



SLOVENSKI STANDARD
oSIST prEN IEC 63184:2023
01-oktober-2023

Ocenjevanje izpostavljenosti ljudi sistemu brezžičnega prenosa energije z električnim in magnetnim poljem - Modeli, instrumenti, meritve ter računalniške metode in postopki (frekvenčno območje od 3 kHz do 30 MHz)

Assessment Methods of the Human Exposure to Electric and Magnetic Fields from Wireless Power Transfer Systems - Models, Instrumentation, Measurement and Computational Methods and Procedures (Frequency Range of 3 kHz to 30 MHz)

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Ta slovenski standard je istoveten z: prEN IEC 63184:2023

ICS:

17.220.20	Merjenje električnih in magnetnih veličin	Measurement of electrical and magnetic quantities
17.240	Merjenje sevanja	Radiation measurements

oSIST prEN IEC 63184:2023 **en**



106/612/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC/IEEE 63184 ED1

DATE OF CIRCULATION:

2023-08-25

CLOSING DATE FOR VOTING:

2023-11-17

SUPERSEDES DOCUMENTS:

106/586/CD, 106/597A/CC

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 26,TC 27,TC 34,SC 62A,SC 62B,TC 69,TC 77,TC 78,TC 96,TC 100,TC 124,TC 125,CISPR

PROPOSED HORIZONTAL STANDARD:

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TITLE:

Assessment Methods of the Human Exposure to Electric and Magnetic Fields from Wireless Power Transfer Systems – Models, Instrumentation, Measurement and Computational Methods and Procedures (Frequency Range of 3 kHz to 30 MHz)

PROPOSED STABILITY DATE: 2030

NOTE FROM TC/SC OFFICERS:

Title corrected.

IEC/IEEE 63184 ED1 replaces IEC PAS 63184 ED1

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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295 IEC/IEEE 63184 was prepared by IEC technical committee 106: Methods for the assessment of
 296 electric, magnetic and electromagnetic fields associated with human exposure, in cooperation
 297 with the International Committee on Electromagnetic Safety of the IEEE Standards Association,
 298 under the IEC/IEEE Dual Logo Agreement between IEC and IEEE. It is an International
 299 Standard.

300 This first edition replaces IEC PAS 63184 ED1, published in 2021

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

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

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

303 Full information on the voting for its approval can be found in the report on voting indicated in
 304 the above table.
 305

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

307 This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2,
 308 available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC
 309 are described in greater detail at www.iec.ch/publications/.

310 The IEC Technical Committee and IEEE Technical Committee have decided that the contents
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 312 under webstore.iec.ch in the data related to the specific document. At this date, the document
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- 314 • reconfirmed,
- 315 • withdrawn,
- 316 • replaced by a revised edition, or
- 317 • amended.

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INTRODUCTION

322 The wireless power transmission systems described in the scope of this document require
323 particularly developed procedures and protocols for the assessment of human exposure. Such
324 systems are increasingly being implemented in a wide range of applications at different
325 frequency ranges from consumer electronics (e.g. mobile phones, tablet PCs) to automotive
326 (electric vehicles). Human exposure to electric and magnetic fields is limited to avoid
327 established adverse health effects, including electrostimulation of nervous tissues
328 (3 kHz < 10 MHz) and thermal effects (> 100 kHz). A published ITU-R report (ITU-R SM.2303-3
329 [1]¹) on WPT systems describes RF exposure assessment methodologies, yet no definitive
330 assessment method was introduced. An exposure assessment method of WPT for EV charging
331 systems was described in IEC 61980-3:2022 [2]; however, there are currently no other detailed
332 product standards related to WPT systems. Because WPT systems will continue to become
333 ubiquitous in a multitude of applications in the future, IEC and IEEE established a joint working
334 group to address WPT system assessment methods related to human exposures to electric,
335 magnetic, and electromagnetic fields.

336 In this document, prepared by IEC Technical Committee 106 (TC 106) and Technical Committee
337 34 (TC 34) Subcommittee 1 (SC 1) of IEEE International Committee on Electromagnetic Safety
338 (ICES), the basic methods to assess the direct and indirect effects of exposure to WPT systems,
339 case studies, and relevant research are described. These methods mainly focus on frequencies
340 between 3 kHz and 30 MHz and consider both electrostimulation and thermal effects. This
341 document specifies:

- 342 • general conformity assessment procedures (Clause 5);
- 343 • measurement methods (Clause 6);
- 344 • computational assessment methods (Clause 7);
- 345 • assessment combining experimental and computational methods (Clause 8).

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¹ Numbers in square brackets refer to the Bibliography.

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ASSESSMENT METHODS OF THE HUMAN EXPOSURE TO ELECTRIC AND MAGNETIC FIELDS FROM WIRELESS POWER TRANSFER SYSTEMS – MODELS, INSTRUMENTATION, MEASUREMENT AND COMPUTATIONAL METHODS AND PROCEDURES (FREQUENCY RANGE OF 3 kHz TO 30 MHz)

1 Scope

356 The objective of this document is to specify the assessment methods to evaluate exposure to
357 stationary wireless power transfer (WPT) systems with electromagnetic human exposure
358 guidelines (specific absorption rate (SAR), internal electric fields, or current density, including
359 contact currents). The frequency range covered by this document is from 3 kHz to 30 MHz. This
360 version of the document focuses on exposures from inductive WPT systems. Future versions
361 will consider extended guidance for assessments of exposure from capacitive WPT systems.

2 Normative references

363 The following documents are referred to in the text in such a way that some or all of their content
364 constitutes requirements of this document. For dated references, only the edition cited applies.
365 For undated references, the latest edition of the referenced document (including any
366 amendments) applies.

367 ISO/IEC Guide 98-1:2009, *Uncertainty of measurement – Part 1: Introduction to the expression*
368 *of uncertainty in measurement*

369 ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of*
370 *uncertainty in measurement (GUM:1995)*

371 IEC 61786-1:2013, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz*
372 *to 100 kHz with regard to exposure of human beings – Part 1: Requirements for measuring*
373 *instruments*

374 IEC 61786-2:2014, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz*
375 *to 100 kHz with regard to exposure of human beings – Part 2: Basic standard for measurements*

376 IEC/IEEE 62704-1:2017, *Determining the peak spatial-average specific absorption rate (SAR)*
377 *in the human body from wireless communications devices, 30 MHz to 6 GHz – Part 1: General*
378 *requirements for using the finite difference time-domain (FDTD) method for SAR calculations*

379 IEC/IEEE 62704-4:2020, *Determining the peak spatial-average specific absorption rate (SAR)*
380 *in the human body from wireless communications devices, 30 MHz to 6 GHz – Part 4: General*
381 *requirements for using the finite element method for SAR calculations*

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3 Terms and definitions

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

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

- 388 • IEC Electropedia: available at <http://www.electropedia.org/>
- 389 • ISO Online browsing platform: available at <http://www.iso.org/obp>

- 390 • IEEE Dictionary Online: available at <http://dictionary.ieee.org>

391 **3.1**

392 **exposure**

393 <of a body> situation that occurs wherever a person is subjected to electric, magnetic, or
394 electromagnetic fields

395 **3.2**

396 **basic restriction**

397 **BR**

398 maximum permissible field level induced in the body of a person exposed to electric, magnetic
399 or electromagnetic fields below which established adverse health effects are assumed not to
400 occur

401 Note 1 to entry: Examples of basic restrictions can be found in ICNIRP Guidelines [3], [4], [5] and in Annex II of the
402 Council Recommendation 1999/519/EC [6].

403 Note 2 to entry: Documents issued by the IEEE ICES TC 95, such as [7] and [8], refer to the basic restrictions as
404 dosimetric reference levels (DRL).

405 Note 3 to entry: Directive 2013/35/EU [9] refers to basic restrictions as "exposure limit values (ELVs)," i.e. "values
406 established on the basis of biophysical and biological considerations, in particular on the basis of scientifically well-
407 established short-term and acute direct effects, i.e. thermal effects and electrical stimulation of tissues."

408 **3.3**

409 **reference level**

410 maximum permissible level of the incident electric, magnetic or electromagnetic fields below
411 which the basic restrictions are assumed not to be exceeded

412 Note 1 to entry: Examples of reference levels can be found in ICNIRP Guidelines [3], [4], [5] and in Annex II of the
413 Council Recommendation 1999/519/EC [6].

414 Note 2 to entry: Documents issued by the IEEE ICES TC 95, such as [7] and [8], refer to the reference levels as
415 exposure reference levels (ERL).

416 Note 3 to entry: Directive 2013/35/EU [9] refers to reference levels as "action levels (ALs)," i.e. "operational levels
417 established for the purpose of simplifying the process of demonstrating the compliance with relevant ELVs or, where
418 appropriate, to take relevant protection or prevention measures specified in this Directive."

419 **3.4**

420 **direct effect**

421 biological effect resulting from exposure of the body to an electric, magnetic, or electromagnetic
422 field without interaction with a conducting object

423 **3.5**

424 **indirect effect**

425 biological effect resulting from interaction of the body with a conducting object with an electric
426 potential different from the one of the body

427 **3.6**

428 **incident field**

429 field that would exist in the absence of a person at a point where a person could be located

430 Note 1 to entry: In some documents, the incident field is called an unperturbed field or environmental field.

431 **3.7**

432 **coupling factor**

433 factor which correlates the measured incident field to the induced field in the human body

434 **3.8**435 **electric field strength**

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

$$438 \quad F = QE$$

439 [SOURCE : IEC 60050-121:1998/AMD5:2021 [10], 121-11-18]

440 **3.9**441 **internal electric field**

442 <in a body> electric field induced inside the body as a result of exposure to electric, magnetic,
443 or electromagnetic fields

444 **3.10**445 **magnetic field strength**

446 vector quantity obtained at a given point by subtracting the magnetization M from the magnetic
447 flux density B divided by the magnetic constant μ_0

448 [SOURCE: IEC 60050-121:1998/AMD5:2021 [10], 121-11-56]

449 **3.11**450 **contact current**

451 <for human body> current flowing into the body resulting from contact with a conductive object
452 in an electromagnetic field

453 Note 1 to entry: This is the localized current flow into the body (usually the hand, for a light brushing contact).

454 **3.12**455 **current density**

456 at a given point within a volume element of quasi-infinitesimal volume V , vector quantity equal
457 to the sum, for all free charge carriers within the volume element, of the products of electric
458 charge and velocity, divided by the volume V : IEC 63184:2023

<https://standards.iteh.ai/catalog/standards/sist/4cc29c90-7423-4027-9f98-80e3fc1a0532/osist-pr-en-iec-63184-2023>

$$J = \frac{1}{V} \sum_{i=1}^n Q_i v_i$$

459

460 where

461 n is the number of free carriers within the volume element;

462 Q_i is the electric charge of the i -th carrier;

463 v_i is the velocity of the i -th carrier.

464 Note 1 to entry: The flux of the electric current density J through any directed surface S is equal to the electric
465 current I through that surface:

$$I = \int J \cdot e_n dA$$

466

467 where $e_n dA$ is the vector surface element.

468 [SOURCE: IEC 60050-121:1998 [10], 121-11-11]

469 **3.13**470 **specific absorption rate**471 **SAR**

472 measure of the rate at which energy is absorbed by the human body when exposed to a radio
473 frequency electromagnetic field

474 Note 1 to entry: The SAR in the tissue (or tissue-equivalent medium) can be determined by the rate of temperature
475 increase or by E-field measurements, according to the following formulas:

$$476 \quad SAR = \frac{\sigma E^2}{\rho}$$

$$477 \quad SAR = c_h \left. \frac{\partial T}{\partial t} \right|_{t=0}$$

478 where

479 *SAR* is the specific absorption rate in W/kg;

480 *E* is the RMS value of the electric field strength in the tissue medium in V/m;

481 σ is the electrical conductivity of the tissue medium in S/m;

482 ρ is the mass density of the tissue medium in kg/m³;

483 c_h is the specific heat capacity of the tissue medium in J/(kg K);

484 $\left. \frac{\partial T}{\partial t} \right|_{t=0}$ is the initial time derivative of temperature in the tissue medium in K/s.

485 [SOURCE: IEC/IEEE 62209-1528:2020 [11]]

486 **3.14**487 **peak spatial-average SAR**488 **psSAR**

489 maximum average SAR within a local region based on a specific averaging volume or mass,
490 e.g. any 1 g or 10 g of tissue in the shape of a cube

491 Note 1 to entry: The cubic shape of the averaging volume is specified in [8] and [3].

492 **3.15**493 **magnitude <of a vector>**

494 for any vector *U*, non-negative scalar, usually denoted by $|U|$, equal to the non-negative square
495 root of the scalar product or, in the case of a complex vector, of the Hermitian product of the
496 vector by itself

497 [SOURCE: IEC 60050-121:1998/AMD5:2021 [10], 102-03-23]

498 **3.16**499 **gradient**

500 vector ∇f associated at each point of a given space region with a scalar *f*, having a direction
501 normal to the surface on which the scalar field has a constant value, in the sense of increasing
502 value of *f*, and a magnitude equal to the absolute value of the derivative of *f* with respect to
503 distance in this normal direction

504 Note 1 to entry: The scalar *f* may refer to a component of a vector field.

505 [SOURCE: IEC 60050-121:1998/AMD5:2021 [10], 102-03-23, Note added.]

506 **3.17**507 **phantom**

508 physical model with an equivalent human anatomy and comprised of a tissue-equivalent
509 medium with dielectric properties specified in this document