INTERNATIONAL STANDARD

IEC 61000-2-13

First edition
2005-03

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) –

Part 2-13:
Environment –
High-power electromagnetic (HPEM) environments –
Radiated and conducted

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 2-13: Environment – High-power electromagnetic (HPEM) environments – Radiated and conducted

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 61000-2-13 has been prepared by subcommittee 77C: High power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility.

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:

FDIS	Report on voting
77C/153/FDIS	77C/155/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- withdrawn;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.

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

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).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 2-13: Environment – High-power electromagnetic (HPEM) environments – Radiated and conducted

1 Scope

This part of IEC 61000 defines a set of typical radiated and conducted HPEM environment waveforms that may be encountered in civil facilities. Such threat environments can produce damaging effects on electrical and electronic equipment in the civilian sector, as described in IEC 61000-1-5. It is necessary to define the radiated and conducted environments, in order to develop protection methods.

For the purposes of this standard, high-power conditions are achieved when the peak electric field exceeds 100 V/m, corresponding to a plane-wave free-space power density of 26,5 W/m^2. This criterion is intended to define the application of this standard to EM radiated and conducted environments that are substantially higher than those considered for "normal" EMC applications, which are covered by the standards produced by IEC SC 77B.

The HPEM environment can be:

- radiated or conducted;
- a single pulse envelope with many cycles of a single frequency (an intense narrowband signal that may have some frequency agility and the pulse envelope may be modulated);
- a burst containing many pulses, with each pulse envelope containing many cycles of a single frequency;
- an ultrawideband transient pulse (spectral content from tens of MHz to several GHz);
- a burst of many ultrawideband transient pulses.

The HPEM signal could be from sources such as radar or other transmitters in the vicinity of an installation or from an intentional generator system targeting a civilian facility. Radiated signals can also induce conducted voltages and currents through the coupling process. In addition, conducted HPEM environments may also be directly injected into the wiring of an installation.

There is a critical distinction between the HEMP (high-altitude electromagnetic pulse) environment and the HPEM environment, in terms of the range or the distance of the affected electrical or electronic components from the source. In the context of HEMP, the range is immaterial, as the HEMP environment propagates downward from space to the earth's surface and is therefore relatively uniform over distances of 1 000 km. On the other hand, in the HPEM context the environment and its effects decrease strongly with range. In addition, the HEMP waveshape is a series of time domain pulses while the HPEM environment may have a wide variety of waveshapes.

Consequently, the standardization process for HPEM environments is more difficult. The recommended approach is to investigate the various types of HPEM environments that have been produced to date and are likely to be feasible in the near future, and then to develop suitable HPEM standard waveforms from such a study. Such HPEM environment standard waveforms can be amended in due course, depending on emerging technologies that make it possible to produce them.

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 61000-1-5, *Electromagnetic compatibility (EMC) – Part 1-5: General – High power electromagnetic (HPEM) effects on civil systems*

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

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

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

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

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

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

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 as well as the following apply.

3.1
attenuation
reduction in magnitude (as a result of absorption and scattering) of an electric or magnetic field or a current or voltage; usually expressed in decibels

3.2
bandratio
br
ratio of the high and low frequencies between which there is 90 % of the energy; if the spectrum has a large dc content, the lower limit is nominally defined as 1 Hz

3.3
bandratio decades
brd
bandratio expressed in decades as: $brd = \log_{10}(br)$

3.4
burst
typically a time frame in which a series of pulses occurs with a given repetition rate. When multiple bursts occur, the time between bursts is usually defined

3.5
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

3.6
continuous wave
CW
time waveform that has a fixed frequency and is continuous

3.7
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

3.8
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system

3.9
electromagnetic interference
EMI
degradation of the performance of a device, transmission channel or system caused by an electromagnetic disturbance

NOTE Disturbance and interference are respectively cause and effect.

3.10
(electromagnetic) shield
electrically continuous housing for a facility, area, or component used to attenuate incident electric and magnetic fields by both absorption and reflection

3.11
(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.

3.12
high-altitude electromagnetic pulse
HEMP
electromagnetic pulse produced by a nuclear explosion outside the earth's atmosphere

NOTE Typically above an altitude of 30 km.

3.13
high-power microwaves
HPM
narrowband signals, nominally with peak power in a pulse, in excess of 100 MW at the source

NOTE 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.

3.14
hyperband signal
signal or waveform with a pbw value between 163,64 % and 200 % or a bandratio >10

3.15
hypoband signal
narrowband signal
signal or waveform with a pbw of <1 % or a bandratio <1,01

3.16
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

3.17
L band
radar frequency band between 1 and 2 GHz

3.18
mesoband signal
signal or waveform with a pbw value between 1 % and 100 % or a bandratio between 1,01 and 3

3.19
percentage bandwidth
pbw
bandwidth of a waveform expressed as a percentage of the centre frequency of that waveform

NOTE 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.

3.20
point-of-entry
PoE
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 A PoE is not limited to a geometrical point.

NOTE 2 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.

3.21
pulse
a transient waveform that usually rises to a peak value and then decays, or a similar waveform that is an envelope of an oscillating waveform

3.22
radiated HPEM environment
high power electromagnetic fields with peak electric field levels that typically exceed 100 V/m

3.23
sub-hyperband signal
a signal or a waveform with a pbw value between 100 % and 163,64 % or a bandratio between 3 and 10

3.24
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 A transient can be a unidirectional impulse of either polarity or a damped oscillatory wave with the first peak occurring in either polarity.

3.25
ultrawideband
UWB
a signal that has a percent bandwidth greater than 25 %

4 General

Figure 1 is provided to help understand the relationship of HPEM environments to other electromagnetic environments. Note that the fast portion of the HEMP electric field Fourier transform from IEC 61000-2-9 is generally most important at frequencies below 300 MHz. The two major types of radiated HPEM environments (narrowband and wideband) are typically found at higher frequencies, as shown.

It is noted in Figure 1 that the wideband spectral density will decrease at very high frequencies (typically above 3 to 5 GHz), however the figure is not intended to portray a specific UWB pulse. Lightning environments are also variable, but they often contain some content up to 10 MHz [19][1]. It is important to understand that the differences shown in the environments can produce different types of effects in electronic systems.

[1] Figures in brackets refer to the bibliography.