IEC 62572-3

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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 fiabilité –
Partie 3: Modules laser utilisés pour les télécommunications**

IEC 62572-3:2011

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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.

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

FDIS	Report on voting
86C/1022/FDIS	86C/1035/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.

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- withdrawn,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.

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, knowledge of the potential risks posed by the use of critical components is required.

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 62752-2:2008.

2 Normative references

The following referenced documents are indispensable for the application 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 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 60747-1, *Semiconductor devices – Part 1: General*

IEC 60749-1, *Semiconductor devices – Mechanical and climatic test methods – Part 1: General*

IEC/TR 62572-2:2008, *Fibre optic active components and devices – Reliability standards – Part 2: Laser module degradation*

ISO 9001, *Quality management and quality assurance standards*

MIL-STD-883, *Test methods and Procedures for Microelectronics*

3 Terms, definitions and symbols

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 and photodiode

NOTE 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 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 specification and the customer's reliability requirements

3.1.4
system supplier
SS
manufacturer of telecommunications/data transmission equipment containing optoelectronic semiconductor lasers, i.e. laser module customer

3.1.5
system operator
SO
network operator of telecommunications/data transmission equipment containing opto-electronic semiconductor lasers in the transmission path

NOTE The system may also be part of other more extensive systems, for example telecommunications, rail, road vehicles, aerospace or weapons.

3.1.6
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 Such components should aid the identification of end product failure mechanisms to enable the determination of activation energies.

3.2 Symbols

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

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 manufacture.

It also gives guidance on the activities of the system supplier, and the system operator as well as feedback of field performance, the laser module manufacturer and the system supplier.

The laser module manufacturer shall be able to demonstrate, by means of qualification approval of devices, technology approval or capability approval of the manufacturing process:

a) a documented and audited manufacturing process including the qualification of purchased components in accordance with ISO 9001;

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 feedback reliability issues to development and production.

4.2 Testing responsibilities

4.2.1 General

The testing detailed in Tables 1 and 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 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 Tables 1 and 2 are designed to accelerate the main failure mechanisms known to be reliability hazards in laser modules (see IEC/TR 62752-2:2008). 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.

NOTE 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 62572-2:2008.

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

Test No.	Test	IEC 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} = <T_{s1} –20 °C Duration: >5 000 h	200 See [d] See [d]
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} = <(T_{s1} –30 °C) Duration: >1 000 h	200 See [d] See [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 see [d] Duration see [d] Min. bend radius see [d]	10
2.2	Fibre retention	60749		
2.2.1	Fibre pull		Fibre pull see [d]	10
2.2.2	Side pull		Side pull see [d]	

Table 1 *(continued)*

Test No.	Test	IEC references	Conditions	*n*
3	Change of temperature		See [c] and [d]	10
3.1	Rapid change of temperature	60749	Temperature: $T_A = T_{stg\ min}$ $T_B = T_{stg\ max}$ Number of cycles = 50	
3.2	Temperature cycling	60749 60068-2-14	Temperature: $T_A = T_{stg\ min}$ $T_B = T_{stg\ max}$ $>$ 1 °C/min Number of cycles = 500	10
4	Sealing	60749	See [d] Test Qk followed by Test Qc See [c] and [d] and A.6	10
5	Shock and vibration	60749	See A.7	10
5.1	Shock		500 G, 1 ms with Thermoelectric cooler, 1500 G, 0,5 ms without Thermoelectric cooler, 6-direction, 5 times each	
5.2	Vibration		20 – 2000 Hz, 20 G, 3-direction, 30 min each	10
6	High temperature storage (not applicable if module life test performed at equivalent case temperature and submount temperature)	60749	Temperature: $T = T_{stg\ max}$ Duration: >2 000 h (See Table 5, IEC/TR 62752-2:2008)	10
7	ESDS, modules a) Lasers b) Photodiodes	60747-1 MIL-STD-883, Method 3015	Human body model, see A.9 5 discharges/test voltage, charge-discharge cycle $>$ 0,1 s	5 per wafer
8	Residual gas analysis	MIL-STD-883, Method 1018	See [d] See A.10	6
9	Low temperature storage	60068-2-1	$T = T_{stg\ min}$ Duration: >1 000 h	10

[a] Provided data about the distribution of wear-out lifetime is accumulated with sufficient accuracy. Provisional approval for product shipment shall be granted at 2 000 h. It is also recommended to continue the test until accurate extrapolation of lifetime is possible with an upper limit of 10 000 h. Durations up to 5 000 h may be needed for accurate lifetime prediction.

[b] Or as limited by technology.

[c] Results from Tests 1.1 and 1.2 shall be supplemented by a laser customer/SS independent test of fully packaged modules in accordance with Table 2, Test 2 and/or Test 3 (sample size ≥ 10 per test) see also 4.2.

[d] Number of samples and conditions shall be determined by a laser customer/SS and LMM.