

# TECHNICAL REPORT

**IEC**  
**TR 61000-1-5**

First edition  
2004-11

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**Electromagnetic compatibility (EMC) –**

**Part 1-5:**

**General –**

**High power electromagnetic (HPEM)**

**effects on civil systems**

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International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland  
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: [inmail@iec.ch](mailto:inmail@iec.ch) Web: [www.iec.ch](http://www.iec.ch)



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## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms and definitions .....	8
4 General introduction .....	12
4.1 Past experience with HPEM effects on systems.....	13
4.2 General EM protection techniques as applied to civil systems .....	14
5 Classification of HPEM environments .....	15
5.1 Radiated and conducted HPEM environments .....	17
5.2 Narrowband (CW) waveform.....	17
5.3 Ultrawideband/short pulse transient environment.....	19
5.4 Repetitive excitations .....	20
6 HPEM effects on systems.....	21
6.1 Topological representation of the system .....	21
6.2 Examples of HPEM effects on electronic systems and components .....	24
6.3 Component/subsystem burnout and permanent damage.....	26
6.4 Logic upset or service interruption.....	34
7 HPEM protection concepts .....	34
7.1 Strategy for selecting immunity levels.....	34
7.2 Overview of HPEM protection techniques.....	35
7.3 Realisation of HPEM protection.....	35
 Bibliography.....	 41
 Figure 1 – Illustration of the spectral content of HPM and UWB signals, together with other EM signals .....	 16
Figure 2 – Plot of a normalised Gaussian modulated sine wave, serving as a simple representation of a narrowband HPEM waveform.....	18
Figure 3 – Illustration of a wideband transient HPEM waveform together with its spectral magnitude .....	19
Figure 4 – Illustration of a repetitive waveform of pulses similar to that of Figure 2 .....	20
Figure 5 – Simplified illustration of a hypothetical facility excited by an external electromagnetic field.....	22
Figure 6 – The topological diagram for the simple system shown in Figure 5 .....	23
Figure 7 – General interaction sequence diagram for the facility of Figure 5 .....	23
Figure 8 – Example of measured susceptibility thresholds in a DM74LS00N [TTL] quad 2-input NAND gate as a function of frequency, illustrating increased susceptibility thresholds at higher frequencies .....	27
Figure 9 – Example of damage caused by the telecom pulse generator due to a single shot of 4,5 kV .....	29
Figure 10 – Description of conducted disturbance injection experiment.....	32
Figure 11 – Illustration of the deliberate and inadvertent penetrations into the hypothetical system of Figure 5 .....	36

Figure 12 – Example of a hypothetical deliberate coupling path into a system.....	37
Figure 13 – Insertion of a protective device in the deliberate coupling path to provide EM protection against out-of-band disturbances.....	38
Figure 14 – Illustration of typical HPEM inadvertent penetration protection methods.....	39
Table 1 – Description of PCs tested, the environment and effects (after LoVetri ) .....	24
Table 2 – HPEM effects on an automobile as a function of range and source power (Based on measured data from Bäckström).....	25
Table 3 – Summary of results of testing power and data ports with the telecom and CWG pulse generators.....	28
Table 4 – Results of injecting EFT pulses on an AppleTalk cable with the number of upsets/number of test sequences indicated .....	30
Table 5 – Results of injecting EFT pulses on a 10Base-T cable with the number of upsets/number of test sequences indicated.....	30
Table 6 – Results of injecting EFT pulses on a 10Base-2 cable with the number of upsets/number of test sequences indicated.....	31

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTROMAGNETIC COMPATIBILITY (EMC) –****Part 1-5: General –  
High power electromagnetic (HPEM) effects  
on civil systems**

## FOREWORD

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IEC 61000-1-5, which is a technical report, has been prepared by subcommittee 77C: High power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility. This document has the status of a Basic EMC Publication in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
77C/146/DTR	77C/152/RVC

Full information on the voting for the approval of this technical report 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.

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## 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 [IEC TR 61000-1-5:2004](#)

Mitigation methods and devices <https://standards.iteh.ai/catalog/standards/sist/1ff9b350-8972-4d93-bc0b-baf8d7fcbd1/iec-tr-61000-1-5-2004>

### **Part 6: Generic standards**

### **Part 9: Miscellaneous**

Each part is further subdivided into several parts and 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 1-5: General – High power electromagnetic (HPEM) effects on civil systems

#### 1 Scope

This part of IEC 61000 is a technical report that provides background material describing the motivation for developing IEC standards on the effects of high power electromagnetic (HPEM) fields, currents and voltages on civil systems. In the light of newly emerging transient antenna technology and the increasing use of digital electronics, the possibility of equipment being upset or damaged by these environments is of concern. This document begins with a general introduction to this subject and a listing of the pertinent definitions used. Following these clauses, the HPEM environments that are of concern are described and a discussion of the various effects that these environments can induce in civil systems is presented. Finally, techniques used to protect systems against these environments are summarised. More detailed information will be provided in separate documents in this 61000 series.

#### 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. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050-161, *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 61000-2-13, *Electromagnetic compatibility (EMC) – Part 2-13: Environment – High-power electromagnetic (HPEM) environments – Radiated and conducted*<sup>1</sup>

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

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*<sup>2</sup>  
Amendment 1 (2000)

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

IEC 61000-5-6, *Electromagnetic compatibility (EMC) – Part 5-6: Installation and mitigation guidelines – Mitigation of external EM influences*

<sup>1</sup> To be published.

<sup>2</sup> A consolidated edition 1.1 exists comprising IEC 61000-4-5:1995 and its Amendment 1 (2000).

### 3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050-161, some of which are repeated here, and the following terms and definitions apply.

#### 3.1

##### **aperture**

an opening in an electromagnetic barrier (shield) through which EM fields may penetrate

#### 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 d.c. 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

##### **broadband**

(1) (of an emission) – an emission which has a bandwidth greater than that of a particular measuring apparatus or receiver

(IEV 161-06-11);

(2) (of a device) – a device whose bandwidth is such that it is able to accept and process all the spectral components of a particular emission

(IEV 161-06-12)

#### 3.5

##### **conducted susceptibility**

susceptibility of a system to conducted signals on cables connected to the system

#### 3.6

##### **coupling**

interaction of electromagnetic fields with a system to produce currents and voltages on system surfaces and cables

#### 3.7

##### **deliberate penetration**

an intentional opening made in an electromagnetic (“EM”) shield that provides a path for the transmission of intended signals into or out of the shielded region. It can also be a consciously made opening for passing power, water, mechanical forces, or even personnel from the outside to the interior, or vice versa

#### 3.8

##### **disturbance**

see electromagnetic disturbance

#### 3.9

##### **electromagnetic barrier (shield)**

topologically closed surface made to prevent or limit EM fields and conducted transients from entering the enclosed space. The barrier consists of the shield surface and points-of-entry treatments, and it encloses the protected volume

**3.10****electromagnetic disturbance**

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

[IEV 161-01-05, modified]

**3.11****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.

[IEV 161-01-06, modified].

**3.12****electromagnetic stress**

an electromagnetic stress is a voltage, current or electromagnetic field which acts on equipment. If the electromagnetic stress exceeds the vulnerability threshold of the equipment, mission-aborting damage or upset may occur. The stress may be described by characteristics such as peak amplitude, rise time, duration or impulse

**3.13****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].

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**3.14****environment**

electromagnetic field arising from an external source that excites a system, possibly causing damage, upset or loss of function

**3.15****failure level**

specification of the amplitude (or other waveform attribute) of an electromagnetic field or induced current (or voltage) that, when applied to an electrical component or system, causes a failure in the device

**3.16****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.

**3.17****high power electromagnetics****HPEM**

the general area or technology involved in producing intense electromagnetic radiated fields or conducted voltages and currents which have the capability to damage or upset electronic systems. Generally these disturbances exceed those produced under normal conditions (e.g. 100 V/m and 100 V)

**3.18**  
**high power microwaves**  
**HPM**

subset of the HPEM environment, typically consisting of a narrowband signal having a pulsed peak power at the source in excess of 100 MW

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.

**3.19**  
**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]

**3.20**  
**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]

**3.21**  
**inadvertent [EM] penetration**

an opening, not deliberately made, that may provide a path for electromagnetic ("EM") energy through the EM shield. Most often inadvertent penetration is undesired. Typically, leakage through imperfectly conducting material is considered as an inadvertent penetration

**3.22**  
**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 purpose

**3.23**  
**interaction sequence diagram**  
**ISD**

graphical description of the paths that an external EM field is able to penetrate through one of more shields surrounding a system or equipment

**3.24**  
**narrowband**

signal or a waveform with a *pbw* (defined in 3.27) of <1 % or a bandratio (defined in 3.2) <1.01

**3.25**  
**nuclear electromagnetic pulse**  
**NEMP**

all types of electromagnetic fields produced by a nuclear explosion

**3.26**  
**penetration**

transfer of electromagnetic energy through an electromagnetic barrier from one volume to another. This can occur by field diffusion through the barrier, by field leakage through apertures, and by electrical current passing through conductors connecting the two volumes (wires, cables, conduits, pipes, ducts, etc.)

**3.27****percentage bandwidth*****pbw***

bandwidth of a waveform, expressed as a percentage of the centre frequency of that waveform

NOTE *pbw* has a maximum value of 200 % when the centre frequency is the mean of the high and low frequencies; *pbw* does not apply to signals with a large d.c. content (ex: HEMP), for which the bandratio decades is used.

**3.28****point/port-of-entry****PoE**

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

NOTE 1 A PoE is not limited to a geometrical point.

NOTE 2 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 functions they serve.

**3.29****radiated susceptibility**

susceptibility of a system to radiated electromagnetic fields

**3.30****rebar**

shortening of the words "reinforcing bar", which refers to the steel reinforcing rods located within poured concrete to enhance structural integrity

**3.31****shielding**

act of reducing the magnitude of an electric or magnetic field provided by a good electrical conductor such as sheet steel, reinforcing bars loops, conduit, etc. Also understood frequently as the enclosure that provides this reduction

**3.32****short pulse****SP**

a transient signal with a rise time and pulse duration measured in ps or ns

**3.33****surge protection device****SPD**

device to suppress line conducted overvoltages and currents, such as surge suppressors defined in IEC 61024-1

**3.34****system**

(1) collection of subsystems, assemblies and/or components that function together in a coherent way to accomplish a basic mission;

(2) collection of equipment, subsystems, skilled personnel, and techniques capable of performing or supporting a defined operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for its operation to the degree that it can be considered self sufficient within its operational or support environment.