



BSI Standards Publication

Information technology — Implementation and operation of customer premises cabling

Part 3: Testing of optical fibre cabling

National foreword

This British Standard is the UK implementation of ISO/IEC 14763-3:2014+A1:2018, incorporating corrigendum March 2015. It supersedes BS ISO/IEC 14763-3:2006+A1:2009, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment A1 is indicated by A1 A1.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by IEC corrigendum March 2015 is indicated in the text by AC1 AC1.

The UK participation in its preparation was entrusted to Technical Committee TCT/7/1, Telecommunications - Installation requirements - Cabling infrastructure, design, planning and commissioning.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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cabling –
Part 3: Testing of optical fibre cabling

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INFORMATION TECHNOLOGY – IMPLEMENTATION AND OPERATION OF CUSTOMER PREMISES CABLING –

Part 3: Testing of optical fibre cabling

FOREWORD

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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 second edition cancels and replaces the first edition published in 2006 and its Amendment 1:2009.

This edition constitutes a technical revision.

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

- general requirements (Clause 5) have been revised and the concept of normalization has been replaced by reference measurements;
- OTDR characterization (6.2) and requirements for cabling interface adapters (6.3) and test cords have been revised and requirements for single-mode fibre test cords (6.3.4) have been removed;
- enhanced three-test-cord reference method has been introduced (9.1.1.2);
- requirements for the attenuation measurement of cords (10.6) have been revised;
- Annex A "Launched modal distribution (LMD)" has been simplified and the new title now reads "Launched modal conditions for testing multimode optical fibre cabling";
- visual inspection criteria for connectors have been reworked (Annex B);
- information on optical time domain reflectometry (Annex C) has been revised;
- examples of calculations of channel and permanent link limits (Annex G) have been revised;
- and information regarding cleaning and inspection of fibre optic connections have been added (Annex H).

A list of all parts in the ISO/IEC 14763 series, published under the general title *Information technology – Implementation and operation of customer premises cabling*, can be found on the IEC website.

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

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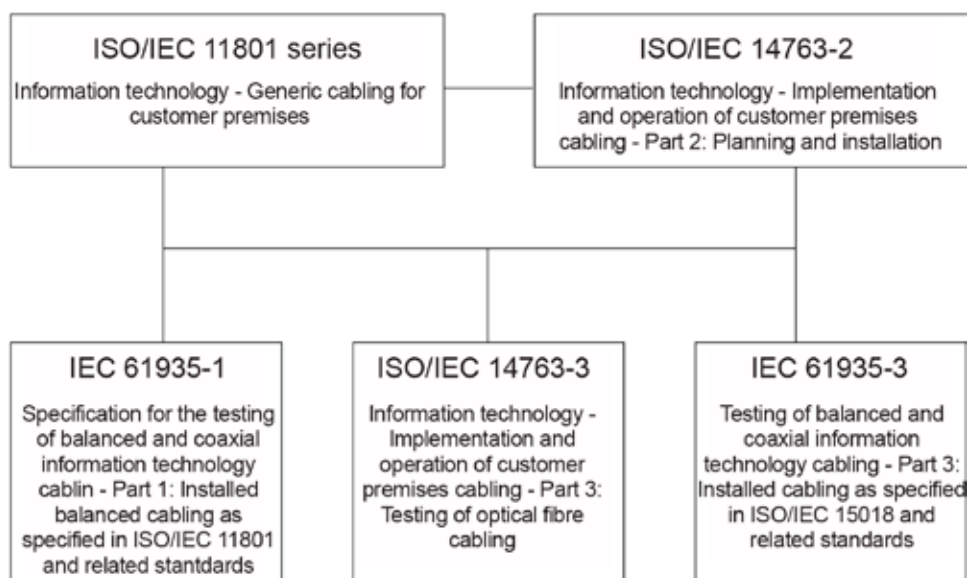
- reconfirmed,
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- amended.

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 document using a colour printer.

INTRODUCTION

A1 This International Standard has been prepared in support of International Standard series ISO/IEC 11801.

Figure 1 below shows the inter-relationship between the ISO/IEC 11801 series and other International Standards and for cabling systems with related standards.



NOTE ISO/IEC 15018 has been replaced by ISO/IEC 11801-4.

Figure 1 – Relationship of related International Standards

ISO/IEC 14763-3 details the inspection and test procedures for optical fibre cabling,

- a) designed in accordance with premises cabling standards including the ISO/IEC 11801 series, and
- b) installed according to the requirements and recommendations of ISO/IEC 14763-2. **A1**

Users of this International Standard should be familiar with relevant premises cabling standards and ISO/IEC 14763-2.

The quality plan for each installation will define the acceptance tests and sampling levels selected for that installation. Requirements and recommendations for the development of a quality plan are described in ISO/IEC 14763-2.

NOTE JTC 1/SC 25, in cooperation with IEC/TC 86, is currently developing an overall quantitative model to calculate total measurement uncertainty as stated in the reference planes of **A1** ISO/IEC 11801-1**A1**. When such a model has been verified, it is expected to be incorporated into this standard in form of an Amendment, thereby removing pertinent clauses currently marked “ffs” (for further study).

INFORMATION TECHNOLOGY – IMPLEMENTATION AND OPERATION OF CUSTOMER PREMISES CABLING –

Part 3: Testing of optical fibre cabling

1 Scope

This part of ISO/IEC 14763 specifies systems and methods for the inspection and testing of installed optical fibre cabling designed in accordance with premises cabling standards including [A1](#) the ISO/IEC 11801 series. [A1](#) The test methods refer to existing standards-based procedures where they exist.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[A1](#) ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements* [A1](#)

ISO/IEC 14763-2, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication*

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

IEC 60874-14-3, *Connectors for optical fibres and cables – Part 14-3: Detail specification for fibre optic adapter (simplex) type SC for single-mode fibre*

IEC 60874-19-1, *Fibre optic interconnecting devices and passive components – Connectors for optical fibres and cables – Part 19-1: Fibre optic patch cord connector type SC-PC (floating duplex) standard terminated on multimode fibre type A1a, A1b – Detail specification*

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 61280-4-1, *Fibre-optic communication subsystem test procedures – Part 4-1: Installed cable plant – Multimode attenuation measurement*

IEC 61280-4-2, *Fibre optic communication subsystem basic test procedures – Part 4-2: Fibre optic cable plant – Single-mode fibre optic cable plant attenuation*

IEC 61300-3-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examinations and measurements – Attenuation*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

▣_{A1} 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* ▣_{A1}

IEC 61300-3-42, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-42: Examinations and measurements – Attenuation of single mode alignment sleeves and or adaptors with resilient alignment sleeves*

IEC 61755-3-1, *Fibre optic connector optical interfaces – Part 3-1: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia PC ferrule, single mode fibre*

IEC 61755-3-2, *Fibre optic connector optical interfaces – Part 3-2: Optical interface, 2,5 mm and 1,25 mm diameter cylindrical full zirconia ferrules for 8 degrees angled-PC single mode fibres*

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

IEC 62664-1-1, *Fibre optic interconnecting devices and passive components – Fibre optic connector product specifications – Part 1-1: LC-PC duplex multimode connectors terminated on IEC 60793-2-10 category A1a fibre*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions of ▣_{A1} ISO/IEC 11801-1 ▣_{A1} and IEC 60050-731 as well as the following apply.

3.1.1

adapter

device that enables interconnection between terminated optical fibre cables

3.1.2

attenuation

A

reduction in optical power induced by transmission through a medium such as optical fibre, given as $A = 10 \lg(P_{\text{out}}/P_{\text{in}})$, where P_{in} and P_{out} are the power, typically measured in mW, into and out of the cabling

Note 1 to entry: The values of *A* are in decibel (dB).

3.1.3

attenuation dead zone

<for a reflective or non-reflective event> region after the event where the displaced trace deviates from the undisturbed backscatter trace by more than a given vertical distance ΔF

Note 1 to entry: ΔF is commonly accepted to be a value of 0,5 dB.

[SOURCE: IEC 61746-1:2009, and IEC 61746-2:2010, 3.3, modified – The note has been changed and Figure 1 has not been included.]

3.1.4

cable sheath

covering over the optical fibre or conductor assembly that may include one or more metallic members, strength members or jackets

Note 1 to entry: Sometimes simply referred to as “sheath”.

3.1.5

3.1.5.1

connection

mated device including terminations connecting two cables or cable elements

3.1.5.2

connection

combination of devices including terminations connecting two cables or cable elements

3.1.6

encircled flux

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

3.1.7

event dead zone

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

3.1.8

fail result

measured value which fails to meet the specified requirement and where the absolute value of the difference between the measured value and the specified requirement is greater than the stated measurement uncertainty

Note 1 to entry: The fail result is for further study (ffs).

3.1.9

launch test cord

cable assembly used to connect from a light source to the cabling under test or as part of a test reference measurement

3.1.10

light source and power meter

test system consisting of a light source (LS), power meter (PM) and associated test cords used to measure the attenuation of installed cable plant

3.1.11

marginal result

measured value which differs from the specified requirement by an amount not exceeding the stated measurement uncertainty

Note 1 to entry: The marginal result is for further study (ffs).

3.1.12

multimode optical fibre

optical fibre along whose core the radiation of two or more bound modes can propagate at the wavelength of interest

Note 1 to entry: A typical multimode fibre propagates about 100 modes or more.

[SOURCE: IEC 60050-731:1991, 731-02-03, modified – definition slightly changed and note added.]

3.1.13

optical fibre

filament shaped optical waveguide made of dielectric materials

[SOURCE: IEC 60050-731:1991, 731-02-01]

3.1.14

optical time domain reflectometer

instrument used to characterise optical fibre cabling by measuring the backscatter and reflection of injected light pulses as a function of time

3.1.15

pass result

measured value which meets the specified requirements and where the absolute value of the difference between the measured value and the specified requirement is greater than the stated measurement uncertainty, provided any apparent gain does not exceed the measurement uncertainty

Note 1 to entry: The pass result is for further study (ffs).

3.1.16

reference adapter

adapter that ensures that the performance of reference connections can be attained

Note 1 to entry: This definition is only applicable to connectors with cylindrical ferrules.

3.1.17

reference connector

connector with tightened tolerances terminated onto an optical fibre that may require tightened tolerances such that the expected attenuation formed by mating two such assemblies is less than or equal to a specified value that is lower than the normal expected attenuation

3.1.18

reference measurement

measurement of the output power of the light source that is used to determine the input power level to the cabling under test

3.1.19

singlemode optical fibre

optical fibre which supports only one mode of light transmission

3.1.20

substitution test cord

test cord used within a reference measurement which is replaced during the measurement of the attenuation of the cabling under test

3.1.21

tail test cord

cable assembly used to connect from a power meter to the cabling under test or as part of a test reference measurement

3.1.22

test cord

cable assembly used either to connect test equipment to the cabling under test or as part of a test reference measurement

3.1.23

test operator

skilled person testing in accordance with instructions provided by the test system designer

3.1.24

test system

test equipment, test cords and adapters necessary to undertake a given test in accordance with the requirements of this standard

A1 3.1.25

defect

surface feature such as pits, chips and loose debris

3.1.26

loose debris

particles and debris on the surface that can be removed by cleaning

3.1.27

pit

permanent non-linear surface damage

3.1.28

scratch

permanent linear surface damage **A1**

3.2 Abbreviations

For the purposes of this document, the abbreviations of **A1** ISO/IEC 11801-1 **A1** as well as the following apply.

APC	Angled Physical Contact
CP	Consolidation Point
DUT	Device Under Test
EQP	Equipment
ffs	for further study
IOR	Index Of Refraction
A1 LC	LC connector A1
LTC	Launch Test Cord
LS	Light Source
LSA	Least Squares Average
LSPM	Light Source And Power Meter
MMF	MultiMode optical Fibre
A1 MPO	Multi-fibre Push On connector (based on rectangular ferrule) A1
N/A	Not Applicable
OTDR	Optical Time Domain Reflectometer
PC	Physical Contact
PM	Power Meter
RL	Return Loss
SC	Subscriber Connector
SMF	Single-Mode optical Fibre
STC	Substitution Test Cord
TTC	Tail Test Cord

3.3 Symbols

For the purposes of this document the following symbols apply.

	Optical fibre connector (general)
	Optical fibre connector on installed cabling
	Optical fibre connector with reference termination
	Optical fibre adapter (general)
	Optical fibre adapter imbedded in cabling
	Optical fibre reference adapter
	Splice

4 Conformance

To test installed cabling according to this International Standard

- a) the general requirements of Clauses 5 and 8 shall be met,
- b) the test equipment and test cords shall conform to the requirements of Clause 6,
- c) the test method, as appropriate, and treatment of results shall conform to Clauses 9 and 10,
- d) the test results shall be documented in accordance with 5.4,
- e) the requirements of IEC 60825-2 concerning safety of laser products shall be met.

To inspect installed cabling according to this standard

- 1) the inspection equipment shall conform to the requirements of Clause 7,
- 2) the inspection method, as appropriate, shall conform to Clause 11,
- 3) the requirements of IEC 60825-2 concerning safety of laser products shall be met.

Relevant national and local regulations covering safe working practices shall be observed.

5 General requirements

5.1 Test system

The test systems defined in this standard comprise local test equipment and remote test equipment (where required) together with test cords and adapters which enable the connection of the test equipment to the cabling under test (see Figure 2).

Certain test methods of this standard may apply to the testing of plastic optical fibre cabling (i.e. attenuation) although no detailed information is provided. Plastic optical fibre category A4 fibres are specified in IEC 60793-2-40.

The test system and, particularly the adapters and reference connectors, affect the uncertainty of the attenuation measurement for a given component, link or channel.

Index matching materials (gels and/or fluids) between the polished end faces of connectors shall not be used.

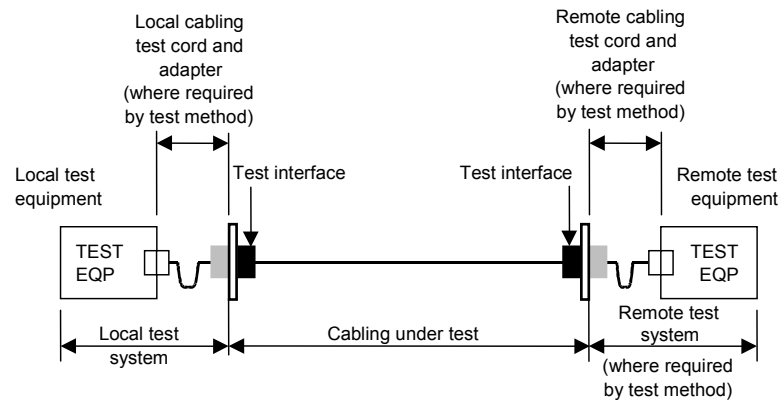


Figure 2 – Test system and the cabling under test

5.2 Reference measurement and calibration

Reference measurement processes are specified, where appropriate, to enable the test system to achieve the stated measurement uncertainty.

The test equipment shall be calibrated using standardised procedures (e.g. IEC 61315 and IEC 61746), or tester manufacturers' documented procedures, as appropriate.

The test operator shall have evidence, in the form of a valid calibration certificate, to support the use of the test equipment at the time the tests are carried out.

5.3 Environmental conditions

5.3.1 Protection of transmission and terminal equipment

Transmission and terminal equipment shall be disconnected from the cabling under test before any testing or inspection according to this standard is carried out.

5.3.2 Inspecting and cleaning connectors

Dust, dirt and other contaminants at the interfaces to the cabling under test or at interfaces of the test cords and at the interface to the test equipment may produce misleading results and in some cases damage the cabling under test.

Connector end faces on the test cords shall be inspected in accordance with Annex B. If they are dirty or contaminated they should be cleaned following the recommendations of Annex H and re-inspected. If the connectors on the test cords are damaged and/or fail to meet the requirements of Annex B, the test cords shall be replaced.

Connector end faces on the cabling under test shall be inspected in accordance with Annex B. If they are dirty or contaminated they should be cleaned following the recommendations of Annex H and re-inspected in accordance with Annex B. If the connectors on the cabling under test are damaged and/or fail to meet the requirements of Annex B, then the failure shall be reported with the recommendation that the connector be replaced.

5.3.3 Use of test equipment

External effects (for example, environmental, electromagnetic or physical) can affect the test equipment and thereby influence the measured results. Test equipment shall be operated per manufacturer's specifications. Unless manufacturer specifications provide other information, test equipment shall be allowed to stabilise at the test environment for at least 15 min prior to readings being taken.

5.3.4 Relevance of measurement

Measurements shall either

- a) be made under environmental conditions which are representative of the intended operational environment,
- b) be documented as being performed under non-representative conditions.

5.3.5 Treatment of marginal test results

Marginal results may be treated in a number of ways including

- a) verification of the reference measurement of the test system,
- b) acceptance of all marginal results,
- c) repetition of the measurement using a test system with improved measurement uncertainty.

5.4 Documentation

The documentation for each parameter shall include

- a) identification and details of the parameter,
- b) whether channel or permanent link is being tested,
- c) test equipment:
 - 1) type and manufacturer;
 - 2) serial number and calibration status;
 - 3) nominal wavelength,
- d) optical fibre cabling details (category of cabled optical fibre performance e.g. OM2, OM3, OM4, OS1, OS2)
- e) details of the cabling connector type(s),
- f) the configuration of the cabling test equipment during the test,
- g) the measured result,
- h) the applicable requirements,
- i) details of the reference numbers and direction of test,
- j) the date of the test (the time may also be recorded),
- k) the test operator,
- l) the calculated measurement uncertainty of the test system (ffs).

6 Test equipment

6.1 Light source and power meter

6.1.1 General

Derived from IEC 61280-4-1, IEC 61280-4-2 and IEC 61300-3-4, the following has been adapted to the requirements of [A1](#) ISO/IEC 11801-1 [A1](#) for link and channel attenuation (this is sometimes called insertion loss) measurements with an LSPM.

6.1.2 Light sources

For required test wavelengths, see [A1](#) ISO/IEC 11801-1 [A1](#) and ISO/IEC 14763-2. LEDs and Fabry Perot lasers should be used for multimode and single-mode testing, respectively. VCSELs should not be used.

Light sources for testing multi-mode optical fibre (MMF) cabling and components shall conform to the spectral characteristics of Table 1 when measured in accordance with IEC 61280-1-3.

Table 1 – MMF light source characteristics

Centre wavelength nm
850 ± 30
1 300 ± 30

Light sources for testing single-mode optical fibre (SMF) shall conform to the spectral characteristics of Table 2 when measured in accordance with IEC 61280-1-3.

Table 2 – SMF light source characteristics

Centre wavelength nm
1 310 ± 30
1 550 ± 30

6.1.3 Power meters

The equipment shall enable optical power measurements to be recorded to at least two significant digits in the decimal place (e.g. -14,32 dBm, 2,19 dB)

When the test set-up (LSPM) is used for a link or channel attenuation, the measurement uncertainty shall not be greater than ±0,2 dB (ffs).

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 <0,2 dB (ffs).

If the power meter consists of an optoelectronic detector with a demountable adapter then the adapter shall be fitted to the meter in accordance with the instructions provided by the supplier of the power meter.

6.1.4 Test system stability (ffs)

The light source shall be stable to ±0,1 dB

NOTE Non-linearity between the measured and incident optical power may cause measurement errors. Also, equipment with internal waveguides may exhibit measurement variability with varying modal conditions.

6.2 OTDR

6.2.1 General

OTDR equipment for testing multimode optical fibre (MMF) cabling and components shall conform to the central wavelengths of Table 1.

OTDR equipment for testing single-mode optical fibre (SMF) shall conform to the central wavelengths of Table 2.

OTDR characterization shall be undertaken using a launch test cord and a tail test cord.

See Annex C for further information on optical fibre time domain reflectometry.

6.2.2 OTDR characterization using a launch test cord and a tail test cord

Characterization of cabling using an OTDR using a launch test cord and a tail test cord

- a) produces an unidirectional characterization of the form shown in Figure 3,
- b) provides a continuity measurement for the cabling under test,
- c) provides information about the general quality of both the local and remote interface to the cabling under test, the quality of the installed cable and any embedded connecting hardware,
- d) provides a quantitative measurement of the local and remote interfaces to the cabling under test using measurements taken in each direction,
- e) provides a quantitative measurement of the channel or link (see Clause 8) attenuation when the measurement is taken in one direction provided that
 - the channel or link only contains a single fixed cable and terminating connectors,
 - the scattering characteristics of the optical fibre within the launch test cord and tail test cord are the same,
- f) provides a quantitative attenuation measurement of the channel, or link embedded connecting hardware (see Clause 8) when the measurement is taken from two directions provided that
 - attenuation measurements of permanent links, channel or embedded connecting hardware are derived by averaging the associated bi-directional test results,
 - the distance between embedded connecting hardware is not less than the dead zone of the OTDR (see C.2.1).

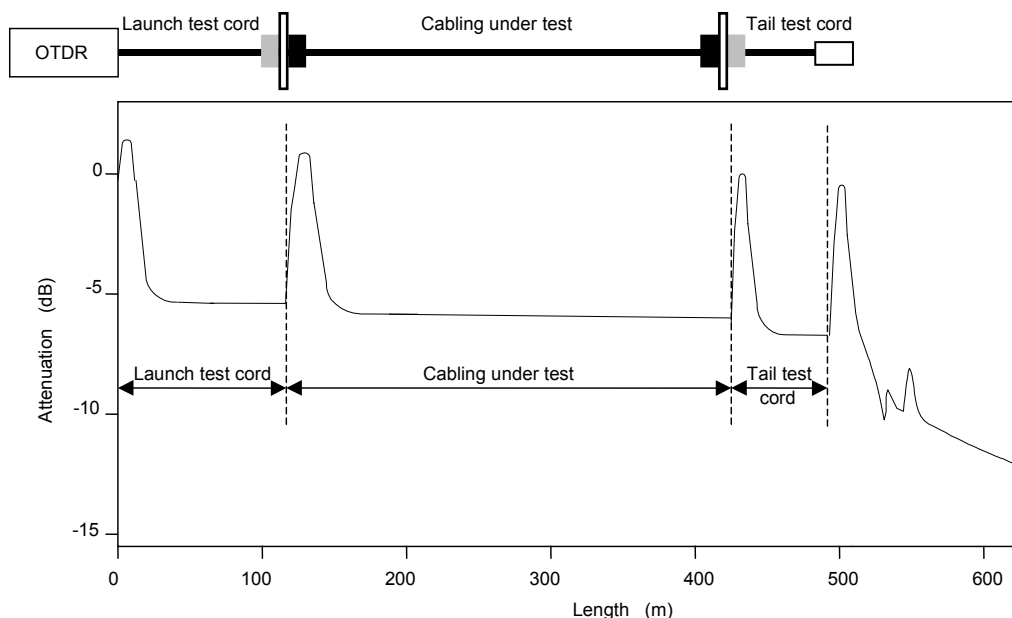


Figure 3 – OTDR characterization using a launch test cord and a tail test cord

6.3 Test cords and adapters

6.3.1 Connecting hardware at test interfaces

The connecting hardware to be connected to the cabling under test (i.e. launch test cords and tail test cords) together with the hardware that terminates the substitution test cords and any connecting hardware adapters used as part of the test methods specified by this standard.

- a) should have the same or better performance specification as the hardware terminating the cabling under test;
- b) should have a controlled end face for radius, dome offset and fibre position
 - for the duplex LC connector for MMF as specified in IEC 62664-1-1,
 - for the simplex LC connector for SMF as will be specified in IEC 62664-1-2¹,
 - for the duplex SC connector for MMF as specified in IEC 60874-19-1,
 - for the simplex SC connector for SMF as specified in IEC 60874-14-3;
- c) should be of the same product as defined by the supplier where IEC specifications do not guarantee interoperability (the only interfaces specified to be interoperable are within the IEC 62664 series on LC connector product specifications);
- d) where used, connecting hardware adapters shall be reference adapters in accordance with the relevant IEC product specification
 - for LC MMF (duplex) as specified in IEC 62664-1-1,
 - for SC SMF (simplex) as specified in IEC 60874-14-3.

The inspection and testing of test cords and connecting hardware adapters shall be done in accordance with Annex D prior to any reference measurement process being undertaken.

NOTE In the case of MPO interfaces, there is no adapter and therefore there is no influence on the final alignment of the connection.

6.3.2 Reference connector requirements

The requirements for reference connectors of cylindrical and rectangular styles are given in Table 3.

Table 3 – Non-LC reference connector requirements

	Cylindrical connector styles		Rectangular connector styles	
	MMF	SMF	MMF	SMF
Eccentricity of core centre to ferrule outer diameter	<1 µm	<0,3 µm	N/A	N/A
True position of the fibre core	N/A	N/A	<1 µm	<0,3 µm
Exit angle	≤0,2°	≤0,2°	≤0,2°	≤0,2°
Accuracy of ferrule diameter	±0,5 µm	±0,5 µm	N/A	N/A
Attenuation of 2 reference connectors in a reference adapter	≤0,10 dB	≤0,20 dB	≤0,10 dB	≤0,20 dB

LC reference adapters are specified in IEC 62664-1-1, and the attenuation of adapters is measured according to IEC 61300-3-42.

The return loss of singlemode reference PC connectors shall be ≥45 dB.

The return loss of singlemode reference APC connectors shall be ≥60 dB mated and ≥55 dB unmated.

Multimode reference PC connectors shall meet the conditions of Grade 3 (≥35 dB).

The geometrical data for singlemode PC connectors are specified in IEC 61755-3-1 and for singlemode APC connectors in IEC 61755-3-2.

¹ Under consideration.