

TECHNICAL REPORT

**Dynamic modules –
Part 6-6: Failure mode effect analysis for optical units of dynamic modules**

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE

T

ICS 33.180.20

ISBN 978-2-88912-327-8

CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Normative references	5
3 Consideration of types of dynamic modules	6
4 Typical failure points	6
5 Failure modes and known failure mechanisms	6
Bibliography.....	25
Table 1 – Categorization based on the structure and how to evaluate	7
Table 2 – Failure mode and known failure mechanisms for the optical units of dynamic devices	8

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DYNAMIC MODULES –

**Part 6-6: Failure mode effect analysis
for optical units of dynamic modules**

FOREWORD

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IEC 62343-6-6, which is a technical report, has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86C/944/DTR	86C/959/RVC

Full information on the voting for the approval of this technical report 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.

A list of all parts of IEC 62343 series, published under the general title *Dynamic modules*, 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

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

DYNAMIC MODULES –

Part 6-6: Failure mode effect analysis for optical units of dynamic modules

1 Scope

This part of IEC 62343, which is a technical report, describes failure mode effect analysis (FMEA) for optical units of dynamic modules. FMEA is one of the effective and useful analysis methods to determine the reliability evaluation test items and conditions which are defined in future reliability qualification documents. In order to estimate the lifetime for a module, there is a typical procedure. The first step is to identify the dominant failure modes. The second step is to determine the acceleration tests according to these failure modes. The third step is to carry out the test. The fourth step is to estimate the acceleration factors. Finally, the fifth step is to calculate the lifetime of the dynamic module. The IEC 61300-2 series defines environment and mechanical tests. This technical report describes the dominant failure mode for dynamic modules and relevant tests from the IEC 61300-2 series.

2 Normative references

The following reference 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 61300-2-9, *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 61300-2-44, *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 62005-3, *Reliability of fibre optic interconnecting devices and passive components – Part 3: Relevant tests for evaluating failure modes and failure mechanisms for passive components*

3 Consideration of types of dynamic modules

There are many types of dynamic modules: dynamic channel equalizer, tuneable optical chromatic dispersion compensator, dynamic gain tilt equalizer, wavelength selective switch, wavelength blocker, optical performance monitor, optical switch, and so on. The main feature of dynamic modules is to control their performances during operation. In order to achieve their features, many kinds of control mechanisms are used for dynamic modules; MEMS (micro electro mechanical system), stepping motor, electromagnet, thermo optics, magnet optics, electro optics, LCD (liquid crystal devices), and so on.

Table 1 shows the first guidance of categorization of dynamic modules to consider how to evaluate. Dynamic modules without an electrical circuit board can be considered similar to passive optical components for purposes of evaluation. On the other hand, for dynamic modules with a control circuit board, it is necessary to give special consideration. There are mainly two types of internal design for dynamic modules: those for which it is easy to divide the constituting parts to consider their reliability, and those which it is not easy to divide. It is necessary to consider how to evaluate according to these structures.

NOTE This technical report describes FMEA only for optical units for dynamic modules. It is necessary to evaluate whole dynamic modules including control circuit boards and firmware if used.

4 Typical failure points

In addition to control circuit boards and control of moving parts, a typical optical unit for a dynamic module consists of the following parts: optical element, outer package, fibre pigtails, optical semiconductor chips, and joint points of these elements. These elements have their own failure mode; for example, break for pigtails, displacement for joint points, and so on. Moreover, these elements may have their acceleration factor of degradation; for example, joint points fixed by adhesive are generally weak against high humidity, and so on. This failure mode analysis can be referred to FMEA for passive optical components (refer to IEC 62005-3).

There are special considerations for dynamic modules. The following are some examples. When a hermetic sealing structure is used, the damp heat test may be omitted because it can generally prevent humidity from entering the package. When using MEMS, operating shock and vibration tests are necessary because MEMS are sensitive to mechanical shock and vibration. When temperature control is used, the temperature cycling test is recommended because temperature control functions generally produce thermal stress. The temperature cycling test can accelerate thermal stress.

5 Failure modes and known failure mechanisms

For some dynamic modules, failure mode and effect analysis (FMEA) was carried out. Table 2 shows known failure mechanisms, failure effects, failure modes, relevant tests and IEC test document numbers for dynamic modules. If new technology and new dynamic modules become commercially available, they will be added to Table 2 in later revisions. Relevant tests are listed with the failure effect and the dominant failure mechanism. As other relevant tests or methods of failure mode excitation become known, these will also be added.

Table 1 – Categorization based on the structure and how to evaluate

Electrical circuits		How to evaluate	Examples
Without electrical circuits	N.A.	As optical component	VOA, 1x2/2x2 optical switch, DGTE
With electrical circuit	Easy to divide optical and electrical unit	As optical and electrical units individually, and as integrated dynamic module	VOA, VOA-MUX, DCDC, DCE, Matrix switch, channel monitor, performance monitor
	Difficult to divide optical and electrical unit	To evaluate as integrated dynamic module	Wavelength blocker, wavelength selectable switch
NOTE 1 Optical active and passive components should comply to the reliability qualification requirement defined in the IEC 62572 series for active components and IEC 62009-9 series for passive optical components, respectively. In cases in which it is difficult to divide optical and electrical units, integrated modules should be tested. NOTE 2 Electrical circuit boards should be qualified individually. The following standard series are useful references for the quality of electrical circuit boards: IEC 61188, IEC 61189, IEC 61190, and IEC 61191. NOTE 3 Three pieces should be tested.			

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