IEC 61000-4-36

Edition 1.0 2014-11

INTERNATIONAL STANDARD

colour inside

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) – Part 4-36: Testing and measurement techniques – IEMI immunity test methods for equipment and systems

IEC 61000-4-36:2014-11(en)

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.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables 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 It also gives information on projects, replaced and withdrawn publications.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 online 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 14 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 55 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC 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.

IEC 61000-4-36

Edition 1.0 2014-11

INTERNATIONAL STANDARD

colour inside

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) – Part 4-36: Testing and measurement techniques – IEMI immunity test methods for equipment and systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XC

ICS 33.100.20

ISBN 978-2-8322-1904-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

ELECTROMAGNETIC COMPATIBILITY (EMC) –

**Part 4-36: Testing and measurement techniques –
IEMI 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.

International Standard IEC 61000-4-36 has been prepared by subcommittee 77C: High-power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms part 4-36 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

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

CDV	Report on voting
77C/231/CDV	77C/236/RVC

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 in 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 stability date indicated on the IEC website 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.

A bilingual version of this publication may be issued at a later date.

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 document using a colour printer.

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: IEC 61000-6-1).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-36: Testing and measurement techniques – IEMI immunity test methods for equipment and systems

1 Scope

This part of IEC 61000 provides methods to determine test levels for the assessment of the immunity of equipment and systems to intentional electromagnetic interference (IEMI) sources. It introduces the general IEMI problem, IEMI source parameters, derivation of test limits and summarises practical test methods.

2 Normative references

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

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

IEC 61000-4-12, *Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Ring wave immunity test*

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

3 Terms, definitions and abbreviations

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

3.1 Terms and defintions

3.1.1
attenuation
reduction in magnitude (as a result of absorption and/or scattering) of an electric or magnetic field or a current or voltage, usually expressed in decibels

3.1.2
bandratio
br
ratio of the high and low frequencies between which there is 90 % of the energy

Note 1 to entry: If the spectrum has a large dc content, the lower limit is nominally defined as 1 Hz (see IEC 61000-2-13 for further details).

3.1.3
bandratio decades
brd
bandratio expressed in decades as: brd = log10(br)

3.1.4
burst
time frame in which a series of pulses occurs with a given repetition rate

Note 1 to entry: When multiple bursts occur, the time between bursts is usually defined.

3.1.5
conducted HPEM environment
high-power electromagnetic currents and voltages that are either coupled or directly injected to cables and wires with voltage levels that typically exceed 1 kV

3.1.6
continuous wave
CW
time waveform that has a fixed frequency and is continuous

3.1.7
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

3.1.8
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system

3.1.9
electromagnetic interference
EMI
degradation of the performance of a device, transmission channel or system caused by an electromagnetic disturbance

Note 1 to entry: Disturbance and interference are respectively cause and effect.

3.1.10
(electromagnetic) shield
electrically continuous housing for a facility, area, or component used to attenuate incident electric and magnetic fields by both absorption and reflection

3.1.11
(electromagnetic) susceptibility
inability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

Note 1 to entry: Susceptibility is a lack of immunity.

3.1.12
equipment under test
EUT
equipment being subjected to the test

3.1.13
high-altitude electromagnetic pulse
HEMP
electromagnetic pulse produced by a nuclear explosion outside the earth's atmosphere

Note 1 to entry: Typically above an altitude of 30 km.

3.1.14
high-power microwaves
HPM
narrowband signals, nominally with peak power in a pulse, in excess of 100 MW at the source

Note 1 to entry: This is a historical definition that depended on the strength of the source. The interest in this document is mainly on the EM field incident on an electronic system.

3.1.15
hyperband signal
signal or waveform with a pbw (see 3.1.20) value between 163,4 % and 200 % or a bandratio > 10

3.1.16
hypoband signal
narrowband signal or waveform with a pbw of < 1 % or a bandratio < 1,01

3.1.17
intentional electromagnetic interference
IEMI
intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes

[SOURCE: IEC 61000-2-13:2005, 3.16]

3.1.18
L band
radar frequency band between 1 GHz and 2 GHz

3.1.19
mesoband signal
signal or waveform with a pbw value between 1 % and 100 % or a bandratio between 1,01 and 3

3.1.20
percentage bandwidth
pbw
bandwidth of a waveform expressed as a percentage of the centre frequency of that waveform

Note 1 to entry: The pbw has a maximum value of 200 % when the centre frequency is the mean of the high and low frequencies. The pbw does not apply to signals with a large dc content (e.g., HEMP) for which the bandratio decades is used.

3.1.21
port-of-entry
PoE
physical location (point) on an electromagnetic barrier, where EM energy may enter or exit a topological volume, unless an adequate PoE protective device is provided

Note 1 to entry: A PoE is not limited to a geometrical point.

Note 2 to entry: PoEs are classified as aperture PoEs or conductive PoEs according to the type of penetration. They are also classified as architectural, mechanical, structural or electrical PoEs according to the functions they serve.

3.1.22
pulse
transient waveform that usually rises to a peak value and then decays, or a similar waveform that is an envelope of an oscillating waveform

3.1.23
pulse repetition frequency
prf
number of pulses per unit time, measured in Hz (per second)

3.1.24
radiated HPEM environment
high-power electromagnetic fields with peak electric field levels that typically exceed 100 V/m

3.1.25
rE_{far}
electric field normalised at a distance of 1 m from the antenna as derived from an E-field measurement at a given distance in the far-field

3.1.26
sub-hyperband signal
signal or a waveform with a pbw value between 100 % and 163,4 % or a bandratio between 3 and 10

3.1.27
transient
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval which is short compared with the time-scale of interest

Note 1 to entry: A transient can be a unidirectional impulse of either polarity or a damped oscillatory wave with the first peak occurring in either polarity.

3.1.28
ultrawideband
UWB
signal that has a percent bandwidth greater than 25 %

3.2 Abbreviations

DS	Damped sinusoid
EMI	Electromagnetic interference
ESD	Electrostatic discharge
HEMP	High-altitude electromagnetic pulse
HIRF	High-intensity radiated fields
HPD	Horizontally polarized dipole
HPEM	High-power electromagnetic
HPM	High-power microwave
LEMP	Lightning electromagnetic pulse
LLSF	Low level swept field
LLSC	Low level swept current
NEMP	Nuclear electromagnetic pulse
SE	Shielding effectiveness
UWB	Ultra wideband

VPD Vertically polarized dipole

4 General

The use of electromagnetic sources to generate intentional electromagnetic interference (IEMI) is of increasing concern as the reliance of society on technology increases significantly. Many technical papers have been published that show the effects of IEMI are cause for concern; they are summarised in [1][1]. A summary of failure mechanisms at equipment level is provided in Annex A.

The effects of IEMI on equipment can be similar to the effects caused by high-power electromagnetic (HPEM) environments. HPEM environments include high-intensity radiated fields (HIRF) generated by radio and radar systems, lightning electromagnetic pulse (LEMP) and electrostatic discharge (ESD). Some of these HPEM environments have similar characteristics to those sources used to cause IEMI but are unintentional EMI sources, i.e. non-malicious. However, it is possible to use information regarding qualification of equipment and systems to these environments to inform the likely response to IEMI.

The IEC defines IEMI within 3.1.17 as 'intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, thus disrupting, confusing or damaging these systems for terrorist or criminal purposes'.

Within this definition it is possible to also include jammers, which are designed to overload antenna receiver circuits (front doors) by operating at or close to the victim receiver frequency of operation. Jammers typically require low power to operate due to the fact that receivers are designed to operate at very low power levels (nW or less). More information on the issue of jammers can be found in Annex G.

This document complements IEC 61000-4-25 [2], which deals with high-altitude electromagnetic pulse (HEMP) immunity test methods for equipment and systems.

5 IEMI environments and interaction

5.1 General

There are many types of sources that can generate electromagnetic environments that can potentially be used to cause intentional electromagnetic interference (IEMI). IEC 61000-2-13 [3] discusses the various environments that can be generated and categorises them in terms of time characteristics, frequency range and bandratio. Further details and actual examples are included within Annex B.

A key requirement of developing IEMI test methods and test levels is to achieve a good understanding of the environment in which the victim equipment or system will be required to operate. Within this document specific focus is provided for victim equipment that is integrated within a site or other fixed installation and it is generally assumed that such equipment is housed within a building.

IEMI phenomena are unlike other EMC standardised phenomena where assumptions can be made about the general or average disturbance level arriving at victim equipment ports. Important parameters related to the IEMI interaction with victim systems which will affect the test level include:

a) IEMI source parameters

   1) frequency range of the source,

[1] Numbers in square brackets refer to the Bibliography in Clause 8.