BRITISH STANDARD

BS EN 61000-4-29: 2001
IEC 61000-4-29: 2000

Electromagnetic compatibility (EMC) —

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

The European Standard EN 61000-4-29:2000 has the status of a British Standard

ICS 33.100.20

National foreword

This British Standard is the official English language version of EN 61000-4-29:2000. It is identical with IEC 61000-4-29:2000.

The UK participation in its preparation was entrusted by Technical Committee GEL/210, EMC-Policy, to Subcommittee GEL 1210/8, Low frequency disturbances, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 July 2001

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EUROPEAN STANDARD **EN 61000-4-29**

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English version

Electromagnetic compatibility (EMC)
Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests
(IEC 61000-4-29:2000)

Compatibilité électromagnétique (CEM)
Partie 4-29: Techniques d'essai et de mesure -
Essais d'immunité aux creux de tension, coupures brèves et variations de tension sur les accès d'alimentation en courant continu
(CEI 61000-4-29:2000)

Elektromagnetische Verträglichkeit (EMV)
Teil 4-29: Prüf- und Messverfahren -
Prüfungen der Störfestigkeit gegen Spannungseinbrüche, Kurzzeitunterbrechungen und Spannungsschwankungen an Gleichstrom-Netzeingängen
(IEC 61000-4-29:2000)

CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of document 77A/307/FDIS, future edition 1 of IEC 61000-4-29, prepared by SC 77A, Low-frequency phenomena, of IEC TC 77, Electromagnetic compatibility, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61000-4-29 on 2000-11-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop) 2001-08-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow) 2003-11-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes B and ZA are normative and annex A is informative.
Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 61000-4-29:2000 was approved by CENELEC as a European Standard without any modification.

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CONTENTS

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, 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).

This part is an International Standard which gives test procedures related to voltage dips, short interruptions and voltage variations on d.c. input power ports.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

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

1 Scope and object

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

This standard is applicable to low voltage d.c. power ports of equipment supplied by external d.c. networks.

The object of this standard 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 d.c. input power ports.

This standard 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 EUT (equipment under test) rated power is greater than the test generator capacity specified in clause 6.

The ripple at the d.c. input power port is not included in the scope of this part of IEC 61000. It is covered by IEC 61000-4-17[1)]

This standard 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.

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1) IEC 61000-4-17, *Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on d.c. input power port immunity test*

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*

3 Definitions

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

3.1
EUT
equipment under test

3.2
immunity (to a disturbance)
the 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
a sudden reduction of the voltage at a point in the low voltage d.c. 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]

3.4
short interruption
the disappearance of the supply voltage at a point of the low voltage d.c. distributed system for a period of time typically not exceeding 1 min. In practice, a dip with amplitude at least 80 % of the rated voltage may be considered as an interruption.

3.5
voltage variation
a gradual change of the supply voltage to a higher or lower value than the rated voltage. The duration of the change can be short or long.

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

4 General

The operation of electrical or electronic equipment may 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 d.c. distribution system, or by sudden large changes of load. Is also possible for two or more consecutive dips or interruptions to occur.

Faults in the d.c. distribution system may inject transient overvoltages into the distribution network; this particular phenomenon is not covered by this standard.

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 d.c. supply network may 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 the deviation from the rated voltage, and duration. 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 d.c. 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 voltage range does not exceed 20 % of its own lower limit, a single voltage from the range may be used as a basis for test level specification (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 voltage test levels (in % U_T) are used:

– 0 %, corresponding to interruptions;
– 40 % and 70 %, corresponding to 60 % and 30 % dips;
– 80 % and 120 %, corresponding to ±20 % variations.

The change of the voltage is abrupt, in the range of μs (see generator specification in clause 6).

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” and “low impedance” reported in table 1b 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 1a – 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 1b – Preferred test levels and durations for short 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*

Table 1c – 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*

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.

6 Test generator

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.

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

6.1 Characteristics and performances of the generator

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
– Short interruptions, dips, and variations of the output voltage:	as given in tables 1a, 1b and 1c
– Output voltage variation with the load (0 to rated current):	less than 5 %
– 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 μs and 50 μs
– Overshoot/undershoot of the output voltage, generator loaded with 100 Ω resistive load:	less than 10 % of the change in voltage
– Output current (steady state) (I_o):	up to 25 A

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.

A test generator with U_o = 360 V_{dc} and I_o = 25 A is recommended to cover the great number of test requirements. In case of systems with rated power exceeding the generator capability, the tests shall be performed on individual modules/subsystems.

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.

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

–	Peak inrush current drive capability:	50 A at U_0 = 24 V 100 A at U_0 = 48 V 220 A at U_0 = 110 V
–	Inrush current polarity:	positive (towards the EUT), and negative (reverse from the EUT)

For practical reasons, the peak inrush current drive capability of the generator, when set at output voltage higher than 110 V, may be reduced due to the increase in output impedance. However, the conditions specified in clause 6.2 for the peak inrush current capability margin shall be satisfied.

A generator with peak inrush current drive capability lower than specified above is allowed, provided that the conditions of 6.2 are satisfied.

The output impedance of the test generator shall be predominantly resistive and shall be low even during the transition of the output voltage.

Additional information on the peak inrush current of the test generator is given in annex B.

6.1.2 Specific characteristics for the generator operating in "high impedance" conditions (short interruption)

The impedance at the output terminal of the generator, during a short interruption, shall be ≥100 kΩ. The impedance shall be measured with the voltage level up to 3 × U_0 for both polarities.

The generator shall be properly protected against transient overvoltages produced by the EUT during the test. In order to achieve the required immunity to surges, the output port of the generator can be protected by protective devices (e.g. diodes, varistors), with suitable clamping voltage in order to maintain the required output impedance.

6.2 Verification of the characteristics of the generator

In order to compare the test results obtained from different test generators, the generator characteristics shall be verified as given below.

The measurement uncertainty of the instrumentation shall be better than ±2 %.

6.2.1 Output voltage and voltage change

The 120 %, 100 %, 85 %, 80 %, 70 % and 40 % output voltages of the generator shall conform to those percentages of the selected operating voltage U_T: 24 V, 48 V, 110 V, etc.

The values of all the voltages shall be measured at no load, and shall vary by less than 5 % when a load is applied.

6.2.2 Switching characteristics

The generator switching characteristics shall be measured with a 100 Ω load (with suitable power dissipation rating).

The rise and fall time of the output voltage, the overshoot and the undershoot, shall be verified when the generator is switched from 0 to U_T and from U_T to 0.

6.2.3 Peak inrush current drive capability

The circuit and the detailed procedure for measuring the generator inrush current are given in figure B.1.

The generator shall be switched from 0 to U_T, when driving a load consisting of an uncharged capacitor (whose value is 1 700 μF); the measured positive inrush current shall meet the requirement in 6.1.1.

The generator, pre-set to operate in “low impedance” condition, shall be switched from U_T to 0 and the negative peak inrush current shall meet the requirement in 6.1.1.

The generator shall then be pre-set to operate in “high impedance” condition, and switched from U_T to 0; the negative peak inrush current should be less than 0,2 % of the nominal current to verify there is no significant leakage current.

The use of generators with inrush current drive capability lower than the values reported in 6.1.1 is allowed, depending on the EUT characteristics. Whenever a generator with reduced performance is used, there must be a 30 % margin between the EUT’s peak inrush current and the peak inrush current capability of the generator. In order to calculate this margin, the EUT’s peak inrush current shall be measured and recorded; this measurement shall be made for a cold start and 5 s after turn-off.

A method for verifying the EUT inrush current is given in figure B.2. The actual EUT inrush current shall be measured for a cold start and 5 s after turn-off.

6.2.4 Output impedance

The generator, pre-set to operate in “high impedance” condition, shall be switched to generate a voltage interruption; in this condition the output impedance shall comply with the requirement of 6.1.2.

7 Test set-up

The test shall be performed with the shortest power supply cable specified by the EUT manufacturer. If no cable length is specified it shall be the shortest possible length suitable for the EUT’s intended application.

8 Test procedure

The test procedure includes:

– the verification of the laboratory reference conditions;

– the preliminary verification of the correct operation of the equipment;

– the execution of the test;

– the evaluation of the test results

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

8.1 Laboratory reference conditions

In order to minimise the impact of the environmental parameters on the test results, the test shall be carried out in the climatic and electromagnetic reference conditions as specified in 8.1.1 and 8.1.2.

8.1.1 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.

8.1.2 Electromagnetic conditions

The electromagnetic conditions of the laboratory shall be such to guarantee the correct operation of the EUT in order not to influence the test results.

8.2 Execution of the test

The EUT shall be configured for its normal operating conditions.

The test shall be performed according to a test plan that shall specify:

– test levels and durations;
– representative operating conditions of the EUT;
– auxiliary equipment.

The power supply, signal and other functional electrical quantities shall be applied within their rated range. If the actual operating signal sources are not available, they may be simulated.

During the test the output voltage of the test generator shall be monitored with an accuracy better than ±2 %.

8.2.1 Voltage dips and short interruptions

The EUT shall be tested, for each selected combination of test level and duration, with a sequence of three dips/interruptions with intervals of 10 s minimum (between each test event).

Each representative mode of operation shall be tested.

Short interruption tests shall be carried out with the generator set to:

– block reverse current from the load (high impedance), and
– absorb negative inrush current from the load (low impedance).

Voltage dips or short interruptions tests can cause transient overvoltages to appear at the EUT input terminals: these conditions shall be described in the test report.

8.2.2 Voltage variations

The EUT shall be tested for each of the specified voltage variations, three times at 10 s intervals in the most representative operating modes.

When requested, the EUT shall be tested with the gradual voltage variation representing the charging and discharging cycle of the batteries, the level and duration of this voltage variation being defined in the relevant product standard.

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 requester 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, requester 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.

This classification may be used as a guide in formulating performance criteria, by committees responsible for generic, product and product-family standards, or as a framework for the agreement on performance criteria between the manufacturer and the purchaser, for example where no suitable generic, product or product-family standard exists.

10 Test report

The test report shall contain all the information necessary to reproduce the test. In particular, the following shall be recorded:

– the items specified in the test plan required by clause 8 of this standard;

– identification of the EUT and any associated equipment, e.g. brand name, product type, serial number;

– identification of the test equipment, e.g. brand name, product type, serial number;

– any special environmental conditions in which the test was performed, e.g. shielded enclosure;

– any special conditions necessary to enable the test to be performed;

– performance level defined by the manufacturer, requester or purchaser;

– performance criterion specified in the generic, product or product-family standard;

– any effects on the EUT observed during or after the application of the test disturbance, and the duration for which these effects persist;

– the rationale for the pass/fail decision (based on the performance criterion specified in the generic, product or product-family standard, or agreed between the manufacturer and the purchaser);

– any specific conditions of use, for example cable length or type, shielding or grounding, or EUT operating conditions, which are required to achieve compliance.

Annex A
(informative)

Example of test generators and test set-up

Figure A.1 and figure A.2 show possible test configurations.

In figure A.1, voltage dips, short interruptions and voltage variations are simulated by means of two d.c. power sources with variable output voltages.

The duration of the interruption can be pre-set.

Voltage drops and rises are simulated by alternately closing switch 1 and switch 2. These two switches are never simultaneously closed. Special precautions have to be made to operate during dips and variation in “low impedance condition”, for example using capacitors, to avoid “high impedance”.

The power supply interruption, for the “high impedance” test condition, is obtained by opening both switches simultaneously.

The power supply interruption, for the “low impedance” test condition, is obtained by replacing d.c. source 2 by a short circuit or a low impedance to allow the test generator to absorb reverse current from the load.

The implementation of a generator may include diodes, resistors and fuses in combination with switches.

In figure A.2 a programmable power supply is used instead of d.c. power sources and switches.

This configuration also allows immunity testing with ripple content on d.c. power supplies (IEC 61000-4-17).

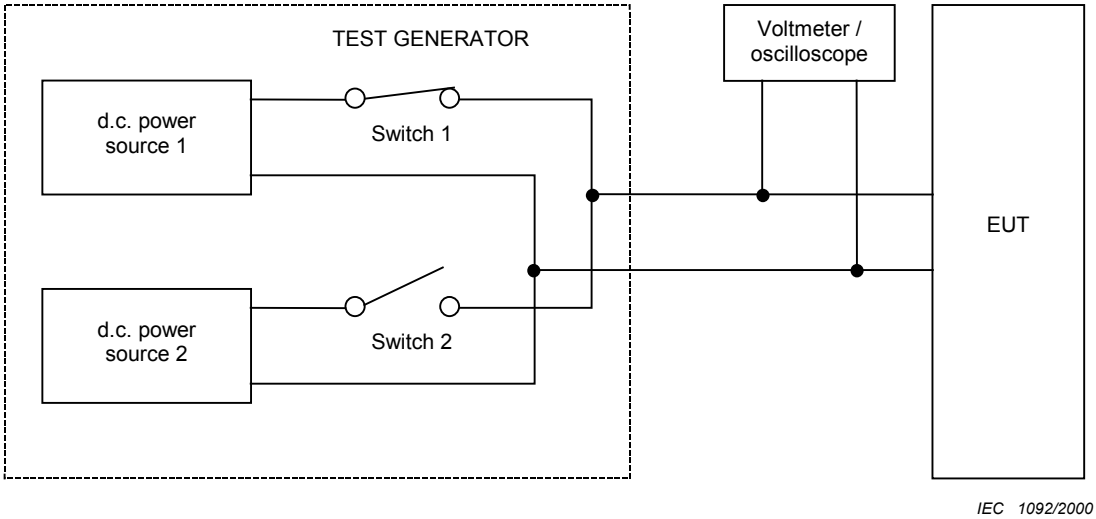


Figure A.1 – Example of test generator based on two power sources with internal switching

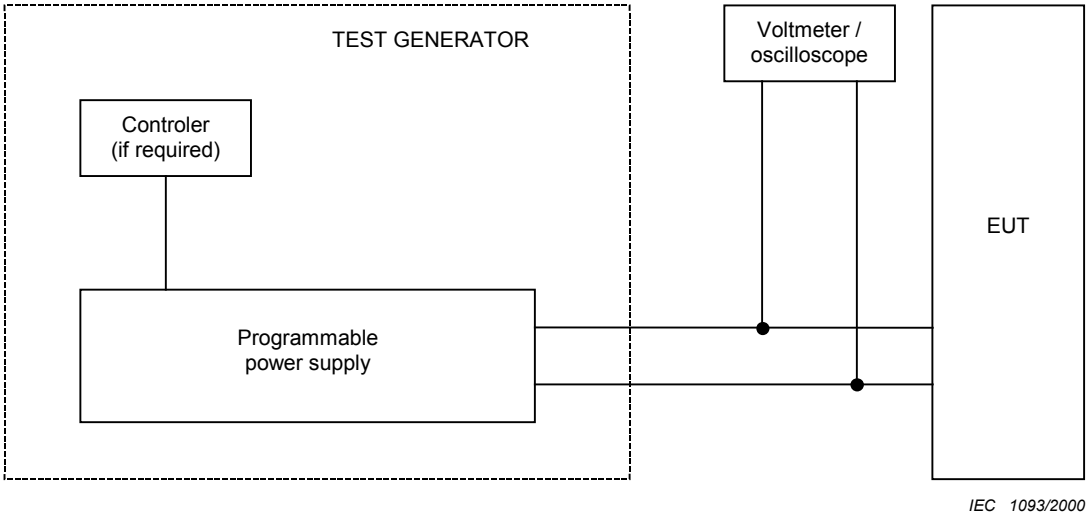


Figure A.2 – Example of test generator based on a programmable power supply

Annex B
(normative)

Inrush current measurement

B.1 Test generator peak inrush current drive capability

The circuit for measuring the generator peak inrush current drive capability is shown in figure B.1.

A similar circuit, incorporating a rectifier bridge, is defined in IEC 61000-4-11.

The 1 700 μF capacitor C shall have a tolerance of less than ±20 %. It shall have a voltage rating preferably 15 % to 20 % in excess of the maximum output voltage of the generator. It shall also be able to accommodate peak inrush current up to at least twice the generator's inrush current drive capability and to provide an adequate operating safety factor. The capacitor shall have the lowest possible equivalent series resistance (ESR) at both 100 Hz and 20 kHz, and shall not exceed 0,1 Ω at either frequency.

Since the test shall be performed with the 1 700 μF capacitor discharged, a resistor R shall be connected in parallel with it and several RC time constants must be allowed between tests. With a 10 000 Ω resistor, the RC time constant is 17 s, so there is an elapsed time of 90 s to 120 s between inrush drive capability tests. Resistors as low as 100 Ω may be used when shorter wait times are desired.

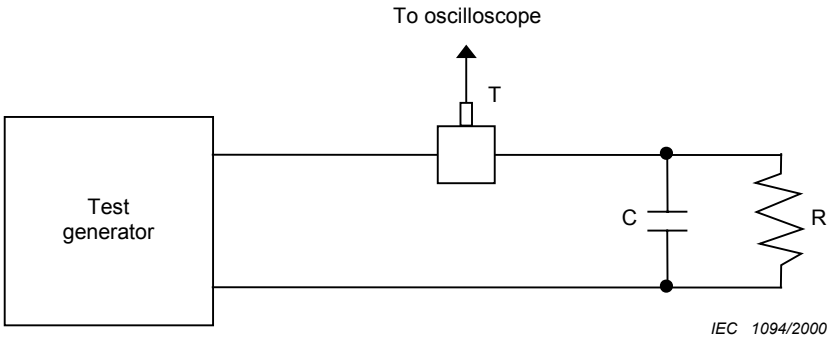
The current transducer (e.g. probe, shunt) shall be able to accommodate the full generator peak inrush current drive.

B.2 EUT peak inrush current

When the generator peak inrush current drive capability meets the specified requirement (e.g., 100 A at 48 V_{cc}), it is not necessary to measure the actual EUT peak inrush current.

As specified in 6.1.2, a generator with low inrush current drive capability may be used, provided that the inrush current of the EUT is less than 70 % of the drive capability of the generator.

Figure B.2 shows an example of how to measure the peak inrush current of an EUT and to verify the possible use of a test generator with reduced performances.



T convenient current transducer (e.g. probe, shunt);

R bleeder resistor, not over 10 000 Ω;

C 1 700 μF ± 20 % electrolytic capacitor.

Figure B.1 – Circuit for measuring the peak inrush current drive capability of a test generator

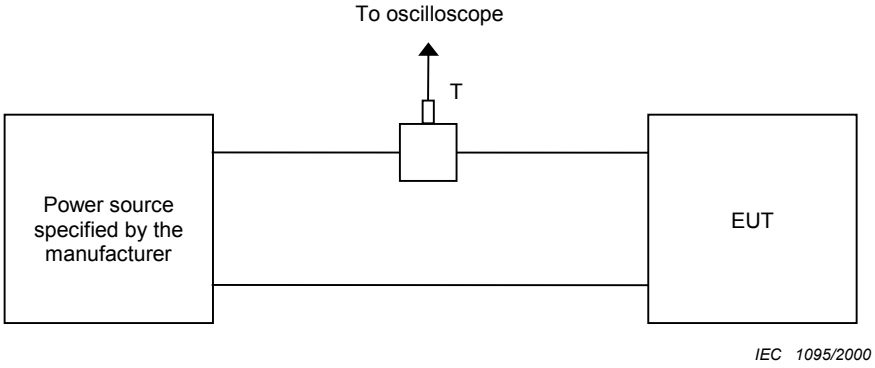


Figure B.2 – Circuit for measuring the peak inrush current of an EUT

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-161	1990	International Electrotechnical Vocabulary (IEV) - Chapter 161: Electromagnetic compatibility	-	-
IEC 61000-4-11	1994	Electromagnetic compatibility (EMC) Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	EN 61000-4-11	1994

BS EN 61000-4-29:2001 IEC 61000-4-29:2000

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