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INTERNATIONAL STANDARD

colour inside

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



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 5-6: Installation and mitigation guidelines – Mitigation of external EM influences

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IEC 61000-5-6 has been prepared by subcommittee 77C: High power transient phenomena, of IEC technical committee 77: Electromagnetic compatibility. It is an International Standard.

This first edition cancels and replaces the first edition of IEC TR 61000-5-6 published in 2002. This edition constitutes a technical revision.

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

a) updating the whole document to include other HPEM environments including IEMI;
b) adding a new Annex A which provides details on the concept of EM resilience and includes information on HPEM detectors, recovery and restoration.

The text of this International Standard is based on the following documents:

Draft	Report on voting
77C/339/FDIS	77C/340/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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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 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 5-6: Installation and mitigation guidelines – Mitigation of external EM influences

1 Scope

This part of IEC 61000 covers guidelines for the mitigation of external electromagnetic influences impinging upon a facility or installation, aimed at ensuring electromagnetic compatibility (EMC) among electrical and electronic apparatus or systems. These influences include lightning, RF transmitters, power-line and telecom transients, high-altitude electromagnetic pulse (HEMP) and other high-power electromagnetic transients such as those from intentional electromagnetic interference (IEMI).

This document is intended for use by installers, manufacturers and users of sensitive electrical or electronic installations or systems. It applies primarily to new installations but, where economically feasible, it can be applied to extensions or modifications to existing facilities.

While the technical principles are applicable to individual equipment or apparatus, such application is not included in the scope of this document.

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 60364 (all parts), *Low-voltage electrical installations*

IEC TR 61000-5-2, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling*

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 62305 (all parts), *Protection against lightning*

IEEE Std 1848-2020, *Techniques and Measurement to Manage Functional Safety and Other Risks with Regards to Electromagnetic Disturbances*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
apparatus
device or assembly of devices which can be used as an independent unit for specific functions

Note 1 to entry: In English, the term "apparatus" sometimes implies use by skilled persons for professional purposes.

[SOURCE: IEC 60050-151:2001, 151-11-22]

3.1.2
attenuation
ratio of the input to the output values of quantities of the same kind in a device or system

Note 1 to entry: When this ratio is less than unity it is usually replaced by its reciprocal, the gain.

[SOURCE: IEC 60050-312:2001, 312-06-06]

3.1.3
device
material element or assembly of such elements intended to perform a required function

Note 1 to entry: A device may form part of a larger device.

[SOURCE: IEC 60050-151:2001,151-11-20]

3.1.4
earthing
grounding, US
electric connections between conductive parts and local earth

[SOURCE: IEC 60050-195:2021, 195-01-24]

3.1.5
earth electrode
ground electrode, US
conductive part that is in electric contact with local earth, directly or through an intermediate conductive medium

[SOURCE: IEC 60050-195:2021,195-02-01]

3.1.6
earthing arrangement
grounding arrangement, US
all electrical means involved in the earthing of a system, installation or equipment

Note 1 to entry: Electric connection and devices used for earthing are examples of electrical means.

[SOURCE: IEC 60050-195:2021,195-02-20]

3.1.7
electromagnetic compatibility
EMC
ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[SOURCE: IEC 60050-161:2018,161-01-07]

3.1.8
electromagnetic disturbance
electromagnetic phenomenon that can degrade the performance of a device, equipment or system, or adversely affect living or inert matter

Note 1 to entry: An electromagnetic disturbance can be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

Note 2 to entry: In French, the terms "perturbation électromagnétique" and "brouillage électromagnétique" designate respectively the cause and the effect and should not be used indiscriminately.

Note 3 to entry: In English, the terms "electromagnetic disturbance" and "electromagnetic interference" designate respectively the cause and the effect and should not be used indiscriminately.

[SOURCE: IEC 60050-161:2018, 161-01-05]

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

Note 1 to entry: In French, the terms "perturbation électromagnétique" and "brouillage électromagnétique" designate respectively the cause and the effect and should not be used indiscriminately.

Note 2 to entry: In English, the terms "electromagnetic disturbance" and "electromagnetic interference" designate respectively the cause and the effect and should not be used indiscriminately.

[SOURCE: IEC 60050-161:2018,161-01-06]

3.1.10
electromagnetic screen
electromagnetic shield (US)
screen of conductive material intended to reduce the penetration of a time-varying electromagnetic field into a given region

[SOURCE: IEC 60050-151:2001, 151-13-12]

3.1.11
equipment
single apparatus or set of devices or apparatuses, or the set of main devices of an installation, or all devices necessary to perform a specific task

Note 1 to entry: Examples of equipment are a power transformer, the equipment of a substation, measuring equipment.

[SOURCE: IEC 60050-151:2001,151-11-25]

3.1.12
equipotential bonding
set of electric connections intended to achieve equipotentiality between conductive parts

[SOURCE: IEC 60050-195:2021, 195-01-10]

3.1.13
facility
entity (such as a hospital, a factory, machinery, etc.) that is built, constructed, installed or established to perform some particular function or to serve or facilitate some particular end

3.1.14
filter
linear two-port device designed to transmit spectral components of the input quantity according to a specified law, generally in order to pass the components in certain frequency bands and to attenuate those in other bands

[SOURCE: IEC 60050-151:2001,151-13-55]

3.1.15
high-altitude electromagnetic pulse
HEMP
electromagnetic pulse produced by a nuclear explosion outside the earth's atmosphere

Note 1 to entry: This typically occurs above an altitude of 30 km.

3.1.16
intentional electromagnetic environment
IEME
totality of high-power transient radiated or conducted electromagnetic phenomena, which are generated intentionally to produce interference in electrical and electronic systems

Note 1 to entry: IEMEs can be generated for defence, law enforcement or for malicious purposes.

3.1.17
intentional electromagnetic interference
IEMI
effect of an intentional electromagnetic environment introducing noise or signals into electrical and electronic systems, thus disrupting, confusing or damaging these systems

3.1.18
installation
one apparatus or a set of devices and/or apparatuses associated in a given location to fulfil specified purposes, including all means for their satisfactory operation

[SOURCE: IEC 60050-151:2001, 151-11-26]

3.1.19
local earth
local ground, US
part of the earth that is in electric contact with an earth electrode and that has an electric potential not necessarily equal to zero

[SOURCE: IEC 60050-195:2011, 195-01-03]

3.1.20
port of entry
PoE
physical location (point) on an electromagnetic barrier, where EM energy can 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.

3.1.21
residual current
peak current that appears at the output terminals of an SPD or filter during application of a standard stress at the input terminals

3.1.22
residual voltage
peak value of voltage that appears at the output terminals of an SPD or filter during application of a standard stress at the input terminals

3.1.23
resilience
electromagnetic resilience
features of a system that enable the system to be prepared for, to withstand, to respond to and to recover from a transient electromagnetic disturbance(s) in a timely and efficient manner

3.1.24
screen
shield (US)
device intended to reduce the penetration of an electric, magnetic or electromagnetic field into a given region

[SOURCE: IEC 60050-151:2001, 151-13-09]

3.1.25
shielded enclosure
screened room
mesh or sheet metallic housing designed expressly for the purpose of separating electromagnetically the internal and the external environment

[SOURCE:IEC 60050-161:1990, 161-04-37]

3.1.26
shielding effectiveness
for a given external source, ratio of electric or magnetic field strength at a point before and after the placement of the shield in question

3.1.27
surge-protective device
SPD
device that is intended to protect the electrical apparatus from transient overvoltages and to divert surge currents

Note 1 to entry: A surge-protective device contains at least one non-linear component.

[SOURCE: IEC 60050-614:2016, 614-03-48, modified – "SPD" has been added to the term.]

3.1.28
system
set of interrelated elements considered in a defined context as a whole and separated from their environment

Note 1 to entry: A system is generally defined with the view of achieving a given objective, e.g. by performing a definite function.

Note 2 to entry: Elements of a system can be natural or man-made material objects, as well as modes of thinking and the results thereof (e.g. forms of organization, mathematical methods, programming languages).

Note 3 to entry: The system is considered to be separated from the environment and the other external systems by an imaginary surface, which cuts the links between them and the system.

Note 4 to entry: The term "system" should be qualified when it is not clear from the context to what it refers, e.g. control system, colorimetric system, system of units, transmission system.

[SOURCE: IEC 60050-151:2001, 151-11-27]

3.1.29
waveguide below cut-off
evanescent waveguide (deprecated)
cut-off waveguide (deprecated)
waveguide used below the waveguide cut-off frequency

[SOURCE: IEC 60050-726:1982, 726-03-19]

3.2 Abbreviated terms

CCTV	closed circuit television
DM-DM	differential-mode-to-differential-mode
EMC	electromagnetic compatibility
EMI	electromagnetic interference
ESM	Electronic surveillance measures
HEMP	high-altitude electromagnetic pulse
HPEM	high-power electromagnetic
HVAC	heating ventilation and air conditioning
ICT	information communications technology
IEMI	intentional electromagnetic interference
PoE	port of entry
SPD	surge-protective device
UPS	uninterruptible power supply

4 Overview and general considerations

4.1 Overview

This part of IEC 61000 covers guidelines for the mitigation of external electromagnetic influences impinging upon a facility, aimed at ensuring electromagnetic compatibility (EMC) among electrical and electronic apparatus or systems. These influences include lightning, RF transmitters, power-line and telecom transients, high-altitude electromagnetic pulse (HEMP) and other high-power electromagnetic transients such as those from intentional electromagnetic interference (IEMI). More particularly, this document is concerned with a protection-led approach which includes concepts such as the arrangement of shielding and screening against radiated disturbances, and with mitigation of conducted disturbances. These arrangements include appropriate electromagnetic barriers for industrial, commercial, and residential installations. Mitigation shall be required if EMC between an apparatus and its intended operating environment is not achieved or is not likely to be achievable.

The concept of barriers installed for mitigating potentially penetrating and unwanted electromagnetic noise is applicable even when there is no designed-in electromagnetic shield. The enclosure through which power and signal (communications, control, etc.) cables can enter or exit, can be considered as a potential electromagnetic barrier that will provide some level of protection. The concept of enclosures can be understood as the perimeter walls of a building, the walls of a single room, or the housing of an apparatus, with protection installed at all points of electromagnetic penetration into the enclosure.

Where human functional safety risks (as defined in IEC 61508-1) have to be reduced to acceptable levels, it is probable that the EMI protections and mitigations described in this document will not be sufficient, and that the electromagnetic resilience approach described in IEEE Std 1848™-2020 will also be necessary.