SLOVENSKI STANDARD

SIST EN 61000-4-27:2002

prva izdaja
maj 2002

Electromagnetic compatibility (EMC) - Part 4-27: Testing and measurement techniques - Unbalance, immunity test (IEC 61000-4-27:2000)

ICS 33.100.20

Referenčna številka
SIST EN 61000-4-27:2002(en)

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61000-4-27

November 2000

ICS 33.100.20

English version

Electromagnetic compatibility (EMC) Part 4-27: Testing and measurement techniques - Unbalance, immunity test (IEC 61000-4-27:2000)

Compatibilité électromagnétique (CEM)
Partie 4-27: Techniques d'essai et de mesure -
Essai d'immunité aux déséquilibres
(CEI 61000-4-27:2000)

Elektromagnetische Verträglichkeit (EMV)
Teil 4-27: Prüf- und Messverfahren -
Prüfung der Störfestigkeit gegen Unsymmetrie (der Versorgungsspannung)
(IEC 61000-4-27:2000)

This European Standard was approved by CENELEC on 2000-09-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

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

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Ref. No. EN 61000-4-27:2000 E

Foreword

The text of document 77A/308/FDIS, future edition 1 of IEC 61000-4-27, 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 61000-4-27 on 2000-09-01.

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) 2001-06-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2003-09-01

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

Endorsement notice

The text of the International Standard IEC 61000-4-27:2000 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60898 NOTE: Harmonized as EN 60898:1991 (modified).

CONTENTS

INTRODUCTION

This standard is part of IEC 61000 series, 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 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 completed by a second number identifying the subdivision (example: 61000-6-1).

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-27: Testing and measurement techniques – Unbalance, immunity test

1 Scope and object

This part of IEC 61000 is a basic EMC (electromagnetic compatibility) publication. It considers immunity tests for electric and/or electronic equipment (apparatus and system) in its electromagnetic environment. Only conducted phenomena are considered, including immunity tests for equipment connected to public and industrial networks.

The object of this standard is to establish a reference for evaluating the immunity of electrical and electronic equipment when subjected to unbalanced power supply voltage.

This standard applies to 50 Hz/60 Hz three-phase powered electrical and/or electronic equipment with rated line current up to 16 A per phase.

This standard does not apply to equipment with three-phase plus neutral connection if that equipment operates as a group of single-phase loads connected between phase and neutral.

This standard does not apply to electrical and/or electronic equipment connected to a.c. 400 Hz distribution networks.

This standard does not include tests for the zero-sequence unbalance factor.

The immunity test levels required for a specific electromagnetic environment together with performance criteria are indicated in the product, product family or generic standards as applicable. This immunity test should be included in product, product family or generic standards when equipment is likely to show reduced performance or function when exposed to a supply voltage with voltage unbalance.

The verification of the reliability of electrical components (capacitors, motors, etc.) and long-term effects (greater than a few minutes) 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 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 IEC and ISO maintain registers of currently valid International Standards.

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

IEC 61000-2-4, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 4: Compatibility levels in industrial plants for low-frequency conducted disturbances*

3 Definitions

For the purposes of this part of IEC 61000, the following definitions apply.

3.1
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]

3.2
voltage unbalance
in a polyphase system, condition in which the r.m.s. values of the phase voltages or the phase angles between consecutive phases are not all equal
[IEV 161-08-09]

3.3
unbalance factor k_{u2} (%)
ratio of the negative sequence component to the positive sequence component measured at mains frequency (50 Hz or 60 Hz) as defined by the method of symmetrical components

$$k_{u2} = 100\ \%\ (U_2 / U_1)$$ (negative-sequence voltage/positive-sequence voltage)

NOTE The negative-sequence voltages in a network mainly result from the negative currents of unbalanced loads flowing in the network.

3.4
malfunction
termination of the ability of an equipment to carry out intended functions or the execution of unintended functions by the equipment

4 General

Three-phase electrical and electronic equipment may be affected by voltage unbalance. Annex A describes the sources, effects and measurement of this disturbance.

Unbalance is caused by either voltage amplitude or phase-shift variations. A formula for the calculation of the unbalance factor, based upon these parameters, is given in annex B.

The purpose of the test is to investigate the influence of unbalance in a three-phase voltage system on equipment which may be sensitive to this disturbance, which could cause:

- overcurrents in a.c. rotating machines;
- generation of non-characteristic harmonics in electronic power converters;
- synchronization problems or control errors in the control part of electrical equipment (see annex A).

5 Test levels

The equipment under test (EUT) is set up at a steady mains voltage and is then subjected to unbalance sequences according to figure 2.

Table 1 specifies the test levels which are derived as explained in annex C.

The duration of the unbalance test, specified between 0,1 s to 60 s, can be taken as a general guide to study short-term effects.

Table 1 – Test levels

Test number	Test level Class 1	Test level for Class 2					Test level for Class 3					Test level for Class X
		Phase	Amplitude % U_N	Angle °	k_{u2} %	Time s	Phase	Amplitude % U_N	Angle	k_{u2} %	Time s	
Test 1	No test required	U_a	100	0°	6	30	U_a	100	0°	8	60	
		U_b	95,2	125°			U_b	93,5	127°			
		U_c	90	240°			U_c	87	240°			
Test 2		U_a	100	0°	13	15	U_a	100	0°	17	15	
		U_b	90	131°			U_b	87	134°			
		U_c	80	239°			U_c	74	238°			
Test 3		U_a	110	0°	25	0,1	U_a	110	0°	25	2	
		U_b	66	139°			U_b	66	139°			
		U_c	71	235°			U_c	71	235°			

NOTE 1 U_N is the nominal voltage.
NOTE 2 U_b is lagging against U_a, and U_c is leading against U_a.

Tests are respectively specified for equipment in relation to levels 2 and 3 in IEC 61000-2-4.

The product committee may specify any test level; however, for equipment connected to public supply systems, it is recommended that the levels should not be lower than those defined for class 2.

6 Test equipment

6.1 Test generators

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

The output voltage shall be adjusted to ±1% of U_N and the phase to ±0,3°.

Table 2 – Characteristics of the generator

Characteristic	Performance specification
Output voltage capability	U_N ± 50 %
Output voltage accuracy	±2 % of U_N.
Output current capability	Sufficient to supply the EUT under all test conditions
Overshoot/undershoot of the actual voltage, generator loaded with 100 Ω resistive load	Less than 5 % of the change in voltage
Voltage rise (and fall time) during voltage changes, generator loaded with 100 Ω resistive load	1 µs to 5 µs
Total harmonic distortion of the output voltage	Less than 3 %
Phase shifting Phase accuracy	0°, 120° and 240° ± 30° 1° between any two phases
Frequency accuracy	0,5 % of f_1 (50 Hz or 60 Hz)

6.2 Verification of the characteristics of the test generators

It is recognized that there is a wide range of EUTs and that consequently test generators with different output power capabilities may be used, as required.

The user shall verify that the test generator complies with the characteristics and performance specifications listed in table 2, as required by the particular EUT.

The performance of the test generator may be verified with a resistive load equal to the real component of the impedance of the EUT.

7 Test set-up

The test shall be performed with the EUT connected to the test generator with a supply cable as specified by the manufacturer. If no cable length is specified, it shall be the shortest possible length adapted to the EUT. The length shall be reported in the test report.

Figure 3 shows a schematic drawing for the generation of voltage unbalance (amplitude or phase change) using a generator with power amplifier.

Generators with transformers and switches need to have variable transformers on at least two phases.

The ports of the EUT shall be connected to appropriate peripherals as defined by the manufacturer. If appropriate peripherals are not available, they may be simulated.

8 Test procedures

8.1 Laboratory reference conditions

In order to minimize the impact of environmental parameters on test results, the tests shall be carried out in 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 not influence the test results.

8.2 Execution of the test

The EUT shall be configured for its normal operating conditions.

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

- test number (see table 1);
- test level;
- test duration;
- ports to which the test shall be applied;
- representative operating conditions of the EUT;
- auxiliary equipment.

The power supply, signals 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.

For each test level, a succession of at least three unbalance sequences shall be applied, with an interval of a least 3 min between each (see figure 2).

The applied test levels shall be rotated as follows:

First sequence: U_a to L_1, U_b to L_2, U_c to L_3;
Second sequence: U_a to L_2, U_b to L_3, U_c to L_1;
Third sequence: U_a to L_3, U_b to L_1, U_c to L_2.