

# INTERNATIONAL STANDARD



BASIC EMC PUBLICATION

**Electromagnetic compatibility (EMC) –  
Part 4-23: Testing and measurement techniques – Test methods for protective  
devices for HEMP and other radiated disturbances**

IEC 61000-4-23:2016

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IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## ELECTROMAGNETIC COMPATIBILITY (EMC) –

**Part 4-23: Testing and measurement techniques –  
Test methods for protective devices for HEMP  
and other radiated disturbances**

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International Standard IEC 61000-4-23 has been prepared by subcommittee 77C: High power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms Part 4-23 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) updates to the shielding effectiveness (SE) test method in Clause 5;
- b) a new Annex F describing methods for testing 'inside-to-out' has been added.



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

CDV	Report on voting
77C/253/CDV	77C/257/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- withdrawn,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.

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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  
Mitigation methods and devices

### **Part 6: Generic Standards**

### **Part 9: Miscellaneous**

Each part is further subdivided into several parts, published either as international standards, 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).

The IEC has initiated the preparation of standardized methods to protect civilian society from the effects of high power electromagnetic (HPEM) environments. Such effects could disrupt systems for communications, electric power, information technology, etc.

This part of IEC 61000 is an international standard that establishes the test concepts, set-ups, required equipment, and test procedures for protective devices against HEMP radiated disturbances.

Annex F provides examples of the SE test method placing the TX antenna inside the barrier.

## ELECTROMAGNETIC COMPATIBILITY (EMC) –

### Part 4-23: Testing and measurement techniques – Test methods for protective devices for HEMP and other radiated disturbances

#### 1 Scope

This part of IEC 61000 provides a protective devices test method for HEMP and other radiated disturbances. It is primarily intended for HEMP testing but can be applied to other externally generated radiated disturbances where appropriate. It provides a brief description of the most important concepts for testing of shielding elements. For each test, the following basic information is provided:

- theoretical foundation of the test (the test concepts);
- test set-up including outside-to-in and inside-to-out measurements;
- required equipment;
- test procedures;
- data processing.

This international standard does not provide information on requirements for specific levels for testing.

This part of IEC 61000 has been updated to include a new test method.

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Due to the available space, a transmitting antenna position outside the barrier has mainly been suggested. However, nowadays, many EMP protection facilities in practical use do not actually have enough space available outside the electromagnetic barrier due to physical constraints such as concrete walls or soil to allow the method described in IEC 61000-4-23:2000 (edition 1) to be applied correctly. From experience many facilities have available space for a 1 m separation or less only.

Therefore, in many practical cases it is not possible to measure shielding effectiveness according to the test method of previous documents. The constructors for EMP protection facilities are also unwilling to build facilities with extra space for measurements with the transmitting antenna outside the barrier due to the great expense and inefficiency of the operational working area for new or existing buildings.

This document provides additionally a method that allows the transmitting antenna to be placed inside the enclosure and the receiving antenna outside the barrier ('inside-to-out' method). Annex F includes test set-up and procedure examples.

#### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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) – Part 161: Electromagnetic compatibility* (available at [www.electropedia.org](http://www.electropedia.org))

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

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

### 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

##### **aperture**

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

#### 3.2

##### **aperture point-of-entry**

intentional or inadvertent holes, cracks, openings or other discontinuities in a shield surface

Note 1 to entry: Intentional aperture points-of-entry are provided for personnel and/or equipment entry and egress and for ventilation through an electromagnetic barrier.

#### 3.3

##### **attenuation**

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

#### 3.4

##### **bandwidth (of a device)**

width of a frequency band over which a given characteristic of an equipment or transmission channel does not differ from its reference value by more than a specified amount or ratio

[SOURCE: IEC 60050-161:1990, 161-06-09, modified – the note has been deleted.]

#### 3.5

##### **bandwidth (of an emission or signal)**

width of the frequency band outside which the level of any spectral component does not exceed a specified percentage of a reference level

[SOURCE: IEC 60050-161:1990, 161-06-10]

#### 3.6

##### **bounded wave simulator**

type of simulator for producing electromagnetic fields in a localized region of space referred to as a "test volume"

#### 3.7

##### **box**

enclosure that contains electrical equipment

Note 1 to entry: Such boxes usually contain modules of subsystems.

#### 3.8

##### **broadband**

##### **3.8.1**

##### **broadband**

<emission> emission which has a bandwidth greater than that of a particular measuring apparatus or receiver

**3.8.2****broadband device**

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

[SOURCE: IEC 60050-161:1990, 161-06-12]

**3.9****circuit**

collection of interconnected electronics forming one or more closed paths

**3.10****conductive point-of-entry**

electrical wire or cable or other conductive object, such as a metal rod, which passes through the electromagnetic barrier

**3.11****coupling**

interaction of electromagnetic fields with electrical systems, whereby part of the energy of the field is transferred to the system

**3.12****current injection test**

test technique by which, through some external means, a current is forced to flow in a circuit at a desired location

Note 1 to entry: For EMP testing purposes, it is a process by which simulated EMP transient current pulses are introduced into a component, circuit or system to measure damage or upset thresholds.

**3.13****cut-off frequency**

<waveguide> lowest frequency for which there is no attenuation of the electromagnetic fields propagating in a lossless waveguide

Note 1 to entry: Below this frequency, the fields attenuate exponentially with distance along the waveguide.

**3.14****dipole**

straight antenna, usually fed in the center, that produces maximum radiation in a plane normal to its principal axis

**3.15****direct drive**

excitation of an electrical system by directly applying a voltage or current source (either transient or continuous wave) to system cables or surfaces as a means of simulating the effects of transient EM pulses

Note 1 to entry: See current injection test (3.12).

**3.16****direct field penetration**

penetration of the system shielding by the EM field

**3.17****direction of propagation**

direction of the electromagnetic plane-wave propagation vector  $k$ , which is perpendicular to the plane containing the vectors of the electric and the magnetic fields

**3.18**  
**electric field strength***E*

magnitude of the electric field vector of an electromagnetic wave or of a field created by an electric charge distribution, measured in volt per meter

**3.19**  
**electromagnetic barrier shield**

topologically closed surface made to prevent or limit EM fields and conducted transients from entering the enclosed space

Note 1 to entry: The barrier consists of the shield surface and PoE treatments and it encloses the protected volume.

**3.20**  
**electromagnetic disturbance**

any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

[SOURCE: IEC 60050-161:1990, 161-01-05]

**3.21**  
**electromagnetic environment**

totality of electromagnetic phenomena existing at a given location

[SOURCE: IEC 60050-161:1990, 161-01-01, modified – the note has been deleted.]

**3.22**  
**electromagnetic pulse**  
**EMP**

all types of electromagnetic fields produced by a nuclear explosion

Note 1 to entry: Electromagnetic pulse is also referred to as nuclear electromagnetic pulse (NEMP).

**3.23**  
**(electromagnetic) radiation**

- a) phenomenon by which energy in the form of electromagnetic waves emanates from a source into space
- b) energy transferred through space in the form of electromagnetic waves

[SOURCE: IEC 60050-161:1990, 161-01-10, modified – the note has been deleted.]

**3.24**  
**electromagnetic topology**

description of the interconnection of shields or electromagnetic barriers in a system that limit the EMP environment within the system

**3.25**  
**external coupling**

process by which an incident electromagnetic field strikes the exterior portions of a conducting system enclosure and induces currents and charges

**3.26**  
**gasket**

element, normally electrically conductive and flexible, used to seal an aperture in an enclosure

**3.27****inside-to-out**

test method where the transmitting antenna is placed inside and the receiving antenna is placed outside the shielded enclosure

**3.28****hardening**

process of decreasing the vulnerability of a system or component by design techniques, for example by protecting against, or decoupling from, an undesirable external environment such as EMP

**3.29****high-altitude electromagnetic pulse****HEMP**

electromagnetic pulse produced when a nuclear explosion occurs outside the earth's atmosphere, typically above an altitude of 30 km

**3.30****hyperband**

spectrum of EM field with a band ratio greater than 10

**3.31****impulse radiating antenna****IRA****half IRA****full IRA**

full IRA with a full parabolic dish or half IRA with a divided parabolic dish on a conducting ground plane and an impedance transformer from 50  $\Omega$  to 100  $\Omega$

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**3.32****inside-to-out**

alternative test method where the receiving antenna is placed outside and the transmitting antenna is placed inside of the shielded enclosure

**3.33****magnetic field strength*****H***

magnitude of the magnetic field vector of an electromagnetic wave, or the field produced by a current flowing in a wire, loop antenna, etc., measured in amperes per meter

**3.34****outside-to-in**

conventional test method where the receiving antenna is placed inside and the transmitting antenna is placed outside of the shielded enclosure

**3.35****overall shielding****global shielding**

protection of an entire entity by use of a single shielding enclosure or some practical equivalent, such as the protection of the contents of an entire building by shielding the entire building

**3.36****penetration**

transfer of electromagnetic energy through an electromagnetic barrier from one volume to another