IEC 61000-4-10

Edition 2.0 2016-07

INTERNATIONAL STANDARD

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colour inside

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

Electromagnetic compatibility (EMC) –
Part 4-10: Testing and measurement techniques – Damped oscillatory magnetic field immunity test

Compatibilité électromagnétique (CEM) –
Partie 4-10: Techniques d'essai et de mesure – Essai d'immunité du champ magnétique oscillatoire amorti

IEC 61000-4-10:2016-07(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-10: Testing and measurement techniques – Damped oscillatory magnetic field immunity test

FOREWORD

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International Standard IEC 61000-4-10 has been prepared by subcommittee 77B: High frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms Part 4-10 of the IEC 61000 series. 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 1993 and Amendment 1:2000. This edition constitutes a technical revision.

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

a) new Annex A on induction coil field distribution;
b) new Annex D on measurement uncertainty;

c) new Annex E for numerical simulations;

d) calibration using current measurement has been addressed in this edition.

The text of this standard is based on the following documents:

CDV	Report on voting
77B/730/CDV	77B/746A/RVC

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 (insofar 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 immunity requirements and test procedures related to "damped oscillatory magnetic field".

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-10: Testing and measurement techniques – Damped oscillatory magnetic field immunity test

1 Scope and object

This part of IEC 61000 specifies the immunity requirements, test methods, and range of recommended test levels for equipment subjected to damped oscillatory magnetic disturbances related to medium voltage and high voltage sub-stations.

The test defined in this standard is applied to equipment which is intended to be installed in locations where the phenomenon as specified in Clause 4 will be encountered.

This standard does not specify disturbances due to capacitive or inductive coupling in cables or other parts of the field installation. IEC 61000-4-18, which deals with conducted disturbances, covers 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 medium voltage and high voltage sub-stations when subjected to damped oscillatory magnetic fields.

The test is mainly applicable to electronic equipment to be installed in H.V. sub-stations. Power plants, switchgear installations, smart grid systems may also be applicable to this standard and may be considered by product committees.

NOTE As described in IEC Guide 107, this is a basic EMC publication for use by product committees of the IEC. As also stated in Guide 107, the IEC product committees are responsible for determining whether this immunity test standard is applied or not, and if applied, they are responsible for determining the appropriate test levels and performance criteria. TC 77 and its sub-committees are prepared to co-operate with product committees in the evaluation of the value of particular immunity test levels for their products.

This standard defines:

– a range of test levels;
– test equipment;
– test setups;
– test procedures.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at www.electropedia.org)

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 as well as the following apply.

3.1.1
calibration
set of operations which establishes, by reference to standards, the relationship which exists, under specified conditions, between an indication and a result of a measurement

Note 1 to entry: This term is based on the "uncertainty" approach.

Note 2 to entry: The relationship between the indications and the results of measurement can be expressed, in principle, by a calibration diagram.

[SOURCE: IEC 60050-311:2001, 311-01-09]

3.1.2
damped oscillatory wave generator
generator delivering a damped oscillation whose frequency can be set to 100 kHz or 1 MHz and whose damping time constant is five periods

3.1.3
immunity
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]

3.1.4
induction coil
conductor loop of defined shape and dimensions, in which a current flows, generating a magnetic field of defined uniformity in a defined volume

3.1.5
induction coil factor
ratio between the magnetic field strength generated by an induction coil of given dimensions and the corresponding current value

Note 1 to entry: The field is that measured at the centre of the coil plane, without the EUT.

3.1.6
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

3.1.7
reference ground
part of the Earth considered as conductive, the electrical potential of which is conventionally taken as zero, being outside the zone of influence of any earthing (grounding) arrangement

[SOURCE: IEC 60050-195:1998, 195-01-01]

3.1.8
system
set of interdependent elements constituted to achieve a given objective by performing a specified function

Note 1 to entry: 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 the external systems, or acts itself on the environment or the external systems.

3.1.9
transient, adjective and noun
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

[SOURCE: IEC 60050-161:1990, 161-02-01]

3.1.10
verification
set of operations which is used to check the test equipment system (e.g. the test generator and its interconnecting cables) to demonstrate that the test system is functioning

Note 1 to entry: The methods used for verification may be different from those used for calibration.

Note 2 to entry: For the purposes of this basic EMC standard this definition is different from the definition given in IEC 60050-311:2001, 311-01-13.

3.2 Abbreviations

AE	Auxiliary equipment
EMC	Electromagnetic compatibility
EUT	Equipment under test
MU	Measurement uncertainty
PE	Protective earth
RGP	Reference ground plane

4 General

Damped oscillatory magnetic fields are generated by the switching of H.V. bus-bars by isolators or disconnectors. The magnetic fields to which equipment is subjected can influence the reliable operation of equipment and systems.

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

The wave shape of the test field corresponds to a damped oscillatory wave (see Figure 2). The characteristics are given in 6.2.2.

Information on the oscillation frequency is given in Annex C.

5 Test levels

The preferred range of test levels is given in Table 1.

Table 1 – Test levels

Level	Damped oscillatory magnetic field strength A/m (peak)
1	not applicable
2	not applicable
3	10
4	30
5	100
X[a]	special
NOTE The magnetic field strength is expressed in A/m; 1 A/m corresponds to a free space magnetic flux density of 1,26 μT. [a] "X" can be any level, above, below or in between the others. This level, as well the duration of the test, shall be specified in the dedicated equipment specification.	

The test levels shall be selected according to the installation conditions. Classes of installation are given in Annex B.

6 Test instrumentation

6.1 General

The test system comprises the damped oscillatory wave generator and the induction coil for a table-top test setup and, in addition, an RGP for a floor-standing test setup.

6.2 Damped oscillatory wave generator

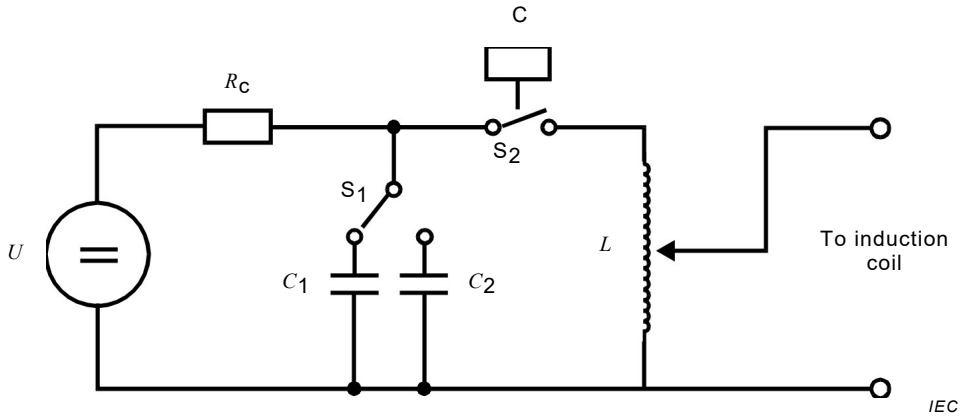
6.2.1 General

The damped oscillatory wave generator shall be able to deliver the required impulse current to the induction coils specified in 6.3.

NOTE For this application, a modified version of a damped oscillatory wave generator similar to the generator mentioned in IEC 61000-4-18 is used as a current source.

The waveform is specified as a short-circuit current and therefore shall be measured with the induction coil connected.

A simplified circuit diagram of the generator is given in Figure 1.



U: High voltage source R_C: Charging resistor

C: Control duration L: Coil oscillation circuit

S_1 Frequency selector S_2 Duration selector

C_1, C_2: Capacitors oscillation circuit (switchable from 0,1 MHz to 1 MHz)

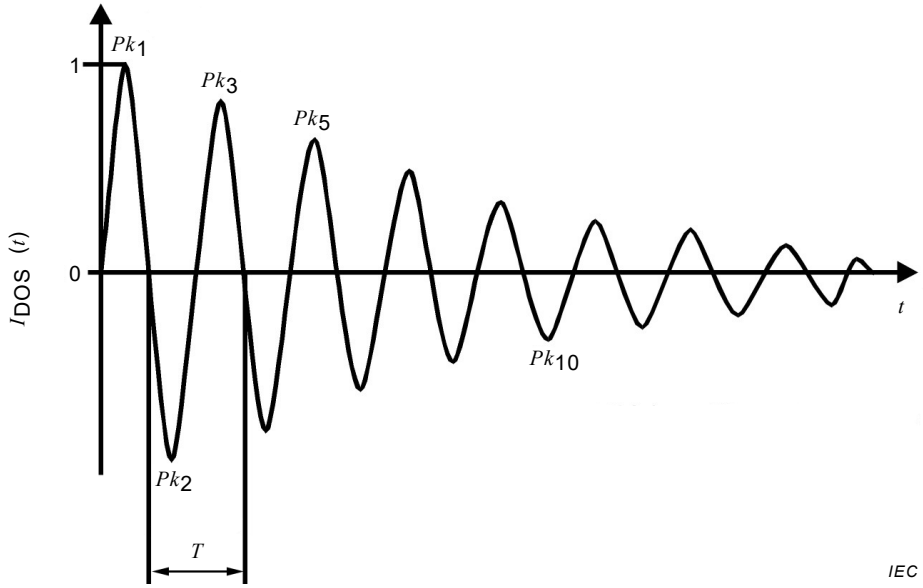
Figure 1 – Simplified schematic circuit of the test generator for damped oscillatory magnetic field

6.2.2 Performance characteristics of the generator connected to the standard induction coil

The performance characteristics below are applicable for the generator connected to the standard induction coils outlined in 6.3.

Oscillation period	see Table 3
Current in the coils (Pk_1 value)	see Table 2
Waveform of the damped oscillatory magnetic field	see Figure 2
Decay rate D_{r1}, D_{r2}	Pk_5 shall be > 50 % of the Pk_1 value and Pk_{10} shall be < 50 % of the Pk_1 value
Repetition rate $1/T_{rep}$ (see Figure 3)	40/s ± 10 % for 100 kHz and 400/s ± 10 % for 1 MHz
Test duration	not less than 2 s
Phase shifting	no requirement

Oscillation frequency is defined as the reciprocal of the period of the first and third zero crossings after the initial peak. This period is shown as T in Figure 2.



Key

T = 1 µs (1 MHz) or 10 µs (0,1 MHz)

Figure 2 – Waveform of short-circuit current in the standard coils

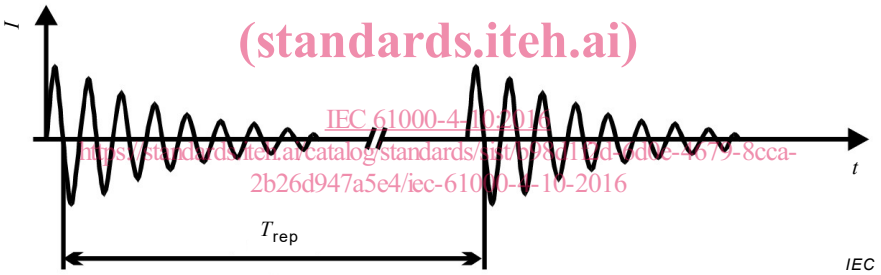


Figure 3 – Waveform of short-circuit current showing the repetition time T_{rep}

The formula of the ideal waveform of Figure 2, $I_{DOS}(t)$, is as follows:

$$I_{DOS}(t) = K_i \frac{i_1}{KH} \left(\frac{\left(\frac{t}{t_{1h}}\right)^{nh}}{1+\left(\frac{t}{t_{1h}}\right)^{nh} e^{\frac{t}{t_{2h}}}} \right) \sin(\beta t)$$

with

$$KH = e^{-\frac{t_{1h}}{t_{2h}}\left(nh\frac{t_{2h}}{t_{1h}}\right)^{\frac{1}{nh}}}$$

where the parameters for oscillation period T = 1 µs are:

K_i = 1; i_1 = 0,963; t_{1h} = 0,08 µs; t_{2h} = 4,8 µs; nh = 2,1; β = 6,27 × 10^6 rad/s: