IEC 61000-4-4

Edition 3.0 2012-04

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BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) –
Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test

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Compatibilité électromagnétique (CEM) –
Partie 4-4: Techniques d'essai et de mesure – Essai d'immunité aux transitoires électriques rapides en salves

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INTERNATIONAL
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COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX X

ICS 33.100.20
ISBN 978-2-83220-016-2

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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test

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

It forms Part 4-4 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*.

This third edition cancels and replaces the second edition published in 2004 and its amendment 1 (2010) and constitutes a technical revision.

This third edition improves and clarifies simulator specifications, test criteria and test setups.

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

FDIS	Report on voting
77B/670/FDIS	77B/673/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.

The list of all currently available parts of the IEC 61000 series, under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC web site.

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,
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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

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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 are 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 electrical fast transients/bursts.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test

1 Scope

This part of IEC 61000 relates to the immunity of electrical and electronic equipment to repetitive electrical fast transients. It gives immunity requirements and test procedures related to electrical fast transients/bursts. It additionally defines ranges of test levels and establishes test procedures.

The object of this standard is to establish a common and reproducible reference in order to evaluate the immunity of electrical and electronic equipment when subjected to electrical fast transient/bursts on supply, signal, control and earth ports. 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 is applied or not, and if applied, they are responsible for determining the appropriate test levels and performance criteria.[1]

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The standard defines:

- test voltage waveform;
- range of test levels;
- test equipment;
- calibration and verification procedures of test equipment;
- test setups;
- test procedure.

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The standard gives specifications for laboratory and in situ tests.

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 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

---

[1] TC 77 and its subcommittees are prepared to co-operate with product committees in the evaluation of the value of particular immunity tests for their products.

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

3.1.1
auxiliary equipment
AE
equipment necessary to provide the equipment under test (EUT) with the signals required for normal operation and equipment to verify the performance of the EUT

3.1.2
burst
sequence of a limited number of distinct pulses or an oscillation of limited duration

[SOURCE: IEC 60050-161:1990, 161-02-07]

3.1.3
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]

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3.1.4
coupling
interaction between circuits, transferring energy from one circuit to another

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3.1.5
common mode (coupling)
simultaneous coupling to all lines versus the ground reference plane

3.1.6
coupling clamp
device of defined dimensions and characteristics for common mode coupling of the disturbance signal to the circuit under test without any galvanic connection to it

3.1.7
coupling network
electrical circuit for the purpose of transferring energy from one circuit to another

3.1.8
decoupling network
electrical circuit for the purpose of preventing EFT voltage applied to the EUT from affecting other devices, equipment or systems which are not under test

3.1.9
degradation (of performance**)**
undesired departure in the operational performance of any device, equipment or system from its intended performance

Note 1 to entry: The term "degradation" can apply to temporary or permanent failure.

[SOURCE: IEC 60050-161:1990, 161-01-19]

3.1.10
EFT/B
electrical fast transient/burst

3.1.11
electromagnetic compatibility
EMC
ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[SOURCE: IEC 60050-161:1990, 161-01-07]

3.1.12
EUT
equipment under test

3.1.13
ground reference plane
GRP
flat conductive surface whose potential is used as a common reference

[SOURCE: IEC 60050-161:1990, 161-04-36]

3.1.14
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]

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3.1.15
port
particular interface of the EUT with the external electromagnetic environment

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3.1.16
pulse width
interval of time between the first and last instants at which the instantaneous value reaches 50 % value of the rising and falling edge of the pulse

[SOURCE: IEC 60050-702:1992, 702-03-04, modified]

3.1.17
rise time
interval of time between the instants at which the instantaneous value of a pulse first reaches 10 % value and then the 90 % value

[SOURCE: IEC 60050-161:1990, 161-02-05, modified]

3.1.18
transient
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval which is short compared with the time-scale of interest

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

3.1.19
unsymmetric mode (coupling)
single line coupling versus the ground reference plane

3.1.20
verification
set of operations which is used to check the test equipment system (e.g. the test generator and the interconnecting cables) and to gain confidence 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 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 Abbreviations

AE	Auxiliary Equipment
CDN	Coupling/Decoupling Network
EFT/B	Electrical Fast Transient/Burst
EMC	ElectroMagnetic Compatibility
ESD	ElectroStatic Discharge
EUT	Equipment Under Test
GRP	Ground Reference Plane
MU	Measurement Uncertainty
PE	Protective Earth
TnL	Terminator non Linearity

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4 General

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The repetitive fast transient test is a test with bursts consisting of a number of fast transients, coupled into power, control, signal and earth ports of electrical and electronic equipment. Significant for the test are the high amplitude, the short rise time, the high repetition frequency, and the low energy of the transients.

The test is intended to demonstrate the immunity of electrical and electronic equipment when subjected to types of transient disturbances such as those originating from switching transients (interruption of inductive loads, relay contact bounce, etc.).

5 Test levels

The preferred test levels for the electrical fast transient test, applicable to power, control, signal and earth ports of the equipment are given in Table 1.

Table 1 – Test levels

Open circuit output test voltage and repetition frequency of the impulses				
Level	Power ports, earth port (PE)		Signal and control ports	
	Voltage peak kV	Repetition frequency kHz	Voltage peak kV	Repetition frequency kHz
1	0,5	5 or 100	0,25	5 or 100
2	1	5 or 100	0,5	5 or 100
3	2	5 or 100	1	5 or 100
4	4	5 or 100	2	5 or 100
X [a]	Special	Special	Special	Special
The use of 5 kHz repetition frequency is traditional, however, 100 kHz is closer to reality. Product committees should determine which frequencies are relevant for specific products or product types. With some products, there may be no clear distinction between power ports and signal ports, in which case it is up to product committees to make this determination for test purposes.				
[a] "X" can be any level, above, below or in between the others. The level shall be specified in the dedicated equipment specification.				

For selection of test levels, see Annex B.

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6 Test equipment

6.1 Overview

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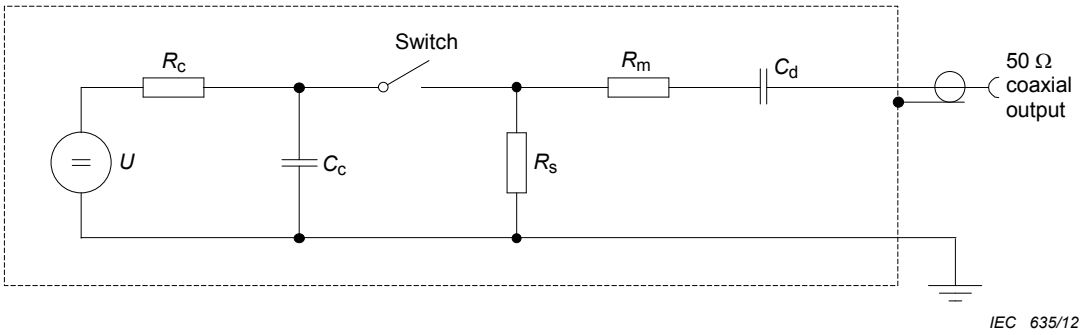
The calibration procedures of 6.2.3, 6.3.2 and 6.4.2 ensure the correct operation of the test generator, coupling/decoupling networks and other items making up the test setup so that the intended waveform is delivered to the EUT.

6.2 Burst generator

6.2.1 General

The simplified circuit diagram of the generator is given in Figure 1. The circuit elements C_c, R_s, R_m, and C_d are selected so that the generator delivers a fast transient under open circuit conditions and with a 50 Ω resistive load. The effective output impedance of the generator shall be 50 Ω.



Components	
U	high-voltage source
R_c	charging resistor
C_c	energy storage capacitor
R_s	impulse duration shaping resistor
R_m	impedance matching resistor
C_d	d.c. blocking capacitor
Switch	high-voltage switch

NOTE The characteristics of the switch together with stray elements (inductance and capacitance) of the layout shape the required rise time.

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Figure 1 – Simplified circuit diagram showing major elements of a fast transient/burst generator

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6.2.2 Characteristics of the fast transient/burst generator

The characteristics of the fast transient/burst generator are the following.

– Output voltage range with 1 000 Ω load shall be at least 0,24 kV to 3,8 kV.

– Output voltage range with 50 Ω load shall be at least 0,125 kV to 2 kV.

The generator shall be capable of operating under short-circuit conditions without being damaged.

Characteristics:

– polarity:	positive/negative
– output type:	coaxial, 50 Ω
– d.c. blocking capacitor	(10 ± 2) nF
– repetition frequency:	(see Table 2) ±20 %
– relation to a.c. mains:	asynchronous
– burst duration:	(15 ± 3) ms at 5 kHz
(see Figure 2)	(0,75 ± 0,15) ms at 100 kHz
– burst period:	(300 ± 60) ms
(see Figure 2)	
– wave shape of the pulse	
• into 50 Ω load	rise time t_r = (5 ± 1,5) ns
	pulse width t_w = (50 ± 15) ns
	peak voltage = according to Table 2, ±10 %

(see Figure 3for the 50 Ω wave shape)

- into 1 000 Ω load

rise time t_r = (5 ± 1,5) ns

pulse width t_w = 50 ns, with a tolerance of –15 ns to +100 ns

peak voltage = according to Table 2, ±20 % (see Note 1 of Table 2)

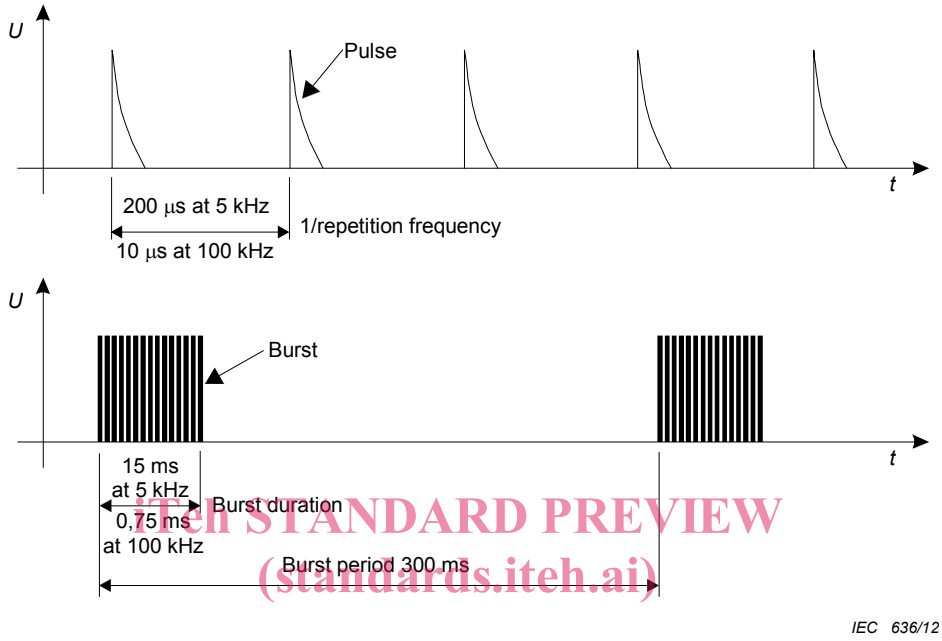

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Figure 2 – Representation of an electrical fast transient/burst

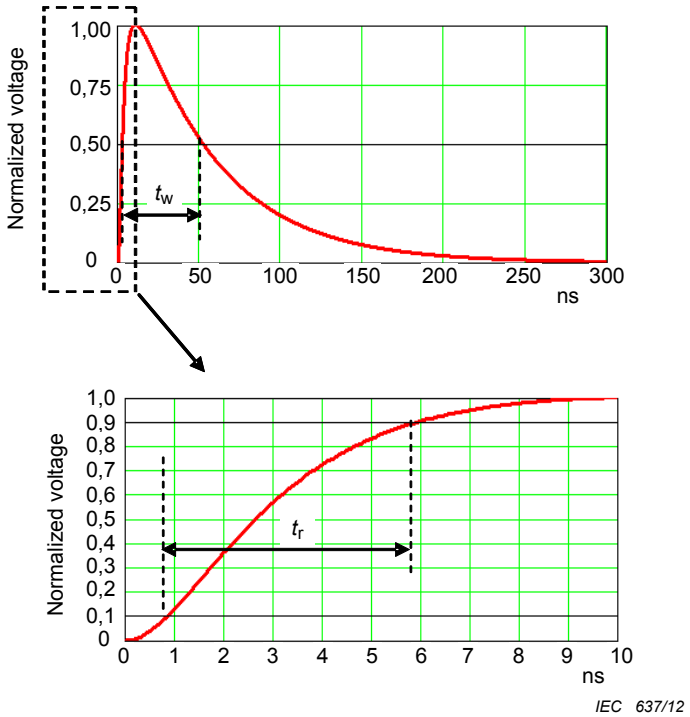

Figure 3 – Ideal waveform of a single pulse into a 50 Ω load with nominal parameters t_r = 5 ns and t_w = 50 ns