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INTERNATIONAL STANDARD

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Fibre optic active components and devices – Test and measurement procedures –
Part 3: Optical power variation induced by mechanical disturbance in optical receptacles and transceiver interfaces

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – TEST AND MEASUREMENT PROCEDURES –

Part 3: Optical power variation induced by mechanical disturbance in optical receptacles and transceiver interfaces

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International Standard IEC 62150-3 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2012 and constitutes a technical revision.

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

– extension of application field to SC connector interface transceivers in addition to LC connector interface transceivers specified in the first edition as both transceiver interfaces are very important in the industry;
– addition of a new Annex E dealing with load value difference for connector type in Method A.

The text of this standard is based on the following documents:

FDIS	Report on voting
86C/1311/FDIS	86C/1330/RVD

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

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

A list of all parts in the IEC 62150 series, published under the general title *Fibre optic active components and devices – Test and measurement procedures*, can be found on the IEC website.

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

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

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FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – TEST AND MEASUREMENT PROCEDURES –

Part 3: Optical power variation induced by mechanical disturbance in optical receptacles and transceiver interfaces

1 Scope

It has been found that some optical transceivers and receptacles are susceptible to fibre optic cable induced stress when side forces are applied to the mated cable-connector assembly, resulting in variations in the transmitted optical power. The purpose of this part of IEC 62150 is to define physical stress tests to ensure that such optical connections (cable and receptacle) can continue to function within specifications.

This standard specifies the test requirements and procedures for qualifying optical devices for sensitivity to coupled power variations induced by mechanical disturbance at the optical ports of the device.

This standard applies to active devices with optical receptacle interfaces.

This standard describes the testing of transceivers for use with single-mode connectors having either 2,5 mm or 1,25 mm ferrules.

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.

IEC 61753 (all parts), *Fibre optic interconnecting devices and passive components performance standard*

IEC 61753-021-6, *Fibre optic interconnecting devices and passive components performance standard – Part 021-6: Grade B/2 single-mode fibre optic connectors for category O – Uncontrolled environment*

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

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1
wiggle
mechanical disturbances that induce coupled optical power variation in the optical receptacle and transceiver interface

3.1.2
wiggle loss
variation in coupled output power (with respect to a no-load, non-rotated measurement) induced in an optical module or receptacle when the mated connector is laterally stressed

3.2 Abbreviations

DUT device under test

LOS loss of signal

Rx receiver

Tx transmitter

4 Measurement consideration

4.1 Multiple test methods

Since the wiggle loss mechanisms are categorized into two different cases, Case A and B, this standard defines two measurement methods, Method A and B, as shown in Table 1. Method A and B are applicable to the tests for the mechanical endurance of transceivers under wiggle Case A and B, respectively.

Table 1 – Multiple test methods

Test methods	Applicable to	Example of parameters to be included
Method A	Wiggle Case A: test for optical transceivers use with patchcord terminated to connectors which meet interface standards (IEC 61754 series)	Test procedure, test fixture, test jumper, test load
Method B	Wiggle Case B: test for optical transceivers use with patchcord terminated to connectors which meet both interface standards (IEC 61754 series) and performance standards (IEC 61753 series)	Test procedure, test fixture, test jumper, test load

4.2 Two wiggle loss mechanisms

4.2.1 Rationale for two different wiggle loss test methods

Some optical transceivers and receptacles are susceptible to fibre optic cable induced stress when forces are applied to the mated cable-connector assembly. Depending on the structure of fibre-optic connectors, two different points of action for the receptacle cause two different types of wiggle loss.

The intention of Method A is to help ensure that the transceiver port design is robust enough to work with a variety of cables that meet interface standards available in the field. The intention of Method B is to ensure port designs are robust enough to endure potential side loads during operation and installation with cables of known performance.

To guarantee the mechanical robustness of optical transceivers both Methods A and B or either Method A or B shall be chosen as appropriate.

4.2.2 Case A: Point of action for the ferrule

When the ferrule floating tolerance is insufficient (see Annex D), external side forces applied to the patchcord can cause deformation of the sleeve of the receptacle caused by the ferrule bending moment. This causes variations in the transmitted optical power of transceivers. In this case, the mechanical robustness of transceivers depends on the sleeve, receptacle port, and optical sub-assembly design. There are also some patchcords which have insufficient ferrule floating tolerance, as this is not specified in interface standards.

4.2.3 Case B: Point of action for the plug housing

When the ferrule floating tolerance is sufficient, external forces applied to the patchcord cause deformation of the receptacle housing caused by the plug bending moment. This causes variations in the transmitted optical power of transceivers. In this case, the mechanical endurance of transceivers depends on the design of the receptacle housings. Sufficient ferrule floating tolerance can be guaranteed by patchcord performance standards as specified in Annex C, Method B.

5 Test Method A

5.1 Apparatus

5.1.1 General

An example of the test apparatus is shown in Figure 1. Details of the elements are given in the following subclauses. Measurement wavelength is in accordance with the wavelength of transceiver specifications, and the test data is obtained at room temperature.

The exact details of the test fixture will depend on the type of DUT. For example, if an optical transceiver is being evaluated, a test board capable of securing and powering up the transceiver may be used. In this case, it is centre-mounted to the spindle of a rotation mechanism so that it can be rotated symmetrically over 360°.

5.1.2 Test cord

In order to simulate the wiggle loss mechanism of Case A, specially designed test patchcords called simulated wiggle test cords are used in Method A. Detail specifications of the simulated wiggle test cord are defined in Annex C.

In Figure 1, the test cord is connected to the transceiver under test. The test jumper has a weight applied to the end of the test cord to stress the connection to the DUT. The test cord is connected to a power meter at the other end to record the transmitted power variations.

5.1.3 Power meter

The power meter is used to measure variations in the coupled power from the DUT. It is set-up to record the maximum peak-to-peak excursions in power level normalized around the initial no-load measurement. In the case of Test Method A, the following measurement set-up is recommended. Both the rotation mechanism (e.g. stepper motor) and power meter are interfaced to a computer for control and data logging purposes. Ideally, the controller software can manipulate the direction of rotation, speed and step increments of the stepper motor. During the 360° continuous rotation, the instrumentation should be capable of collecting at least one data point for every 2,5 degrees of rotation, which equates to a response time of better than 100 ms for the measuring instrumentation.

5.1.4 Test load

The test load or weight should be applied to the end of the test cord. The test load is defined in Annex A.

5.2 Test procedures for Tx interfaces

5.2.1 Test procedures

The test is conducted with a suitable fixture, as illustrated in Figure 1. (Figure 1 is an example of the case using a 1,25 mm ferrule connector.) This example utilizes an optical transceiver (Tx) port or other connectorized optical source. The simulated wiggle test cord (fibre cord and connector) is flexed at the point of entry to the connector on the DUT by applying a load in the form of a weight to the fibre while rotating the test fixture. The test is conducted as follows.

5.2.2 Set-up

Mount the connector/optical assembly as shown in Figure 1 and connect the simulated wiggle test cord from the device output port/Tx port to the power meter. If the DUT contains more than one port (for example a Tx port and an Rx port in the case of a transceiver), only one port should be analysed at a time. Hence, only a single simulated wiggle test cord should be connected to the device at any given time.

5.2.3 Initial measurement

Without applying any load and without rotating the fixture, measure and record the output power of the DUT when mounted in the fixture. The power meter should be reset at this point so that all measurements are normalized around this output level.

5.2.4 Apply load and rotate

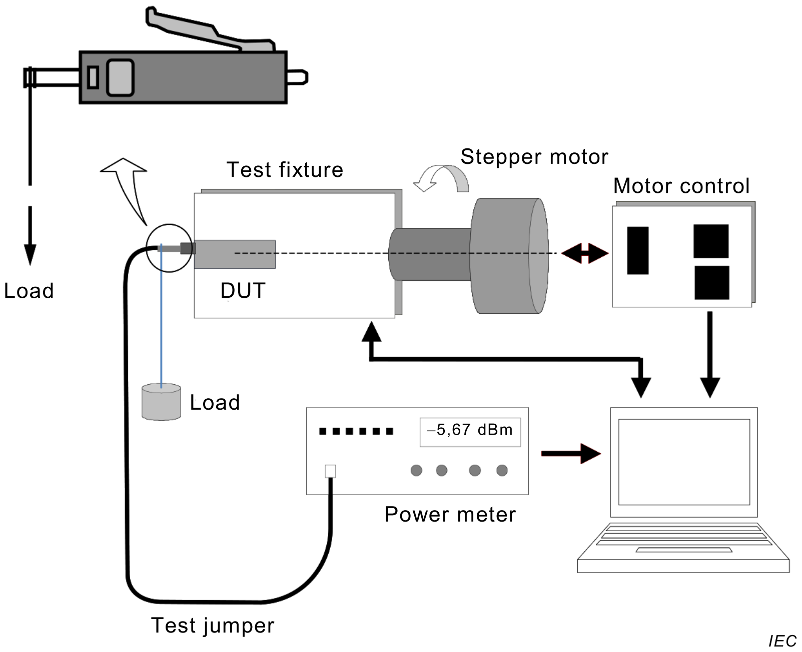
Apply the appropriate load to the simulated wiggle test cord as shown in Figure 1.

The fixture/DUT to which the load is attached shall rotate both clockwise and anticlockwise. Allow for a settling time of 10 s after the load is attached or disturbed and before and after each rotation.

With a 360° rotation at a speed of 4 r/min (or less), record the power meter readings after the clockwise and anticlockwise rotations have completed.

5.2.5 Wiggle loss

The wiggle loss is defined as the maximum peak-to-peak delta of the measured power during the loading process of 5.2.4, including the initial measurement value of 5.2.3.



NOTE The details of the loading point are described in Annex C.

Figure 1 – Equipment setup of Method A for Tx interfaces

5.3 Test procedures for Rx interfaces and optical receptors

5.3.1 Test procedures

In the case of Rx interfaces or optical receptors (for example a transceiver Rx connector test or where the DUT does not contain a light source), the DUT is mounted in a test fixture as shown in Figure 2, with one of the following test methods applied. (Figure 2 is an example of the case using a 1,25 mm ferrule connector.)

5.3.2 LOS indicator method

The procedure is as follows:

a) adjust the input power to the receptacle to find the LOS threshold;

b) increase the input power by 1,5 dB;

c) apply the relevant load specified in Table A.1 and rotate the test fixture from 0° to 360° with continuous motion in clockwise and anticlockwise directions;

d) if LOS is detected, then the device fails the test; if no LOS is detected, the device passes.

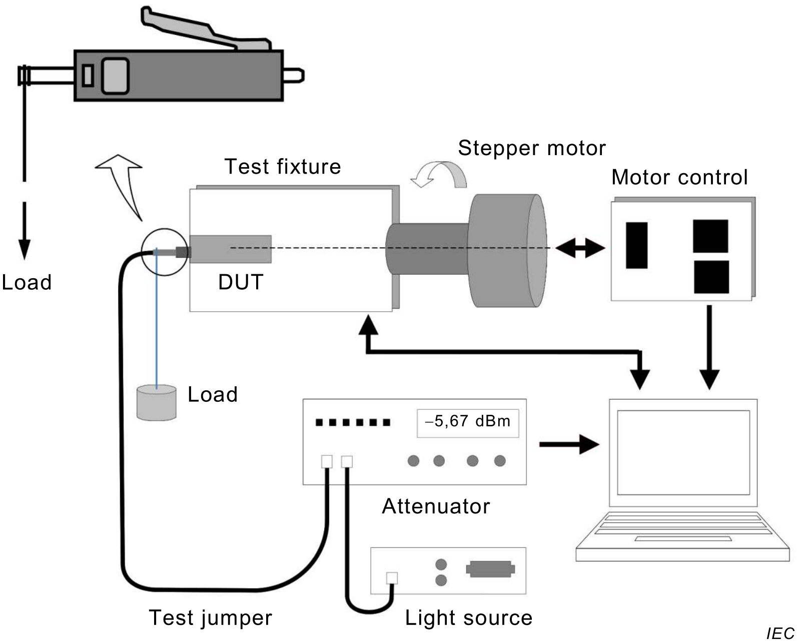
5.3.3 Receiver optical power monitor method

The receiver optical power monitor method can be implemented on transceivers or other optical receptors that support digital diagnostic monitoring. The robustness of the optical port to wiggle is determined by monitoring changes in the received optical power reported by the digital diagnostics. The procedure is as follows:

a) set the input power to the receiver to a level at which the receiver power monitor is in its most accurate range;

b) apply the relevant load specified in Table A.1 and rotate the test fixture from 0° to 360° with continuous motion in clockwise and anticlockwise directions while monitoring the digital diagnostics for receiver optical power;

c) record the maximum change in receiver optical power in dB; wiggle loss is defined as the maximum peak-to-peak delta of the measured power during the measurement from a) through b).



NOTE The details of the loading point are described in Annex C.

Figure 2 – Equipment set-up of Method A for Rx interfaces and optical receptors

6 Test Method B

6.1 Apparatus

6.1.1 General

An example of the test apparatus is shown in Figure 3. Details of the elements are given in the following subclauses. Measurement wavelength is in accordance with the wavelength of transceiver specifications, and the test data is obtained at room temperature.

6.1.2 Test fixture and rotation mechanism

The exact details of the test fixture will depend on the type of DUT. For example, if an optical transceiver is being evaluated, a test board capable of securing and powering up the transceiver may be used. In this case, it is centre-mounted to the spindle of a rotation mechanism so that it can be rotated symmetrically over 360°. In Test Method B, the rotation function is not absolutely necessary if the test fixture enables measurement at every 90° interval around the spindle (0°, 90°, 180°, 270°).

6.1.3 Test cord

In order to simulate the wiggle loss mechanism of Case B, normal patchcords which satisfy both interface standards (see IEC 61754 series) and performance standards (see IEC 61753 series) are used in Method B.

In Figure 3, the test cord is connected to the transceiver under test. The test jumper has a weight applied to the end of test cord to stress the connection to the DUT. The test cord is connected to a power meter at the other end to record the transmitted power variations.

6.1.4 Power meter

The power meter is used to measure variations in the coupled power from the DUT. It is set-up to record the maximum peak-to-peak excursions in power level normalized around the initial no-load measurement.

6.1.5 Test load

The test load or weight shall be applied to the end of the test cord. The test load is defined in Annex A.

6.2 Test procedures for Tx interfaces

6.2.1 Test procedures

The test is conducted with a suitable fixture, as illustrated in Figure 3 (Figure 3 is an example of the case using a 1,25mm ferrule connector.) This example utilizes an optical transceiver (Tx) port or other connectorized optical source. The standard test cord (fibre cord and connector) is flexed at the point of entry to the connector on the DUT by applying a load in the form of a weight to the fibre while rotating the test fixture. The continuous rotation mechanism is not absolutely necessary if the test fixture enables measurement at each of the 90° directions around the spindle (0°, 90°, 180°, 270°). The test is conducted as follows.

6.2.2 Set-up

Mount the connector/optical assembly as shown in Figure 3 and connect a standard test cord from the device output port/Tx port to the power meter. If the DUT contains more than one port (for example, a Tx port and an Rx port in the case of a transceiver), only one port should be analysed at a time. Hence, only a single standard test cord should be connected to the device at any given time.

6.2.3 Initial measurement

Without applying any load and without rotating the fixture, measure and record the output power of the DUT when mounted in the fixture. The power meter should be reset at this point so that all measurements are normalized around this output level.

6.2.4 Apply load

Apply the appropriate load as specified in Table A.2 to the standard test cord as shown in Figure 3.

6.2.5 Measurement

Record the power meter after the positioning of four angular directions (0°, 90°, 18°, 270°) has completed.

6.2.6 Wiggle loss

The wiggle loss is defined as the maximum peak-to-peak delta of the measured power during the measurement of 6.2.5 including the initial measurement value of 6.2.3.

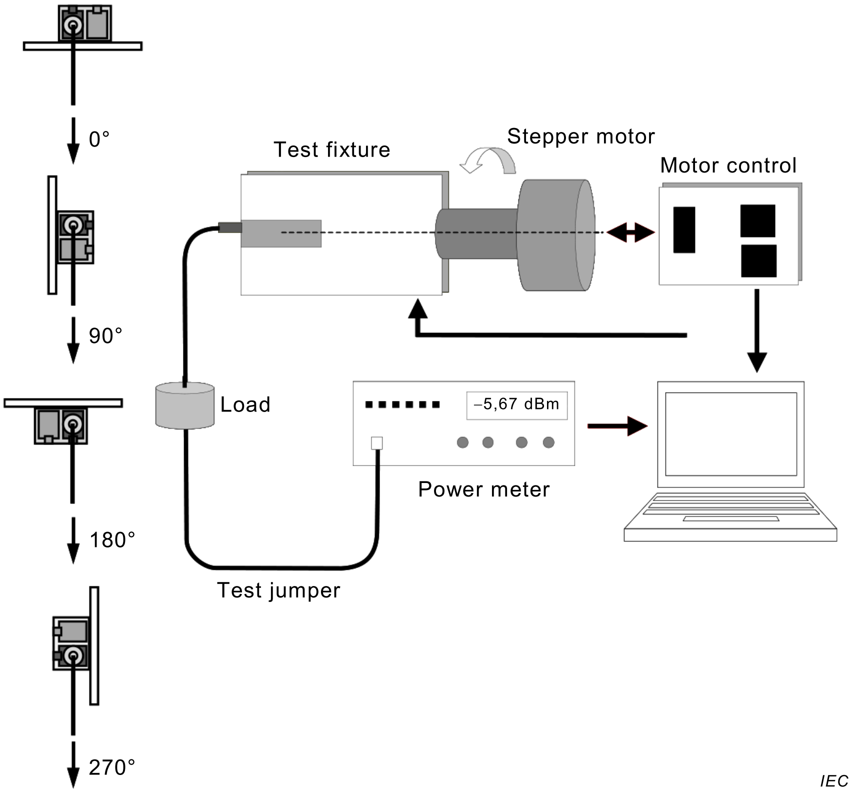


Figure 3 – Equipment set-up of Method B for Tx interfaces

6.3 Test procedures for Rx interfaces and optical receptors

6.3.1 Test procedures

In the case of Rx interfaces or optical receptors (for example, a transceiver Rx connector test or where the DUT does not contain a light source), the DUT is mounted in a test fixture as shown in Figure 4, and one of the following test methods is applied. (Figure 4 is an example of the case using a 1,25 mm ferrule.)

6.3.2 LOS-indicator method

The procedure is as follows:

a) adjust the input power to the receptacle to find the LOS threshold;

b) increase the input power by 1,5 dB;

c) apply the relevant load specified in Table A.2 and rotate the test fixture at angles of 0°, 90°, 180° and 270°;

d) if LOS is detected, then the device fails the test. If no LOS is detected, the device passes.

6.3.3 Receiver optical power monitor method

The receiver optical power monitor method can be implemented on transceivers or other optical receptors that support digital diagnostic monitoring. The robustness of the optical port to wiggle is determined by monitoring changes in the received optical power reported by the digital diagnostics.

a) set the input power to the receiver to a level at which the receiver power monitor is in its most accurate range;

b) apply the relevant load specified in Table A.2 and rotate the test fixture at angles of 0°, 90°, 180° and 270° while monitoring the digital diagnostics for receiver optical power;

c) record the maximum change in receiver optical power in dB. Wiggle loss is defined as the maximum peak-to-peak delta of the measured power during the measurement from a) to b).

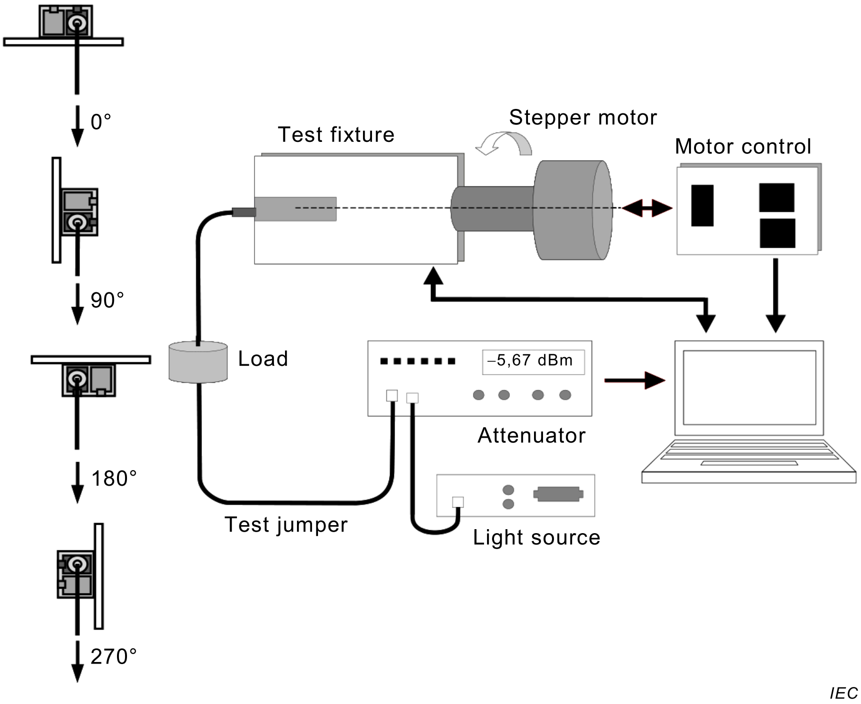


Figure 4 – Equipment set-up of Method B for Rx interface and optical receptors

7 Test results

The test results shall provide the following details:

a) The method used (Method A and/or Method B)
b) The load value
c) Wiggle loss
d) Pass or fail
e) Receiver optical power variation
f) Sample size
g) Number of cords

Annex A
(normative)

Load requirements

See Table A.1 and Table A.2.

A.1 Loads for Method A

Table A.1 – Method A: Loads applied for devices using connector cords with 1,25 mm ferrule and 2,5 mm ferrule

Connector type	Load N	Angles °
LC	1,5	0 to 360
SC	0,5	0 to 360

A.2 Loads for Method B

Table A.2 – Method B: Loads applied for devices using connector cords with 1,25 mm ferrule and 2,5 mm ferrule

Connector type	Load N	Angles °
LC	4,5	0, 90, 180, 270
SC	4,5	0, 90, 180, 270

Annex B
(normative)

Summary of test conditions

See Table B.1 and Table B.2.

Table B.1 – Summary of test conditions for Method A (normative)

Connector style	**Port (Rx/Tx)**	**Measurement parameters**	**Test cord**	**Load** N	**Sample size**	**Number of cords**	**Failures allowed**	**Pass/fail criteria**
LC (single-mode)	Tx	Tx power	Clause C.1	1,5	11	5	0	Max wiggle loss <1,5 dB
	Rx	LOS power delta or bit errors						Depends on method used: no LOS or received power delta <1,5 dB
SC (single-mode)	Tx	Tx power	Clause C.2	0,5	11	5	0	Max wiggle loss <1,5 dB
	Rx	LOS power delta or bit errors						Depends on method used: no LOS or received power delta <1,5 dB

Table B.2 – Summary of test conditions for Method B (normative)

Connector style	**Port (Rx/Tx)**	**Measurement parameters**	**Test cord**	**Load** N	**Sample size**	**Number of cords**	**Failures allowed**	**Pass/fail criteria**
LC (single-mode)	Tx	Tx power	Clause C.1	4,5	11	5	0	Max wiggle loss <1,5 dB
	Rx	LOS,power delta or bit errors						Depends on method used: no LOS or received power delta <1,5 dB
SC (single-mode)	Tx	Tx power	Clause C.2	4,5	11	5	0	Max wiggle loss <1,5 dB
	Rx	LOS power delta or bit errors						Depends on method used: no LOS or received power delta <1,5 dB

Annex C
(normative)

Characteristics of the test cord

See Figure C.1, Figure C.2, Table C.1, Table C.2, Table C.3 and Table C.4.

Table C.1 – Wiggle test cord specification (LC connector)

Test method	Specifications for wiggle test cord
Method A	The details of this test cord are in Figure C.1 and Table C.2
Method B (standard test cord)	IEC 61753-021-6

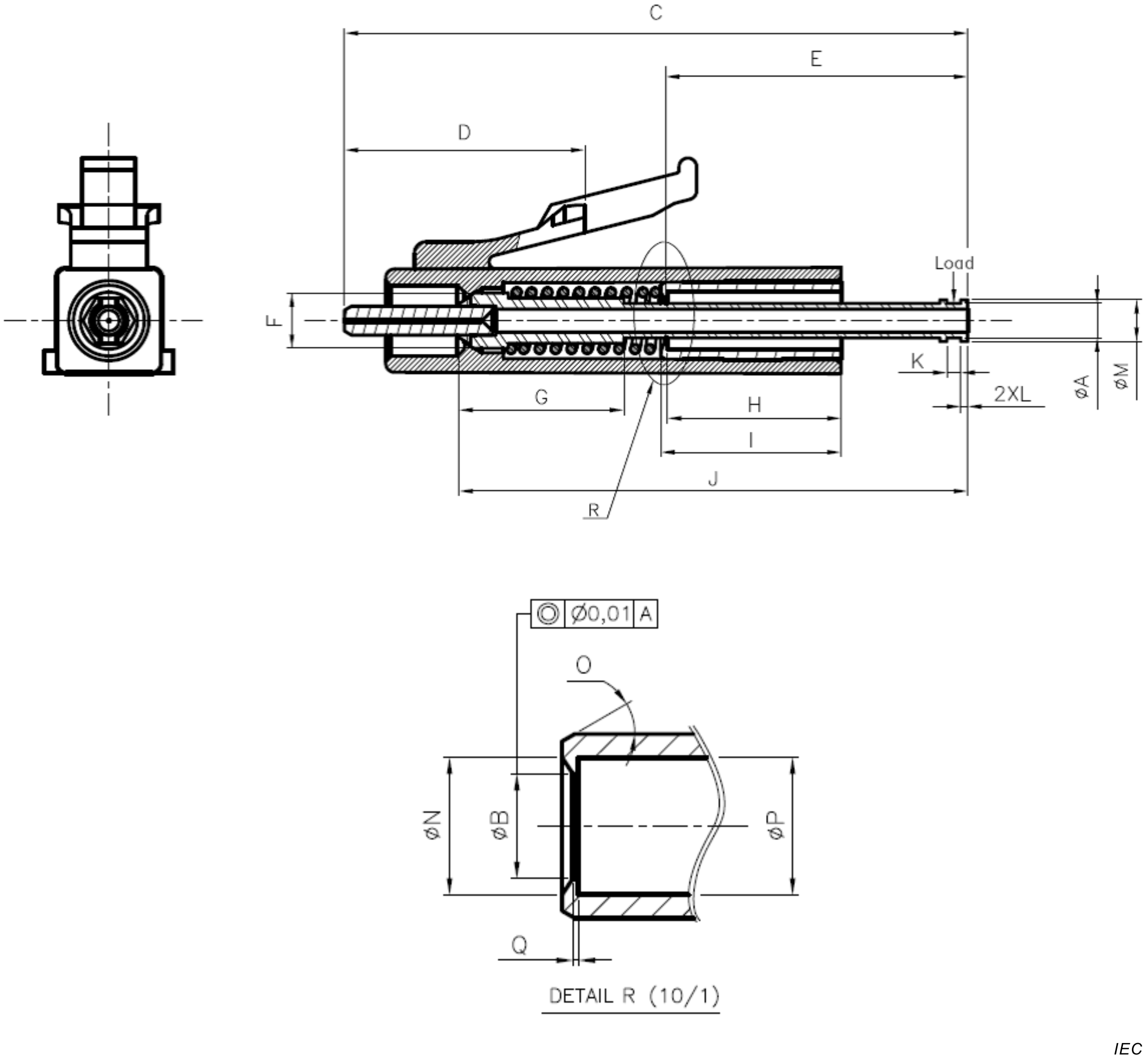


Figure C.1 – Wiggle test cord interface (LC connector)

Table C.2 – Dimensions of the wiggle test cord interface

Reference	Dimensions		Notes
	Minimum	Maximum	
A	1,49 mm	1,51 mm	
B	1,89 mm	1,91 mm	
C	26,85 mm	27,05 mm	
D	10,3 mm	10,5 mm	
E	12,97 mm	13,17 mm	
F	2,35 mm	2,45 mm	
G	7,03 mm	7,23 mm	
H	7,46 mm	7,54 mm	
I	7,76 mm	7,84 mm	
J	21,9 mm	22,1 mm	
K	0,5 mm	0,7 mm	
L	0,2 mm	0,4 mm	
M	1,75 mm	1,85 mm	
N	2,46 mm	2,54 mm	
O	25°	35°	Degrees
P	2,46 mm	2,54 mm	
Q	0,06 mm	0,14 mm	
NOTE The interface dimensions other than those specified in Table C.2 are compliant with IEC 61754-20.			

Table C.3 – Wiggle test cord specification (SC connector)

Test method	Specifications for wiggle test cord
Method A	The details of this test cord are in Figure C.2 and Table C.4
Method B (standard test cord)	IEC 61753-021-6

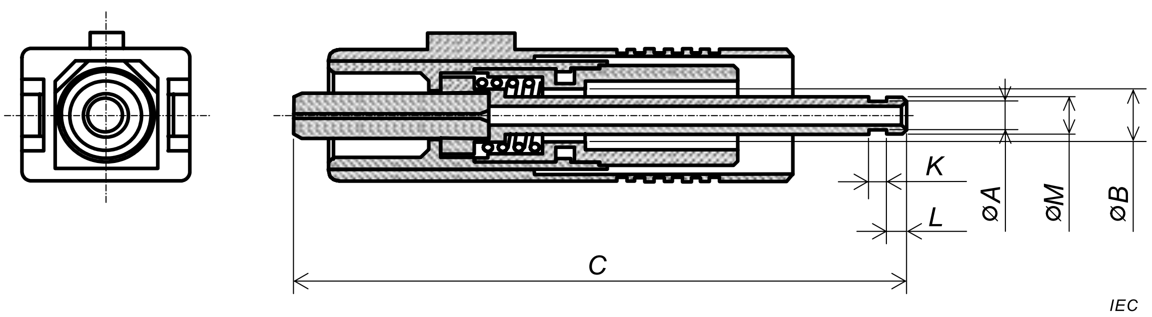


Figure C.2 – Wiggle test cord interface (SC connector)

Table C.4 – Dimensions of the wiggle test cord interface

Reference	Dimensions mm		Notes
	Minimum	Maximum	
A	1,49	1,51	
B	2,8	3,0	
C	32,5	33,5	
K	0,5	0,7	
L	0,4	0,8	
M	1,75	1,85	

NOTE The interface dimensions other than those specified in Table C.4 are compliant with IEC 61754-4.

Annex D
(normative)

Floating tolerance

In order to control the loss induced by wiggle, it is necessary to keep the accurate relative positioning of the ferrule in the housing. This is true even in the case where external housing deformation is caused by the optical cable bending, as shown in Figure D.1. In this situation, the ferrule floating mechanism called “floating tolerance” is necessary. The precise dimensions of this tolerance are not quantified in this standard as they depend upon the design, construction and materials of both connector and housing.

However, if the floating tolerance is not sufficient, the ferrule comes into contact with housing as the deformation increases causing wiggle loss. Therefore guaranteeing sufficient floating tolerance is required by the detailed design of the housing and/or connector in order to meet the performance requirements of this test method.

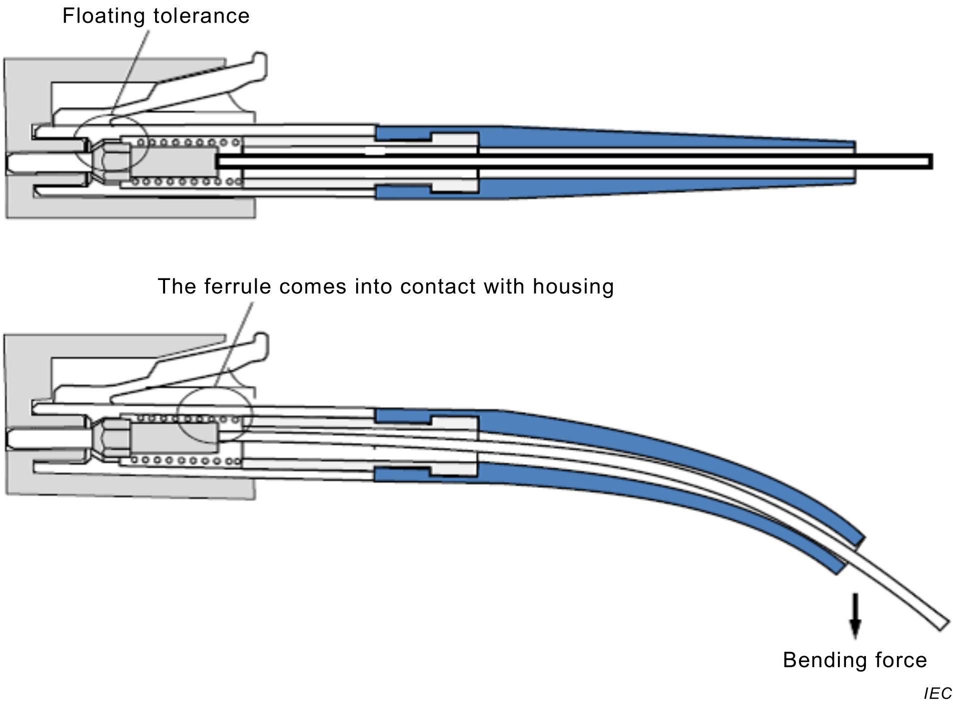


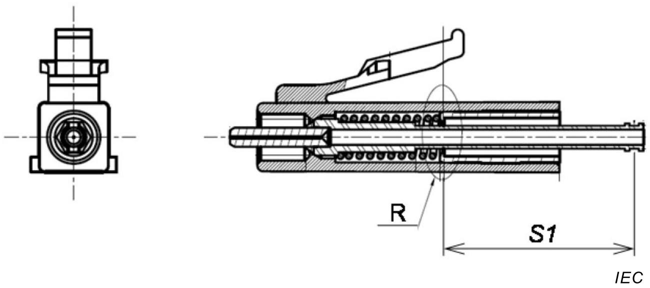
Figure D.1 – Floating tolerance

Annex E
(informative)

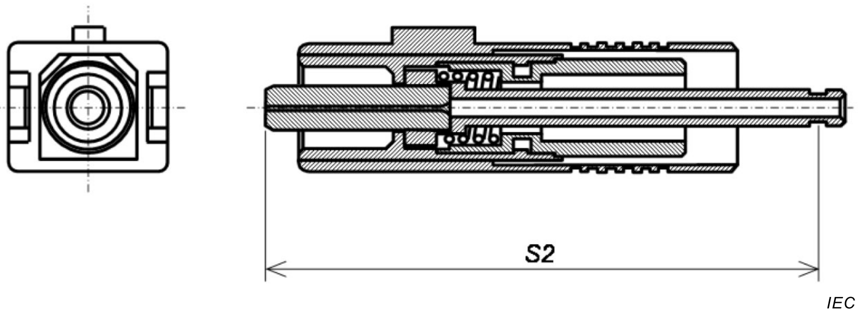
Load value difference for connector type in Method A

As specified in Table A.1, there is a specified load value difference in test Method A, depending on the type of connector. The reason for this difference comes from the effective torque load difference between the two test cords specified in Figure C.1 and Figure C.2.

In the case of the SC type test cord, the stiffness of the split sleeve is sufficient enough to apply some torque to the test ferrule and the stable measurement can be achievable. However, the stiffness of the ϕ1,25 split sleeve is lower than that of the ϕ2,5 split sleeve, and it is not sufficient enough to apply some torque to the test ferrule. If the split sleeve of ϕ1,25 is applied to the test, the results would be very unstable. To stabilize the wiggle test result for the LC type, a projection at the inside wall of the outer cylindrical pipe (around the R area in Figure E.1 (a)) is needed to relax torque. With this projection (R area), the effective torque length between the load point and the work point will be S1 in Figure E.1 (a). On the other hand, in the case of the SC type test cord, there is no projection inside the pipe, and this effective torque length is equivalent to the dimension S2 shown in Figure E.1 (b). Dimension S2 is three times as long as S1, and this leads to the specified load difference between LC and SC.



a) LC type test cord



b) SC type test cord

Figure E.1 – Floating tolerance

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