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Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests

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Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on DC input power port immunity tests

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61000-4-29:2000. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61000-4-29 has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility. It is an International Standard.

It forms part 4-29 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

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

a) Increase of the output voltage of the test generator to take into account new DC networks voltages;
b) provision of tolerances for the duration of the voltage changes;
c) limitation of the current when applying short interruptions in low impedance condition;
d) general technical clarifications for the specifications of the test generator and their verification;
e) clarifications regarding the loads used to verify the switching characteristics and the peak inrush current drive capability of the test generator;
f) clarifications regarding the evaluation of test results and test reports;
g) description of the DC environment.

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

Draft	Report on voting
77A/1276/CDV	77A/1282/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,
– withdrawn, or
– revised.

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).

This part is an international standard which gives ~~test procedures related to~~ immunity requirements for testing DC equipment and systems with voltage dips, ~~short~~ interruptions and ~~voltage~~ variations on the DC input power port~~s~~.

1 Scope ~~and object~~

This part of IEC 61000 defines test methods for immunity to voltage dips, short interruptions and voltage variations at the DC input power port of electrical or electronic equipment.

This document is applicable to ~~low voltage d.c. power ports of equipment supplied by external d.c. networks~~ equipment and systems whose DC input power ports are intended to be connected to low voltage DC networks external to the equipment and systems.

The object of this document is to establish a common and reproducible basis for testing electrical and electronic equipment when subjected to voltage dips, short interruptions or voltage variations on DC input power ports.

This document defines:

– the range of test levels;

– the test generator;

– the test set-up;

– the test procedure.

The test described hereinafter applies to electrical and electronic equipment and systems. It also applies to modules or subsystems whenever the equipment under test's (EUT) rated power is greater than the test generator capacity specified in Clause 6.

The ripple at the DC input power port is not included in the scope of this document. It is covered by IEC 61000-4-17.

This document does not specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to IEC product committees. These product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the tests and the severity level to be applied to their equipment.

2 Normative references

~~The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61000. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61000 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.~~

~~IEC 60050(161), *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*~~

~~IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4: Testing and measuring techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests*~~

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

– IEC Electropedia: available at https://www.electropedia.org/

– ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
immunity (to a disturbance)
~~the~~ 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]

3.1.2
voltage dip
sudden reduction of the voltage at a point in the low voltage DC distribution system, followed by voltage recovery after a short period of time, from a few milliseconds up to a few seconds

~~[IEV 161-08-10, modified]~~

3.1.3
short interruption
~~disappearance~~ change of the supply voltage at a point of the low voltage DC distributed system below 20 % of the nominal voltage for a time interval which typically does not exceed 1 min~~. In practice, a dip with amplitude at least 80 % of the rated voltage may be considered as an interruption~~

Note 1 to entry: A short interruption does not necessarily result in a complete disappearance of the supply voltage.

3.1.4
voltage variation
gradual change of the supply voltage from the rated voltage to a lower voltage or from the rated voltage to a higher voltage~~. The duration of the change can be short or long.~~

3.1.5
malfunction
termination of the ability of an equipment to carry out intended functions, or the execution of unintended functions by the equipment

3.2 Abbreviated terms

DC Direct current

ESR Equivalent series resistance

EUT Equipment under test

LVDC Low-voltage direct current

4 General

The operation of electrical or electronic equipment ~~may~~ can be affected by voltage dips, short interruptions or voltage variations of the power supply.

Voltage dips and short interruptions are mainly caused by faults in the DC distribution system, or by sudden large changes of load. Two or more consecutive dips or interruptions can also occur.

Faults in the DC distribution system ~~may~~ can inject transient overvoltages into the distribution network; this particular phenomenon is not covered by this document.

Voltage interruptions are primarily caused by the switching of mechanical relays when changing from one source to another (e.g. from generator set to battery).

During a short interruption, the DC supply network ~~may~~ can present either a "high impedance" or "low impedance" condition. The first condition can be due to switching from one source to another; the second condition can be due to the clearing of an overload or fault condition on the supply bus. The latter can cause reverse current (negative peak inrush current) from the load.

These phenomena are random in nature and can be characterised in terms of their duration and the deviation from the ~~rated~~ nominal voltage. Voltage dips and short interruptions are not always abrupt.

The primary cause of voltage variations is the discharging and recharging of battery systems; however, they are also created when there are significant changes to the load condition of the DC network.

5 Test levels

The rated voltage for the equipment (U_T) shall be used as a reference for the specification of the voltage test level.

~~The following shall be applied for equipment with a rated voltage range~~ If the EUT has a rated voltage range, the rated voltage U_T to be used as reference voltage shall be determined as follows:

– if the upper limit of the voltage range does not exceed by more than 20 % ~~of its own~~ the lower limit of the voltage range, a single voltage ~~from~~ within the voltage range may be used as ~~a basis for test level specification (U_T)~~ rated voltage U_T;

– in all other cases, the test procedure shall be applied for both the lower and upper limits of the rated voltage range.

The ~~following~~ preferred voltage test levels (in % of U_T) ~~are used~~ and durations are given in Table 1, Table 2 and Table 3 as follows:

~~– 0 %, corresponding to interruptions;~~

~~– 40 % and 70 %, corresponding to 60 % and 30 % dips;~~

~~– 80 % and 120 %, corresponding to ±20 % variations.~~

– Table 1 corresponding to voltage dips;

– Table 2 corresponding to short voltage interruptions;

– Table 3 corresponding to voltage variations;

The change of the voltage for dips and interruptions is abrupt, in the range of microseconds (see the test generator specifications in Clause 6, Figure 1 and Figure 2).

~~The preferred test levels and durations are given in tables 1a, 1b and 1c.~~

~~The levels and durations shall be selected by the product committee.~~

The test conditions of high impedance (see 6.2.3) and low impedance (see 6.2.2) reported in Table 2 refer to the output impedance of the test generator as seen by the EUT during the voltage interruption~~; additional information is given in the definition of the test generator and test procedures~~.

Table 1 – Preferred test levels and durations for voltage dips

Test	Test level % U_T	Duration s
Voltage dips	40 and 70 or *x*	0,01 0,03 0,1 0,3 1 *x*

Table 2 – Preferred test levels and durations for short voltage interruptions

Test	Test condition	Test level % U_T	Duration s
Short interruptions	High impedance ~~and/~~or low impedance	0	0,001 0,003 0,01 0,03 0,1 0,3 1 *x*
NOTE For certain types of equipment it is appropriate to repeat the test in high impedance and low impedance condition.			

Table 3 – Preferred test levels and durations for voltage variations

Test	Test level % U_T	Duration s
Voltage variations	85 and 120 or 80 and 120 or *x*	0,1 0,3 1 3 10 *x*
The decrease and increase time (see Figure 3) shall be specified by the product standard based on the specific application.		

~~NOTE 1 "*x*" is an open value.~~

~~NOTE 2 One or more of the test levels and durations specified in each table may be chosen.~~

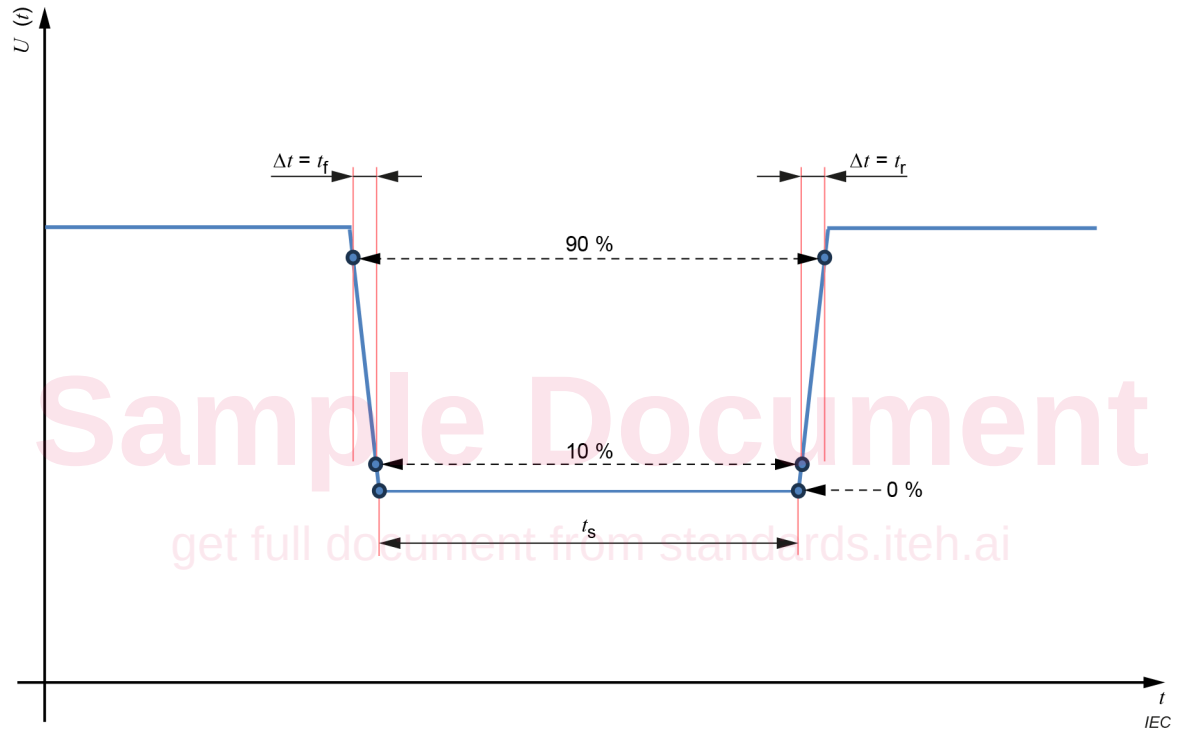
~~NOTE 3 If the EUT is tested for short interruptions, it is unnecessary to test for other levels of the same duration, unless the immunity of the equipment is detrimentally affected by voltage dips of less than 70 % U_T.~~

~~NOTE 4 Shorter duration in the tables, in particular the shortest one, should be tested to be sure that the EUT operates as intended.~~

Product standards may choose from each table one or more of the test levels and associated durations. In each table, "x" is an open value that may be chosen to test a special application.

The EUT can be sensitive to voltage changes of any duration specified in the tables. In particular, the shortest duration should be tested.

If the EUT is immune to short interruptions in low impedance condition of a specific duration, it is unnecessary to test for other test levels of the same duration (e.g. 40 % or 70 % U_T).



Key

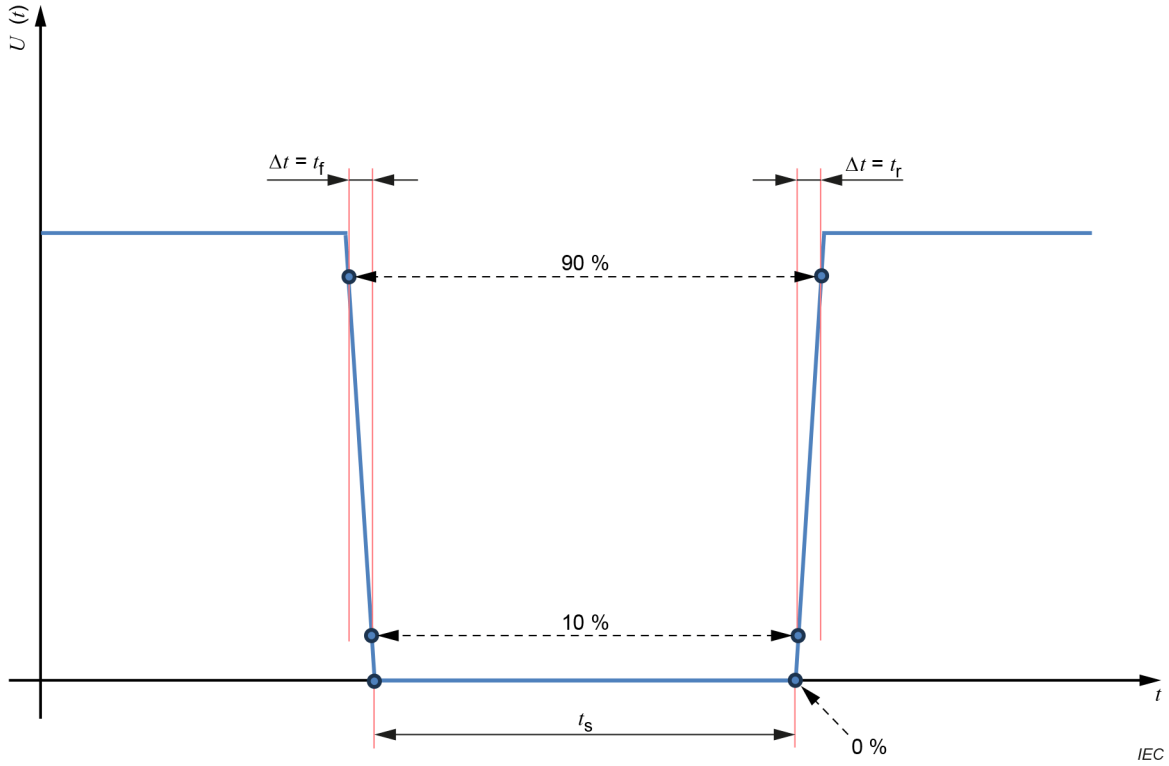
t_f fall time of the voltage change

t_r rise time of the voltage change

t_s time at the reduced voltage

NOTE The percentage values refer to the amplitude of the voltage dip.

Figure 1 – Example of voltage dip



Key

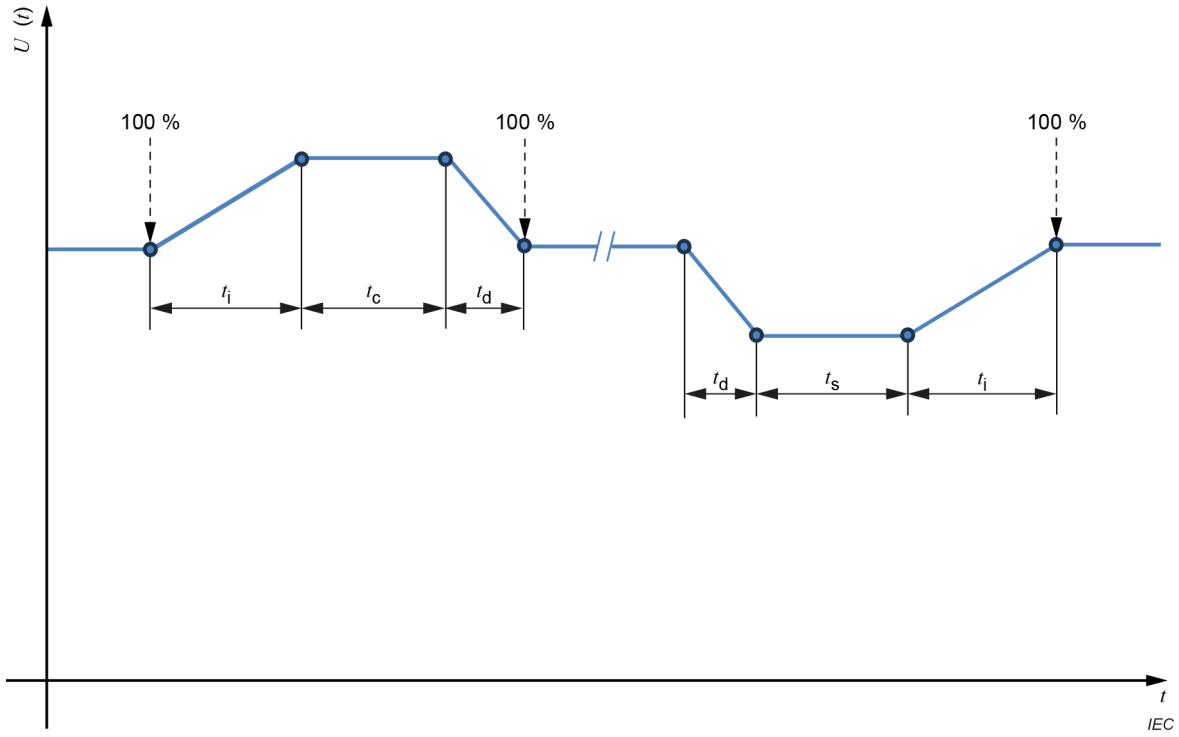
t_f fall time of the voltage change

t_r rise time of the voltage change

t_s time at 0 %

NOTE The percentage values refer to the amplitude of the voltage interruption.

Figure 2 – Example of short voltage interruption



Key

t_i time for increasing voltage

t_d time for decreasing voltage

t_c time at increased voltage

t_s time at reduced voltage

NOTE The percentage values refer to the rated voltage U_T.

Figure 3 – Examples of voltage variations

6 Test generator

6.1 General

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

~~The generator shall have provisions to prevent the emission of disturbances which may influence the test results.~~ Apart from the generation of the intended dips and interruptions, the test generator shall not emit disturbances which can influence the performance of the EUT.

Examples of generators are given in Figure A.1 (test generator based on two power sources with ~~internal switching~~ switches) and Figure A.2 (test generator based on a single programmable power ~~supply~~ source).

6.2 Characteristics and performances of the generator

6.2.1 General

The test generator shall be able to operate in continuous mode with the following main specifications:

– Output voltage range (U_o):	up to ~~360 V~~ 120 % of the maximum U_T
– Short interruptions, dips, and variations of the output voltage:	as given in Table 1, Table 2 and Table 3
– Output voltage ~~variation with the load (0 to rated current)~~ tolerance:	~~less than~~ ±5 % of U_T (see 6.3.2)
– Ripple content:	less than 1 % of the output voltage
– Rise and fall time of the voltage change ~~generator loaded with 100 Ω resistive load~~:	between ~~1~~ 0,5 µs and 50 µs (see 6.3.3)
– Overshoot/undershoot of the output voltage ~~generator loaded with 100 Ω resistive load~~:	less than 10 % of the voltage change
– Test generator rated output current (steady state) (I_o):	~~up to 25 A~~ at least 120 % of the rated input current of the EUT

NOTE The slew rate of the voltage change at the output of the generator can range from a few V/µs up to hundreds V/µs, depending on the output voltage change.

The accuracy of the durations is specified in 6.3.6. A test generator with U_o = ~~360 V_{dc}~~ 780 V and I_o = 25 A is recommended where it is necessary to cover ~~the great~~ a large number of ~~test requirements~~ applications. In case of ~~systems~~ equipment with rated power, or current, exceeding the capability of the test generator, the tests shall be performed on individual modules~~/~~ or subsystems if these parts can be operated independently.

~~The use of a generator with higher or lower voltage/current capability is allowed provided that the other specifications (output voltage variation with the load, rise and fall time of the voltage change, etc.) are preserved. The test generator steady state power/current capability shall be at least 20 % greater than the EUT power/current ratings.~~

The test generator, during the generation of short interruptions, shall be able to:

– operate in “low impedance” condition, absorbing inrush current from the load (if any), or
– operate in “high impedance” condition, blocking reverse current from the load.

The test generator, during the generation of voltage dips and voltage variations, shall operate in “low impedance” condition.

6.2.2 Specific characteristics for the generator operating in "low impedance" conditions

The output impedance of the test generator during the transition of the output voltage shall be low when the generator is operating in low impedance condition.

~~– Peak inrush current drive capability: 50 A at U_o = 24 V~~
~~100 A at U_o = 48 V~~
~~220 A at U_o = 110 V~~

~~– Inrush current polarity: positive (towards the EUT), and~~
~~negative (reverse from the EUT)~~