SLOVENSKI STANDARD
SIST ENV 50142:1997

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Electromagnetic compatibility - Basic immunity standard - Surge immunity test

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Elektromagnetische Verträglichkeit - Störfestigkeits-Grundnorm - Störfestigkeit gegen Stoßspannungen

Compatibilité électromagnétique - Publication fondamentale d'immunité - Prescriptions relatives à l'immunité aux ondes de choc

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English Version

Electromagnetic compatibility - Basic immunity standard - Surge immunity tests

This European Prestandard (ENV) was approved by CENELEC on 1994-06-07 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CENELEC will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard (EN).

CENELEC members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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FOREWORD

This European Prestandard has been prepared by working group 2 of CENELEC Technical Committee TC 110, EMC. It corresponds to the IEC document that will be used as the DIS for parallel voting on IEC 1000-4-5 / EN 61000-4-5.

It is intended to be used for reference as a basic standard in generic and product standards while the DIS is under the IEC-CENELEC parallel vote procedure. When the IEC 1000-4-5 / EN 61000-4-5 has been ratified, this ENV will be immediately withdrawn.

This European Prestandard ENV 50142 was accepted by TC 110 on 1994-06-07.

The following date has been fixed:

- latest date of announcement of the ENV at national level (doa) 1995-01-15

This document has the status of basic EMC publication, in accordance with IEC Guide 107.

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given only for information.
In this standard, annexes A and ZA are normative and annexes B and C are informative.

1 Scope

This section of International Standard IEC 1000-4 relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by overvoltages from switching and lightning transients. Several test levels are defined which relate to different environmental and installation conditions. These requirements are developed for and applicable to electrical and electronic equipment.

The object of this section of International Standard IEC 1000-4 is to establish a common reference for evaluating the performance of equipment when subjected to high energy disturbances on the power and interconnection lines.

The standard defines:

- range of test levels,
- test equipment,
- test set-up,
- test procedure.

The task of the described laboratory test is to find the reaction of the EUT under specified operational conditions caused by surge voltages from switching and lightning effects at certain threat-levels.
It is not intended to test the capability of the insulation to withstand high voltage stress.
Direct lightning is not considered in this standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of International Standard IEC 1000-4. At the time of publication, the editions indicated were valid. All documents are subject to revision, and parties to agreements based on this documents are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(161): 1990, *International Electrotechnical Vocabulary (IEV) - Chapter 161: Electromagnetic compatibility*

IEC 60-1: 1989, *High-voltage test techniques - Part 1: General definitions and test requirements*

IEC 469-1: 1987, *Pulse techniques and apparatus - Part 1: Pulse terms and definitions*

3 General

Switching transients

System switching transients can be separated into transients associated with:

1) major power system switching disturbances, such as capacitor bank switching;

2) minor switching activity near the instrumentation or load changes in the power distribution system;

3) resonating circuits associated with switching devices, such as thyristors;

4) various system faults, such as short circuits and arcing faults of the earthing system of the installation.

Lightning transients

The major mechanisms by which lightning produces surge voltages are the following:

1) a direct lightning stroke to an external circuit (outdoor) injecting high currents producing voltages by either flowing through earth resistance or flowing through the impedance of the external circuit;

2) an indirect lightning stroke (a stroke between or within clouds or to nearby objects which produces electromagnetic fields) that induce voltages/currents on the conductors outside and/or inside a building;

3) lightning earth current flow resulting from nearby direct-to-earth discharges coupling into the common earth paths of the earthing system of the installation.

The rapid change of voltage and flow of current which may occur when a protector is excited may couple into internal circuits.

Simulation of the transients

1) the characteristics of the test generator are such that it simulates the above-mentioned phenomena as closely as possible;

2) if the source of disturbance is in the same circuit, e.g. in the power supply network (direct coupling), the generator may simulate a low impedance source at the ports of the equipment under test;

3) if the source of disturbance is not in the same circuit (indirect coupling) as the ports of the receptor-equipment, than the generator may simulate a higher impedance source.

4 Definitions

Unless otherwise stated the definitions in IEC 50 Chapter 161 (IEV) apply:

4.1 **balanced lines:** Within the meaning of this standard balanced lines are a pair of symmetrically driven conductors with conversion loss from differential to common mode of less than 20 dB.

4.2 **coupling network:** Electrical circuit for the purpose of transferring energy from one circuit to another.

4.3 **decoupling network:** Electrical circuit for the purpose of preventing surges applied to the EUT from affecting other devices, equipment or systems which are not under test.

4.4 **duration:** The absolute value of the interval during which as specified waveform or feature exists or continues, IEC 469-1.

4.5 **EUT:** Equipment under test.

4.6 **front time**

surge voltage: The front time T_1 of a surge voltage is a virtual parameter defined as 1,67 times the interval T, between the instants when the impulse is 30 % and 90 % of the peak value (see figure 2).

surge current: The front time T_1 of a surge current is a virtual parameter defined as 1,25 times the interval T, between the instants when the impulse is 10 % and 90 % of the peak value (see figure 3). (from IEC 60- 1).

4.7 **immunity:** The ability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance, IEV (161-01-20).

4.8 **installation:** An assembly of associated electrical equipment to fulfil a specific purpose or purposes and having coordinated characteristics, IEV (826-01-01).

4.9 **interconnection lines consist of:**

- I/O lines (input/output lines)
- Communication lines
- Balanced lines

4.10 primary protection: The means by which the majority of stressful energy is prevented from propagating beyond the designated interface.

4.11 rise time: The interval of time between the instants at which the instantaneous value of a pulse first reaches a specified lower value and then a specified upper value.

NOTE - Unless otherwise specified, the lower and upper values are fixed at 10 % and 90 % of the impulse magnitude, IEV (161-02-05).

4.12 secondary protection: The means by which the let through energy from primary protection is suppressed. It may be a special device or an inherent characteristic of the EUT.

4.13 surge: A transient wave of electrical current, voltage, or power propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease, see also IEV (161-08-11).

4.14 system: Set of interdependent elements constituted to achieve a given objective by performing a specified function, IEV (351-01-01).

NOTE - The system is considered to be separated from the environment and other external systems by an imaginary surface which cuts the links between them and the considered system. Through these links, the system is affected by the environment, is acted upon by external systems, or acts itself on the environment or the external systems.

4.15 time to half value: The time to half-value T_2 of a surge is a virtual parameter defined as the time interval between the virtual origin O_1 and the instant when the voltage/current has decreased to half the peak value. (from IEC 60-1, 1989).

4.16 transient: Pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady-states during a time interval short compared to the time-scale of interest, IEV (161-02-01).

5 Test levels

The preferential range of test levels is given in table 1.

Table 1 - Test levels

Test Level	Open circuit test voltage ± 10 % kV
1	0,5
2	1,0
3	2,0
4	4,0
x	special
NOTE - "x" is an open test level. The test level can be specified in the product specification.	

The test levels shall be selected according to the installation conditions; classes of installation are given in B.3 of annex B.

All voltages of the lower test levels shall be satisfied (see 8.2).

For selection of the test levels for the different interfaces see annex A.

6 Test instrumentation

6.1 *Combination wave (hybrid) generator (1,2/50 µs - 8/20 µs)*

A simplified circuit diagram of the generator is given in figure 1. The different components R_{s1}, R_{s2}, R_m, L_r and C_c have to be selected so that the generator delivers a 1,2/50 µs voltage surge (at open circuit conditions), a 8/20 µs current surge into a short circuit, and the generator has an effective output impedance of 2 Ω.

For convenience, an effective output impedance is defined for a surge generator by calculating the ratio of peak open circuit output voltage and peak short circuit current.

Such a generator with 1,2/50 µs open circuit voltage waveform and 8/20 µs short circuit current waveform is referred to as a Combination Wave Generator (CWG) or hybrid generator.

NOTES

1) The waveform of the voltage and current is a function of the EUT input impedance. This impedance may change during surges and due either to proper operation of the installed protection devices, or to flashover or component breakdown, if the protection devices are absent or inoperative. Therefore the 1,2/50 µs voltage and the 8/20 µs current waves shall be available from the same test generator output as instantaneously required by the load.

2) The combination wave generator described in this standard is identical with the hybrid generator sometimes specified in some other standards.

6.1.1 *Characteristics and performance of the Combination Wave Generator*

Open circuit output voltage:	at least as low as 0,5 kV to at least as high as 4,0 kV
Waveform of the surge voltage:	see figure 2 and table 2
Tolerance of the open circuit output voltage:	± 10 %
Short circuit output current:	at least as low as 0,25 kA to at least as high as 2,0 kA
Waveform of the surge current:	see figure 3 and table 2
Tolerance of the short circuit output current:	± 10 %
Polarity:	positive/negative
Phase shifting:	in a range between 0 to 360° versus the a.c. line phase angle
Repetition rate:	at least 1 per minute

A generator with floating output shall be used.

Additional resistors (10 or 40 Ω) shall be included to increase the required effective source impedances for the specified test conditions (see 7 and B.1 of annex B).

Under these circumstances the open circuit voltage waveform and the short circuit current waveform in combination with the coupling/decoupling network is no longer 1,2/50 µs or 8/20 µs respectively (combination wave).

6.1.2 *Verification of the characteristics of the generator*

In order to compare the test results from different test generators, the test generator characteristics shall be verified. For this purpose, the following procedure is necessary to measure the most essential characteristics of the generator.

The tests generator output shall be connected to a measuring system with a sufficient bandwidth and voltage capability to monitor the characteristics of the waveforms.

The characteristics of the generator shall be measured under open circuit conditions (load greater or equal to 10 kΩ) and under short circuit conditions (load smaller than or equal to 0,1 Ω) at the same charge voltage.

NOTE - Short circuit current: 0,25 kA minimum with the open circuit voltage set to 0,5 kV and 2,0 kA minimum with the open circuit voltage set to 4,0 kV.

6.2 *Test generator 10/700 µs according to CCITT*

The simplified circuit diagram of the generator is reported in figure 4. The values for the different elements R_c, C_c, R_s, R_{m1}, C_s and R_{m2} are defined so that the generator delivers a 10/700 µs surge.

6.2.1 *Characteristics and performance of the generator*

Open circuit output voltage:	at least as low as 0,5 kV to at least as high as 4,0 kV
Waveform of the surge voltage:	see figure 5 (IEC 60-1)and table 3
Tolerance of the open circuit output voltage:	± 10 %
Short circuit output current:	at least as low as 12,5 A to at least as high as 100 A
Waveform of the surge current:	see table 3
Tolerance of the short circuit output current:	± 10 %
Polarity:	positive/negative
Repetition rate:	at least 1 per minute

A generator with floating output shall be used.

6.2.2 *Verification of the characteristics of the generator*

The verification conditions for the 10/700 µs test generator are identical with 6.1.2 with the following note.

NOTE - Short circuit current: 12,5 A minimum with the open circuit voltage set to 0,5 kV and 100 A minimum with the open circuit voltage set to 4,0 kV.

6.3 *Coupling/decoupling networks*

The coupling/decoupling networks shall not significantly influence the parameters of the generators e.g. open circuit voltage, short circuit current capability as in the specified tolerances.

Exception: Coupling via arrestor.

NOTE - Lossy material for the inductances reduces ringing.

Each coupling/decoupling network shall satisfy the following requirements:

6.3.1 *Coupling/decoupling networks for a.c./d.c. power supply circuits (only used with Combination Wave Generator)*

The front time and surge time to half value shall be verified for voltage under open circuit conditions and for current under short circuit conditions.

The test generator output or its coupling network shall be connected to a measuring system with a sufficient bandwidth and voltage capability to monitor the open circuit voltage waveform.

The short circuit current waveform can be measured with a current transformer through whose aperture passes a short circuit link between the output terminals of the coupling network.

All waveform definitions, as well as all other performance parameters of the test generator, should be as specified in 6.1.1 at the output of the coupling/decoupling network as well as at the output of the generator itself.

NOTE - When the generator impedance is increased from 2 Ω to e.g. 12 or 42 Ω according to the requirements of the test set-up the duration of the surge at the output of the coupling network might be significantly changed.

6.3.1.1 *Capacitive coupling for power supply circuits*

Capacitive coupling enables the test voltage to be applied line to line or one line to earth while the power supply decoupling network is also connected. The circuit diagrams for single phase systems are shown in figures 6 and 7 and for three phase systems are shown in figures 8 and 9.

Rated characteristics of the coupling/decoupling network:

Coupling
Coupling capacitors: C = 9 µF or 18 µF (see test set-up)

Decoupling
Decoupling inductance for supply voltage: L = 1,5 mH

The residual surge voltage on unsurged lines shall not exceed 15 % of maximum applicable test voltage when the EUT is disconnected.
The residual surge voltage on the power supply inputs of the decoupling network when the EUT and the power supply network are disconnected, shall not exceed 15 % of applied test voltage or twice peak value of the power line voltage whichever is higher.

The above mentioned characteristics for single phase systems (line, neutral, protective earth) are also valid for three phase systems (three phase wires, neutral and protective earth).

6.3.1.2 *Inductive coupling for power supply*

Under consideration

6.3.2 *Coupling/decoupling networks for interconnection lines*

The coupling method shall be selected as a function of the circuits and operational conditions. This has to be specified in the product specification.