

Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 3: Vector measurement-based systems (Frequency range of 600 MHz to 6 GHz)

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN IEC 62209-3:2019 sisaldab Euroopa standardi EN IEC 62209-3:2019 ingliskeelset teksti.	This Estonian standard EVS-EN IEC 62209-3:2019 consists of the English text of the European standard EN IEC 62209-3:2019.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 22.11.2019.	Date of Availability of the European standard is 22.11.2019.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 33.060.20

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

ICS 33.060.20

English Version

Measurement procedure for the assessment of specific
absorption rate of human exposure to radio frequency fields from
hand-held and body-mounted wireless communication devices -
Part 3: Vector measurement-based systems (Frequency range
of 600 MHz to 6 GHz)
(IEC 62209-3:2019)

Procédure de mesure pour l'évaluation du débit
d'absorption spécifique de l'exposition humaine aux champs
radiofréquence produits par les dispositifs de
communications sans fil tenus à la main ou portés près du
corps - Partie 3: Systèmes basés sur la mesure vectorielle
(plage de fréquences comprise entre 600 MHz et 6 GHz)
(IEC 62209-3:2019)

Messverfahren für die Beurteilung der spezifischen
Absorptionsrate bei der Exposition von Personen
gegenüber hochfrequenten Feldern von handgehaltenen
und am Körper getragenen schnurlosen
Kommunikationsgeräten - Teil 3: Auf Vektormessungen
basierende Systeme (Frequenzbereich von 600 MHz bis 6
GHz)
(IEC 62209-3:2019)

This European Standard was approved by CENELEC on 2019-10-29. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

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



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 106/494/FDIS, future edition 1 of IEC 62209-3, prepared by IEC/TC 106 "Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62209-3:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-07-29
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-10-29

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62209-3:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

ISO/IEC 17025	NOTE	Harmonized as EN ISO/IEC 17025
ISO 3611:2010	NOTE	Harmonized as EN ISO 3611:2010 (not modified)
ISO/IEC 17043	NOTE	Harmonized as EN ISO/IEC 17043

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 62209-1	2016	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz)	EN 62209-1	2016
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)	EN 62209-2	2010
IEC 62479	-	Assessment of the compliance of low-power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz)	EN 62479	-
IEC TR 62630	2010	Guidance for evaluating exposure from multiple electromagnetic sources	-	-
ISO/IEC Guide 98-1 2009		Uncertainty of measurement – Part 1: Introduction to the expression of uncertainty in measurement	-	-
ISO/IEC Guide 98-3 -		Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)	-	-
IEC/IEEE 62704-1 -		Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 1: General requirements for using the finite difference time-domain (FDTD) method for SAR calculations	-	-

CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	12
2 Normative references	12
3 Terms and definitions	13
4 Symbols and abbreviated terms.....	14
5 Overview of the measurement procedure.....	14
6 Measurement system specifications.....	17
6.1 General requirements	17
6.2 Phantom specifications	19
6.2.1 Head phantom specifications – shell.....	19
6.2.2 Body phantom specifications – shell	19
6.2.3 Tissue-equivalent medium properties.....	19
6.3 Measurement system requirements.....	19
6.3.1 General	19
6.3.2 Scanning measurement system specifications	19
6.3.3 Array measurement system specifications	20
6.4 Device holder specification	21
6.5 Reconstruction algorithm and peak spatial-averaging specifications	22
7 Protocol for SAR assessments	22
7.1 Measurement preparation	22
7.1.1 General	22
7.1.2 Preparation of tissue-equivalent medium	22
7.1.3 System check	23
7.1.4 Preparation of the device under test (DUT).....	23
7.1.5 Operating modes	23
7.1.6 Position of the DUT in relation to the phantom.....	23
7.1.7 Positions of the DUT in relation to the flat phantom for large DUT	23
7.1.8 Test frequencies for DUT.....	24
7.2 Tests to be performed.....	24
7.3 General measurement procedure.....	25
7.3.1 General	25
7.3.2 Measurement procedure for scanning systems	25
7.3.3 Measurement procedure for array systems	26
7.4 SAR measurements for simultaneous transmission	26
7.4.1 General	26
7.4.2 SAR measurements for uncorrelated signals	27
7.4.3 SAR measurements for correlated signals	31
8 Measurement uncertainty estimation.....	32
8.1 General.....	32
8.2 Requirements on the measurement uncertainty evaluation.....	32
8.3 Description of measurement uncertainty models	33
8.3.1 General	33
8.3.2 Uncertainty models for array measurement system and scanning measurement systems	34
8.3.3 Example uncertainty budget templates	35

9	Measurement report	39
	Annex A (normative) Phantom specifications	40
	A.1 SAM phantom specifications	40
	A.1.1 Justification	40
	A.1.2 SAM phantom geometry.....	40
	A.1.3 Tissue-equivalent medium	40
	A.2 Flat phantom specifications.....	41
	A.3 Specific phantoms.....	42
	A.4 Tissue-equivalent medium	43
	Annex B (normative) Calibration and characterization of dosimetric probes.....	44
	B.1 General.....	44
	B.2 Types of calibration.....	44
	B.2.1 Amplitude calibration with analytical fields	44
	B.2.2 Amplitude and phase calibration by transfer calibration	45
	B.2.3 Amplitude and phase calibration using numerical reference	47
	Annex C (informative) Field reconstruction techniques.....	49
	C.1 General.....	49
	C.2 Objective of field reconstruction techniques	49
	C.3 Background.....	49
	C.4 Reconstruction techniques	51
	C.4.1 Expansion techniques.....	51
	C.4.2 Source reconstruction techniques	52
	C.4.3 Source base function decomposition.....	52
	C.4.4 Phase reconstruction	52
	C.5 Source reconstruction and SAR estimation from fields measured outside the phantom.....	53
	C.6 Additional considerations for field reconstruction in scanning systems	53
	Annex D (normative) SAR measurement system verification and system validation.....	54
	D.1 Objectives and purpose	54
	D.1.1 General	54
	D.1.2 Objectives and purpose of <i>system check</i>	54
	D.1.3 Objectives of <i>system validation</i>	54
	D.2 SAR measurement setup and procedure for <i>system check</i> and <i>system validation</i>	55
	D.2.1 General	55
	D.2.2 Power measurement setups.....	55
	D.2.3 Procedure to measure and normalize SAR.....	57
	D.2.4 Power measurement uncertainty.....	59
	D.3 <i>System check</i>	61
	D.3.1 <i>System check</i> antennas and test conditions.....	61
	D.3.2 <i>System check</i> antennas and test conditions for scanning systems	61
	D.3.3 <i>System check</i> antennas and test conditions for array systems	61
	D.3.4 <i>System check</i> acceptance criteria.....	62
	D.4 <i>System validation</i>	62
	D.4.1 Validation of array systems and scanning systems	62
	D.4.2 Requirements for <i>system validation</i> antennas and test conditions.....	62
	D.4.3 Requirements for array systems and scanning systems	62
	D.4.4 Test positions for <i>system validation</i>	64
	D.4.5 <i>System validation</i> procedure based on peak spatial-average SAR	71

D.4.6	On-site <i>system validation</i> after installation	79
D.4.7	<i>System validation</i> acceptance criteria	80
Annex E (informative)	Interlaboratory comparisons	82
E.1	Purpose	82
E.2	Monitor laboratory	82
E.3	Phantom set-up	82
E.4	Reference devices	82
E.5	Power set-up	83
E.6	Interlaboratory comparison – Procedure	83
Annex F (normative)	<i>System validation</i> antennas	84
F.1	General requirements	84
F.2	Return loss requirements	84
F.3	Standard dipole antenna	85
F.4	VPIFA	88
F.5	2-PEAK CPIFA	90
F.6	Additional antennas	94
Annex G (normative)	SAR calibration of reference antennas	95
G.1	Purpose	95
G.2	Parameters or quantities and ranges to be determined by calibration method	96
G.3	Reference antenna calibration setup	96
G.4	Reference antenna calibration procedure	97
G.4.1	Verification of return loss	97
G.4.2	Calibration of reference antennas: step-by-step procedure	97
G.4.3	Uncertainty budget of reference antenna calibration	98
G.5	Method and uncertainties for the transfer of calibration between two or more antennas of the same type using the array system	102
Annex H (informative)	General considerations on uncertainty estimation	105
H.1	Concept of uncertainty estimation	105
H.2	Type A and Type B evaluations	106
H.3	Degrees of freedom and coverage factor	106
H.4	Combined and expanded uncertainties	107
H.5	Analytical reference functions	108
Annex I (normative)	Evaluation of measurement uncertainty of SAR results from scanning vector measurement-based systems with single probes	111
I.1	Measurement uncertainties to be evaluated by the system manufacturer <i>MM</i>	111
I.1.1	General	111
I.1.2	Calibration <i>CF</i>	111
I.1.3	Isotropy <i>ISO</i>	111
I.1.4	System linearity <i>LIN</i>	112
I.1.5	Sensitivity limit <i>SL</i>	112
I.1.6	Boundary effect <i>BE</i>	112
I.1.7	Readout electronics <i>RE</i>	113
I.1.8	Response time <i>RT</i>	113
I.1.9	Probe positioning <i>PP</i>	113
I.1.10	Sampling error <i>SE</i>	113
I.1.11	Phantom shell <i>PS</i>	114
I.1.12	Tissue-equivalent medium parameters <i>MAT</i>	114
I.1.13	Measurement system immunity/secondary reception <i>MSI</i>	116

I.2	Uncertainty of reconstruction corrections and post-processing to be specified by the manufacturer <i>MN</i>	116
I.2.1	General	116
I.2.2	Evaluation of uncertainty due to reconstruction <i>REC</i>	116
I.2.3	Impact of noise on reconstruction <i>POL</i>	117
I.2.4	SAR averaging <i>SAV</i>	117
I.2.5	SAR scaling <i>SARS</i>	117
I.2.6	SAR correction for deviations in permittivity and conductivity <i>SC</i>	118
I.3	Uncertainties that are dependent on the DUT <i>MD</i>	119
I.3.1	General	119
I.3.2	Probe coupling with the DUT <i>PC</i>	119
I.3.3	Modulation Response <i>MOD</i>	119
I.3.4	Integration time <i>IT</i>	120
I.3.5	Measured SAR drift <i>SD</i>	120
I.4	Uncertainties related to the measurement environment <i>ME</i>	120
I.4.1	General	120
I.4.2	Device holder <i>DH</i>	120
I.4.3	Device positioning <i>DP</i>	121
I.4.4	RF ambient conditions <i>AC</i>	121
I.4.5	Measurement system drift and noise <i>DN</i>	121
I.5	Uncertainties of validation antennas <i>MV</i>	122
I.5.1	General	122
I.5.2	Deviation of experimental antennas <i>DEX</i>	122
I.5.3	Power measurement uncertainty <i>PMU</i>	122
I.5.4	Other uncertainty contributions when using validation antennas <i>OVS</i>	122
Annex J (normative)	Evaluation of the measurement system uncertainty of fixed array or scanning array vector measurement-based systems	123
J.1	Measuring system uncertainties to be evaluated by the manufacturer <i>MM</i>	123
J.1.1	General	123
J.1.2	Calibration <i>CF</i>	123
J.1.3	Isotropy <i>ISO</i>	123
J.1.4	Mutual sensor coupling <i>MSC</i>	124
J.1.5	Scattering due to the presence of the array <i>AS</i>	125
J.1.6	System linearity <i>LIN</i>	126
J.1.7	Sensitivity limit <i>SL</i>	126
J.1.8	Boundary effect <i>BE</i>	126
J.1.9	Readout electronics <i>RE</i>	127
J.1.10	Response time <i>RT</i>	127
J.1.11	Probe position <i>PP</i>	127
J.1.12	Sampling error <i>SE</i>	128
J.1.13	Array boundaries <i>AB</i>	128
J.1.14	Phantom shell <i>PS</i>	129
J.1.15	Tissue-equivalent medium parameters <i>MAT</i>	129
J.1.16	Phantom homogeneity <i>HOM</i>	131
J.1.17	Measurement system immunity/secondary reception <i>MSI</i>	132
J.2	Uncertainty of reconstruction, corrections, and post-processing to be specified by the manufacturer <i>MN</i>	132
J.2.1	General	132
J.2.2	Evaluation of uncertainty due to reconstruction <i>REC</i>	132

J.2.3	Impact of noise on reconstruction <i>POL</i>	132
J.2.4	SAR averaging <i>SAV</i>	132
J.2.5	SAR scaling <i>SARS</i>	132
J.2.6	SAR correction for deviations in permittivity and conductivity <i>SC</i>	132
J.3	Measurement system uncertainties that are dependent on the DUT <i>MD</i>	132
J.3.1	General	132
J.3.2	Probe or probe-array coupling with the DUT <i>PC</i>	132
J.3.3	Modulation response <i>MOD</i>	133
J.3.4	Integration time <i>IT</i>	133
J.3.5	Measurement system drift and noise <i>DN</i>	133
J.4	Uncertainties related to the source or noise <i>ME</i>	133
J.4.1	General	133
J.4.2	Device holder <i>DH</i>	133
J.4.3	Device positioning <i>DP</i>	133
J.4.4	RF ambient conditions <i>AC</i>	134
J.4.5	Measurement system drift and noise <i>DN</i>	134
J.5	Uncertainties of validation antennas <i>MV</i>	134
J.5.1	General	134
J.5.2	Deviation of experimental antennas <i>DEX</i>	134
J.5.3	Power measurement uncertainty <i>PMU</i>	134
J.5.4	Other uncertainty contributions when using validation antennas <i>OVS</i>	134
	Bibliography.....	135
	Figure 1 – Evaluation plan checklist.....	15
	Figure 2 – Illustration of the shape and orientation relative to a curved phantom surface of the distorted cubic volume for computing psSAR	22
	Figure 3 – Measurements performed by shifting a large device over the efficient measurement area of the system including overlapping areas – in this case: six tests performed	24
	Figure 4 – Flow chart for SAR measurements of uncorrelated signals at different frequencies using a measurement system able to distinguish between different frequency components (Method 2)	27
	Figure 5 – Illustration of the amplitude spectrum, as function of frequency, for simultaneously transmitted signals of multiple frequency bands emitted by a DUT	28
	Figure 6 – Illustration of a completely covered signal bandwidth B_S by the measurement system analysis bandwidth B_a at single transmission mode	29
	Figure 7 – Illustration of a completely covered signal bandwidths B_{S_i} (for $i = 2$ to N) by the measurement system analysis bandwidth B_a for simultaneous multiple-frequency transmission mode.....	29
	Figure 8 – Illustration of a non-coverage of the signal bandwidths B_{S_i} (for $i = 2$ to N) by the measurement system analysis bandwidth B_a for simultaneous multiple-frequency transmission mode.....	29
	Figure 9 – Illustration of a partial-coverage of the signal bandwidths B_{S_i} (for $i = 2$ to N) by the measurement system analysis bandwidth B_a for simultaneous multiple-frequency transmission mode	30
	Figure 10 – Illustration of reduction of the measurement system analysis bandwidth B_a to cover only one signal bandwidth B_{S_i} (for $i = 1$ to N) for simultaneous multiple-frequency transmission mode	30
	Figure 11 – Illustration of increasing or moving the measurement system analysis bandwidth B_a to cover one or more signal bandwidth B_{S_i} (for $i = 1$ to N) for simultaneous multiple-frequency transmission mode.....	30

Figure A.1 – Sagittally-bisected phantom with extended perimeter, used for scanning measurement systems	41
Figure A.2 – Dimensions of the elliptical phantom	42
Figure C.1 – Coordinate system for 2D planar measurement-system	50
Figure C.2 – Generic configuration of SAR measurement system	50
Figure C.3 – Schematic representation of 2D planar measurement-based SAR system and its coordinate system	52
Figure C.4 – Source reconstruction from fields outside a phantom	53
Figure D.1 – Recommended power measurement setup for <i>system check</i> and <i>system validation</i>	56
Figure D.2 – Equipment setup for measurement of forward power P_f and forward coupled power P_{fc}	57
Figure D.3 – Equipment setup for measuring the shorted reverse coupled power P_{rcs}	58
Figure D.4 – Equipment setup for measuring the power with the reference antenna connected	58
Figure D.5 – Port numbering for the S -parameter measurements of the directional coupler	60
Figure D.6 – SAM masks for positioning dipole antennas and VPIFAs on the head phantoms, including holes where the antenna spacer is inserted	65
Figure D.7 – Flat masks for positioning VPIFAs on the flat phantoms, including a hole in the centre where the VPIFA spacer is inserted	66
Figure D.8 – Dipole showing the distance of $s = 15$ mm	67
Figure D.9 – 2-PEAK CPIFA showing the fixed distance of $s = 7$ mm	67
Figure D.10 – VPIFA positioned showing the fixed distance of $s = 2$ mm	68
Figure D.11 – <i>System check</i> and validation locations for the flat phantom	69
Figure D.12 – <i>System check</i> and validation locations for the head phantom	70
Figure D.13 – Definition of rotation angles for dipoles	71
Figure F.1 – Mechanical details of the standard dipole	87
Figure F.2 – VPIFA validation antenna	89
Figure F.3 – 2-PEAK CPIFA at 2 450 MHz	92
Figure F.4 – Detail of the tuning structure and matching structure	93
Figure G.1 – Measurement setup for waveguide calibration of dosimetric probe, and similar setup (same tissue-equivalent liquid, dielectric spacer, power sensors and coupler) for antenna calibration	95
Figure G.2 – Setup for calibration of a reference antenna	96
Figure G.3 – Method for the transfer of calibration between two antennas of the same type using the array system	103
Figure I.1 – Illustration of SAR measurement results during 8 h and the centred moving average	122
Table 1 – Evaluation plan checklist	16
Table 2 – Uncertainty budget template for the evaluation of the measurement system uncertainty of the 1 g or 10 g psSAR to be carried out by the system manufacturer	36
Table 3 – Uncertainty budget template for evaluating the uncertainty in the measured value of 1 g SAR or 10 g SAR from a DUT	37
Table 4 – Uncertainty budget template for evaluating the uncertainty in the measured value of 1 g SAR or 10 g SAR from a validation antenna	38

Table 5 – Uncertainty budget template for evaluating the uncertainty in the measured value of 1 g SAR or 10 g SAR from the <i>system check</i>	39
Table A.1 – Dielectric properties of the tissue-equivalent medium	43
Table B.1 – Uncertainty analysis for single-probe calibration in waveguide	45
Table B.2 – Uncertainty analysis for transfer calibration of array systems	46
Table B.3 – Uncertainty analysis of transfer calibration of array systems	48
Table D.1 – Example of power measurement uncertainty in %	60
Table D.2 – Modulations and multiplexing modes used by radio systems	64
Table D.3 – Peak spatial-average SAR (psSAR) averaged over 1 g and 10 g values for the flat phantom filled with tissue-equivalent medium for the antennas specified in Annex F	72
Table D.4 – Peak spatial-average SAR (psSAR) averaged over 1 g and 10 g values for antenna generating two peaks on the flat phantom filled with tissue-equivalent medium for the antennas specified in Annex F	73
Table D.5 – Peak spatial-average SAR (psSAR) averaged over 1 g and 10 g values on the head left and right phantom for the antennas specified in Annex F	74
Table D.6 – Peak spatial-average SAR (psSAR) averaged over 1 g and 10 g values for antenna generating two peaks on the head left and right phantom for the antennas specified in Annex F. Modulations are as specified in Table D.2	79
Table D.7 – Set of randomised tests for on-site <i>system validation</i> using flat phantom 1 g and 10 g psSAR, normalized to 1 W forward power, using the antennas specified in Annex F	79
Table D.8 – Set of tests for on-site <i>system validation</i> using left and right head phantoms for 1 g and 10 g psSAR for the antennas specified in Annex F	80
Table F.1 – Return loss values for antennas specified in Annex F and flat phantom filled with tissue-equivalent medium	85
Table F.2 – Mechanical dimensions of the reference dipoles	86
Table F.3 – Dimensions for VPIFA antennas at different frequencies	90
Table F.4 – Dielectric properties of the dielectric layers for VPIFA antennas	90
Table F.5 – Thickness of substrates and planar metallization	93
Table F.6 – Dielectric properties of FR4	93
Table F.7 – Values for the antenna dimensions in Figures F.4 and F.5	94
Table G.1 – Example uncertainty budget for reference dipole antenna calibration for 1 g and 10 g averaged SAR (750 MHz to 3 GHz)	99
Table G.2 – Example uncertainty budget for reference antenna calibration (PIFA) for 1 g and 10 g averaged SAR (750 MHz to 3 GHz)	100
Table G.3 – Example uncertainty budget for reference antenna (dipole) calibration for 1 g and 10 g averaged SAR (3 GHz to 6 GHz)	101
Table G.4 – Example uncertainty budget for the calibration of an antenna using the transfer method, as percentages	104
Table H.1 – Parameters of analytical reference functions and associated reference peak 10 g SAR value	109

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MEASUREMENT PROCEDURE FOR THE ASSESSMENT
OF SPECIFIC ABSORPTION RATE OF HUMAN EXPOSURE
TO RADIO FREQUENCY FIELDS FROM HAND-HELD AND
BODY-MOUNTED WIRELESS COMMUNICATION DEVICES –**

**Part 3: Vector measurement-based systems
(Frequency range of 600 MHz to 6 GHz)**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62209-3 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 International Standard is based on the following documents:

FDIS	Report on voting
106/494/FDIS	106/497/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

In this standard, the following print types are used:

- specific test protocols: in *italic* type.

This standard contains attached files in the form of four *.IGS files of inner and outer surfaces for the left and right halves extracted from the CAD model of the SAM phantom (see A.1.2). These files are available in the supporting documents folder at www.iec.ch/tc106/supportingdocuments.

This standard contains attached files for the analytical functions that are to be used for the evaluation of the reconstruction algorithm uncertainty in Table H.1. These files are available in the supporting documents folder at www.iec.ch/tc106/supportingdocuments.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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 document specifies the requirements for vector measurement-based systems to measure the Specific Absorption Rate (SAR) of devices that are used in close proximity to the human body or head.

Because SAR measurement systems are used for showing compliance with national and international exposure limits, the test procedures have to be standardized. This standardization aims at achieving comparable results for the equipment approval process.

Vector measurement-based systems and the associated protocols can differ from traditional SAR measurement systems and protocols. These systems use more advanced field reconstruction methods, allowing the application of indirect measurement approaches in which the SAR is evaluated in three dimensions from a limited number of measurement points that may be located in a limited part of the volume of interest, or even outside this volume. Such new SAR assessment approaches result in significantly reduced SAR measurement times.

This document is a preview generated by EVS

MEASUREMENT PROCEDURE FOR THE ASSESSMENT OF SPECIFIC ABSORPTION RATE OF HUMAN EXPOSURE TO RADIO FREQUENCY FIELDS FROM HAND-HELD AND BODY-MOUNTED WIRELESS COMMUNICATION DEVICES –

Part 3: Vector measurement-based systems (Frequency range of 600 MHz to 6 GHz)

1 Scope

This part of IEC 62209 specifies measurement protocols and test procedures for the reproducible measurement of peak spatial-average specific absorption rate (psSAR) induced inside a simplified model of a human head or body by radio-frequency (RF) transmitting devices, with a specified measurement uncertainty. Requirements are provided for psSAR assessment using vector measurement-based systems. Such systems determine the psSAR by three-dimensional (3D) field reconstruction within the volume of interest in accordance with the requirements herein for the measurement system, calibration, uncertainty assessment and validation methods. The protocols and procedures apply for the psSAR assessments covering a significant majority of people including children during use of wireless communication devices operated in close proximity to the head or body.

This document is applicable to wireless communication devices intended to be used at a position near the human head or body at distances up to and including 200 mm. This document may be employed to evaluate SAR compliance of different types of wireless communication devices used next to the ear, in front of the face, mounted on the body, combined with other RF-transmitting or non-transmitting devices or accessories (e.g. belt-clip), or embedded in garments. The overall applicable frequency range is from 600 MHz to 6 GHz.

The *system validation* procedures provided within this document cover frequencies from 600 MHz to 6 GHz.

With a vector measurement-based system this document can be employed to evaluate SAR compliance of different types of wireless communication devices.

The wireless communication device categories covered include but are not limited to mobile telephones, cordless microphones, auxiliary broadcast devices and radio transmitters in personal computers, desktop and laptop devices, multi-band, multi-antenna, and push-to-talk devices.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 62209-1:2016, *Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz)*