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INTERNATIONAL STANDARD

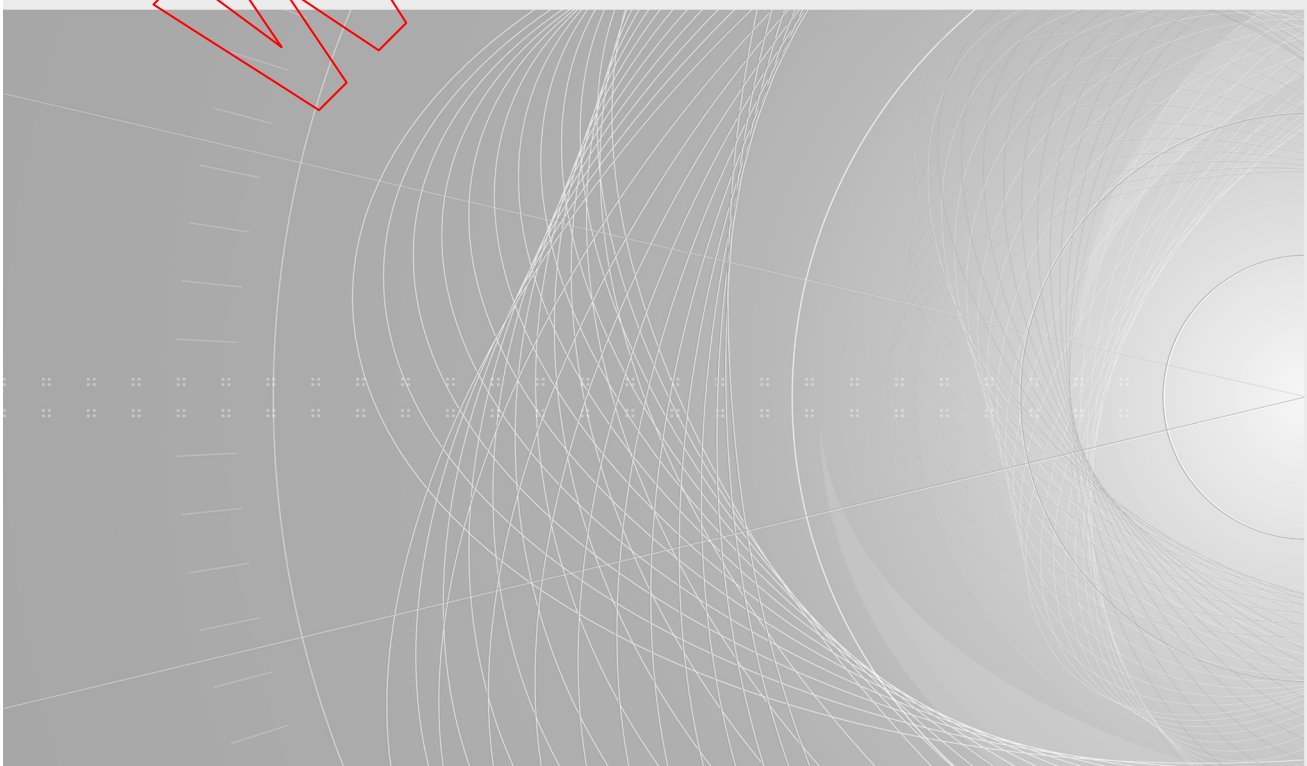
NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test

Compatibilité électromagnétique (CEM) – Partie 4-5: Techniques d'essai et de mesure – Essai d'immunité aux ondes de choc



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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-5 : Testing and measurement techniques – Surge 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 61000-4-5 has been prepared by subcommittee 77B: High frequency phenomena, of IEC technical Committee 77: Electromagnetic compatibility.

It forms Part 4-5 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*.

This second edition cancels and replaces the first edition published in 1995 and its amendment 1 (2000), and constitutes a technical revision. Particularly, the clauses dedicated to coupling/decoupling networks and to test setups are more detailed.

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

FDIS	Report on voting
77B/467/FDIS	77B/486/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.

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.

The contents of the corrigendum of October 2009 have been included in this copy.

INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

Part 1: General

General considerations (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: 61000-6-1).

This part is an International Standard which gives immunity requirements and test procedures related to surge voltages and surge currents.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-5 : Testing and measurement techniques – Surge immunity test

1 Scope and object

This part of IEC 61000 relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by overvoltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment.

The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to surges. The test method documented in this part of IEC 61000 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon.

NOTE As described in IEC Guide 107, this is a basic EMC publication for use by product committees of the IEC. As also stated in Guide 107, the IEC product committees are responsible for determining whether this immunity test standard should be applied or not, and if applied, they are responsible for determining the appropriate test levels and performance criteria. TC 77 and its sub-committees are prepared to co-operate with product committees in the evaluation of the value of particular immunity tests for their products.

This standard defines:

– a range of test levels;
– test equipment;
– test setups;
– test procedures.

The task of the described laboratory test is to find the reaction of the EUT under specified operational conditions, to surge voltages caused by switching and lightning effects at certain threat levels.

It is not intended to test the capability of the EUT's insulation to withstand high-voltage stress. Direct injections of lightning currents, i.e, direct lightning strikes, are not considered 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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60469-1, *Pulse techniques and apparatus – Part 1: Pulse terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions in IEC 60050(161) and the following apply.

3.1
avalanche device
diode, gas tube arrestor, or other component that is designed to break down and conduct at a specified voltage

3.2
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

[IEV 311-01-09]

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.

3.3
clamping device
diode, varistor or other component that is designed to prevent an applied voltage from exceeding a specified value

3.4
combination wave generator
generator with 1,2/50 µs or 10/700 µs open-circuit voltage waveform and respectively 8/20 µs or 5/320 µs short-circuit current waveform

3.5
coupling network
electrical circuit for the purpose of transferring energy from one circuit to another

3.6
decoupling network
electrical circuit for the purpose of preventing surges applied to the EUT from affecting other devices, equipment or systems which are not under test

3.7
duration
absolute value of the interval during which a specified waveform or feature exists or continues

[IEC 60469-1]

3.8
effective output impedance (of a surge generator)
ratio of the peak open-circuit voltage to the peak short-circuit current

3.9
electrical installation
assembly of associated electrical equipment having co-ordinated characteristics to fulfil purposes

[IEV 826-10-01]

3.10
EUT
equipment under test

3.11
front time
surge voltage
the front time T_1 of a surge voltage is a virtual parameter defined as 1,67 times the interval T between the instants when the impulse is 30 % and 90 % of the peak value (see Figures 2 and 5)

surge current
the front time T_1 of a surge current is a virtual parameter defined as 1,25 times the interval T between the instants when the impulse is 10 % and 90 % of the peak value (see Figures 3 and 6)

[IEC 60060-1, 24.3 modified]

3.12
ground (reference)
part of the Earth considered as conductive, the electrical potential of which is conventionally taken as zero, being outside the zone of influence of any earthing (grounding) arrangement

[IEV 195-01-01]

3.13
high-speed communication lines
input/output lines which operate at transmission frequencies above 100 kHz

3.14
immunity
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

3.15
interconnection lines
I/O lines (input/output lines) and communication lines

3.16
primary protection
means by which the majority of stressful energy is prevented from propagating beyond a designated interface

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.

[IEV 161-02-05]

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

3.18
secondary protection
means by which the let-through energy from primary protection is suppressed. It may be a special device or an inherent characteristic of the EUT

3.19
surge
transient wave of electrical current, voltage, or power propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease

[IEV 161-08-11 modified]

3.20
symmetrical lines
pair of symmetrically driven conductors with a conversion loss from differential to common mode of greater than 20 dB

3.21
system
set of interdependent elements constituted to achieve a given objective by performing a specified function

[IEV 351-11-01 modified]

NOTE The system is considered to be separated from the environment and other external systems by an imaginary surface which cuts the links between them and the considered system. Through these links, the system is affected by the environment, is acted upon by the external systems, or acts itself on the environment or the external systems.

3.22
time to half-value
***T*$_2$**
interval of time between the instant of virtual origin O_1 and the instant when the voltage or current has decreased to half the peak value

[IEC 60060-1, 18.1.6 modified]

NOTE The time to half-value T_2 of a surge is a virtual parameter.

3.23
transient
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared to the time scale of interest

[IEV 161-02-01]

3.24
verification
set of operations which is used to check the test equipment system (e.g. the test generator and the interconnecting cables) to demonstrate that the test system is functioning within the specifications given in Clause 6

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

NOTE 2 The procedure of 6.1.2 and 6.2.2 is meant to ensure the correct operation of the test generator, and other items making up the test setup so that the intended waveform is delivered to the EUT.

NOTE 3 For the purposes of this basic EMC standard this definition is different of the definition given in IEV 311-01-13.

3.25
virtual Origin
***O*$_1$**
for the surge voltage waveform, it is the instant at which a straight line drawn through the 30 % and 90 % amplitude values crosses the time axis. For the surge current waveform, it is the instant at which a straight line drawn through the 10 % and 90 % amplitude values crosses the time axis

4 General

4.1 Power system switching transients

Power system switching transients can be separated into transients associated with

a) major power system switching disturbances, such as capacitor bank switching;
b) minor local switching activity or load changes in the power distribution system;
c) resonating circuits associated with switching devices, such as thyristors;
d) various system faults, such as short circuits and arcing faults to the grounding system of the installation.

4.2 Lightning transients

The major mechanisms by which lightning produces surge voltages are the following:

a) direct lightning stroke to an external (outdoor) circuit injecting high currents producing voltages by either flowing through ground resistance or flowing through the impedance of the external circuit;
b) an indirect lightning stroke (i.e. a stroke between or within clouds or to nearby objects which produces electromagnetic fields) that induces voltages/currents on the conductors outside and/or inside a building;
c) lightning ground current flow resulting from nearby direct-to-earth discharges coupling into the common ground paths of the grounding system of the installation.

The rapid change of voltage and flow of current which can occur as a result of the operation of a lightning protection device can induce electromagnetic disturbances into adjacent equipment.

4.3 Simulation of the transients

The characteristics of the test generator are such that it simulates the above-mentioned phenomena as closely as possible.

If the source of interference is in the same circuit, for example in the power supply network (direct coupling), the generator may simulate a low impedance source at the ports of the equipment under test.

If the source of interference is not in the same circuit as the victim equipment (indirect coupling), then the generator may simulate a higher impedance source.

5 Test levels

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

Table 1 – Test levels

Level	Open-circuit test voltage ±10 % kV
1	0,5
2	1,0
3	2,0
4	4,0
X	Special
NOTE X can be any level, above, below or in between the other levels. This level can be specified in the product standard.	

The test levels shall be selected according to the installation conditions; classes of installation are given in Clause B.3.

All voltages of the lower test levels shall be satisfied (see 8.2).

For selection of the test levels for the different interfaces, refer to Annex A.

6 Test instrumentation

Two types of combination wave generator are specified. Each has its own particular applications, depending on the type of port to be tested (see Clause 7). The 10/700 µs combination wave generator is used to test ports intended for connection to symmetrical communication lines. The 1,2/50 µs combination wave generator is used in all other cases, and in particular, for testing ports intended for power lines and short-distance signal connections.

6.1 1,2/50 µs combination wave generator

It is the intention of this standard that the output waveforms meet specifications at the point where they are to be applied to the EUT. Waveforms are specified as open-circuit voltage and short-circuit current and therefore are measured without the EUT connected. In the case of an a.c. or d.c. powered product where the surge is applied to the a.c. or d.c. supply lines, the output must be as specified in Tables 6 and 7. In the case where the surge is to be applied directly from the generator output terminals, the waveforms shall be as specified in Table 2. It is not intended that the waveforms meet specifications both at the generator output and at the output of coupling/decoupling networks simultaneously, but only as applied to the EUT. The waveform specifications are to be met without an EUT connected.

This generator is intended to generate a surge having: an open-circuit voltage front time of 1,2 µs; an open-circuit voltage time to half value of 50 µs; a short-circuit current front time of 8 µs; and a short-circuit current time to half value of 20 µs.