replace "this variable factor" *by* "these variations".

9.1.1.2 Test method

Replace, in the first paragraph, ”3-jumper” *by* “three test cord reference”.

Replace, in the second paragraph, ”1-jumper” *by* “one test cord reference”.

Replace the fifth paragraph by the following new text:

The reference measurement, P_0, shall be recorded in watts or dBm.

Replace the ninth paragraph by the following new text:

The cabling under test shall be connected between the launch and tail cords and the test measurement, P_1, shall be recorded in watts or dBm.

Figure 9 LSPM 3-jumper attenuation measurement of installed cabling

Replace the title of Figure 9 by the following:

Figure 9 – SSPM three test cord attenuation measurement of installed cabling

Figure 10 LSPM 1-jumper attenuation measurement of installed link

Replace the title of Figure 10 by the following:

Figure 10 – SSPM one test cord attenuation measurement of installed cabling

9.1.1.3 Test result

Replace the first paragraph by the following new text:

For a given wavelength and in a given direction, measured loss is calculated using P_0 and P_1 as follows:

$$L = P_0 - P_1 \quad \text{(dB)} \tag{1}$$

where P_1 and P_0 are expressed in dBm.

Add, before the last paragraph, the following new paragraph:

For example, if the reference power level P_0 is −20 dBm (0,01 mW) and the measured power level P_1 is −23 dBm (0,005 mW) then the loss is 3 dB.

9.1.1.5 Treatment of channel test results

Add, before the existing paragraph, the following new text:

The use of reference terminations on the test cords affects the calculation of limits of testing for channel attenuation. The referencing procedure involves the interconnection of reference terminations in accordance with Table 2. The measurement of the channel includes connection of the test cords to non-reference terminations, which for ISO/IEC 11801 compliant connecting hardware, are specified in Table 4.

Using the default three test cord reference method specified in 9.1.1.2, the limit of testing for channel attenuation is

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- for MMF: Limit = 0,4 dB + Σ (cable attenuation) + Σ (embedded connection attenuation);
- for SMF: Limit = 0,6 dB + Σ (cable attenuation) + Σ (embedded connection attenuation).

NOTE Where the performance of the interfaces to the cabling under test is not in accordance with ISO/IEC 11801, information should be sought from the manufacturers of the interfaces to determine the relevant information for Table 3 and Table 4. The general formula for the value = 2 × {(reference/embedded) − (reference/reference)}.

Examples of these calculations are shown in Annex G.

9.1.1.6 Treatment of permanent link test results

Replace the first and second paragraphs by the following new text:

The use of reference terminations on the test cords affects the calculation of limits of testing for permanent link attenuation. The referencing procedure involves the interconnection of reference terminations in accordance with Table 2. The measurement of the channel includes connection of the test cords to non-reference terminations, which, for ISO/IEC 11801 compliant connecting hardware, are specified in Table 3.

Using the default three test cord reference method specified in 9.1.1.2, the limit of testing for permanent link attenuation is

- for MMF: Limit = 0,4 dB + Σ (cable attenuation) + Σ (embedded connection attenuation);
- for SMF: Limit = 0,6 dB + Σ (cable attenuation) + Σ (embedded connection attenuation).

NOTE 1 Where the performance of the interfaces to the cabling under test is not in accordance with ISO/IEC 11801, information should be sought from the manufacturers of the interfaces to determine the relevant information for Tables 3 and 4. The general formula for the value = 2 × {(reference/random) − (reference/reference)}.

Using the alternative one test cord reference method specified in 9.1.12, the limit for testing for permanent link attenuation is

- for MMF: Limit = 0,6 dB + Σ (cable attenuation) + Σ (embedded connection attenuation);
- for SMF: Limit = 1,0 dB + Σ (cable attenuation) + Σ (embedded connection attenuation).

NOTE 2 Where the performance of the interfaces to the cabling under test is not in accordance with ISO/IEC 11801, then information should be sought from the manufacturers of the interfaces to determine the relevant information for Table 4. The general formula for the value = 2 × (reference/embedded).

Examples of these calculations are shown in Annex G.

9.1.2.1 Test method

Replace the existing second paragraph before the bullet points as follows:

The OTDR/optical source shall be selected for the mode/wavelength as defined in Annex C and the appropriate settings established:

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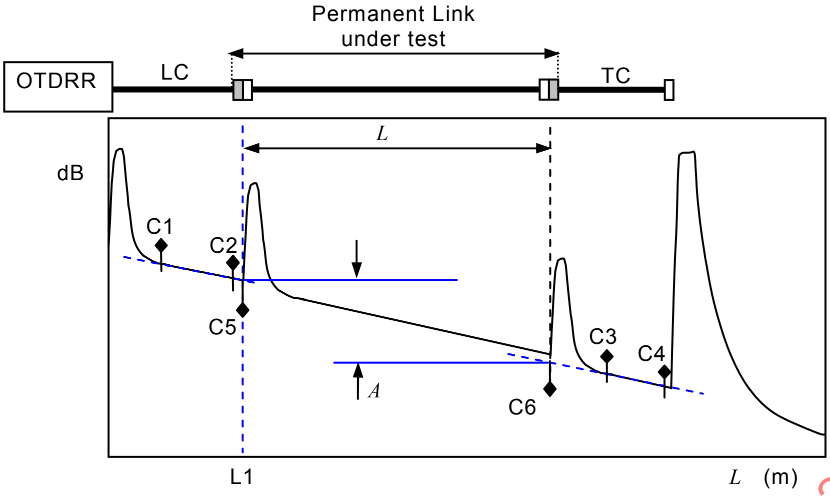
Replace the existing Figure 11 by the new Figure 11:



Key

LC	Launch cord
TC	Tail cord
C1, C2, C3, C4	Cursors for linear regression definition
C5, C6	Cursors at attenuation location
A	Attenuation/Insertion loss of permanent link
L	Length of permanent link

Figure 11 – OTDR measurement of installed cabling (permanent link)

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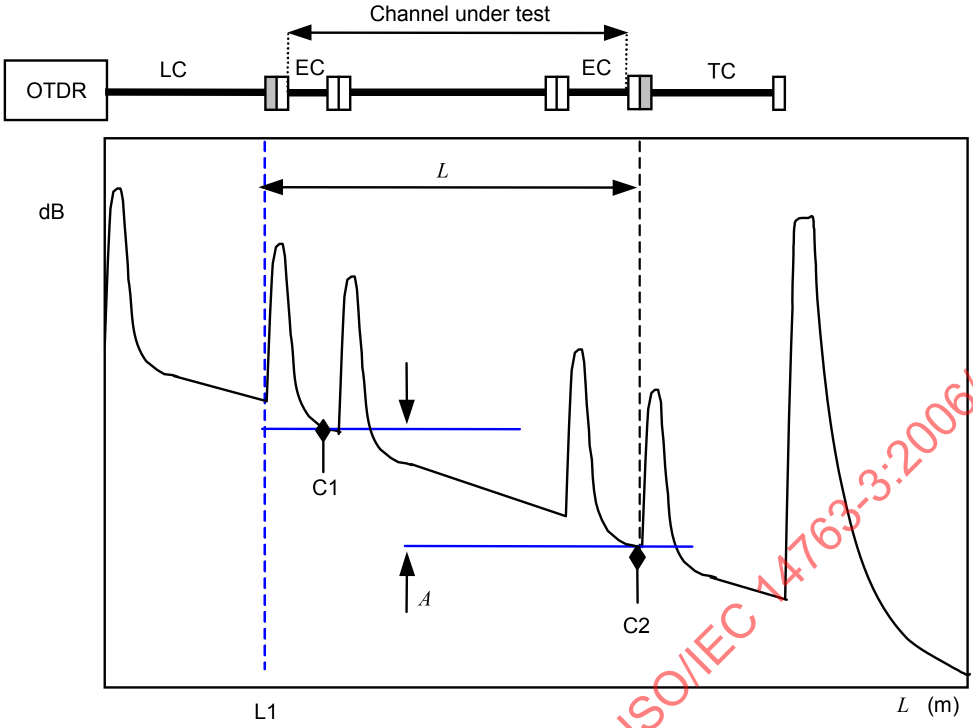
Replace the existing Figure 12 by the new Figures 12a and 12b as follows:



Key

LC	Launch cord
TC	Tail cord
EC	Equipment cord
C1, C2	Cursors for 2-point channel insertion loss/attenuation measurement
A	Attenuation/Insertion loss of channel plus equipment connectors
L	Length of channel

Figure 12a – Alternative a

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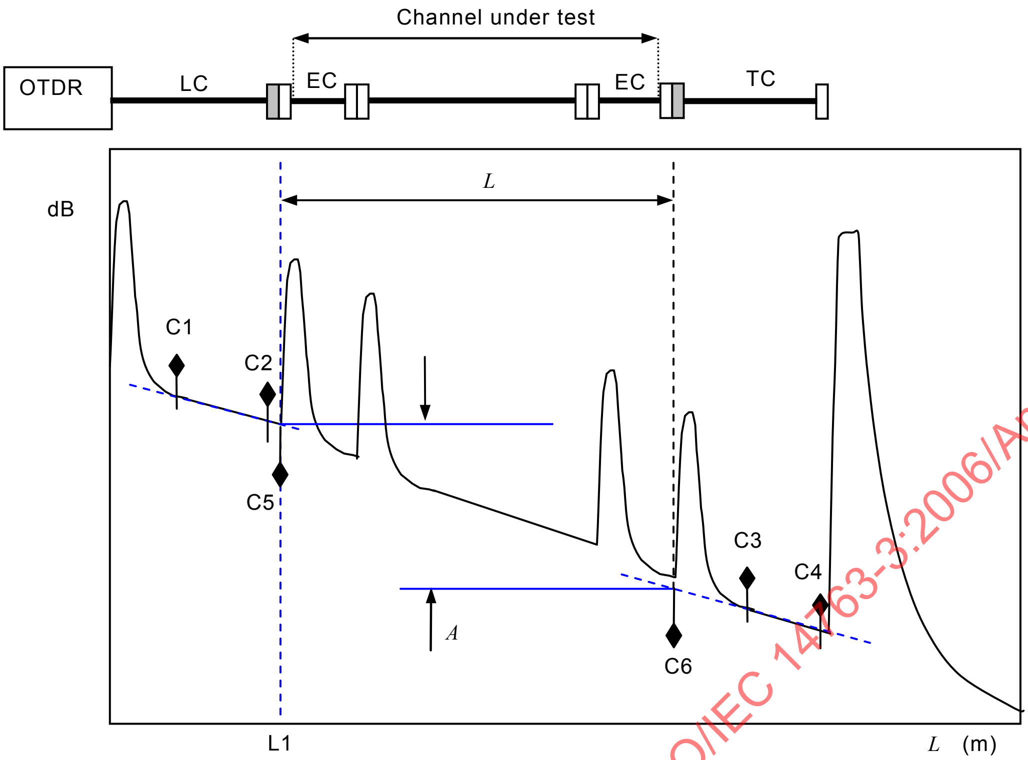

Key

LC	Launch cord
TC	Tail cord
EC	Equipment cord
C1, C2, C3, C4	Cursors for linear regression definition
C5, C6	Cursors at attenuation location
A	Attenuation/Insertion loss of channel plus equipment connectors
L	Length of channel

Figure 12b – Alternative b

Figure 12 – OTDR measurement of installed cabling (channel)

9.1.2.3 Treatment of channel test results

Replace the first and second paragraphs by the following new text:

The attenuation/insertion loss of the installed cabling shall be measured either as shown in Figure 12a or as shown in Figure 12b.

Figure 12a shows the 2 points at which the attenuation/insertion loss of the installed cabling shall be measured. If the equipment cords are very short and/or the OTDR dead zone is long, then it may reduce the accuracy of the insertion loss measurement.

It should be noted that

- it is not possible to carry out the more accurate five point insertion loss measurement where two reflective events are in close proximity as there is unlikely to be sufficient length of optical fibre in the equipment connection cords to obtain a linear fit to these sections around C1 and C2;
- if the equipment connection cords are very short and/or the OTDR dead zone is long then it may not be possible to measure the channel attenuation.

Figure 12b shows the alternative approach where the attenuation of the channel is measured plus the insertion loss of the equipment connectors.

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9.2.1 Test method

Replace the last sentence of this subclause by the following new paragraph:

Propagation delay may be calculated as follows:

Propagation delay T = optical fibre length × n/c

where

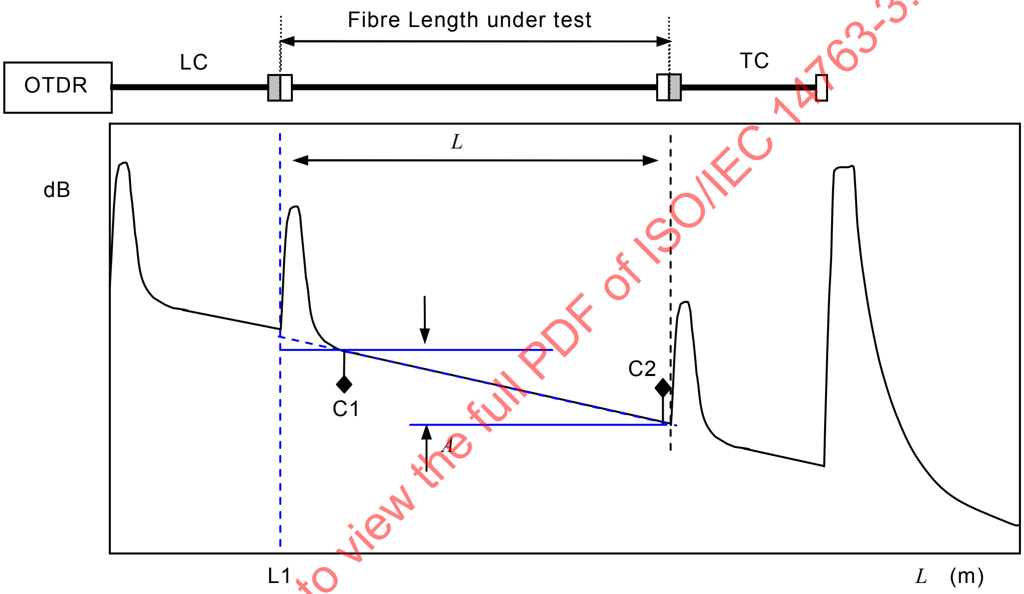
c = speed of light in a vacuum (3×10^8 ms^{-1})

n = group refractive index of the optical fibre

NOTE As n ~ 1,5 for all optical fibres the formula can be approximated to T = optical fibre length × 5 (ns).

10.1.3 Treatment of results

Replace the existing Figure 13 by the new Figure 13 as follows:



Key

LC Launch cord
TC Tail cord
C1, C2 Cursors for linear regression definition
A Attenuation/Insertion loss of optical fibre
L Length of optical fibre

Figure 13 – OTDR measurement of optical fibre attenuation

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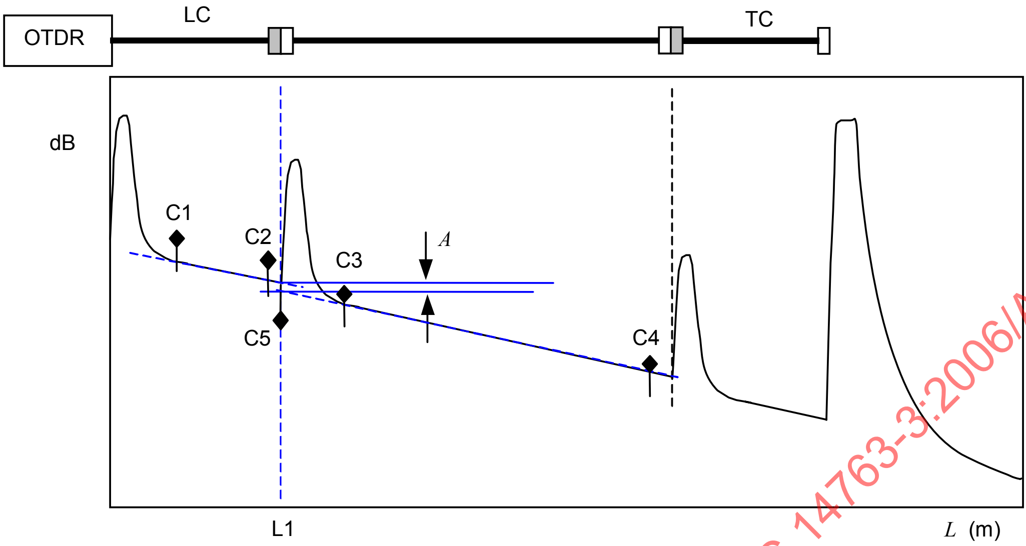
10.2.3 Treatment of results

Replace the existing Figure 14 by the new Figure 14 as follows:



Key

LC	Launch cord
TC	Tail cord
C1, C2, C3, C4	Cursors for linear regression definition
C5	Cursor at attenuation location
A	Attenuation/Insertion loss of measured connection

Figure 14 – OTDR measurement of connection insertion loss

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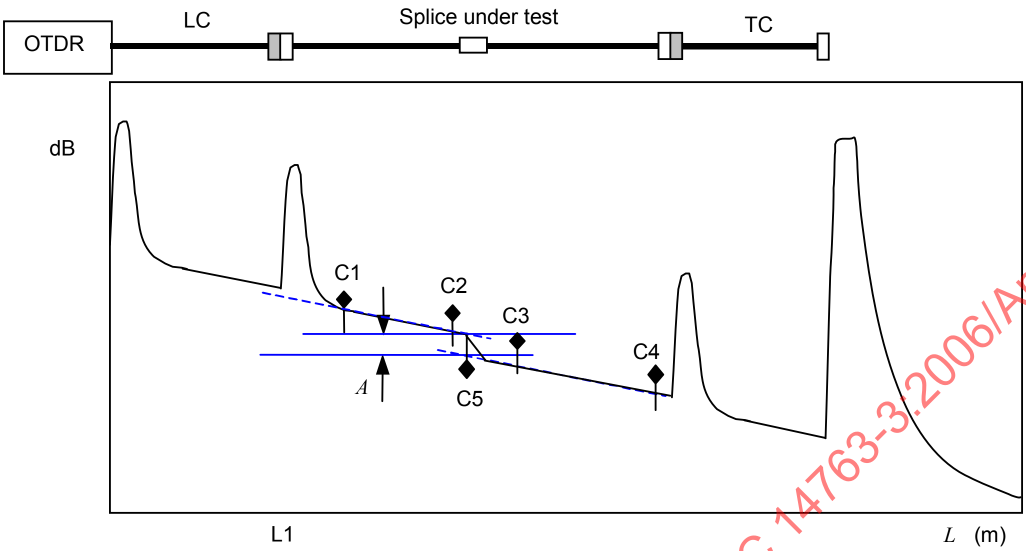
10.3.2 Treatment of results

Replace the existing Figure 15 by the new Figure 15 as follows:



Key

LC	Launch cord
TC	Tail cord
C1, C2, C3, C4	Cursors for linear regression definition
C5	Cursor at attenuation location
A	Insertion loss of non-reflective event under test

Figure 15 – OTDR measurement of joint insertion loss

10.6.1 Test method

Replace the fourth paragraph by the following new paragraph:

The reference measurement, P_0, shall be recorded in W or dBm.

Replace the fifth paragraph by the following:

The cord under test shall be connected between the launch cord and the power meter and the test measurement, P_1, shall be recorded in W or dBm.

Add, below Table 20, the following new paragraph:

The insertion loss measurement method is detailed in IEC 61300-3-4.

10.6.2 Treatment of results

Replace the first paragraph by the following new text:

For a given wavelength and in a given direction, measured loss is calculated using P_0 and P_1 as follows:

$$L = P_0 - P_1 \quad \text{(dB)} \qquad (1)$$

where P_1 and P_0 are expressed in dBm.

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Annex A
(normative)

Launched modal distribution (LMD)

Replace the entire Annex A by the following:

A.1 General

This annex describes the general launch condition requirements used for measuring attenuation. The purpose of these requirements is to ensure consistency of field measurements when different types of test equipment are used.

This annex is based on the encircled flux metric and describes the target to achieve the above.

The material of this annex is extracted from IEC/PAS 62614 and IEC 61280-4-1.

A.2 Description

Light sources, typically used in measuring attenuation, may have varying modal distributions when launched into multimode fibre. These differing modal distributions, combined with the Differential Mode Attenuation (DMA) inherent in most multimode components, commonly cause measurement variations when measuring attenuation of multimode components. For example, attenuation measurement variations can occur when two similar light sources or different launch cords are used.

In the past legacy (LED based) applications had a wide power budget which in most cases masked the variance in result between the factory and field measurement.

As technology has evolved, the system requirements for attenuation have become more stringent. Demanding application requirements are driving the need for accurate and reproducible multimode attenuation measurements over a variety of field-test instruments. Attenuation measurement experiments, with different field-test instruments having the same standards compliant set-up, produce measurement variations that are induced by their differing launch conditions. This document provides launch condition options and requirements for test instrument suppliers, component manufacturers and installers.

A.3 Background on multimode launch conditions

For background on the development of the launch condition from coupled power ratio and modal power distribution, see IEC/PAS 62614.

A.4 Test source launch

A.4.1 General

These guidelines are suitable for 50 µm and 62,5 µm core fibres, both with 125 µm cladding diameter.

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A.4.2 Encircled flux

The EF is determined from the near field measurement of the light coming from the end of the reference grade launching cord.

The near field measurement is conducted in accordance with IEC 61280-1-4. The measured near field result is a function, $I(r)$, of radius, r, away from the optical center of the core, which is used to generate the Encircled Flux (EF) function as

$$EF(r) = \frac{\int_0^r xI(x)\mathrm{d}x}{\int_0^R xI(x)\mathrm{d}x} \qquad (1)$$

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A.4.3 EF template example

An example of an encircled flux template for 50 µm fibre at 850 nm is shown in Figure A.1.

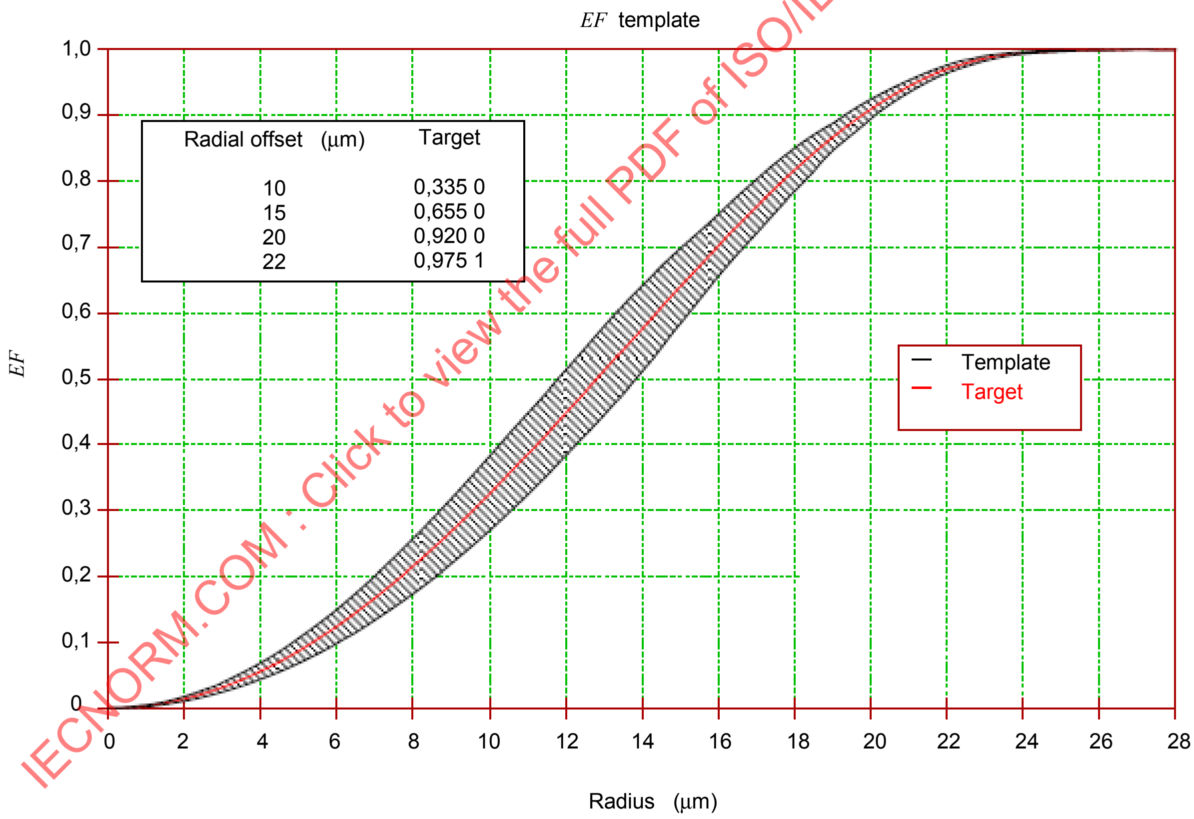

Figure A.1 – Encircled flux template example

A.4.4 EF target of the multimode launch condition for attenuation measurement

The EF requirements are defined as a collection of limiting values for a set of particular radial control points for each of four combinations of fibre core diameter and wavelength, as tabulated in Table A.1 to Table A.4.

Table A.1 – EF target for 50 µm core fibre at 850 nm (see Figure A.1)

Radial offset µm	Target
10	0,335 0
15	0,655 0
20	0,919 3
22	0,975 1

Table A.2 – EF target for 50 µm core fibre at 1 300 nm

Radial offset µm	Target
10	0,336 6
15	0,656 7
20	0,918 6
22	0,972 8

Table A.3 – EF target for 62,5 µm fibre at 850 nm

Radial offset µm	Target
10	0,210 9
15	0,439 0
20	0,692 3
26	0,935 0
28	0,978 3

Table A.4 – EF target for 62,5 µm fibre at 1 300 nm

Radial offset µm	Target
10	0,211 9
15	0,439 0
20	0,692 3
26	0,935 0
28	0,978 3

A.5 Adjustments to the raw near field data

Use IEC 61280-1-4 as the basis for the near field measurement. This annex documents adjustments that need to be made to IEC 61280-1-4 for the purposes of qualifying launch cord output near fields.

A.6 Target launch and upper and lower tolerance bands for attenuation measurements of multimode optical fibre cabling

A.6.1 General

The specified launch condition in this annex is valid for attenuation measurements of multimode fibre optic cabling. The launch condition for field attenuation of multimode fibre

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optic cabling shall meet the encircled flux requirements of Table A.5 to Table A.8 when measured at the output of the reference connector.

A.6.2 Limits on encircled flux

The limits for the encircled flux are derived from a target near field and a set of boundary conditions designed to constrain the variation in attenuation induced by variations in the source to no greater than the larger of ±10 % (on a dB basis) or the threshold value. For example, a threshold value of 0,08 dB means that the loss variation is expected to be within ±10 % for losses equal to, or greater than 0,8 dB, and within 0,08 dB for losses less than 0,8 dB. The various threshold values are given in the titles of Table A.5 to Table A.8.

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Table A.5 – EF requirements for 50 µm core fibre at 850 nm
(For threshold = 0,08 dB)

Radial offset µm	EF lower bound	EF upper bound
10	0,278 5	0,391 5
15	0,598 0	0,711 9
20	0,910 5	0,929 5
22	0,969 0	0,981 2

Table A.6 – EF requirements for 50 µm core fibre at1 300 nm
(For threshold = 0,12 dB)

Radial offset µm	EF lower bound	EF upper bound
10	0,279 2	0,394 0
15	0,599 6	0,713 8
20	0,907 2	0,930 0
22	0,966 3	0,979 3

Table A.7 – EF requirements for 62,5 µm fibre cabling at 850 nm
(For threshold = 0,10 dB)

Radial offset µm	EF lower bound	EF upper bound
10	0,168 3	0,253 5
15	0,369 5	0,508 5
20	0,.633 7	0,750 9
26	0,924 5	0,945 5
28	0,971 0	0,9856

Table A.8 – EF requirements for 62,5 µm fibre cabling at 1 300 nm
(For threshold = 0,15 dB)

Radial offset µm	EF lower bound	EF upper bound
10	0,168 0	0,255 8
15	0,369 9	0,511 9
20	0,636 9	0,752 1
26	0,925 4	0,946 0
28	0,9708	0,985 6

Table B.2 Requirements for visual end-face inspection

Replace the entire Table B.2 including the NOTE by the following new Table B.2 and add the paragraph and NOTE as follows:

Table B.2 – Requirements for visual end-face inspection

	MMF minimum 100× magnification	**SMF** minimum 200× magnification
Number of scratches (maximum)	10 (between 2 µm and 5 µm)	2 (≤3 µm)
	0 (>5 µm)	0 (>3 µm)
Number of pits/chips (maximum)	10 (between 2 µm and 5 µm)	2 (≤3 µm)
	0 (>5 µm)	0 (>3 µm)

It is assumed that the inspection equipment has a minimum total magnification to offer a field of view of at least 250 µm is capable of detecting low contrast defects of 2 µm in diameter. With such equipment, phenomena within the size ranges in Table B.2 are easily visible. The size of the phenomenon can be approximated by comparison to the visible core diameter.

NOTE Text from, and references to, IEC 61300-3-35 are intended to be included at the circulation.

D.2 Insertion loss (test and field calibration cord reference connections)

Replace the fourth and fifth paragraphs by the following new text:

The reference measurement, P_0, shall be recorded in W or dBm.

The launch cord shall remain connected to the light source. The reference connector on the field calibration, tail or other launch cord under test shall be connected between the launch cord and the power meter and the test measurement, P_1, shall be recorded in W or dBm.

Replace the sixth paragraph by the following new paragraph:

For a given nominal wavelength, the measured loss is calculated using P_0 and P_1 as follows:

$$L = P_0 - P_1 \quad \text{(dB)} \qquad \text{(D.1)}$$

where P_1 and P_0 are expressed in dBm.

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