IEC 61000-4-28

Edition 1.2 2009-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) –
Part 4-28: Testing and measurement techniques – Variation of power frequency, immunity test for equipment with input current not exceeding 16 A per phase

Compatibilité électromagnétique (CEM) –
Partie 4-28: Techniques d'essai et de mesure – Essai d'immunité à la variation de la fréquence d'alimentation pour des matériels avec un courant appelé n'excédant pas 16 A par phase

IEC 61000-4-28:1999+A1:2001+A2:2009

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 33.100.20

ISBN 978-2-88910-390-4

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FOREWORD

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International Standard IEC 61000-4-28 has been prepared by subcommittee 77A: Low-frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This standard forms part 4-28 of the IEC 61000 series. It has the status of a basic EMC publication in accordance with IEC Guide 107.

This consolidated version of IEC 61000-4-28 consists of the first edition (1999) [77A/287/FDIS and 77A/299/RVD], its amendment 1 (2001) [77B/291+293/FDIS and 77B/298+300/RVD] and its amendment 2 (2009) [77A/673/FDIS and 77A/676/RVD].

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 1.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A and B are for information only.

The committee has decided that the contents of the base publication and its amendments 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- withdrawn,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.

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 Standard, 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 completed by a second number identifying the subdivision.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-28: Testing and measurement techniques – Variation of power frequency, immunity test for equipment with input current not exceeding 16 A per phase

1 Scope

This part of IEC 61000 is a basic EMC (electromagnetic compatibility) publication. It considers immunity tests for electric and/or electronic equipment in its electromagnetic environment. Only conducted phenomena are considered, including immunity tests for equipment connected to public and industrial networks.

The object of this part is to establish a reference for evaluating the immunity of electric and electronic equipment when subjected to variations of the power frequency.

This standard applies to electric and/or electronic equipment connected to 50 Hz or 60 Hz distributed network with rated line current up to 16 A per phase.

It does not apply to electric and/or electronic equipment connected to a.c. 400 Hz distribution networks. Tests concerning these networks will be covered by other IEC standards.

In general, electrical and electronic equipment is not susceptible to minor variations of the power frequency. Testing according to this standard should be limited to products which are assessed to be susceptible to power frequency variations by virtue of design, environment or failure consequences.

The immunity test levels required for a specific electromagnetic environment together with the performance criteria are indicated in the product, product family or generic standards as applicable.

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*

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 61000-2-4, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 4: Compatibility levels in industrial plants for low-frequency conducted disturbances*

3 General

The purpose of the test is to investigate effects of power frequency variations on equipment which may be sensitive to this disturbance. The effects are generally instantaneous.

Electrical and electronic equipment may be affected by variations of the power frequency.

The frequency of a.c. power derived from public systems is directly related to the rotational speed of the generators, as is the frequency of a.c. power derived from an alternator which is separate from the public network. The frequency depends at any instant on the dynamic balance between the loads and the capacity of the generating plants. Consequently, as this dynamic balance changes, small changes in frequency will occur. The size and duration of these changes depends on the characteristics of the load changes and response of the generating plant to the load changes. Where the supply is derived from an independent inverter, the frequency may be derived from the control circuitry and is then fixed.

The frequency of public systems is, under normal conditions, generally declared by the supplier in terms of a nominal value (50 Hz or 60 Hz) with a small bandwidth within which these changes in frequency will normally be limited. However, in non-interconnected systems (small networks isolated like islands), variations of frequency are likely to be greater and consequently more important.

Frequency variations can affect

– control systems referring to time (measurement errors, loss of synchronization, etc.);
– equipment including passive filter (de-tuned).

4 Definitions

For the purposes of this part of IEC 61000, the following definitions and terms apply as well as the definitions of IEC 60050(161).

4.1
immunity
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance [IEV 161-01-20]

4.2
malfunction
termination of the ability of an equipment to carry out intended functions or the execution of unintended functions by the equipment

5 Test levels

The test is performed at nominal mains voltage.

The equipment under test (EUT) is initially in operation at a mains frequency f_1 and is then subjected to frequency variation sequence according to figure 1.

$\Delta f/f_1$ is specified as a percentage of nominal frequency f_1.

Test values are specified in table 1.

Table 1 – Test levels for frequency variations

Test levels	Frequency variation ($\Delta f/f_1$)	Transitional period t_p
Level 1	No test required	No test required
Level 2	±3 %	10 s
Level 3	+4 % –6 %	10 s
Level 4	±15 %	1 s
Level X	Open	Open

During the transitional period, t_p, (figure 2), the maximum change in frequency per cycle shall be less than 0,5 % of f_1.

Levels 1 and 2 are specified for equipment in relation to class 1 and 2 in IEC 61000-2-4 respectively (see annex B).

Levels 3 and 4 are specified for equipment of which the misoperation is critical for specific application. These two test levels cover the frequency variations 100 % of the week.

Level 3 is specified for interconnected networks and level 4 is specified for non-interconnected networks.

X is an open test level. All of the levels can be proposed by a product committee, however, the value shall not be less than level 2 for equipment connected to public networks

NOTE The upper and the lower frequency operation limits defined by the product manufacturer should not, however, be exceeded.

6 Test equipment

6.1 Test generators: characteristics and performances

The generator shall have provisions to prevent the emission of heavy disturbances which, if injected in the power supply network, may influence the test results.

Table 2 – Characteristics of the generator

Output voltage accuracy	±2 %
Output voltage and current capability	The generator shall be able to supply enough voltage and current according to the type of EUT
Phase accuracy for each phase	2° (0,5 % of 360°)
Frequency accuracy	0,3 % of f_1 (50 Hz or 60 Hz)
Frequency capability range	f_1 ± 20 %
Test duration accuracy	±10 %

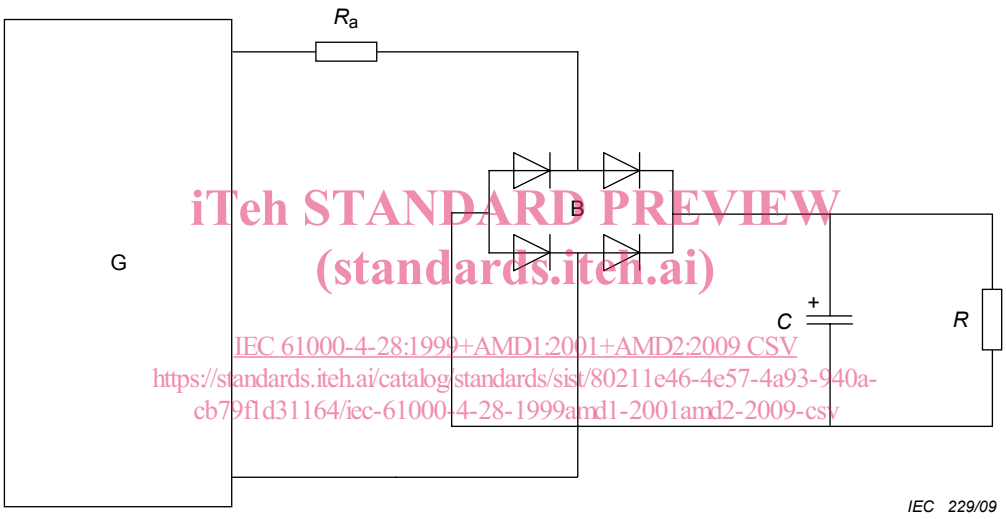
6.2 Verification of the characteristics

It is recognized that there is a wide range of EUTs, and that consequently test generators with different output power capabilities may be utilized, as required by particular tests.

It shall be verified that the test generator meets the characteristics and performance specifications as listed in Table 2.

Performance of the test generator shall be verified with a resistive load drawing an r.m.s. current of no more than the output capability of the generator. For example, a 230V/16A generator shall be verified with a 14,3 Ω load.

In addition, the generator's output current capability shall be verified as being able to provide a crest factor of at least 3 when U_N is applied to a single phase load drawing an rms current of no more than the output capability of the generator. Each output phase of the generator shall be verified in turn. An example of a 230 V/16 A verification load is given in Figure 4.



Components

G	Test generator
B	Bridge rectifier
C	11 000 µF ± 20 % electrolytic capacitor
R	61 Ω ± 1 % resistor
R_a	Additional resistor

NOTE R_a is selected so that the total series resistance (sum of the additional resistor R_a, the wiring resistance R_{wire}, the internal resistance of two conducting diodes R_{diodes} and the internal resistance of the capacitor R_c) is 92 mΩ (±10 %).

Figure 4 – Example of test generator verification load

7 Test set-up

Figure 3 shows the test configuration for mains supply simulation.

Waveform generators and power amplifiers are used.

Tests on the threephase EUT are accomplished by using generators with synchronization between each phase.

8 Test procedure

Before starting the test of a given equipment, a test plan shall be prepared.

It is recommended that the test plan shall identify the following:

– the type designation of the EUT;
– information on possible connections (plugs, terminals, etc.) and corresponding cables and peripherals;
– input power port of equipment to be tested;
– representative operational modes of the EUT for the test;
– performance criteria used and defined in the technical specifications;
– description of the test set-up.

If the actual operating signal sources are not available to the EUT, they may be simulated.

For each test, any degradation of performance shall be recorded. The monitoring equipment should be capable of displaying the status of the operational mode of the EUT during and after the tests. After the test, a representative functional check shall be performed.

8.1 Climatic conditions

Unless otherwise specified by the committee responsible for the generic or product standard, the climatic conditions in the laboratory shall be within any limits specified for the operation of the EUT and the test equipment by their respective manufacturers.

Tests shall not be performed if the relative humidity is so high as to cause condensation on the EUT or the test equipment.

NOTE Where it is considered that there is sufficient evidence to demonstrate that the effects of the phenomenon covered by this standard are influenced by climatic conditions, this should be brought to the attention of the committee responsible for this standard.

8.2 Execution of the test

The EUT shall be tested using the appropriate test level. Each test shall be performed three times according to figure 2. Each representative mode of operation shall be tested.

For the three-phase system, all three phases shall be tested simultaneously. The frequency variation is applied simultaneously on the three phases.