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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

IEC 61000-4-2:2008

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

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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.
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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*

3 Terms and definitions

For the purposes of this part of IEC 61000, the following terms and definitions apply and are applicable to the restricted field of electrostatic discharge; not all of them are included in IEC 60050(161) [IEV].

3.1
air discharge method
method of testing in which the charged electrode of the test generator is moved towards the EUT until it touches the EUT

3.2
antistatic material
material exhibiting properties which minimize charge generation when rubbed against or separated from the same or other similar materials

3.3
calibration
set of operations which establishes, by reference to standards, the relationship which exists, under specified conditions, between an indication and a result of a measurement

NOTE 1 This term is based on the "uncertainty" approach.

NOTE 2 The relationship between the indications and the results of measurement can be expressed, in principle, by a calibration diagram.

[IEV 311-01-09]

3.4
conformance test
test on a representative sample of the equipment with the objective of determining whether the equipment, as designed and manufactured, can meet the requirements of this standard

3.5
contact discharge method
method of testing in which the electrode of the test generator is kept in contact with the EUT or coupling plane and the discharge is actuated by the discharge switch within the generator

3.6
coupling plane
metal sheet or plate, to which discharges are applied to simulate electrostatic discharge to objects adjacent to the EUT; HCP: Horizontal Coupling Plane; VCP: Vertical Coupling Plane

3.7
degradation (of performance)
undesired departure in the operational performance of any device, equipment or system from its intended performance

NOTE The term "degradation" can apply to temporary or permanent malfunction.

[IEV 161-01-19]

3.8
direct application
application of the discharge directly to the EUT

3.9
electromagnetic compatibility (EMC)
ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[IEV 161-01-07]

3.10
electrostatic discharge (ESD)
transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

[IEV 161-01-22]

3.11
energy storage capacitor
capacitor of the ESD-generator representing the capacity of a human body charged to the test voltage value

NOTE This element may be provided as a discrete component or a distributed capacitance.

3.12
EUT
equipment under test

3.13
ground reference plane (GRP)
flat conductive surface whose potential is used as a common reference

[IEV 161-04-36]

3.14
holding time
interval of time within which the decrease of the test voltage due to leakage, prior to the discharge, is not greater than 10 %

3.15
immunity (to a disturbance)
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

3.16
indirect application
application of the discharge to a coupling plane in the vicinity of the EUT to simulate personnel discharge to objects which are adjacent to the EUT

3.17
rise time
interval of time between the instants at which the instantaneous value of a pulse first reaches the specified lower and upper limits

NOTE Unless otherwise specified, the lower and upper values are fixed at 10 % and 90 % of the pulse magnitude.

[IEV 161-02-05, modified]

3.18
verification
set of operations which are used to check the test equipment system (e.g., the test generator and the interconnecting cables) and to demonstrate that the test system is functioning

NOTE 1 The methods used for verification can be different from those used for calibration.

NOTE 2 For the purpose of this basic EMC standard this definition is different from the definition given in IEV 311-01-13.

4 General

This standard relates to equipment, systems, subsystems and peripherals which may be involved in static electricity discharges owing to environmental and installation conditions, such as low relative humidity, use of low-conductivity (artificial-fiber) carpets, vinyl garments, etc., which may exist in all locations classified in standards relevant to electrical and electronic equipment (for more detailed information, see Clause A.1).

NOTE From the technical point of view, the precise term for the phenomenon would be static electricity discharge. However, the term electrostatic discharge (ESD) is widely used in the technical world and in technical literature. Therefore, it has been decided to retain the term electrostatic discharge in the title of this standard.

5 Test levels

The preferred range of test levels for the ESD test is given in Table 1.

Contact discharge is the preferred test method. Air discharges shall be used where contact discharge cannot be applied. Voltages for each test method are given in Table 1. The voltages shown are different for each method due to the differing methods of test. This does not imply that the test severity is equivalent between test methods.

Details concerning the various parameters which may influence the voltage to which the human body may be charged are given in Clause A.2. Clause A.4 also contains examples of the application of the test levels related to environmental (installation) classes.

For air discharge testing, the test shall be applied at all test levels in Table 1 up to and including the specified test level. For contact discharge testing, the test shall be applied at the specified test level only unless otherwise specified by product committees.

Further information is given in Clauses A.3, A.4 and A.5.

Table 1 – Test levels

Contact discharge		Air discharge	
Level	**Test voltage** kV	**Level**	**Test voltage** kV
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15
x [a]	Special	x [a]	Special

[a] "x" can be any level, above, below or in between the others. The level shall be specified in the dedicated equipment specification. If higher voltages than those shown are specified, special test equipment may be needed.

6 Test generator

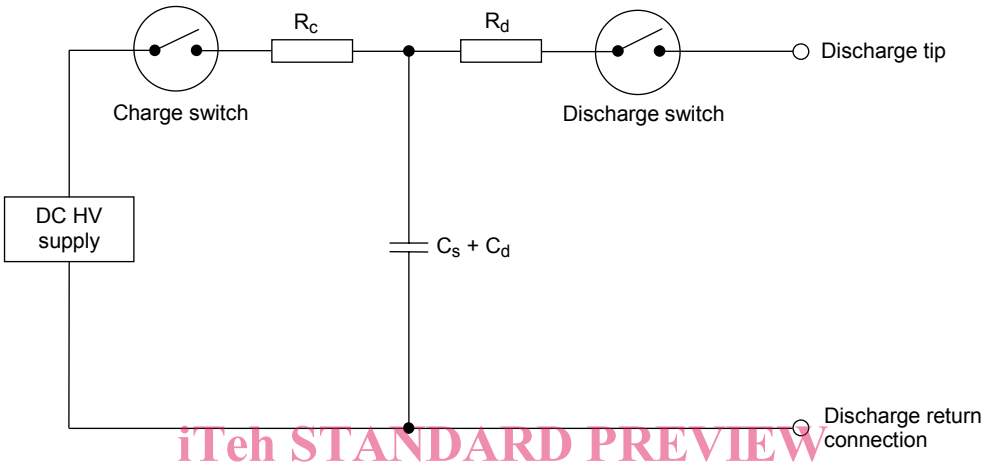
6.1 General

The test generator consists, in its main parts, of

– charging resistor R_c;
– energy-storage capacitor C_s;
– distributed capacitance C_d;
– discharge resistor R_d;
– voltage indicator;

– discharge switch;
– charge switch;
– interchangeable tips of the discharge electrode (see Figure 3);
– discharge return cable;
– power supply unit.

A simplified diagram of the ESD generator is given in Figure 1. Constructional details are not given.



NOTE 1 C_d is a distributed capacitance which exists between the generator and its surroundings.

NOTE 2 $C_d + C_s$ has a typical value of 150 pF.

NOTE 3 R_d has a typical value of 330 Ω.

Figure 1 – Simplified diagram of the ESD generator

The generator shall meet the requirements given in 6.2 when evaluated according to the procedures in Annex B. Therefore, neither the diagram in Figure 1, nor the element values are specified in detail.

6.2 Characteristics and performance of the ESD generator

The test generator shall meet the specifications given in Tables 2 and 3. Figure 2 shows an ideal current waveform and the measurement points referred to in Tables 2 and 3. Conformance with these specifications shall be demonstrated according to the methods described in Annex B.

Table 2 – General specifications

Parameters	Values
Output voltage, contact discharge mode (see NOTE 1)	At least 1 kV to 8 kV, nominal
Output voltage, air discharge mode (see NOTE 1)	At least 2 kV to 15 kV, nominal (see NOTE 3)
Tolerance of output voltage	±5 %
Polarity of output voltage	Positive and negative
Holding time	≥5 s
Discharge mode of operation	Single discharges (see NOTE 2)
NOTE 1 Open circuit voltage measured at the discharge electrode of the ESD generator. NOTE 2 The generator should be able to generate at a repetition rate of at least 20 discharges per second for exploratory purposes. NOTE 3 It is not necessary to use a generator with 15 kV air discharge capability if the maximum test voltage to be used is lower.	

Table 3 – Contact discharge current waveform parameters

Level	Indicated voltage kV	First peak current of discharge ±15 % A	Rise time t_r (±25 %) ns	Current (±30 %) at 30 ns A	Current (±30 %) at 60 ns A
1	2	7,5	0,8	4	2
2	4	15	0,8	8	4
3	6	22,5	0,8	12	6
4	8	30	0,8	16	8
The reference point for measuring the time for the current at 30 ns and 60 ns is the instant when the current first reaches 10 % of the 1st peak of the discharge current. NOTE The rise time, t_r, is the time interval between 10 % and 90 % value of 1st peak current.					

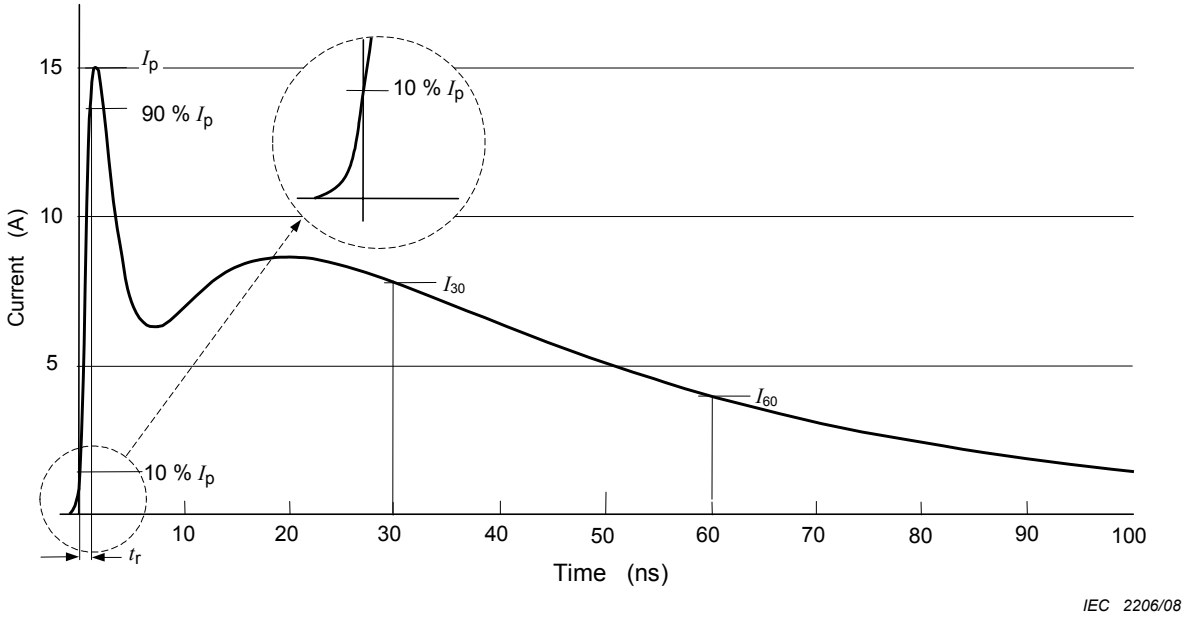


Figure 2 – Ideal contact discharge current waveform at 4 kV

The equation for the idealized waveform of Figure 2, $I(t)$, is as follows:

$$I(t) = \frac{I_1}{k_1} \times \frac{\left(\frac{t}{\tau_1}\right)^n}{1+\left(\frac{t}{\tau_1}\right)^n} \times \exp\left(\frac{-t}{\tau_2}\right) + \frac{I_2}{k_2} \times \frac{\left(\frac{t}{\tau_3}\right)^n}{1+\left(\frac{t}{\tau_3}\right)^n} \times \exp\left(\frac{-t}{\tau_4}\right)$$

where

$$k_1 = \exp\left(-\frac{\tau_1}{\tau_2}\left(\frac{n\tau_2}{\tau_1}\right)^{1/n}\right)$$

$$k_2 = \exp\left(-\frac{\tau_3}{\tau_4}\left(\frac{n\tau_4}{\tau_3}\right)^{1/n}\right)$$

and

τ_1 = 1,1 ns; τ_2 = 2 ns; τ_3 = 12 ns; τ_4 = 37 ns;

I_1 = 16,6 A (at 4 kV); I_2 = 9,3 A (at 4 kV);

n = 1,8.

The generator should be provided with means of preventing unintended radiated or conducted emissions, either of pulse or continuous type, so as not to disturb the EUT or auxiliary test equipment by parasitic effects (see Annex D).

The discharge electrodes shall conform to the shapes and dimensions shown in Figure 3. The electrodes may be covered with insulated coatings, provided the discharge current waveform specifications are met.