

# 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**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2016 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

#### **About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

#### **About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### **IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)**

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### **IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)**

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### **IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

#### **Electropedia - [www.electropedia.org](http://www.electropedia.org)**

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### **IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)**

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### **IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

---

#### **A propos de l'IEC**

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

#### **A propos des publications IEC**

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### **Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)**

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### **Recherche de publications IEC - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)**

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### **IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

#### **Electropedia - [www.electropedia.org](http://www.electropedia.org)**

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### **Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)**

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### **Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).

# 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**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 33.100.20

ISBN 978-2-8322-3501-0

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## 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 × 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 × 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 × 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 × 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 × 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 × 2,6 m induction coil without reference ground plane .....	25
Figure E.1	– Current with period of 1 $\mu$ s and H-field in the center of the 1 m × 1 m standard induction coil .....	36
Figure E.2	– $H_x$ -field along the side of 1 m × 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 × 1 m standard induction coil .....	37
Figure E.4	– $H_x$ -field along the side in dB for 1 m × 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 – $\alpha$ factor (see equation (D.6)) of different unidirectional impulse responses corresponding to the same bandwidth of the system $B$ .....	33
Table D.3 – $\beta$ 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](http://www.electropedia.org))