

© Copyright SEK. Reproduction in any form without permission is prohibited.

Exponering för radiofrekventa elektromagnetiska fält från handhållen och kroppsburen trådlös kommunikationsutrustning – Kroppsmodeller, instrumentering, och metoder –

Del 1: Bestämning av specifik absorptionshastighet (SAR) för handhållna apparater som används nära örat (frekvensområde 300 MHz till 3 GHz)

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)

Som svensk standard gäller europastandarden EN 62209-1:2006. Den svenska standarden innehåller den officiella engelska språkversionen av EN 62209-1:2006.

Nationellt förord

Europastandarden EN 62209-1:2006^{*)}

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 62209-1, First edition, 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)**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 50361, utgåva 1, 2001, gäller ej fr o m 2009-03-01.

^{*)} EN 62209-1:2006 ikraftsattes 2006-11-20 som SS-EN 62209-1 genom offentliggörande, d v s utan utgivning av något svenskt dokument.

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a säkerhet, prestanda, dokumentation, utförande och skötsel av elprodukter, elanläggningar och metoder. Genom att utforma sådana standarder blir säkerhetskraven tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English version

**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 62209-1:2005)**

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 1: Détermination du débit d'absorption
spécifique (DAS) produit par les appareils
tenus à la main et utilisés près de l'oreille
(plage de fréquence de 300 MHz à 3 GHz)
(CEI 62209-1:2005)

Sicherheit von Personen in hochfrequenten
Feldern von handgehaltenen und
am Körper getragenen schnurlosen
Kommunikationsgeräten –
Körpermodelle, Messgeräte und Verfahren
Teil 1: Verfahren zur Bestimmung der
spezifischen Absorptionsrate (SAR) von
handgehaltenen Geräten, die in enger
Nachbarschaft zum Ohr benutzt werden
(Frequenzbereich von 300 MHz bis 3 GHz)
(IEC 62209-1:2005)

This European Standard was approved by CENELEC on 2006-03-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of the International Standard IEC 62209-1:2005, prepared by IEC TC 106, Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure, was submitted to the formal vote and was approved by CENELEC as EN 62209-1 on 2006-03-01 without any modification.

This European Standard supersedes EN 50361:2001.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2007-03-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2009-03-01 |

Endorsement notice

The text of the International Standard IEC 62209-1:2005 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO/IEC Guide	1995	Guide to the expression of uncertainty in measurement	-	-
ISO/IEC 17025	1999	General requirements for the competence of testing and calibration laboratories	EN ISO/IEC 17025 ¹⁾	2000

¹⁾ EN ISO/IEC 17025 is superseded by EN ISO/IEC 17025:2005, which is based on ISO/IEC 17025:2005.

CONTENTS

INTRODUCTION.....	13
1 Scope	15
2 Normative references	15
3 Terms and definitions	15
4 Symbols and abbreviated terms	31
4.1 Physical quantities.....	31
4.2 Constants.....	33
4.3 Abbreviations	33
5 Measurement system specifications	33
5.1 General requirements	33
5.2 Phantom specifications (shell and liquid).....	35
5.3 Specifications of the SAR measurement equipment	45
5.4 Scanning system specifications.....	45
5.5 Device holder specifications.....	45
5.6 Measurement of liquid dielectric properties.....	47
6 Protocol for SAR assessment.....	47
6.1 Measurement preparation	47
6.2 Tests to be performed.....	59
6.3 Measurement procedure	63
6.4 Post-processing of SAR measurement data.....	65
7 Uncertainty estimation	67
7.1 General considerations	67
7.2 Components contributing to uncertainty.....	69
7.3 Uncertainty estimation	93
8 Measurement report	97
8.1 General.....	97
8.2 Items to be recorded in the test report.....	97
Annex A (normative) Phantom specifications	101
Annex B (normative) Calibration (linearity, isotropy, sensitivity) of the measurement instrumentation and uncertainty estimation.....	113
Annex C (normative) Post-processing techniques and uncertainty estimation	143
Annex D (normative) SAR measurement system validation	153
Annex E (informative) Interlaboratory comparisons	167
Annex F (informative) Definition of a phantom coordinate system and a device under test coordinate system	171
Annex G (informative) Validation dipoles	175
Annex H (informative) Flat phantom	179
Annex I (informative) Recommended recipes for phantom head tissue-equivalent liquids	183
Annex J (informative) Measurement of the dielectric properties of liquids and uncertainty estimation.....	187
Bibliography	207

Figure 1 – Picture of the phantom showing ear reference points RE and LE, mouth reference point M, reference line N-F, and central strip.....	37
Figure 2 – Sagittally bisected phantom with extended perimeter (shown placed on its side as used for device SAR tests).....	37
Figure 3 – Cross-sectional view of SAM at the reference plane containing B-M	41
Figure 4 – Side view of the phantom showing relevant markings	43
Figure 5 – Handset vertical and horizontal reference lines and reference points A, B on two example device types	53
Figure 6 – Cheek position of the wireless device on the left side of SAM.....	55
Figure 7 – Tilt position of the wireless device on the left side of SAM	57
Figure 8 – Block diagram of the tests to be performed	61
Figure 9 – Orientation of the probe with respect to the line normal to the surface, shown at two different locations	65
Figure 10 – Orientation and surface of the averaging volume relative to the phantom surface ..	93
Figure A.1 – Illustration of dimensions in Table A.1	103
Figure A.2 –Close up side view of phantom showing the ear region.....	107
Figure A.3 – Side view of the phantom showing relevant markings.....	109
Figure B.1 – Experimental set-up for assessment of the sensitivity (conversion factor) using a vertically-oriented rectangular waveguide	121
Figure B.2 – Description of the antenna gain evaluation set-up	125
Figure B.3 – Set-up to assess spherical isotropy deviation in tissue-equivalent liquid	131
Figure B.4 – Alternative set-up to assess spherical isotropy deviation in tissue-equivalent liquid.....	133
Figure B.5 – Experimental set-up for the hemispherical isotropy assessment [11]	135
Figure B.6 – Conventions for dipole position (ξ) and polarization (θ) [11].....	135
Figure B.7 – Measurement of axial isotropy with a reference antenna	139
Figure B.8 – Measurement of hemispherical isotropy with reference antenna	139
Figure C.1 – Methods of three points.....	145
Figure C.2 – Method of the tangential face	145
Figure C.3 – Method of averaging	147
Figure C.4 – Extrude method of averaging.....	147
Figure C.5 – Extrapolation of SAR data to the inner surface of the phantom based on a least-square polynomial fit of the measured data (squares).....	151
Figure D.1 – Set-up for the <i>system check</i>	157
Figure F.1 – Example reference coordinate system for the SAM phantom	171
Figure F.2 – Example coordinate system on the device under test	173
Figure G.1 – Mechanical details of the reference dipole	177
Figure H.1 – Dimensions of the flat phantom set-up used for deriving the minimal dimensions for W and L	179
Figure H.2 – FDTD predicted uncertainty in the 10 g peak spatial-average SAR as a function of the dimensions of the flat phantom compared with an infinite flat phantom	181
Figure J.1 – Slotted line set-up.....	189
Figure J.2 – An open-ended coaxial probe with inner and outer radii a and b , respectively	193
Figure J.3 – TEM line dielectric test set-up [60]	197

Table 1 – Dielectric properties of the tissue-equivalent liquid	43
Table 2 – Reference SAR values in watts per kilogram used for estimating post-processing uncertainties	87
Table 3 – Measurement uncertainty evaluation template for handset SAR test	95
Table A.1 – Head dimensions relevant to phantom shape: SAM dimensions compared to 90th-percentile large male head from Gordon report [18]	105
Table A.2 – Specific guidelines for the design of SAM phantom and CAD file	107
Table B.1 – Uncertainty analysis for transfer calibration using temperature probes	119
Table B.2 – Uncertainty template for calibration using analytical field distribution inside waveguide	123
Table B.3 – Uncertainty template for evaluation of reference antenna gain	127
Table B.4 – Uncertainty template for calibration using reference antenna	129
Table D.1 – Numerical reference SAR values for reference dipole and flat phantom	165
Table G.1 – Mechanical dimensions of the reference dipoles	175
Table H.1 – Parameters used for calculation of reference SAR values in Table D.1	181
Table I.1 – Suggested recipes for achieving target dielectric parameters	185
Table J.1 – Parameters for calculating the dielectric properties of various reference liquids	201
Table J.2 – Dielectric properties of reference liquids at 20 °C	203
Table J.3 – Example uncertainty template and example numerical values for dielectric constant (ϵ_r') and conductivity (σ) measurement	205

INTRODUCTION

The international committees IEC TC 106, CENELEC Technical Committee TC 106x WG1, and IEEE Standards Coordinating Committee 34 (SCC34) worked together informally through common membership to achieve the goal of harmonization, specifically between IEC TC 106 Project Team 62209 for the document "Procedure to Measure the Specific Absorption Rate (SAR) for Hand-Held Mobile Telephones in the Frequency Range of 300 MHz to 3 GHz" and IEEE SCC34 for the IEEE Std 1528 "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques" [22]¹.

During the process a primary effort involved was to harmonize these two standards

¹) Numbers 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 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)

1 Scope

This International Standard applies to any electromagnetic field (EMF) transmitting device intended to be used with the radiating part of the device in close proximity to the human head and held against the ear, including mobile phones, cordless phones, etc. The frequency range is 300 MHz to 3 GHz.

The objective of this standard is to specify the measurement method for demonstration of compliance with the specific absorption rate (SAR) limits for such devices.

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.

ISO/IEC Guide:1995, *Guide to the Expression of Uncertainty in Measurement*

ISO/IEC 17025:1999, *General requirements for the competence of testing and calibration laboratories*