IEC 63287-2

Edition 1.0 2023-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Semiconductor devices – Guidelines for reliability qualification plans – Part 2: Concept of mission profile

Dispositifs à semiconducteurs – Lignes directrices concernant les plans de qualification de la fiabilité – Partie 2: Concept de profil de mission



IEC 63287-2:2023-03(en-fr)



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2023 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 63287-2

Edition 1.0 2023-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Semiconductor devices – Guidelines for reliability qualification plans – Part 2: Concept of mission profile

Dispositifs à semiconducteurs – Lignes directrices concernant les plans de qualification de la fiabilité – Partie 2: Concept de profil de mission

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 31.080.01

ISBN 978-2-8322-6708-0

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FOREWORD 3
1 Scope 5
2 Normative references 5
3 Terms and definitions 5
4 Mission profile 5
4.1 Concept of mission profile 5
4.2 Example of reliability test plan considering the mission profile of automotive engine peripherals application (1) 6
4.3 Example of reliability test plan considering the mission profile of automotive engine peripherals application (2) 8
4.4 Example of reliability test plan considering the mission profile of automotive cabin peripherals application 9
5 Calculation examples of mission profiles (Calculation of sample and test time of life tests) 10
Bibliography 15

Figure 1 – Example of mission profile for automotive application 6

Table 1 – Trial calculation example of equivalent time under operating life test based on consideration of the mission profile (automotive application in the engine peripheral) 7
Table 2 – Trial calculation example of number of samples/test time of operating life test with consideration of the mission profile (Automotive application in the engine peripheral) 7
Table 3 – Trial calculation example of equivalent time under operating life test with consideration of the mission profile (automotive application in the engine peripheral) 8
Table 4 – Trial calculation example of equivalent time under operating life test with consideration of the mission profile (Automotive application in the engine peripheral) 9
Table 5 – Trial calculation example of equivalent time under operating life test with consideration of the mission profile (automotive application in the cabin peripheral) 9
Table 6 – Trial calculation example of number of samples/test time of high temperature operating life test with consideration of the mission profile (Automotive application in the cabin peripheral) 10
Table 7 – Calculation examples of mission profiles (Calculation of sample and test time of life tests) 11
Table 8 – Calculation examples of mission profiles (Calculation of sample and test time of life tests) 13

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

SEMICONDUCTOR DEVICES – GUIDELINES FOR RELIABILITY QUALIFICATION PLANS –

Part 2: Concept of mission profile

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 63287 Part 2 has been prepared by IEC technical committee 47: Semiconductor devices. It is an International Standard.

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

Draft	Report on voting
47/2796/FDIS	47/2803/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

This International Standard is to be read in conjunction with IEC 63287-1.

A list of all parts in the IEC 63287 series, published under the general title *Semiconductor devices*, 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 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 document 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.

SEMICONDUCTOR DEVICES – GUIDELINES FOR RELIABILITY QUALIFICATION PLANS –

Part 2: Concept of mission profile

1 Scope

This part of IEC 63287 gives guidelines for the development of reliability qualification plans using the concept of mission profile, based on the environmental conditioning and proposed usage of the product. This document is not intended for military- and space-related applications.

2 Normative references

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 63287-1:2021, *Semiconductor devices – Generic semiconductor qualification guidelines – Part 1: Guidelines for IC reliability qualification*

3 Terms and definitions

For the purposes 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 https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
failure mode
style 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.

4 Mission profile

4.1 Concept of mission profile

In designing the reliability test plan, the test plan greatly changes depending on how the environmental conditions of the LSI is assumed. For example, in the case of electronic units for automotive application installed in the vicinity of the engine, operational temperature gradually rises by the heat generated by the engine but the temperature decreases after the engine stops, meaning that the unit is not always subjected to sever temperature conditions. The set of changing environmental temperature conditions and their time ratio is called the “mission profile”. Because mission profile depends on multiple factors such as operational duty of LSI, installation environment, generation of heat by peripheral parts, etc., it cannot be unconditionally standardized. Therefore, it is important to agree the mission profile between the LSI vendor and the user and decide on accurate test conditions.

Figure 1 shows an example of mission profile, with the ambient temperature and the estimated hours of operation at that temperature differing between installation around the engine and around the cabin for cases of automotive application with an estimated lifetime of 15 years (7 500 operational hours). A design method for the reliability test plan using the mission profile shown in Figure 1 is given in 4.2**.** For comparison, as an example of change in the test plan content due to the difference of mission profile, a design method for lifetime of 15 years (12 000 operational hours) as application for engine peripherals is given in 4.3

Trial calculation procedures of test time and number of test samples are based on JEITA ED-4701/002.

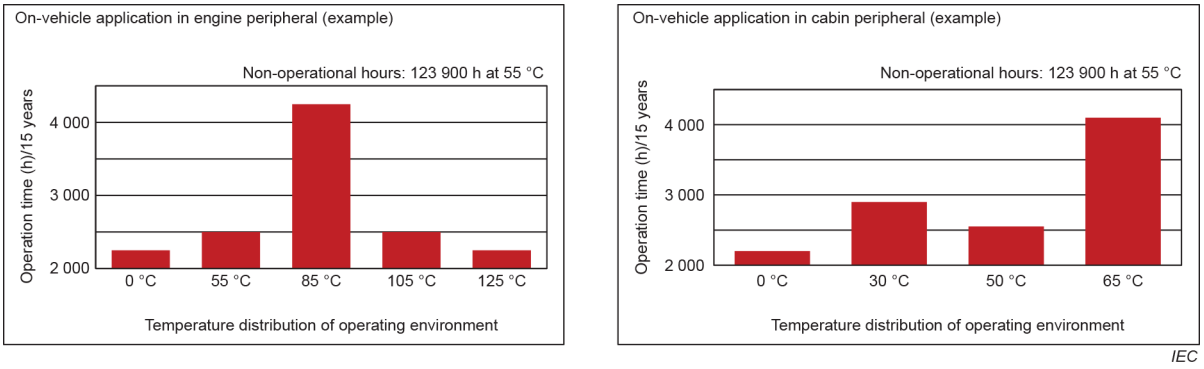


Figure 1 – Example of mission profile for automotive application

4.2 Example of reliability test plan considering the mission profile of automotive engine peripherals application (1)

Table 1 below shows the trial calculation of the reliability test plan (number of samples and time for the reliability test), based on the mission profile of on-vehicle application in the engine peripheral shown in Figure 1**,** taking the operating life test as an example. Table 1 is an example assuming general automotive applications in Japan with a presupposition of 500 annual operational hours.

In designing a test plan for the operating life test, only the hours of operation in the mission profile shall be regarded as the stress time in the LSI use environment. In this example, the rise in junction temperature (ΔTj) during operation is assumed as 20 °C and the test temperature is set as Ta = 125 °C. As shown in Table 1, conducting about 279 hours of operating life test at 125 °C gives stress equivalent to 15 years of actual use.

Table 1 – Trial calculation example of equivalent time under operating life test based on consideration of the mission profile (automotive application in the engine peripheral)

Mission profile (environment of actual use)			Test conditions	Convert hours of operation to equivalent time under acceleration condition	
				125 °C temperature acceleration only[b]	125 °C temperature acceleration[b] + 3,96 V voltage acceleration [c]
Ta	Tj [a]	Hours of operation			
0 °C	20 °C	500 h	125 °C 3,96 V (Voltage in actual use 3,3 V)	0,3 h	0,02 h
55 °C	75 °C	1 000 h		53 h	4 h
85 °C	105 °C	4 500 h		1 530 h	109 h
105 °C	125 °C	1 000 h		1 000 h	71 h
125 °C	145 °C	500 h		1 327 h	95 h
Total		7 500 h		3 910 h	279 h

[a] Tj = Ta + 20 °C (Assumption)

[b] Ea = 0,7 eV (Formula (1))

[c] β = 4 (Formula (2))

Table 2 uses the reliability test plan of IEC 63287-1. It shows the calculated values based on the number of samples and test time of operating life test in the case of 90 % confidence level and less than 0,1 % total of confirmation level of wear-out failure in the above mission profile (15 years of actual use).

NOTE The reliability tests of IEC 63287-1 are conducted by accelerating voltage, temperature, humidity, etc. of the actual use environment.

Table 2 – Trial calculation example of number of samples/test time of operating life test with consideration of the mission profile (Automotive application in the engine peripheral)

Test items	Assumed failure mode	Failure distribution	Acceleration parameter	Test conditions	Reliability test scale to confirm the life of 15 years/0,1 % (Confidence level 90 %)			Reference: AEC-Q100
High temperature operating life test	TDDB	Weibull distribution m = 3	Ea = 0,7 eV (Formula (1)) voltage acceleration β = 4 (Formula (2))	125 °C 3,96 V (Voltage in actual use 3,3 V)	Number of test samples	45 pcs	231 pcs	231 pcs
					Test time	1 037 h	601 h	1 000 h
TDDB = time-dependent dielectric breakdown								

As shown above, designing test plan with consideration of the mission profile is effective in the case of application with large temperature change in environment of actual use. Therefore, use of mission profile in conducting efficient test is recommended.

4.3 Example of reliability test plan considering the mission profile of automotive engine peripherals application (2)

Table 3 shows an example of change in the test plan content due to the difference of mission profile. Table 3 is an example assuming general automotive applications in North America and Europe with a presupposition of 800 hours (12 000 hours/15 years) of annual operational hours, intended by AEC-Q100.

Similarly to the design of the test plan of the operating life test in 4.2, only the hours of operation in the mission profile shall be regarded as the stress time in the LSI use environment. The rise in junction temperature (ΔTj) during operation is assumed as 20 °C and the test temperature was set as Ta = 125 °C. Table 3 shows the trial calculation example of conversion of operational hours to equivalent time under operating life test. Here, the assumed failure mode is time-dependent dielectric breakdown (TDDB). The temperature acceleration is estimated as Ea = 0,7 eV (Formula (1)) and the voltage acceleration as β = 4 (Formula (2)) for the trial calculation. As shown in Table 3, conducting about 528 hours of operating life test at 125 °C gives stress equivalent to 15 years of actual use.

Table 3 – Trial calculation example of equivalent time under operating life test with consideration of the mission profile (automotive application in the engine peripheral)

Mission profile (environmental conditions of actual use)			**Test conditions**	**Convert hours of operation to equivalent time under acceleration condition**	
				125 °C temperature acceleration only [b]	**125 °C temperature acceleration [b] + 3.96 V voltage acceleration [c]**
Ta	**Tj [a]**	**Hours of operation**			
0 °C	20 °C	500 h	125° C 3,96 V (Voltage in actual use 3,3 V)	0,3 h	0,02 h
55 °C	75 °C	500 h		27h	2 h
85 °C	105 °C	8 000 h		2 719h	194 h
105 °C	125 °C	2 000 h		2 000h	143 h
125 °C	145 °C	1 000 h		2 654 h	189 h
Total		12 000 h		7 400 h	528 h

[a] Tj = Ta + 20 °C (Assumption)

[b] Ea = 0,7 eV (Formula [a])

[c] β = 4 (Formula [b])

Table 4 shows the calculated values based on the reliability test plan of IEC 63287-1. It shows the calculated values based on the number of samples and test time of operating life test in the case of 90 % confidence level and 0,1 % or less total of confirmation level of wear-out failures in the above mission profile (15 years of actual use).

NOTE The reliability tests of IEC 63287-1 are conducted by accelerating voltage, temperature, humidity, etc. of the actual use environment.

Table 4 – Trial calculation example of equivalent time under operating life test with consideration of the mission profile (Automotive application in the engine peripheral)

Test items	Assumed failure mode	Failure distribution	Acceleration parameter	Test conditions	Reliability test scale to confirm the life of 15 years/0.1 % (Confidence level 90 %)			Reference: AEC-Q100
High temperature operating life test	TDDB	Weibull distribution m = 3	Ea = 0,7 eV (Formula (1)) voltage acceleration β = 4 (Formula (2))	125 °C 3,96 V (Voltage in actual use 3,3 V)	Number of test samples	45 pcs	231 pcs	231 pcs
					Test time	1 961 h	1 137 h	1 000 h

As shown above, the difference in mission profile changes the reliability test plan (number of samples and time for the reliability test), even if it is under the same test conditions. The concept of mission profile allows the development of a suitable test plan for individual applications.

4.4 Example of reliability test plan considering the mission profile of automotive cabin peripherals application

The mission profile below shows the design procedure of a reliability test plan (number of samples and time for the reliability test) for automotive application in the cabin peripheral of Figure 1.

In designing a test plan for the operating life test, only the hours of operation in the mission profile shall be regarded as the stress time in the LSI use environment. In this example, the trial calculation example of conversion of operational hours to equivalent time under operating life test is shown in Table 6 for the case where rise in junction temperature (ΔTj) during operation is assumed as 20 °C and the test temperature is set as Ta = 125 °C. Here, the assumed failure mode is TDDB. The temperature acceleration is estimated as Ea = 0,7 eV (Formula (1)) and the voltage acceleration as β = 4 (Formula (2)) for the trial calculation. As shown in Table 5, conducting about 130 hours of operating life test at 125 °C gives stress equivalent to 15 years of actual use.

Table 5 – Trial calculation example of equivalent time under operating life test with consideration of the mission profile (automotive application in the cabin peripheral)

Mission profile (environmental conditions of actual use)			Test conditions	Convert hours of operation to equivalent time under acceleration condition	
Ta	Tj [a]	Hours of operation		125 °C temperature acceleration only [b]	125 °C temperature acceleration [b] + 3,63 V voltage acceleration [c]
0 °C	20 °C	400 h	125 °C 3,63 V (Voltage in actual use 3,3 V)	0,3 h	0,1 h
30 °C	50 °C	1 800 h		15,8 h	4,2 h
50 °C	75 °C	1 100 h		41,8 h	11,2 h
65 °C	85 °C	4 200 h		430,1 h	114,9 h
Total		7 500 h		488h	130,4 h

[a] Tj = Ta + 20 °C (Assumption)

[b] Ea = 0,7 eV (Formula [a])

[c] β = 4 (Formula [b])

Table 6 shows the calculated values based on the reliability test plan of IEC 63287-1. It shows the calculated values based on the number of samples and test time of operating life test in the case of 90 % confidence level and 0,1 % or less total of confirmation level of wear-out failures in the above mission profile (15 years of actual use).

NOTE The reliability tests of IEC 63287-1 are conducted by accelerating voltage, temperature, humidity, etc. of the actual use environment.

Table 6 – Trial calculation example of number of samples/test time of high temperature operating life test with consideration of the mission profile (Automotive application in the cabin peripheral)

Test items	Assumed failure mode	Failure distribution	Acceleration parameter	Test conditions	Reliability test scale to confirm the life of 15 years/0,1 % (Confidence level 90 %)			Reference: AEC-Q100
High temperature operating life test	TDDB	Weibull distribution m = 3	Ea = 0,7 eV (Formula (1)) voltage acceleration β = 4 (Formula (2))	125 °C 3,63 V (Voltage in actual use 3,3 V)	Number of test samples	45 pcs	231 pcs	231 pcs
					Test time	484 h	281 h	1 000 h

As shown above, consideration of the concept of mission profile is effective in the case of applications with a large temperature change in the environment of actual use. Therefore, use of mission profile in conducting efficient test is recommended. As a calculation, an example of mission profile, in comparison with the example of AEC-Q100 is shown in Clause 5.

5 Calculation examples of mission profiles (Calculation of sample and test time of life tests)

Table 7 and Table 8 show examples of trial calculations substituting acceleration conditions and acceleration model used in JEITA EDR-4708B by the mission profile of AEC-Q100, and comparing the sample size and time. AEC Q100 only provides an example.

Table 7 – Calculation examples of mission profiles (Calculation of sample and test time of life tests)

Test items	Mission profile		Acceleration conditions/Assumed failure mode		Acceleration model		**EDR-4708B** Calculated sample size/time **0,1 %-Lifetime at CL90 %**	**AEC-Q100** Specified sample size/time **LTPD Standard**
	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100		
High temperature operating life test (Comparison between **EDR-4708B** engine peripherals application (1) and **AEC-Q100**)	15 years/3,3 V 20 °C/500 h 75 °C/1 000 h 105 °C/4 500 h 125 °C/1 000 h 145 °C/500 h Operating hour counter 7 500 h	15 years 87 °C/12 000 h	TDDB m = 3 Ea = 0,7 eV β = 4 125 °C 3,96 V	Ea = 0,7 eV 125 °C	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$ $\alpha_V = \exp\left\{\beta\left(V_2 - V_1\right)\right\}$	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$	231 pcs/601 h 50 pcs/1 000 h	231 pcs/1 000 h (1 393 h)
High temperature operating life test (Comparison between **EDR-4708B** engine peripherals application (2) and **AEC-Q100**)	15 years/3.3 V 20 °C/500 h 75 °C/500 h 105 °C/8 000 h 125 °C/2 000 h 145 °C/ 1000 h Operating hour counter 12 000 h	15 years 87°C/12 000 h	TDDB m = 3 Ea = 0,7 eV β = 4 125 °C 3,96 V	Ea = 0,7 eV 125 °C	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$ $\alpha_V = \exp\left\{\beta\left(V_2 - V_1\right)\right\}$	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$	231 pcs/1 137 h 339 pcs/1 000 h	231 pcs/1 000 h (1 393 h)
High temperature operating life test (Comparison between **EDR-4708B** cabin peripherals application and **AEC-Q100**)	15 years/3.3 V 20 °C/400 h 50 °C/1 800 h 75 °C/1 100 h 85 °C/4 200 h Operating hour counter 7 500 h	15 years 87 °C/12 000 h	TDDB m = 3 Ea = 0,7 eV β = 4 125 °C 3,63 V	Ea = 0,7 eV 125 °C	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$ $\alpha_V = \exp\left\{\beta\left(V_2 - V_1\right)\right\}$	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$	231 pcs/281 h	231 pcs/1 000 h (1 393 h)

Test items	Mission profile		Acceleration conditions/Assumed failure mode		Acceleration model		EDR-4708B Calculated sample size/time 0,1 %-Lifetime at CL90 %	AEC-Q100 Specified sample size/time LTPD Standard
	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100		
High temperature operating life test	Trial calculation by AEC-Q100 mission profile	15 years 87 °C/12 000 h	TDDB m = 3 Ea = 0,7 eV β = 4 125 °C 3,63 V	Ea = 0,7 eV 125 °C	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$ $\alpha_V = \exp\left\{\beta\left(V_2 - V_1\right)\right\}$	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$	231 pcs/802 h 119 pcs/1 000 h	231 pcs/1 000 h (1 393 h)

Table 8 – Calculation examples of mission profiles (Calculation of sample and test time of life tests)

Test items	Mission profile		Acceleration conditions/Assumed failure mode		Acceleration model		EDR-4708B Calculated sample size/time 0,1 %-Lifetime at CL90 %	AEC-Q100 Specified sample size/time LTPD Standard
	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100		
High temperature storage test	Trial calculation by **AEC-Q100** mission profile Non-operating time = 119 400 h at 55 °C	15 years 87 °C 12 000 h	Degradation of wire bond area m = 4 Ea = 1,0 eV 150 °C	150 °C	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$	$\alpha_T = \exp\left\{\frac{E_a}{k}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)\right\}$	45 pcs/379 h 15 pcs/500 h	45 pcs/1 000 h
Temperature humidity bias test (Relative humidity model)	Trial calculation by **AEC-Q100** mission profile	15 years 32 °C/74 %RH 131 400 h	Corrosion of metallic fine wiring m = 4 Ea = 0,8 eV P = 3 85 °C/85 %RH Vccmax	Ea = 0,8 eV P = 3 85 °C/85 %RH Vccmax	$A_f\left(\frac{RH_t}{RH_u}\right)^P \cdot \exp\left(\frac{E_a}{k}\left(\frac{1}{T_u}-\frac{1}{T_t}\right)\right)$	$A_f\left(\frac{RH_t}{RH_u}\right)^P \cdot \exp\left(\frac{E_a}{k}\left(\frac{1}{T_u}-\frac{1}{T_t}\right)\right)$	231 pcs/1 708 h 1 963 pcs/ 1 000 h	231 pcs/1 000 h (960 h)
Temperature humidity bias test (Absolute water vapor pressure model)	Trial calculation by **AEC-Q100** mission profile	15 years 32 °C/74 %RH 131 400 h	Corrosion of metallic fine wiring m = 4 n = 2 85 °C/85 %RH Vccmax	Ea = 0,8 eV P = 3 85 °C/85 %RH Vccmax	$\alpha_{vp} = \left(\frac{V_{p2}}{V_{p1}}\right)^n$	$A_f\left(\frac{RH_t}{RH_u}\right)^P \cdot \exp\left(\frac{E_a}{k}\left(\frac{1}{T_u}-\frac{1}{T_t}\right)\right)$	478 pcs/1 000 h 231 pcs/1 200 h	231 pcs/1 000 h (960 h)

Test items	Mission profile		Acceleration conditions/Assumed failure mode		Acceleration model		EDR-4708B Calculated sample size/time 0,1 %-Lifetime at CL90 %	AEC-Q100 Specified sample size/time LTPD Standard
	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100	EDR-4708B	AEC-Q100		
Temperature humidity storage test (Relative humidity model)	Trial calculation by **AEC-Q100** mission profile	15 years 32 °C/74 %RH 131 400 h	Corrosion of metallic fine wiring m = 4 Ea = 0,8 eV P = 3 130 °C/85 % RH	Ea = 0,8 eV P = 3 130 °C/85 % RH	$A_f\left(\frac{RH_t}{RH_u}\right)^P \cdot \exp\left(\frac{E_a}{k}\left(\frac{1}{T_u}-\frac{1}{T_t}\right)\right)$	$A_f\left(\frac{RH_t}{RH_u}\right)^P \cdot \exp\left(\frac{E_a}{k}\left(\frac{1}{T_u}-\frac{1}{T_t}\right)\right)$	231 pcs/95 h	231 pcs/96 h (53 h)
Temperature humidity storage test (Absolute water vapor pressure model)	Trial calculation by **AEC-Q100** mission profile	15 years 32 °C/74 %RH 131 400 h	Corrosion of metallic fine wiring m = 4 n = 2 130 °C/85 % RH	Ea = 0,8 eV P = 3 130 °C/85 % RH	$\alpha_{vp} = \left(\frac{V_{p2}}{V_{p1}}\right)^n$	$A_f\left(\frac{RH_t}{RH_u}\right)^P \cdot \exp\left(\frac{E_a}{k}\left(\frac{1}{T_u}-\frac{1}{T_t}\right)\right)$	231 pcs/55 h 25 pcs/96 h	231pcs/96h (53 h)
Temperature cycle test	Trial calculation by **AEC-Q100** mission profile	15 years ΔT = 76 °C 54 750 cycles (10 cycles/day)	Au wire fracture m = 4 n = 4 – 55 °C/150 °C	n = 4 – 55 °C/150 °C	$\alpha_{\Delta T} = \left(\Delta T_2 \div \Delta T_1\right)^n$	$\alpha_{\Delta T} = \left(\Delta T_2 \div \Delta T_1\right)^n$	2 634 pcs/ 1 000 cycles 231 pcs/ 1 838 cycles	231 pcs/1 000 h (1 034 cycles)

Bibliography

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

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests: Test Db: Damp heat cyclic (12 h + 12 h cycle)*

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

JEITA EDR-4704A, *Application Guide of the Accelerated Life Test for Semiconductor Devices, Japan Electronics and Information Technology Industries Association (JEITA), 2007*

JEDEC JESD94A, *Application Specific Qualification Using Knowledge Based Test Methodology, 2007*

JEDEC JEP122, *Failure Mechanisms and Models for Semiconductor Devices*

JP001, *Joint publication. foundry process. qualification guidelines. (Wafer Fabrication Manufacturing Sites)*

IECQ (Parts 01-03), *IEC Quality Assessment System for Electronic Components (IECQ System)*

JEDEC JESD74, *Early Life Failure Rate Calculation*

JEITA EDR-4705, *Report on Failure Mechanism of LSI and Reliability Test Method*

JEDEC JESD47, *Failure mechanism based stress test qualification for integrated circuits*

JEDEC JEP122, *Failure Mechanisms and Models for Semiconductor Devices*

JEDEC JESD85, *Calculating Failure Rates in Units of FITS*

JEITA EDR-4708, *Guideline for LSI Reliability Qualification Plan*

AEC Q100*, Stress Test Qualification for Integrated Circuits*

JEITA ED-4701/002 *Procedure of the test time and the sample size determination for the life tests*

_____

SOMMAIRE

AVANT-PROPOS 17
1 Domaine d'application 19
2 Références normatives 19
3 Termes et définitions 19
4 Profil de mission 20
4.1 Concept de profil de mission 20
4.2 Exemple de plan d'essai de fiabilité prenant en considération le profil de mission de l'application automobile des périphériques du moteur (1) 20
4.3 Exemple de plan d'essai de fiabilité prenant en considération le profil de mission de l'application automobile des périphériques du moteur (2) 22
4.4 Exemple de plan d'essai de fiabilité prenant en considération le profil de mission de l'application automobile des périphériques de la cabine 24
5 Exemples de calcul de profils de mission (Calcul de l'échantillon et de la durée d'essai des essais de durée de vie) 25
Bibliographie 30

Figure 1 – Exemple de profil de mission pour une application automobile 20

Tableau 1 – Exemple de calcul d'approximation de la durée équivalente dans le cadre de l'essai de durée de vie en fonctionnement, prenant en considération le profil de mission (Application automobile dans le périphérique du moteur) 21
Tableau 2 – Exemple de calcul d'approximation du nombre d'échantillons/de la durée de l'essai de durée de vie en fonctionnement, prenant en considération le profil de mission (Application automobile dans le périphérique du moteur) 22
Tableau 3 – Exemple de calcul d'approximation de la durée équivalente dans le cadre de l'essai de durée de vie en fonctionnement, prenant en considération le profil de mission (Application automobile dans le périphérique du moteur) 23
Tableau 4 – Exemple de calcul d'approximation de la durée équivalente dans le cadre de l'essai de durée de vie en fonctionnement, prenant en considération le profil de mission (Application automobile dans le périphérique du moteur) 23
Tableau 5 – Exemple de calcul d'approximation de la durée équivalente dans le cadre de l'essai de durée de vie en fonctionnement, prenant en considération le profil de mission (Application automobile dans le périphérique de la cabine) 24
Tableau 6 – Exemple de calcul d'approximation du nombre d'échantillons/de la durée de l'essai de durée de vie en fonctionnement à haute température, prenant en considération le profil de mission (Application automobile dans le périphérique de la cabine) 25
Tableau 7 – Exemples de calcul de profils de mission (Calcul de l'échantillon et de la durée d'essai des essais de durée de vie) 26
Tableau 8 – Exemples de calcul de profils de mission (Calcul de l'échantillon et de la durée d'essai des essais de durée de vie) 28

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

_____

DISPOSITIFS À SEMICONDUCTEURS – LIGNES DIRECTRICES CONCERNANT LES PLANS DE QUALIFICATION DE LA FIABILITÉ –

Partie 2: Concept de profil de mission

AVANT-PROPOS

1) La Commission Électrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

L'IEC 63287 Partie 2 a été établie par le comité d'études 47 de l'IEC: Dispositifs à semiconducteurs. Il s'agit d'une Norme internationale.

Le texte de cette Norme internationale est issu des documents suivants :

Projet	Rapport de vote
47/2796/FDIS	47/2803/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Cette Norme internationale doit être lue conjointement avec l'IEC 63287-1.

Une liste de toutes les parties de la série IEC 63287, publiées sous le titre général *Dispositifs à semiconducteurs*, se trouve sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de ce document indique qu'il contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer ce document en utilisant une imprimante couleur.

DISPOSITIFS À SEMICONDUCTEURS – LIGNES DIRECTRICES CONCERNANT LES PLANS DE QUALIFICATION DE LA FIABILITÉ –

Partie 2: Concept de profil de mission

1 Domaine d'application

La présente partie de l'IEC 63287 fournit des lignes directrices pour l'élaboration de plans de qualification de la fiabilité à l'aide du concept de profil de mission, sur la base des conditions environnementales et de l'utilisation prévue du produit. Le présent document n'est pas destiné aux applications militaires et spatiales.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 63287-1:2021, *Dispositifs à semiconducteurs – Lignes directrices génériques concernant la qualification des semiconducteurs – Partie 1: Lignes directrices concernant la qualification de la fiabilité des circuits intégrés*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

3.1
mode de défaillance
classification du style d'un phénomène de défaut qui provoque la défaillance d'un produit

Note 1 à l'article: Une coupure de l'alimentation, un court-circuit, une perte occasionnelle, l'abrasion, la dégradation de caractéristiques, etc. sont des éléments types considérés comme des modes de défaillance.