IEC 62209-2

Edition 1.0 2010-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

Exposition humaine aux champs radiofréquence produits par les dispositifs de communications sans fils tenus à la main ou portés près du corps – Modèles de corps humain, instrumentation et procédures –
Partie 2: Procédure de détermination du débit d'absorption spécifique produit par les appareils de communications sans fil utilisés très près du corps humain (gamme de fréquences de 30 MHz à 6 GHz)

IEC 62209-2:2010

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HUMAN EXPOSURE TO RADIO FREQUENCY FIELDS FROM HAND-HELD AND BODY-MOUNTED WIRELESS COMMUNICATION DEVICES – HUMAN MODELS, INSTRUMENTATION, AND PROCEDURES –

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FOREWORD

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International Standard IEC 62209-2 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
106/195/FDIS	106/200/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.

The French version of this standard has not been voted upon.

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

A list of all parts of the IEC 62209 series, published under the general title *Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures*, 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 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- withdrawn,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.

The contents of the corrigendum of June 2010 have been included in this copy.

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

The IEC work item “Evaluation of the Human Exposure to Radio Fields from Hand-Held and Body-Mounted Wireless Communication Devices in the Frequency range 30 MHz to 6 GHz (Human Models, Instrumentation, Procedures),” has the objective to measure the human exposure from devices intended to be used at a position near the human body. This standard was developed to provide procedures to evaluate exposures due to any electromagnetic field (EMF) transmitting device when held in the hand or in front of the face, mounted on the body, combined with other transmitters within a product, or embedded in garments. The types of devices dealt with include but are not limited to mobile telephones, cordless telephones, cordless microphones, auxiliary broadcast devices and radio transmitters in personal computers. For transmitters used in close proximity to the human ear, specific absorption rate (SAR) measurements should be performed using the procedures of IEC 62209-1:2005.

TC 106 has the scope to prepare international standards on measurement and calculation methods used to assess human exposure to electric, magnetic and electromagnetic fields. The task includes assessment methods for the exposure produced by specific sources. It applies to basic restrictions and reference levels. Although the establishment of exposure limits is not within the scope of TC 106, the results of assessments performed in accordance with TC 106 standards can be compared with the basic restrictions of relevant standards and guidelines. Conformity assessment depends on the policy of national regulatory bodies.

A Category D liaison in IEC involves organizations that can make an effective technical contribution and participate at the working group level or specific project level of the IEC technical committees or subcommittees. Obvious goals are standards harmonization and minimizing duplication of effort. The work of IEC technical committee 106 (TC 106) and IEEE International Committee on Electromagnetic Safety (ICES SCC39), technical committee 34 (TC 34), is an example where two international committees worked together informally through common membership to achieve the goal of harmonization, specifically between IEC Project Team 62209 (PT 62209) on the “Procedure to Measure the Specific Absorption Rate (SAR) for Hand-Held Mobile Telephones” and IEEE/SCC39-ICES/TC34 on IEEE Std 1528-2003 “IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques” [32].[1]

IEEE/SCC39-ICES/TC34 has a similar project. Because the project is more advanced in IEC, a Category D liaison was sought in order to avoid divergence of standards and duplication of work. Thus, rather than developing two separate standards (IEC and IEEE), the IEEE committee felt it would be more efficient to develop a single IEC standard with direct input from the members of IEEE/SCC39-ICES/TC34, many of whom are also members of PT 62209 or are from the same organizations that send delegates to participate in the work of PT 62209. The Category D liaison is limited only to this project (Part 2 of IEC 62209 series).

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1 Figures in square brackets refer to the Bibliography.

HUMAN EXPOSURE TO RADIO FREQUENCY FIELDS FROM HAND-HELD AND BODY-MOUNTED WIRELESS COMMUNICATION DEVICES – HUMAN MODELS, INSTRUMENTATION, AND PROCEDURES –

Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

1 Scope

This part of IEC 62209 series is applicable to any wireless communication device capable of transmitting electromagnetic fields (EMF) intended to be used at a position near the human body, in the manner described by the manufacturer, with the radiating part(s) of the device at distances up to and including 200 mm from a human body, i.e. when held in the hand or in front of the face, mounted on the body, combined with other transmitting or non-transmitting devices or accessories (e.g. belt-clip, camera or Bluetooth add-on), or embedded in garments. For transmitters used in close proximity to the human ear, the procedures of IEC 62209-1:2005 are applicable.

This standard is applicable for radio frequency exposure in the frequency range of 30 MHz to 6 GHz, and may be used to measure simultaneous exposures from multiple radio sources used in close proximity to human body. Definitions and evaluation procedures are provided for the following general categories of device types: body-mounted, body-supported, desktop, front-of-face, hand-held, laptop, limb-mounted, multi-band, push-to-talk, clothing-integrated. The types of devices considered include but are not limited to mobile telephones, cordless microphones, auxiliary broadcast devices and radio transmitters in personal computers.

This International Standard gives guidelines for a reproducible and conservative measurement methodology for determining the compliance of wireless devices with the SAR limits.

Because studies suggest that exclusion of features to represent a hand in human models constitutes a conservative case scenario for SAR in the trunk and the head, a representation of a hand is not included if the device is intended to be used next to the head or supported on or near the torso [73], [80]. This standard does not apply for exposures from transmitting or non-transmitting implanted medical devices. This standard does not apply for exposure from devices at distances greater than 200 mm away from the human body.

IEC 62209-2 makes cross-reference to IEC 62209-1:2005 where complete clauses or subclauses apply, along with any changes specified.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62209-1:2005, *Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the IEC 62209-1:2005, as well the following apply.

3.1
accessory
optional component that can be used in conjunction with a transmitting device

EXAMPLES

Accessories for mobile phones, wireless transmitting devices, wireless receiving devices or wireless transceiving devices, or two-way radios include the following:

a) accessories for holding, affixing, or otherwise carrying, wearing or attaching the device, as well as providing spacing from the body (e.g. a belt-clip, wrist-strap or any other body strap, or lanyard for wearing the device as necklace);

b) electronic accessories for performing tasks or which provide features (e.g., GPS modules, outboard printers, MP3 players, cameras or viewing devices);

c) electronic accessories providing audio or video input or output (e.g., headsets, microphones, cameras);

d) accessories providing enhanced RF capability to the device (e.g., replacement or auxiliary antennas);

e) batteries and related d.c. power components;

f) combinations of accessories, where two or more of the above are combined within one component (e.g., belt clip with built-in Bluetooth and "pigtail" audio cable to device).

3.2
body-mounted device[2]
body-worn device
portable device containing a wireless transmitter or transceiver which is positioned in close proximity to a person's torso or limbs (excluding the head) by means of a carry accessory during its intended use or operation of its radio functions

3.3
body-supported device
a device whose intended use includes transmitting with any portion of the device being held directly against a user's body

NOTE This differs from a body-mounted device in that it is not attached to a user's body by means of a carry accessory

3.4
cable
wire that is necessary for the functionality in the intended operational configuration

3.5
conservative exposure
estimate of the peak spatial-average SAR, including uncertainties as defined in this standard, representative of and slightly higher than expected to occur in the bodies of a significant majority of persons during intended use of hand-held devices

NOTE Conservative estimate does not mean the absolute maximum SAR value that could possibly occur under every conceivable combination of body size, body shape, wireless device orientation, and spacing relative to the body. In order to ensure that the results are not overly restrictive, and thereby unnecessarily inhibit the

2 Both terms are used. Colloquially the term "body-worn" is preferred over "body-mounted".

advancement of new mobile communications technologies, SAR overestimates should be as small as possible. For example, overestimates of the order of 20 % have been reported for head exposures [78], [79], and were deemed reasonable. Achieving an optimal compromise between over- or underestimate conditions is a complex task, which is why the conductivity of the tissue-equivalent liquid is not selected to be arbitrarily large, for example.

3.6
desktop device
a device placed or mounted on a desk, table, or similar supporting structure, and the antenna of which is intended to be operated closer than 200 mm from the human body

3.7
device under test
DUT
a device that contains one or more wireless transmitters or transceivers that is subject to this standard

NOTE A device under test may be further categorised as a body-worn, body-supported, desktop, front-of-face, hand-held, limb-worn, clothing-integrated or as a generic device.

3.8
duty factor
operational time averaging factor
the proportion of time that a transmitter transmits over a specified period

3.9
front-of-face device
hand-held device operated in close proximity to the face

EXAMPLE Front-of-face device types include push-to-talk devices, two-way radios, devices equipped with a camera.

3.10
generic device
a device that cannot be categorized as any of the specific device types

3.11
hand-held device
a portable device which is located in a user's hand during its intended use

3.12
host
any equipment which has complete user functionality when not connected to the radio equipment part and to which the radio equipment part provides additional functionality and to which connection is necessary for the radio equipment part to offer functionality

3.13
intended use
intended purpose
use for which a product, process or service is intended according to the specifications, instructions and information provided by the manufacturer. Also, use of a device for the full range of available functions, in accordance with the specifications, instructions and information provided by the manufacturer

NOTE 1 User guide instructions may include the intended use operating position and orientation.

NOTE 2 Intended use, i.e. the way a manufacturer specifies that a device should be used may not encompass all possible use conditions.

3.14
laptop device
portable computer
a portable device containing one or more wireless transceivers, that can sit on the user's lap and is not intended for hand-held use

NOTE Laptop device types include laptop (notebook) computers, typically comprised of separate keyboard and display sections connected by hinge, and tablet computers, which typically have a one-section construction where the display section also serves as input interface using a stylus or virtual keyboard.

3.15
limb-mounted device
a device whose intended use includes being strapped to the arm or leg of the user while transmitting (except in idle mode)

EXAMPLE Limb-mounted device types include wrist-mounted, ankle-mounted, and forearm-mounted devices.

3.16
measurement drift
continuous or incremental change over time in indication, due to changes in metrological properties of a measuring instrument

3.17
multi-band transmission
operation mode for transmitting on several radio frequency bands simultaneously

3.18
output power
power at the output of the RF transmitter when the antenna, or a load with the same impedance at the test frequency and in the considered test position, is connected to it

3.19
peak SAR value, primary
largest SAR value determined in an area scan measurement

3.20
peak SAR value, secondary
other local SAR maxima determined in an area scan measurement that are smaller than the primary peak SAR value

3.21
separation distance
distance between the DUT and the outside surface of the phantom, representing the distance during intended use

3.22
two-way radio
push-to-talk (PTT) device
a hand-held radio transceiver in which a switch is used to toggle between radio transmission and reception

4 Symbols and abbreviated terms

4.1 Physical quantities

The internationally accepted SI-units are used throughout the standard.

Symbol	Quantity	Unit	Unit symbol
E	Electric field strength	volt per metre	V/m
f	Frequency	Hertz	Hz
H	Magnetic field strength	ampere per metre	A/m
J	Current density	ampere per square metre	A/m^2
$\overline{P}_{avg}$	Average (temporal) absorbed power	watt	W
SAR	Specific absorption rate	watt per kilogram	W/kg
T	Temperature	kelvin	K
ε	Permittivity	farad per metre	F/m
λ	Wavelength	metre	m
μ	Permeability	henry per metre	H/m
ρ	Mass density	kilogram per cubic metre	kg/m^3
σ	Electric conductivity	siemens per metre	S/m

NOTE In this standard, temperature is quantified in degrees Celsius, as defined by: T (°C) = T (K) - 273,16.

4.2 Constants

Symbol	Physical constant	Magnitude
c	Speed of light in vacuum	$2{,}998 \times 10^8$ m/s
η	Impedance of free space	120π or 377 Ω
ε_0	Permittivity of free space	$8{,}854 \times 10^{-12}$ F/m
μ_0	Permeability of free space	$4\pi \times 10^{-7}$ H/m

4.3 Abbreviations

CDMA	code division multiple access
CW	continuous wave
DOE	design of experiments
DUT	device under test
E-field	electric field
EMC	electromagnetic compatibility
FDTD	finite-difference time-domain
FDMA	frequency division multiple access
GPRS	general packet radio service
GSM	global system for mobile communication
MIMO	multiple input multiple output
MOD	modulation
OFAT	one-factor-at- a-time
PTT	push-to-talk
RF	radio frequency

RMS	root mean square
RSS	root sum square
SAR	specific absorption rate
TDMA	time division multiple access

5 Measurement system specifications

5.1 General requirements

A SAR measurement system consists of a human body model (phantom), electronic measurement instrumentation, a scanning system and a device holder.

The test shall be performed using a miniature probe that is automatically positioned to measure the internal *E*-field distribution in a phantom representing the human body exposed to the electromagnetic fields produced by wireless devices. From the measured *E*-field values, the SAR distribution and the peak spatial-average SAR value shall be calculated.

The test shall be performed in a laboratory conforming to the following environmental conditions:

- both the ambient and liquid temperatures shall both be in the range of 18 °C to 25 °C; see 7.2.4.4 to determine the liquid temperature uncertainty;
- the DUT, test equipment, liquid and phantom shall have been kept in the laboratory long enough for their temperatures to have stabilized (i.e., they should not have been recently moved from another area with a different ambient temperature, such as a refrigerator or outdoors);
- the variation of the liquid temperature during the test shall not deviate from the liquid temperature during dielectric property measurement by more than ± 2 °C or that which would result in a SAR deviation within ± 5 %, whichever is smaller; see 7.2.4.4 to determine the liquid temperature uncertainty;
- the ambient noise (e.g., noise of measurement system, noise due to the robot motors, other RF transmitters, etc.) shall not induce a 1 g SAR greater than 0,012 W/kg (3 % of the lower measurement value of 0,4 W/kg that can be determined with the uncertainties of Table 5), as measured according to 7.2.4.5 with the RF transmitter of the DUT turned off;
- during testing the DUT shall not connect to any wireless network; the connection to a base station simulator is acceptable;
- the effects of scatterers (e.g., floor, robot, other devices, etc.) other than the transmitter and the phantom shall be smaller than 3 % of the measured SAR, as measured according to 7.2.4.5 with the RF transmitter of the DUT turned on. If the effect of the scatterers is larger than 3 %, additional uncertainty shall be added (7.2.4.5).

System validation according to the protocol defined in Annex B shall be done at least once per year, including when a new system is put into operation and whenever modifications have been made to the system, such as a new software version, different type or version of readout electronics or different types of probes. The standard sources used for system validation (e.g. a half-wave dipole, patch antenna, open-ended waveguide) shall be designed and validated according to the protocol in Annex B. Additional sources (e.g. dipoles at specific frequencies not presently included in Tables B.1, D.1, and D.2) may be used as standard sources provided they meet the requirements specified in Annex B.

Where this standard explicitly specifies performance characteristics for the measurement system or a device part of the measurement system, the manufacturer of the system or of the device, or the system integrator shall document the conformity with the provisions of this standard.