

# TECHNICAL REPORT



---

## Assessment of contact current related to human exposure to electric, magnetic and electromagnetic fields





## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 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.

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

Tel.: +41 22 919 02 11  
[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 - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

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 It also gives information on projects, replaced and withdrawn publications.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 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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

67 000 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: [sales@iec.ch](mailto:sales@iec.ch).



# TECHNICAL REPORT



---

## Assessment of contact current related to human exposure to electric, magnetic and electromagnetic fields

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 17.220.20

ISBN 978-2-8322-5751-7

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

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms and definitions .....	7
4 Abbreviated terms .....	8
5 Contact current in EMF exposure guidelines.....	8
6 Consideration in evaluating contact currents.....	9
6.1 General.....	9
6.2 Assumed situations of human exposure to contact current.....	9
6.2.1 General .....	9
6.2.2 Capacitive coupling (power line).....	9
6.2.3 Inductive coupling (power line) .....	9
6.2.4 Induction heating equipment.....	9
6.2.5 Wireless power transfer (WPT).....	10
6.2.6 Broadcasting .....	10
6.3 Methods of measurement of touch current used in electrical safety standards.....	10
6.3.1 General .....	10
6.3.2 IEC standards related to electrical safety.....	10
6.3.3 Modelling human body impedance .....	12
6.4 Proposed methods of measuring contact current.....	15
6.4.1 General .....	15
6.4.2 Contact current measurement using a human subject.....	15
6.4.3 Contact current measurement using a human equivalent impedance/circuit.....	16
6.4.4 Contact current calculated from measurement of open-circuit voltage.....	16
7 Consideration in standardization of evaluation method for contact current .....	17
Annex A (informative) Contact current limits in international EMF guidelines.....	18
Bibliography.....	20

Figure 1 – Time/current zones of effects of alternating currents (15 Hz to 100 Hz) on persons for a current path corresponding to left hand to feet (for explanation see Table 2).....	12
--	----

Figure 2 – Measuring network for unweighted touch current [16].....	13
---	----

Figure 3 – Measuring network for touch current weighted for perception or startle-reaction [16].....	14
--	----

Figure 4 – Simulated body impedance for contact current measurements shown in IEEE C95.3 [27].....	14
--	----

Figure 5 – Impedances of various parts of the body proposed in IEC TS 62996 for 1 kHz to 6 MHz [11] .....	15
---	----

Figure 6 – Realistic computational 3D human body model and results of calculation of current density and pathway .....	17
--	----

Table 1 – Selected IEC technical committees and standards related to electrical safety.....	11
---	----

Table 2 – Time/current zones for alternating current 15 Hz to 100 Hz for hand to feet pathway – Summary of zones in Figure 1.....	12
---	----

Table A.1 – Reference levels in ICNIRP guidelines for time varying contact current from conductive object [1], [2] ..... 18

Table A.2 – Maximum permissible exposure (MPE) levels of contact current in IEEE safety standards [3], [4] ..... 18

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ASSESSMENT OF CONTACT CURRENT RELATED TO HUMAN EXPOSURE  
TO ELECTRIC, MAGNETIC AND ELECTROMAGNETIC FIELDS**

## 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.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 63167, which is a Technical Report, 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 Technical Report is based on the following documents:

Enquiry draft	Report on voting
106/422/DTR	106/436A/RVDTR

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

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

A bilingual version of this publication may be issued at a later date.

**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

In the guidelines limiting human exposure to electric, magnetic and electromagnetic fields (EMF guidelines), limits for the contact current are given to avoid adverse indirect effects, i.e. electric shocks and burn hazards caused by contact with a conductive object located in an electric and/or magnetic field, when the object has an electric potential owing to electric or magnetic induction to the object.

At the moment, no standardized method for evaluating the contact current, in the context of human exposures to the above fields has been well established. On the other hand, there is a huge amount of knowledge, as well as many standards and regulations on the issue of electrical safety (i.e. direct contact with live part of conductive object) to avoid severe electric shock hazards. Therefore, the evaluation methods used in the field of electrical safety might be useful references. This document summarizes general information on the assessment of contact current related to human exposure to electric, magnetic and electromagnetic fields.