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TECHNICAL REPORT

colour inside

Procedures for the assessment of human exposure to electromagnetic fields from radiative wireless power transfer systems – Measurement and computational methods (frequency range of 30 MHz to 300 GHz)



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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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PROCEDURES FOR THE ASSESSMENT OF HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS FROM RADIATIVE WIRELESS POWER TRANSFER SYSTEMS – MEASUREMENT AND COMPUTATIONAL METHODS (FREQUENCY RANGE OF 30 MHz TO 300 GHz)

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IEC TR 63377 has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
106/568/DTR	106/578/RVDTR

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

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- reconfirmed,
- withdrawn,
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- amended.

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INTRODUCTION

IEC TC 106 is tasked with preparing International Standards on measurement and simulation methods used to assess human exposure to electric fields, magnetic fields, and electromagnetic fields. Wireless power transfer (WPT) systems operating at 30 MHz to 300 GHz utilize electric fields, magnetic fields, or electromagnetic fields to provide power to equipment nearby or at distances up to several metres or more. Users or bystanders in close proximity to both the transmitting equipment and receiving equipment or in between them could be exposed to these fields. Assessment methods are needed to demonstrate compliance with applicable human exposure limits. A working group (WG9) was established by IEC TC 106 to address assessment methods of human exposure to WPT equipment.

This document consists of an overview of radiative WPT, exposure assessment methods, procedures, and case studies, to help in the development of international standards for WPT exposure assessment. This document addresses the frequency range of 30 MHz to 300 GHz. For lower frequencies, WPT equipment operating below 10 MHz is covered by IEC TR 62905:2018, and below 30 MHz is covered by IEC PAS 63184:2021, with an associated subsequent International Standard currently under consideration by IEC TC 106. The methods and procedures described in this document are based on the techniques of other exposure standards covering the same frequency range. Other methods are referenced when deviations from these assessment methods are needed.

PROCEDURES FOR THE ASSESSMENT OF HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS FROM RADIATIVE WIRELESS POWER TRANSFER SYSTEMS – MEASUREMENT AND COMPUTATIONAL METHODS (FREQUENCY RANGE OF 30 MHz TO 300 GHz)

1 Scope

This Technical Report describes assessment methods to evaluate the compliance of radiative wireless power transfer (WPT) systems operating in the frequency range from 30 MHz to 300 GHz with electromagnetic guidelines on human exposure (electromagnetic field strength, specific absorption rate (SAR), and power density). This document includes but is not limited to systems that focus the electromagnetic energy emitted by the transmitter to regions surrounding the receiver, for example, by narrow beam-forming systems, wide-beam systems and spatially closed systems. Implementations without transmitter, for example, applications that harvest energy from the environment, are not included in the scope of this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
basic restriction
BR
human exposure limits for compliance with time-varying electric, magnetic, and electromagnetic fields evaluated inside the body that are based on established adverse health effects

Note 1 to entry: Within the scope of this document, the physical quantity used as a basic restriction is the specific absorption rate (SAR) or absorbed (epithelial) power density.

3.2
equipment under test
EUT
equipment that is tested according to the procedures described in this document

3.3
plane-wave equivalent power density
electromagnetic wave, magnitude of the power density of a plane wave having the same ratio of electric (E) field strength to magnetic (H) field strength

Note 1 to entry: The SI unit of plane-wave equivalent power density is watt per square metre (W/m^2).

3.4
exposure
<for a person> situation that occurs wherever a person is subjected to electric, magnetic, or electromagnetic fields

3.5
far-field region
<of an antenna> region of the electromagnetic field of an antenna wherein the predominant components of the field are those which represent a propagation of energy and wherein the angular field distribution is essentially independent of the distance from the antenna

[SOURCE: IEC 60050-712:1992 [1], 712-02-02, modified – Hyphen added to the term, notes to entry omitted.]

3.6
incident field
field that would exist in the absence of a person over a volume where a person could be located

Note 1 to entry: In some documents, the incident field is called an unperturbed field or environmental field.

3.7
reactive near-field region
region of space immediately surrounding an antenna, where the predominant components of the electric field and magnetic field are those that represent an exchange of reactive energy between the antenna and the surrounding medium, and where the electric field and magnetic field components are 90° out of phase

[SOURCE: IEC/IEEE 63195-1:2022 [2], 3.2.10, modified – The word "region" has been added to the term.]

3.8
peak spatial-average SAR
psSAR
maximum SAR averaged within a local region based on a specific averaging mass, e.g. any 1 g or 10 g of tissue in the shape of a cube

[SOURCE: IEC/IEEE 62209-1528:2020 [3], 3.37, modified – The note to entry has been omitted.]

3.9
phantom
physical model with an equivalent human anatomy and comprised of a tissue-equivalent medium with dielectric properties specified in IEC/IEEE 62209-1528:2020

[SOURCE IEC/IEEE 62209-1528 [3], 3.39, modified – The wording "in this document" is replaced with "IEC/IEEE 62209-1528:2020".]

3.10
radiative wireless power transfer system
radiative WPT system
system that transfers power by radiation of electromagnetic energy from a transmitter to a receiver in the frequency range from 30 MHz to 300 GHz

3.11
reference level
RL
level of field strength or power density derived from the basic restrictions using conservative assumptions about exposure

Note 1 to entry: If the reference levels are met, then the basic restrictions will be complied with, but if the reference levels are exceeded, that does not necessarily mean that the basic restrictions will not be met.

[SOURCE IEC 62311:2019 [4], 3.1.22, modified – Abbreviated term "RL" added.]

3.12
specific absorption rate
SAR
measure of the rate at which energy is absorbed by the human body when exposed to a radio frequency electromagnetic field

Note 1 to entry: The SAR in the tissue-equivalent medium can be determined by the rate of temperature increase or by E-field measurements, according to the following formula:

$$SAR = \frac{\sigma E^2}{\rho} = c_{\mathrm{h}} \left.\frac{\partial T}{\partial t}\right|_{t=0}$$

where

SAR is the specific absorption rate in W/kg;

E is the RMS value of the electric field strength in the tissue-equivalent medium in V/m;

σ is the electrical conductivity of the tissue-equivalent medium in S/m;

ρ is the mass density of the tissue-equivalent medium in kg/m^3;

c_{h} is the specific heat capacity of the tissue-equivalent medium in J/(kg K);

$\left.\frac{\partial T}{\partial t}\right|_{t=0}$ is the initial time derivative of temperature in the tissue-equivalent medium in K/s.

[SOURCE IEC/IEEE 62209-1528:2020 [3], 3.5.1, modified – The two formulae now appear on one line and units have been formatted as symbols rather than as written words.]

3.13
beamwidth
<of an antenna> in a specified plane containing the direction of maximum radiation or the axis of symmetry of a beam or a radiation lobe, angle between two directions (corresponding, for example, to a given fraction of the maximum radiation or to the first minimums) on both sides of this direction or axis

Note 1 to entry: The most generally used fraction is half-power beamwidth.

[SOURCE IEC 60050-712:2021 [1], 712-01-33, modified – Note 2 to entry omitted.]

3.14
whole-body SAR
wbSAR
SAR averaged over the whole body

3.15
epithelial power density
power flow through the epithelium per unit area directly under the body surface

[SOURCE IEEE Std C95.1™-2019 [5], 3.1, modified – Note 1 and Note 2 omitted.]

4 Symbols and abbreviated terms

4.1 Physical quantities

The internationally accepted SI units are used throughout this document.