IEC 61000-4-25

Edition 1.1 2012-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electromagnetic compatibility (EMC)
Part 4-25: Testing and measurement techniques – HEMP immunity test methods for equipment and systems

Compatibilité électromagnétique (CEM)
Partie 4-25: Techniques d'essai et de mesure – Méthodes d'essai d'immunité à l'IEMN-HA des appareils et des systèmes

IEC 61000-4-25:2001+A1:2012

IEC Central Office
3, rue de Varembé
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It also gives information on projects, replaced and withdrawn publications.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 61000-4-25

Edition 1.1 2012-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electromagnetic compatibility (EMC)
Part 4-25: Testing and measurement techniques – HEMP immunity test methods for equipment and systems

Compatibilité électromagnétique (CEM)
Partie 4-25: Techniques d'essai et de mesure – Méthodes d'essai d'immunité à l'IEMN-HA des appareils et des systèmes

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.100.99

ISBN 978-2-88912-055-0

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-25: Testing and measurement techniques – HEMP immunity test methods for equipment and systems

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 IEC 61000-4-25 consists of the first edition (2001) [documents 77C/113/FDIS and 77C/117/RVD] and its amendment 1 (2012) [documents 77C/216/FDIS and 77C/218/RVD]. It bears the edition number 1.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. 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 61000-4-25 has been prepared by subcommittee 77C: High power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms part 4-25 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

~~Annex D forms an integral part of this standard.~~

Annexes A, B C and D are for information only.

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.

INTRODUCTION

This standard is part of the IEC 61000 series, 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 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 completed by a second number identifying the subdivision (example: 61000-6-1).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-25: Testing and measurement techniques – HEMP immunity test methods for equipment and systems

1 Scope

This part of IEC 61000 describes the immunity test levels and related test methods for electrical and electronic equipment and systems exposed to high-altitude electromagnetic pulse (HEMP) environments. It defines ranges of immunity test levels and establishes test procedures. Specifications for test equipment and instrumentation test set-up, test procedures, pass/fail criteria, and test documentation requirements are also defined by this standard. These tests are intended to demonstrate the immunity of electrical and electronic equipment when subjected to HEMP radiated and conducted electromagnetic disturbances. For radiated disturbance immunity tests, specifications are defined in this standard both for small test facilities and large HEMP simulators.

This part of IEC 61000 defines specifications for laboratory immunity tests. On-site tests performed on equipment in the final installation to verify immunity are also specified. These verification tests use the same specifications as laboratory tests, except for the climatic environmental specifications.

The objective of this part of IEC 61000 is to establish a common and reproducible basis for evaluating the performance of electrical and electronic equipment, when subjected to HEMP radiated environments and the associated conducted transients on power, antenna, and input/output (I/O) signal and control lines.

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 – Chapter 161: Electromagnetic compatibility*

IEC 60038, *IEC standard voltages*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 61000-2-5, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 5: Classification of electromagnetic environments.* Basic EMC publication

IEC 61000-2-9, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 9: Description of HEMP environment – Radiated disturbance.* Basic EMC publication

IEC 61000-2-10:1998, *Electromagnetic compatibility (EMC) – Part 2-10: Environment – Description of HEMP environment – Conducted disturbance*

IEC 61000-2-11, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 11: Classification of HEMP environments.* Basic EMC publication

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test.* Basic EMC Publication

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests*

~~IEC 61000-4-12, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 12: Oscillatory waves immunity test*~~

IEC 61000-4-13, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests* – Basic EMC Publication [1]

IEC 61000-4-18, *Electromagnetic compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test*

IEC 61000-4-20, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*[1]

IEC 61000-4-33, *Electromagnetic compatibility (EMC) – Part 4-33: Testing and measurement techniques – Measurement methods for high-power transient parameters*

IEC 61000-5-3, *Electromagnetic compatibility (EMC) – Part 5-3: Installation and mitigation guidelines – HEMP protection concepts*

IEC 61000-5-4/TR, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 4: Immunity to HEMP – Specifications for protective devices against HEMP radiated disturbance.* Basic EMC Publication

IEC 61024-1, *Protection of structures against lightning – Part 1: General principles*

~~ISO 7137, *Aircraft – Environmental conditions and test procedures for airborne equipment*~~

3 Definitions

For the purpose of this part of IEC 61000, the following definitions apply.

3.1
compatibility level
specified electromagnetic disturbance level used as a reference level for co-ordination in the setting of emission and immunity limits

[IEV 161-03-10]

3.2
coupling (HEMP)
interaction of electromagnetic fields with a system to produce currents and voltages on system surfaces and cables

3.3
coupling clamp
device of defined dimensions and characteristics for common mode coupling of the disturbance signal to the circuit under test without any galvanic connection to it

---

[1] To be published

3.4
coupling network
electrical circuit for the purpose of transferring energy from one circuit to another

3.5
decoupling network
electrical circuit for the purpose of preventing over-voltages applied to the EUT from affecting other devices, equipment or systems, which are not under test

3.6
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 a temporary or permanent failure.

[IEV 161-01-19]

3.7
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system

[IEV 161-01-05, modified]

3.8
electromagnetic interference
degradation of the performance of a device, transmission channel or system caused by an electromagnetic disturbance

[IEV 161-01-06]

3.9
electromagnetic susceptibility
inability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

NOTE Susceptibility is a lack of immunity.

[IEV 161-01-21]

3.10
EUT (equipment under test)
the equipment under test can be a single unit or multiple units interconnected by cables, data links, etc.

NOTE Multiple units interconnected by cables, etc. are also called a system [see 3.27 below].

3.11
fast Fourier transform
FFT
mathematical procedure for rapidly computing the direct or inverse Fourier transform of a time domain signal or of a frequency domain spectrum, respectively. It requires 2^m (m = integer) data points that are equally spaced in time or frequency, and involves much less computation time than a standard discrete Fourier transform (DFT)

3.12
ground reference plane
flat conductive surface, whose potential is used as a common reference

[IEV 161-04-36]

3.13
HV transmission line
power line with a nominal a.c. system voltage equal to or greater than 100 kV

3.14
short circuit current
I_{sc}
current resulting from an abnormal connection of relatively low resistance between two points of different potentials in a circuit

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
immunity level
maximum level of a given electromagnetic disturbance incident on a particular device, equipment or system for which it remains capable of operating at a required degree of performance

[IEV 161-03-14]

3.17
immunity test level
value of an influencing electromagnetic quantity specified for an immunity test

NOTE It is to be noted that the text of this definition is the same as for severity level. A test standard can specify several severity levels according to different immunity levels.

3.18
large HEMP simulator
transient electromagnetic pulse test facility with a test volume sufficiently large to test objects with cubical dimensions equal to or greater than 1 m × 1 m × 1 m

3.19
LV (low-voltage) power circuit
power circuit with a nominal a.c. voltage between 120 V and 1 000 V

NOTE The standard voltages in this voltage range are presented in IEC 60038.

3.20
MV (medium voltage) distribution power line
power line with a nominal a.c. voltage above 1 kV and not exceeding 35 kV used to distribute power within a local area

NOTE The standard voltages in this voltage range are presented in IEC 60038.

3.21
point-of-entry
port-of-entry
PoE

the physical location (point/port) on the electromagnetic barrier, where EM energy may enter or exit a topological volume, unless an adequate PoE protective device is provided. A PoE is not limited to a geometrical point. PoEs are classified as aperture PoEs or conductor PoEs, according to the type of penetration. They are also classified as architectural, mechanical, structural or electrical PoEs, according to the architectural engineering discipline in which they are usually encountered

3.22
pulse width
time interval between the points on the leading and trailing edges of a pulse at which the instantaneous value is 50 % of the peak pulse amplitude

3.23
rise time (of a pulse)
interval of time between the instants at which the instantaneous value of a pulse first reaches a specified lower value and then a specified upper value

[IEV 161-02-05]

NOTE In this standard, the lower value is ten (10) percent of the peak, and the upper value is ninety (90) percent of the peak value

3.24
severity level
value of an influencing electromagnetic quantity specified for an immunity test

NOTE It is to be noted that the text of this definition is the same as for immunity test level. A test standard can specify several severity levels according to different immunity levels.

3.25
small radiated test facility
laboratory transient electromagnetic pulse test facility such as a TEM cell with a test volume sufficiently large to test objects with cubical dimensions less than 1 × 1 × 1 meter

3.26
surge protection device (SPD)
device to suppress line conducted overvoltages and currents

NOTE Examples are surge suppressors defined in IEC 61024-1.

3.27
system
multiple equipment or electrical units connected by cables, data links, etc.

3.28
test volume
volume in which the incident electromagnetic fields meet, or exceed, the required strength and field uniformity requirements.

3.29
transient
phenomenon which varies between two consecutive steady states during a time interval short compared with the time-scale of interest

[IEV 161-02-01]

3.30
open circuit voltage
V_{oc}
voltage between points in a circuit where one of the points was created by opening or breaking the circuit

4 General

The nuclear high-altitude electromagnetic pulse test consists of two major parts: radiated immunity testing and conducted immunity testing. The radiated immunity test is performed for the purpose of demonstrating that the equipment under test has the ability to continue functioning when exposed to *radiated* HEMP fields. Similarly, the conducted immunity test is

performed for the purpose of demonstrating that the equipment under test will not be adversely affected by exposure to *conducted* HEMP transients. These transients are current and voltage pulses on conductors (wires, cables) that are connected to the equipment. In general, conducted HEMP transients induced in power and telecom lines are often the most severe threats to equipment. The immunity tests described in this standard involve hazardous voltages. High-voltage precautions will be necessary to protect the health and safety of test personnel.

5 Immunity tests and immunity test levels

5.1 Introduction

This standard has been developed to specify the HEMP immunity test for electrical or electronic equipment and systems. The intent is to allow manufacturers to qualify equipment early in the design cycle, and to use many of the same IEC laboratory immunity tests that are already prescribed for other EMC purposes.

5.2 Immunity tests

HEMP immunity tests consist of two major types: radiated immunity tests and conducted immunity tests. For the purpose of this standard, the term "electronic equipment" denotes an apparatus that performs a specific function. This could be a small computer or a telephone. Some equipment (for example, a computer connected to additional peripherals such as control boards to monitor processes in a factory) may be considered as part of a larger system. Often, electronic equipment are relatively small – on the order of 1 m x 1 m x 1 m or smaller. It is expected that most of the tests on such small equipment will be performed in laboratories using current injection simulators and TEM cells.

For HEMP (and EMC) tests, size can be an important factor, since very large systems may be difficult to test, especially by radiated fields. In general, radiated field tests on systems and large equipment with dimensions greater than 1 m on a side will require a large HEMP simulator. One aspect of HEMP testing that is different from other kinds of EMC testing is that there are several large (~10 m high) early-time (t < 1 μs) HEMP simulators throughout the world. It is possible to expose some systems and large equipment to the early-time HEMP threat by reproducing the pulsed electric and magnetic fields. These simulators are also useful in verifying that equipment designed and tested for HEMP survival at the equipment level, will work properly when integrated into a complete system.

5.3 Immunity test levels

This standard defines electromagnetic disturbances that represent those which could result at the equipment ports due to a high-altitude nuclear event. These electromagnetic disturbances will be the result of the radiated and conducted HEMP environments, as modified by any protection elements. These electromagnetic disturbances are described in IEC 61000-2-9, IEC 61000-2-10 and IEC 61000-2-11. The rationale for the immunity test levels and threat reductions due to protection elements and probable flashovers are described in annex A.

5.4 Radiated disturbance tests

5.4.1 Radiated immunity test levels

The radiated immunity test levels described below involve only the early time radiated fields. Testing for the intermediate-time and late-time HEMP fields are not required. Information regarding the selection of the immunity test levels is given in annex A. The peak values of the early-time electric field, E_{peak}, for selected immunity test levels are listed in table 1.