

TECHNICAL SPECIFICATION

**Fibre optic interconnecting devices and passive components –
Conditions for testing the protection against dust and water ingress of passive
optical protective housings and hardened fibre optic connectors (IP5X, IPX4,
IPX5, IPX6)**

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TECHNICAL SPECIFICATION

**Fibre optic interconnecting devices and passive components –
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IPX5, IPX6)**

INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**FIBRE OPTIC INTERCONNECTING DEVICES
AND PASSIVE COMPONENTS –**
**Conditions for testing the protection against dust
and water ingress of passive optical protective housings and
hardened fibre optic connectors (IP5X, IPX4, IPX5, IPX6)**

FOREWORD

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IEC TS 63334 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
86B/4475/DTS	86B/4516A/RVDTS

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 Technical Specification 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/standardsdev/publications.

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- withdrawn,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

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INTRODUCTION

This document includes conditions for testing the protection against dust and water ingress of passive optical protective housings and hardened fibre optic connectors according to IEC 60529.

The conditions included in this document are applicable for testing the IP ratings as summarized in Table 1.

Table 1 – Overview of conditions for IP ratings covered in this document

Passive optical protective housings and hardened fibre optic connectors	
Degree of protection against dust	Degree of protection against water
-	IPX4 (protected against splashing water)
IP 5X (dust-protected)	IPX5 (protected against water jets)
-	IPX6 (protected against powerful water jets)

Suitable acceptance conditions for the degree of protection as listed in Table 1 were searched for in IEC SC 86B and CENELEC TC 86BXA and different options were evaluated and discussed. The acceptance conditions in this document were presented and agreed in the Autumn 2019 meeting of IEC SC 86B/WG 6. This information was handed over to WG4, where this document was developed.

The acceptance conditions for first characteristic numeral 5 (dust ingress) according to IEC 60529 define that the protection is satisfactory if, on inspection, talcum powder has not accumulated together with and any other kind of dust in quantity and location that could interfere with the correct operation of equipment or impair safety. Additionally, it is satisfactory if no dust deposits where it could lead to tracking along the creepage distances. Dust accumulation does usually not impair the correct operation or impair the safety of passive optical protective housings containing optical fibre cables, fibres, connectors and passive optical components, and of hardened fibre optic connectors. Therefore, these conditions do not support the evaluation if the product has passed or failed. It is not necessary to ban dust ingress for passive optical protective housings and hardened fibre optic connectors with IP5X rating (dust-protected). Applicable acceptance conditions for IP5X are included in this document specifically for passive optical products.

Conditions for IP1X, IP2X, IP3X and IP4X rating (against solid foreign objects) are not included in this document because probes with a defined form and diameter are used.

The acceptance conditions for second characteristic numerals (water ingress) according to IEC 60529 define that if any water has entered, it generally does not interfere with the correct operation of the equipment or impair safety, not deposit on insulation parts where it could lead to tracking along the creepage distances, not reach live parts or windings not designed to operate when wet, not accumulate near the cable end or enter the cable if any, and not accumulate without doing any harm to the equipment. Water ingress does usually not impair the correct operation or impair the safety of passive optical protective housings containing optical fibre cables, fibres, connectors and/or passive optical components, and of hardened fibre optic connectors. Therefore, these conditions do not support the evaluation if the product has passed or failed. It is not necessary to ban water ingress for passive optical protective housings and hardened fibre optic connectors with IPX4, IPX5 and IPX6 rating (splashing water or water jet). A single fixed limit (e.g. 1 %, 0,1 %) was considered as not suitable for all sizes of protective housings and hardened connectors, because it may be too low for the determination of the volume of water ingress for small housings (e.g. 0,1 % of 0,1 l = 0,1 ml) but suitable for larger housings. On the other hand, a larger limit that is suitable for small housings may allow an excessive volume of water ingress in large housings that was also not considered as suitable (e.g. 1 % of 750 l = 7,5 l). To take small and large housings into account, a higher percentage for housings having a small inner volume (≤ 1 l) and a lower percentage for large volumes (above 1 l) was considered as the best solution. Applicable acceptance

conditions for IPX4, IPX5 and IPX6 are included in this document specifically for passive optical products.

Requirements against water ingress with IPX1, IPX2 and IPX3 (dripping and spraying) rating are not specified in the performance standards for optical products. Therefore, no conditions are included in this document for these ratings.

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

Conditions for testing the protection against dust and water ingress of passive optical protective housings and hardened fibre optic connectors (IP5X, IPX4, IPX5, IPX6)

1 Scope

This document defines the conditions for testing the protection against dust and water ingress of passive optical protective housings and hardened fibre optic connectors (IP5X, IPX4, IPX5, IPX6) performed according to IEC 60529.

The conditions in this document supplement the test requirements specified in IEC 60529.

Protective housings and hardened connectors containing electrical conductors, electrical connections, passive electrical components, active electrical equipment or electronics that transmit signals or provide power are not within the scope of this document.

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 60529, *Degrees of protection provided by enclosures (IP Code)*

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

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

IEC 61753-1, *Fibre optic interconnecting devices and passive components – Performance standard – Part 1: General and guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61753-1 and IEC 60529 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Abbreviated terms

DUT device under test

5 Conditions for dust ingress testing (IP5X) of protective housings

5.1 General

The conditions in Clause 5 are applicable for testing the protection against dust ingress with IP5X rating (dust-protected) of passive optical protective housings according to IEC 60529. The conditions in Clause 5 supplement the test requirements specified in IEC 60529.

5.2 Preparation of test sample

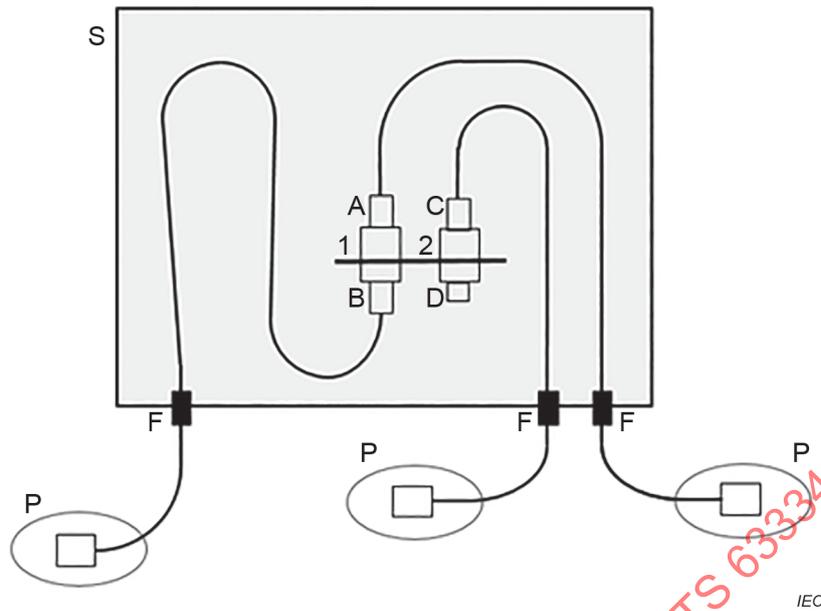
The device under test (DUT) preparation shall be done in accordance with IEC 60529, according to the requirements in the relevant specification and with the supplement conditions in 5.2.

Within the DUT, one fibre circuit with one connection (connector plug A, adaptor 1, connector plug B) and with a connector plug C plugged in an adaptor 2 shall be mounted in an adaptor field of the DUT, as shown in Figure 1.

If not otherwise specified in the relevant specification, one circuit with one connection shall be prepared as shown in Figure 1. If more than one circuit with each a connection is specified, then Annex A shows the configuration with three circuits (and three tested connections) for illustration purposes and describes the procedure for more than one circuit.

A connector type with an optical interface that can be efficiently cleaned should be used, for example a LC or SC connector type. The dust cap D provided by the manufacturer of the adaptor 2 shall be mounted on the opposite side of connector plug C in adaptor 2.

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Key

- 1, 2 adaptor
- A, B, C connector plug
- D dust cap
- F cable feed through
- P protection of cable end with connector plug
- S protective housing

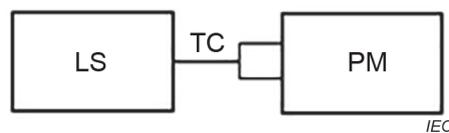
Figure 1 – Example of DUT preparation

All the fibre ends that are usually protected in cables shall exit the DUT and sealed according to the manufacturer’s instruction of the DUT. The second end of the cables shall be prepared for connection to optical performance measurement equipment (for example to a light source and a power meter) and protected during conditioning with dust or guided out of the dust chamber.

NOTE The fibre circuits and connector plugs in the DUT are arranged in the example given in Figure 1, Figure 3 and Figure 4 so that the preparation of the DUT can be easily recognised. In real products, the fibre circuits can be arranged in a different way. The pre-installed connector plugs (A, C) are typically oriented downward whereas the partly later installed cables and connector plugs (connected to the free port of adaptor 2) are oriented upward.

5.3 Initial measurement

A light source with a launch cord shall be connected with the power meter, as shown in Figure 2. Then the reference optical performance measurement shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6.

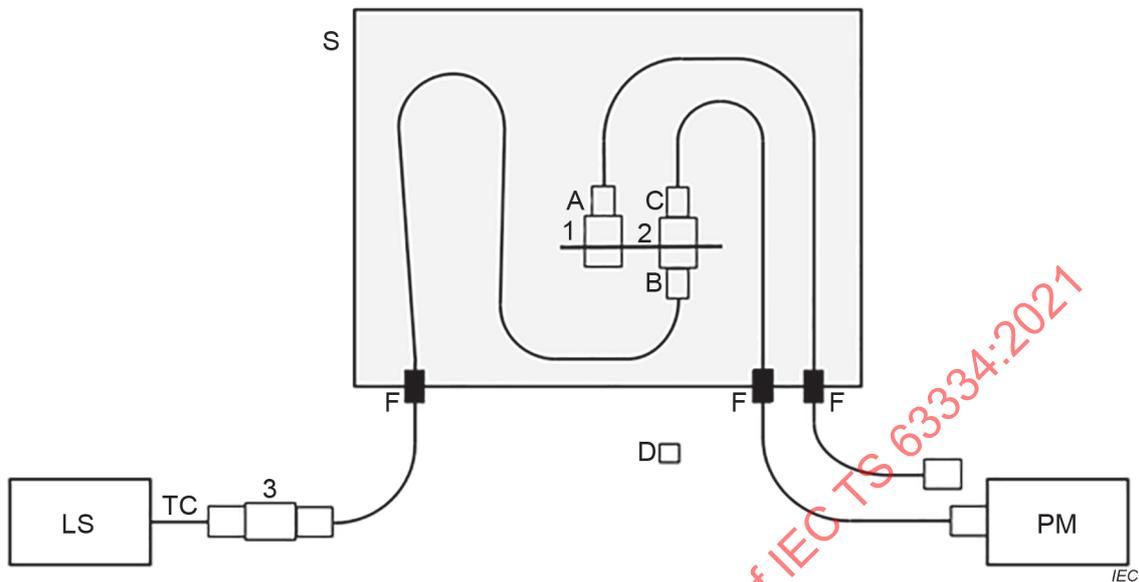


Key

- LS light source
- PM power meter
- TC launch cord

Figure 2 – Example of reference optical performance measurement

The second end of the cable with connector plug B shall be connected to the launch cord that connects to the light source and the second end of the cable with connector plug C to the power meter, as shown in Figure 3.



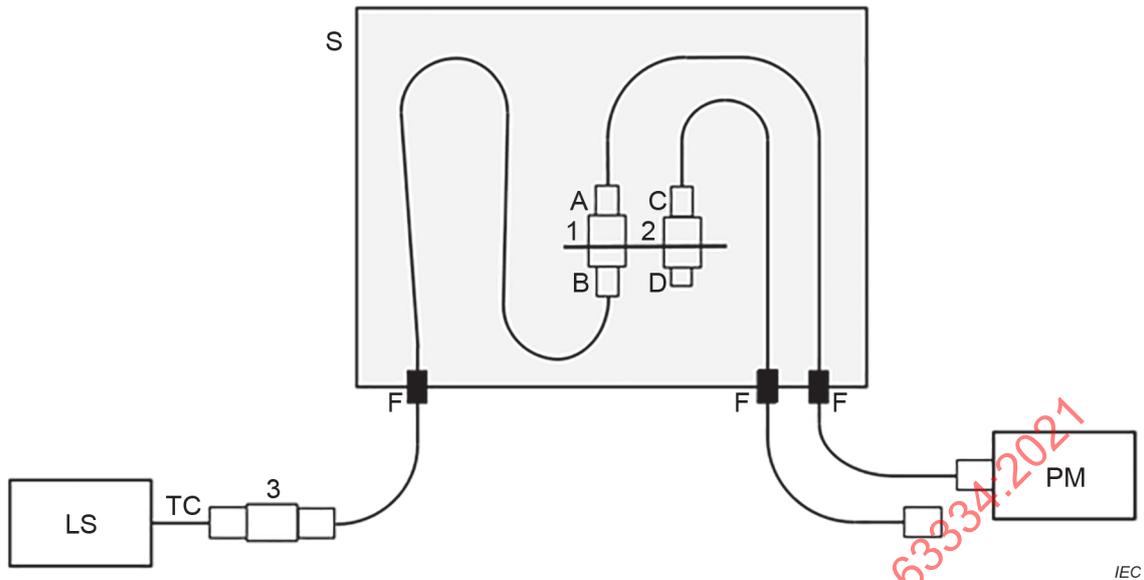
Key

1, 2	adaptor
3	connection
A, B, C	connector plug
D	dust cap
F	cable feed through
LS	light source
PM	power meter
S	protective housing
TC	launch cord

Figure 3 – Example of optical performance measurement of connection B-2-C

The optical performance measurement of the connection with connector plug B, adaptor 2 and connector plug C shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6.

Connector plug B shall be disconnected and plugged into the adaptor 1, and the dust cap D put onto the adaptor 2, as shown in Figure 4.



Key

- 1, 2 adaptor
- 3 connection
- A, B, C connector plug
- D dust cap
- F cable feed through
- LS light source
- PM power meter
- S protective housing
- TC launch cord

Figure 4 – Example of optical performance measurement of connection B-1-A

The optical performance measurement of the connection with connector plug B, adaptor 1 and connector plug A shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6.

Connector plug B may be mated with connector plug A or C minimum three times as described in 5.3 and 5.5 and, if necessary, two more times as described in 5.5. The total number of matings of connector plug B with connector plug A or C is maximum five.

5.4 Conditioning

The DUT in the configuration as shown in Figure 1 shall be conditioned for the IP5X rating defined in IEC 60529.

5.5 Visual and final optical performance check

After the dust conditioning, the outer surface of the DUT shall be cleaned carefully.

The cover of the DUT shall be carefully opened and the location and the accumulation of the dust inside the DUT shall be examined according to IEC 61300-3-1.

The reference optical performance measurement shall be done as described in 5.3.

The optical performance measurement of the connection with connector plug B, adaptor 1 and connector plug A shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6, as shown in Figure 4.

The connector plug B shall be removed from the adaptor 1, the ferrule end face inspected and, if necessary, cleaned. IEC TR 62627-01 should be consulted for recommendations on cleaning methods for connectors.

Afterwards, the dust cap D shall be removed from adaptor 2. The ferrule end face of connector plug C shall be inspected and if necessary cleaned. Connector plug B shall be plugged in adaptor 2, as shown in Figure 3. The optical performance measurement of the connection with connector plug B, adaptor 2 and connector plug C shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6. If a connection fails the requirements, then two additional inspections, cleaning attempts and optical performance measurements may be performed. In a cleaning attempt, one or more cleaning process steps may be included depending on the effective cleaning method. IEC TR 62627-01 should be consulted for recommendations on cleaning methods for connectors.

5.6 Requirements

The optical performance of the connection B-1-A shall meet the specification (e.g. attenuation and return loss grade) and the one of the connection B-2-C shall meet the specification (e.g. attenuation and return loss grade) after maximum 3 cleaning attempts of each ferrule end face.

The definition of the optical performance specifications should take into account that two connections (3 and B-1-A/B-2-C) and optical cable attenuation are measured when using the reference measurement and optical performance measurement method of the DUT as described above.

NOTE 1 Example of a suitable attenuation specification: If a maximum attenuation of 0,3 dB is specified for connection 3 (connection to light source) and a maximum attenuation of 0,5 dB for connection B-1-A/B-2-C (connections within the housing), then the total attenuation specification is 0,8 dB for pass/fail evaluation.

NOTE 2 Example of the pass/fail evaluation: If the total attenuation of the connections 3 and B-2-C of 1,1 dB is measured and the total maximum attenuation of 0,8 dB for connections 3 and B-2-C is specified, then the ferrule end face of connector plugs B and C can be cleaned. If after the second cleaning attempt, the measured attenuation is 0,65 dB, then the DUT passes the requirement of maximum 0,8 dB.

5.7 Details to be specified and reported

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

- a) type and configuration of DUT including optical fibre and cable type;
- b) allowed optical performance (e.g. attenuation and return loss grade) of connection 3 and B-1-A/B-2-C after conditioning with dust;
- c) wavelength(s);
- d) detailed description of the DUT including the installed cables, cable feed throughs and connector type;
- e) number of DUTs;
- f) number of circuits (connections B-1-A/B-2-C) for evaluation;
- g) conditions for mounting, assembling and positioning of the DUT;
- h) pre-conditioning of the DUT;
- i) atmospheric conditions during the test;
- j) observation of the location and accumulation of the dust inside the DUT;
- k) type of used optical performance measurement equipment and measurement method;
- l) number of cleaning attempts of each ferrule end face;
- m) measured optical performance of connection B-1-A and B-2-C after conditioning with dust;
- n) number of performed cleaning attempts of connection B-2-C after dust conditioning;
- o) any deviations from the test method.

6 Conditions for dust ingress testing (IP5X) of hardened connectors

6.1 General

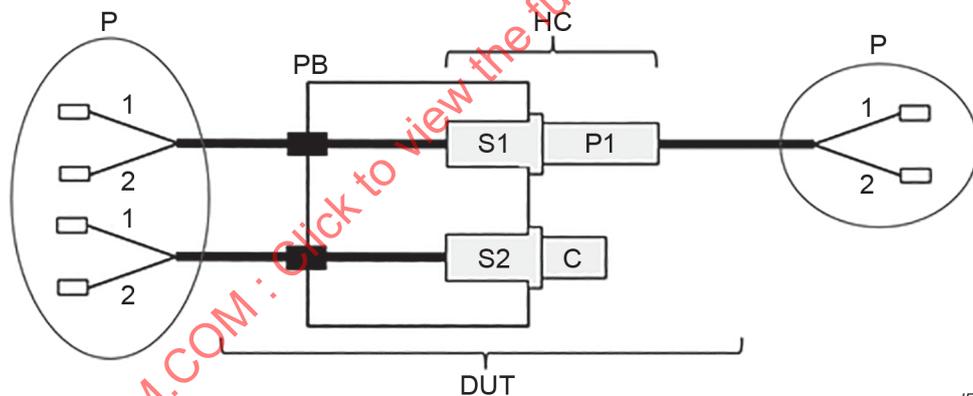
The conditions in Clause 6 are applicable for testing the protection against dust ingress with IP5X rating (dust-protected) of hardened fibre optic connectors according to IEC 60529. The conditions in Clause 6 supplement the test requirements specified in IEC 60529.

6.2 Preparation of test sample

The device under test (DUT) preparation shall be done in accordance with IEC 60529, according to the requirements in the relevant specification and with the supplement conditions in 6.2.

Hardened fibre optic connectors are often designed with two pieces, a plug and a socket, and contain usually two or more optical interfaces (or fibres). For a complete connection, one plug and one socket is needed. Such a two piece connector configuration is used in this document.

A tight protective box is required because the socket is usually not dust and water protected from the rear side. Two sockets shall be mounted into cut-outs of a protective box, as shown in Figure 5. The socket flanges should seal the interfaces to the protective box adequately. The cables leading away from the rear side of the sockets shall be fed through holes in the protective box and sealed. The DUT consist of the protective box containing two socket assemblies with a connected plug assembly. If a configuration with generally dust and water protected pieces will be tested (e.g. a plug connected to an extension plug or a plug-adaptor-plug configuration), then a protective box is not needed.



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Key

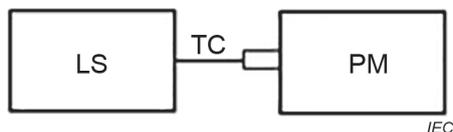
- 1, 2 fibre number at cable end
- C sealing protection cap
- HC hardened connector
- P1 plug
- DUT device under test
- S1, S2 socket
- P protection of cable end with connector plug
- PB protective box

Figure 5 – Example of DUT preparation

The end of the fibres from the plug and socket cable assembly shall be prepared for connection to optical performance measurement equipment (for example to a light source and a power meter) and protected during the conditioning with dust or guided out of the dust chamber.

6.3 Initial measurement

A light source with a launch cord shall be connected with the power meter, as shown in Figure 6. Then the reference optical performance measurement shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6.

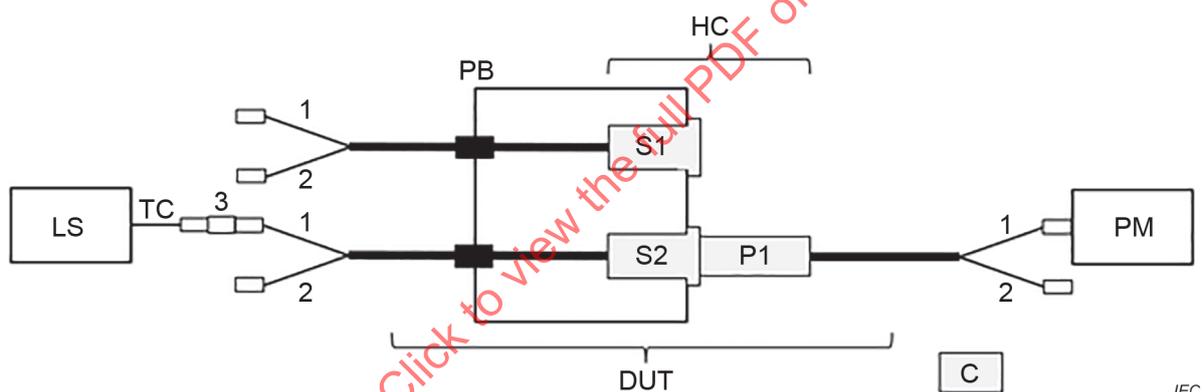


Key

LS	light source
PM	power meter
TC	launch cord

Figure 6 – Example of reference optical performance measurement

The second end of the cable of socket S2 shall be connected to the launch cord that connects to the light source and the second end of the plug P1 to the power meter, as shown in Figure 7.



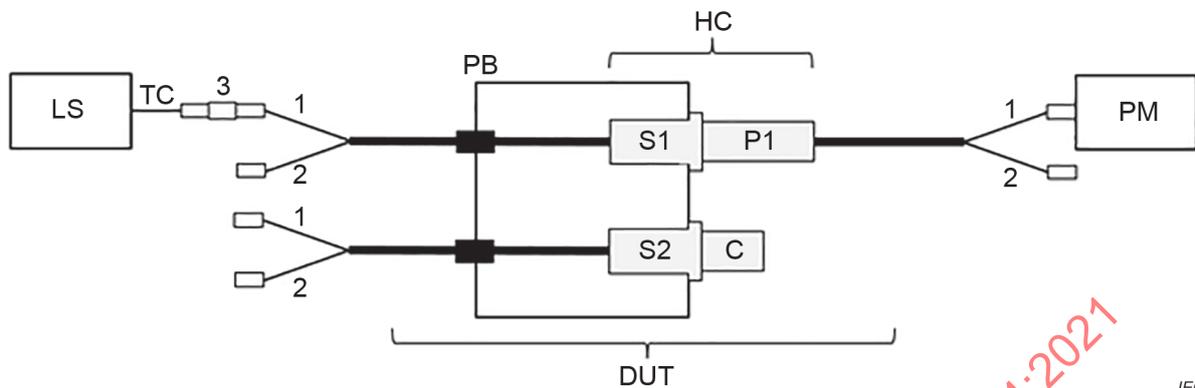
Key

1, 2	fibre number at cable end
3	connection
C	sealing protection cap
HC	hardened connector
LS	light source
P1	plug
PB	protective box
PM	power meter
DUT	device under test
S1, S2	socket
TC	launch cord

Figure 7 – Example of optical performance measurement of plug connected to socket 2

The optical performance measurement of the plug P1 connected to the socket S2 shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6. Each fibre shall be measured individually.

Plug P1 shall be disconnected and plugged into socket S1, and the sealing protection cap C put onto the socket S2, as shown in Figure 8.



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Key

- 1, 2 fibre number at cable end
- 3 connection
- C sealing protection cap
- HC hardened connector
- LS light source
- P1 plug
- PB protective box
- PM power meter
- DUT device under test
- S1, S2 socket
- TC launch cord

Figure 8 – Example of optical performance measurement of plug connected to socket 1

The optical performance measurement of the plug P1 connected to the socket S1 shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6. Each fibre shall be measured individually.

Plug P1 may be mated with socket S1 or S2 minimum three times as described in 6.3 and 6.5 and, if necessary, two more times as described in 6.5. The total number of matings of plug P1 with socket S1 or S2 is maximum five.

6.4 Conditioning

The DUT in the configuration as shown in Figure 5 shall be conditioned for the IP5X rating defined in IEC 60529.

6.5 Visual and final optical performance check

The reference optical performance measurement shall be done as described in 6.3.

After the dust conditioning, the optical performance measurement of the plug P1 connected to socket S1 shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6, as shown in Figure 8. Each fibre shall be measured individually.

Then the plug P1 from socket S1 and the sealing protection cap C of socket S2 shall be removed carefully so that the dust does not migrate into the plug and socket housings. The accumulation of the dust inside the plug P1, socket S1 and socket S2 shall be examined according to IEC 61300-3-1.

The optical interfaces (e.g. ferrule end faces or lens front faces) of the plug P1 and socket S2 shall be inspected and, if necessary, cleaned. IEC TR 62627-01 should be consulted for recommendations on cleaning methods for connectors.

Afterwards, the plug P1 shall be connected to the socket S2, as shown in Figure 7. The optical performance measurement of the plug P1 connected to the socket S2 shall be performed in accordance with IEC 61300-3-4 and/or IEC 61300-3-6. Each fibre shall be measured individually. If a connection fails the requirements, then two additional inspections, cleaning attempts and optical performance measurements may be performed. In a cleaning attempt, one or more cleaning process steps may be included depending on the effective cleaning method. IEC TR 62627-01 should be consulted for recommendations on cleaning methods for connectors.

6.6 Requirements

The optical performance of the fibre connections of the plug P1 connected to the socket S1 shall meet the specification (e.g. attenuation and return loss grade) and the one of the fibre connections of the plug P1 connected to the socket S2 shall meet the specification (e.g. attenuation and return loss grade) after maximum 3 cleaning attempts of each optical interface (e.g. ferrule end face or lens front face).

The definition of the optical performance specifications should take into account that two connections (3 and plug P1 connected to socket S1/S2) and optical cable attenuation are measured when using the reference measurement and optical performance measurement method of the DUT as described above.

NOTE 1 Example of a suitable attenuation specification: If a maximum attenuation of 0,3 dB is specified for connection 3 (e.g. LC connection) and a maximum attenuation of 0,5 dB for connection of the plug P1 and socket S1/S2, then the total attenuation specification is 0,8 dB for pass/fail evaluation.

NOTE 2 Example of the pass/fail evaluation: If the total attenuation of the connections 3 and the plug P1 connected to socket S2 of 1,1 dB is measured after conditioning with dust and the total maximum attenuation of 0,8 dB for connection 3 and the plug P1 connected to socket S2 is specified, then each optical interface of the connector can be cleaned. If after the third cleaning attempt, the measured attenuation is 0,65 dB, then the DUT passes the requirement of maximum 0,8 dB.

6.7 Details to be specified and reported

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

- a) type and configuration of DUT including optical fibre and cable type;
- b) allowed optical performance (e.g. attenuation and return loss grade) of connection 3 and plug P1 connected to socket S1/S2 after conditioning with dust;
- c) wavelength(s);
- d) detailed description of the DUT including the hardened connector type, the used protective box and the connector type at the second end;
- e) number of DUTs (number of hardened connectors – plugs and sockets);
- f) conditions for mounting, assembling and positioning of the DUT;
- g) pre-conditioning of the DUT;
- h) atmospheric conditions during the test;
- i) observation of the location and accumulation of the dust inside the plug and the front side of the sockets;

- j) type of used optical performance measurement equipment and measurement method;
- k) number of cleaning attempts of each optical interface (e.g. ferrule end face or lens front face);
- l) measured optical performance of each fibre of the plug P1 connected to socket S1 and S2 after conditioning with dust;
- m) number of performed cleaning attempts of each optical interface of plug P1 connected to socket S2 after dust conditioning;
- n) any deviations from the test method.

7 Conditions for water ingress testing (IPX4, IPX5, IPX6) of protective housings and hardened connectors

7.1 General

The conditions in Clause 7 are applicable for testing the protection against water ingress with IPX4, IPX5 or IPX6 rating (splashing water or water jets) of passive optical protective housings and hardened fibre optic connectors according to IEC 60529. The conditions in Clause 7 supplement the test requirements specified in IEC 60529.

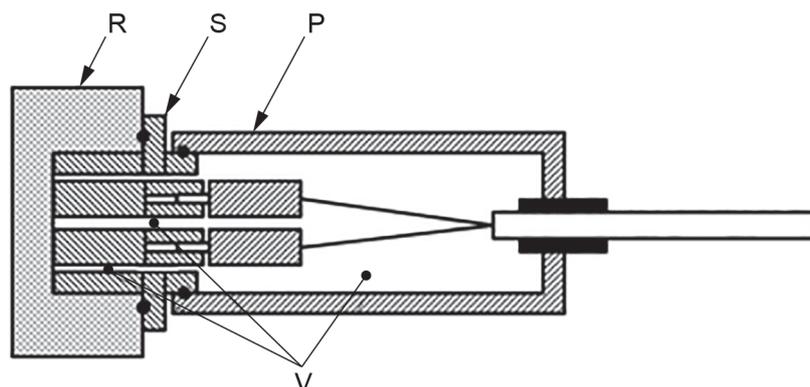
7.2 Preparation

Prepare the DUT according to IEC 60529 and to the requirements in the relevant specification.

For protective housings, the DUT preparation described in 5.2 and shown in Figure 1 shall be done but the second end of the cables need not to be prepared for connection to optical performance measurement equipment because optical performance measurements are not required for water ingress testing. The second cable ends that are outside the protective housing shall be sealed against water penetration.

The inner volume of a protective housing shall be determined as the complete volume within the sealing outer housing that consists of air and where water can ingress. It can be determined by calculation using a 3D model in a computer aided design program or by calculating the difference in weight when the sealing outer housing of the protective housing is filled with air and fresh water.

For hardened connectors, it is usually necessary to protect the rear side of the socket using a sealing auxiliary part that shall contour the rear side of the socket but shall not be watertight and offer a flat surface to enable an effective sealing by the sealing part at the socket flange, as shown in Figure 9.



IEC

Key

- P plug of hardened connector
- R sealing auxiliary part
- S socket of hardened connector
- V inner volume

Figure 9 – Example of DUT preparation of a hardened connector

The inner volume of a hardened connector shall be determined as the complete volume within the sealing outer housing(s) of the plug and socket that consists of air and where water can ingress (see Figure 9). It can be determined by calculation using a 3D model in a computer aided design program or by calculating the difference in weight when the sealing outer housings are filled with air and fresh water.

If a configuration with generally dust and water protected hardened connector pieces will be tested (e.g. a plug connected to an extension plug or a plug-adaptor-plug configuration), then a sealing auxiliary part is not needed. The inner volume shall be determined as the complete volume within the sealing outer housings of the plug connected to an extension or of two plug connected to an adaptor that consists of air and where water can ingress.

7.3 Conditioning

The DUT shall be conditioned for the adequate IPX4, IPX5 or IPX6 rating defined in IEC 60529 that is specified in the relevant specification.

7.4 Final examination

After the conditioning, the outer surface of the DUT shall be dried carefully. Afterwards, the water ingress within the inner room of the DUT shall be determined.

NOTE Methods for the determination of water ingress are for example to calculate the difference of weight of the DUT before and after conditioning with water, the change in weight of swellable material placed inside the DUT and the extracted water from inside the DUT using pipettes. The determined weight of fresh water can be converted to volume as follows:

$$V = m / \rho$$

where

V is the volume of fresh water;

m is the weight of fresh water;

ρ is the density of fresh water and is 1 g/cm³ or 1 kg/dm³. 1 dm³ is equal to 0,001 m³ and 1 l.

7.5 Requirement

The maximum water ingress (I_{\max}) in the inner room of the DUT shall be as the following:

- a) If the inner volume (V) of the DUT is smaller or equal than 1 l:

$$I_{\max} = 0,01 \times V \quad (1)$$

- b) If the inner volume (V) of the DUT is larger than 1 l:

$$I_{\max} = 0,01 + (0,001 \times (V - 1)) \quad (2)$$

where

V is the inner volume of DUT in l (or dm³).

The definition what the inner volume (V) consists of and examples to determine the inner volume are described in 7.2.

A graphical representation of the maximum allowable water ingress is given in Annex B. Examples of calculated maximum allowable water ingress of different DUT sizes are listed in Annex C.

NOTE Example of the pass/fail evaluation: If the determined water ingress is 32 ml and the maximum allowable water ingress is calculated as 15 ml, then the DUT fails the requirement. On the other hand, if the determined water ingress is 8 ml and the maximum allowable water ingress is calculated as 15 ml, then the DUT passes the requirement.

7.6 Details to be specified and reported

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

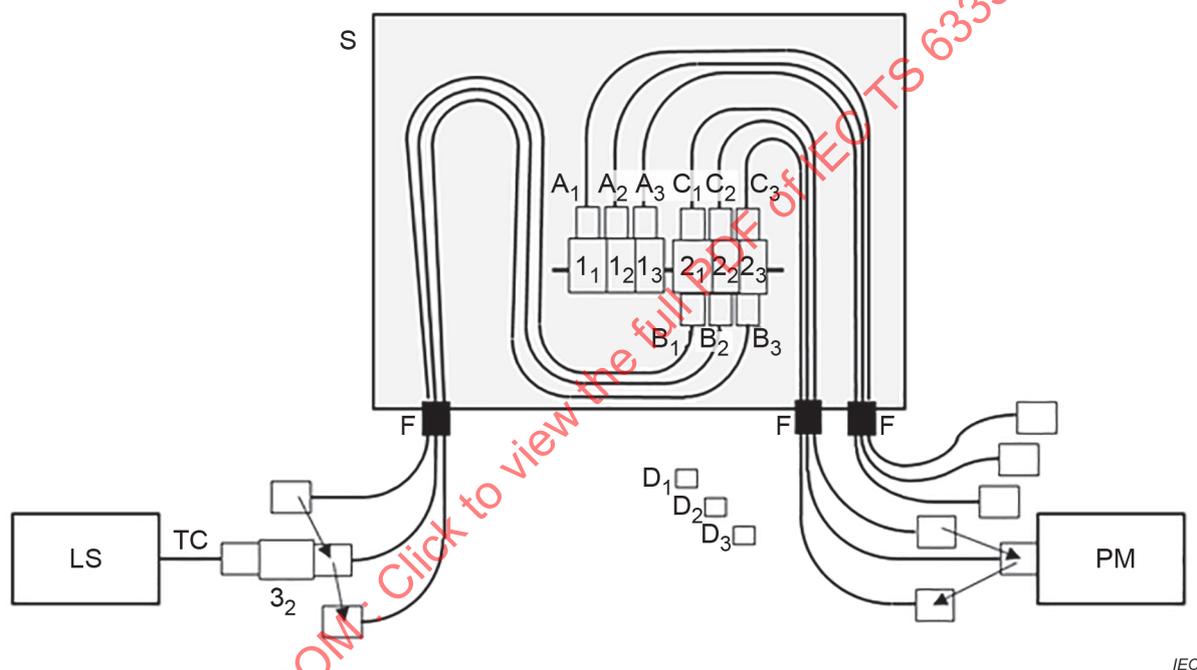
- a) IP rating for water ingress (IPX4, IPX5 or IPX6);
- b) detailed description of the DUT including the installed components and cables;
- c) number of DUTs;
- d) conditions for mounting, assembling and positioning of the DUT;
- e) pre-conditioning of the DUT;
- f) atmospheric conditions during the test;
- g) calculated maximum allowable water ingress;
- h) determined water ingress in DUT;
- i) any deviations from the test method.

Annex A (normative)

Dust ingress testing of protective housings with more than one connection

If not otherwise specified in the relevant specification, one circuit with one connection shall be prepared for dust ingress testing of a protective housing, as described in 5.2. Annex A describes the procedure if more than one circuit with each a connection for dust ingress testing is specified by the relevant specification.

Figure A.1 shows the measurement set-up if the number of connections is specified as three by the relevant specification for illustration purposes. In this case, the optical performance of three connections, B₁-2₁-C₁, B₂-2₂-C₂ and B₃-2₃-C₃, shall be measured.



IEC

Key

- 1_i, 2_i adaptor, numbered with *i* from 1 to 3
- 3_i connection, numbered with *i* from 1 to 3
- A_i, B_i, C_i connector plug, numbered with *i* from 1 to 3
- D_i dust cap, numbered with *i* from 1 to 3
- F cable feed through
- LS light source
- PM power meter
- S protective housing
- TC launch cord

Figure A.1 – Example of optical performance measurement of connection B-2-C

Figure A.1 shows the measurement set-up for the second measurement of connection B₂-2-C₂ with the optical measurement equipment. The arrows in the figure indicate the sequence of fibre ends to be connected to the optical measurement equipment.

The procedure for dust ingress testing (IP5X) of protective housings shall be done as described in Clause 5. The only difference is that three measurements instead of one shall be made sequentially for initial and final measurement.

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