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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Reliability – Part 9-1: Qualification of passive optical components

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Dispositifs d'interconnexion et composants passifs à fibres optiques – Fiabilité – Partie 9-1: Qualification des composants optiques passifs

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – RELIABILITY –

Part 9-1: Qualification of passive optical components

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International Standard IEC 62005-9-1 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

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

FDIS	Report on voting
86B/3896/FDIS	86B/3921/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.

It is the intent of this standard to be compatible with and work in conjunction with the performance standards defined in the IEC 61753 series, the test and measurement standards defined in the IEC 61300 series, and the reliability standards defined in the IEC 62005 series.

A list of all parts in the IEC 62005 series, published under the general title, *Fibre optic interconnecting and passive components – Reliability*, 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

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INTRODUCTION

Qualification reliability standards define the conditions for a set of stress tests, the passing of which suggests an acceptable level of reliability in the referenced performance categories and operating service environments. Upon passing, the specific product tested is called qualified to that standard. The results of these tests are attribute data, i.e. pass or fail. True reliability prediction and quantification requires significantly greater testing.

This International Standard is meant to be a general document that can be applied to all passive optical components, except connectors. As such, it does not and cannot cover every possible component and application. Its application to electrically assisted non-active components such as optical switches is under study. The stress tests are specific and explicitly defined to establish consistency. The measurements and pass/fail criteria are not explicitly stated in this standard; however, guidance is given in the relevant clause to establish reasonable parameters and values. Explicit reporting requirements are defined which include written justifications and technical support for all selected measurements and pass/fail criteria.

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – RELIABILITY –

Part 9-1: Qualification of passive optical components

1 Scope

This part of IEC 62005 establishes a general reliability qualification program that applies to all passive fibre optic components except connectors and connector assemblies, the passing of which, suggests a minimum level of reliability assurance and allows that specific device to be called qualified to this standard.

The objectives of this International Standard are as follows:

– to specify the requirements for a general reliability qualification standard (RQS) for passive optical components;
– to give direction to the supplier and to the end user on the production and purchase of passive optical components to meet and verify reliability qualification standards for certain specified service environments;
– to give the minimum list of reliability qualification stress tests and conditions;
– to establish guidance for the selection of appropriate measurements and pass/fail criteria;
– to give relevant references; and
– to establish the minimum reporting requirements.

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This standard defines a series of stress tests, their severity, sequences, quantities of devices under the test (DUT), acceptance criteria, and reporting requirements. It also gives guidelines to selecting appropriate measurements and pass/fail criteria.

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 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*

IEC 61300 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures*

IEC 61300-2-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*

IEC 61300-2-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-4: Tests – Fibre/cable retention*

IEC 61300-2-9, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: Tests – Shock*

IEC 61300-2-17, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-17: Tests – Cold*

IEC 61300-2-18, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-18: Tests – Dry heat – High temperature endurance*

IEC 61300-2-19, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Damp heat* (steady state)

IEC 61300-2-22, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*

IEC 61300-2-42, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-42: Tests – Static side load for strain relief*

IEC 61300-2-44, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-44: Tests – Flexing of the strain relief of fibre optic devices*

IEC 61300-2-47, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-47: Tests – Thermal shocks*

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

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

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IEC 62005 (all parts), *Fibre optic interconnecting devices and passive components – Reliability*

IEC 62005-1, *Reliability of fibre optic interconnecting devices and passive components – Part 1: Introductory guide and definitions*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62005-1, as well as the following apply.

3.1.1
reliability qualification stress test
RQST
test which applies a mechanical, electrical, optical, environmental or other stress or any combination of the above to the DUT

Note 1 to entry: This note applies to the French language only.

3.1.2
lot tolerance per cent defective
LTPD
level of quality that is unsatisfactory and should be rejected by the sampling plan

Note 1 to entry: This note applies to the French language only.

3.2 Abbreviations

CD Chromatic dispersion

DUT Devices under test

ESD Electrostatic discharge

FMEA Failure mode and effect analysis

GDR Group delay ripple

HBM Human body model

LTPD Lot tolerance per cent defective

RQS Reliability qualification standard

RQST Reliability qualification stress test

TDL Temperature dependent loss

TEC Thermo-electric cooler

VIPA Virtually imaged phased array

4 General requirements

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4.1 DUT

The specific passive optical component to which this standard relates shall be clearly defined. The DUTs shall be selected randomly from a larger population of samples such that the DUTs are representative of devices that would be shipped to the customer.

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Although it is anticipated that a homogeneous set of the DUTs be used for all tests in a RQS program, it is recognized that this is not always possible or practical. When this is the case, generally referred to as a ‘read across’ or a ‘test by similarity’, the specific description of the products used in each test shall be stated. Justification for every ‘read across’ and ‘test by similarity’ shall be documented. In addition, the level of manufacturing maturity of each DUT type shall be defined, for example, the product is in production with all documentation or the product is in development and was made with significant engineering support.

4.2 Product family

When one model number of a family of products is qualified and qualification is subsequently claimed for the entire family of products, the DUT shall be the model number with the most demanding specifications. Only models with equivalent or lesser specifications than the device tested can be called qualified. The same applies if the test result is extended to products of lower complexity.

EXAMPLE Qualification of 1 x 8 splitters may be justified by qualification of 1 x 16 splitters if the same technology is used.

In both cases, a technical argumentation is required to justify the qualification by similarity.

4.3 Service environments

The performance requirements for passive fibre optic components are defined in IEC 61753-1. The relevant service environments for this standard are as follows:

Table 1 – Service environments

Category	Environment
C	Controlled
U	Uncontrolled
O	Uncontrolled environment (sequential test)

In general, conducting a test to a more severe condition shall be regarded as having satisfied the criteria for a less severe condition, thus eliminating the need for redundant testing. Testing to a service environment of greater severity than that contained in Table 1 is not part of the current issue of this RQST.

5 Tests

5.1 General

Three types of tests are defined in Annex A, B, C and D. These are required tests, informative tests and optional tests. The required tests which need to be carried out for each performance category are defined in Annex A, for a controlled environment, and in Annexes B and C, for an uncontrolled environment. The required tests shall be performed, the required measurements taken and the data subjected to the pass/fail criteria.

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The optional and the informative tests for each performance category are defined in Annex D. The informative tests shall be performed, and the required measurements taken. The measured data shall be reported, however, the pass/fail criteria no longer apply. The optional tests are not required, but may be performed. If performed, the required measurements shall be taken and data subjected to the pass/fail criteria.

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In order to qualify and certify the reliability of passive optical components and modules, it is necessary to confirm their failure mode using failure mode and effect analysis (FMEA) (see Annex E), and to compare test items in FMEA and Annex A, B, C or D. When Annex A, B, C or D does not cover all test items required by FMEA, tests in Annex E shall be carried out.

5.2 Quantity of the DUTs

The quantity of the DUTs shall be defined and shall never be less than the minimum required. Additional DUTs can be added to a test at any time such that the required LTPD is met.

5.3 Sequence

The test sequence shall be defined. All tests may be run in parallel, series or series/parallel except for the mechanical shock and vibration test. These shall be run in series with the mechanical shock being first.

5.4 Acceptance criteria

The test acceptance (pass) criteria shall be defined. The number of failures in a test shall be equal to or less than the LTPD allows in order to claim a pass for that test.

5.5 Test methods

The test method to be used shall be clearly defined for each test. The test measurements are defined in the IEC 61300 series. Where this is not possible, such as when the IEC 61300 test method has not been issued, other test methods may be defined. If a previously undefined test method is used, the test method and details used shall be technically justified and included in the RQST.

5.6 Severity

The severity and duration of the variables in the tests shall be clearly defined.

6 Measurements

6.1 General

This is a general standard and, as such, states limited measurement requirements because of the broad range of the DUTs covered and their differing specific performance parameters. Measurement selection for a product being qualified shall be justified and fully compliant with that product's IEC performance specification.

6.2 Measurements

The measurements used to determine whether or not an individual DUT has passed or failed a specific test shall be defined. They can include absolute values and changes in those absolute values.

6.3 Pass/fail criteria

The pass/fail criteria for each measurement shall be defined and justified. It can be no worse than the end of life performance conditions stated in the relevant IEC performance standard. In the event that an IEC performance document does not exist, the product's publicly advertised data sheet may be substituted.

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6.4 Measurement methods

When an IEC measurement standard exists, it shall be used to perform the measurement. When an IEC measurement standard does not exist, then accepted industry techniques can be used as long as they are clearly defined.

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6.5 Required leak rate and residual gas analysis measurements

Hermetic devices shall meet a leak rate of 5×10^{-8} atm cm^3/s (He) after each of the tests except for electrostatic discharge (ESD) and the fibre or cable retention tests when the hermetic seal is not being stressed in these tests.

The water vapour content as measured by residual gas analysis shall be $\leq 5\,000 \times 10^{-6}$ for hermetic devices only.

The water vapour content as measured by residual gas analysis shall be measured and reported after the damp heat (steady state) test for hermetic devices only.

7 Report

When a report is written, it shall contain the following minimum information:

a) A table with headings for the test name; test longevity and severity of the test; number of devices in the test; number of devices that failed during the test results.

b) Full description of the DUT.

c) Test procedure.

d) Description of and justification for all read 'acrosses' or 'tests by similarity'.

e) The sequence of tests for every group of parts.

f) Service environment to which qualification is being claimed.

g) Test method reference or full description of test method.

h) Description of and justification for all measurement reported.

i) Description of and justification for all pass/fail reported.

j) Tables and/or charts and/or other means such that the reader can verify that the requirements were met. For example, a simple table of minimum and maximum, values or a chart of parameter vs. time with the pass/fail criteria clearly marked.

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Annex A
(normative)

Required reliability qualification tests for passive optical components used in category C, controlled environments

The required reliability qualification tests for passive optical components used in category C, controlled environments, are summarized in Table A.1.

Table A.1 – Required reliability qualification tests for passive optical components used in category C, controlled environments *(1 of 2)*

Test name	Requirements	Sequential /parallel	LTPD %	Min qty.	No. of fail.	References/ Remarks
Required tests						
Static side load	Reinforced cable: Load: 1 N Duration: 60 min Secondary coated fibres Load: 0,2 N Duration: 5 min	P NOTE 3	20	11	0	IEC 61300-2-42 NA for connector, plug and receptacle styles
Mechanical shock (impact test)	Number of shocks: 5 times/dir, 6 directions Shock level: 4,9 N Duration: 1 ms or Drop height: 1,8 m Number of drops per three mutually perpendicular axes: 8 Number of repetitions of impact test cycle: 5	G1-1 NOTE 1	20	11	0	NOTE 4
Vibration	Acceleration: 20 G Frequency: 20 Hz to 2 000 Hz Duration: 4 min/cycle, 4 cycle/axis or Acceleration: 20 G or 1,52 mm} Frequency: 10 Hz to 2 000 Hz Duration: Sweep cycle performed 12 times in each of three mutually perpendicular directions	G1-2 NOTE 2	20	11	0	NOTE 4
Temperature cycling	Temperature: –40 °C to 70 °C Dwell time: ≥ 15 min Number of cycles: 100	P NOTE 3	20	11	0	NOTE 4

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