

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Electromagnetic compatibility (EMC) –
Part 6-5: Generic standards – Immunity for equipment used in power station and
substation environment**

**Compatibilité électromagnétique (CEM) –
Partie 6-5: Normes génériques – Immunité pour les équipements utilisés dans
les environnements de centrales électriques et de postes**



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les environnements de centrales électriques et de postes**

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ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 6-5: Generic standards – Immunity for equipment used
in power station and substation environment**

FOREWORD

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International Standard IEC 61000-6-5 has been prepared by committee 77: Electromagnetic compatibility (EMC).

This first edition cancels and replaces the first edition of IEC TS 61000-6-5 published in 2001. This edition constitutes a technical revision.

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

- a) the scope is extended in order to cover also power generating systems in industrial facilities;
- b) the locations under consideration, i.e. power stations and substations are described in more detail;
- c) performance criteria and the EUT functions they apply to are reviewed;

- d) immunity requirements are reviewed and more specifically related to the relevant locations;
- e) informative annexes for guidance and on protected zones are added.

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

FDIS	Report on voting
77/484/FDIS	77/500/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.

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 web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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INTRODUCTION

IEC 61000 series 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

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Each part is further subdivided into sections which are to be 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).

This International Standard deals with the electromagnetic compatibility (EMC) of equipment used in the generation, transmission and distribution of electricity and related telecommunication systems.

Several EMC product standards have been published by technical committees dealing with different application areas in the generation, transmission and distribution of electricity and related telecommunication systems, for example:

- fixed power supply installations and apparatus for railway applications (TC 9),
- switchgear and controlgear (TC 17),
- instrument transformers (TC 38),
- nuclear instrumentation (TC 45),
- power systems management and associated information exchange (TC 57),
- industrial-process measurement and control – system aspects (SC 65A),
- measuring relays and protection equipment (TC 95), etc.

The requirements specified in these product standards consider product-specific aspects only. It is the task of this generic standard IEC 61000-6-5 to specify a set of essential requirements, test procedures and generalized performance criteria applicable to such products or systems operating in this electromagnetic environment.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 6-5: Generic standards – Immunity for equipment used in power station and substation environment

1 Scope and object

This part of IEC 61000 specifies EMC immunity requirements which apply to electrical and electronic equipment intended for use in power stations and substations, as described below. Immunity requirements for electromagnetic phenomena with spectral contributions in the frequency range 0 Hz to 400 GHz are covered. No tests need to be performed at frequencies or for phenomena where no requirements are specified.

This international standard sets immunity test requirements for equipment intended for use in the generation, transmission and distribution of electricity and related telecommunication systems. The electromagnetic environments encompassed by this standard are those which exist at locations

- in power stations, and
- in high and medium voltage substations.

Installations to generate or convert into electrical power inside industrial facilities are also covered by this standard as long as they, at their primary electrical connection, cannot be directly connected to the LV power network, e.g. where the generator output voltage is medium voltage or higher. Power installations that directly provide power into the low voltage network (such as photovoltaic cells or combined heat power systems in private houses) are not covered by this standard.

NOTE 1 In general, power stations comprise installations which are mainly built to convert some kind of primary energy into electrical energy. Moreover, these power stations are connected to the medium or high voltage power system directly or via a step-up transformer.

The object of this standard is to define immunity test requirements for equipment defined in the scope in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges.

The immunity test requirements are given on a port-by-port basis, and selected according to the location, with differentiated levels for equipment to be installed in power stations or substations. In special cases, situations will arise where the level of electromagnetic disturbances may exceed the levels specified in this standard; in these instances, special mitigation measures should be adopted.

The immunity requirements are suitable for satisfying the particular needs related to the functions and tasks of equipment and systems, for which reliable operation is required under realistic electromagnetic conditions; in this respect, this standard establishes performance criteria for different functional requirements.

This generic EMC immunity standard is applicable if no relevant dedicated product or product-family EMC immunity standard exists. According to IEC Guide 107, this generic standard should be considered for the preparation or revision of any EMC standard referring to specific products used in power stations and substations.

NOTE 2 Product standards covering EMC aspects for equipment to be used in power stations or substations are for example IEC 62271-1 (switchgear and controlgear), IEC 60255-26 (measuring relays and protection equipment) or IEC 62236-5 (fixed power supply installations and apparatus for railway applications).

Non-electronic high voltage and power equipment (primary system) are excluded from the scope of this standard.

Emission requirements are not within the scope of this standard and are covered by relevant product or product-family standards.

NOTE 3 Where no dedicated product or product family standard covering emission requirements exists, the generic standard IEC 61000-6-4 applies.

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 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

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 – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – 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 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-16, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz*

IEC 61000-4-17, *Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on d.c. input power port immunity test*

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

IEC 61000-4-29, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*

IEC 61000-4-34, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

NOTE The definitions related to EMC and to relevant electromagnetic phenomena can be found in IEC 60050-161 and in other IEC publications.

3.1.1

connections to HV equipment

connections from control equipment to HV equipment such as circuit breakers, current transformers, voltage transformers, power line carrier systems

3.1.2

DC distribution network

local DC electricity supply network in the infrastructure of a certain site or building intended for flexible use by one or more different types of equipment and guaranteeing continuous power supply independently from the conditions of the public mains network

Note 1 to entry: Connection to a remote local battery is not regarded as a DC distribution network, if such a link comprises only power supply for a single piece of equipment.

3.1.3

enclosure port

physical boundary of the equipment through which electromagnetic fields may radiate or impinge on

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3.1.4

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]

3.1.5

field connections

cables which are intended to be connected to process equipment of the plant, within the same earth network

EXAMPLE

Examples of this category are:

- connections from control room or equipment room to the field of power stations and HV substations;
- connections to low voltage power equipment;
- connections within the relay house or telecommunication house of HV substations, where no special mitigation measures are adopted (e.g. shielding);
- field bus.

Note 1 to entry: Those cable ports of process instrumentation which are self-powered through the signal conductors (e.g. 4 mA to 20 mA) are considered as signal ports.

**3.1.6
high voltage
HV**

set of voltage levels in excess of medium voltage

Note 1 to entry: In the context of this standard the following terms for system voltage are used (see also 3.1.9):

- low voltage (LV) refers to $U_n \leq 1$ kV;
- medium voltage (MV) refers to $1 \text{ kV} < U_n \leq 36$ kV;
- high voltage (HV) refers to voltage above 36 kV and includes EHV and UHV.

**3.1.7
installation**

several combined items of equipment (including cables) put together at a given place to fulfil a specific task

**3.1.8
low voltage**

set of voltage levels used for the distribution of electricity and whose upper limit is generally accepted to be 1 000 V a.c.

[SOURCE: IEC 60050-601:1985, 601-01-26]

**3.1.9
medium voltage
MV**

any set of voltage levels lying between low and high voltage

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Note 1 to entry: The boundaries between medium and high voltage levels overlap and depend on local circumstances and history or common usage. Nevertheless the band 30 kV to 100 kV frequently contains the accepted boundary.

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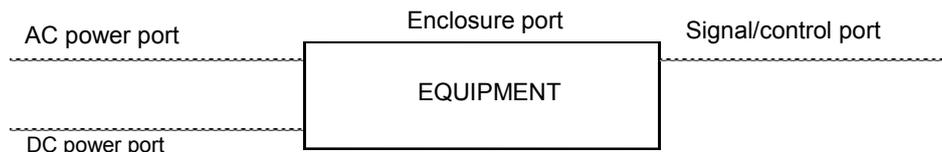
Note 2 to entry: In the context of this standard, medium voltage is defined as the voltage range of $1 \text{ kV} < U_n \leq 36$ kV.

[SOURCE: IEC 60050-601:1985, 601-01-28, modified – a note to entry 2 has been added.]

**3.1.10
port**

particular interface of the equipment which couples this equipment with, or is influenced by, the external electromagnetic environment

Note 1 to entry: Examples of ports of interest are shown in Figure 1. The enclosure port is the physical boundary of the equipment (e.g. enclosure). The enclosure port provides for radiated and electrostatic discharge (ESD) energy transfer, whereas the other ports provide for conducted energy transfer.



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Figure 1 – Equipment ports

3.1.11**power port**

port at which a conductor or cable carries the primary electrical power needed for the operation (functioning) of equipment

3.1.12**power station**

installation whose purpose is to generate electricity and which includes civil engineering works, energy conversion equipment and all the necessary ancillary equipment

[SOURCE: IEC 60050-601:1985, 601-03-01]

3.1.13**protected area**

area inside an installation in which electromagnetic phenomena appear in a mitigated extent compared to other areas of the same installation

Note 1 to entry: Mitigation can be provided for example by means of shielding or filtering.

3.1.14**signal/control port**

port at which a conductor or cable intended to carry signals is connected to equipment

Note 1 to entry: Examples are analog inputs, outputs and control lines; data busses; communication lines, fibre-optic lines containing metallic conductors, etc.

3.1.15**substation (of a power system)**

part of an electrical system, confined to a given area, mainly including ends of transmission or distribution lines, electrical switchgear and control gear, buildings and transformers. A substation generally includes safety or control devices (for example protection)

Note 1 to entry: The substation can be qualified according to the designation of the system of which it forms a part. Examples: transmission, substation (transmission system), distribution substation, 400 kV or 20 kV substation.

[SOURCE: IEC 60050-601:1985, 601-03-02]

3.1.16**switchgear**

general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy

[SOURCE: IEC 60050-441:2000, 441-11-02]

3.1.17**system**

several items of equipment combined to fulfil a specific task as a single functional unit

3.1.18**telecommunication connections**

communication cables which reach the border of the earth network of the plant for interfacing with a telecommunication network or with a remote equipment without any particular insulation barrier

3.2 Abbreviations

AIS	Air insulated switchgear
CRT	Cathode ray tube
CT	Current transformer
EHV	Extra high voltage
ESD	Electrostatic discharge
EUT	Equipment under test
GIS	Gas insulated switchgear
HV	High voltage
MTU	Master terminal unit
MV	Medium voltage
PLC	Power line communication
PT	Power transformer
RTU	Remote terminal unit
UHV	Ultra high voltage
UPS	Uninterruptable power systems

4 Electromagnetic environment

The typical locations covered by this international standard are power stations (see Figure 2), medium voltage (MV) and high-voltage (HV) substations, comprising air insulated switchgear (AIS) (see Figure 3), and/or gas insulated switchgear (GIS) (see Figure 4). In Figure 2, the solid lines do not represent physical boundaries between the areas where the equipment is installed. They rather indicate boundaries between electromagnetic environments. It should be kept in mind that the electromagnetic environments can be different for items of equipment installed close to each other.

For the purpose of the specifications given in this international standard, the term "HV" is taken to mean extra high voltage and high voltage of 36 kV and above.

NOTE A different limit between MV and HV can be agreed upon between the parties involved and the manufacturer.

An overview of electromagnetic phenomena to be taken into account at the locations covered by this standard is given in Table 1. For the purpose of determining the need of the corresponding phenomenon as well as of the applicable performance criterion, the phenomena are grouped with respect to their nature and probability of occurrence. A survey of these electromagnetic phenomena is given in IEC TR 61000-2-5 and IEC 61000-4-1. Additional information on the typical sources and causes of electromagnetic disturbances is given in Annex A. Typical values of electromagnetic phenomena observed in high voltage substations and power stations can be found in the publications listed in the bibliography.

Table 1 – Characterization of the electromagnetic phenomena

Continuous phenomena	Transient phenomena with high occurrence	Transient phenomena with low occurrence
Voltage variations: – a.c. power supply – d.c. power supply ^a Harmonics, interharmonics ^a Signalling voltages ^a Ripple on d.c. power supply Power frequency variation ^a Conducted disturbances in the range 2 kHz to 150 kHz ^a Conducted disturbances in the range 1,6 MHz to 30 MHz ^a Power frequency magnetic field (according to IEC 61000-4-8) Radiated, radio frequency electromagnetic field Conducted disturbances, induced by radio-frequency fields Mains frequency voltage (according to IEC 61000-4-16)	Voltage dips (duration $\leq 0,02$ s): – a.c. power supply – d.c. power supply Voltage fluctuations Fast transient/burst Damped oscillatory/ring wave Damped oscillatory magnetic field Electrostatic discharge	Voltage dips (duration $> 0,02$ s): – a.c. power supply – d.c. power supply Voltage interruptions: – a.c. power supply – d.c. power supply Short duration power frequency variation ^{a, b} Surge Short duration power frequency voltage Short duration power frequency magnetic fields (according to IEC 61000-4-8) Radiated pulsed disturbances
^a Not covered in this standard by dedicated immunity requirements.		
^b In case of islanded systems (e.g. not connected to a public network), the characterization of the phenomenon changes from "low occurrence" to "high occurrence".		

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<https://standards.iteh.ai/catalog/standards/sist/826d7c18-14b9-479d-9006-61000-6-5>

Items of equipment are installed and implemented within power stations and substations according to the rules/guidelines given by the manufacturers. It is essential that these items of equipment operate according to the specified performances when exposed to the variety of electromagnetic phenomena, conducted and radiated, typical of these installations.

In addition to the mentioned electrical plants, equipment can be installed in control centres, radio repeaters, or low voltage distribution points in industrial, commercial or residential areas. These locations are covered by other generic standards or product standards.

In some cases, special mitigation measures (e.g. use of special cabling, shielding of some areas, and/or avoidance of interference sources, etc.) are taken in order to create a "protected area" and to reduce the immunity requirements accordingly. This allows the use of equipment that does not meet the requirements of this standard.

A protected area can be created by means of mitigation measures and/or avoidance of disturbance sources in order to reduce immunity requirements to the immunity levels of product standards or generic standards.

In this document a protected area (see 3.1.13) is considered as a location where at least the requirements of IEC 61000-6-1 are sufficient to demonstrate immunity (see Annex C for further information).