

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz – 300 GHz)

Evaluation des équipements électroniques et électriques en relation avec les restrictions d'exposition humaine aux champs électromagnétiques (0 Hz – 300 GHz)



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2007 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 la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: 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.

- Catalogue of IEC publications: www.iec.ch/searchpub

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

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

- Electropedia: www.electropedia.org

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

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique internationale (CEI) 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 CEI

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

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

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

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Assessment of electronic and electrical equipment related to human exposure
restrictions for electromagnetic fields (0 Hz – 300 GHz)**

**Evaluation des équipements électroniques et électriques en relation avec
les restrictions d'exposition humaine aux champs électromagnétiques
(0 Hz – 300 GHz)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX

XB

CONTENTS

FOREWORD.....	4
1 Scope and object.....	6
2 Normative references	6
3 Terms and definitions	6
4 Compliance criteria.....	10
5 Assessment methods	10
6 Evaluation of compliance to limits.....	11
7 Applicability of compliance assessment methods.....	12
7.1 General.....	12
7.2 Generic procedure for assessment of equipment.....	14
8 Sources with multiple frequencies	17
8.1 Introduction	17
8.2 Frequency range from 1 Hz – 10 MHz (ICNIRP-based).....	17
8.2.1 Frequency domain assessment.....	17
8.2.2 Time domain assessment	19
8.3 Frequency range from 100 kHz – 300 GHz (ICNIRP-based).....	21
8.4 Frequency range from 0 kHz – 5 MHz (IEEE-based).....	22
8.4.1 Frequency domain assessment.....	22
8.4.2 Time domain assessment.....	22
8.5 Frequency range from 3 kHz – 300 GHz (IEEE-based).....	23
9 Assessment report.....	23
9.1 General.....	23
9.2 Items to be recorded in the assessment report	24
9.2.1 Assessment method	24
9.2.2 Presentation of the results.....	24
9.2.3 Equipment using external antennas	24
10 Information to be supplied with the equipment.....	24
Annex A (informative) Field calculation	25
Annex B (informative) SAR compliance assessment	30
Annex C (informative) Information for numerical modelling.....	32
Annex D (informative) Measurements of physical properties and body currents	61
Annex E (informative) Specific absorption rate (SAR)	65
Annex F (informative) Measurement of <i>E</i> and <i>H</i> field.....	67
Annex G (informative) Source modelling	70
Bibliography.....	73
Figure 1 – Assessment flowchart	16
Figure 2 – Schematic of “weighting circuit”.....	19
Figure 3 – Dependency on frequency of the reference levels <i>V</i> plotted with smoothing edges	19
Figure 4 – Transfer function <i>A</i>	20

Figure A.1 – Geometry of antenna with largest linear dimension D	25
Figure A.2 – Current element $Id/\sin(\omega t)$ at the origin of spherical coordinate system	26
Figure A.3 – Ratio of E^2 , H^2 , and $E \times H$ field components	27
Figure A.4 – Ratio of $E \times H$ field components for three typical antennas.....	28
Figure A.5 – Far-field = straight line, radiated near-field = lower line & all near-fields = other line	29
Figure C.1 – Numerical model of a homogenous ellipsoid	34
Figure C.2 – Numerical model of a homogenous cuboid.....	35
Figure C.3a — Description of the whole body	36
Figure C.3b — Details of the construction of the head and shoulders.....	37
Figure C.3 – Numerical model of a homogenous human body.....	37
Figure C.4 – Schematic of straight wire.....	41
Figure C.5 – Schematic of circular coil.....	42
Figure C.6 – Block diagram of the method	43
Figure C.7 – Test situation for validation – Current loop in front of a cuboid.....	45
Figure C.8 – Distribution of the electric current density J in the planes $x = + 0,20$ m (left) and $y = 0,0$ m (right)	46
Figure C.9 – Helmholtz coils and prolate spheroid	47
Figure C.10a – Magnetic field	47
Figure C.10b – Induced current density	48
Figure C.10 – Modelling results for a 60 cm by 30 cm prolate spheroid.....	48
Figure C.11 – Induced current density.....	48
Figure C.12a – Magnetic field	49
Figure C.12b – Induced current density	49
Figure C.12 – Modelling results for a 160 cm by 80 cm prolate spheroid	49
Figure C.13 – Distribution of induced electric current density.....	50
Figure C.14 – Schematic position of source Q against model K	51
Figure C.15 – Position of source Q , sensor and model K	52
Figure C.16 – Hot spot.....	54
Figure C.17 – Gradient of flux density and area G	55
Figure C.18 – Equivalent coil	55
Figure C.19 – Gradients of flux density and coil.....	56
Figure C.20 – Measurement distance and related distances.....	58
Table 1 – Characteristics and parameters of the equipment to be considered	13
Table 2 – List of possible assessment methods	14
Table B.1 – Determining whole-body SAR implicit compliance levels	30
Table C.1 – Conductivity of tissue types	38
Table C.2 – Relative permittivity of tissue types.....	40
Table C.3 – Summary of results	50
Table C.4 – Values $G[m]$ of different coils with radius r_{coil} and distance d_{coil}	56
Table C.5 – Coupling factor $k \left[\frac{A/m^2}{T} \right]$ at 50 Hz for the whole body.....	57

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ASSESSMENT OF ELECTRONIC AND ELECTRICAL EQUIPMENT
RELATED TO HUMAN EXPOSURE RESTRICTIONS
FOR ELECTROMAGNETIC FIELDS (0 Hz – 300 GHz)**

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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 62311 has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

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

FDIS	Report on voting
106/129/FDIS	106/134/RVD

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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site 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.

Withdrawn