

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

**Electromagnetic compatibility (EMC) –  
Part 4-2: Testing and measurement techniques – Electrostatic discharge  
immunity test**

**Compatibilité électromagnétique (CEM) –  
Partie 4-2: Techniques d'essai et de mesure – Essai d'immunité aux décharges  
électrostatiques**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2008 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  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://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.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00

### 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.

- Catalogue des publications de la CEI: [www.iec.ch/searchpub/cur\\_fut-f.htm](http://www.iec.ch/searchpub/cur_fut-f.htm)

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

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

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: [www.iec.ch/webstore/custserv/custserv\\_entry-f.htm](http://www.iec.ch/webstore/custserv/custserv_entry-f.htm)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tél.: +41 22 919 02 11  
Fax: +41 22 919 03 00



# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

BASIC EMC PUBLICATION  
PUBLICATION FONDAMENTALE EN CEM

**Electromagnetic compatibility (EMC) –  
Part 4-2: Testing and measurement techniques – Electrostatic discharge  
immunity test**

**Compatibilité électromagnétique (CEM) –  
Partie 4-2: Techniques d'essai et de mesure – Essai d'immunité aux décharges  
électrostatiques**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE **XB**  
CODE PRIX

ICS 33.100.20

ISBN 2-8318-1019-7

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions.....	8
4 General.....	10
5 Test levels.....	10
6 Test generator.....	10
6.1 General.....	10
6.2 Characteristics and performance of the ESD generator.....	11
6.3 Verification of the ESD setup.....	14
7 Test setup.....	15
7.1 Test equipment.....	15
7.2 Test setup for tests performed in laboratories.....	15
7.2.1 Test requirements.....	15
7.2.2 Table-top equipment.....	16
7.2.3 Floor-standing equipment.....	17
7.2.4 Ungrounded equipment.....	18
7.3 Test setup for post-installation tests.....	22
8 Test procedure.....	23
8.1 Laboratory reference conditions.....	23
8.1.1 Environmental parameters.....	23
8.1.2 Climatic conditions.....	23
8.1.3 Electromagnetic conditions.....	24
8.2 EUT exercising.....	24
8.3 Execution of the test.....	24
8.3.1 Discharges to the EUT.....	24
8.3.2 Direct application of discharges to the EUT.....	24
8.3.3 Indirect application of the discharge.....	26
9 Evaluation of test results.....	27
10 Test report.....	27
Annex A (informative) Explanatory notes.....	28
Annex B (normative) Calibration of the current measurement system and measurement of discharge current.....	33
Annex C (informative) Example of a calibration target meeting the requirements of Annex B.....	39
Annex D (informative) Radiated fields from human metal discharge and ESD generators.....	45
Annex E (informative) Measurement uncertainty (MU) considerations.....	55
Annex F (informative) Variation in test results and escalation strategy.....	62
Bibliography.....	63
Figure 1 – Simplified diagram of the ESD generator.....	11
Figure 2 – Ideal contact discharge current waveform at 4 kV.....	13
Figure 3 – Discharge electrodes of the ESD generator.....	14

Figure 4 – Example of test set-up for table-top equipment, laboratory tests .....	17
Figure 5 – Example of test setup for floor-standing equipment, laboratory tests .....	18
Figure 6 – Example of a test setup for ungrounded table-top equipment .....	20
Figure 7 – Example of a test setup for ungrounded floor-standing equipment.....	21
Figure 8 – Example of test setup for floor-standing equipment, post-installation tests .....	23
Figure A.1 – Maximum values of electrostatic voltages to which operators may be charged while in contact with the materials mentioned in Clause A.2 .....	29
Figure B.1 – Example of a target adapter line attached to current target .....	34
Figure B.2 – Example of a front side of a current target .....	34
Figure B.3 – Example of measurement of the insertion loss of a current target-attenuator-cable chain .....	35
Figure B.4 – Circuit diagram to determine the low-frequency system transfer impedance .....	36
Figure B.5 – Typical arrangement for calibration of ESD generator performance.....	38
Figure C.1 – Mechanical drawing of a coaxial target (drawing 1 of 5).....	40
Figure C.2 – Mechanical drawing of a coaxial target (drawing 2 of 5).....	41
Figure C.3 – Mechanical drawing of a coaxial target (drawing 3 of 5).....	42
Figure C.4 – Mechanical drawing of a coaxial target (drawing 4 of 5).....	43
Figure C.5 – Mechanical drawing of a coaxial target (drawing 5 of 5).....	44
Figure D.1 – Electric field of a real human, holding metal, charged at 5 kV measured at 0,1 m distance and for an arc length of 0,7 mm.....	48
Figure D.2 – Magnetic field of a real human, holding metal, charged at 5 kV, measured at 0,1 m distance and for an arc length of approximately 0,5 mm .....	48
Figure D.3 – Semi-circle loop on the ground plane.....	49
Figure D.4 – Voltages induced in a semi-loop .....	50
Figure D.5 – Example of test setup to measure radiated ESD fields.....	50
Figure D.6 – Comparison between measured (solid line) and calculated numerically (dot line) voltage drop on the loop for a distance of 45 cm .....	52
Figure D.7 – Comparison between calculated $H$ field from measured data (solid line) and $H$ field calculated by numerical simulation (dotted line) for a distance of 45 cm.....	52
Figure D.8 – Structure illuminated by radiated fields and equivalent circuit .....	53
Figure D.9 – Radiated $H$ fields .....	54
Table 1 – Test levels.....	10
Table 2 – General specifications .....	12
Table 3 – Contact discharge current waveform parameters .....	12
Table 4 – Cases for application of ESD on connectors .....	25
Table A.1 – Guideline for the selection of the test levels .....	30
Table B.1 – Contact discharge calibration procedure .....	37
Table E.1 – Example of uncertainty budget for ESD rise time calibration .....	59
Table E.2 – Example of uncertainty budget for ESD peak current calibration .....	60
Table E.3 – Example of uncertainty budget for ESD $I_{30}$ , $I_{60}$ calibration.....	61

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTROMAGNETIC COMPATIBILITY (EMC) –****Part 4-2: Testing and measurement techniques –  
Electrostatic discharge immunity test**

## 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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 61000-4-2 has been prepared by subcommittee 77B: High-frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This second edition cancels and replaces the first edition published in 1995, its amendment 1 (1998) and its amendment 2 (2000) and constitutes a technical revision.

It forms Part 4-2 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

The main changes with respect to the first edition of this standard and its amendments are the following:

- the specifications of the target have been extended up to 4 GHz. An example of target matching these requirements is also provided;

- information on radiated fields from human-metal discharge and from ESD generators is provided;
- measurement uncertainty considerations with examples of uncertainty budgets are given too.

The text of this standard is based on the following documents:

FDIS	Report on voting
77B/574/FDIS	77B/584/RVD

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

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

A list of all parts of the IEC 61000 series, published under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

## INTRODUCTION

IEC 61000-4 is a part of the IEC 61000 series, according to the following structure:

### Part 1: General

General consideration (introduction, fundamental principles)

Definitions, terminology

### Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

### Part 3: Limits

Emission limits

Immunity limits (in so far as they do not fall under the responsibility of the product committees)

### Part 4: Testing and measurement techniques

Measurement techniques

Testing techniques

### Part 5: Installation and mitigation guidelines

Installation guidelines

Mitigation methods and devices

### Part 6: Generic standards

### Part 9: Miscellaneous

Each part is further subdivided into several parts, published either as international standards or as technical specifications or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

This part of IEC 61000 is an International Standard which gives immunity requirements and test procedures related to electrostatic discharge.

## ELECTROMAGNETIC COMPATIBILITY (EMC) –

### Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

#### 1 Scope

This part of IEC 61000 relates to the immunity requirements and test methods for electrical and electronic equipment subjected to static electricity discharges, from operators directly, and from personnel to adjacent objects. It additionally defines ranges of test levels which relate to different environmental and installation conditions and establishes test procedures.

The object of this standard is to establish a common and reproducible basis for evaluating the performance of electrical and electronic equipment when subjected to electrostatic discharges. In addition, it includes electrostatic discharges which may occur from personnel to objects near vital equipment.

This standard defines:

- typical waveform of the discharge current;
- range of test levels;
- test equipment;
- test setup;
- test procedure;
- calibration procedure;
- measurement uncertainty.

This standard gives specifications for test performed in "laboratories" and "post-installation tests" performed on equipment in the final installation.

This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the tests and the severity level to be applied to their equipment.

In order not to impede the task of coordination and standardization, the product committees or users and manufacturers are strongly recommended to consider (in their future work or revision of old standards) the adoption of the relevant immunity tests specified in this standard.

#### 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 60050(161), *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60068-1, *Environmental testing – Part 1: General and guidance*