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REDLINE VERSION

INTERNATIONAL STANDARD

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Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 3-45: Examinations and measurements – Attenuation of random mated multi-fibre connectors

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IEC 61300-3-45 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is an International Standard.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

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

a) addition of sample size for > 12-fibre connector measurement;
b) inclusion of guidance for multimode measurement.

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

Draft	Report on voting
86B/4757/FDIS	86B/4774/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61300 series, published under the general title *Fibre optic interconnecting devices and passive components – Basic test and measurement 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 3-45: Examinations and measurements – Attenuation of random mated multi-fibre connectors

1 Scope

The purpose of this part of IEC 61300 is to describe the procedure required to measure the statistical distribution and mean attenuation for random mated optical connectors with physical contact (PC) and angled physical contact (APC) polished ~~1-row~~ multi-fibre rectangular ferrules as defined in the IEC 61754 series. This measurement method is applicable to cable assemblies.

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 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61300-3-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*

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 ~~connector endface visual and automated inspection~~ connectors and fibre-stub transceivers*

IEC 61754 (all parts), *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces*

IEC 63267 (all parts), *Fibre optic interconnecting devices and passive components – Connector optical interfaces for enhanced macro bend loss multimode fibres*

3 Terms and definitions

No terms and definitions are listed in this document.

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

4 General description

4.1 Test methods

Two test methods are described for measuring the attenuation of random mated optical connectors. Both provide an estimate of the expected average performance that a group of cable assemblies (including an adaptor, if applicable) ~~selected from a batch~~ will exhibit when used in an optical system. The device under test (DUT) is a cable assembly with on one side a plug with pins (pinned plug) and on the other side a plug without pins (unpinned plug). The cable assemblies, and any adaptors, ~~must~~ shall be chosen at random to ensure that the measurements provide a statistically unbiased estimate.

Method 1 describes a procedure using a sample of cable assemblies and adaptors specified in Table 1. In this case the pinned plugs ~~(with pins)~~ are used as ~~“reference” plugs~~ "launch test plugs” and the unpinned plugs ~~(without pins)~~ are tested against them sequentially. The results, based on the number of measurements specified in Table 1, are recorded in the test matrix shown in Figure 3 to Figure 5.

~~Method 1 is intended to be part of a design approval exercise that may involve one or more suppliers. Once approval is achieved, Method 2 would be relied on to maintain process control. However, in the event of a dispute, Method 1 shall act as the reference measurement method.~~

Method 2 describes a procedure for the measurement of a sample of cable assemblies and adaptors specified in Table 2. ~~Three cable assemblies are selected from the sample as “reference” cable assemblies and pins are fitted. The other test cable assemblies (without pins) are tested against each of the three “reference cable assemblies” sequentially.~~ Three cable assemblies are selected from the sample as "launch test cords” and the remaining cable assemblies are grouped as “receive test cords”. First, the pinned plugs of the launch test cords are used as launch test plugs and the unpinned plugs of the receive test cords are tested against them sequentially. Then the unpinned plugs of the launch test cords are used as launch test plugs and the pinned plugs of the receive test cords are tested. This produces the number of measurements specified in Table 2 and the results are recorded in the test matrix shown in Figure 10 to Figure 12.

Method 1 is intended to be part of a design approval exercise that can involve one or more suppliers. It is recognised that the number of measurements required by Method 1 ~~may~~ can be excessive for day-to-day routine checking of either in-house or supplier produced products. In this case, ~~as indicated above~~ once approval is achieved, Method 2 ~~may~~ would be relied on to maintain process control as an alternative option. However, in the event of a dispute, Method 1 shall act as the reference measurement method.

NOTE ~~In this measurement method, the terms “reference” plug or “reference” cord are used to define those components chosen at random from a batch, against which a number of comparative measurements are made.~~ In this measurement method, the term “launch test cord” is used to define one of the mated DUTs which is installed on the light source side. On the other hand, the other DUT which is installed on the detector side is defined as “receive test cord”. In the same way, the plugs mated at the connection point under test are defined as “launch test plug” and “receive test plug”, respectively. "Launch test plug” and "launch test cord" are used to define those components chosen at random from the sample, against which a number of comparative measurements are made. It is not intended that the terms ~~should~~ imply specially chosen or manufactured components, such as those used, for example, in screen testing.

Table 1 – Sample size for Method 1

Connectors (*n*-fibre connector)	Sample sizes		
	Cords and adaptors	Measurements	Fibres
2-fibre connector	15	210	420
4-fibre connector	12	132	528
8-fibre connector	10	90	720
10-fibre connector	10	90	900
12-fibre connector	10	90	1 080
> 12-fibre connector	10	90	90*n
NOTE Parameter n is the number of fibres in the connector.			

Table 2 – Sample size for Method 2

~~Connector (n-fibre connector)~~	~~Sample size~~				
	~~Cord and adaptors~~			~~Measurements~~	~~Fibres~~
	~~Total~~	~~Reference~~	~~Test :N~~		
~~2-fibre connector~~	~~12~~	~~3~~	~~9~~	~~54~~	~~108~~
~~4-fibre connector~~	~~8~~	~~3~~	~~5~~	~~30~~	~~120~~
~~8-fibre connector~~	~~6~~	~~3~~	~~3~~	~~18~~	~~144~~
~~10-fibre connector~~	~~6~~	~~3~~	~~3~~	~~18~~	~~180~~
~~12-fibre connector~~	~~6~~	~~3~~	~~3~~	~~18~~	~~216~~

Connectors (*n* -fibre connector)	Sample sizes					
	Cords			Adaptors	Measurements	Fibres
	Total	Launch test cord	Receive test cord			
2-fibre connector	12	3	9	3	54	108
4-fibre connector	8	3	5	3	30	120
8-fibre connector	6	3	3	3	18	144
10-fibre connector	6	3	3	3	18	150
12-fibre connector	6	3	3	3	18	216
> 12-fibre connector	6	3	3	3	18	18*n
NOTE Parameter n is the number of fibres in the connector.						

4.2 Precautions

The following test requirements shall be met.

a) ~~Precautions shall be taken to ensure that~~ The cladding modes ~~do~~ shall not affect the measurement. Cladding modes shall be stripped as a function of the fibre coating.

~~b) Precautions shall be taken to ensure that the position of the fibres in the test remains fixed between the measurement of P_1 and P_2 to avoid changes in attenuation due to bending losses.~~

b) The fibres in the test shall remain fixed between the reference power measurement and the corresponding attenuation measurements to avoid changes in attenuation due to bending losses.

b) The stability performance of the test equipment shall be ≤ 0,05 dB or 10 % of the attenuation to be measured, whichever is the lower value. The stability shall be maintained over the measurement time and operational temperature range. The required measurement resolution shall be 0,01 dB for both multimode and single-mode.

c) To achieve consistent results, ~~clean and~~ inspect all connectors and adaptors prior to the setup of the measurement system and if contaminated clean them. During measurement steps, inspect all connectors and adaptors except those in the unchanged connections and if contaminated clean them before mating. Visual examination shall be undertaken in accordance with IEC 61300-3-1 and IEC 61300-3-35.

NOTE A cladding mode stripper usually comprises a material having a refractive index equal to or greater than that of the fibre cladding.

5 Apparatus

5.1 Launch conditions and light source (LS)

~~The source consists of an optical emitter, the means to connect to it and associated drive electronics. In addition to meeting the stability and power level requirements, the source shall have the following characteristics:~~

~~– Centre wavelength, as detailed in the performance and product standard;~~

~~– Spectral width, filtered light emitting diode (LED) ≤ 150 nm full width half maximum (FWHM);~~

~~– Spectral width, laser diode (LD) < 10 nm FWHM.~~

~~For multimode fibres, broadband sources such as an LED shall be used.~~

~~For single mode fibres either an LED or LD may be used.~~

The source unit consists of an optical emitter, the associated drive electronics, and fibre pigtail (if any). Preferred source conditions are given in Table 3. The stability of the single-mode fibre source at 23 °C shall be ±0,01 dB over the duration of the measurement. The stability of the multimode fibre source at 23 °C shall be ±0,05 dB over the duration of the measurement. The source output power shall be ≥ 20 dB above the minimum measurable power level.

Table 3 – Preferred source conditions

No.	Type	Central wavelength nm	Spectral width (RMS) nm	Source type
S1	Multimode	660 ± 30	≥ 10	Monochromator or LED
S2	Multimode	780 ± 30	≥ 10	Monochromator or LED
S3	Multimode	850 ± 30	≥ 10	Monochromator or LED
S4	Multimode	1 300 ± 30	≥ 10	Monochromator or LED
S5	Single-mode	1 310 ± 30	To be reported	Laser diode, monochromator, or LED
S6	Single-mode	1 550 ± 30	To be reported	Laser diode, monochromator, or LED
S7	Single-mode	1 625 ± 30	To be reported	Laser diode, monochromator, or LED

It is recognized that some components, for example for coarse wavelength division multiplexing (CWDM), can require the use of other source types such as tunable lasers. It is therefore recommended in these cases that the preferred source characteristics are specified on the basis of the component to be measured.

NOTE Central wavelength and spectral width are defined in IEC 61280-1-3.

The launch condition shall be specified in accordance with IEC 61300-1. In case the specified launch condition is not obtained by the original light from the source, an appropriate apparatus for launch condition control (E) shall be used.

~~NOTE~~ The interference of modes from a coherent source will create speckle patterns in multimode fibres. These speckle patterns give rise to speckle or modal noise and are observed as power fluctuations, since their characteristic times are longer than the resolution time of the detector. As a result, ~~it may be impossible to achieve~~ stable launch conditions cannot be achieved using coherent sources for multimode measurements. Consequently, lasers, including optical time domain reflectometer (OTDR) sources, should be avoided in favour of LEDs or other incoherent sources for measuring multimode components.

~~4.2 Launch conditions (E)~~

~~The launch condition shall be specified in accordance with IEC 61300-1.~~

5.2 Detector (D)

The detector consists of an optical detector, the means to connect to it and associated electronics. The connection to the detector will be an adaptor that accepts a connector plug of the appropriate design. The detector shall capture all light emitted by the connector plug.

In addition to meeting the stability and resolution requirements, the detector shall have the following characteristics:

– linearity of multimode, ≤ ±0,25 dB (over −5 dBm up to −60 dBm);
– linearity of single-mode, ≤ ±0,1 dB (over −5 dBm up to −60 dBm).

~~NOTE~~ The ~~power meter~~ detector linearity should be referenced to a power level of −23 dBm at the operational wavelength.

Where the connection to the detector is broken between the reference power measurement ~~of P_1~~ and ~~P_2~~ the corresponding attenuation measurements, the measurement repeatability shall be within 0,05 dB or 10 % of the attenuation to be measured, whichever is the lower value. A large sensitive area detector ~~may~~ can be used to achieve this.

The precise characteristics of the detector shall be compatible with the measurement requirements. The dynamic range of the ~~power meter~~ detector shall be capable of measuring the power level exiting from the device under test (DUT) at the wavelength being measured.

6 Procedure

6.1 Method 1

~~a) Randomly select the sample number of cable assemblies specified in Table 1. Sequentially label the plugs under test as shown in Figures 3 to 5.~~

~~b) Randomly select the sample size of adaptors as specified in Table 1. Sequentially label the adaptors under test as shown in Figures 3 to 5.~~

~~c) Set up the measurement system as shown in Figure 1, with cord 1as the "reference" cord and with plug 1 as the "reference" plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord.~~

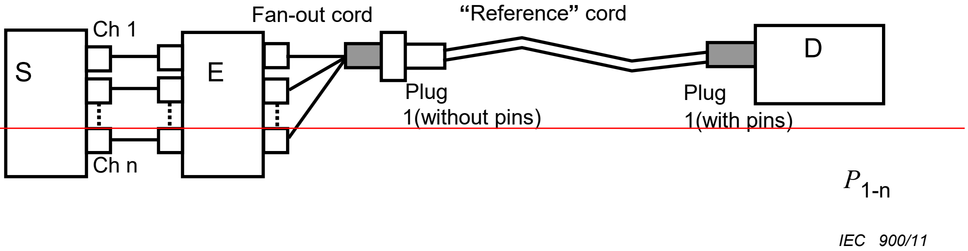


Figure 1 – "Reference" cord measurement – Method 1

d) Connect test cord 2 and adaptor 1 to the system and mate plug 1 (with pins) to plug 2 (without pins) as shown in Figure 2. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-n}}$ for all fibres in the cord.

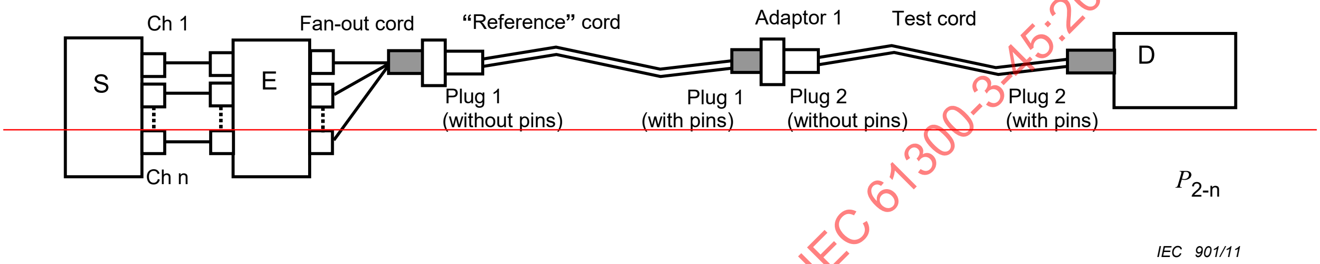


Figure 2 – Test cord measurement – Method 1

e) Calculate the attenuation of the mated plug pair 1 (with pins) / 2 (without pins) with adaptor 1, using Equation (1):

$$\text{Attenuation} = [-10 \log (P_{2\text{-i}}/P_{1\text{-i}})] - (A \times L)\ \text{dB} \qquad (1)$$

Where

i is fibre number of Test cord;

A is fibre attenuation per km;

L is length of fibre in km.

NOTE The product $A \times L$ may be ignored for both single mode and multimode [50/125 µm and 62,5/125 µm] where the cord length is small, i.e. < 10 m.

f) Record the attenuation results for each fibre into an appropriate matrix format.

NOTE An example of record table (for 4 fibre connectors) is shown in Figure 13.

g) Keeping plug 1 (with pins) and adaptor 1 as the "reference" configuration, replace test cord 2 by test cord 3 and mate plug 3 (without pins) with plug 1 (with pins).

h) Measure the power $P_{3\text{-}1}$ to $P_{3\text{-n}}$ and record the attenuation results for each fibre.

i) Repeat steps g) and h) until all the plugs (without pins) of the remaining test cable assemblies have been tested against the "reference" plug 1 (with pins).

j) After step i) has been completed, replace the "reference" plug and adaptor so that plug 2 (with pins) and adaptor 2 are the "reference" configuration.

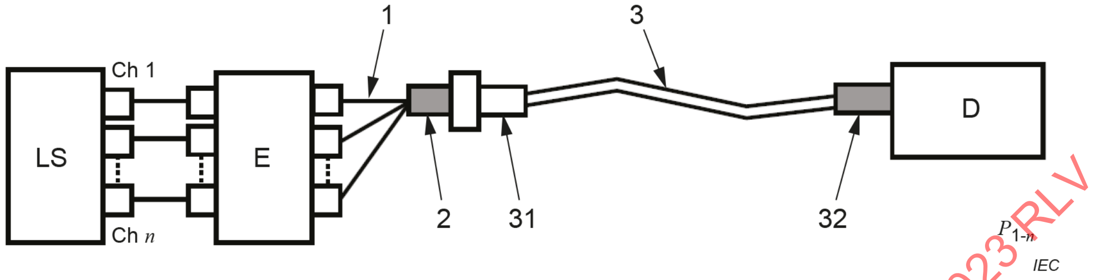
k) Measure the attenuation for all plugs against "reference" plug 2 (with pins) and adaptor 2.

l) Continue this process until all allocated plugs have been used as "reference" plugs.

a) Randomly select the sample number of cable assemblies specified in Table 1. Sequentially label the cable assemblies and plugs under test as shown in Figure 3 to Figure 5.

b) Randomly select the sample size of adaptors as specified in Table 1. Sequentially label the adaptors under test as shown in Figure 3 to Figure 5.

c) Set up the reference power measurement system as shown in Figure 1, with cord 1 as the launch test cord and plug 1 (pinned) as the launch test plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord. For multimode measurement, tight tolerance fibre and tight tolerance plug as specified in Annex A shall be used for the launch plug. The launch condition at the launch plug shall comply with IEC 61300-1.

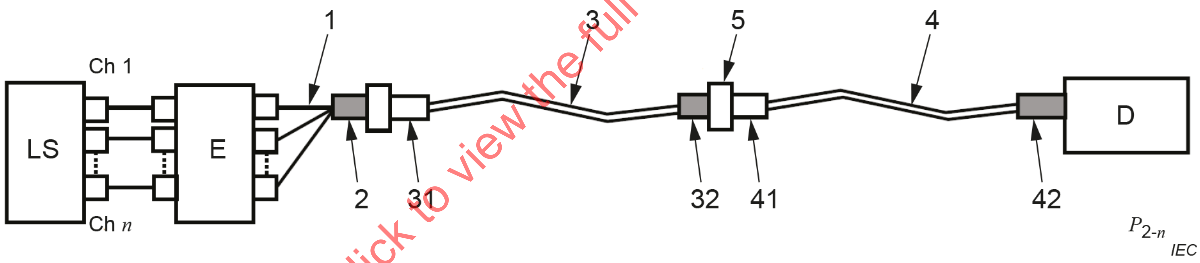


Key

LS	light source	3	launch test cord
E	launch condition control	31	unpinned plug of launch test cord
1	fan-out cord	32	pinned plug of launch test cord (launch test plug)
2	launch plug		

Figure 1 – Reference power measurement system – Method 1

d) Pick up cord 2 as the receive test cord. Mate plug 1 (pinned) to plug 2 (unpinned) using adaptor 1 as shown in Figure 2. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-}n}$ for all fibres in the cord.



Key

LS	light source	4	receive test cord
E	launch condition control	41	unpinned plug of receive test cord (receive test plug)
1	fan-out cord	42	pinned plug of receive test cord
2	launch plug	5	adaptor
3	launch test cord		
31	unpinned plug of launch test cord		
32	pinned plug of launch test cord (launch test plug)		

Figure 2 – Attenuation measurement system – Method 1

e) Calculate the attenuation A of the mated plug pair 1 (pinned)/2 (unpinned) with adaptor 1, using Formula (1):

$$A = \left[-10\log\left(\frac{P_{2-i}}{P_{1-i}} \right) \right] - \left(A_f \times L \right) \text{ dB} \qquad (1)$$

where

A is the attenuation;

i is the number of fibres of the test cord;

A_f is the fibre attenuation per kilometre;

L is the length of the fibre in kilometre.

The product $A_f \times L$ depends on the fibre attenuation level and can be neglectable when it is small enough compared to the connection losses.

f) Record the attenuation results for each fibre into an appropriate matrix format.

g) Keeping plug 1 (pinned) as the launch test plug, replace cord 2 with cord 3 and mate plug 3 (unpinned) to plug 1 (pinned) using adaptor 1.

h) Measure the power $P_{3\text{-}1}$ to $P_{3\text{-}n}$ and record the attenuation results for each fibre.

i) Repeat steps g) and h) until all the unpinned plugs of the remaining cable assemblies have been tested against the launch test plug 1 (pinned).

j) After step i) has been completed, replace the launch test cord and the adaptor so that plug 2 (pinned) is used as the launch test plug. Measure the reference power for the configuration.

k) Measure the attenuation for all plugs (unpinned) against the launch test plug 2 (pinned) using adaptor 2.

l) Continue this process until all allocated plugs (pinned) have been used as launch test plugs.

~~"Reference" Configuration~~		~~Test cord and labelling Plug (without pins)~~														
		~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10~~	~~11~~	~~12~~	~~13~~	~~14~~	~~15~~
~~Plug 1 (with pins)~~	~~Adaptor 1~~	~~–~~														
~~Plug 2 (with pins)~~	~~Adaptor 2~~		~~–~~													
~~Plug 3 (with pins))~~	~~Adaptor 3~~			~~–~~												
~~Plug 4 (with pins)~~	~~Adaptor 4~~				~~–~~											
~~Plug 5 (with pins)~~	~~Adaptor 5~~					~~–~~										
~~Plug 6 (with pins)~~	~~Adaptor 6~~						~~–~~									
~~Plug 7 (with pins)~~	~~Adaptor 7~~							~~–~~								
~~Plug 8 (with pins)~~	~~Adaptor 8~~								~~–~~							
~~Plug 9 (with pins)~~	~~Adaptor 9~~									~~–~~						
~~Plug 10 (with pins)~~	~~Adaptor 10~~										~~–~~					
~~Plug 11 (with pins)~~	~~Adaptor 11~~											~~–~~				
~~Plug 12 (with pins)~~	~~Adaptor 12~~												~~–~~			
~~Plug 13 (with pins)~~	~~Adaptor 13~~													~~–~~		
~~Plug 14 (with pins)~~	~~Adaptor 14~~														~~–~~	
~~Plug 15 (with pins)~~	~~Adaptor 15~~															~~–~~

IEC 902/11

Launch test cord and adaptor			Receive test cord Plug (unpinned) as receive test plug														
Cord	Launch test plug	Adaptor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Plug 1 (pinned)	Adaptor 1	–														
2	Plug 2 (pinned)	Adaptor 2		–													
3	Plug 3 (pinned)	Adaptor 3			–												
4	Plug 4 (pinned)	Adaptor 4				–											
5	Plug 5 (pinned)	Adaptor 5					–										
6	Plug 6 (pinned)	Adaptor 6						–									
7	Plug 7 (pinned)	Adaptor 7							–								
8	Plug 8 (pinned)	Adaptor 8								–							
9	Plug 9 (pinned)	Adaptor 9									–						
10	Plug 10 (pinned)	Adaptor 10										–					
11	Plug 11 (pinned)	Adaptor 11											–				
12	Plug 12 (pinned)	Adaptor 12												–			
13	Plug 13 (pinned)	Adaptor 13													–		
14	Plug 14 (pinned)	Adaptor 14														–	
15	Plug 15 (pinned)	Adaptor 15															–

IEC

Figure 3 – Test matrix and labelling for measuring Method 1 (2-fibre connector)

~~"Reference" configuration~~		~~Test cord and labelling Plug (without pins)~~											
		~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10~~	~~11~~	~~12~~
~~Plug 1 (with pins)~~	~~Adaptor 1~~	~~–~~											
~~Plug 2 (with pins)~~	~~Adaptor 2~~		~~–~~										
~~Plug 3 (with pins)~~	~~Adaptor 3~~			~~–~~									
~~Plug 4 (with pins)~~	~~Adaptor 4~~				~~–~~								
~~Plug 5 (with pins)~~	~~Adaptor 5~~					~~–~~							
~~Plug 6 (with pins)~~	~~Adaptor 6~~						~~–~~						
~~Plug 7 (with pins)~~	~~Adaptor 7~~							~~–~~					
~~Plug 8 (with pins)~~	~~Adaptor 8~~								~~–~~				
~~Plug 9 (with pins)~~	~~Adaptor 9~~									~~–~~			
~~Plug 10 (with pins)~~	~~Adaptor 10~~										~~–~~		
~~Plug 11 (with pins)~~	~~Adaptor 11~~											~~–~~	
~~Plug 12 (with pins)~~	~~Adaptor 12~~												~~–~~

IEC 903/11

Launch test cord and adaptor			Receive test cord Plug (unpinned) as receive test plug											
Cord	Launch test plug	Adaptor	1	2	3	4	5	6	7	8	9	10	11	12
1	Plug 1 (pinned)	Adaptor 1	—											
2	Plug 2 (pinned)	Adaptor 2		—										
3	Plug 3 (pinned)	Adaptor 3			—									
4	Plug 4 (pinned)	Adaptor 4				—								
5	Plug 5 (pinned)	Adaptor 5					—							
6	Plug 6 (pinned)	Adaptor 6						—						
7	Plug 7 (pinned)	Adaptor 7							—					
8	Plug 8 (pinned)	Adaptor 8								—				
9	Plug 9 (pinned)	Adaptor 9									—			
10	Plug 10 (pinned)	Adaptor 10										—		
11	Plug 11 (pinned)	Adaptor 11										IEC	~~904/11~~	
12	Plug 12 (pinned)	Adaptor 12												—

IEC

Figure 4 – Test matrix and labelling for measuring Method 1 (4-fibre connector)

"Reference" configuration		Test cord and labelling Plug (without pins)									
		1	2	3	4	5	6	7	8	9	10
Plug 1 (with pins)	Adaptor 1	–									
Plug 2 (with pins)	Adaptor 2		–								
Plug 3 (with pins)	Adaptor 3			–							
Plug 4 (with pins)	Adaptor 4				–						
Plug 5 (with pins)	Adaptor 5					–					
Plug 6 (with pins)	Adaptor 6						–				
Plug 7 (with pins)	Adaptor 7							–			
Plug 8 (with pins)	Adaptor 8								–		
Plug 9 (with pins)	Adaptor 9									–	
Plug 10 (with pins)	Adaptor 10										–

Launch test cord and adaptor			Receive test cord Plug (unpinned) as receive test plug									
Cord	Launch test plug	Adaptor	1	2	3	4	5	6	7	8	9	10
1	Plug 1 (pinned)	Adaptor 1	—									
2	Plug 2 (pinned)	Adaptor 2		—								
3	Plug 3 (pinned)	Adaptor 3			—							
4	Plug 4 (pinned)	Adaptor 4				—						
5	Plug 5 (pinned)	Adaptor 5					—					
6	Plug 6 (pinned)	Adaptor 6						—				
7	Plug 7 (pinned)	Adaptor 7							—			
8	Plug 8 (pinned)	Adaptor 8								—		
9	Plug 9 (pinned)	Adaptor 9									—	
10	Plug 10 (pinned)	Adaptor 10										—

IEC

Figure 5 – Test matrix and labelling for measuring Method 1 (8-, 10-, 12- and > 12-fibre connectors)

6.2 Method 2

a) Randomly select the sample number of cable assemblies specified in Table 2.

b) Choose three cable assemblies at random and sequentially label the plugs of each cord as "reference" plugs. Sequentially label the plugs of the remaining cable assemblies as test plugs. Sequentially label three adaptors 1 to 3 (as shown in Figures 10 to 12).

c) Set up the measurement system as shown in Figure 6, with "reference" cord 1 so that the plug 1 (with pins) is the "reference" plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord.

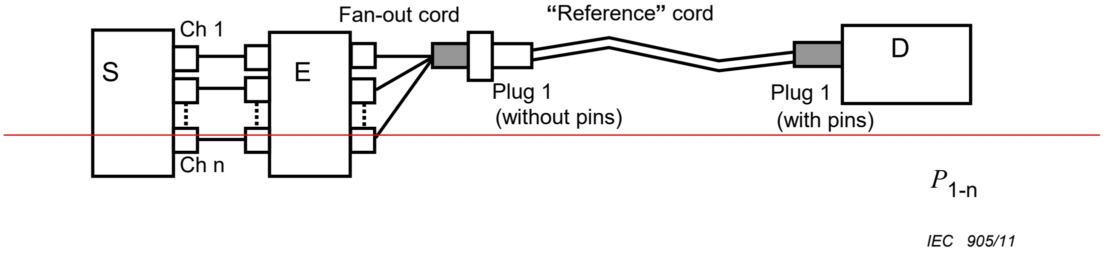


Figure 6 – "Reference" cord measurement (1) – Method 2

d) Connect test cord 2 and adaptor 1 to the measurement system and mate reference plug 1 (with pins) with test plug 2 (without pins) as shown in Figure 7. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-n}}$.

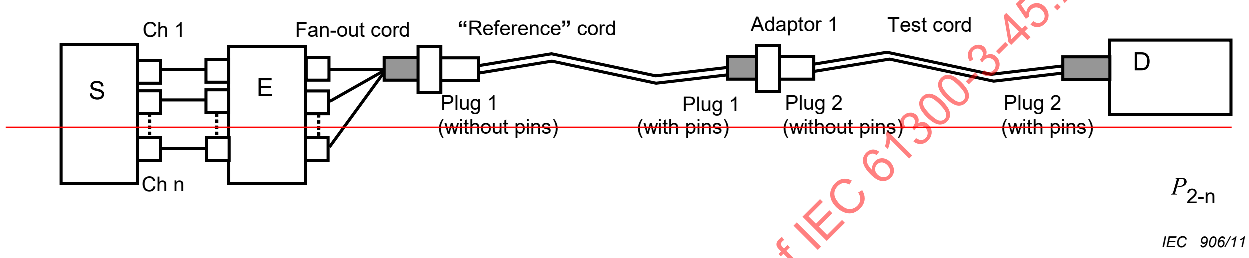


Figure 7 – Test cord measurement (1) – Method 2

e) Calculate the attenuation of the mated plug pair 1 (with pins) / 2 (without pins) with adaptor 1, using Equation (2):

$$\text{Insertion loss} = [-10 \log (P_{2\text{-i}}/P_{1\text{-i}})] - (A \times L) \text{ dB} \qquad (2)$$

Where

i is fiber number of Test cord

A is fibre attenuation per km

L is length of fibre in km

NOTE The product $A \times L$ may be ignored for both single mode and multimode [50/125 µm and 62.5/125 µm] where the cord length is small, i.e. < 10 m.

f) Record the attenuation results for each fibre into an appropriate matrix format.

g) Repeat steps d) to f) until all test plugs (without pins) have been tested against "reference" plug 1 (with pins) and adaptor 1.

h) After step g) has been completed, replace the "reference" plug and adaptor so that "reference" plug 2 (with pins) and adaptor 2 are the "reference" configuration.

i) Measure the attenuation for all test plugs (without pins) against "reference" plug 2 (with pins) and adaptor 2, using the procedures described above.

j) Continue this process until all allocated "reference" plugs (with pins) and adaptors have been used and all test cable assemblies (without pins) have been tested.

k) Set up the measurement system shown in Figure 8, with "reference" cord 1 so that the plug (without pins) 1 is the "reference" plug, Measure power $P_{1\text{-}1}$ to $P_{1\text{-n}}$ for all fibres in the cord.

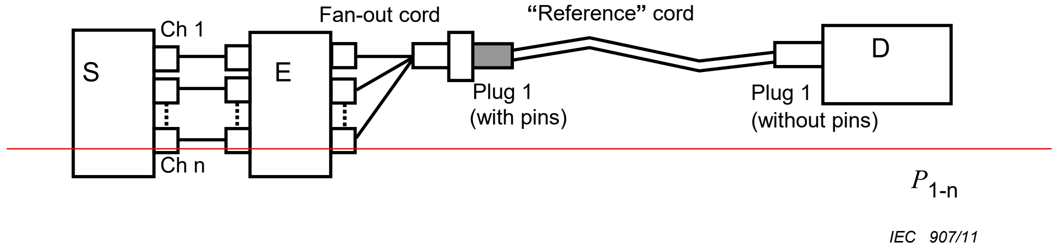


Figure 8 – "Reference" cord measurement (2) – Method 2

l) Connect test cord 2 and adaptor 1 to the measurement system and mate "reference" plug 1 (without pins) with test plug 2 (with pins) as shown in Figure 9. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-}n}$.

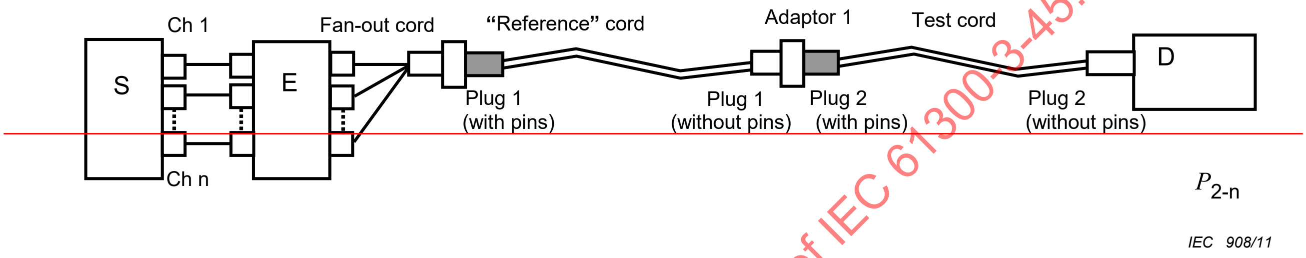


Figure 9 – Test cord measurement (2) – Method 2

m) Calculate the attenuation of the mated plug pair 1 (without pins) / 2 (with pins) with adaptor 1, using the equation given above.

n) Record the attenuation results for each fibre into an appropriate matrix format.

o) Repeat steps l) to n) until all test plugs (with pins) have been tested against the "reference" plug 1 (without pins) and adaptor 1.

p) After step m) has been completed, replace the "reference" plug and adaptor so that "reference" plug 2 (without pins) and adaptor 2 are the "reference" configuration.

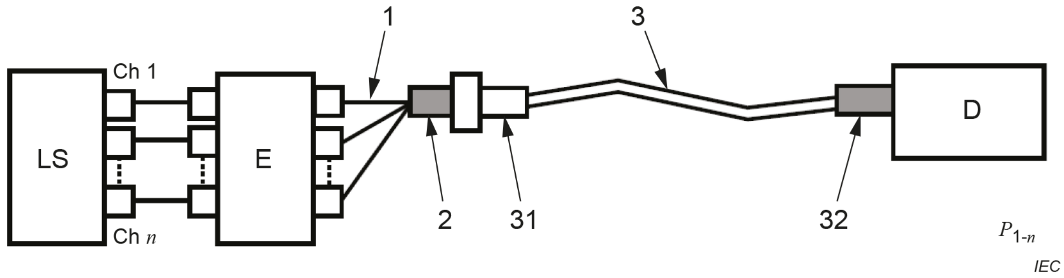
q) Measure the attenuation for all test plugs (with pins) against "reference" plug 2 (without pins) and adaptor 2, using the procedures described above.

r) Continue this process until all allocated "reference" plugs (without pins) and adaptors have been used and all test cable assemblies (with pins) have been tested.

a) Randomly select the sample number of cable assemblies specified in Table 2.

b) Choose three cable assemblies at random and sequentially label them as launch test cords, and the plugs of each cord as launch test plugs as shown in Figure 10 to Figure 12. Sequentially label the remaining cable assemblies as receive test cords, and the plugs of each cord as receive test plugs as shown in Figure 10 to Figure 12. Sequentially label three adaptors 1 to 3.

c) Set up the reference power measurement system as shown in Figure 6, with launch test cord L1 so that plug L1 (pinned) is the launch test plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord. For multimode measurement, tight tolerance fibre and tight tolerance plug as specified in Annex A shall be used for the launch plug. The launch condition at the launch plug shall comply with IEC 61300-1.

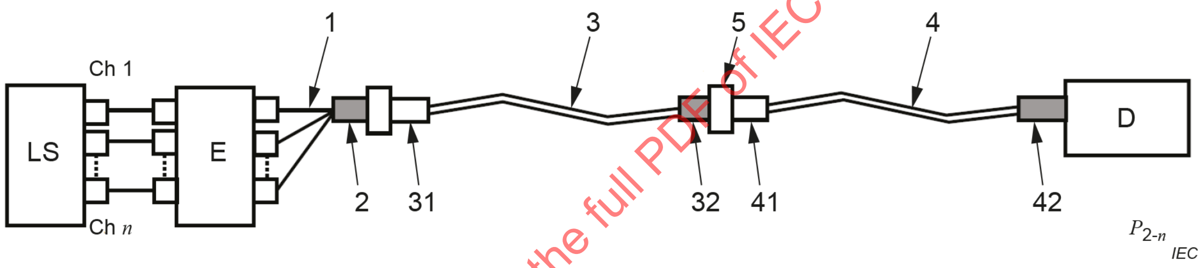


Key

LS	light source
E	launch condition control
1	fan-out cord
2	launch plug
3	launch test cord
31	unpinned plug of launch test cord
32	pinned plug of launch test cord (launch test plug)

Figure 6 – Reference power measurement system (1) – Method 2

d) Pick up receive test cord R1 and mate launch test plug L1 (pinned) to receive test plug R1 (unpinned) using adaptor 1 as shown in Figure 7. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-}n}$.



Key

LS	light source
E	launch condition control
1	fan-out cord
2	launch plug
3	launch test cord
31	unpinned plug of launch test cord
32	pinned plug of launch test cord (launch test plug)
4	receive test cord
41	unpinned plug of receive test cord receive test plug)
42	pinned plug of receive test cord
5	adaptor

Figure 7 – Attenuation measurement system (1) – Method 2

e) Calculate the attenuation of the mated plug pair L1 (pinned)/R1 (unpinned) with adaptor 1, using Formula (1).

f) Record the attenuation results for each fibre into an appropriate matrix format.

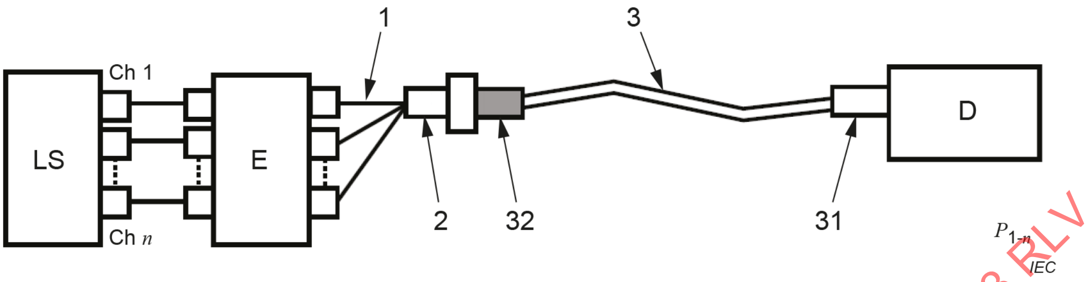
g) Repeat steps d) to f) until all receive test plugs (unpinned) have been tested against launch test plug L1 (pinned) and adaptor 1.

h) After step g) has been completed, replace the launch test cord and the adaptor so that launch test plug L2 (pinned) is used as the launch test plug. Measure the reference power for the configuration.

i) Measure the attenuation for all receive test plugs (unpinned) against launch test plug L2 (pinned) and adaptor 2, using the procedures described above.

j) Continue this process until all allocated launch test plugs (pinned) and adaptors have been used and all receive test plugs (unpinned) have been tested.

k) Set up the measurement system shown in Figure 8, with launch test cord 1 so that plug L1 (unpinned) is the launch test plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord.

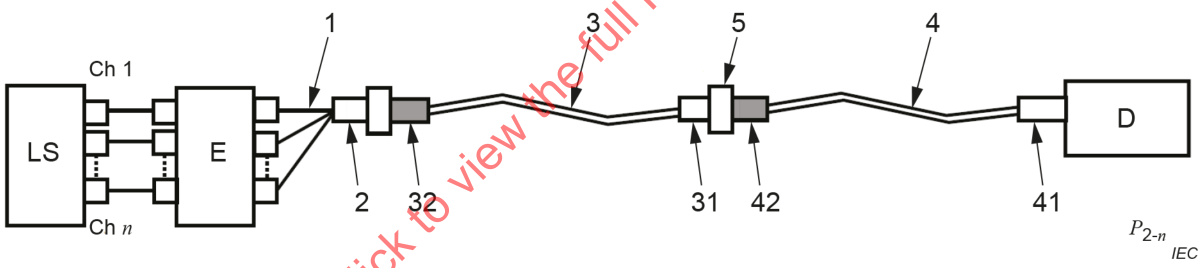


Key

LS	light source	3	launch test cord
E	launch condition control	31	unpinned plug of launch test cord
1	fan-out cord	32	pinned plug of launch test cord (launch test plug)
2	launch plug		

Figure 8 – Reference power measurement system (2) – Method 2

l) Pick up receive test cord R1 and mate launch test plug L1 (unpinned) to receive test plug R1 (pinned) using adaptor 1 as shown in Figure 9. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-}n}$.



Key

LS	light source	4	receive test cord
E	launch condition control	41	unpinned plug of receive test cord (receive test plug)
1	fan-out cord	42	pinned plug of receive test cord
2	launch plug	5	adaptor
3	launch test cord		
31	unpinned plug of launch test cord		
32	pinned plug of launch test cord (launch test plug)		

Figure 9 – Attenuation measurement system (2) – Method 2

m) Calculate the attenuation of the mated plug pair L1 (unpinned)/R1 (pinned) with adaptor 1, using Formula (1).

n) Record the attenuation results for each fibre into an appropriate matrix format.

o) Repeat steps l) to n) until all receive test plugs (pinned) have been tested against launch test plug L1 (unpinned) and adaptor 1.

p) After step o) has been completed, replace the launch test cord and the adaptor so that launch test plug L2 (unpinned) is used as launch test plug. Measure the reference power for the configuration.

q) Measure the attenuation for all receive test plugs (pinned) against launch test plug L2 (unpinned) and adaptor 2, using the procedures described above.

r) Continue this process until all allocated launch test plugs (unpinned) and adaptors have been used and all receive test plugs (pinned) have been tested.

"Reference" Configuration (1)		Test cord and labelling Test plug (without pins)								
"Reference" Plug	Adaptor	1	2	3	4	5	6	7	8	9
Plug 1 (with pins)	Adaptor 1									
Plug 2 (with pins)	Adaptor 2									
Plug 3 (with pins)	Adaptor 3									
"Reference" Configuration (2)		Test cord and labelling Test plug (with pins)								
"Reference" Plug	Adaptor	1	2	3	4	5	6	7	8	9
Plug 1 (without pins)	Adaptor 1									
Plug 2 (without pins)	Adaptor 2									
Plug 3 (without pins)	Adaptor 3									

IEC 909/11

Launch test plug configuration (1) pinned			Receive test cord Plug (unpinned) as receive test plug								
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5	R6	R7	R8	R9
L1	Plug L1 (pinned)	Adaptor 1									
L2	Plug L2 (pinned)	Adaptor 2									
L3	Plug L3 (pinned)	Adaptor 3									
Launch test plug configuration (2) unpinned			Receive test Plug (pinned) as receive test plug								
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5	R6	R7	R8	R9
L1	Plug L1 (unpinned)	Adaptor 1									
L2	Plug L2 (unpinned)	Adaptor 2									
L3	Plug L3 (unpinned)	Adaptor 3									

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Figure 10 – Test matrix and labelling for measuring Method 2 (2-fibre connector)

"Reference" Configuration (1)		Test cord and labelling Test plug (without pins)				
"Reference" Plug	Adaptor	1	2	3	4	5
Plug 1 (with pins)	Adaptor 1					
Plug 2 (with pins)	Adaptor 2					
Plug 3 (with pins)	Adaptor 3					
"Reference" Configuration (2)		Test cord and labelling Test plug (with pins)				
"Reference" Plug	Adaptor	1	2	3	4	5
Plug 1 (without pins)	Adaptor 1					
Plug 2 (without pins)	Adaptor 2					
Plug 3 (without pins)	Adaptor 3					

IEC 910/11

Launch test plug configuration (1) pinned			Receive test cord Plug (unpinned) as receive test plug				
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5
L1	Plug L1 (pinned)	Adaptor 1					
L2	Plug L2 (pinned)	Adaptor 2					
L3	Plug L3 (pinned)	Adaptor 3					
Launch test plug configuration (2) unpinned			**Receive test** Plug (pinned) as receive test plug				
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5
L1	Plug L1 (unpinned)	Adaptor 1					
L2	Plug L2 (unpinned)	Adaptor 2					
L3	Plug L3 (unpinned)	Adaptor 3					

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Figure 11 – Test matrix and labelling for measuring Method 2 (4-fibre connector)

"Reference" Configuration (1)		Test cord and labelling Test plug (without pins)		
"Reference" Plug	Adaptor	1	2	3
Plug 1 (with pins)	Adaptor 1			
Plug 2 (with pins)	Adaptor 2			
Plug 3 (with pins)	Adaptor 3			
"Reference" Configuration (2)		**Test cord and labelling** Test plug (with pins)		
"Reference" Plug	Adaptor	1	2	3
Plug 1 (without pins)	Adaptor 1			
Plug 2 (without pins)	Adaptor 2			
Plug 3 (without pins)	Adaptor 3			

Launch test plug configuration (1) pinned			Receive test cord Plug (unpinned) as receive test plug		
Cord	Launch test plug	Adaptor	R1	R2	R3
L1	Plug L1 (pinned)	Adaptor 1			
L2	Plug L2 (pinned)	Adaptor 2			
L3	Plug L3 (pinned)	Adaptor 3			
Launch test plug configuration (2) unpinned			**Receive test** Plug (pinned) as receive test plug		
Cord	Launch test plug	Adaptor	R1	R2	R3
L1	Plug L1 (unpinned)	Adaptor 1			
L2	Plug L2 (unpinned)	Adaptor 2			
L3	Plug L3 (unpinned)	Adaptor 3			

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Figure 12 – Test matrix and labelling for measuring Method 2 (8-, 10-, 12- and > 12-fibre connectors)

5.3 Analysis of results

The mean value and 97 % percentile values of the measurement data from all the fibres of either Method 1 or Method 2, shall comply with the values specified in the relevant connector performance standard.

7 Calculation and analysis

Calculate the mean value and 97th percentile values from all the attenuation data measured for all mating combinations and all fibres of either Method 1 or Method 2. The 97th percentile value is the smallest measured value within which 97 % of all the measured data fall. Then compare these values with the values specified in the relevant connector performance standard and judge pass or fail.

8 Details to be specified and reported

The following details, as applicable, shall be specified in the relevant specification and shall be reported in the test report:

- ~~Performance characteristics (allowable attenuation, statistical variation, etc.).~~
- ~~Source wavelength.~~
- ~~Fibre attenuation per km.~~
- detailed description of the test samples (cable assemblies and adaptors, fibre type);
- test method used (Method 1 or 2);
- type of measurement equipment;
- measurement wavelength(s);
- statistical results (mean value and 97th percentile value);
- measurement uncertainty;
- any deviations from this test method.

Annex A
(normative)

Requirements for launch fibre and launch plug for multimode measurement

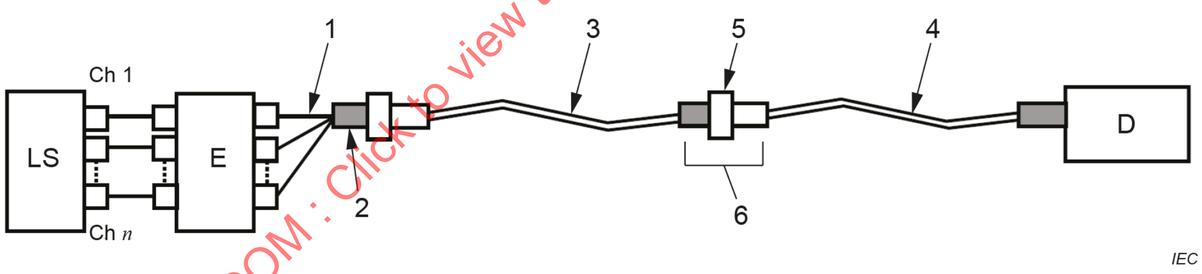
In this test method the attenuation of the connection of two DUT plugs of two DUT cable assemblies is measured. However, in case of multimode measurement the launch plug, which is placed right before and connected to the first DUT cable assembly as shown in Figure A.1, shall consist of tight tolerance fibre and a tight tolerance plug to reduce the measurement uncertainty.

For the launch fibre, core diameter (CD) and numerical aperture (NA) are specified. For the launch plug, parameters which influence the lateral, angular, and longitudinal offset of the optical fibre axes are specified.

The requirements for the launch fibre and the launch plug are summarised in Table A.1.

Table A.1 – Requirements for launch fibre and launch plug

Fibre type of DUT	Launch fibre	Launch plug	Launch condition
Single-mode	Any single-mode fibre	Any	Not applicable
Multimode 50 µm core	Core diameter (CD) 50 µm ± 0,5 µm Numerical aperture (NA) 0,200 ± 0,002	Compliant with corresponding reference grade optical interface specified in the IEC 63267 series	Compliant with encircled flux (EF) specified in IEC 61300-1 at the launch plug



Key

LS light source
E launch condition control
1 launch fibre
2 launch plug
3 DUT (launch test cord)
4 DUT (receive test cord)
5 adaptor
6 connection under test

Figure A.1 – Attenuation measurement system

Bibliography

IEC 61280-1-3, *Fibre optic communication subsystem test procedures – Part 1-3: General communication subsystems – Measurement of central wavelength, spectral width and additional spectral characteristics*

IEC 61300-3-34, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-34: Examinations and measurements – Attenuation of random mated connectors*

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IEC 61300-3-45

Edition 2.0 2023-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 3-45: Examinations and measurements – Attenuation of random mated multi-fibre connectors

Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures –
Partie 3-45: Examens et mesures – Affaiblissement dû à l'accouplement sans choix préalable de connecteurs multifibres

IEC 61300-3-45:2023-06(en-fr)

CONTENTS

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 3-45: Examinations and measurements – Attenuation of random mated multi-fibre connectors

FOREWORD

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IEC 61300-3-45 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is an International Standard.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

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

a) addition of sample size for > 12-fibre connector measurement;
b) inclusion of guidance for multimode measurement.

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

Draft	Report on voting
86B/4757/FDIS	86B/4774/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61300 series, published under the general title *Fibre optic interconnecting devices and passive components – Basic test and measurement 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 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.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 3-45: Examinations and measurements – Attenuation of random mated multi-fibre connectors

1 Scope

The purpose of this part of IEC 61300 is to describe the procedure required to measure the statistical distribution and mean attenuation for random mated optical connectors with physical contact (PC) and angled physical contact (APC) polished multi-fibre rectangular ferrules as defined in the IEC 61754 series. This measurement method is applicable to cable assemblies.

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 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61300-3-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*

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 61754 (all parts), *Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces*

IEC 63267 (all parts), *Fibre optic interconnecting devices and passive components – Connector optical interfaces for enhanced macro bend loss multimode fibres*

3 Terms and definitions

No terms and definitions are listed in this document.

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

4 General description

4.1 Test methods

Two test methods are described for measuring the attenuation of random mated optical connectors. Both provide an estimate of the expected average performance that a group of cable assemblies (including an adaptor, if applicable) will exhibit when used in an optical system. The device under test (DUT) is a cable assembly with on one side a plug with pins (pinned plug) and on the other side a plug without pins (unpinned plug). The cable assemblies, and any adaptors, shall be chosen at random to ensure that the measurements provide a statistically unbiased estimate.

Method 1 describes a procedure using a sample of cable assemblies and adaptors specified in Table 1. In this case the pinned plugs are used as "launch test plugs" and the unpinned plugs are tested against them sequentially. The results, based on the number of measurements specified in Table 1, are recorded in the test matrix shown in Figure 3 to Figure 5.

Method 2 describes a procedure for the measurement of a sample of cable assemblies and adaptors specified in Table 2. Three cable assemblies are selected from the sample as "launch test cords" and the remaining cable assemblies are grouped as "receive test cords". First, the pinned plugs of the launch test cords are used as launch test plugs and the unpinned plugs of the receive test cords are tested against them sequentially. Then the unpinned plugs of the launch test cords are used as launch test plugs and the pinned plugs of the receive test cords are tested. This produces the number of measurements specified in Table 2 and the results are recorded in the test matrix shown in Figure 10 to Figure 12.

Method 1 is intended to be part of a design approval exercise that can involve one or more suppliers. It is recognised that the number of measurements required by Method 1 can be excessive for day-to-day routine checking of either in-house or supplier produced products. In this case, once approval is achieved, Method 2 would be relied on to maintain process control as an alternative option. However, in the event of a dispute, Method 1 shall act as the reference measurement method.

NOTE In this measurement method, the term "launch test cord" is used to define one of the mated DUTs which is installed on the light source side. On the other hand, the other DUT which is installed on the detector side is defined as "receive test cord". In the same way, the plugs mated at the connection point under test are defined as "launch test plug" and "receive test plug", respectively. "Launch test plug" and "launch test cord" are used to define those components chosen at random from the sample, against which a number of comparative measurements are made. It is not intended that the terms imply specially chosen or manufactured components, such as those used, for example, in screen testing.

Table 1 – Sample size for Method 1

Connectors (n-fibre connector)	Sample sizes		
	Cords and adaptors	Measurements	Fibres
2-fibre connector	15	210	420
4-fibre connector	12	132	528
8-fibre connector	10	90	720
10-fibre connector	10	90	900
12-fibre connector	10	90	1 080
> 12-fibre connector	10	90	90*n

NOTE Parameter n is the number of fibres in the connector.

Table 2 – Sample size for Method 2

Connectors (n -fibre connector)	Sample sizes					
	Cords			Adaptors	Measurements	Fibres
	Total	Launch test cord	Receive test cord			
2-fibre connector	12	3	9	3	54	108
4-fibre connector	8	3	5	3	30	120
8-fibre connector	6	3	3	3	18	144
10-fibre connector	6	3	3	3	18	150
12-fibre connector	6	3	3	3	18	216
> 12-fibre connector	6	3	3	3	18	18*n
NOTE Parameter n is the number of fibres in the connector.						

4.2 Precautions

The following test requirements shall be met.

a) The cladding modes shall not affect the measurement. Cladding modes shall be stripped as a function of the fibre coating.

b) The fibres in the test shall remain fixed between the reference power measurement and the corresponding attenuation measurements to avoid changes in attenuation due to bending losses.

c) The stability performance of the test equipment shall be ≤ 0,05 dB or 10 % of the attenuation to be measured, whichever is the lower value. The stability shall be maintained over the measurement time and operational temperature range. The required measurement resolution shall be 0,01 dB for both multimode and single-mode.

d) To achieve consistent results, inspect all connectors and adaptors prior to the setup of the measurement system and if contaminated clean them. During measurement steps, inspect all connectors and adaptors except those in the unchanged connections and if contaminated clean them before mating. Visual examination shall be undertaken in accordance with IEC 61300-3-1 and IEC 61300-3-35.

NOTE A cladding mode stripper usually comprises a material having a refractive index equal to or greater than that of the fibre cladding.

5 Apparatus

5.1 Launch conditions and light source (LS)

The source unit consists of an optical emitter, the associated drive electronics, and fibre pigtail (if any). Preferred source conditions are given in Table 3. The stability of the single-mode fibre source at 23 °C shall be ±0,01 dB over the duration of the measurement. The stability of the multimode fibre source at 23 °C shall be ±0,05 dB over the duration of the measurement. The source output power shall be ≥ 20 dB above the minimum measurable power level.

Table 3 – Preferred source conditions

No.	Type	Central wavelength nm	Spectral width (RMS) nm	Source type
S1	Multimode	660 ± 30	≥ 10	Monochromator or LED
S2	Multimode	780 ± 30	≥ 10	Monochromator or LED
S3	Multimode	850 ± 30	≥ 10	Monochromator or LED
S4	Multimode	1 300 ± 30	≥ 10	Monochromator or LED
S5	Single-mode	1 310 ± 30	To be reported	Laser diode, monochromator, or LED
S6	Single-mode	1 550 ± 30	To be reported	Laser diode, monochromator, or LED
S7	Single-mode	1 625 ± 30	To be reported	Laser diode, monochromator, or LED

It is recognized that some components, for example for coarse wavelength division multiplexing (CWDM), can require the use of other source types such as tunable lasers. It is therefore recommended in these cases that the preferred source characteristics are specified on the basis of the component to be measured.

NOTE Central wavelength and spectral width are defined in IEC 61280-1-3.

The launch condition shall be specified in accordance with IEC 61300-1. In case the specified launch condition is not obtained by the original light from the source, an appropriate apparatus for launch condition control (E) shall be used.

The interference of modes from a coherent source will create speckle patterns in multimode fibres. These speckle patterns give rise to speckle or modal noise and are observed as power fluctuations, since their characteristic times are longer than the resolution time of the detector. As a result, stable launch conditions cannot be achieved using coherent sources for multimode measurements. Consequently, lasers, including optical time domain reflectometer (OTDR) sources, should be avoided in favour of LEDs or other incoherent sources for measuring multimode components.

5.2 Detector (D)

The detector consists of an optical detector, the means to connect to it and associated electronics. The connection to the detector will be an adaptor that accepts a connector plug of the appropriate design. The detector shall capture all light emitted by the connector plug.

In addition to meeting the stability and resolution requirements, the detector shall have the following characteristics:

– linearity of multimode, ≤ ±0,25 dB (over −5 dBm up to −60 dBm);

– linearity of single-mode, ≤ ±0,1 dB (over −5 dBm up to −60 dBm).

The detector linearity should be referenced to a power level of −23 dBm at the operational wavelength.

Where the connection to the detector is broken between the reference power measurement and the corresponding attenuation measurements, the measurement repeatability shall be within 0,05 dB or 10 % of the attenuation to be measured, whichever is the lower value. A large sensitive area detector can be used to achieve this.

The precise characteristics of the detector shall be compatible with the measurement requirements. The dynamic range of the detector shall be capable of measuring the power level exiting from the device under test (DUT) at the wavelength being measured.

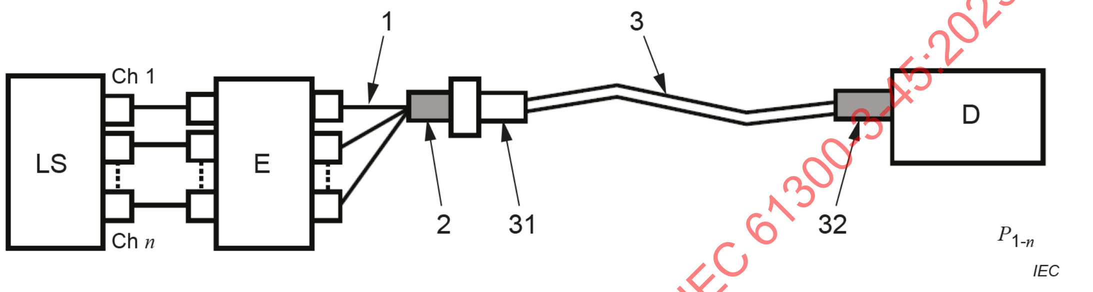
6 Procedure

6.1 Method 1

a) Randomly select the sample number of cable assemblies specified in Table 1. Sequentially label the cable assemblies and plugs under test as shown in Figure 3 to Figure 5.

b) Randomly select the sample size of adaptors as specified in Table 1. Sequentially label the adaptors under test as shown in Figure 3 to Figure 5.

c) Set up the reference power measurement system as shown in Figure 1, with cord 1 as the launch test cord and plug 1 (pinned) as the launch test plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord. For multimode measurement, tight tolerance fibre and tight tolerance plug as specified in Annex A shall be used for the launch plug. The launch condition at the launch plug shall comply with IEC 61300-1.



Key

LS light source

E launch condition control

1 fan-out cord

2 launch plug

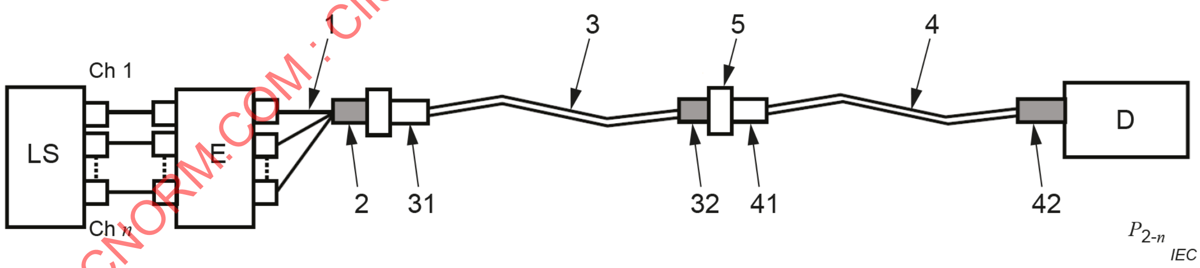
3 launch test cord

31 unpinned plug of launch test cord

32 pinned plug of launch test cord (launch test plug)

Figure 1 – Reference power measurement system – Method 1

d) Pick up cord 2 as the receive test cord. Mate plug 1 (pinned) to plug 2 (unpinned) using adaptor 1 as shown in Figure 2. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-}n}$ for all fibres in the cord.



Key

LS light source

E launch condition control

1 fan-out cord

2 launch plug

3 launch test cord

31 unpinned plug of launch test cord

32 pinned plug of launch test cord (launch test plug)

4 receive test cord

41 unpinned plug of receive test cord (receive test plug)

42 pinned plug of receive test cord

5 adaptor

Figure 2 – Attenuation measurement system – Method 1

e) Calculate the attenuation A of the mated plug pair 1 (pinned)/2 (unpinned) with adaptor 1, using Formula (1):

$$A = \left[-10\log\left(\frac{P_{2-i}}{P_{1-i}}\right)\right] - \left(A_f \times L\right) \text{ dB} \quad (1)$$

where

A is the attenuation;

i is the number of fibres of the test cord;

A_f is the fibre attenuation per kilometre;

L is the length of the fibre in kilometre.

The product $A_f \times L$ depends on the fibre attenuation level and can be neglectable when it is small enough compared to the connection losses.

f) Record the attenuation results for each fibre into an appropriate matrix format.

g) Keeping plug 1 (pinned) as the launch test plug, replace cord 2 with cord 3 and mate plug 3 (unpinned) to plug 1 (pinned) using adaptor 1.

h) Measure the power $P_{3\text{-}1}$ to $P_{3\text{-}n}$ and record the attenuation results for each fibre.

i) Repeat steps g) and h) until all the unpinned plugs of the remaining cable assemblies have been tested against the launch test plug 1 (pinned).

j) After step i) has been completed, replace the launch test cord and the adaptor so that plug 2 (pinned) is used as the launch test plug. Measure the reference power for the configuration.

k) Measure the attenuation for all plugs (unpinned) against the launch test plug 2 (pinned) using adaptor 2.

l) Continue this process until all allocated plugs (pinned) have been used as launch test plugs.

Launch test cord and adaptor			Receive test cord Plug (unpinned) as receive test plug														
Cord	Launch test plug	Adaptor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Plug 1 (pinned)	Adaptor 1	–														
2	Plug 2 (pinned)	Adaptor 2		–													
3	Plug 3 (pinned)	Adaptor 3			–												
4	Plug 4 (pinned)	Adaptor 4				–											
5	Plug 5 (pinned)	Adaptor 5					–										
6	Plug 6 (pinned)	Adaptor 6						–									
7	Plug 7 (pinned)	Adaptor 7							–								
8	Plug 8 (pinned)	Adaptor 8								–							
9	Plug 9 (pinned)	Adaptor 9									–						
10	Plug 10 (pinned)	Adaptor 10										–					
11	Plug 11 (pinned)	Adaptor 11											–				
12	Plug 12 (pinned)	Adaptor 12												–			
13	Plug 13 (pinned)	Adaptor 13													–		
14	Plug 14 (pinned)	Adaptor 14														–	
15	Plug 15 (pinned)	Adaptor 15															–

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Figure 3 – Test matrix and labelling for measuring Method 1 (2-fibre connector)

Launch test cord and adaptor			Receive test cord Plug (unpinned) as receive test plug											
Cord	Launch test plug	Adaptor	1	2	3	4	5	6	7	8	9	10	11	12
1	Plug 1 (pinned)	Adaptor 1	—											
2	Plug 2 (pinned)	Adaptor 2		—										
3	Plug 3 (pinned)	Adaptor 3			—									
4	Plug 4 (pinned)	Adaptor 4				—								
5	Plug 5 (pinned)	Adaptor 5					—							
6	Plug 6 (pinned)	Adaptor 6						—						
7	Plug 7 (pinned)	Adaptor 7							—					
8	Plug 8 (pinned)	Adaptor 8								—				
9	Plug 9 (pinned)	Adaptor 9									—			
10	Plug 10 (pinned)	Adaptor 10										—		
11	Plug 11 (pinned)	Adaptor 11											—	
12	Plug 12 (pinned)	Adaptor 12												—

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Figure 4 – Test matrix and labelling for measuring Method 1 (4-fibre connector)

Launch test cord and adaptor			Receive test cord Plug (unpinned) as receive test plug									
Cord	Launch test plug	Adaptor	1	2	3	4	5	6	7	8	9	10
1	Plug 1 (pinned)	Adaptor 1	—									
2	Plug 2 (pinned)	Adaptor 2		—								
3	Plug 3 (pinned)	Adaptor 3			—							
4	Plug 4 (pinned)	Adaptor 4				—						
5	Plug 5 (pinned)	Adaptor 5					—					
6	Plug 6 (pinned)	Adaptor 6						—				
7	Plug 7 (pinned)	Adaptor 7							—			
8	Plug 8 (pinned)	Adaptor 8								—		
9	Plug 9 (pinned)	Adaptor 9									—	
10	Plug 10 (pinned)	Adaptor 10										—

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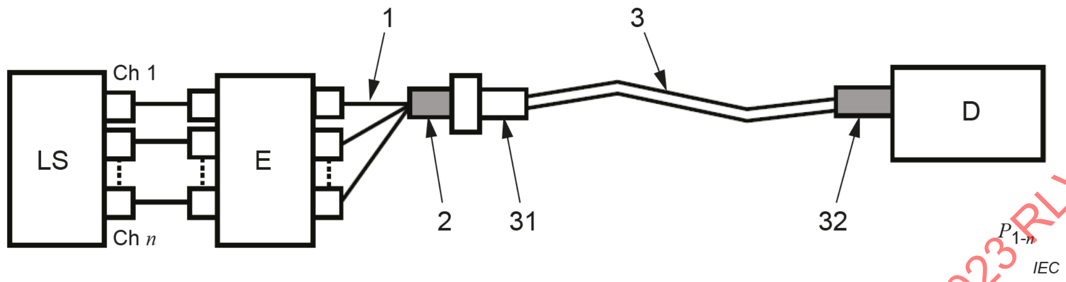
Figure 5 – Test matrix and labelling for measuring Method 1 (8-, 10-, 12- and > 12-fibre connectors)

6.2 Method 2

a) Randomly select the sample number of cable assemblies specified in Table 2.

b) Choose three cable assemblies at random and sequentially label them as launch test cords, and the plugs of each cord as launch test plugs as shown in Figure 10 to Figure 12. Sequentially label the remaining cable assemblies as receive test cords, and the plugs of each cord as receive test plugs as shown in Figure 10 to Figure 12. Sequentially label three adaptors 1 to 3.

c) Set up the reference power measurement system as shown in Figure 6, with launch test cord L1 so that plug L1 (pinned) is the launch test plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord. For multimode measurement, tight tolerance fibre and tight tolerance plug as specified in Annex A shall be used for the launch plug. The launch condition at the launch plug shall comply with IEC 61300-1.

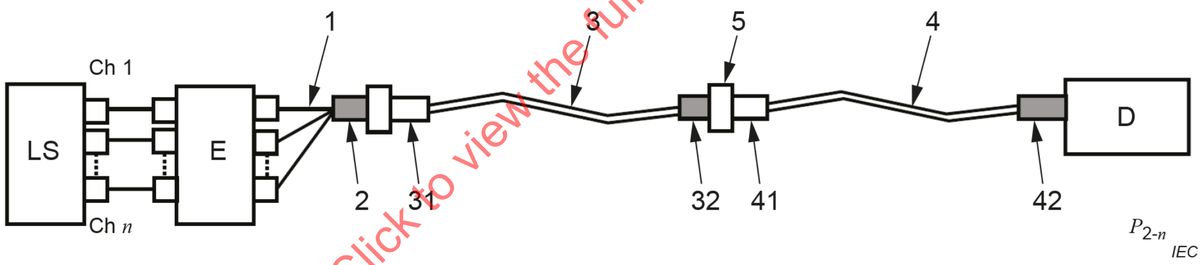


Key

LS light source
E launch condition control
1 fan-out cord
2 launch plug
3 launch test cord
31 unpinned plug of launch test cord
32 pinned plug of launch test cord (launch test plug)

Figure 6 – Reference power measurement system (1) – Method 2

d) Pick up receive test cord R1 and mate launch test plug L1 (pinned) to receive test plug R1 (unpinned) using adaptor 1 as shown in Figure 7. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-}n}$.



Key

LS light source
E launch condition control
1 fan-out cord
2 launch plug
3 launch test cord
31 unpinned plug of launch test cord
32 pinned plug of launch test cord (launch test plug)
4 receive test cord
41 unpinned plug of receive test cord receive test plug)
42 pinned plug of receive test cord
5 adaptor

Figure 7 – Attenuation measurement system (1) – Method 2

e) Calculate the attenuation of the mated plug pair L1 (pinned)/R1 (unpinned) with adaptor 1, using Formula (1).

f) Record the attenuation results for each fibre into an appropriate matrix format.

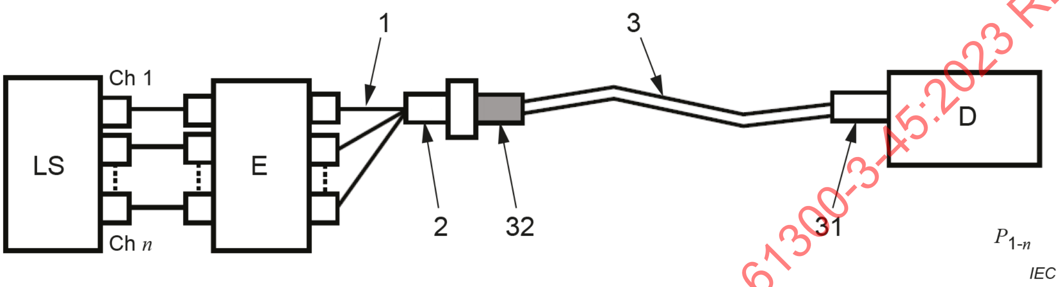
g) Repeat steps d) to f) until all receive test plugs (unpinned) have been tested against launch test plug L1 (pinned) and adaptor 1.

h) After step g) has been completed, replace the launch test cord and the adaptor so that launch test plug L2 (pinned) is used as the launch test plug. Measure the reference power for the configuration.

i) Measure the attenuation for all receive test plugs (unpinned) against launch test plug L2 (pinned) and adaptor 2, using the procedures described above.

j) Continue this process until all allocated launch test plugs (pinned) and adaptors have been used and all receive test plugs (unpinned) have been tested.

k) Set up the measurement system shown in Figure 8, with launch test cord 1 so that plug L1 (unpinned) is the launch test plug. Measure power $P_{1\text{-}1}$ to $P_{1\text{-}n}$ for all fibres in the cord.

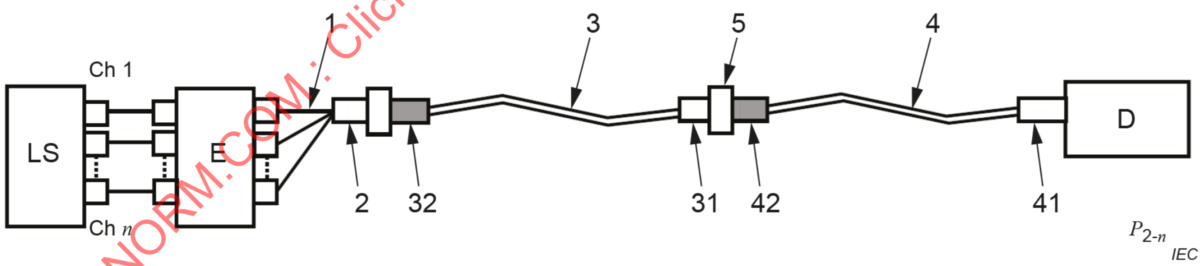


Key

LS	light source	3	launch test cord
E	launch condition control	31	unpinned plug of launch test cord
1	fan-out cord	32	pinned plug of launch test cord
2	launch plug		(launch test plug)

Figure 8 – Reference power measurement system (2) – Method 2

l) Pick up receive test cord R1 and mate launch test plug L1 (unpinned) to receive test plug R1 (pinned) using adaptor 1 as shown in Figure 9. Measure the power $P_{2\text{-}1}$ to $P_{2\text{-}n}$.



Key

LS	light source	4	receive test cord
E	launch condition control	41	unpinned plug of receive test cord
1	fan-out cord		(receive test plug)
2	launch plug	42	pinned plug of receive test cord
3	launch test cord	5	adaptor
31	unpinned plug of launch test cord		
32	pinned plug of launch test cord		
	(launch test plug)		

Figure 9 – Attenuation measurement system (2) – Method 2

m) Calculate the attenuation of the mated plug pair L1 (unpinned)/R1 (pinned) with adaptor 1, using Formula (1).

n) Record the attenuation results for each fibre into an appropriate matrix format.

o) Repeat steps l) to n) until all receive test plugs (pinned) have been tested against launch test plug L1 (unpinned) and adaptor 1.

p) After step o) has been completed, replace the launch test cord and the adaptor so that launch test plug L2 (unpinned) is used as launch test plug. Measure the reference power for the configuration.

q) Measure the attenuation for all receive test plugs (pinned) against launch test plug L2 (unpinned) and adaptor 2, using the procedures described above.

r) Continue this process until all allocated launch test plugs (unpinned) and adaptors have been used and all receive test plugs (pinned) have been tested.

Launch test plug configuration (1) pinned			**Receive test cord** Plug (unpinned) as receive test plug								
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5	R6	R7	R8	R9
L1	Plug L1 (pinned)	Adaptor 1									
L2	Plug L2 (pinned)	Adaptor 2									
L3	Plug L3 (pinned)	Adaptor 3									
Launch test plug configuration (2) unpinned			**Receive test** Plug (pinned) as receive test plug								
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5	R6	R7	R8	R9
L1	Plug L1 (unpinned)	Adaptor 1									
L2	Plug L2 (unpinned)	Adaptor 2									
L3	Plug L3 (unpinned)	Adaptor 3									

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Figure 10 – Test matrix and labelling for measuring Method 2 (2-fibre connector)

Launch test plug configuration (1) pinned			**Receive test cord** Plug (unpinned) as receive test plug				
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5
L1	Plug L1 (pinned)	Adaptor 1					
L2	Plug L2 (pinned)	Adaptor 2					
L3	Plug L3 (pinned)	Adaptor 3					
Launch test plug configuration (2) unpinned			**Receive test** Plug (pinned) as receive test plug				
Cord	Launch test plug	Adaptor	R1	R2	R3	R4	R5
L1	Plug L1 (unpinned)	Adaptor 1					
L2	Plug L2 (unpinned)	Adaptor 2					
L3	Plug L3 (unpinned)	Adaptor 3					

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Figure 11 – Test matrix and labelling for measuring Method 2 (4-fibre connector)

Launch test plug configuration (1) pinned			Receive test cord Plug (unpinned) as receive test plug		
Cord	Launch test plug	Adaptor	R1	R2	R3
L1	Plug L1 (pinned)	Adaptor 1			
L2	Plug L2 (pinned)	Adaptor 2			
L3	Plug L3 (pinned)	Adaptor 3			
Launch test plug configuration (2) unpinned			**Receive test** Plug (pinned) as receive test plug		
Cord	Launch test plug	Adaptor	R1	R2	R3
L1	Plug L1 (unpinned)	Adaptor 1			
L2	Plug L2 (unpinned)	Adaptor 2			
L3	Plug L3 (unpinned)	Adaptor 3			

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Figure 12 – Test matrix and labelling for measuring Method 2 (8-, 10-, 12- and > 12-fibre connectors)

7 Calculation and analysis

Calculate the mean value and 97th percentile values from all the attenuation data measured for all mating combinations and all fibres of either Method 1 or Method 2. The 97th percentile value is the smallest measured value within which 97 % of all the measured data fall. Then compare these values with the values specified in the relevant connector performance standard and judge pass or fail.

8 Details to be specified and reported

The following details, as applicable, shall be specified in the relevant specification and shall be reported in the test report:

- detailed description of the test samples (cable assemblies and adaptors, fibre type);
- test method used (Method 1 or 2);
- type of measurement equipment;
- measurement wavelength(s);
- statistical results (mean value and 97th percentile value);
- measurement uncertainty;
- any deviations from this test method.

Annex A
(normative)

Requirements for launch fibre and launch plug for multimode measurement

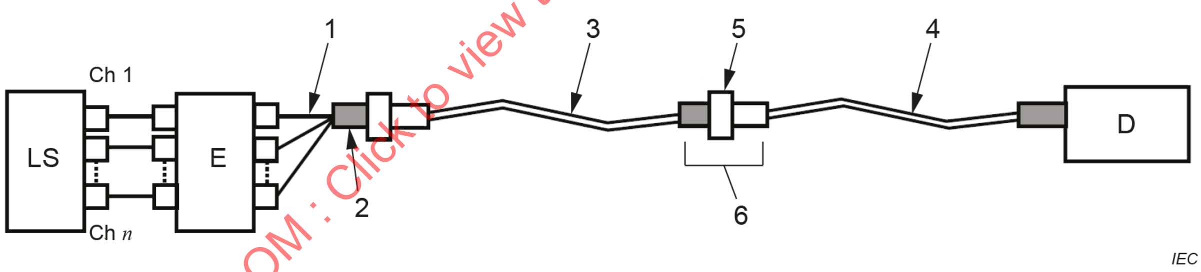
In this test method the attenuation of the connection of two DUT plugs of two DUT cable assemblies is measured. However, in case of multimode measurement the launch plug, which is placed right before and connected to the first DUT cable assembly as shown in Figure A.1, shall consist of tight tolerance fibre and a tight tolerance plug to reduce the measurement uncertainty.

For the launch fibre, core diameter (CD) and numerical aperture (NA) are specified. For the launch plug, parameters which influence the lateral, angular, and longitudinal offset of the optical fibre axes are specified.

The requirements for the launch fibre and the launch plug are summarised in Table A.1.

Table A.1 – Requirements for launch fibre and launch plug

Fibre type of DUT	Launch fibre	Launch plug	Launch condition
Single-mode	Any single-mode fibre	Any	Not applicable
Multimode 50 µm core	Core diameter (CD) 50 µm ± 0,5 µm Numerical aperture (NA) 0,200 ± 0,002	Compliant with corresponding reference grade optical interface specified in the IEC 63267 series	Compliant with encircled flux (EF) specified in IEC 61300-1 at the launch plug



Key

LS light source
E launch condition control
1 launch fibre
2 launch plug
3 DUT (launch test cord)
4 DUT (receive test cord)
5 adaptor
6 connection under test

Figure A.1 – Attenuation measurement system

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IEC 61280-1-3, *Fibre optic communication subsystem test procedures – Part 1-3: General communication subsystems – Measurement of central wavelength, spectral width and additional spectral characteristics*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – PROCÉDURES FONDAMENTALES D'ESSAIS ET DE MESURES –

Partie 3-45: Examens et mesures – Affaiblissement dû à l'accouplement sans choix préalable de connecteurs multifibres

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L'IEC 61300-3-45 a été établie par le sous-comité 86B: Dispositifs d'interconnexion et composants passifs à fibres optiques, du comité d'études 86 de l'IEC: Fibres optiques. Il s'agit d'une Norme internationale.

Cette seconde édition annule et remplace la première édition parue en 2011. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) ajout du nombre d'échantillons pour la mesure de connecteurs à plus de 12 fibres;
b) ajout de recommandations pour les mesures multimodales.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
86B/4757/FDIS	86B/4774/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 61300, publiées sous le titre général *Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures*, se trouve sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

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- amendé.

DISPOSITIFS D'INTERCONNEXION ET COMPOSANTS PASSIFS FIBRONIQUES – PROCÉDURES FONDAMENTALES D'ESSAIS ET DE MESURES –

Partie 3-45: Examens et mesures – Affaiblissement dû à l'accouplement sans choix préalable de connecteurs multifibres

1 Domaine d'application

L'objet de la présente partie de l'IEC 61300 est de décrire la procédure exigée pour mesurer la distribution statistique et l'affaiblissement moyen des connecteurs optiques accouplés sans choix préalable avec férules rectangulaires polies multifibres à contact physique (PC), et à contact physique avec angle (APC), comme défini dans la série IEC 61754. Cette méthode de mesure s'applique aux câbles assemblés.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61300-1, *Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures – Partie 1: Généralités et lignes directrices*

IEC 61300-3-1, *Dispositifs d'interconnexion et composants passifs à fibres optiques – Méthodes fondamentales d'essais et de mesures – Partie 3-1: Examens et mesures – Examen visuel*

IEC 61300-3-35, *Dispositifs d'interconnexion et composants passifs à fibres optiques – Procédures fondamentales d'essais et de mesures – Partie 3-35: Examens et mesures – Examen visuel des connecteurs à fibres optiques et des émetteurs-récepteurs à embase fibrée*

IEC 61754 (toutes les parties), *Dispositifs d'interconnexion et composants passifs fibroniques – Interfaces de connecteurs fibroniques*

IEC 63267 (toutes les parties), *Fibre optic interconnecting devices and passive components – Connector optical interfaces for enhanced macro bend loss multimode fibres (disponible en anglais seulement)*

3 Termes et définitions

Aucun terme n'est défini dans le présent document.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

4 Description générale

4.1 Méthodes d'essai

Deux méthodes d'essai sont décrites pour mesurer l'affaiblissement de connecteurs optiques accouplés sans choix préalable. Les deux donnent une estimation de la performance moyenne attendue qu'un groupe de câbles assemblés (y compris avec raccord, le cas échéant) va présenter quand ces câbles assemblés sont utilisés dans un système optique. Le dispositif soumis à essai (DUT, Device Under Test) est un câble assemblé comprenant à une extrémité une fiche avec des repères (fiche avec repérage) et à l'autre extrémité une fiche sans repères (fiche sans repérage). Les câbles assemblés, et tout raccord éventuel, doivent être choisis aléatoirement afin de s'assurer que les mesures fournissent une estimation statistique non faussée.

La Méthode 1 décrit une procédure utilisant un échantillon de câbles assemblés et de raccords spécifiés dans le Tableau 1. Dans ce cas, les fiches avec repérage sont utilisées en tant que "fiches d'essai d'injection" et les fiches sans repérage sont soumises à essai par rapport à celles-ci de manière séquentielle. Les résultats, fondés sur le nombre de mesures spécifié dans le Tableau 1, sont consignés dans la matrice d'essais représentée aux figures de la Figure 3 à la Figure 5.

La Méthode 2 décrit une procédure pour la mesure d'un échantillon de câbles assemblés et de raccords spécifiés dans le Tableau 2. Trois câbles assemblés sont choisis parmi l'échantillon comme "câbles d'essai d'injection" et les autres câbles assemblés sont regroupés sous la forme de "cordons d'essai de réception". Tout d'abord, les fiches avec repérage des cordons d'essai d'injection sont utilisées comme fiches d'essai d'injection et les fiches sans repérage des cordons d'essai de réception sont soumises à essai par rapport à celles-ci de manière séquentielle. Ensuite, les fiches sans repérage des cordons d'essai d'injection sont utilisées comme fiches d'essai d'injection et les fiches avec repérage des cordons d'essai de réception sont soumises à essai. Ceci produit le nombre de mesures spécifié dans le Tableau 2 et les résultats sont consignés dans la matrice d'essais représentée aux figures de la Figure 10 à la Figure 12.

La Méthode 1 est destinée à faire partie de la phase d'approbation de la conception qui peut impliquer un ou plusieurs fournisseurs. Il est reconnu que le nombre de mesures exigé par la Méthode 1 peut paraître excessif pour une tâche quotidienne de contrôle de routine, sur des produits fabriqués soit en interne soit par un fournisseur. Dans ce cas, une fois l'approbation obtenue, une variante consiste à privilégier la Méthode 2 pour assurer le contrôle du processus. Cependant, en cas de conflit, la Méthode 1 doit constituer la méthode de mesure de référence.

NOTE Dans cette méthode de mesure, le terme "cordon d'essai d'injection" est utilisé pour définir l'un des DUT accouplés qui est installé sur le côté de la source de rayonnement lumineux. D'autre part, l'autre DUT qui est installé côté détecteur est défini comme "cordon d'essai de réception". De la même manière, les fiches accouplées au point de connexion soumis à essai sont définies respectivement comme "fiche d'essai d'injection" et "fiche d'essai de réception". La "fiche d'essai d'injection" et le "cordon d'essai d'injection" sont utilisés pour définir les composants choisis au hasard dans l'échantillon, sur lesquels un certain nombre de mesures comparatives sont effectuées. Il n'est pas prévu que ces termes concernent des composants choisis ou fabriqués spécialement, tels que ceux utilisés, par exemple, dans les essais de déverminage.

Tableau 1 – Nombre d'échantillons pour la Méthode 1

Connecteur (connecteur à *n* fibres)	Nombre d'échantillons		
	Cordons et raccords	Mesures	Fibres
Connecteur 2 fibres	15	210	420
Connecteur 4 fibres	12	132	528
Connecteur 8 fibres	10	90	720
Connecteur 10 fibres	10	90	900
Connecteur 12 fibres	10	90	1 080
Connecteur à plus de 12 fibres	10	90	90*n

NOTE Le paramètre n correspond au nombre de fibres dans le connecteur.

Tableau 2 – Nombre d'échantillons pour la Méthode 2

Connecteurs (connecteur à *n* fibres)	Nombre d'échantillons					
	Cordons			Raccords	Mesures	Fibres
	Total	Cordon d'essai d'injection	Cordon d'essai de réception			
Connecteur 2 fibres	12	3	9	3	54	108
Connecteur 4 fibres	8	3	5	3	30	120
Connecteur 8 fibres	6	3	3	3	18	144
Connecteur 10 fibres	6	3	3	3	18	150
Connecteur 12 fibres	6	3	3	3	18	216
Connecteur à plus de 12 fibres	6	3	3	3	18	18*n

NOTE Le paramètre n correspond au nombre de fibres dans le connecteur.

4.2 Précautions

Les exigences d'essai suivantes doivent être satisfaites.

a) Les modes de gaine ne doivent pas avoir d'influence sur la mesure. Les modes de gaine doivent être extraits dans le cadre d'une fonction du revêtement de fibre.

b) Les fibres de l'essai doivent rester fixes entre la mesure de la puissance de référence et les mesures d'affaiblissement correspondantes, afin d'éviter les variations d'affaiblissement dues aux pertes de courbure.

c) La performance concernant la stabilité de l'équipement d'essai doit être inférieure ou égale à 0,05 dB ou 10 % de l'affaiblissement à mesurer, la valeur retenue étant la plus faible des deux. La stabilité doit être maintenue pendant le temps de mesure et sur la gamme des températures de fonctionnement. La résolution de mesure exigée doit être de 0,01 dB tant pour les mesures multimodales que les mesures unimodales.

d) Pour obtenir des résultats cohérents, examiner tous les connecteurs et tous les raccords avant la mise en place du système de mesure, et les nettoyer en cas de contamination. Pendant les étapes de mesure, examiner tous les connecteurs et tous les raccords, sauf ceux figurant dans des connexions restées inchangées, et les nettoyer en cas de contamination, avant l'accouplement. Un examen visuel doit être effectué conformément à l'IEC 61300-3-1 et l'IEC 61300-3-35.

NOTE Un extracteur de mode de gaine se compose généralement d'un matériau ayant un indice de réfraction supérieur ou égal à celui de la gaine de la fibre.

5 Appareillage

5.1 Conditions d'injection et source de rayonnement lumineux (LS, Light Source)

La source est composée d'un émetteur optique, des dispositifs électroniques de commande associés et de la fibre amorce (le cas échéant). Les conditions préférentielles pour la source sont données dans le Tableau 3. La stabilité de la source pour des fibres unimodales à 23 °C doit être de ±0,01 dB sur la durée de la mesure. La stabilité de la source pour des fibres multimodales à 23 °C doit être de ±0,05 dB sur la durée de la mesure. La puissance de sortie de la source doit être supérieure d'au moins 20 dB au niveau minimal de puissance mesurable.

Tableau 3 – Conditions préférentielles pour la source

Réf.	Type	Longueur d'onde centrale nm	Largeur spectrale (en valeur efficace) nm	Type de source
S1	Multimodal	660 ± 30	≥ 10	Monochromateur ou LED
S2	Multimodal	780 ± 30	≥ 10	Monochromateur ou LED
S3	Multimodal	850 ± 30	≥ 10	Monochromateur ou LED
S4	Multimodal	1 300 ± 30	≥ 10	Monochromateur ou LED
S5	Unimodal	1 310 ± 30	À spécifier	Monochromateur, diode laser ou LED
S6	Unimodal	1 550 ± 30	À spécifier	Monochromateur, diode laser ou LED
S7	Unimodal	1 625 ± 30	À spécifier	Monochromateur, diode laser ou LED

Il est reconnu que certains composants, par exemple pour le multiplexage par répartition approximative en longueur d'onde (CWDM, Coarse Wavelength Division Multiplexing), peuvent exiger l'utilisation d'autres types de sources, telles que les lasers réglables. Il est donc recommandé dans ces cas que les caractéristiques de la source préférentielle soient spécifiées sur la base du composant à mesurer.

NOTE La longueur d'onde centrale et la largeur spectrale sont définies dans l'IEC 61280-1-3.

Les conditions d'injection doivent être spécifiées conformément à l'IEC 61300-1. Dans le cas où les conditions d'injection spécifiées ne sont pas obtenues par le rayonnement lumineux d'origine émis par la source, un appareillage approprié pour le contrôle des conditions d'injection (E) doit être utilisé.

L'interférence de modes à partir d'une source cohérente crée des motifs de tachetures dans les fibres multimodales. Ces motifs de tachetures donnent lieu à du bruit de tacheture ou du bruit modal et sont observés comme des fluctuations de la puissance, étant donné que leurs temps caractéristiques sont plus longs que le temps de résolution du détecteur. De ce fait, il n'est pas possible d'obtenir des conditions d'injection stables en utilisant des sources cohérentes pour les mesures multimodales. En conséquence, il convient d'éviter les lasers, y compris les sources de type réflectomètre optique dans le domaine temporel (RODT), en faveur des LED ou d'autres sources incohérentes pour mesurer les composants multimodaux.