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Edition 3.0 2016-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic active components and devices – Reliability standards – Part 3: Laser modules used for telecommunication

Composants et dispositifs actifs en fibres optiques – Normes de fiabilite – Partie 3: Modules laser utilisés pour les télécommunications

IEC 62572-3:2016-02(en-fr)

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FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – RELIABILITY STANDARDS –

Part 3: Laser modules used for telecommunication

FOREWORD

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International Standard IEC 62572-3 has been prepared by subcommittee 86C: Fibre optic systems and active devices of IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition published in 2014. This third edition constitutes a technical revision in which errors in Table 1 and Table 2 have been corrected.

This bilingual version (2017-08) corresponds to the monolingual English version, published in 2016-02.

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

CDV	Report on voting
86C/1302/CDV	86C/1345/RVC

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

The French version of this standard has not been voted upon.

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

A list of all parts in the IEC 62572 series, published under the general title *Fibre optic active components and devices – Reliability standards*, 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 website 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- withdrawn,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.

INTRODUCTION

The laser modules covered by this International Standard are purchased by system suppliers (SS) to be inserted in equipment, which in turn are supplied/sold to a system operator (SO) or a network operator (see definitions in Clause 3).

For the system operator to act as an informed buyer, he/she should have knowledge of the potential risks posed by the use of critical components.

Optoelectronic component technology is continuing to develop. Consequently, during product development phases, many failure mechanisms in laser modules have been identified. These failure mechanisms, if undetected, could result in very short laser lifetime in system use.

FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – RELIABILITY STANDARDS –

Part 3: Laser modules used for telecommunication

1 Scope

This part of IEC 62572 deals with reliability assessment of laser modules used for telecommunication.

The aim of this standard is

– to establish a standard method of assessing the reliability of laser modules in order to minimize risks and to promote product development and reliability;

– to establish means by which the distribution of failures with time can be determined. This should enable the determination of equipment failure rates for specified end of life criteria.

In addition, guidance is given in IEC TR 62572-2.

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 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60749-6, *Semiconductor devices – Mechanical and climatic test methods – Part 6: Storage at high temperature*

IEC 60749-8, *Semiconductor devices – Mechanical and climatic test methods – Part 8: Sealing*

IEC 60749-10, *Semiconductor devices – Mechanical and climatic test methods – Part 10: Mechanical shock*

IEC 60749-11, *Semiconductor devices – Mechanical and climatic test methods – Part 11: Rapid change of temperature – Two-fluid-bath method*

IEC 60749-12, *Semiconductor devices – Mechanical and climatic test methods – Part 12: Vibration, variable frequency*

IEC 60749-25, *Semiconductor devices – Mechanical and climatic test methods – Part 25: Temperature cycling*

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

IEC TR 62572-2, *Fibre optic active components and devices – Reliability standards – Part 2: Laser module degradation*

MIL-STD-883, *Test method standard – Microcircuits*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document the following definitions apply.

3.1.1
laser module
packaged assembly containing a laser diode with/without photodiode

Note 1 to entry: The module may also include a cooler and temperature sensor to enable laser temperature to be controlled and monitored. The optical output is normally via an optical fibre pigtail.

3.1.2
submount
substrate upon which a laser diode or photodiode may be mounted for assembly into the laser module

Note 1 to entry: Components on submounts are also subject to qualification testing.

3.1.3
laser module manufacturer
LMM
manufacturer of laser modules who provides devices meeting the requirements of the relevant detail specification (DS) and the customer's reliability requirements

3.1.4
network operator
NO
organization which operates a telecommunications network

3.1.5
system supplier
SS
manufacturer of telecommunications/data transmission equipment containing optoelectronic semiconductor lasers

Note 1 to entry: The system supplier can be a laser module customer.

3.1.6
system operator
SO
network operator of telecommunications/data transmission equipment containing opto-electronic semiconductor lasers in the transmission path

Note 1 to entry: The system may also be part of other more extensive systems, for example telecommunications, rail, road vehicles, aerospace or weapons.

3.1.7
capability qualifying components
CQC
components selected to represent critical stages of the process and limiting or boundary characteristics of mechanical and electro-optic design

Note 1 to entry: Such components should aid the identification of end product failure mechanisms to enable the determination of activation energies.

3.2 Symbols and abbreviations

T_A	minimum storage temperature
T_B	maximum storage temperature
T_c	module case temperature
T_s	submount temperature
$T_{s\ nom}$	recommended submount temperature
$T_{op\ min}$	module minimum operating temperature
$T_{op\ max}$	module maximum operating temperature
$T_{stg\ min}$	module minimum storage temperature
$T_{stg\ max}$	module maximum storage temperature
Qc	test for gross leak detection
Qk	test for fine leak detection
p	periodicity (in months)
n	sample size
CA	capability approval
CQC	capability qualifying components
DS	detail specification
LMM	laser module manufacturer
ML	median life
NO	network operator
QA	quality approval
QIP	quality improvement programmes
RGA	residual gas analysis
SO	system operator
SS	system supplier

4 Laser reliability and quality assurance procedure

4.1 Demonstration of product quality

This standard (where required by the specification) gives the minimum mandatory requirements and is part of a total laser reliability and quality assurance procedure adopted by the laser module manufacturer.

It also provides guidance on the activities of system suppliers and system operators and provides feedback on field performance to laser module manufacturers and system suppliers.

The laser module manufacturer shall be capable of demonstrating, by means of qualification approval of devices, technology approval or capability approval of the manufacturing process, the following:

a) a documented and audited manufacturing process including the qualification of purchased components in accordance with an internationally recognized quality management system;

b) a performance qualification programme, including for example, accelerated life testing, burn-in and screening of components and modules;

c) a qualification maintenance programme to ensure continuity of reliability performance;

d) a procedure to provide feedback on reliability issues to development and production.

4.2 Testing responsibilities

4.2.1 General

The testing detailed in Table 1 and Table 2 is to be performed by the laser module manufacturer and component suppliers (where applicable). Additional testing may be specified in the specification.

4.2.2 Recommendation applicable to laser customer/system supplier

The system supplier is recommended to have a programme to analyse and verify the results including failure analysis. This programme includes an independent life test of fully packaged laser modules (see Table 2, test 1 and/or test 2 and 3 and/or test 5 (sample size >10 per test)).

4.2.3 Recommendation applicable to system operator

The system operator is recommended to have a programme to monitor and report field failure rates in sufficient detail to enable the system supplier and laser module manufacturer to initiate any necessary corrective actions at an early stage in the lifetime of a product.

Suppliers may have different approaches (i.e. to reliability concepts) during the development of product maturity, and resource limitations may dictate testing strategies.

Alternative tests and activities to those specified are permitted, provided the LMM/SS/SO can show intent to remove end-product failures and the associated failure mechanisms. However, this will require significant data to substantiate compliance.

4.3 Quality improvement programmes (QIPs)

Quality improvement programmes (QIPs) shall be initiated with component suppliers and customers (SOs, SSs and LMMs) to address non-compliances (including quality and reliability problems identified during subsequent service life of the laser). The correction of non-compliances and subsequent QIPs are a required strategy to minimize reliability risks. The operation of QIPs should be stated in the quality approval (QA) generic and capability approval documents.

5 Tests

5.1 General

The tests described in Table 1 and Table 2 are designed to accelerate the main failure mechanisms known to be reliability hazards in laser modules and shall follow the guidance from IEC TR 62572-2. Where appropriate, the CQC shall demonstrate an ability to reduce end product failure mechanisms. Final product validation is required to demonstrate that CQCs are operating at the boundaries of the process or technology. These tests will reduce the risk of unreliable components entering system use and will enable estimates to be made of the distribution of laser lifetimes and hence the laser failure rates.

The sample size and level of testing may vary depending on the business volume between the laser customer/system supplier (SS) and laser module manufacturer (LMM). This information will be given in the capability approval (CA) document and the specification where appropriate.

It is essential that the lasers evaluated are entirely representative of standard production devices and have passed all the production and/or specified (where applicable in the specification) burn-in and screening procedures.

Table 1 – Initial qualification

These tests will normally be performed by the laser manufacturer as part of an initial qualification programme.

Table 2 – Maintenance of qualification

These tests cover periodic monitoring performed on production devices to ensure that the quality and reliability performance established during initial qualification is maintained or improved.

5.2 Structural similarity

Where a range of laser modules is produced by a laser manufacturer, there may be some significant structural similarity between different type codes. A combination of results from different test programmes, where appropriate, is therefore permitted.

Consideration should be given to the fact that minor differences in technology or processing can have a major impact on reliability, whilst not being apparent during quality assessment.

Evidence shall be presented which demonstrates that all results are directly relevant.

5.3 Burn-in and screening (when applicable in the specification)

NOTE See IEC TR 62572-2.

The screening test should be designed by the laser module manufacturer specifically for his particular technology. Any approach based on similarity to that which is performed by other manufacturers is good for comparison purposes, but can be ineffective in achieving the actual screening goal. This is particularly true for fibre optic components whose technology is not yet mature and varies significantly from supplier to supplier.

Where a manufacturer can demonstrate component and process stability, screening procedures may be revised.

Table 1 – Initial qualification (*1 of 3*)

Test no.	Test	References	Conditions	*n*
1	Initial endurance test			
1.1	a) Module with thermoelectric cooler		Φ_e specified, constant power Temperature: $T_c = T_{op\ max}$ $T_s = T_{s\ nom}$ Duration: 5 000 h [a]	25
1.2	b) Module without thermoelectric cooler		Φ_e specified, constant power Temperature: $T_c = T_{op\ max}$ Duration: 5 000 h [a]	25
1.3	Laser diode (submount)		Temperature: at least two test temperatures: Φ_e specified, constant power $T_{s1} = T_s$ max $T_{s2} \leq (T_{s1} - 20)$ °C or $T_{s2} \leq (T_{s1} - 10)$ °C if applicable Duration: > 5 000 h	See footnote [d] See footnote [d]

Table 1 *(2 of 3)*

Test no.	Test	References	Conditions	*n*
1.4	Photodiode (in representative package)		Temperature: at least two test temperatures: V_r or I_r specified T_{s1} = 125 °C min [b] $T_{s2} \leq (T_{s1} - 30\ °C)$ Duration: > 1 000 h	See footnote [d] See footnote [d]
1.5	High temperature storage of the thermoelectric cooler		$T = T_{stg\ max}$ of the cooler Duration: 1 000 h	25
1.6	Power cycle tests cooled devices		Number of cycles: 20 K $T_c = T_{op\ max}$ $T_s = T_c$ to $(T_c - \Delta T_{max})$	25
1.7	High-temperature storage of the thermal sensor		$T = T_{stg\ max}$ of the sensor	25
2	Fibre test			
2.1	Fibre proof test		Proof test [d] Duration [d] Min. bend radius [d]	10
2.2	Fibre retention			
2.2.1	Fibre pull		Fibre pull [d]	10
2.2.2	Side pull		Side pull [d]	
3	Change of temperature		See footnotes [c] and [d]	
3.1	Rapid change of temperature	IEC 60749-11	Temperature: $T_A = T_{stg\ min}$ $T_B = T_{stg\ max}$ Number of cycles = 50	10
3.2	Temperature cycling	IEC 60749-25 IEC 60068-2-14	Temperature: $T_A = T_{stg\ min}$ $T_B = T_{stg\ max}$ > 1 °C/min Number of cycles = 500	10
4	Sealing	IEC 60749-8	See footnote [d] Test Qk followed by Test Qc See footnotes [c] and [d] and Clause A.6	10
5	Shock and vibration		See Clause A.7	
5.1	Shock	IEC 60749-10	5 000 m/s^2, 0,5 ms with/without thermoelectric cooler, 15 000 m/s^2, 0,5 ms without thermoelectric cooler (where appropriate) 6-directions, 5 times each	10
5.2	Vibration	IEC 60749-12	20 Hz to 2 000 Hz, 200 m/s^2, 3-directions, 30 min each	10