IEC 62232

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Determination of RF field strength and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure

Détermination des champs de radiofréquences et du DAS aux environs des stations de base utilisées pour les communications radio dans le but d'évaluer l'exposition humaine

IEC 62232:2011

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

DETERMINATION OF RF FIELD STRENGTH AND SAR IN THE VICINITY OF RADIOCOMMUNICATION BASE STATIONS FOR THE PURPOSE OF EVALUATING HUMAN EXPOSURE

FOREWORD

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This publication contains attached files in the form of a CD-ROM for the paper version and embedded files for the electronic version. These files are intended to be used as a complement and do not form an integral part of the standard.

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

FDIS	Report on voting
106/221/FDIS	106/228/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 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- withdrawn,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.

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

This standard addresses the evaluation of RF field strength or specific absorption rate levels in the vicinity of non-broadcast RF radiocommunication sources (i.e. RBS) intentionally radiating in the frequency range 300 MHz to 6 GHz according to the scope (see Clause 1). It does not address the evaluation of current density which exposure guidelines often do not consider to be relevant when evaluating RF fields in the intended RBS operating frequency range.

This standard defines how a suitably qualified surveyor shall select between the described evaluation methods in order to prepare specific or generic evaluation plans and how to validate their implementation. When using this standard to establish RBS compliance, the full set of limiting conditions needs to be defined. These may include for example limits on human exposure to RF fields; the likelihood that people may have access to a specific location; specific decision rules for interpretation of uncertainty. This standard does not define such limits or the associated requirements for a safety programme. Further, this standard recognises that national regulators (or the test client) may establish rules (termed "assessment schemes") on how to interpret uncertainty when establishing compliance. However, this standard does provide guidance on how to apply the described evaluation methods consistent with such rules. Additional guidance can be found in Technical Report IEC 62669 [54][1)] which includes a set of worked case studies giving practical examples of the application of this standard.

Clause 2, Clause 3 and Clause 4 address normative references, definitions and abbreviations respectively.

Clause 5, with Annex A, Annex B and Annex C, defines how to select the evaluation methods to be used and how to plan the evaluation task. The standard describes the alternative methods that may be included in the evaluation plan and defines a ranking to be applied in the event of dispute where the higher ranking evaluation takes precedence. Lower ranking evaluations are of course valid within their applicability and may be more practical to implement.

Clause 6 describes the evaluation methods to determine a measurand (SAR or RF field strength) value at a specified point. These cover both laboratory and *in situ* measurement methods for SAR and electric field strength and computation methods for SAR, power flux density, electric field strength and magnetic field strength. Annex C describes how the evaluation methods may be employed for specific purposes. Annex F and Annex G provide information on implementation of computation methods and Annex H with included referenced spread sheets provides computation validation information.

Clause 7 and Annex O address the estimation of uncertainty or the determination that the evaluated value meets a specified confidence level. Annex L and Annex M describe how to address uncertainty when determining compliance with limit values in accordance with relevant national regulatory requirements.

Clause 8 describes reporting requirements for the evaluation.

Other annexes and the bibliography are referenced extensively to provide useful clarifications or guidance.

1) Numerals in square brackets refer to the Bibliography.

DETERMINATION OF RF FIELD STRENGTH AND SAR IN THE VICINITY OF RADIOCOMMUNICATION BASE STATIONS FOR THE PURPOSE OF EVALUATING HUMAN EXPOSURE

1 Scope

This International Standard provides methods for the determination of radio-frequency (RF) field strength and specific absorption rate (SAR) in the vicinity of radiocommunication base stations (RBS) for the purpose of evaluating human exposure.

This standard:

a) considers RBS which transmit on one or more antennas using one or more frequencies in the range 300 MHz to 6 GHz;

b) describes several RF field strength and SAR measurement and computation methodologies with guidance on their applicability to address both the *in situ* evaluation of installed RBS and laboratory-based evaluations;

c) describes how surveyors with a sufficient level of expertise shall establish their specific evaluation procedures appropriate for their evaluation purpose;

d) considers the evaluation purposes, namely:

   1) product conformity: to establish that a RBS conforms to a defined set of limit conditions under its intended use;

   2) compliance boundary: to establish the compliance boundary or boundaries for a RBS in relation to a defined set of limit conditions;

   3) to evaluate RF field strength or SAR values at one or more evaluation locations, namely:

      i) evaluation location(s) at arbitrary locations outside the control boundary to provide information for interested parties;

      ii) evaluation location(s) at the control boundary to confirm validity of control boundary;

      iii) evaluation location(s) within the control boundary with the specific conditions relevant to investigate an alleged over-exposure incident;

e) provides guidance on how to report, interpret and compare results from different evaluation methodologies and, where the evaluation purpose requires it, determine a justified decision against a limit value;

f) provides informative guidance on how to evaluate ambient RF field strength levels in the vicinity of a RBS from RF sources other than the RBS under evaluation and at frequencies within and outside the range 300 MHz to 6 GHz;

g) provides short descriptions of the informative example case studies to aid the surveyor given in the companion Technical Report IEC 62669 [54].

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 60215, *Safety requirements for radio transmitting equipment*

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)*

IEC 62209-2:2010, *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)*

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 following terms and definitions apply.

3.1
ambient fields
background electromagnetic fields in the frequency range from 100 kHz to 300 GHz other than the emissions from the EUT in the frequency range 300 MHz to 6 GHz

3.2
antenna factor
ratio of the electromagnetic field strength incident upon an antenna to the voltage (V) that is produced across a specified impedance (e.g. 50 Ω) terminating the line connection of the antenna

3.3
assessment
determination of a decision based on measurand value (e.g. comparison with a relevant limit)

3.4
assessment configuration
set of parameter values which together represent the RBS configuration to be assessed according to the evaluation purpose, e.g. for conformity assessment

3.5
average (temporal) transmitted power
rate of radiated energy transfer expressed in W given by

$$\overline{P}_{\text{avg}} = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} P(t)\,\mathrm{d}t$$

where

t_1 is the start time of the observation in seconds;

t_2 is the stop time of the observation in seconds;

$P(t)$ is the instantaneous transmitted power in watts

NOTE The transmitted power is the conducted power applied to the antenna input connector minus the reflected power at the antenna input connector and minus the power dissipated as heat within the antenna.

3.6
average (temporal) absorbed power
ohmic power dissipated in a volume V given by

$$P_{\mathrm{A}} = \int_V \sigma[E(x,y,z)]^2 \,\mathrm{d}V$$

where

$E(x,y,z)$ is the r.m.s. value of the electric field strength in the tissue in volts per metre;

σ is the electric conductivity of the tissue in siemens per metre

3.7
axial isotropy, probe
maximum deviation of the SAR, E^2 or H^2 when rotating around the major axis of the probe enclosure/case while the probe is exposed to a reference wave impinging from a direction along the probe major axis

3.8
basic restriction
restriction on human exposure to time-varying electric, magnetic, and electromagnetic fields that is based on the applicable exposure guidelines

NOTE For this standard, the physical quantity used as a basic restriction is the specific absorption rate (SAR) or power flux density (S) depending on the frequency and defined by the relevant compliance standard.

3.9
collinear array (antenna)
antenna consisting of a linear array of radiating elements, usually dipoles, with their axes lying in a straight line

3.10
compliance boundary
surface of arbitrary shape defining a volume outside of which there is an applicable confidence that the applicable limit condition is not exceeded

3.11
control boundary
set of locations which together define where human access to a compliance boundary is controlled either via warnings or physical controls

3.12
detection limits
lower detection limit defined by the minimum quantifiable response of the measuring equipment; upper detection limit defined by the maximum quantifiable response of the measuring equipment

3.13
directivity (of an antenna, in a given direction)
D
ratio of the radiation intensity produced by an antenna in a given direction to the value of the radiation intensities averaged in all directions in space

NOTE 1 If no direction is specified, the direction of maximum radiation intensity from the given antenna is implied.

NOTE 2 The directivity is independent of antenna losses and equal to the absolute gain in the same direction if the antenna has no internal losses.

NOTE 3 The ratio may also be expressed in decibels.

3.14
duty factor
the ratio of (1) the sum of pulse durations to (2) a stated averaging time. For repetitive phenomena, the averaging time is the pulse repetition period

IEC 60050-531:1974, 531-18-15, [67][2)]

3.15
dynamic range
quotient of the signal from the maximum measurable indication of a quantity by the signal from the minimum measurable value of that quantity

NOTE In some cases the dynamic range may be expressed as an interval of the above-mentioned corresponding values.

IEC 60050-394:2007, 394-40-17, [71]

3.16
equivalent isotropic radiated power (in a given direction)
EIRP
the product of the radiofrequency power supplied to an antenna and the absolute gain of the antenna in a given direction

IEC 60050-712:1992, 712-02-51, [68] modified

3.17
electric field strength
vector field quantity E which exerts on any charged particle at rest a force F equal to the product of E and the electric charge Q of the particle:

$$F = Q\,E$$

IEC 60050-121:1998, 121-11-18, [70]

3.18
evaluation
process of determining a value of a measurand

3.19
evaluation configuration
set of parameter values which together represent the RBS configuration used in the evaluation

3.20
evaluation plan
document defining the specific methodology to be employed for an evaluation case, prepared in advance of the performance of the evaluation, including all methods to be used and which evaluation locations will be investigated using each defined method

3.21
evaluation location
specific physical location at which a single field parameter value has been measured or computed

NOTE In the case of spatial averaging, this is the reference location defined in the averaging scheme.

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2) Numerals in square brackets refer to the Bibliography.