IEC 61000-4-11

Edition 3.0 2020-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) –
Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase

Compatibilité électromagnétique (CEM) –
Partie 4-11: Techniques d'essai et de mesure – Essais d'immunité aux creux de tension, coupures brèves et variations de tension pour les appareils à courant d'entrée inférieur ou égal à 16 A par phase

IEC 61000-4-11:2020-01(en-fr)

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FOREWORD

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International Standard IEC 61000-4-11 has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms Part 4-11 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 2004 and Amendment 1:2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) rise time and fall time of transients are now defined terms in Clause 3;
b) the origin of voltage dips and short interruptions is now stated in Clause 4.

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

FDIS	Report on voting
77A/1039/FDIS	77A/1056/RVD

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 document 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document 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- withdrawn,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).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 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 document applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase, for connection to 50 Hz or 60 Hz AC networks.

It does not apply to electrical and electronic equipment for connection to 400 Hz AC networks. Tests for these networks will be covered by future IEC documents.

The object of this document 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 fluctuation immunity tests are covered by IEC 61000-4-14.

The test method documented in this document describes a consistent method to assess the immunity of equipment or a system against a defined phenomenon.

NOTE 2 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 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 TR 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*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1
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]

3.2
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 to entry: 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 to entry: A voltage dip is a two-dimensional electromagnetic disturbance, the level of which is determined by both voltage and time (duration).

3.3
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 1 to entry: Short interruptions are typically associated with switchgear operations related to the occurrence and termination of short circuits on the system or on installations connected to it.

3.4
residual voltage
<voltage dip> minimum value of RMS voltage recorded during a voltage dip or short interruption

Note 1 to entry: The residual voltage can be expressed as a value in volts or as a percentage or per unit value relative to the reference voltage.

3.5
malfunction
breakdown of the ability of equipment to carry out intended functions or the execution of unintended functions by the equipment

3.6
calibration
method to prove that the measurement equipment is in compliance with its specifications

Note 1 to entry: For the purposes of this document, calibration is applied to the test generator.

3.7
verification
set of operations which are used to check the test equipment system (e.g. the test generator and the interconnecting cables) to demonstrate that the test system is functioning within the specifications given in Clause 6

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

Note 2 to entry: The verification procedure of 6.1.3 is meant as a guide to ensure 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.

3.8
rise time
interval of time between the instants at which the instantaneous value of a transition first reaches a specified lower value and then a specified upper value

Note 1 to entry: The lower and upper values are fixed at 10 % and 90 % of the transition magnitude.

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

3.9
fall time
interval of time between the instants at which the instantaneous value of a transition first reaches a specified upper value and then a specified lower value

Note 1 to entry: The lower and upper values are fixed at 10 % and 90 % of the transition magnitude.

Note 2 to entry: This definition is derived from IEC 60050-161:1990, 161-02-05.

4 General

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

Voltage dips and short interruptions occur due to faults in a (public or non-public) network or in installations by sudden changes of large loads. In certain cases, two or more consecutive dips or interruptions can occur. Voltage variations are caused by continuously varying loads connected to the network.

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 document 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 document are relevant and to decide on the applicability of the test.

5 Test levels

5.1 General

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

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 the 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;
- guidance for the selection of test levels and durations is given in IEC TR 61000-2-8.

5.2 Voltage dips and short interruptions

The change between U_T and the changed voltage is abrupt. The step can start and stop at any phase angle on the mains voltage. The following test voltage levels (in % U_T) are used: 0 %, 40 %, 70 % and 80 %, corresponding to dips 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 1a) and Figure 1b).

For short interruptions, the preferred test levels and durations are given in Table 2, and an example is shown in Figure 2.

The rise and fall time are detailed in Figure 3.

The preferred test levels and durations given in Table 1 and Table 2 take into account the information given in IEC TR 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 dips, for example 0 % for 1 s and balanced three-phase dips, may be considered by product committees.

The generator specification for voltage rise time, t_r, and voltage fall time, t_f, during abrupt changes is 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 a total interruption.

Shorter durations in Table 1, in particular the half-cycle, should be tested to ensure that the equipment under test (EUT) operates within the performance limits specified for it.

When setting performance criteria for disturbances of a half-period duration for products with a mains transformer, product committees should pay particular attention to effects which can result from inrush currents. For such products, these can reach 10 times to 40 times the rated current because of the magnetic flux saturation of the transformer core after the voltage dip.

High inrush currents can also occur in products with capacitors (e.g. EMC filters, bridge rectifiers connected to DC capacitors).

Table 1 – Preferred test levels and durations for voltage dips

Class[a]	Test levels 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 ½ cycle	0 % during 1 cycle	70 % during 25/30[c] cycles		
Class 3	0 % during ½ cycle	0 % during 1 cycle	40 % during 10/12[c] cycles	70 % during 25/30[c] cycles	80 % during 250/300[c] cycles
Class X[b]	X	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 the public network, the levels shall 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".

Table 2 – Preferred test levels and durations for short interruptions

Class[a]	Test levels 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 the public network, the levels shall 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".

5.3 Voltage variations

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

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

The preferred duration of the voltage 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 rates of change of voltage.

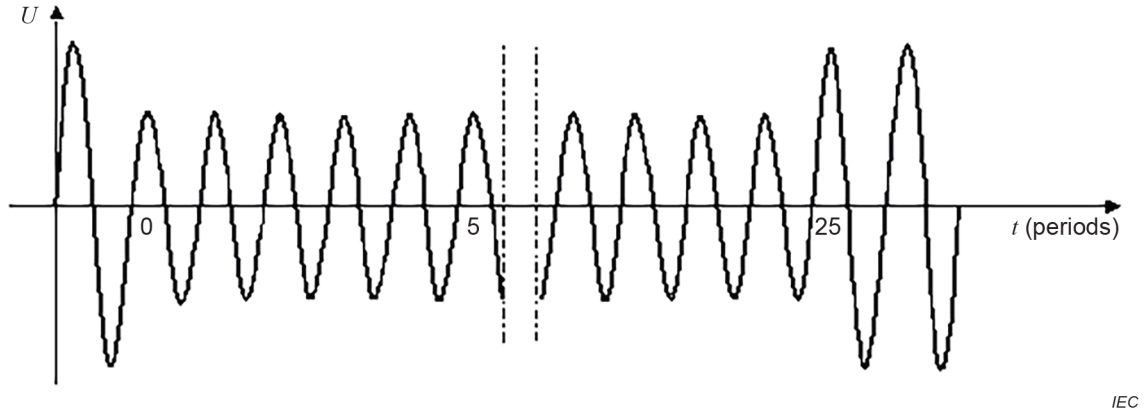
Table 3 – Timing of short-term supply voltage variations

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.

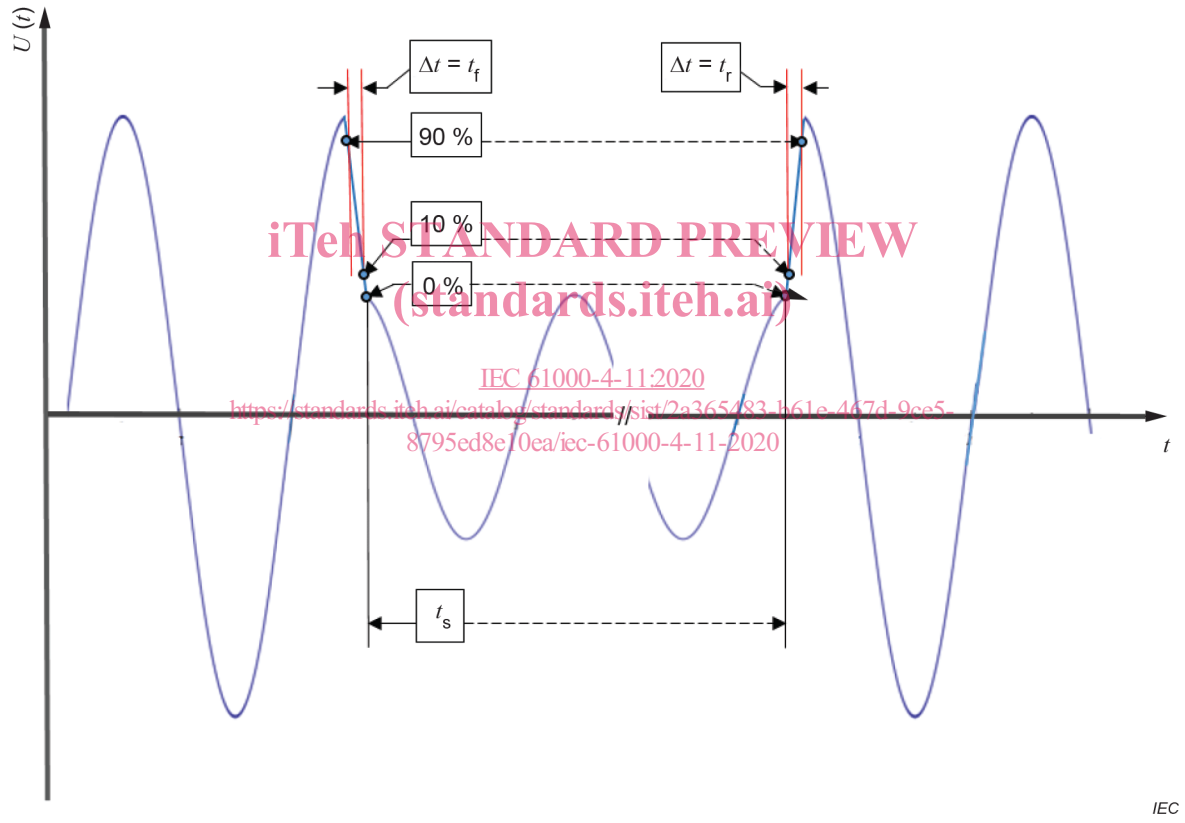
[b] "25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test".

This shape is the typical shape of a motor starting.



NOTE The voltage decreases to 70 % for 25 periods. Step at zero crossing.

a) Voltage dip: 70 % voltage dip sine wave graph at 0°



Key

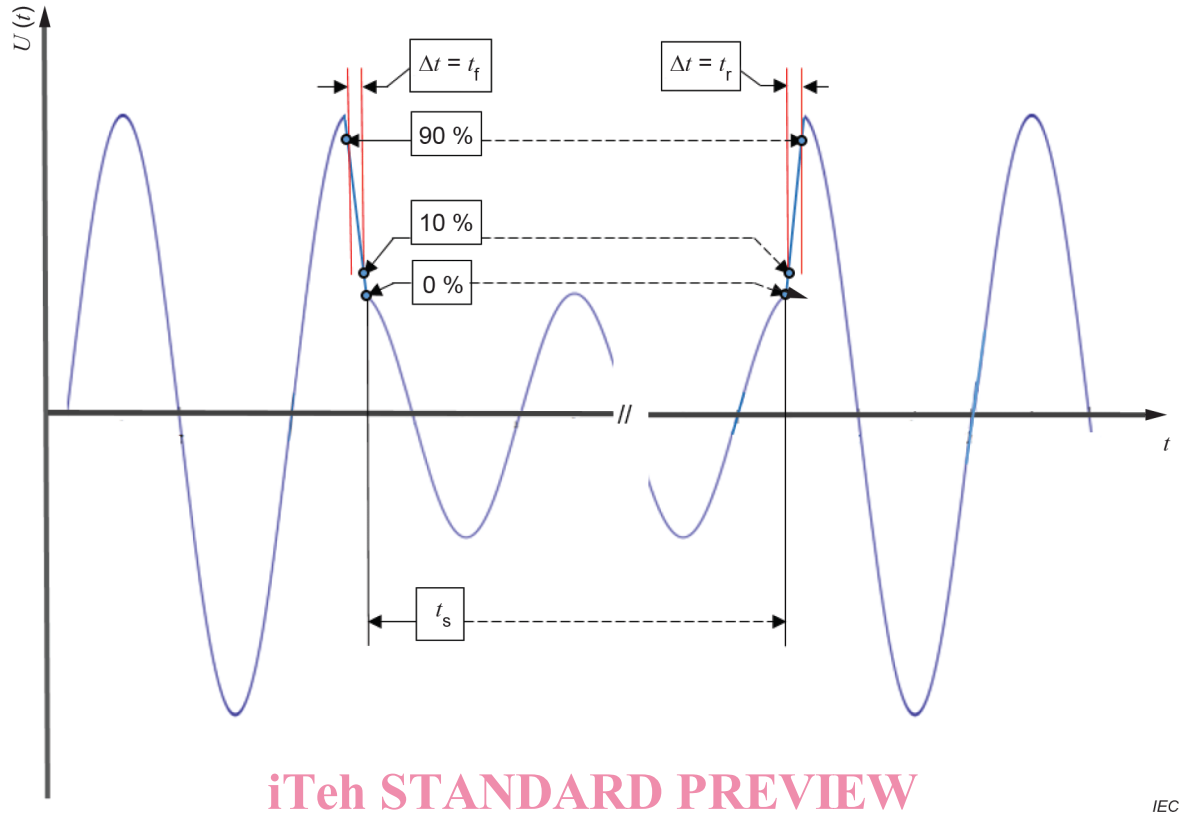
t_f fall time

t_r rise time

t_s duration of reduced voltage

b) Voltage dip: 40 % voltage dip sine wave graph at 90°

Figure 1 – Voltage dip – Examples



Key

t_f fall time

t_r rise time

t_s duration of reduced voltage

Figure 2 – Short interruption

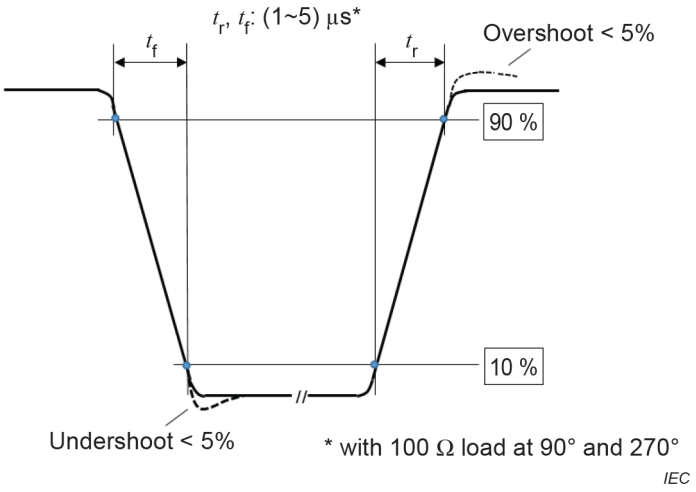


Figure 3 – Detailed view of rise and fall time

Figure 4 shows the RMS voltage as a function of time. Other values may be taken in justified cases and shall be specified by the product committee.