SLOVENSKI STANDARD
oSIST prEN IEC/IEEE 62704-4:2026

01-september-2026

Določanje največje prostorsko povprečene specifične hitrosti absorpcije (SAR) v človeškem telesu zaradi brezžičnih komunikacijskih naprav, 100 MHz do 10 GHz - 4. del: Splošne zahteve za uporabo metode končnih elementov za izračun SAR

Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communication devices, 100 kHz to 10 GHz - Part 4: General requirements for using the finite element method for SAR calculations

Ta slovenski standard je istoveten z: **prEN IEC/IEEE 62704-4:2026**

ICS:

13.280	Varstvo pred sevanjem	Radiation protection
17.220.20	Merjenje električnih in magnetnih veličin	Measurement of electrical and magnetic quantities
33.070.01	Mobilni servisi na splošno	Mobile services in general

oSIST prEN IEC/IEEE 62704-4:2026 **en**

106/735/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC/IEEE 62704-4 ED2**	
DATE OF CIRCULATION: **2026-05-29**	CLOSING DATE FOR VOTING: **2026-08-21**
SUPERSEDES DOCUMENTS:	

IEC TC 106 : METHODS FOR THE ASSESSMENT OF ELECTRIC, MAGNETIC AND ELECTROMAGNETIC FIELDS ASSOCIATED WITH HUMAN EXPOSURE	
SECRETARIAT: Germany	SECRETARY: Mr Alexander Prokop
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 9,TC 27,TC 29,TC 34,SC 62A,SC 62B,TC 69,TC 77,TC 78,TC 96,TC 100,TC 124,TC 125,CISPR	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED: Safety	
☒ SUBMITTED FOR CENELEC PARALLEL VOTING **Attention IEC-CENELEC parallel voting** The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any relevant “In Some Countries” clauses to be included should this proposal proceed. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (SEE AC/22/2007 OR NEW GUIDANCE DOC).

TITLE:

Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communication devices, 100 kHz to 10 GHz - Part 4: General requirements for using the finite element method for SAR calculations</p>

PROPOSED STABILITY DATE: 2029

NOTE FROM TC/SC OFFICERS:

This CDV of IEC/IEEE 62704-4 Ed2 reflects the changes that have been made to the already approved IEC/IEEE 62704-1 Ed2. Therefore, no critical comments are expected and it is intended to publish IEC/IEEE 62704-4 Ed2 after the CDV is approved.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

DETERMINING THE PEAK SPATIAL-AVERAGE SPECIFIC ABSORPTION RATE (SAR) IN THE HUMAN BODY FROM WIRELESS COMMUNICATION DEVICES, 100 kHZ TO 10 GHZ –

Part 4: General requirements for using the finite element method for SAR calculations

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.

   IEEE Standards documents are developed within IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through a consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of IEEE and serve without compensation. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards. Use of IEEE Standards documents is wholly voluntary. IEEE documents are made available for use subject to important notices and legal disclaimers (see http://standards.ieee.org/IPR/disclaimers.html for more information).

   IEC collaborates closely with IEEE 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. The formal decisions of IEEE on technical matters, once consensus within IEEE Societies and Standards Coordinating Committees has been reached, is determined by a balanced ballot of materially interested parties who indicate interest in reviewing the proposed standard. Final approval of the IEEE standards document is given by the IEEE Standards Association (IEEE-SA) Standards Board.
3) IEC/IEEE Publications have the form of recommendations for international use and are accepted by IEC National Committees/IEEE Societies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC/IEEE 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 (including IEC/IEEE Publications) transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC/IEEE Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC and IEEE do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC and IEEE are 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 IEEE or their directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees, or volunteers of IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board, 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/IEEE Publication or any other IEC of IEEE 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/IEEE Publication may require use of material covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. IEC or IEEE shall not be held responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patent Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

International Standard IEC/IEEE 62704-4 has been prepared by IEC technical committee TC 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure, in cooperation with International Committee on Electromagnetic Safety of the IEEE Standards Association, under the IEC/IEEE Dual Logo Agreement.

This publication is published as an IEC/IEEE Dual Logo standard.

This edition includes the following significant technical changes with respect to the previous edition:

a) specification of a SAR averaging algorithm for the calculation of the psSAR from computational results for arbitrarily shaped homogeneous phantoms, which avoids inconsistencies with respect to the algorithm for SAR averaging algorithm specified in IEC/IEEE 62209-1528:2020 for measurement methods;
b) provision of SHA-256 checksums for all supplemental files.

This standard contains attached files in the form of CAD models and reference results described in Annex B. Download links and checksums for these files can be found in Annex D.

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

FDIS	Report on voting
106/###/FDIS	106/###/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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

A list of all parts in the IEC/IEEE 62704 series, published under the general title *Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 100 kHz to 10 GHz*, can be found on the IEC website.

Future documents in this series will carry the new general title as listed in the preceding paragraph. Titles of existing documents in this series will be updated at the time of the next edition.

The IEC technical committee and IEEE technical committee have 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

Finite element methods have reached a level of maturity that allows their application in specific absorption rate (SAR) assessment of professional-use and consumer-use wireless communication devices. In the recent past, SAR compliance assessment for small transmitters was performed almost exclusively using measurements. Some wireless communication devices are used in situations where laboratory SAR assessment is extremely complex or not possible at all. The benefits of consensus standards to users and regulators include standardized and accepted protocols, verification and validation techniques, benchmark data, reporting format and means for estimating the overall assessment uncertainty in order to produce valid, repeatable, and reproducible data.

The purpose of this document is to specify computational techniques and models to determine peak spatial-average specific absorption rates (SAR). SAR will be determined by applying finite element method computations of the electromagnetic field conditions produced by wireless communication devices in models of the human anatomy. Intended users of this document are (but are not limited to) wireless communication device manufacturers, service providers for wireless communication that are required to certify that their products comply with the applicable SAR limits, and government agencies.

Several methods described in this document are based on techniques specified in IEC/IEEE 62704-1:2025.

DETERMINING THE PEAK SPATIAL-AVERAGE SPECIFIC ABSORPTION RATE (SAR) IN THE HUMAN BODY FROM WIRELESS COMMUNICATION DEVICES, 100 kHZ TO 10 GHZ –

Part 4: General requirements for using the finite element method for SAR calculations

1 Scope

This part of IEC/IEEE 62704 describes the concepts, techniques, and limitations of the finite element method (FEM) and specifies models and procedures for verification, validation and uncertainty assessment for the FEM when used for determining the peak spatial-average specific absorption rate (psSAR) in phantoms or anatomical models. It recommends and provides guidance on the modelling of wireless communication devices, and provides benchmark data for simulating the SAR in such phantoms or models.

This document does not recommend specific SAR limits because these are found elsewhere (e.g. in IEEE Std C95.1 [1][1] or in the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [2]).

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/IEEE 62209-1528:2020, *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: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)*

IEC/IEEE 62704-1:2025, *Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 100 kHz to 10 GHz – Part 1: General requirements for using the finite-difference time-domain (FDTD) method for SAR calculations*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO, IEC, and IEEE maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp
- IEEE Dictionary Online: available at https://ieeexplore.ieee.org/browse/standards/dictionary

[1] Numbers in square brackets refer to the Bibliography.

3.1
mesh
<finite-difference time-domain method> discrete representation of the simulation model as a set of voxels in a regular three-dimensional Cartesian arrangement

Note 1 to entry: In the scientific literature, the mesh is often referred to as a "grid."

[SOURCE: IEC/IEEE 62704-1:2025, 3.17, modified – The specific context "<finite-difference time-domain method>" has been added.]

3.2
mesh
<finite element method> discrete representation of the simulation model as a set of tetrahedral elements in an irregularly three-dimensional arrangement

Note 1 to entry: In the scientific literature, the mesh is often referred to as a "grid."

3.3
element
smallest three-dimensional part of a mesh

EXAMPLE A voxel or a tetrahedron.

3.4
subregion
spatially limited three-dimensional region within a computational domain

4 Abbreviated terms

ASCII	American Standard Code for Information Interchange
BVP	boundary value problem
DoF	degrees of freedom
DUT	device under test
FDTD	finite-difference time-domain
FEM	finite element method
PDE	partial differential equation
PEC	perfect electric conductor
PMC	perfect magnetic conductor
psSAR	peak spatial-average specific absorption rate
SAR	specific absorption rate
SI	international system of units
TVFE	tangential vector finite elements

5 Finite element method

5.1 Description

This document describes applications of the finite element method (FEM) to calculate the specific absorption rate (SAR). Reasons for using FEM include its proven track record in a broad range of electromagnetic applications, and its ability to use an unstructured, usually tetrahedral, mesh that conforms to complicated geometries, employing arbitrarily small elements where needed and larger elements elsewhere.

Multiple ways exist to solve Maxwell’s equations with FEM. Implementations can be based on field quantities or on potential quantities, and may be formulated using either the weighted residual method or the variational method [3], [4]. The weighted residual method starts directly from the partial differential equation (PDE) of the boundary value problem, whereas the variational method starts from the variational representation of the boundary value problem. All implementations have the following in common:

a) They are based on PDEs, not on integral equations. The PDEs are derived from Maxwell's equations augmented by proper boundary conditions in order to frame a well-defined boundary value problem on a finite computational domain.
b) The size of the computational domain is finite. Radiation towards infinity is implemented through an open boundary condition on its outer boundaries. Radiated fields outside the domain can be computed by integrating over a boundary that encloses the radiating structure.
c) After applying excitations and boundary conditions and discretizing the computational domain into a mesh, the derived PDE is transformed into a matrix equation in which the matrix is large, sparse, and banded. "Large" is a consequence of having a large number of unknowns, several per element on a large mesh. "Sparse" and "banded" are consequences of the fact that all interactions are formulated as local interactions.
d) In the limit of infinitesimally small elements, the solution approaches the exact solution of the PDE.

Annex A contains more information on FEM, along with references to literature and a discussion of its limitations. Clause 8 describes a set of tests is described that shall be used to verify whether a particular implementation of FEM is correct and sufficiently accurate to be used for SAR calculations.

This document refers to Nédélec elements of the first kind, which are polynomially exact up to order 0 (H_0(curl) or edge elements) as lowest order; up to order 1 (H_1(curl) elements) as second lowest order; and up to order 2 (H_2(curl) elements) as third lowest order [5]. If an implementation of the FEM is applied with one of these orders, the respective parts of the code verification shall be executed with this order.

5.2 Requirements on the implementation of the FEM

The implementation of the FEM shall follow the definition in 5.1. Moreover, it shall implement SAR calculation and averaging according to Clause 6. The implementation of the FEM shall be verified according to Clause 8.

6 SAR calculation and averaging

6.1 General

The local specific absorption rate (SAR) in a location in tissue is given in Formula (1):

$$SAR = \frac{\sigma E^2}{2\rho} \tag{1}$$

where ρ is the mass density of the tissue, E is the magnitude of the electric field vector, and σ is the electric conductivity. Since the local SAR can vary strongly with position, the quantity of interest is often the peak spatial-average SAR averaged over a cubical volume.

NOTE The spatial-average SAR (sSAR) is averaged over a specified mass with a specified volume, e.g. 1 g or 10 g of tissue in the shape of a cube as required by FCC and [1], [2].

6.2 SAR averaging

6.2.1 General

The objective of the methods to evaluate the psSAR described here is to yield results that correspond to the methods and definitions of Subclause 6.3 of IEC/IEEE 62704-1:2025, which describes the computation of the psSAR a) in cubical volumes aligned with a rectangular mesh (6.2.2) and b) in cubical volumes following the orientation of the surfaces of arbitrarily shaped phantoms filled with homogeneous tissue simulant (6.2.3). Depending on the phantom or body model or on the application, one of these two algorithms shall be applied to calculate the psSAR using FEM simulations within this document.

NOTE An example of a phantom filled with homogeneous tissue simulant is the SAM phantom specified in IEC/IEEE 62209-1528:2020. Its surface follows the shape of a human head.

6.2.2 Evaluation of psSAR aligned with a Cartesian mesh on an FEM mesh

6.2.2.1 General

Since the algorithm for the computation of the psSAR in cubical volumes aligned with the mesh in IEC/IEEE 62704-1:2025 is specified for rectilinear meshes with varying mesh step, the vector components of the electric fields, the conductivity, and the mass density of the finite element mesh shall be resampled on a Cartesian mesh. The resampling is carried out with increasingly fine mesh steps until convergence of the dissipated power is reached in the regions where local SAR maxima are located. In order to reduce the computation time for the iterative resampling and SAR averaging, subregions with local SAR maxima are identified in a pre-scan. In these subregions, the psSAR is then calculated according to Subclauses 6.3.1 (aligned) or 6.3.2 (homogeneous) of IEC/IEEE 62704-1:2025. The maximum psSAR of all subregions shall be reported as the psSAR maximum together with its interpolation uncertainty.

The following steps shall be carried out to resample the geometry and the power density in a set of regions around local SAR maxima for the application of the SAR averaging algorithms of IEC/IEEE 62704-1:2025.

a) Specify an orientation of a rectilinear mesh relative to the coordinate system of the FEM mesh considering the relevant features of the model; this orientation shall align with surface planes or conducting planes of the phantom or of the DUT.

b) Iteratively resample the geometry and local SAR distribution in the rectilinear mesh and evaluate psSAR at each iteration until convergence is achieved (see 6.2.2.2).

c) Report the highest psSAR of all subregions together with its interpolation uncertainty.

6.2.2.2 Calculation of the aligned psSAR on an iteratively refined rectangular mesh

The aligned psSAR according to 6.3.1 IEC/IEEE 62704-1:2025 shall be evaluated on a rectilinear mesh that encompasses a region around a local SAR maximum with individual equidistant mesh steps for each axis. Each mesh cell is assigned the local distribution of the dissipated power, the conductivity, and the mass density.

a) The mass density for each mesh cell shall be assigned by nearest-neighbour interpolation of the mass density distribution of the tetrahedral mesh.

b) The conductivity for each mesh cell shall be assigned by nearest-neighbour interpolation of the mass density distribution of the tetrahedral mesh.

c) In the mesh cells that have a mass density different from zero, the dissipated power density is calculated by evaluating the electric field of the finite element mesh in the centre of the mesh cell of the rectilinear mesh.

d) The initial mesh step length Δ_0 for each axis of the rectilinear mesh shall be calculated in accordance with Formula (2):