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BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test

Compatibilité électromagnétique (CEM) – Partie 4-8: Techniques d'essai et de mesure – Essai d'immunité au champ magnétique à la fréquence du réseau

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FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61000-4-8 has been prepared by subcommittee 77B: High frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms section 8 of part 4 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

This consolidated version of IEC 61000-4-8 consists of the first edition (1993) [documents 77B(CO)7 and 77B(CO)13] and its amendment 1 (2000) [documents 77B/291+293/FDIS and 77B/298+300/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

Annexes A and B form an integral part of this standard.

Annexes C and D are for information only.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until 2002. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

This standard is part of the 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 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 9: Miscellaneous

Each part is further subdivided into sections which are to be published either as international standards or as technical reports.

These standards and reports will be published in chronological order and numbered accordingly.

This part is an international standard which gives immunity requirements and test procedures related to "power frequency magnetic field".

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test

1 Scope

This international standard relates to the immunity requirements of equipment, only under operational conditions, to magnetic disturbances at power frequency related to:

– residential and commercial locations;
– industrial installations and power plants;
– medium voltage and high voltage sub-stations.

The applicability of this standard to equipment installed in different locations is determined by the presence of the phenomenon, as specified in clause 3.

This standard does not consider disturbances due to capacitive or inductive coupling in cables or other parts of the field installation.

Other IEC standards dealing with conducted disturbances cover these aspects.

The object of this standard is to establish a common and reproducible basis for evaluating the performance of electrical and electronic equipment for household, commercial and industrial applications when subjected to magnetic fields at power frequency *(continuous and short duration field).*

The standard defines:

– recommended test levels;
– test equipment;
– test set-up;
– test procedure.

Other kinds of magnetic fields would be object of standardization:

– fields at other power frequencies (16 2/3 – 20 or 30 – 400 Hz);
– fields of harmonic currents (100 Hz to 2 000 Hz);
– fields of higher frequencies (up to 150 kHz, e.g. for mains signalling systems);
– D.C. fields.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 61000-4. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 61000-4 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

3 General

The magnetic fields to which equipment is subjected may influence the reliable operation of equipment and systems.

The following tests are intended to demonstrate the immunity of equipment when subjected to power frequency magnetic fields related to the specific location and installation condition of the equipment (e.g. proximity of equipment to the disturbance source).

The power frequency magnetic field is generated by power frequency current in conductors or, more seldom, from other devices (e.g. leakage of transformers) in the proximity of equipment.

As for the influence of nearby conductors, one should differentiate between:

– the current under normal operating conditions, which produces a steady magnetic field, with a comparatively small magnitude;

– the current under fault conditions which can produce comparatively high magnetic fields but of short duration, until the protection devices operate (a few milliseconds with fuses, a few seconds for protection relays).

The test with a steady magnetic field may apply to all types of equipment intended for public or industrial low voltage distribution networks or for electrical plants.

The test with a short duration magnetic field related to fault conditions, requires test levels that differ from those for steady-state conditions; the highest values apply mainly to equipment to be installed in exposed places of electrical plants.

The test field waveform is that of power frequency.

In many cases (household areas, sub-stations and power plant under normal conditions), the magnetic field produced by harmonics is negligible. However, in very special cases like heavy industrial areas (large power convertors, etc.) they occur, and will be considered in a future revision of this standard.

4 Definitions

The following definitions and terms are used in this standard and apply to the restricted field of magnetic disturbances; not all of them are included in IEC 60050(161) [IEV].

4.1
EUT
equipment under test

4.2
induction coil
conductor loop of defined shape and dimensions, in which flows a current, generating a magnetic field of defined constancy in its plane and in the enclosed volume

4.3
induction coil factor
ratio between the magnetic field strength generated by an induction coil of given dimensions and the corresponding current value; the field is that measured at the centre of the coil plane, without the EUT

4.4
immersion method
method of application of the magnetic field to the EUT, which is placed in the centre of an induction coil (figure 1)

4.5
proximity method
method of application of the magnetic field to the EUT, where a small induction coil is moved along the side of the EUT in order to detect particularly sensitive areas

4.6
ground (reference) plane (GRP)
a flat conductive surface whose potential is used as a common reference for the magnetic field generator and the auxiliary equipment (the ground plane can be used to close the loop of the induction coil, as in figure 4)
[IEV 161-04-36, modified]

4.7
decoupling network, back filter
electrical circuit intended to avoid reciprocal influence with other equipment not submitted to the magnetic field test

5 Test levels

The preferential range of test levels, respectively for continuous and short duration application of the magnetic field, applicable to distribution networks at 50 Hz and 60 Hz, is given in table 1 and table 2.

The magnetic field strength is expressed in A/m; 1 A/m corresponds to a free space induction of 1,26 μT.

Table 1 – Test levels for continuous field

Level	Magnetic field strength A/m
1	1
2	3
3	10
4	30
5	100
x [1)]	special
NOTE 1 "x" is an open level. This level can be given in the product specification.	

Table 2 – Test levels for short duration: 1 s to 3 s

Level	Magnetic field strength A/m
1	n.a. [2)]
2	n.a. [2)]
3	n.a. [2)]
4	300
5	1 000
x [1)]	special
NOTE 1 "x" is an open level. This level, as well the duration of the test, can be given in the product specification. NOTE 2 "n.a." = not applicable.	

Information on the selection of the test levels is given in annex C.

Information on actual levels is given in annex D.

6 Test equipment

The test magnetic field is obtained by a current flowing in an induction coil; the application of the test field to the EUT is by the *immersion method.*

An example of application of the immersion method is given in figure 1.

The test equipment includes the current source (test generator), the induction coil and auxiliary test instrumentation.

6.1 Test generator

The generator, with the output waveform corresponding to the test magnetic field, shall be able to deliver the required current in the induction coils specified in 6.2.

The generator power capability shall therefore be dimensioned by taking into account the coil impedance; the inductance may range from 2,5 μH for the 1 m standard coil, to several μH (e.g. 6 μH) for a rectangular induction coil (1 m × 2,6 m, see 6.2).

The specifications of the generator are:

– current capability, determined by the maximum selected test level and induction coil factor (see 6.2.2 and annex A), ranging from 0,87 m^{-1}, (1 m standard coil for testing table-top or small equipment) to 0,66 m^{-1} (rectangular induction coil, 1 m × 2,6 m, for testing floor-standing or large equipment);
– operability in short-circuit condition;
– low output terminal connected to the earth terminal (for connection to the safety earth of the laboratory);
– precautions to prevent the emission of large disturbances that may be injected in the power supply network or may influence the test results.

The characteristics and performances of the current source or test generator for the different fields considered in this standard are given in 6.1.1.

6.1.1 Characteristics and performances of the test generator

The current source typically consists of a voltage regulator (connected to the mains distribution network), a current transformer and a circuit for the control of short duration application. The generator shall be able to operate in continuous mode or short duration mode.

Specifications

Output current range for continuous mode operation: 1 A to 100 A, divided by the coil factor

Output current range for short duration mode operation: 300 A to 1000 A, divided by the coil factor

Total distortion factor of the output current: less than 8 %

Set time for short duration mode operation: 1 s to 3 s

NOTE The output current range for the standard coil is from 1,2 A to 120 A for continuous mode, and from 350 A to 1200 A for short duration mode.

The waveform of the output current is a sinusoid.

The schematic circuit of the generator is given in figure 2.

6.1.2 Verification of the characteristics of the test generator

In order to compare the results for different test generators, the essential characteristics of the output current parameters shall be verified.

The output current shall be verified with the generator connected to the standard induction coil specified in 6.2.1 a); the connection shall be realized by twisted conductors of up to 3 m length and suitable cross-section.

The emission of disturbances by the generator shall be verified (see 6.1).

The characteristics to be verified are:

– output current value;
– total distortion factor.

The verifications shall be carried out with a current probe and measurement instrumentation having ±2 % accuracy.

6.2 Induction coil

6.2.1 Characteristics of the induction coil

The induction coil, connected to the test generator previously defined (see 6.1.1), shall generate a field strength corresponding to the selected test level and the defined homogeneity.

The induction coil shall be made of copper, aluminium or any conductive non-magnetic material, of such cross-section and mechanical arrangement as to facilitate its stable positioning during the tests.

A same coil is suitable for the generation of the magnetic fields considered in this standard; it may be a "*single turn*" coil and shall have a suitable current capability, as may be necessary for the selected test level.

Multi-turn coils may be used in order to have a lower testing current.

The induction coil shall be adequately dimensioned to surround the EUT (three orthogonal positions).

Depending on the size of the EUT, induction coils of different dimensions may be used.

The dimensions recommended below are suitable for the generation of magnetic fields over the whole volume of the EUT's *(table-top equipment or floor-standing equipment),* with an acceptable variation of ±3 dB.

The characteristics of induction coils in respect of the magnetic field distribution are given in annex B.

a) *Induction coil for table-top equipment*

The induction coil of standard dimensions for testing small equipment (e.g. computer monitors, watt-hour meters, transmitters for process control, etc.) has a square (or circular) form with 1 m side (or diameter), made of a conductor of relatively small cross-section.

The test volume of the standard square coil is 0,6 m × 0,6 m × 0,5 m (height).

A double coil of standard size (Helmholtz coil) could be used in order to obtain a field homogeneity better than 3 dB or for testing larger EUT's.

The double coil (Helmholtz coil) shall be comprised of two or more series of turns, properly spaced (see figure 6, figure B.4, figure B.5).

The test volume of a double standard size coil, 0,8 m spaced, for a 3 dB homogeneity is 0,6 m × 0,6 m × 1 m (height).

For example, the Helmholtz coils, for a 0,2 dB inhomogeneity, have dimensions and separation distances as given in figure 6.

b) *Induction coil for floor-standing equipment*

Induction coils shall be made according to the dimensions of the EUT and the different field polarizations.

The coil shall be able to envelop the EUT; the coil dimensions shall be such as to give a minimum distance of coil conductors to EUT walls equal to 1/3 of the dimension of the EUT considered.