SLOVENSKI STANDARD
oSIST prEN IEC 63287-3:2025

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Polprevodniški elementi - Splošne smernice za kvalifikacijo polprevodnikov - 3. del: Smernice za načrtovanje ocenjevanja zanesljivosti močnostnega polprevodniškega modula

Semiconductor devices - Generic semiconductor qualification guidelines - Part 3: Guidelines for reliability qualification plans for power semiconductor module

Dispositifs à semiconducteurs - Lignes directrices génériques concernant la qualification des semiconducteurs - Partie 3: Lignes directrices pour les plans de qualification de la fiabilité des modules à semiconducteurs de puissance

Ta slovenski standard je istoveten z: **prEN IEC 63287-3:2024**

ICS:

31.080.01	Polprevodniški elementi (naprave) na splošno	Semiconductor devices in general

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COMMITTEE DRAFT FOR VOTE (CDV)

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IEC TC 47 : SEMICONDUCTOR DEVICES	
SECRETARIAT:	SECRETARY:
Korea, Republic of	Mr Cheolung Cha
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
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☒ SUBMITTED FOR CENELEC PARALLEL VOTING	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING
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TITLE:

Semiconductor devices - Generic semiconductor qualification guidelines - Part 3: Guidelines for reliability qualification plans for power semiconductor module

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NOTE FROM TC/SC OFFICERS:

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SEMICONDUCTOR DEVICES – GENERIC SEMICONDUCTOR QUALIFICATION GUIDELINES –

Part 3: Guidelines for reliability qualification plans for power semiconductor module

FOREWORD

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International Standard IEC 63287-3 has been prepared by IEC technical committee 47: Semiconductor devices.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
47 /XX/FDIS	47 /XX/RVD

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

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

A list of all parts in the IEC 63287 series, published under the general title semiconductor devices - generic semiconductor qualification guidelines, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

When performing qualification tests, semiconductor device vendors prepare a specific reliability test plan upon consultation with semiconductor device users in order to efficiently carry out the reliability test.

This guideline presents examples of methods for preparing test plans to determine appropriate reliability test conditions, based on the level of quality required in the operating environments of various applications of power semiconductor modules. As a target of reliability, grades have been specified for each of the following applications: automotive, industrial and consumer electronics. Based on the number of annual operating hours, use period and other parameters assumed for each grade, this guideline defines verification methods for the wear-out failure, and proposes appropriate reliability tests. This guideline defines the concept of quality assurance from early failure to wear-out failure. It also presents approaches to appropriately ensure the reliability of power semiconductor modules.

The test conditions and the acceleration factor values presented in this guideline are only examples used for setting reliability test conditions to verify a required level of quality.

NOTE Qualification tests are tests performed by power semiconductor device vendors, taking into account the quality required by the users of their products.

SEMICONDUCTOR DEVICES – GENERIC SEMICONDUCTOR QUALIFICATION GUIDELINES –

Part 3: Guidelines for reliability qualification plans for power semiconductor module

1 Scope

This part of the IEC 63287 provides guidelines for a reliability qualification plan for power semiconductor modules to assure reliability targets over the entire product life.

Here, the term power semiconductor module refers to multichip semiconductor power modules as defined below in 3.3.

Power semiconductor modules with incorporated control circuits are excluded. Clamped packages that need external pressure for being mounted in a system are excluded, e.g. disc-type pressure pack devices.

This document is not intended for medical, military, aeronautics and astronautics-related applications.

2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60191-4, Mechanical standardization of semiconductor devices - Part 4: Coding system and classification into forms of package outlines for semiconductor device packages

IEC 63287-1, Semiconductor devices - Generic semiconductor qualification guidelines - Part 1: Guidelines for IC reliability qualification

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
failure mode

classification of a fault phenomenon which causes product failure

Note 1 to entry disconnection, a short circuit, occasional loss, abrasion, characteristic deterioration, etc. are typical items considered as failure modes

3.2
failure mechanism

physical, chemical or other process that results in a failure mode, which leads to a product that fails to meet functional requirements

3.3
power module
isolated or non-isolated semiconductor module with two or more semiconductor chips according to the package outline style code “MP” specified in IEC 60191-4
Note 1 to entry: The predominantly used package body material is plastic (including epoxy) according to IEC 60191-4 and both the frame based and resin based embodiment are possible.

3.4
mode A failures
early failures with a decreasing failure rate due to extrinsic defects

3.5
mode B failures
random failures with relatively constant failure rate. The end of mode B regime limits the use period of a power semiconductor module

3.6
mode C failures
wear-out failures with increasing failure rate due to intrinsic limitation of lifetime

3.7
bathtub curve
a plot of failure rate versus time or cycles that exhibits three phases of life: infant mortality (decreasing failure rate), random failure period (relatively constant failure rate), and intrinsic wear-out (increasing failure rate)

4 Product categories and applications

4.1 Quality grade by application

Level of quality, operating hours and operating environment required for power semiconductor modules in the market are varied, depending on the application of products for which power semiconductor modules are used. As an example of a method for preparing test plans, this guideline has grouped the applications into three major grades of requirements, namely the automotive, the industrial and the consumer electronics application. And for each grade, the required level of quality and its preconditions are defined, as shown in Table 1.

4.2 Definition of quality grade（Example）

Table 1 – Definition of quality grade

Grade	I	II	III
Description of grade	Automotive application	Industrial application	Consumer electronics application
Example of application	Powertrains, DC/DC Converter, OBC, Power steering, etc.	Motor controls, Power converters, Robots,	Air conditioners, Home appliances, etc.

		Machine tools, Railway, etc.	
Annual operating hours	500 hours (driving hours) The operation differs between when it works with KEY ON/OFF and when it does not work with KEY ON/OFF.	Up to 8760 hours; varies depending on application.	Up to 8760 hours; varies depending on application.
Use period	15 years (cumulative failure probability: <1%)	10~20 years (cumulative failure probability:1%); varies depending on application.	5~10 years (cumulative failure probability:1%); varies depending on application.
Operating environment assumed (varies depending on application) [a]	For engine compartment: T_a= -40 °C (min)/125°C (max) T_j= 100°C (typ)/150°C (max) RH=0 (min)/100 (max)% RH typ. (10% when driving) (70% when stopping)	T_a= -20°C (min)/100°C (max) T_j= 70 °C (typ)/125°C (max) RH=10 (min)/80 (max)% RH typ. (20% when being energized) (60% when being de-energized)	T_a= 0°C (min)/70 °C (max) T_j = 70°C (typ)/105 °C (max) RH= 10 (min)/80 (max)% RH typ. (20% when being energized) (60% when being de-energized)
Early failure rate	1 ppm/year or less	50 to 100 ppm/year or less; varies depending on application.	100 ppm/year or less; varies depending on application.
Failure rate in the random failure period	1 FIT or less	50 to 100 FIT or less; varies depending on application.	100 FIT or less; varies depending on application.

NOTE The values shown in Table 1 are only examples. In real business life, these conditions are set according to market and customer requirements.

[a] as an alternative, the limiting values according to the climatic classes reported in IEC 60721 should be used as boundary conditions for a mission profile of climatic conditions (Ta, RH)

5 Failure

5.1 Failure distribution

The failure distribution of power semiconductor modules has been divided into three major areas: early failure, random failure and wear-out failure. **Figure 1** shows the bathtub curve representing the relationship between the field use time and the instantaneous failure rate. Each of the three areas is described in detail in **5.2** to **5.4**.

In the case of power semiconductor modules, most modules that may cause early failures are rejected