

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Semiconductor devices – Mechanical and climatic test methods –
Part 27: Electrostatic discharge (ESD) sensitivity testing – Machine model (MM)**

**Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques –
Partie 27: Essai de sensibilité aux décharges électrostatiques (DES) – Modèle de
machine (MM)**

[IEC 60749-27:2006](https://standards.iteh.ai/)

<https://standards.iteh.ai/catalog/standards/iec/fb1a1218-13a8-4e72-aa68-705d5ba699fe/iec-60749-27-2006>



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2012 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 la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you 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 on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

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: csc@iec.ch.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI 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.

Just Published CEI - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

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



IEC 60749-27

Edition 2.1 2012-09
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Semiconductor devices – Mechanical and climatic test methods –
Part 27: Electrostatic discharge (ESD) sensitivity testing – Machine model (MM)**

**Dispositifs à semiconducteurs – Méthodes d'essais mécaniques et climatiques –
Partie 27: Essai de sensibilité aux décharges électrostatiques (DES) – Modèle
de machine (MM)**

IEC 60749-27:2006

<https://standards.iteh.ai/catalog/standards/iec/fb1a1218-13a8-4e72-aa68-705d5ba699fe/iec-60749-27-2006>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.080.01

ISBN 978-2-8322-0407-8

**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.....	3
1 Scope.....	5
2 Normative references	5
3 Terms and definitions	5
4 Equipment.....	6
4.1 MM ESD waveform generator	6
4.2 Waveform verification equipment.....	6
5 MM current waveform requirements.....	7
5.1 General.....	7
5.2 Waveform qualification and verification	10
5.3 Extra consideration for waveform specifications	9
6 Device specific evaluation considerations.....	10
6.1 Sample size and test conditions	10
6.2 Worst-case pin or standard qualification board	10
7 Classification procedure	11
7.1 Device requirements	11
7.2 Device selection	11
7.3 Device characterization	11
7.4 Device stress levels	11
7.5 Pin combinations.....	12
7.6 Order of test.....	12
8 Failure criteria	12
9 Classification criteria	12
10 Summary.....	13
Figure 1 – MM ESD waveform generator equivalent.....	7
Figure 2 – Typical current waveform through a shorting wire.....	8
Figure 3 – Typical current waveform through a 500 Ω resistor.....	9
Table 1 – Waveform specification	8
Table 2 – Pin combinations for integrated circuits	12

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SEMICONDUCTOR DEVICES –
MECHANICAL AND CLIMATIC TEST METHODS –****Part 27: Electrostatic discharge (ESD) sensitivity testing –
Machine model (MM)**

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.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60749-27 edition 2.1 contains the second edition (2006) [documents 47/1861/FDIS and 47/1873/RVD] and its amendment 1 (2012) [documents 47/2135/FDIS and 47/2144/RVD].

A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 60749-27 has been prepared by IEC technical committee 47: Semiconductor devices.

This second edition cancels and replaces the first edition, published in 2003, and has been revised in collaboration with technical committee 101. Whilst it does not contain any major technical changes, reference is now made, where necessary, to IEC 61340-3-2.

A list of all parts of IEC 60749 series, 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 the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

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 publication using a colour printer.

<https://standards.iteh.ai>
Document Preview

[IEC 60749-27:2006](https://standards.iteh.ai/catalog/standards/iec/fb1a1218-13a8-4e72-aa68-705d5ba699fe/iec-60749-27-2006)

<https://standards.iteh.ai/catalog/standards/iec/fb1a1218-13a8-4e72-aa68-705d5ba699fe/iec-60749-27-2006>

SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

Part 27: Electrostatic discharge (ESD) sensitivity testing – Machine model (MM)

1 Scope

This part of IEC 60749 establishes a standard procedure for testing and classifying semiconductor devices according to their susceptibility to damage or degradation by exposure to a defined machine model (MM) electrostatic discharge (ESD). It may be used as an alternative test method to the human body model ESD test method. The objective is to provide reliable, repeatable ESD test results so that accurate classifications can be performed.

This test method is applicable to all semiconductor devices and is classified as destructive.

ESD testing of semiconductor devices is selected from this test method, the human body model (HBM – see IEC 60749-26) or other test methods in the IEC 60749 series. The MM and HBM test methods produce similar but not identical results. Unless otherwise specified, the HBM test method is the one selected.

NOTE 1 This test method does not truly simulate discharge from real machines or metallic tools because the test method uses high parasitic inductance of the test circuit, whereas real machines and metallic tools, whose discharge rise time is approximately 100 ps, have no inductance.

NOTE 2 Certain clauses in this test method are in accordance with IEC 61340-3-2.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61340-3-2, *Electrostatics – Part 3-2: Methods for simulation of electrostatic effects – Machine model (MM – Component testing) electrostatic discharge test waveforms*

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

3 Terms and definitions

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

3.1

device under test

DUT

semiconductor product subjected to MM ESD test

3.2

DUT failure

condition in which a DUT does not meet one or more specified parameters as a result of ESD test

3.3

ESD withstand voltage

maximum applied ESD voltage level that does not cause failure parameter limits to be exceeded provided that all DUTs stressed at lower levels have also passed

NOTE Clause 3 of this test method is in accordance with IEC 61340-3-2 except for the specific reference to devices.

3.4

ringing

noise component caused by a large inductance in the discharge circuit

4 Equipment

4.1 MM ESD waveform generator

This equipment produces an electrostatic discharge current pulse simulating a MM ESD event for application to the DUT. The equivalent waveform generator circuit and tester evaluation loads are illustrated in Figure 1.

4.2 Waveform verification equipment

4.2.1 General

Equipment capable of verifying the MM current waveform is defined in this standard. This equipment includes but is not limited to a waveform recording system, a high voltage resistor and a current transducer.

4.2.2 Waveform recording system

The waveform recording system shall have a minimum single shot bandwidth of 350 MHz.

4.2.3 Evaluation loads

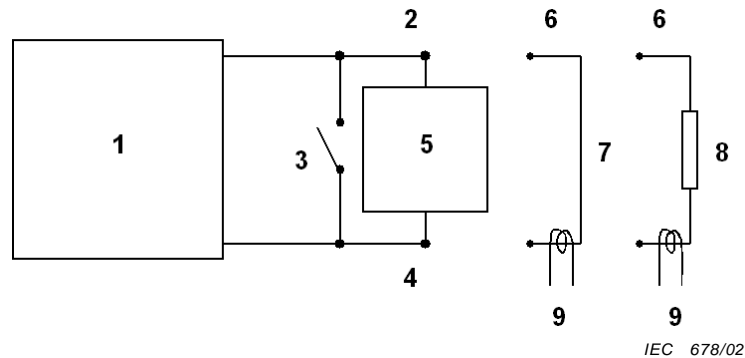
Two evaluation loads are necessary to verify the functionality of the waveform generator:

- a) load 1: a shorting wire;
- b) load 2: a 500 Ω with a tolerance of ± 1 % low inductance resistor appropriate rated for the voltages that will be used for waveform qualification.

The lead length of the evaluation loads (shorting wire or resistor) shall be as short as possible consistent with connecting the evaluation load to the appropriate reference terminals (A and B in Figure 1) while passing through the current transducer.

4.2.4 Current transducer

The current transducer shall have a minimum bandwidth of 350 MHz.

**Key**

- 1 MM ESD waveform generator (nominally 200 pF)
- 2 Terminal A
- 3 Switch
- 4 Terminal B
- 5 DUT
- 6 Evaluation load
- 7 Shorting wire
- 8 Resistance $R = 500 \Omega$
- 9 Current transducer

Figure 1 – MM ESD waveform generator equivalent

Requirements for Figure 1:

1. The evaluation loads (7 and 8) are specified in 4.2.3.
2. The current transducer (9) is specified in 4.2.4.
3. The reversal of terminals A (2) and B (4) to achieve dual polarity is not permitted.
4. The switch (3) is closed 10 ms to 100 ms after the pulse delivery period of each single MM pulse to ensure that the DUT and any test fixture are not left in a charged state.

NOTE 1 The performance of the waveform generator is strongly influenced by parasitic capacitance and inductance.

NOTE 2 Precautions must be taken in the design of the waveform generator to avoid recharge transients and double pulses.

NOTE 3 A resistance in series with the switch would ensure a slow discharge of the DUT.

NOTE 4 Clause 4 of this test method is in accordance with IEC 61340-3-2 except for the specific reference to devices.

5 MM current waveform requirements

5.1 General

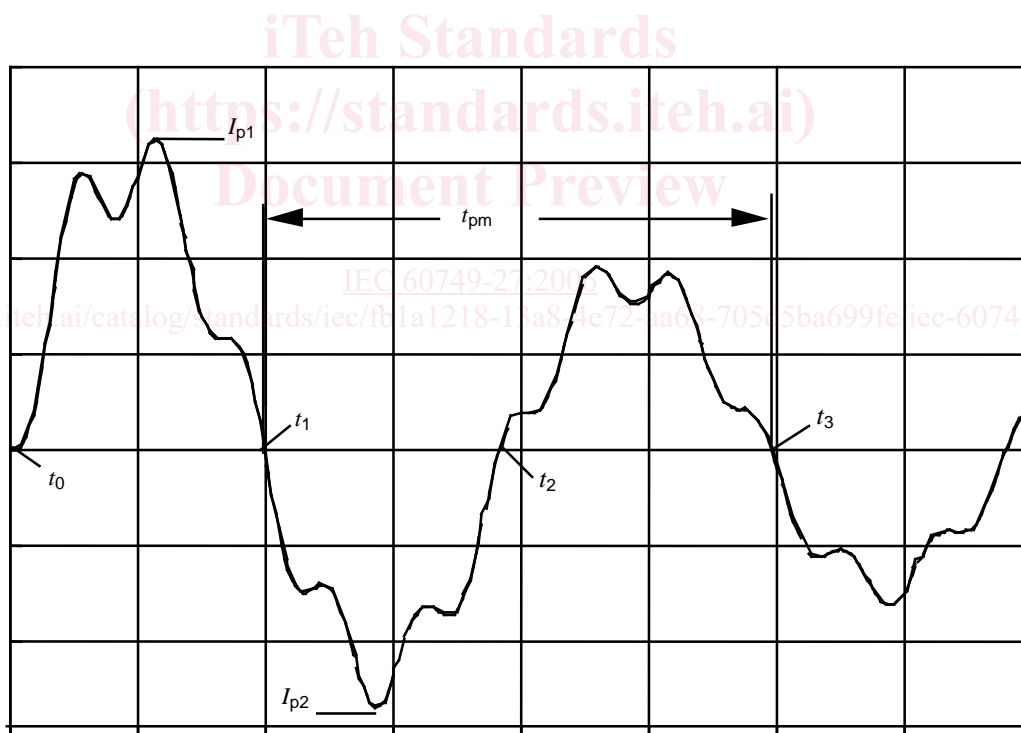
Prior to DUT testing, MM ESD waveform generator qualification shall ensure waveform integrity of the discharge current through both a shorting wire and a resistive load. The shorting wire waveform requirements are specified in Figure 2 for all positive and negative voltages defined in Table 1, while the resistive load waveform requirements for $\pm 400 \text{ V}$ are shown in Figure 3 and Table 1.

Table 1 – Waveform specification

Level	Equivalent voltage V	I_{p1} peak current through a shorting wire A ($\pm 15\%$)	I_{PR} peak current through a 500 Ω resistor A	I_{100} current through a 500 Ω resistor at 100 ns A ($\pm 15\%$)
1	100	1,7	-	-
2	200	3,5	-	-
3	400	7,0	$< I_{100} \times 4,5$	0,29
4	800	14,0	-	-

Level	Equivalent voltage V	I_{p1} peak current through a shorting wire A ($\pm 15\%$) ^a	I_{PR} peak current through a 500 Ω resistor A	I_{100} current through a 500 Ω resistor at 100 ns A ($\pm 15\%$)
1	100	1,7 (1,5)	-	-
2	200	3,5 (3,0)	-	-
3	400	7,0 (6,0)	$< I_{100} \times 4,5$	0,29
4	800	14,0 (12,0)	-	-

^a Values in parentheses are the peak current value without ringing.



20 ns per division

IEC 682/02

Figure 2 – Typical current waveform through a shorting wire

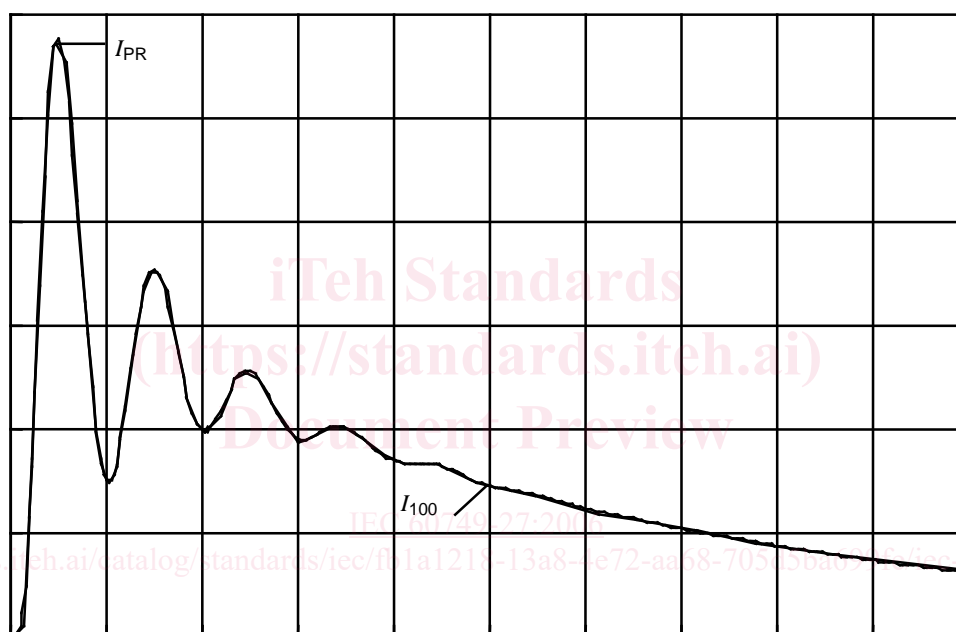
Requirements for Figure 2:

The current pulse shall meet the following requirements:

I_{p1} is the maximum peak current is specified in Table 1;

I_{p2} is the second peak current shall be between 67 % and 90 % of the absolute value obtained for I_{p1} for each level;

t_{pm} is the period of the major pulse shall be between 63 ns and 91 ns. The measurement shall be made between the first zero crossing point, t_1 , and the third zero crossing point, t_3 . The inductance (L) which is related to t_{pm} shall be controlled to meet the above specified pulse period. The recommended value is 750 nH.



20 ns per division

IEC 683/02

Figure 3 – Typical current waveform through a 500 Ω resistor

Requirements for Figure 3:

The current pulse through a 500 Ω resistor shall meet the following characteristics:

I_{PR} is the maximum peak current shall be within the range specified in Table 1;

I_{100} is the current at 100 ns is defined in Table 1.

5.3 Extra consideration for waveform specifications

The peak current I_{p1} without ringing shall be verified against the values in Table 1.