TECHNICAL REPORT

IEC TR 61000-2-14

First edition
2006-12

Electromagnetic compatibility (EMC) –

Part 2-14:
Environment – Overvoltages on public electricity distribution networks

Reference number
IEC/TR 61000-2-14:2006(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

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International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE X

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 2-14: Environment – Overvoltages on public electricity distribution networks

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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The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 61000-2-14, which is a technical report, has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

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

Enquiry draft	Report on voting
77A/540/DTR	77A/547/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.

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 2-14: Environment – Overvoltages on public electricity distribution networks

1 Scope

This part of IEC 61000 describes the electromagnetic environment with respect to the voltages in excess of normal that are found on electricity supply networks operating at low and medium nominal voltages and that can be impressed on equipment connected to those networks, without considering further effects (e.g. amplification or attenuation) within an installation. Since these overvoltages have the potential to hinder the functioning of electrical and electronic equipment, they fall within the definition of *electromagnetic disturbance* in the field of EMC. Various categories of overvoltage are described, based on relative magnitude, duration and energy content.

This Technical Report describes the phenomena of overvoltages, it does not specify compatibility levels and does not directly specify emission and immunity levels.

The report describes the various phenomena and processes that cause overvoltages, including the transfer into the networks concerned of overvoltages that originate in or traverse other networks and installations, including higher voltage networks and the installations of electricity users. The effects of overvoltages on equipment are outlined. Some case studies of overvoltage events are presented.

Recommendations are made regarding the general technical approach to mitigating the risk of equipment being hindered from operating as intended by the effects of overvoltages. (It is not the function of IEC publications to assign responsibility for mitigating measures to any of the parties involved.)

The purpose of this report is to ensure that this important category of electromagnetic disturbance is included in the description of the environment in Part 2 of IEC 61000. For that purpose, only a brief description is provided of the various overvoltages and their causes and effects. A much more detailed treatment can be found in IEC 62066. A UIE publication – *Guide to quality of electrical supply for industrial installations, Part VI: Transient and temporary overvoltages and currents* – has a similar content. Measurement methods are specified in IEC 61000-4-30.

NOTE This Technical Report does not include detailed measurement results for overvoltages, therefore it is not possible to provide an assessment of the probability of occurrence.

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*

3 Terms and definitions

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

3.1
back flashover
flashover of phase-to-earth insulation resulting from a lightning stroke to that part of the system which is normally at earth potential

3.2
breakdown
dielectric failure of an insulation under the effect of a strong electric field and/or by physico-chemical deterioration of the insulating material

3.3
direct lightning stroke
lightning striking a component of the network, e.g.: conductor, tower, substation equipment, etc.

3.4
declared supply voltage
U_c
normally the nominal voltage of the system. If by agreement between the electricity supplier and the consumer a voltage different from the nominal voltage is applied to the supply terminals, then this voltage is the declared voltage

3.5
disruptive discharge/flashover/sparkover
passage of an arc following dielectric breakdown

NOTE 1 The term “sparkover” (in French: “amorçage”) is used when a disruptive discharge occurs in a gaseous or liquid dielectric.

NOTE 2 The term “flashover” (in French: “contournement”) is used when a disruptive discharge occurs over the surface of a solid dielectric surrounded by a gaseous or liquid medium.

NOTE 3 The term “puncture” (in French: “perforation”) is used when a disruptive discharge occurs through a solid dielectric.

3.6
indirect lightning stroke
lightning stroke that does not strike directly any part of the network but that induces an overvoltage in that network

3.7
insulation coordination
selection of the dielectric strength of equipment in relation to the operating voltages and overvoltages which can appear on the system for which the equipment is intended to operate, taking into account the service environment and the characteristics of the available prevention and protective devices

[IEV 604-03-08, modified]

NOTE In this instance, the term "dielectric strength of the equipment" means its rated or its standard insulation level as defined in IEC 60071-1.

3.8
lightning arrester
surge diverter
/surge arrester/
surge protective device (SPD)
device designed to protect the electrical apparatus from high transient overvoltages and to limit the duration and frequently the amplitude of the follow-on current

3.9
lightning impulse
voltage impulse of a specified shape applied during dielectric tests with a virtual front duration of the order of 1 µs and a time to half value of the order of 50 µs

NOTE The lightning impulse is defined by the two figures giving these durations in microseconds; in particular the standard lightning impulse is: 1,2/50 µs.

3.10
long duration overvoltages
overvoltage with a duration in excess of 10 min

NOTE The magnitude of a long duration overvoltage is typically given as a r.m.s. value.

3.11
nominal voltage
U_N
the voltage by which a system is designated or identified

3.12
overvoltage
any voltage having a value, either peak or r.m.s., exceeding the maximum value of the corresponding declared voltage

3.13
per unit (p.u.)
methodology used to simplify equations and the presentation of electrical parameters by expressing them as a fraction of a reference parameter:

$$\text{p.u. value} = \left(\frac{\text{Actual}}{\text{Base}}\right)$$

where the Actual and Base values are of the same quantity, e.g. voltage, current, impedance etc.

NOTE Typically the Base value for voltage is the nominal voltage for fundamental frequency phenomena and the peak line to ground voltage for transients.

3.14
power frequency withstand voltage
r.m.s. value of sinusoidal power frequency voltage that the equipment can withstand during tests made under specified conditions and for a specified time

3.15
rise time (of a pulse)
the interval of time between the instants at which the instantaneous value of a pulse first reaches a specific lower value and then a specific upper value

NOTE Unless otherwise specified, the lower and upper values are fixed at 10 % and 90 % of the pulse magnitude.

3.16
short duration overvoltage
voltage swell
power frequency overvoltage with a duration lasting greater than one period (one cycle) and up to 10 min

NOTE The magnitude of a short duration overvoltage is typically given as a r.m.s. value.

3.17
surge
transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage

[IEV 161-8-11]

NOTE In some parts of the world the term “Impulse” is used to describe a short duration overvoltage characterised by a very rapid change in magnitude with a duration less than 200 μs.

3.18
temporary overvoltage
oscillatory overvoltage (at power frequency) at a given location, of relatively long duration and which is undamped or weakly damped

NOTE Temporary overvoltages usually originate from switching operations or faults (e.g. sudden load rejection, single-phase faults) and/or from non-linearities (ferroresonance effects, harmonics).

3.19
transient
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short when compared with the time-scale of interest

[IEV 161-02-01]

3.20
very short duration overvoltage (transient)
overvoltage with a duration from less than a microsecond to several periods at fundamental frequency

NOTE The magnitude of a very short duration overvoltage is typically given as a peak value.

3.21
voltage impulse
transient voltage wave applied to a line or equipment, characterized by a rapid increase, followed generally by a slower non-oscillatory decrease of the voltage

3.22
front time
***T*$_1$**
for a lightning impulse voltage T_1 is a virtual parameter defined as 1,67 times the interval T between the instants when the impulse is 30 % and 90 % of the peak value on the test voltage curve (points A and B, Figure 1)

3.23
time to half-value
***T*$_2$**
for a lightning impulse voltage T_2 is a virtual parameter defined as the time interval between the virtual origin, O_1, and the instant when the test voltage curve has decreased to half the peak value

4 Description of overvoltages

4.1 General

Overvoltages are an intrinsic phenomena present on all networks. Overvoltage events can be created in the public network or in the electricity user's installation. The dynamic response of a network to load switching, both planned and unplanned (faults) will result in the storage and release of energy. This transfer of energy will cause an overvoltage to be propagated within the network.