IEC 62369-1

Edition 1.0 2008-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Evaluation of human exposure to electromagnetic fields from short range devices (SRDs) in various applications over the frequency range 0 GHz to 300 GHz –
Part 1: Fields produced by devices used for electronic article surveillance, radio frequency identification and similar systems

Evaluation de l'exposition humaine aux champs électromagnétiques produits par les dispositifs radio à courte portée dans la plage de fréquence 0 GHz à 300 GHz –
Partie 1: Champs produits par les dispositifs utilisés pour la surveillance électronique des objets, l'identification par radiofréquence et les systèmes similaires

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

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

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EVALUATION OF HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS FROM SHORT RANGE DEVICES (SRDS) IN VARIOUS APPLICATIONS OVER THE FREQUENCY RANGE 0 GHz to 300 GHz –

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FOREWORD

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International Standard IEC 62369-1 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
106/156/FDIS	106/159/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 list of all parts of IEC 62369 series, published under the title *Evaluation of human exposure to electromagnetic fields from short range devices (SRDs) in various applications over the frequency range 0 GHz to 300 GHz*, can be found on the IEC website.

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- withdrawn;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.

INTRODUCTION

Electromagnetic fields interact with the human body and other biological systems through a number of physical mechanisms. The main mechanisms of interaction are based on nervous system effects and heating. These effects are dependent on frequency and are defined by biologically relevant quantities. Based on these scientifically established health effects, there are international, regional and sometimes national exposure requirements. These are set as basic restrictions on quantities, which are not necessarily directly measurable, and contain high safety factors to ensure a high level of protection. These quantities may be determined either by calculation for each case, or by measuring a reference value that has a pre-derived relationship to them, usually under worst-case, far-field conditions. Respect of the reference value will ensure respect of the relevant basic restriction, except in some specific near field situations which would normally be identified or highlighted within the applicable exposure guidelines. If the measured quantity exceeds the reference value, it does not necessarily follow that the basic restriction is also exceeded. Under those circumstances, more detailed evaluation techniques will be necessary which are specific to that type of equipment and exposure.

This document is part of a multi-part standard covering the evaluation of human exposure to electromagnetic fields from short range devices (SRDs) in various applications over the frequency range from 0 GHz to 300 GHz.

EVALUATION OF HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS FROM SHORT RANGE DEVICES (SRDS) IN VARIOUS APPLICATIONS OVER THE FREQUENCY RANGE 0 GHz to 300 GHz –

Part 1: Fields produced by devices used for electronic article surveillance, radio frequency identification and similar systems

1 Scope

This part of IEC 62369 presents procedures for the evaluation of human exposure to electromagnetic fields (EMFs) from devices used in electronic article surveillance (EAS), radio frequency identification (RFID) and similar applications. It adopts a staged approach to facilitate compliance assessment. The first stage (Stage 1) is a simple measurement against the appropriate derived reference values. Stage 2 is a more complex series of measurements or calculations, coupled with analysis techniques. Stage 3 requires detailed modelling and analysis for comparison with the basic restrictions. When assessing any device, the most appropriate method for the exposure situation may be used.

At the time of writing this International Standard, electronic article surveillance, radio frequency identification and similar systems do not normally operate at frequencies below 1 Hz or above 10 GHz. EMF exposure guidelines and standards can cover a wider range of frequencies, so clarification on the required range is included as part of the evaluation procedures.

The devices covered by this document normally have non-uniform field patterns. Often these devices have a very rapid reduction of field strength with distance and operate under near-field conditions where the relationship between electric and magnetic fields is not constant. This, together with typical exposure conditions for different device types, is detailed in Annex A.

Annex B contains comprehensive information to assist with numerical modelling of the exposure situation. It includes both homogeneous and anatomical models as well as the electrical properties of tissue.

This International Standard does not include limits. Limits can be obtained from separately published human exposure guidelines. Different guidelines and limit values may apply in different regions. Linked into the guidelines are usually methods for summation across wider frequency ranges and for multiple exposure sources. These shall be used. A simplified method for summation of multiple sources is contained in Annex C. This has to be used with care as it is simplistic and will overestimate the exposure; however it is useful as a guide, when the results of different evaluations are in different units of measure which are not compatible.

Different countries and regions have different guidelines for handling the uncertainties from the evaluation. Annex D provides information on the two most common methods.

A bibliography at the end of this standard provides general information as well as useful I information for the measurement of electromagnetic fields. See [1],[2],[3],[4],[5],[6][1)].

Similar national or international standards may be used as an alternative.

1) Figures between brackets refer to the bibliography.

2 Normative references

None.

3 Terms, definitions, and abbreviations

The internationally accepted SI units are used throughout this document.

3.1 Quantities

Quantity	Symbol	Unit	Dimension
Magnetic flux density	B	tesla (Vs/m^2)	T
Electric flux density	D	coulomb per square metre	Cm^{-2}
Electric field strength	E	volt per metre	Vm^{-1}
Frequency	f	hertz	Hz
Magnetic field strength	H	ampere per metre	Am^{-1}
Current density	J	ampere per square metre	Am^{-2}
Power density	S	watt per square metre	Wm^{-2}
Specific absorption rate	SAR	watt per kilogram	Wkg^{-1}
Temperature	T	kelvin	K
Permittivity	ε	farad per metre	Fm^{-1}
Wavelength	λ	metre	m
Permeability	μ	henry per metre	Hm^{-1}
Mass density	ρ	kilogram per cubic metre	kgm^{-3}
Electric conductivity	σ	siemens per metre	Sm^{-1}

3.2 Constants

Physical constant	Symbol	Magnitude
Velocity of light in free space	c	$2{,}998 \times 10^{8}$ ms^{-1}
Permittivity of free space	ε_0	$8{,}854 \times 10^{-12}$ Fm^{-1}
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ Hm^{-1}
Impedance of free space	Z_0	120π (or 377) Ω

3.3 Terms and definitions

3.3.1
antenna
antennas are conductive elements that radiate, and/or receive energy in the radio frequency spectrum

3.3.2
average (temporal) absorbed power
P_{avg}
time – averaged rate of energy transfer defined by:

$$P_{\text{avg}} = \frac{1}{t_2 - t_1}\int_{t1}^{t2} P(t)dt$$

where t_1 and t_2 are the start and stop time of the exposure (the period $t_2 - t_1$ is the exposure duration)

3.3.3
averaging time
t_{avg}
appropriate time over which exposure is averaged for purposes of determining compliance

3.3.4
bandwidth
range or band of frequencies in the electromagnetic spectrum within which a system is capable of receiving and transmitting

3.3.5
basic restrictions (or basic limits)
values for human exposure to time-varying electric, magnetic, and electromagnetic fields that are based on levels for which there are established health effects, with a high level of safety included. These values may be defined in terms of induced current density, in-situ electric field, specific absorption rate or similar dosimetric quantity

3.3.6
carrier
frequency used to carry data by appropriate modulation of the carrier waveform

3.3.7
conductivity
σ
ratio of the conduction–current density in a medium to the electric field strength in the medium

$$J = \sigma E$$

3.3.8
current density
J
electromagnetic field-induced current per unit area inside the body

3.3.9
deactivator
device which changes transponders so that they no longer respond

3.3.10
dielectric constant
ε
See permittivity.

3.3.11
electric field strength
E
magnitude of a field vector at a point that represents the force (*F*) on an infinitely small charge (*q*) divided by the charge

$$E = \frac{F}{q}$$

3.3.12
electric flux density
D
magnitude of a field vector that is equal to the electric field strength (*E*) multiplied by the permittivity (ε)

$$D = \varepsilon E$$

3.3.13
electronic article surveillance
EAS
system which detects the presence of transponders, which is often used for anti-theft purposes

3.3.14
exposure
exposure occurs whenever and wherever a person is subjected to electric, magnetic or electromagnetic fields or to touch currents other than those originating from physiological processes in the body and other natural phenomena

3.3.15
exposure level
value of the quantity under analysis when a person is exposed to electromagnetic fields or touch currents

3.3.16
exposure requirements
standard, recommendation, set of guidelines or limits or other document that defines exposure levels for guidance, assessment or compliance purposes

3.3.17
far-field
that region of the field of an antenna where the angular field distribution is essentially independent of the distance from the antenna. In this region (also called the free space region), the field has a predominantly plane-wave character, i.e. locally uniform distribution of electric field strength and magnetic field strength in planes transverse to the direction of propagation

3.3.18
harmonics
multiples of a principal frequency, invariably exhibiting lower amplitudes

3.3.19
induced current
current induced inside the body as a result of direct exposure to electromagnetic fields

3.3.20
interrogator
module in which all the basic processing of the data protocol takes place and there is an interface to the transponder (for communicating and facilitating data transfer). An interrogator is often also known as a reader.

3.3.21
magnetic flux density
B
magnitude of a field vector that is equal to the magnetic field *H* multiplied by the permeability (μ) of the medium

$$B = \mu H$$

3.3.22
magnetic field strength
H
magnitude of a field vector in a point that results in a force (*F*) on a charge (*q*) moving with velocity (*v*)

$$F = q(v \times \mu H)$$

[or magnetic flux density divided by permeability of the medium, see “magnetic flux density”]

3.3.23
near-field
region generally in proximity to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point. The near–field region is further subdivided into two sub-regions. The **reactive near-field region** is closest to the radiating structure and contains most or nearly all of the stored energy. The **radiating near-field region** is where the radiation field predominates over the reactive field, but lacks substantial plane-wave character and is complicated in structure

3.3.24
permeability
μ
property of a material which defines the relationship between magnetic flux density *B* and magnetic field strength *H*. It is commonly used as the combination of the permeability of free space and the relative permeability for specific dielectric materials

$$\mu = \mu_R \mu_0 = B/H$$

where

μ is the permeability of the medium expressed in henrys per metre (Hm^{-1})

μ_0 is the permeability of a vacuum

μ_R is the relative permeability

3.3.25
permittivity
ε
property of a dielectric material (e.g. biological tissue) which defines the relationship between electrical flux density *D* and electrical field strength *E*. It is commonly used as the combination

of the permittivity of free space and the relative permittivity (or dielectric constant) for specific dielectric materials

$$\varepsilon = \varepsilon_R \varepsilon_0 = D/E$$

where

ε is the permittivity of the medium expressed in farads per metre (Fm^{-1})

ε_0 is the permittivity of a vacuum

ε_R is the relative permittivity

3.3.26
power density
S
power per unit area normal to the direction of electromagnetic wave propagation. For plane waves the power density (*S*), electric field strength (*E*) and magnetic field strength (*H*) are related by the impedance of free space, i.e. 377 Ω

$$S = \frac{E^2}{377} = 377H^2 = EH$$

where *E* and *H* are expressed in units of Vm^{-1} and Am^{-1}, respectively, and *S* in Wm^{-2}.

NOTE Although many survey instruments indicate power density units, the actual quantities measured are *E* or *H*, or the square of those quantities. It should be further noted that the value of 377 Ω is only valid for free space, far field measurement conditions (and does not apply for inductive devices operating in the reactive near field).

3.3.27
radio frequency identification
RFID
system which reads the data stored in transponders, using electromagnetic fields. Some system/transponder combinations also allow new or updated data to be transferred to the transponders (read/write)

3.3.28
read
decoding, extraction and presentation of data from formatting, control and error management bits sent from a transponder

3.3.29
read/write transponder
transponders that are capable of having their data repeatedly modified are called read/write transponders

3.3.30
reference value
reference level
maximum permissible exposure
action value
value of exposure in a measurable quantity that has been conservatively derived from basic restrictions or basic limits in such a way that compliance with the value ensures that there is also compliance with the basic restrictions it is derived from. Non-compliance with the reference value does not imply non-compliance with the basic restrictions it is derived from, only that additional evaluations or actions are required to show such compliance.