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INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) –
Part 4-14: Testing and measurement techniques – Voltage fluctuation immunity test for equipment with input current not exceeding 16 A per phase

Compatibilité électromagnétique (CEM) –
Partie 4-14: Techniques d'essai et de mesure – Essai d'immunité aux fluctuations de tension pour le matériel dont le courant d'entrée est inférieur ou égal à 16 A par phase

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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 61000-4-14 has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This standard forms part 4-14 of IEC 61000 series. It has the status of basic EMC publication in accordance with IEC Guide 107.

This consolidated version of IEC 61000-4-14 consists of the first edition (1999) [documents 77A/263/FDIS and 77A/268/RVD], its amendment 1 (2001) [documents 77B/291+293/FDIS and 77B/298+300/RVD] and its amendment 2 (2009) [documents 77A/669/CDV and 77A/685/RVC].

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.

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 (insofar as these limits 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 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 4-14: Testing and measurement techniques – Voltage fluctuation immunity test for equipment with input current not exceeding 16 A per phase

1 Scope

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

This part aims to establish a reference for evaluating the immunity of electric and electronic equipment when subjected to positive and negative low amplitude voltage fluctuations.

The voltage fluctuations considered by this standard do not include flicker, which is a physiological phenomenon due to lighting luminance fluctuations.

This standard applies to electrical and/or electronic equipment that have a rated input current up to 16 A per phase. It does not apply to electrical and/or electronic equipment connected to d.c. or a.c. 400 Hz distribution networks. Tests concerning these networks will be covered by other IEC standards.

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. However, most product groups do not have a history of being susceptible to voltage fluctuations. Consequently, testing for these phenomena is often not required.

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

3.1 Effects of voltage fluctuations

Electrical and electronic equipment may be affected by voltage fluctuations. Examples of these effects include the following:

– degradation of performances in equipment using storage devices (e.g. capacitors);
– loss of function in control systems;

– instability of internal voltages and currents in equipment;
– increased ripple.

3.2 Sources

There is a significant number of domestic appliances in the low-voltage network. However, fluctuations caused by these appliances are not generally significant.

Fluctuations are mainly produced by

a) continuously but randomly varying large loads such as:
   1) resistance welding machines;
   2) rolling mills;
   3) large motors with varying loads;
   4) arc furnaces;
   5) arc welding plant;
b) single on/off switching of loads (e.g. motors);
c) step voltage changes (due to tap voltage regulators of transformers).

These industrially produced fluctuations can affect a large number of consumers. Such equipment operates continuously or infrequently. The public supply network impedance has wide variations, consequently the transmission of the disturbances will be different for different networks.

4 Definitions

For the purpose of this part of IEC 61000, the following definitions and terms apply. They are applicable only to the field of voltage fluctuations; not all of them are included in IEC 60050(161).

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

4.2
voltage fluctuations
series of voltage changes or a cyclic variation of the voltage envelope [IEV 161-08-05]

5 Test levels

This test may apply to all equipment intended for connection to public networks, industrial networks and electricity plants that are likely to be sensitive to this type of disturbance.

It can be assumed that step voltage changes are the most disturbing type of voltage fluctuations.

The equipment under test (EUT) is initially operated using a steady supply voltage and is then subjected to repetitive step voltage changes according to figure 1a.

The initial voltage is set to

$$U_n,\ U_n - 10\ \%\ U_n,\ U_n + 10\ \%\ U_n$$

NOTE U_n is the nominal voltage.

The magnitude of the voltage steps is chosen as follows:

Class 1: no test required.

Class 2: ΔU = 8 % U_n for equipment intended for connection to public networks or other lightly disturbed networks. This test level is specified for class 2.

Class 3: ΔU = 12 % U_n for equipment connected to heavily disturbed networks (i.e. industrial networks). This test level is specified for class 3.

Classes 1, 2 and 3 are defined in annex A.

Table 1 gives the test levels for the different initial voltages:

$$U_n,\ U_n - 10\ \%\ U_n,\ U_n + 10\ \%\ U_n$$

Table 1 – Test levels

Class	U_n	U_n – 10 % U_n	U_n + 10 % U_n
1	No test required		
2	ΔU = ±8 % U_n	ΔU = +8 % U_n	ΔU = –8 % U_n
3	ΔU = ±12 % U_n	ΔU = +12 % U_n	ΔU = –12 % U_n
x	x	x	x
NOTE The levels for class "x" are open.			

The repetition period T and the duration t of the voltage fluctuations are specified as T = 5 s and t = 2 s (see Figure 1d).

The changes from the initial voltage to the test voltage, or from the test voltage back to the initial voltage are achieved through five successive voltage steps in five consecutive cycles of the mains supply, see Figure 1d. Each voltage step is of $\Delta U/5$ and occurs over $\pi/2$ radians of the period of the nominal frequency, f_n, (e.g. 5 ms for 50 Hz) see Figure 1b and Figure 1c.

For falling voltage changes, the voltage step begins at phase angle φ = 270° and finishes at φ = 360°, see Figure 1b.

For rising voltage changes, the voltage step begins at phase angle φ = 180° and finishes at φ = 270°, see Figure 1c.

x is an open test level. This value may be defined by the product standard in order to cover situations other than the normal operating conditions of the network.

All of the levels can be proposed by the product committee, but for equipment for use in public supply systems, the values shall not be lower than those specified for class 2.

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

6 Test equipment

6.1 Test generator

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

6.2 Characteristics and performance of the test generator

Table 2 – Characteristics of the test generator

Output voltage capability	U_n ± 15 %
Voltage accuracy	±1 %
Zero crossing accuracy	250 μs at zero voltage crossover
Output current capability	The generator shall be able to supply enough current according to the type of EUT in the test voltage range.
Overshoot/undershoot of the actual voltage	Less than 5 % of the change in voltage
Voltage rise (and fall) time during switching	Under 1 ms
Maximum interphase error (three-phase power supply)	2,5°
Frequency accuracy	2,5 % of f_n (50 Hz or 60 Hz)
NOTE The generator with a power amplifier specified in IEC 61000-4-11 is suitable for this test. An over-voltage capability of U_n + 15 % is necessary.	

6.3 Verification of the test generator

Test generators with different output power capabilities may be used.

The test generator shall be verified that it complies with the characteristics and specifications 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 230 V/16 A 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 r.m.s. 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 suitable 230 V/16 A verification load is given in Figure 4.

7 Test set-up

Figure 3 shows the test configuration for mains supply simulation.

Waveform generators and power amplifiers may be used.

Tests on three-phase EUT are carried out using three synchronised generators.

8 Test procedure

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

It is recommended that the test plan include the following:

– description of the EUT;
– information on possible connections (plugs, terminals, etc.) and corresponding cables and peripherals;
– input power port of the EUT;
– 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 each group of tests, a full 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 for each selected combination of test level and duration with a series of three sequences of voltage fluctuations, with intervals of two times 60 s minimum between the voltage fluctuation sequences (see figure 2). Each representative mode of operation shall be tested.

The test duration shall be determined by the product committee.

In the case of a three-phase apparatus, all three phases shall be tested at the same time. The voltage steps are made phase by phase at the same phase angle, φ, and not simultaneously on the three phases.

9 Evaluation of test results

The test results shall be classified in terms of the loss of function or degradation of performance of the equipment under test, relative to a performance level defined by its manufacturer or the requestor of the test, or agreed between the manufacturer and the purchaser of the product. The recommended classification is as follows:

a) normal performance within limits specified by the manufacturer, requestor or purchaser;

b) temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention;

c) temporary loss of function or degradation of performance, the correction of which requires operator intervention;

d) loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.

The manufacturer's specification may define effects on the EUT which may be considered insignificant, and therefore acceptable.