

---

**Ocenjevanje gostote moči izpostavljenosti človeka radiofrekvenčnim poljem brezžičnih naprav v neposredni bližini glave in telesa (frekvenčno območje 6 GHz do 300 GHz) - 2. del: Izračunski postopek**

Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz) - Part 2: Computational procedure

Bewertung der Leistungsdichte der Exposition des Menschen gegenüber hochfrequenten Feldern von drahtlosen Geräten in unmittelbarer Nähe des Kopfes und des Körpers (Frequenzbereich von 6 GHz bis 300 GHz) - Teil 2: Berechnungsverfahren

Évaluation de la densité de puissance de l'exposition humaine aux champs radiofréquences provenant de dispositifs sans fil à proximité immédiate de la tête et du corps (plage de fréquences de 6 GHz à 300 GHz) - Partie 2: Procédure de calcul

**Ta slovenski standard je istoveten z: EN IEC/IEEE 63195-2:2023**

**ICS:**

17.220.20	Merjenje električnih in magnetnih veličin	Measurement of electrical and magnetic quantities
-----------	---	---

**SIST EN IEC/IEEE 63195-2:2025** en



EUROPEAN STANDARD

EN IEC/IEEE 63195-2

NORME EUROPÉENNE

EUROPÄISCHE NORM

January 2023

ICS 17.220.20

English Version

Assessment of power density of human exposure to radio  
frequency fields from wireless devices in close proximity to the  
head and body (frequency range of 6 GHz to 300 GHz) - Part 2:  
Computational procedure  
(IEC/IEEE 63195-2:2022)

Évaluation de la densité de puissance de l'exposition  
humaine aux champs radiofréquences provenant de  
dispositifs sans fil à proximité immédiate de la tête et du  
corps (plage de fréquences de 6 GHz à 300 GHz) - Partie  
2: Procédure de calcul  
(IEC/IEEE 63195-2:2022)

Bewertung der Leistungsdichte der Exposition des  
Menschen gegenüber hochfrequenten Feldern von  
drahtlosen Geräten in unmittelbarer Nähe des Kopfes und  
des Körpers (Frequenzbereich von 6 GHz bis 300 GHz) -  
Teil 2: Berechnungsverfahren  
(IEC/IEEE 63195-2:2022)

This European Standard was approved by CENELEC on 2023-01-09. 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, Türkiye 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

**EN IEC/IEEE 63195-2:2023 (E)****European foreword**

This document (EN IEC/IEEE 63195-2:2023) consists of the text of document IEC/IEEE 63195-2:2022, prepared by IEC/TC 106 "Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure".

The following dates are fixed:

- latest date by which this document has to be (dop) 2024-01-09 implemented at national level by publication of an identical national standard or by endorsement
- latest date by which the national standards (dow) 2026-01-09 conflicting with this document have to be withdrawn

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.

This document has been prepared under a Standardization Request given to CENELEC by the European Commission and the European Free Trade Association.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

iteh Standards

(<https://standards.iteh.ai>)

**Endorsement notice**

Document Preview

The text of the International Standard IEC/IEEE 63195-2:2022 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 standard indicated:

IEC/IEEE 62209-1528:2020 NOTE Harmonized as EN IEC/IEEE 62209-1528:2021 (not modified)

## 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](http://www.cenelec.eu).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC/IEEE 62704-1	2017	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	-	-
IEC/IEEE 62704-4	2020	Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communication devices, 30 MHz to 6 GHz - Part 4: General requirements for using the finite element method for SAR calculations	-	-
IEC/IEEE 63195-1	2022	Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz) - Part 1: Measurement procedure	EN IEC/IEEE 63195-1	2023
IEEE 145	-	Definitions of terms for antennas	-	-





IEC/IEEE 63195-2

Edition 1.0 2022-05

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz) – Part 2: Computational procedure**

**Évaluation de la densité de puissance de l'exposition humaine aux champs radiofréquences provenant de dispositifs sans fil à proximité immédiate de la tête et du corps (plage de fréquences de 6 GHz à 300 GHz) – Partie 2: Procédure de calcul**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 17.220.20

ISBN 978-2-8322-0184-8

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references .....	9
3 Terms and definitions .....	10
3.1 Exposure metrics and parameters.....	10
3.2 Spatial, physical, and geometrical parameters associated with exposure metrics.....	11
3.3 Test device technical operating and antenna parameters .....	13
3.4 Computational parameters .....	13
3.5 Uncertainty parameters.....	14
4 Symbols and abbreviated terms.....	14
4.1 Symbols.....	14
4.1.1 Physical quantities.....	14
4.1.2 Constants .....	15
4.2 Abbreviated terms.....	15
5 Overview and application of this document.....	16
5.1 Overview of the numerical evaluation.....	16
5.2 Application of this document .....	17
5.3 Stipulations.....	18
6 Requirements on the numerical software .....	18
7 Model development and validation.....	19
7.1 General.....	19
7.2 Development of the numerical model of the DUT.....	19
7.3 Power normalization .....	20
7.4 Requirements on the experimental test equipment for model validation.....	22
7.4.1 General .....	22
7.4.2 Ambient conditions and device holder.....	23
7.4.3 Power measurement.....	23
7.5 Testing configurations for the validation of the DUT model.....	24
7.5.1 General .....	24
7.5.2 Tests to be performed.....	24
7.5.3 Determining the validity of the DUT model .....	25
7.5.4 Test reduction for additional DUTs.....	25
8 Power density computation and averaging.....	26
8.1 Evaluation surface .....	26
8.2 Tests to be performed and DUT configurations .....	26
8.2.1 General .....	26
8.2.2 Devices with a single radiating element or with multiple elements that do not operate simultaneously .....	27
8.2.3 Devices with antenna arrays or sub-arrays .....	27
8.2.4 Devices with multiple antennas or multiple transmitters .....	28
8.3 Considerations on the evaluation surface and dimensions of the computational domain .....	29
8.4 Averaging of power density on an evaluation surface.....	29
8.4.1 General .....	29
8.4.2 Construction of the averaging area on an evaluation surface.....	30

8.5	Computation of $sPD$ by integration of the Poynting vector.....	31
8.5.1	General .....	31
8.5.2	Surface-normal propagation-direction power density into the evaluation surface, $sPD_{n+}$ .....	31
8.5.3	Total propagating power density into the evaluation surface, $sPD_{tot+}$ .....	32
8.5.4	Total power density directed into the phantom considering near-field exposure, $sPD_{mod+}$ .....	32
8.6	Software .....	33
9	Uncertainty evaluation .....	33
9.1	General.....	33
9.2	Uncertainty of the $sPD$ and of the $mpsPD$ due to the computational parameters .....	33
9.2.1	Uncertainty contributions due to the computational parameters .....	33
9.2.2	Mesh resolution .....	34
9.2.3	Absorbing boundary conditions .....	35
9.2.4	Power budget .....	35
9.2.5	Model truncation.....	35
9.2.6	Convergence .....	35
9.2.7	Dielectric properties.....	36
9.2.8	Lossy conductors.....	36
9.3	Uncertainty contribution of the computational representation of the DUT model .....	36
9.4	Uncertainty of the maximum exposure evaluation .....	37
9.5	Uncertainty budget.....	38
10	Reporting .....	39
Annex A (normative)	Code verification .....	41
A.1	General.....	41
A.2	Interpolation and superposition of vector field components .....	41
A.3	Computation of the far-field pattern and the radiated power .....	43
A.4	Implementation of lossy conductors .....	43
A.5	Implementation of anisotropic dielectrics.....	46
A.6	Computation of the $sPD$ and $psPD$ .....	47
A.6.1	General .....	47
A.6.2	Planar surfaces .....	49
A.6.3	Non-planar surfaces .....	50
A.7	Implementation of the field extrapolation according to the surface equivalence principle .....	52
Annex B (informative)	Experimental evaluation of the radiated power .....	53
B.1	General.....	53
B.2	Direct conducted power measurements.....	53
B.3	Radiated power measurement methods .....	54
B.4	Information provided by the DUT.....	54
Annex C (normative)	Maximum-exposure evaluation techniques .....	55
C.1	General.....	55
C.2	Evaluation of EM fields radiated by each antenna element.....	55
C.3	Evaluation of the $mpsPD$ by superposition of individual EM fields .....	56
C.3.1	General .....	56
C.3.2	Maximization over the entire codebook by exhaustive search .....	56
C.3.3	Optimization with fixed total conducted power.....	56

C.3.4	Optimization with fixed power at each port.....	56
Annex D (informative)	Examples of the implementation of power density averaging algorithms.....	58
D.1	Example for the evaluation of the $psPD$ on a planar surface .....	58
D.1.1	General .....	58
D.1.2	Evaluation of the $psPD$ by direct construction of the averaging area.....	58
D.1.3	Example for the efficient evaluation of the $psPD$ using an equidistant mesh on the evaluation surface .....	59
D.2	Example for the evaluation of the $psPD$ on a non-planar surface .....	60
Annex E (informative)	File format for exchange of field data .....	62
Annex F (informative)	Rationales of the methods applied in IEC/IEEE 63195-1 and this document.....	64
F.1	Frequency range.....	64
F.2	Computation of $sPD$ .....	64
F.2.1	Application of the Poynting vector for computation of incident power density.....	64
F.2.2	Averaging area .....	65
Annex G (informative)	Square averaging area on non-planar evaluation surfaces .....	66
G.1	General.....	66
G.2	Example implementation for the evaluation of the $psPD$ on a non-planar surface using square-shaped averaging area.....	66
Annex H (informative)	Validation of the maximum-exposure evaluation techniques .....	67
H.1	General.....	67
H.2	Validation of the exhaustive search.....	67
H.2.1	Validation of the exhaustive search .....	67
H.2.2	Validation using reconstruction method .....	67
H.2.3	Validation of optimization with fixed total conducted power or with fixed power at each port.....	67
H.2.4	Validation of the maximum-exposure evaluation of measurement results .....	67
H.3	Example validation source for maximum-exposure evaluation validation .....	68
H.3.1	Description .....	68
H.3.2	Positioning.....	70
H.3.3	Nominal codebook, uncertainty and conducted power $P_R$ .....	71
H.3.4	Target values.....	71
Annex I (normative)	Supplemental files and their checksums .....	73
Bibliography	.....	74
Figure 1	– Overview of the numerical power density evaluation procedure.....	17
Figure 2	– Power reference planes .....	22
Figure 3	– Example for configurations of radiating elements as different antenna sub-arrays on the same DUT .....	27
Figure 4	– Flow chart for the evaluation of power density for DUTs with antenna arrays or sub-arrays as described in 8.2.3 .....	28
Figure 5	– Example of the construction of the averaging area within a sphere with fixed radius according to 8.4 .....	31
Figure A.1	– Configuration of three $\lambda/2$ dipoles, $D_1$ , $D_2$ , and $D_3$ , for the evaluation of the interpolation and superposition of the electric field and magnetic field components.....	42
Figure A.2	– R320 waveguide .....	45

Figure A.3 – Cross section of the R320 waveguide showing the locations of the $E_y$ components to be recorded.....	46
Figure A.4 – $S_i(x,y)$ computed with Formula (A.4) for the six parameter sets of Table A.6 normalized to their maxima .....	49
Figure A.5 – Cross sections of the symmetric quarters of the testing geometries (SAR Stars) for the benchmarking of the power density averaging algorithm.....	51
Figure A.6 – Areas for the computation of the $sPD$ on a cone of the SAR Star.....	51
Figure D.1 – Rotated averaging area on the discretized evaluation surface (base mesh) .....	60
Figure D.2 – Reduction of the area of triangles that are partially included in the averaging sphere .....	61
Figure H.1 – Main dimensions of patch array stencil .....	69
Figure H.2 – Main dimensions of the validation device, including polypropylene casing .....	70
Figure H.3 – Validation device with SAM head in the tilt position .....	70
Figure H.4 – Validation device with SAM head in the touch position.....	71
Table 1 – Budget of the uncertainty contributions of the computational algorithm for the validation setup or testing setup .....	34
Table 2 – Budget of the uncertainty of the developed model of the DUT .....	37
Table 3 – Computational uncertainty budget .....	38
Table A.1 – Interpolation and superposition of vector field components; maximum permissible deviation from the reference results is 10 % .....	42
Table A.2 – Computation of $P_R$ ; maximum permissible deviation from the reference results is 10 % for the radiated power and for the electric field amplitude of the far-field pattern .....	43
Table A.3 – Minimum fine and coarse mesh step for used method .....	46
Table A.4 – Results of the evaluation of the computational dispersion characteristics.....	46
Table A.5 – Results of the evaluation of the representation of anisotropic dielectrics .....	47
Table A.6 – Parameters for the incident power density distribution of Formula (A.4) .....	48
Table B.1 – Comparison of the experimental methods for the evaluation of the radiated power .....	53
Table H.1 – Main dimensions for the patch array stencil .....	68
Table H.2 – Main dimensions of the validation device .....	68
Table H.3 – Target values for validation device with the nominal codebook.....	72
Table H.4 – Target values for validation device with infinite codebook .....	72

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ASSESSMENT OF POWER DENSITY OF HUMAN EXPOSURE TO RADIO  
FREQUENCY FIELDS FROM WIRELESS DEVICES IN CLOSE PROXIMITY  
TO THE HEAD AND BODY (FREQUENCY RANGE OF 6 GHz TO 300 GHz) –****Part 2: Computational procedure**

## 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 document(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, approved by the American National Standards Institute, 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. This Dual Logo International Standard was jointly developed by the IEC and IEEE under the terms of that agreement.

- 2) The formal decisions 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 or IEEE 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 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 or 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 implementation 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.

IEC/IEEE 63195-2 was prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure, in cooperation with the International Committee on Electromagnetic Safety (ICES) of the IEEE Standards Association, under the IEC/IEEE Dual Logo Agreement between IEC and IEEE. It is an International Standard.

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

This publication contains supplemental files that are required for the code verification according to Annex A. Download links and checksums for these files can be found in Annex I.

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

Draft	Report on voting
106/564/FDIS	106/569/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

A list of all parts in the IEC/IEEE 63195 series, published under the general title *Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body*, can be found on the IEC website.

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

**IMPORTANT – The "colour inside" logo on the cover page of this document 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 provides a method to evaluate the human exposure from wireless devices using computational methods. This document was developed to provide procedures for the numerical modelling and evaluation of such wireless devices operating close to the head, held in the hand or in front of the face, mounted on the body or embedded in garments. It applies to individual transmitters as well as to transmitters operating simultaneously with other transmitters within a product. The choice of technique, i.e. FDTD or FEM, is optional but can be influenced by the application. The advantages of computational procedures include the capability to provide repeatable, non-intrusive methods for determining exposure in or near an object and without the need for expensive hardware equipment. Device categories covered include but are not limited to mobile telephones, radio transmitters in personal computers, desktop and laptop devices, and multi-band and multi-antenna devices. This document specifies:

- requirements on the numerical software (Clause 5);
- model development and validation (Clause 7);
- power density computation and averaging (Clause 8);
- uncertainty evaluation (Clause 9);
- reporting requirements (Clause 10).

To develop this document, IEC Technical Committee 106 (TC 106) and IEEE International Committee on Electromagnetic Safety (ICES), Technical Committee 34 (TC 34) Subcommittee 1 (SC 1) formed Joint Working Group 11 (JWG 11) on computational methods to assess the power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body.

(<https://standards.iteh.ai>)  
Document Preview

[SIST EN IEC/IEEE 63195-2:2025](https://standards.iteh.ai/catalog/standards/sist/52bb735c-e0dd-4de4-ace8-29ae44c027f5/sist-en-iec-ieee-63195-2-2025)

<https://standards.iteh.ai/catalog/standards/sist/52bb735c-e0dd-4de4-ace8-29ae44c027f5/sist-en-iec-ieee-63195-2-2025>