



IEC 61000-4-10

Edition 2.0 2016-07
REDLINE VERSION

INTERNATIONAL STANDARD



BASIC EMC PUBLICATION

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100.20

ISBN 978-2-8322-3525-6

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope and object.....	8
2 Normative references.....	8
3 Terms, definitions and abbreviated terms	9
3.1 Terms and definitions	9
3.2 Abbreviations	10
4 General	11
5 Test levels.....	11
6 Test equipment.....	15
6 Test instrumentation	15
6.1 General.....	15
6.2 Damped oscillatory wave generator	15
6.2.1 General.....	15
6.2.2 Performance characteristics of the generator connected to the standard induction coil	16
6.3 Standard induction coil	18
6.4 Calibration of the test system	18
7 Test setup	19
7.1 Test equipment	19
7.2 Verification of the test instrumentation	21
7.3 Test setup for table-top EUT.....	21
7.4 Test setup for floor standing EUT	22
7.5 Test setup for damped oscillatory field applied in-situ	24
8 Test procedure	24
8.1 General.....	24
8.2 Laboratory reference conditions	24
8.2.1 Climatic conditions	24
8.2.2 Electromagnetic conditions	25
8.3 Carrying out Execution of the test.....	25
9 Evaluation of test results.....	26
10 Test report.....	27
Annex A (normative) Induction coil calibration method	32
Annex A (informative) Information on the field distribution of standard induction coils	32
A.1 General.....	32
A.2 Determination of the coil factor	32
A.2.1 General.....	32
A.2.2 Coil factor calculation	32
A.3 1 m × 1 m standard induction coil	33
A.4 1 m × 2,6 m standard induction coil with reference ground plane	34
A.5 1 m × 2,6 m standard induction coil without reference ground plane	35
Annex B (normative) Characteristics of the induction coils	43
Annex B (informative) Selection of the test levels	43
Annex C (informative) Damped oscillatory magnetic field frequency	46

Annex D (informative) Information on magnetic field strength	
Annex D (informative) Measurement uncertainty (MU) considerations	47
D.1 General	47
D.2 Legend	47
D.3 Uncertainty contributors to the peak current and to the damped oscillatory magnetic field measurement uncertainty	47
D.4 Uncertainty of peak current and damped oscillatory magnetic field calibration	48
D.4.1 General	48
D.4.2 Peak current	48
D.4.3 Further MU contributions to amplitude and time measurements	50
D.4.4 Rise time of the step response and bandwidth of the frequency response of the measuring system	50
D.4.5 Impulse peak distortion due to the limited bandwidth of the measuring system	51
D.5 Application of uncertainties in the damped oscillatory wave generator compliance criterion	52
Annex E (informative) 3D numerical simulations	53
E.1 General	53
E.2 Simulations	53
E.3 Comments	53
Bibliography	59
 Figure 1 – Example of application of the test field by the immersion method	
Figure 1 – Simplified schematic circuit of the test generator for damped oscillatory magnetic field	16
Figure 2 – Current waveform of the test generator for damped oscillatory magnetic field (sinusoid wave)	
Figure 2 – Waveform of short-circuit current in the standard coils	17
Figure 3 – Schematic circuit of the test generator for damped oscillatory magnetic field	
Figure 3 – Waveform of short-circuit current showing the repetition time T_{rep}	17
Figure 4 – Example of a current measurement of standard induction coils	18
Figure 5 – Example of test set-up for floor-standing equipment	
Figure 5 – Example of test setup for table-top equipment	22
Figure 6 – Example of investigation of susceptibility to magnetic field by the proximity method	
Figure 6 – Example of test setup for floor standing equipment showing the horizontal orthogonal plane	23
Figure 7 – Illustration of Helmholtz coils	
Figure 7 – Example of test setup for floor standing equipment showing the vertical orthogonal plane	23
Figure 8 – Example of test setup using the proximity method	24
Figure A.1 – Rectangular induction coil with sides $a + b$ and c	33
Figure A.2 – +3 dB isoline for the magnetic field strength (magnitude) in the x - y plane for the 1 m × 1 m induction coil	33
Figure A.3 – +3 dB and –3 dB isolines for the magnetic field strength (magnitude) in the x - z plane for the 1 m × 1 m induction coil	34
Figure A.4 – +3 dB isoline for the magnetic field strength (magnitude) in the x - z plane for the 1 m × 2,6 m induction coil with reference ground plane	34

Figure A.5 – +3 dB and –3 dB isolines for the magnetic field strength (magnitude) in the x - y plane for the 1 m × 2,6 m induction coil with reference ground plane	35
Figure A.6 – +3 dB isoline for the magnetic field strength (magnitude) in the x - y plane for the 1 m × 2,6 m induction coil without reference ground plane	35
Figure A.7 – +3 dB and –3 dB isolines for the magnetic field strength (magnitude) in the x - z plane for the 1 m × 2,6 m induction coil without reference ground plane	36
Figure B.1 – Characteristics of the field generated by a square induction coil (1 m side) in its plane	36
Figure B.2 – 3 dB area of the field generated by a square induction coil (1 m side) in its plane	36
Figure B.3 – 3 dB area of the field generated by a square induction coil (1 m side) in the mean orthogonal plane (component orthogonal to the plane of the coil)	36
Figure B.4 – 3 dB area of the field generated by two square induction coils (1 m side) 0,6 m spaced, in the mean orthogonal plane (component orthogonal to the plane of the coils)	36
Figure B.5 – 3 dB area of the field generated by two square induction coils (1 m side) 0,8 m spaced, in the mean orthogonal plane (component orthogonal to the plane of the coils)	36
Figure B.6 – 3 dB area of the field generated by a rectangular induction coil (1 m × 2,6 m) in its plane	36
Figure B.7 – 3 dB area of the field generated by a rectangular induction coil (1 m × 2,6 m) in its plane (ground plane as a side of the induction coil)	36
Figure B.8 – 3 dB area of the field generated by a rectangular induction coil (1 m × 2,6 m) with ground plane, in the mean orthogonal plane (component orthogonal to the plane of the coil)	36
Figure E.1 – Current with period of 1 μ s and H-field in the center of the 1 m × 1 m standard induction coil	54
Figure E.2 – H_x -field along the side of 1 m × 1 m standard induction coil in A/m	54
Figure E.3 – H_x -field in direction x perpendicular to the plane of the 1 m × 1 m standard induction coil	55
Figure E.4 – H_x -field along the side in dB for 1 m × 1 m standard induction coil	55
Figure E.5 – H_x -field along the diagonal in dB for the 1 m × 1 m standard induction coil	56
Figure E.6 – H_x -field plot on y - z plane for the 1 m × 1 m standard induction coil	56
Figure E.7 – H_x -field plot on x - y plane for the 1 m × 1 m standard induction coil	57
Figure E.8 – H_x -field along the vertical middle line in dB for the 1 m × 2,6 m standard induction coil	57
Figure E.9 – H_x -field 2D-plot on y - z plane for the 1 m × 2,6 m standard induction coil	58
Figure E.10 – H_x -field 2D-plot on x - y plane at $z = 0,5$ m for the 1 m × 2,6 m standard induction coil	58
Table 1 – Test levels	11
Table 2 – Peak current specifications of the test system	19
Table 3 – Waveform specifications of the test system	19
Table D.1 – Example of uncertainty budget for the peak of the damped oscillatory current impulse (I_p)	49
Table D.2 – α factor (see equation (D.6)) of different unidirectional impulse responses corresponding to the same bandwidth of the system B	51
Table D.3 – β factor (equation (D.12)) of the damped oscillatory waveform	52

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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).

~~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 "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 ~~relates to~~ specifies the immunity requirements ~~of equipment, only under operational conditions~~, 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 applicability of this standard to equipment installed in different locations is determined by the presence of the phenomenon, as specified in clause 3.~~

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 ~~consider~~ 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 ~~has the object to~~ defines:

- ~~recommended~~ 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 60068-1:1988, Environmental testing – Part 1: General and guidance~~

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

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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**

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope and object.....	8
2 Normative references.....	8
3 Terms, definitions and abbreviated terms	9
3.1 Terms and definitions	9
3.2 Abbreviations	10
4 General	10
5 Test levels.....	10
6 Test instrumentation	11
6.1 General.....	11
6.2 Damped oscillatory wave generator	11
6.2.1 General.....	11
6.2.2 Performance characteristics of the generator connected to the standard induction coil	12
6.3 Standard induction coil	14
6.4 Calibration of the test system	14
7 Test setup	15
7.1 Test equipment	15
7.2 Verification of the test instrumentation	15
7.3 Test setup for table-top EUT.....	16
7.4 Test setup for floor standing EUT	16
7.5 Test setup for damped oscillatory field applied in-situ	18
8 Test procedure	18
8.1 General.....	18
8.2 Laboratory reference conditions	18
8.2.1 Climatic conditions	18
8.2.2 Electromagnetic conditions	18
8.3 Execution of the test	19
9 Evaluation of test results.....	19
10 Test report.....	20
Annex A (informative) Information on the field distribution of standard induction coils	21
A.1 General.....	21
A.2 Determination of the coil factor	21
A.2.1 General.....	21
A.2.2 Coil factor calculation	21
A.3 1 m × 1 m standard induction coil	22
A.4 1 m × 2,6 m standard induction coil with reference ground plane	23
A.5 1 m × 2,6 m standard induction coil without reference ground plane	24
Annex B (informative) Selection of the test levels	26
Annex C (informative) Damped oscillatory magnetic field frequency	28
Annex D (informative) Measurement uncertainty (MU) considerations	29
D.1 General.....	29
D.2 Legend	29

D.3	Uncertainty contributors to the peak current and to the damped oscillatory magnetic field measurement uncertainty	29
D.4	Uncertainty of peak current and damped oscillatory magnetic field calibration	30
D.4.1	General.....	30
D.4.2	Peak current	30
D.4.3	Further MU contributions to amplitude and time measurements	32
D.4.4	Rise time of the step response and bandwidth of the frequency response of the measuring system	32
D.4.5	Impulse peak distortion due to the limited bandwidth of the measuring system.....	33
D.5	Application of uncertainties in the damped oscillatory wave generator compliance criterion	34
Annex E (informative)	3D numerical simulations	35
E.1	General.....	35
E.2	Simulations	35
E.3	Comments	35
Bibliography		41
Figure 1	– Simplified schematic circuit of the test generator for damped oscillatory magnetic field	12
Figure 2	– Waveform of short-circuit current in the standard coils	13
Figure 3	– Waveform of short-circuit current showing the repetition time T_{rep}	13
Figure 4	– Example of a current measurement of standard induction coils	14
Figure 5	– Example of test setup for table-top equipment.....	16
Figure 6	– Example of test setup for floor standing equipment showing the horizontal orthogonal plane.....	17
Figure 7	– Example of test setup for floor standing equipment showing the vertical orthogonal plane.....	17
Figure 8	– Example of test setup using the proximity method	18
Figure A.1	– Rectangular induction coil with sides $a + b$ and c	22
Figure A.2	– +3 dB isoline for the magnetic field strength (magnitude) in the x - y plane for the 1 m $\times$ 1 m induction coil	22
Figure A.3	– +3 dB and –3 dB isolines for the magnetic field strength (magnitude) in the x - z plane for the 1 m $\times$ 1 m induction coil	23
Figure A.4	– +3 dB isoline for the magnetic field strength (magnitude) in the x - z plane for the 1 m $\times$ 2,6 m induction coil with reference ground plane	23
Figure A.5	– +3 dB and –3 dB isolines for the magnetic field strength (magnitude) in the x - y plane for the 1 m $\times$ 2,6 m induction coil with reference ground plane	24
Figure A.6	– +3 dB isoline for the magnetic field strength (magnitude) in the x - y plane for the 1 m $\times$ 2,6 m induction coil without reference ground plane	24
Figure A.7	– +3 dB and –3 dB isolines for the magnetic field strength (magnitude) in the x - z plane for the 1 m $\times$ 2,6 m induction coil without reference ground plane	25
Figure E.1	– Current with period of 1 μ s and H-field in the center of the 1 m $\times$ 1 m standard induction coil	36
Figure E.2	– H_x -field along the side of 1 m $\times$ 1 m standard induction coil in A/m	36
Figure E.3	– H_x -field in direction x perpendicular to the plane of the 1 m $\times$ 1 m standard induction coil	37
Figure E.4	– H_x -field along the side in dB for 1 m $\times$ 1 m standard induction coil	37

Figure E.5 – H_x -field along the diagonal in dB for the 1 m × 1 m standard induction coil.....	38
Figure E.6 – H_x -field plot on y - z plane for the 1 m × 1 m standard induction coil.....	38
Figure E.7 – H_x -field plot on x - y plane for the 1 m × 1 m standard induction coil	39
Figure E.8 – H_x -field along the vertical middle line in dB for the 1 m × 2,6 m standard induction coil	39
Figure E.9 – H_x -field 2D-plot on y - z plane for the 1 m × 2,6 m standard induction coil.....	40
Figure E.10 – H_x -field 2D-plot on x - y plane at $z = 0,5$ m for the 1 m × 2,6 m standard induction coil	40
Table 1 – Test levels.....	11
Table 2 – Peak current specifications of the test system	15
Table 3 – Waveform specifications of the test system	15
Table D.1 – Example of uncertainty budget for the peak of the damped oscillatory current impulse (I_p)	31
Table D.2 – α factor (see equation (D.6)) of different unidirectional impulse responses corresponding to the same bandwidth of the system B	33
Table D.3 – β factor (equation (D.12)) of the damped oscillatory waveform.....	34

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 4-10: Testing and measurement techniques –
Damped oscillatory magnetic field immunity test**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). 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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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)

SOMMAIRE

AVANT-PROPOS.....	45
INTRODUCTION.....	47
1 Domaine d'application et objet	48
2 Références normatives	48
3 Termes, définitions et termes abrégés.....	49
3.1 Termes et définitions	49
3.2 Abréviations	50
4 Généralités.....	50
5 Niveaux d'essais.....	50
6 Instrumentation d'essai	51
6.1 Généralités	51
6.2 Générateur d'ondes oscillatoires amorties.....	51
6.2.1 Généralités	51
6.2.2 Caractéristiques de performances du générateur connecté à la bobine d'induction normalisée.....	52
6.3 Bobine d'induction normalisée	54
6.4 Etalonnage du système d'essai.....	54
7 Montage d'essai	55
7.1 Équipement d'essai	55
7.2 Vérification de l'instrumentation d'essai	55
7.3 Montage d'essai pour EUT de table	56
7.4 Montage d'essai pour EUT posé au sol	57
7.5 Montage d'essai pour le champ oscillatoire amorti appliqué in situ.....	58
8 Procédure d'essai	58
8.1 Généralités	58
8.2 Conditions de référence du laboratoire	58
8.2.1 Conditions climatiques	58
8.2.2 Conditions électromagnétiques	59
8.3 Exécution de l'essai	59
9 Évaluation des résultats d'essais	59
10 Rapport d'essai	60
Annexe A (informative) Informations relatives à la distribution du champ des bobines d'induction normalisées.....	61
A.1 Généralités	61
A.2 Détermination du facteur de bobine	61
A.2.1 Généralités	61
A.2.2 Calcul du facteur de bobine	61
A.3 Bobine d'induction normalisée de 1 m × 1 m	62
A.4 Bobine d'induction normalisée de 1 m × 2,6 m avec plan de masse de référence	63
A.5 Bobine d'induction normalisée de 1 m × 2,6 m sans plan de masse de référence	65
Annexe B (informative) Choix des niveaux d'essais	67
Annexe C (informative) Fréquence du champ magnétique oscillatoire amorti.....	69
Annexe D (informative) Considérations relatives à la mesure de l'incertitude.....	70
D.1 Généralités	70

D.2	Légende.....	70
D.3	Contributeurs à l'incertitude de mesure du courant de crête et du champ magnétique oscillatoire amorti	70
D.4	Incertitude du courant de crête et étalonnage du champ magnétique oscillatoire amorti.....	71
D.4.1	Généralités	71
D.4.2	Courant de crête	71
D.4.3	Autres contributions à l'incertitude de mesure pour les mesures d'amplitude et de temps	73
D.4.4	Temps de montée de la réponse à un échelon du système de mesure et largeur de bande de la réponse en fréquence du système de mesure	73
D.4.5	Distorsion de la crête d'impulsion en raison de la largeur de bande limitée du système de mesure	74
D.5	Application des incertitudes au critère de conformité du générateur d'ondes oscillatoires amorties.....	76
Annexe E (informative)	Simulations numériques 3D	77
E.1	Généralités	77
E.2	Simulations	77
E.3	Commentaires.....	77
	Bibliographie	83
Figure 1	Schéma simplifié du générateur d'essai produisant le champ magnétique oscillatoire amorti	52
Figure 2	Forme d'onde du courant de court-circuit dans les bobines normalisées	53
Figure 3	Forme d'onde du courant de court-circuit présentant le temps de répétition T_{rep}	53
Figure 4	Exemple de mesure du courant des bobines d'induction normalisées.....	54
Figure 5	Exemple de montage d'essai pour équipement de table.....	56
Figure 6	Exemple de montage d'essai pour équipement posé au sol montrant le plan orthogonal horizontal	57
Figure 7	Exemple de montage d'essai pour équipement posé au sol montrant le plan orthogonal vertical	57
Figure 8	Exemple de montage d'essai utilisant la méthode de proximité	58
Figure A.1	Bobine d'induction rectangulaire avec les côtés $a + b$ et c	62
Figure A.2	Isoligne +3 dB pour l'excitation magnétique (amplitude) dans le plan $x-y$ pour la bobine d'induction de $1\text{ m} \times 1\text{ m}$	62
Figure A.3	Isolignes +3 dB et -3 dB pour l'excitation magnétique (amplitude) dans le plan $x-z$ pour la bobine d'induction de $1\text{ m} \times 1\text{ m}$	63
Figure A.4	Isoligne +3 dB pour l'excitation magnétique (amplitude) dans le plan $x-z$ pour la bobine d'induction de $1\text{ m} \times 2,6\text{ m}$ avec plan de masse de référence	64
Figure A.5	Isolignes +3 dB et -3 dB pour l'excitation magnétique (amplitude) dans le plan $x-y$ pour la bobine d'induction de $1\text{ m} \times 2,6\text{ m}$ avec plan de masse de référence	64
Figure A.6	Isoligne +3 dB pour l'excitation magnétique (amplitude) dans le plan $x-y$ pour la bobine d'induction de $1\text{ m} \times 2,6\text{ m}$ sans plan de masse de référence	65
Figure A.7	Isolignes +3 dB et -3 dB pour l'excitation magnétique (amplitude) dans le plan $x-z$ pour la bobine d'induction de $1\text{ m} \times 2,6\text{ m}$ sans plan de masse de référence.....	66
Figure E.1	Courant avec une période de $1\text{ }\mu\text{s}$ et champ H au centre de la bobine d'induction normalisée de $1\text{ m} \times 1\text{ m}$	78

Figure E.2 – Champ H_x le long de la bobine d'induction normalisée de 1 m × 1 m en A/m.....	78
Figure E.3 – Champ H_x dans le sens x perpendiculaire au plan de la bobine d'induction normalisée de 1 m × 1 m.....	79
Figure E.4 – Champ H_x le long du côté, en dB, de la bobine d'induction normalisée de 1 m × 1 m	79
Figure E.5 – Champ H_x le long de la diagonale, en dB, de la bobine d'induction normalisée de 1 m × 1 m.....	80
Figure E.6 – Tracé du champ H_x sur le plan y - z pour la bobine d'induction normalisée de 1 m × 1 m	80
Figure E.7 – Tracé du champ H_x sur le plan x - y pour la bobine d'induction normalisée de 1 m × 1 m	81
Figure E.8 – Champ H_x le long de la ligne médiane verticale, en dB, de la bobine d'induction normalisée de 1 m × 2,6 m.....	81
Figure E.9 – Tracé 2D du champ H_x sur le plan y - z pour la bobine d'induction normalisée de 1 m × 2,6 m.....	82
Figure E.10 – Tracé 2D du champ H_x sur le plan x - y à $z = 0,5$ m pour la bobine d'induction normalisée de 1 m × 2,6 m.....	82
Tableau 1 – Niveaux d'essai	51
Tableau 2 – Spécifications de courant de crête du système d'essai.....	55
Tableau 3 – Spécifications de forme d'onde du système d'essai.....	55
Tableau D.1 – Exemple de budget d'incertitude pour la crête du courant de choc oscillatoire amorti (I_p).....	72
Tableau D.2 – Facteur α (voir l'équation (D.6)) de différentes réponses impulsionsnelles unidirectionnelles correspondant à la même largeur de bande du système B	74
Tableau D.3 – Facteur β (équation (D.12)) de la forme d'onde oscillatoire amortie.....	75

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

COMPATIBILITÉ ÉLECTROMAGNÉTIQUE (CEM) –**Partie 4-10: Techniques d'essai et de mesure –
Essai d'immunité du champ magnétique oscillatoire amorti****AVANT-PROPOS**

- 1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 61000-4-10 a été établie par le sous-comité 77B: Phénomènes haute fréquence, du comité d'études 77 de l'IEC: Compatibilité électromagnétique.

Elle constitue la Partie 4-10 de la série IEC 61000. Elle a le statut d'une publication fondamentale en CEM conformément au Guide 107 de l'IEC.

Cette deuxième édition annule et remplace la première édition parue en 1993 et l'Amendement 1:2000. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) nouvelle Annexe A relative à la distribution du champ de bobine d'induction;

- b) nouvelle Annexe D relative à l'incertitude de mesure;
- c) nouvelle Annexe E pour les simulations numériques;
- d) l'étalonnage par la mesure du courant a été abordé dans la présente édition.

Le texte de cette norme est issu des documents suivants:

CDV	Rapport de vote
77B/730/CDV	77B/746A/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61000, publiées sous le titre général *Compatibilité électromagnétique (CEM)*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

IMPORTANT – Le logo "*colour inside*" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

INTRODUCTION

L'IEC 61000 est publiée en plusieurs parties, conformément à la structure suivante:

Partie 1: Généralités

Considérations générales (introduction, principes fondamentaux)

Définitions, terminologie

Partie 2: Environnement

Description de l'environnement

Classification de l'environnement

Niveaux de compatibilité

Partie 3: Limites

Limites d'émission

Limites d'immunité (dans la mesure où elles ne relèvent pas de la responsabilité des comités de produits)

Partie 4: Techniques d'essai et de mesure

Techniques de mesure

Techniques d'essai

Partie 5: Guide d'installation et d'atténuation

Guide d'installation

Méthodes et dispositifs d'atténuation

Partie 6: Normes génériques

Partie 9: Divers

Chaque partie est à son tour subdivisée en plusieurs parties, publiées soit comme normes internationales, soit comme spécifications techniques ou rapports techniques, dont certaines ont déjà été publiées en tant que sections. D'autres sont publiées avec le numéro de la partie suivi d'un tiret et d'un second chiffre identifiant la subdivision (exemple: IEC 61000-6-1).

La présente partie constitue une norme internationale qui traite des exigences en matière d'immunité et des procédures d'essai qui s'appliquent au "champ magnétique oscillatoire amorti".

COMPATIBILITÉ ÉLECTROMAGNÉTIQUE (CEM) –

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

1 Domaine d'application et objet

La présente partie de l'IEC 61000 spécifie les exigences en matière d'immunité, les méthodes d'essai et la plage des niveaux d'essai recommandés des équipements soumis aux perturbations magnétiques oscillatoires amorties dans les postes moyenne et haute tension.

L'essai défini dans la présente norme s'applique aux équipements destinés à être installés à des emplacements où les phénomènes spécifiés à l'Article 4 sont rencontrés.

La présente norme ne spécifie pas les perturbations provoquées par le couplage capacitif ou inductif sur les câbles ou autres parties de l'installation. L'IEC 61000-4-18, qui porte sur les perturbations conduites, couvre ces aspects.

La présente norme a pour objet d'établir une base commune et reproductible pour évaluer la performance des équipements électriques et électroniques des postes moyenne et haute tension lorsqu'ils sont soumis à des champs magnétiques oscillatoires amortis.

L'essai s'applique principalement aux équipements électroniques destinés à être installés dans des postes haute tension. Les centrales électriques, les installations d'appareillage et les réseaux intelligents peuvent également être concernés par la présente norme et peuvent être pris en compte par les comités de produits.

NOTE Comme indiqué dans le Guide 107 de l'IEC, il s'agit d'une publication fondamentale en CEM destinée à être utilisée par les comités de produits de l'IEC. Comme l'indique également le Guide 107, les comités de produits de l'IEC ont la responsabilité de déterminer si cette norme d'essai d'immunité est appliquée ou non, et si elle l'est, ils ont la responsabilité de déterminer les niveaux d'essai et critères de performances appropriés. Le comité d'études 77 et ses sous-comités sont prêts à coopérer avec les comités de produits dans le cadre de l'évaluation de la valeur des essais d'immunité particuliers pour leurs produits.

La présente norme définit:

- une plage de niveaux d'essai;
- l'équipement d'essai;
- les montages d'essai;
- les procédures d'essai.

2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050 (toutes les parties), *Vocabulaire Électrotechnique International (VEI)* (disponible à l'adresse www.electropedia.org)