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INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase

Compatibilité électromagnétique (CEM) – Partie 4-34: Techniques d'essai et de mesure – Essais d'immunité aux creux de tension, coupures brèves et variations de tension pour matériel ayant un courant d'alimentation de plus de 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 61000-4-34 has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms Part 4-34 of IEC 61000. It has the status of a Basic EMC Publication in accordance with IEC Guide 107.

This consolidated version of IEC 61000-4-34 consists of the first edition (2005) [documents 77A/498/FDIS and 77A/515/RVD] and its amendment 1 (2009) [documents 77A/670/CDV and 77A/688/RVC].

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

It bears the edition number 1.1.

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 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 (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 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase

1 Scope

This part of IEC 61000 defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations.

This standard applies to electrical and electronic equipment having a rated mains current exceeding 16 A per phase. (See Annex E for guidance on electrical and electronic equipment rated at more than 200 A per phase.) It covers equipment installed in residential areas as well as industrial machinery, specifically voltage dips and short interruptions for equipment connected to either 50 Hz or 60 Hz a.c. networks, including 1-phase and 3-phase mains.

NOTE 1 Equipment with a rated mains current of 16 A or less per phase is covered by publication IEC 61000-4-11.

NOTE 2 There is no upper limit on rated mains current in this publication. However, in some countries, the rated mains current may be limited to some upper value, for example 75 A or 250 A, because of mandatory safety standards.

It does not apply to electrical and electronic equipment for connection to 400 Hz a.c. networks. Tests for equipment connected to these networks will be covered by future IEC standards.

The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to voltage dips, short interruptions and voltage variations.

NOTE 1 Voltage fluctuations are covered by publication IEC 61000-4-14.

NOTE 2 For equipment under test with rated currents above 250 A, suitable test equipment may be difficult to obtain. In these cases, the applicability of this standard should be carefully evaluated by committees responsible for generic, product and product-family standards. Alternatively, this standard might be used as a framework for an agreement on performance criteria between the manufacturer and the purchaser.

The test method documented in this part of IEC 61000 describes a consistent method to assess the immunity of equipment or a system against a defined phenomenon. 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 applied or not, and if applied, they are responsible for defining the appropriate test levels. Technical committee 77 and its sub-committees are prepared to co-operate with product committees in the evaluation of the value of particular immunity tests for their products.

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 61000-2-8, *Electromagnetic compatibility (EMC) – Part 2-8: Environment – Voltage dips and short interruptions on public electric power supply systems with statistical measurement results*

IEC 61000-4-30, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

3 Terms and definitions

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

3.1
basic EMC standard (ACEC)[1)]
standard giving general and fundamental conditions or rules for the achievement of EMC, which are related or applicable to all products and systems, and serve as reference documents for product committees

3.2
immunity (to a disturbance)
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

3.3
voltage dip
sudden reduction of the voltage at a particular point of an electricity supply system below a specified dip threshold followed by its recovery after a brief interval

NOTE 1 Typically, a dip is associated with the occurrence and termination of a short circuit or other extreme current increase on the system or installations connected to it.

NOTE 2 A voltage dip is a two-dimensional electromagnetic disturbance, the level of which is determined by both voltage and time (duration).

3.4
short interruption
sudden reduction of the voltage on all phases at a particular point of an electric supply system below a specified interruption threshold followed by its restoration after a brief interval

NOTE Short interruptions are typically associated with switchgear operation related to the occurrence and termination of short circuits on the system or installations connected to it.

3.5
residual voltage (of voltage dip)
minimum value of r.m.s. voltage recorded during a voltage dip or short interruption

NOTE The residual voltage may be expressed as a value in volts or as a percentage or per unit value relative to the reference voltage.

3.6
malfunction
termination of the ability of equipment to carry out intended functions or the execution of unintended functions by the equipment

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1) Advisory Committee on Electromagnetic Compatibility (ACEC).

3.7
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 This term is based on the "uncertainty" approach.

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

[IEV 311-01-09]

3.8
verification
set of operations which is used to check the test equipment system (e.g. the test generator and the interconnecting cables) and to demonstrate that the test system is functioning within the specifications given in Clause 6

NOTE 1 The methods used for verification may be different from those used for calibration.

NOTE 2 The procedure of 6.1.2 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 3 For the purpose of this basic EMC standard this definition is different from the definition given in IEV 311-01-13.

4 General

Electrical and electronic equipment may be affected by voltage dips, short interruptions or voltage variations of power supply.

Voltage dips and short interruptions are caused by faults in the network, primarily short circuits (see also IEC 61000-2-8), in installations or by sudden large changes of load. In certain cases, two or more consecutive dips or interruptions may occur. Voltage variations are caused by continuously varying loads connected to the network.

Voltage dips at equipment terminals are influenced by the transformer connections between the fault location on the supply system and the equipment connection point. The transformer connections will influence both the magnitude and the phase relationship of the voltage dip experienced by the equipment.

These phenomena are random in nature and can be minimally characterized for the purpose of laboratory simulation in terms of the deviation from the rated voltage, and duration.

Consequently, different types of tests are specified in this standard to simulate the effects of abrupt voltage change. These tests are to be used only for particular and justified cases, under the responsibility of product specification or product committees.

It is the responsibility of the product committees to establish which phenomena among the ones considered in this standard are relevant and to decide on the applicability of the test.

5 Test levels

The voltages in this standard use the rated voltage for the equipment as a basis for voltage test level specification (U_T).

Where the equipment has a rated voltage range the following shall apply:

– if the voltage range does not exceed 20 % of the lower voltage specified for the rated voltage range, a single voltage within that range may be specified as a basis for test level specification (U_T);

– in all other cases, the test procedure shall be applied for both the lowest and highest voltages declared in the voltage range;

– the selection of test levels and durations shall take into account the information given in IEC 61000-2-8.

5.1 Voltage dips and short interruptions

The change between U_T and the changed voltage is abrupt. Unless otherwise specified by the responsible product committee, the start and stop phase angle for the voltage dips and interruptions shall be 0° (i.e. the positive-going voltage zero-crossing on the dipped phase), See 8.2.1. The following test voltage levels (in % U_T) are used: 0 %, 40 %, 70 % and 80 %, corresponding to voltage dips or interruptions with residual voltages of 0 %, 40 %, 70 % and 80 %.

For voltage dips, the preferred test levels and durations are given in Table 1, and an example is shown in Figure 1.

For short interruptions, the preferred test levels and durations are given in Table 2.

The preferred test levels and durations given in Tables 1 and 2 take into account the information given in IEC 61000-2-8.

The preferred test levels in Table 1 are reasonably severe, and are representative of many real world dips, but are not intended to guarantee immunity to all voltage dips. More severe test levels, for example 0 % test level for 1 s, and balanced three-phase dips, may be considered by product committees.

The voltage rise time, t_r, and voltage fall time, t_f, during abrupt changes are indicated in Table 4.

The levels and durations shall be given in the product specification. A test level of 0 % corresponds to a total supply voltage interruption. In practice, a test voltage level from 0 % to 20 % of the rated voltage may be considered as an interruption.

Table 1 – Preferred test level and durations for voltage dips

Classes[a]	**Test level and durations for voltage dips (t_s) (50 Hz/60 Hz)**			
Class 1	Case-by-case according to the equipment requirements			
Class 2	0 % during 1 cycle	70 % during 25/30[c] cycles		
Class 3	0 % during 1 cycle	40 %[d] during 10/12[c] cycles	70 % during 25/30[c] cycles	80 % during 250/300[c] cycles
Class X[b]	X	X	X	X

a Classes as per IEC 61000-2-4; see Annex B.

b To be defined by product committee. For equipment connected directly or indirectly to public network, the levels must not be less severe than class 2.

c "25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test", “10/12 cycles” means “10 cycles for 50 Hz test” and “12 cycles for 60 Hz test” and “250/300 cycles” means “250 cycles for 50 Hz test” and “300 cycles for 60 Hz test”.

d May be replaced by product committee with a test level of 50 % for equipment that is intended primarily for 200 V or 208 V nominal operation.

Table 2 – Preferred test level and durations for short interruptions

Classes[a]	Test level and durations for short interruptions (t_s) (50 Hz/60 Hz)
Class 1	Case-by-case according to the equipment requirements
Class 2	0 % during 250/300[c] cycles
Class 3	0 % during 250/300[c] cycles
Class X[b]	X

[a] Classes as per IEC 61000-2-4; see Annex B.

[b] To be defined by product committee. For equipment connected directly or indirectly to public network, the levels must not be less severe than Class 2.

[c] "250/300 cycles" means "250 cycles for 50 Hz test" and "300 cycles for 60 Hz test.

5.2 Voltage variations (optional)

This test considers a defined transition between rated voltage U_T and the changed voltage.

NOTE The voltage change takes place over a short period, and may occur due to change of load.

The preferred duration of the voltages changes and the time for which the reduced voltages are to be maintained are given in Table 3. The rate of change should be constant; however, the voltage may be stepped. The steps should be positioned at zero crossings, and should be no larger than 10 % of U_T. Steps under 1 % of U_T are considered as constant rate of change of voltage.

Table 3 – Timing of short-term supply voltage variations

Voltage test level	Time for decreasing voltage (t_d)	Time at reduced voltage (t_s)	Time for increasing voltage (t_i) (50 Hz/60 Hz)
70 %	Abrupt	1 cycle	25/30[b] cycles
X[a]	X[a]	X[a]	X[a]

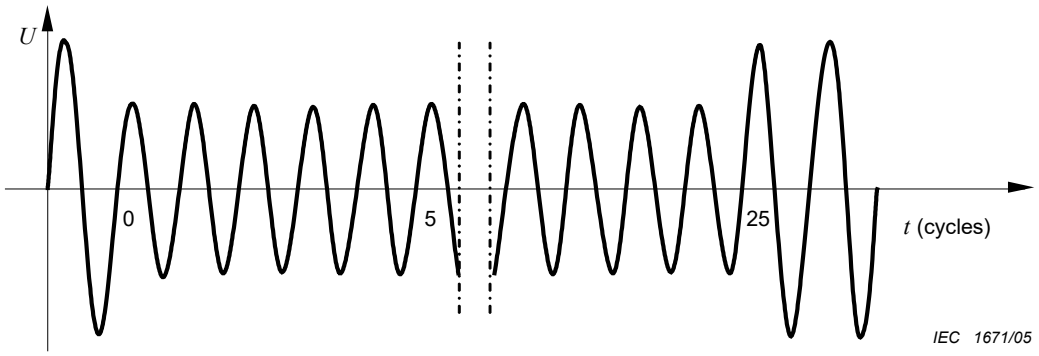
[a] To be defined by product committee.

[b] "25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test.

For voltage variations in three-phase systems with or without neutral, all the three phases shall be tested simultaneously. Simultaneous voltage variations in three-phase systems are positioned at the zero-crossing of one of the voltages.

This shape is the typical shape of a motor starting with a rapid time for decreasing voltage, t_d, and slower time for increasing voltage, t_i.

Figure 2 shows the r.m.s. voltage as a function of time. Other values may be taken in justified cases and shall be specified by the product committee.



NOTE The voltage decreases to 70 % for 25 cycles (50 Hz). Step at zero crossing.

Figure 1 – Voltage dip – 70 % voltage dip sine wave graph

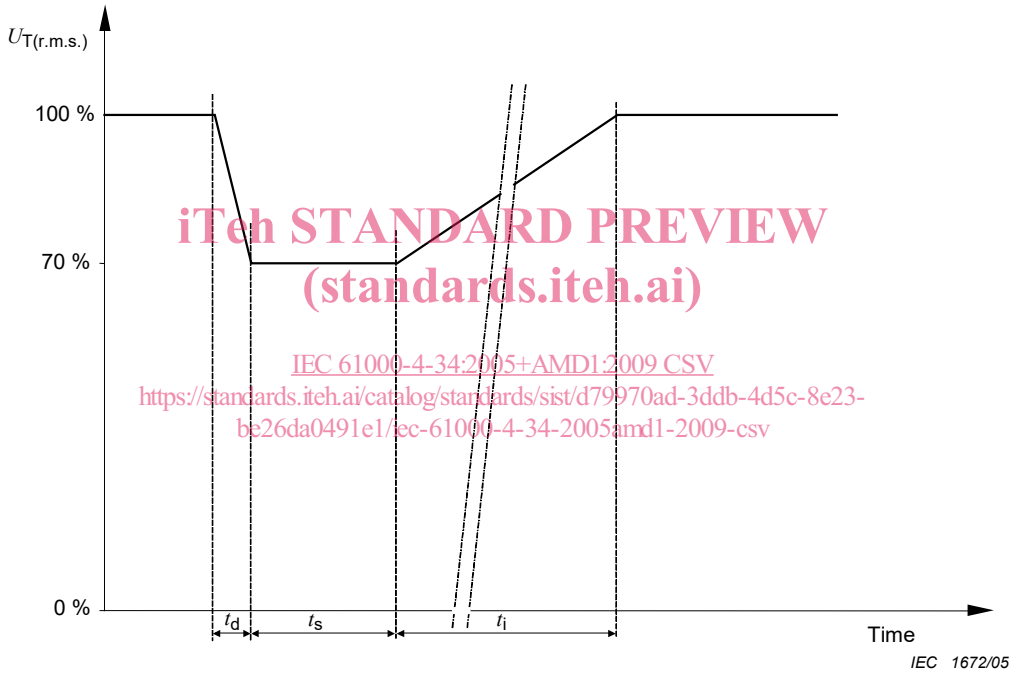


Figure 2 – Voltage variation

6 Test instrumentation

6.1 Test generator

The following features are common to the generator for voltage dips, short interruptions and voltage variations, except as indicated.

Examples of generators are given in Annex D.

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

Any generator creating a voltage dip of equal or more severe characteristics (amplitude and duration) than that prescribed by the present standard is permitted.

The output of the generator may be influenced by the generator characteristics, the load characteristics, and/or the characteristics of the a.c. network that supplies the generator.

6.1.1 Characteristics and performance of the generator

Table 4 – Generator specifications

Output voltage at no load	As required in Table 1, ±5 % of residual voltage value
Voltage at the output of the generator during equipment test	As required in Table 1, ±10 % of residual voltage value, measured as r.m.s. value refreshed each ½ cycle per IEC 61000-4-30
Output current capability	See Annex A
Peak inrush current capability (no requirement for voltage variation tests)	See Annex A
Instantaneous peak overshoot/undershoot of the actual voltage, generator loaded with resistive load – see NOTE 1	Less than 5 % of U_T
Voltage rise (and fall) time t_r (and t_f), during abrupt change, generator loaded with resistive load – see NOTE A and NOTE 1	Between 1 µs and 5 µs for current ≤75 A Between 1 µs and 50 µs for current >75 A
Phase angle at which the voltage dip begins and ends	0° to 360° with a maximum resolution of 5°, see NOTE B
Phase relationship of voltage dips and interruptions with the power frequency	Less than ±5°
Zero crossing control of the generators	±10°
NOTE A These values must be checked with a resistive load as per NOTE 1 after this table, but they need not be checked when an EUT is connected. NOTE B Phase angle adjustment may be required to comply with 5.1.	

Output impedance shall be predominantly resistive.

The output impedance of the test voltage generator shall be low even during transitions when generating dips. A brief interval (up to 100 µs) of high impedance is permitted during each transition. For generating interruptions, a high impedance open circuit is permitted.

NOTE 1 The value of the non-inductive resistive load for testing overshoot, undershoot, rise time, and fall time shall be 100 ohms for generators rated for 50 A or less, 50 ohms for generators rated for more than 50 A and less or equal than 100 A, and 25 ohms for generators rated more than 100 A.

NOTE 2 To test equipment which regenerates energy, an external resistor connected in parallel to the load can be added. The test result shall not be influenced by this load.

NOTE 3 A high-impedance interruption, when applied to an inductive load, may generate substantial over-voltages.