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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) –
Part 4-12: Testing and measurement techniques – Ring wave immunity test

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-12: Testing and measurement techniques – Ring wave immunity test

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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International Standard IEC 61000-4-12 has been prepared by subcommittee 77B: High frequency phenomena, of IEC technical Committee 77: Electromagnetic compatibility.

It forms Part 4-12 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

This third edition cancels and replaces the second edition published in 2006. This edition constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

a) addition of a mathematical modelling of ring wave waveform;
b) new Annex B on selection of generators and test levels;
c) new Annex C on explanatory notes;
d) new Annex D on measurement uncertainty;
e) addition of high speed CDN;
f) addition of a calibration procedure for CDN.

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

CDV	Report on voting
77B/764/CDV	77B/774/RVC

Full information on the voting for the approval of this International 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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).

This part is an International Standard which gives immunity requirements and test procedures related to ring waves. It should be noted that edition 1 of IEC 61000-4-12, published in 1995, covered immunity tests against two phenomena, ring waves and damped oscillatory waves. This situation was changed in edition 2, published in 2006, where IEC 61000-4-12 covered the ring wave phenomena only and the damped oscillatory wave phenomenon was moved into a new standard IEC 61000-4-18.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-12: Testing and measurement techniques – Ring wave immunity test

1 Scope ~~and object~~

This part of IEC 61000 relates to the immunity requirements and test methods for electrical and electronic equipment, under operational conditions, to ~~non-repetitive damped oscillatory transients (~~ ring waves~~)~~ occurring in low-voltage power, control and signal lines supplied by public and non-public networks.

The object of this document is to establish ~~the immunity requirements and~~ a common reference for evaluating ~~in a laboratory the performance of electrical and electronic equipment intended for residential, commercial and industrial applications, as well as of equipment intended for power stations and substations, as applicable~~ the immunity of electrical and electronic equipment when subjected to ring waves. The test method documented in this part of IEC 61000 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon.

NOTE As described in IEC Guide 107, this is a basic EMC publication for use by product committees of the IEC. As also stated in Guide 107, the IEC product committees are responsible for determining whether this immunity test standard ~~should be~~ is applied or not, and if applied, they are responsible for determining the appropriate test levels and performance criteria. TC 77 and its sub-committees are prepared to co-operate with product committees in the evaluation of the value of particular immunity test and test levels for their products.

This document defines:

– test voltage and current waveforms;
– a range of test levels;
– test equipment;
– test setups;
– test procedures.

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) – Chapter 161: Electromagnetic compatibility*~~

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at www.electropedia.org)

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 ~~161~~ (all parts) as well as the following apply.

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

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

~~NOTE Several of the most relevant terms and definitions from IEC 60050-161 are presented among the definitions below.~~

~~**3.1**~~
~~**burst**~~
~~sequence of a limited number of distinct pulses or an oscillation of limited duration~~

~~[IEV 161-02-07]~~

3.1.1
calibration
set of operations which establishes, by reference to standards, the relationship which exists under specified conditions, between an indication and a result of a measurement

Note 1 to entry: This term is based on the "uncertainty" approach.

Note 2 to entry: The relationship between the indications and the results of measurement can be expressed, in principle, by a calibration diagram.

[SOURCE: IEC 60050-311:2001, 311-01-09]

3.1.2
coupling
interaction between circuits, transferring energy from one circuit to another

3.1.3
coupling network
CN
electrical circuit for the purpose of transferring energy from one circuit to another

3.1.4
coupling/decoupling network
CDN
combination of a coupling network and a decoupling network

3.1.5
decoupling network
DN
electrical circuit for the purpose of preventing test voltages applied to the equipment under test (EUT) from affecting other devices, equipment, or systems which are not under test

3.1.6
immunity (to a disturbance)
ability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-01-20]

3.1.7
port
particular interface of ~~the EUT~~ an equipment, which couples this equipment with the external electromagnetic environment (IEC 60050-161:1990, 161-01-01) and through which the equipment is influenced by the environment

[SOURCE: IEC 60050-161:1990, 161-01-27]

3.1.8
ring wave
damped oscillation, whose damping time constant is of the order of one period

[SOURCE: IEC 60050-161:1990, 161-02-30]

3.1.9
rise time
T_r
interval of time between the instants at which the instantaneous value of an impulse first reaches 10 % value and then the 90 % value

[SOURCE: IEC 60050-161:1990, 161-02-05, modified – the content of the note has been included in the definition and "pulse" has been changed to "impulse"]

3.1.10
transient (adj and noun)
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest

[SOURCE: IEC 60050-161:1990, 161-02-01]

3.1.11
verification
set of operations which is used to check the test equipment system (e.g. the test generator and ~~the~~ its interconnecting cables) ~~and~~ to demonstrate that the test system is functioning ~~within the specifications given in Clause 6~~

Note 1 to entry: The methods used for verification may be different from those used for calibration.

~~NOTE 2 The procedure of 6.1.2 and 6.2.2 is meant as a guide to insure the correct operation of the test generator and other items making up the test set-up, so that the intended waveform is delivered to the EUT.~~

Note 2 to entry: For the purposes of this basic EMC standard this definition is different from the definition given in IEC 60050-311:2001, 311-01-13.

3.2 Abbreviated terms

AE	Auxiliary equipment
CD	Coupling device
CDN	Coupling/decoupling network
CLD	Clamping device
CN	Coupling network
DN	Decoupling network
EMC	Electromagnetic compatibility
EUT	Equipment under test
GDT	Gas discharge tube
MU	Measurement uncertainty

PDF Probability density function
PE Protective earth
RGP Reference ground plane
RWG Ring wave generator
SPD Surge protective device

4 General

4.1 Description of the phenomenon

The ring wave (described in Figure 1) is ~~a typical~~ an oscillatory transient, induced in low-voltage cables due to the switching of electrical networks and reactive loads, faults and insulation breakdown of power supply circuits or lightning. It is, in fact, the most diffused phenomenon occurring in power supply (high voltage, medium voltage, low voltage) networks, as well as in control and signal lines.

The ring wave is representative of a wide range of electromagnetic environments of residential, as well as industrial installations. It is suitable for checking the immunity of equipment in respect of the above-mentioned phenomena, which give rise to impulses characterized by sharp front-waves that, in the absence of filtering actions, are in the order of 10 ns to a fraction of μs. The duration of these impulses may range from 10 μs to 100 μs.

The rise time and duration of the ~~parameters~~ impulse are ~~subject to modification, depending~~ dependent on the propagation characteristics of the media and the path.

The propagation of the wave in the lines (power and signal) is always subject to reflections, due to the mismatching impedance (the lines are terminated ~~on their own~~ with loads or connected to protection devices, input line filters, etc.). These reflections produce oscillations, whose frequency is related to the propagation speed. The presence of parasitic parameters (e.g. stray capacitance of components like motors, transformer windings, etc.) are ~~other conditioning~~ additional influencing factors.

~~The rise time is reduced to slowing down due to the low-pass characteristic of the line involved in the propagation. This modification is more relevant for the fast rise times (in the order of 10 ns), and less relevant for values in the range of a fraction of μs.~~

~~The resultant phenomenon at the equipment ports is an oscillatory transient, or ring wave. This ring wave with a defined 0,5 μs rise time and 100 kHz oscillation frequency has been determined to be typical and is widely used by some industries for testing products.~~

The rise time can be increased by the low-pass characteristics of the line. This effect is more relevant for fast rise times (in the order of 10 ns), and less relevant for slow rise times (in the order of 1 μs).

Another cause of the ring wave is lightning, which itself is characterized by a unidirectional waveform (standard 1,2/50 μs impulse). Circuits subjected to the indirect effects of lightning (inductive coupling among lines) are influenced by the derivative of the primary impulse and the coupling mechanisms involved, which ~~gives rise to~~ can cause oscillations. The characteristics of the resulting ring wave depend on the reactive parameters of the ground circuits, metal structures involved in the lightning current flow, and the propagation in the low-voltage transmission lines.

The phenomenon, which is created by the above mentioned effects at the equipment ports, is an oscillatory transient or a ring wave. Oscillatory transients are covered in IEC 61000-4-18. A ring wave with a defined 0,5 μs rise time and 100 kHz oscillation frequency has been determined to be typical and is widely used for testing products.