

STN	Polovodičové zariadenia Všeobecné pokyny pre kvalifikáciu polovodičov Časť 1: Pokyny pre kvalifikáciu spoľahlivosti IC	STN EN IEC 63287-1 35 8779
------------	---	--

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

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 12/21

Obsahuje: EN IEC 63287-1:2021, IEC 63287-1:2021

133972

EUROPEAN STANDARD

EN IEC 63287-1

NORME EUROPÉENNE

EUROPÄISCHE NORM

October 2021

ICS 31.080.01

English Version

Semiconductor devices - Generic semiconductor qualification guidelines - Part 1: Guidelines for IC reliability qualification (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 (IEC 63287-1:2021)

Halbleiterbauelemente - Allgemeine Leitlinien für die Qualifikation von Halbleitern - Teil 1: Leitlinien für die IC-Zuverlässigkeitsqualifikation (IEC 63287-1:2021)

This European Standard was approved by CENELEC on 2021-09-29. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 63287-1:2021 (E)

European foreword

The text of document 47/2703/FDIS, future edition 1 of IEC 63287-1, prepared by IEC/TC 47 "Semiconductor devices" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 63287-1:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2022-06-29
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-09-29

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 63287-1:2021 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068-2-1 NOTE Harmonized as EN 60068-2-1

IEC 60068-2-30 NOTE Harmonized as EN 60068-2-30

IEC 60749-11 NOTE Harmonized as EN 60749-11

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60749-5	-	Semiconductor devices - Mechanical and climatic test methods - Part 5: Steady-state temperature humidity bias life test	EN 60749-5	-
IEC 60749-6	-	Semiconductor devices - Mechanical and climatic test methods - Part 6: Storage at high temperature	EN 60749-6	-
IEC 60749-15	-	Semiconductor devices - Mechanical and climatic test methods - Part 15: Resistance to soldering temperature for through-hole mounted devices	EN IEC 60749-15	-
IEC 60749-20	-	Semiconductor devices - Mechanical and climatic test methods - Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat	EN IEC 60749-20	-
IEC 60749-21	-	Semiconductor devices - Mechanical and climatic test methods - Part 21: Solderability	EN 60749-21	-
IEC 60749-23	-	Semiconductor devices - Mechanical and climatic test methods - Part 23: High temperature operating life	EN 60749-23	-
IEC 60749-25	-	Semiconductor devices - Mechanical and climatic test methods - Part 25: Temperature cycling	EN 60749-25	-
IEC 60749-26	-	Semiconductor devices - Mechanical and climatic test methods - Part 26: Electrostatic discharge (ESD) sensitivity testing - Human body model (HBM)	EN IEC 60749-26	-
IEC 60749-28	-	Semiconductor devices - Mechanical and climatic test methods - Part 28: Electrostatic discharge (ESD) sensitivity testing - Charged device model (CDM) - device level	EN 60749-28	-
IEC 60749-29	-	Semiconductor devices - Mechanical and climatic test methods - Part 29: Latch-up test	EN 60749-29	-

EN IEC 63287-1:2021 (E)

IEC 60749-42 - Semiconductor devices - Mechanical andEN 60749-42 -
climatic test methods - Part 42:
Temperature and humidity storage



IEC 63287-1

Edition 1.0 2021-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Semiconductor devices – Generic semiconductor qualification guidelines –
Part 1: Guidelines for IC reliability qualification**

**Dispositifs à semiconducteurs – Lignes directrices génériques concernant la
qualification des semiconducteurs –
Partie 1: Lignes directrices concernant la qualification de la fiabilité des circuits
intégrés**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2021 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 Central Office
3, rue de Varembe
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 online collection - oc.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 22 000 terminological entries in English and French, with equivalent terms in 18 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 online collection - oc.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 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 63287-1

Edition 1.0 2021-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Semiconductor devices – Generic semiconductor qualification guidelines –
Part 1: Guidelines for IC reliability qualification**

**Dispositifs à semiconducteurs – Lignes directrices génériques concernant la
qualification des semiconducteurs –
Partie 1: Lignes directrices concernant la qualification de la fiabilité des circuits
intégrés**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.080.01

ISBN 978-2-8322-1017-2

**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.**

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Product categories and applications	8
5 Failure.....	9
5.1 Failure distribution	9
5.2 Early failure	10
5.2.1 Description	10
5.2.2 Early failure rate	11
5.2.3 Screening	15
5.3 Random failure	17
5.3.1 Description	17
5.3.2 Mean failure rate	18
5.4 Wear-out failure	21
5.4.1 Description	21
5.4.2 Wear-out failure rate.....	21
6 Reliability test.....	24
6.1 Reliability test description	24
6.2 Reliability test plan	24
6.2.1 Procedures for creating a reliability test plan	24
6.2.2 Estimation of the test time required to confirm the TDDB from the number of test samples	27
6.2.3 Estimation of the number of samples required to confirm the TDDB from the test time.....	28
6.3 Reliability test methods.....	29
6.4 Acceleration models for reliability tests	33
6.4.1 Arrhenius model	33
6.4.2 V-model.....	33
6.4.3 Absolute water vapor pressure model	33
6.4.4 Coffin-Manson model.....	33
6.5 Concept of family	34
6.5.1 General	34
6.5.2 Conducting life test using family	34
6.5.3 Verification of early failure rate using family	37
7 Stress test methods.....	39
8 Supplementary tests	40
9 Summary table of assumptions	40
10 Summary	42
Bibliography.....	43
Figure 1 – Bathtub curve.....	10
Figure 2 – Failure process of IC manufacturing lots during the early failure period.....	11
Figure 3 – Weibull conceptual diagram of the early failure rate	12

Figure 4 – Example of a failure ratio: α (in hundreds) and the number of failures for CL of 60 %	14
Figure 5 – Screening and estimated early fail rate in Weibull diagram.....	16
Figure 6 – Bathtub curve setting the point immediately after production as the origin.....	17
Figure 7 – Bathtub curve setting the point after screening as the origin.....	17
Figure 8 – Conceptual diagram of calculation method for the mean failure rate from the exponential distribution	18
Figure 9 – Conceptual diagram of calculation method for the mean failure rate as an extension of early failure	19
Figure 10 – Conceptual diagram of the wear-out failure	21
Figure 11 – Conceptual diagram describing the concept of the acceleration test.....	22
Figure 12 – Concept of the reliability test in a Weibull diagram (based on sample size)	26
Figure 13 – Concept of the reliability test in a Weibull diagram (based on test time)	29
Figure 14 – Difference in sampling sizes according to the m value (image)	30
Figure 15 – How the screening defect rate is seen depending on the difference of chip size (example)	37
Table 1 – Examples of product categories.....	9
Table 2 – Cumulative failure probability 0,1 % over 10 years [$\times 10^{-6}$] for the third, fifth and seventh years	26
Table 3 – Major reliability (life) test methods and purposes.....	31
Table 4 – Examples of the number of test samples and the test time in typical reliability (life) test methods	32
Table 5 – Concept of family (example).....	34
Table 6 – Concept of difference/failure mechanism/corresponding test item (examples).....	36
Table 7 – Factors for calculation examples of early failure rate using family data.....	38
Table 8 – LTPD sampling table for acceptance number $A_c = 0$	39
Table 9 – Major reliability (strength) test methods and purposes.....	39
Table 10 – Supplementary tests.....	40
Table 11 – Accelerating factors, calculation formulae and numerical values ^a	41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES – GENERIC SEMICONDUCTOR QUALIFICATION GUIDELINES –

Part 1: Guidelines for IC reliability qualification

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.

International Standard IEC 63287-1 has been prepared by IEC technical committee 47: Semiconductor devices.

This first edition of IEC 63287-1 cancels and replaces the first edition of IEC 60749-43 published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the document has been renamed and renumbered to distinguish it from the IEC 60749 (all parts);
- b) a new section concerning the concept of "family" has been added with appropriate renumbering of the existing text.

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

DRAFT	Report on voting
47/2703/FDIS	47/2720/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.

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 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

This document provides guidelines for semiconductor IC vendors in the preparation of detailed reliability test plans for device qualification. Such plans are intended to be prepared before commencing qualification tests and after consultation with the user of their semiconductor integrated circuit product.

The guideline gives some examples for creating reliability qualification test plans to determine appropriate reliability test conditions based on the use conditions and requirements for each application of semiconductor integrated circuits. Categories are set for automotive applications and for general applications as a target of reliability. The grade for automotive use is further classified into two grades according to applications. The guideline assumes annual operating hours, useful life, etc. for each grade, and defines the verification methods for early failure rate and wear-out failure to propose appropriate reliability tests, and at the same time, presents concepts to properly ensure the quality of semiconductor integrated circuits using screening techniques which are designed to reduce the early failure rate.

The test conditions and the values of acceleration factors presented in this guideline are shown to provide examples of calculations for obtaining reliability test conditions in order to verify the required quality standards and are not designed to define the standards to ensure reliability of semiconductor integrated circuits.

NOTE Qualification tests are tests in which the semiconductor vendor takes account of the reliability required by its product users.

SEMICONDUCTOR DEVICES – GENERIC SEMICONDUCTOR QUALIFICATION GUIDELINES –

Part 1: Guidelines for IC reliability qualification

1 Scope

This part of IEC 63287 gives guidelines for reliability qualification plans of semiconductor integrated circuit products. This document is not intended for military- and space-related applications.

NOTE 1 The manufacturer can use flexible sample sizes to reduce cost and maintain reasonable reliability by this guideline adaptation based on EDR-4708, AEC Q100, JESD47 or other relevant document can also be applicable if it is specified.

NOTE 2 The Weibull distribution method used in this document is one of several methods to calculate the appropriate sample size and test conditions of a given reliability project.

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 60749-5, *Semiconductor devices – Mechanical and climatic test methods – Part 5: Steady-state temperature humidity bias life test*

IEC 60749-6, *Semiconductor devices – Mechanical and climatic test methods – Part 6: Storage at high temperature*

IEC 60749-15, *Semiconductor devices – Mechanical and climatic test methods – Part 15: Resistance to soldering temperature for through-hole mounted devices*

IEC 60749-20, *Semiconductor devices – Mechanical and climatic test methods – Part 20: Resistance of plastic encapsulated SMDs to the combined effect of moisture and soldering heat*

IEC 60749-21, *Semiconductor devices – Mechanical and climatic test methods – Part 21: Solderability*

IEC 60749-23, *Semiconductor devices – Mechanical and climatic test methods – Part 23: High temperature operating life*

IEC 60749-25, *Semiconductor devices – Mechanical and climatic test methods – Part 25: Temperature cycling*

IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*

IEC 60749-28, *Semiconductor devices – Mechanical and climatic test methods – Part 28: Electrostatic discharge (ESD) sensitivity testing – Charged device model (CDM) – Device level*

IEC 60749-29, *Semiconductor devices – Mechanical and climatic test methods – Part 29: Latch-up test*

IEC 60749-42, *Semiconductor devices – Mechanical and climatic test methods – Part 42: Temperature and humidity*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN