

STN	Polovodičové súčiastky Mechanické a klimatické skúšobné metódy Časť 34-1: Skúška cyklického zaťaženia výkonových polovodičových modulov	STN EN IEC 60749-34-1 35 8799
------------	--	---

Semiconductor devices - Mechanical and climatic test methods - Part 34-1: Power cycling test for power semiconductor module

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. 10/25

Obsahuje: EN IEC 60749-34-1:2025, IEC 60749-34-1:2025

141257

Úrad pre normalizáciu, metrológiu a skúšobníctvo Slovenskej republiky, 2025

Slovenská technická norma a technická normalizačná informácia je chránená zákonom č. 60/2018 Z. z. o technickej normalizácii v znení neskorších predpisov.

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN IEC 60749-34-1

August 2025

ICS 31.080.01

English Version

**Semiconductor devices - Mechanical and climatic test methods -
Part 34-1: Power cycling test for power semiconductor module
(IEC 60749-34-1:2025)**

Dispositifs à semiconducteurs - Méthodes d'essais
mécaniques et climatiques - Partie 34-1: Essai de cycles en
puissance pour modules de puissance à semiconducteurs
(IEC 60749-34-1:2025)

Halbleiterbauelemente - Mechanische und klimatische
Prüfverfahren - Teil 34-1: Leistungszyklusprüfung für
Leistungshalbleitermodule
(IEC 60749-34-1:2025)

This European Standard was approved by CENELEC on 2025-07-25. 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, Türkiye 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 60749-34-1:2025 (E)**European foreword**

The text of document 47/2902/FDIS, future edition 1 of IEC 60749-34-1, prepared by TC 47 "Semiconductor devices" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60749-34-1:2025.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2026-08-31 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2028-08-31 document have to be withdrawn

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 60749-34-1:2025 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 standard indicated:

IEC 60747 (series) NOTE Approved as EN IEC 60747 (series)

IEC 60747-15:2024 NOTE Approved as EN IEC 60747-15:2024 (not modified)

IEC 60749 (series) NOTE Approved as EN 60749 (series)

IEC 60749-23 NOTE Approved as EN 60749-23

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.cencenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60191-4	-	Mechanical standardization of semiconductor devices - Part 4: Coding system and classification into forms of package outlines for semiconductor device packages	EN 60191-4	-
IEC 60747-2	2016	Semiconductor devices - Part 2: Discrete devices - Rectifier diodes	-	-
IEC 60747-6	2016	Semiconductor devices - Part 6: Discrete devices - Thyristors	-	-
IEC 60747-8	2010	Semiconductor devices - Discrete devices - Part 8: Field-effect transistors	-	-
+ A1	2021			
IEC 60747-9	2019	Semiconductor devices - Part 9: Discrete devices - Insulated-gate bipolar transistors (IGBTs)	-	-
IEC 60749-34	-	Semiconductor devices - Mechanical and climatic test methods - Part 34: Power cycling	EN 60749-34	-



IEC 60749-34-1

Edition 1.0 2025-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Semiconductor devices - Mechanical and climatic test methods -
Part 34-1: Power cycling test for power semiconductor module**

**Dispositifs à semiconducteurs - Méthodes d'essais mécaniques et climatiques -
Partie 34-1: Essai de cycles en puissance pour modules de puissance à
semiconducteurs**

**THIS PUBLICATION IS COPYRIGHT PROTECTED****Copyright © 2025 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 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 Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. 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 22 500 terminological entries in English and French, with equivalent terms in 25 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, symboles graphiques et le glossaire. 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 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

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.**

IEC 60749-34-1:2025 © IEC 2025

CONTENTS

FOREWORD	3
INTRODUCTION	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	6
4 Test apparatus and structure of DUT	8
5 Procedure	12
5.1 General	12
5.2 Determination of $T_{vj(min)}$, $T_{vj(max)}$ and $R_{th(j-c)}$	15
5.2.1 General	15
5.2.2 Real-time temperature measurement	15
5.2.3 Temperature calculation method	17
6 Test conditions	17
6.1 General	17
6.2 Power cycling test (short-time test)	18
6.3 Power cycling test (long-time test)	18
6.4 Test conditions and objectives	19
6.4.1 Certification test	19
6.4.2 Lifetime model validation test	19
7 Measurements	20
8 Failure criteria	20
Annex A (informative) Estimation of the power cycling capability	22
A.1 Simple Weibull regression method (the "mean of m method")	22
A.1.1 General	22
A.1.2 Improve estimation accuracy under small sample size conditions	22
A.1.3 Lifetime estimation using the "mean of m method"	22
A.1.4 Estimation of the power cycling capability	23
A.2 Least square regression method	24
Bibliography	28
Figure 1 – Example of the basic structure of a power semiconductor module (schematic diagram) (case type module for industrial use)	9
Figure 2 – A basic test circuit for the power cycling test (for IGBT module)	9
Figure 3 – A basic test circuit for power MOSFET module	11
Figure 4 – A basic test circuit for diode module	11
Figure 5 – A basic test circuit for thyristor module	12
Figure 6 – A basic circuit of 6-in-1 IGBT module	13
Figure 7 – Temperature change profile and on/off cycle of the power cycling test (short-time)	14
Figure 8 – Temperature change profile and on/off cycle of the power cycling test (long- time)	15
Figure A.1 – Lifetime estimation by the mean of m method	23
Figure A.2 – Power cycling capability in the power cycling test (short-time)	23
Figure A.3 – Power cycling capability in the power cycling test (long-time)	24

IEC 60749-34-1:2025 © IEC 2025

Figure A.4 – Power cycling tests at a minimum of 2 ΔT conditions	26
Figure A.5 – Curve fitting by the regression analysis and determination of the parameter of the lifetime model.....	26
Figure A.6 – Normalization of the number of cycles to one ΔT_{norm} and T_{norm} by the $N_f = f(\Delta T, T)$ -model	26
Figure A.7 – Fit procedure for the Weibull graph for the normalized cycle numbers	26
Figure A.8 – Deduction of the lifetime curve for the product that crosses the specified failure rate percentage x	27
Table 1 – Test conditions	18
Table 2 – Failure criteria for long-time and short-time tests.....	21
Table A.1 – The sample size N for power cycling tests	22

IEC 60749-34-1:2025 © IEC 2025

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Semiconductor devices - Mechanical and climatic test methods -
Part 34-1: Power cycling test for power semiconductor module**

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch> [and/or] www.iso.org/patents. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60749-34-1 has been prepared by subcommittee IEC technical committee TC 47: Semiconductor devices. It is an International Standard.

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

Draft	Report on voting
47/2902/FDIS	47/2924/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.

IEC 60749-34-1:2025 © IEC 2025

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, and the ISO/IEC Directives available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60749 series, published under the general title *Semiconductor devices – Mechanical and climatic test methods*, 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, or
- revised.

IEC 60749-34-1:2025 © IEC 2025

INTRODUCTION

A power semiconductor module is affected by thermal and mechanical stress due to the power dissipation of the internal semiconductor dies and connectors. This occurs when low-voltage operating bias for forward conduction is periodically applied and removed, causing rapid changes in temperature. The power cycling test is intended to simulate the temperature swing in typical power electronics applications, which is different from the stable temperatures reached under the high temperature operating life (HTOL) test as shown in IEC 60749-23. Exposure to the power cycling test would not induce the same failure mechanisms as exposure to the thermal cycling test, or thermal shock test. The power cycling test is a destructive test that will cause wear-out failure of the device under test (DUT) if it is driven above the specification of the device.

The power cycling test is applied to general power semiconductor modules such as for example those used for motor control, robots, and renewable energy generation. The power cycling test has two modes: a short-time test (based on a short cycle time) that simulates rapid acceleration and deceleration of the equipment, and a long-time test (based on a long cycle time) that simulates repeated operation and stop of the equipment. The short-time test mainly verifies the effect of the temperature change of virtual junction temperature (T_{vj}) and causes the deterioration of the joint between the semiconductor die and the wire, and that of the die attach under the semiconductor die. The long-time test verifies the effect of the temperature change of case temperature (T_c) and causes the deterioration of the joining layer between the metallic base plate and the insulating substrate, and the deterioration of the die attach under the semiconductor die.

The power cycling test is performed in two cases: as a certification test for the products whose power cycling lifetime model has already been confirmed, and as a lifetime model validation test for the products whose lifetime model has not been confirmed. The purpose of the certification test is to verify that the product has a longer life than the specified number of cycles.

Moreover, the purpose of the lifetime model validation test is to statistically estimate the power cycling lifetime model from the test results and obtain the expected lifetime model of power modules. This is essential when customers design the lifetime of their products.

1 Scope

This part of IEC 60749 describes a test method that is used to determine the capability of power semiconductor modules to withstand thermal and mechanical stress resulting from cycling the power dissipation of the internal semiconductors and the internal connectors. It is based on IEC 60749-34, but is developed specifically for power semiconductor module products, including insulated-gate bipolar transistor (IGBT), metal-oxide-semiconductor field-effect transistor (MOSFET), diode and thyristor.

If there is a customer request for an individual use or an application specific guideline (for example ECPE Guideline AQG 324), details of the test method can be based on these requirements if they deviate from the content of this document.

This test causes wear-out and is considered destructive.

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 60191-4, *Mechanical standardization of semiconductor devices – Part 4: Coding system and classification into forms of package outlines for semiconductor device packages*

IEC 60747-2:2016, *Semiconductor devices – Part 2: Discrete devices – Rectifier diodes*

IEC 60747-6:2016, *Semiconductor devices – Part 6: Discrete devices – Thyristors*

IEC 60747-8:2010, *Semiconductor devices – Discrete devices – Part 8: Field-effect transistors*
IEC 60747-8:2010/AMD1:2021

IEC 60747-9:2019, *Semiconductor devices – Part 9: Discrete devices – Insulated-gate bipolar transistors (IGBTs)*

IEC 60749-34, *Semiconductor devices – Mechanical and climatic test methods – Part 34: Power cycling*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN