IEC 62343-2

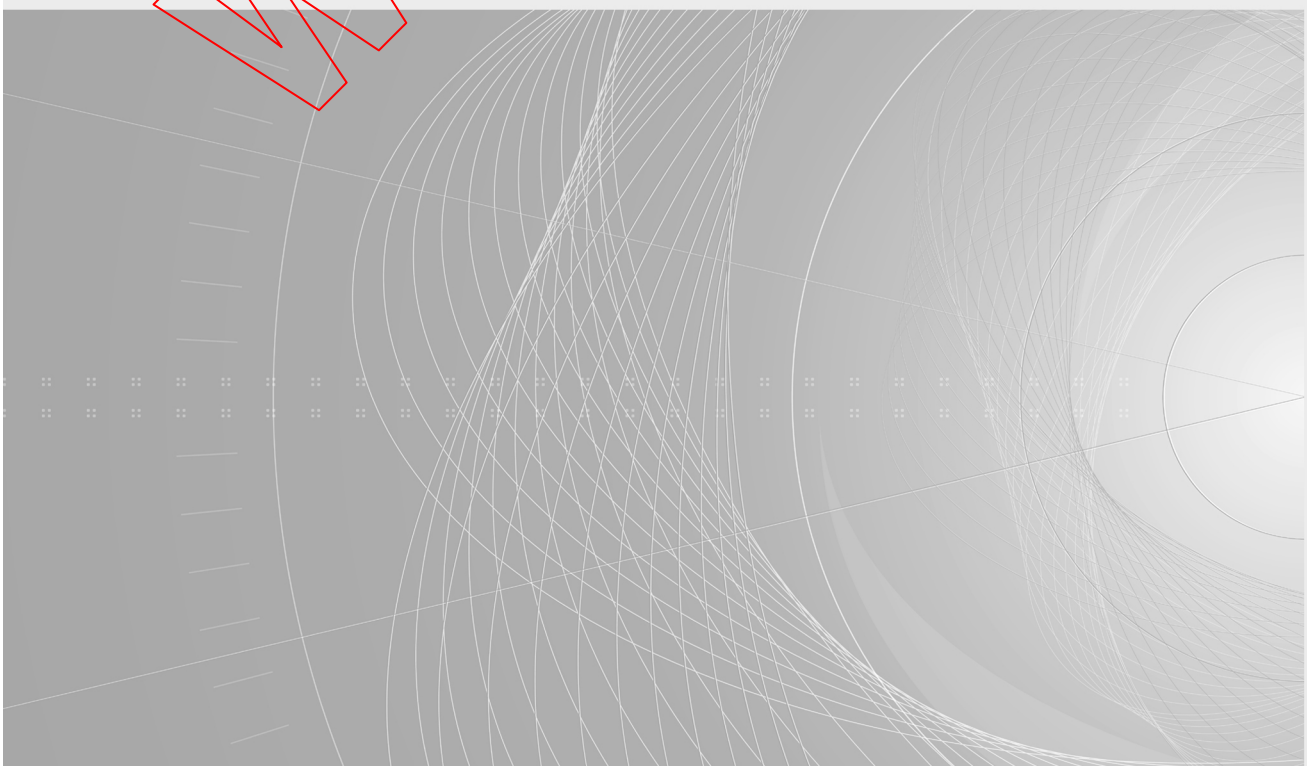
Edition 1.0 2011-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Dynamic modules – Part 2: Reliability qualification

Modules dynamiques – Partie 2: Qualification de fiabilité



IEC 62343-2:2011

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX

R

ICS 33.180

ISBN 978-2-88912-405-3

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 62343-2 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:

CDV	Report on voting
86C/960/CDV	86C/978/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.

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- withdrawn,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

This part of IEC 62243 is dedicated to the subject of reliability qualification of dynamic modules. Since the technology is quite new and still evolving, amendments and new editions to this document can be expected at a shorter interval.

DYNAMIC MODULES –

Part 2: Reliability qualification

1 Scope

This part of IEC 62343 applies to dynamic modules and devices (DMs) which are commercially available. Examples are tuneable chromatic dispersion compensators, reconfigurable optical cross-connects, and dynamic channel equalizers. (Optical amplifiers are not included in this list, but are treated in IEC 61291-5-2).

For reliability qualification purposes, some information about the internal components, parts and interconnections is needed; these internal parts are treated as black boxes. This standard gives requirements for the evaluation of DM reliability by combining the reliability of such internal black boxes.

The objectives of this part of IEC 62343 are the following:

- to specify the requirements for the reliability qualification of DMs;
- to give the minimum list of reliability qualification tests, requirements on failure criteria during testing and on reliability predictions, and give the relevant normative references.

2 Normative references

The following 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 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 61300-2-12, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-12: Tests – Impact*

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 62005-9-2, *Reliability of fibre optic interconnecting devices and passive optical components – Part 9-2: Reliability qualification for single fibre optic connector sets – Single mode*

IEC 62372 (all parts), *Fibre optic active components and devices – Reliability standards*

ISO 9000, *Quality management systems – Fundamentals and vocabulary*

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
failure
non-compliance to product specification or change in parameters as set by the standard or agreed by the customer and supplier

3.1.2
qualification
commonly used as the abbreviation for Reliability Qualification. It is used as a formal testing to determine whether or not the product is suitable for telecom applications and therefore, "pass or fail" is the expected outcome

NOTE This is different from reliability test, which is in nature a reliability "engineering test". Reliability tests are designed to understand the reliability consideration or estimate the reliability of the product. Pass or fail is not the main output.

3.1.3
reliability
There are two common uses of this term:

a) minimum period of DM continuous operation without failure at specified operating and environmental conditions

b) probability to perform required functions at specified operating and environmental conditions

NOTE The reliability of a DM is expressed by either of the following two parameters: mean time between failure (MTBF) and failures in time (FIT):

- The MTBF is the mean period of DM continuous operation without any failure at specified operating and environmental conditions.
- The FIT is the number of failures expected in 10^9 device-hours at specified operating and environmental conditions.

3.2 Abbreviated terms

Each abbreviation introduced in this International Standard is explained in the text at least the first time it appears. However, for an easier understanding of the whole text, the following is a list of all abbreviations used in this International Standard:

DM	Dynamic Module
DS	Detail Specification
ESD	Electrostatic Discharge
FIT	Failure In Time
FMEA	Failure Mode and Effects Analysis
MTBF	Mean Time Between Failure
RH	Relative Humidity
UCL	Upper Confidence Level

4 Reliability qualification considerations

4.1 General

Since DMs are relatively new products in the commercial market and involve different technologies, the requirements included in this standard will need to be reviewed as technology progresses.

4.2 General consideration approach

It is worth emphasizing the fundamental approach of reliability qualification adopted in this standard:

a) Any parts that can be effectively qualified on their individual levels must be qualified at that level. Their qualification shall be based on IEC standards or other industrial standards in the absence of such IEC standards.

b) The qualification tests required at DM level must be based on the degradation mechanisms and failure modes that cannot be effectively detected in the lower part levels. At the DM level, the qualification tests shall not attempt to discover or identify those degradation mechanisms and failure modes that can be discovered in the lower assembly levels than the final product level. For example, if all parts in the DM can be effectively tested for damp heat-accelerated degradations, there is no need to repeat the damp heat test at the DM level.

4.3 DM product design

A DM is an assembly of various components, parts, and interconnections. There are two basic designs in the current commercial DM market:

a) Design 1: Parts (as a general term that includes components, parts and interconnections used to build a DM from this point on for this standard) are packaged separately. Their packages are usually either hermetic or moisture-resistant. They are integrated into a housing (usually non-hermetic or not moisture-resistant).

b) Design 2: Some parts used in DMs are unpackaged basic optical elements (e.g. crystals, lenses, mirrors, etc.). These parts cannot be effectively qualified by themselves. These parts/elements are integrated and packaged inside a hermetic box or moisture-resistant box.

In Design 1, the individual parts can be tested and qualified individually and therefore, the DM qualification does not have to repeat the tests that are performed in the part levels for the same degradation mechanisms and failure modes.

In Design 2, the DM qualification is again focused on the tests that cannot be effectively performed in the lower assembly levels (i.e., the basic part level). However, in this case there are usually more tests required since the parts cannot be effectively tested at the part level individually.

Due to the differences in the designs, and therefore different mechanisms and failure modes, different qualification test approaches must be developed separately. They are described in 5.4.4 for Design 1 and 5.4.5 for Design 2, respectively.

5 Reliability qualification requirements

5.1 General

For the purpose of this International Standard, each internal component, part, and interconnection shall be treated as a black box. It is also important to point out that the parts in the DM of this design include the fibre splicing, fibre routing, and fibre anchoring, as well as how the fibre exits from the housing and how parts are mounted.

This International Standard is based on the assumption that the reliability of a DM can be evaluated with sufficient confidence from the FIT rates of its internal black boxes when the assembly process of the constituents has been qualified.

There are degradation and failures not due to part failures. An example is the fibre routing and fibre holders. The quality and reliability of the assembling, for example fibre routing, must be assessed and qualified through the process evaluation and qualification. The procedures to qualify the assembly process are described in 5.4.3.

The internal black boxes often constituting a DM are listed below.

- Passive optical components, including patch cords, pigtails, connectors and splices.
- Active optical components.
- Electronics, including PCBs, electrical connectors, etc.
- Others (e.g., the fibre splicing, fibre routing, and fibre anchoring, as well as how the fibre exits from the housing and how components are mounted).

The DM manufacturers shall declare the number and type of the internal black boxes constituting the DM and give the failure rates (in FITs) for each black box.

The DM failure rate shall be calculated by suitably combining the failure rates in FITs of its black boxes, as described in the next section. The model and assumptions used in DM failure rate calculation must be provided and justified for review, if the DM Manufacturer is so requested.

5.2 Demonstration of product quality

Since the reliability qualification tests are performed on a limited number of units, it is essential to have a quality management system in place to assure that the quality of all units is consistent. Testing on a limited number of samples will be representative of the production units to be delivered after the qualification is completed.

This International Standard (where required by the detailed specification) specifies the minimum mandatory requirements to assess reliability qualification of a DM and is intended to be part of a total DM reliability program and quality management system developed and implemented by the DM manufacturer.

The DM manufacturer shall demonstrate:

- a documented and audited manufacturing process, including the reliability qualification of purchased parts, in accordance with ISO 9000;
- Performance data of production units shall be available for review, and its distribution must show processes are under adequate controls;
- a reliability qualification programme, including, for example, accelerated life testing, burn-in and screening of parts and DMs;
- a reliability qualification maintenance programme to ensure continuity of qualification status (this can be achieved by means of periodic reliability qualification tests of the product or similar products);
- a procedure to ensure an appropriate feedback to development and production on reliability issues.

5.3 Testing responsibilities

The DM manufacturer is responsible to perform reliability qualification testing.

The testing detailed in this standard is to be performed by the DM manufacturer. Additional testing may be specified in the detailed specification.

5.4 Tests

5.4.1 Thorough characterization

A thorough characterisation of the product for its performance (may be beyond those in the performance specifications) over all operating conditions (may be beyond those in the operating condition specifications) shall be performed. The data shall be collected and analysed (minimal for the mean and standard deviation), and be available for review.

5.4.2 Reliability qualification of components, parts and interconnections

All components, parts, and interconnections used to build DMs shall be qualified according to the appropriate IEC standards for each of them. The components may include, but are not limited to, variable optical attenuators (VOAs), taps/splitters, detectors, isolators, circulators, electronic components, splicing connections (including the packaging or re-coating), crystals, mirrors, prisms, etc.

If the IEC standards for the parts are under development or not yet available, the IEC standards for parts of similar failure modes and degradation mechanisms should be adopted. An analysis of similarity of failure modes and degradation mechanisms shall be provided to support the approach.

Considerations must be given to designs that use many pieces of same parts. The failure rates of such parts may significantly contribute to the overall system failure rate or downtime. The cumulative degradation from individual parts should also be investigated. The results may require tests on additional samples or more stringent failure definitions.

Additionally, the pass/fail criteria of the part qualification must be thoroughly examined to determine whether or not the part qualification is adequate. For an example, if several 1x2 taps are used in a series design, not only the failure rate but also the degradation is multiplied (i.e. 0,5 dB pass/fail criterion is multiplied), which may not be acceptable. The pass/fail criterion of the parts commonly defined as 0,5 dB changes in insertion loss is much too loose for the needs of a product such as a DM. The assessment of tighter criteria must be carried out and the qualification status justified.

5.4.3 Reliability qualification of DM assembly process

Fibre routing and component mounting are both important module assembling processes, and they can be significant failure rate contributors if they are not done properly. Their designs and processes must be thoroughly documented and tested. Any changes must be supported by adequate experiment data.

If the fibre routing is thoroughly documented and controlled (e.g., through performance measurements before and after routing) and the final DM is qualified, the fibre routing process can be considered as a qualified process and can be used in other similar products to produce a product that is claimed to be qualified by similarity.

5.4.4 Reliability qualification of the Design 1 DM

As described in 5.1 for Design 1, parts (components used to build a DM) are packaged separately. Their packages are usually either hermetic or moisture-resistant. They are integrated into a housing (usually non-hermetic or not moisture-resistant).

A reliability qualification procedure related to the complete DM is described in Table 1. It gives the minimum list of tests to be performed on DMs in order to assure reliability.

On the basis of the reliability assurance required for the reliability tests for the DM internal black boxes, the sampling level is generally low (for example a few samples for each DM type).

In some specific cases the use of adhesives in the DM can be considered as a critical process and shall require separate qualification. Depending on the possible function of the adhesive (mechanical anchoring, splice protection, index matching, etc.), the different failure modes shall be addressed and supported by reliability/qualification data.

The main point in the reliability qualification of the Design 1 DM is to ensure the reliability of each part is not degraded in the manufacturing process used.