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Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 2: Specific requirements for finite difference time domain (FDTD) modelling of exposure from vehicle mounted antennas

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INTRODUCTION

Computational techniques have reached a level of maturity which allows their use in compliance assessments of wireless communication devices with vehicle mounted antennas. The increasing complexity of assessing product compliance with exposure standards according to specific absorption rate (SAR) limits calls for new compliance techniques. This technique should be time efficient and cost effective. Experimental compliance assessments for wireless communication devices used in combination with vehicles are extremely complex to perform or even not possible at all. National regulatory bodies (e.g. US Federal Communications Commission) encouraged the development of consensus standards as well as the establishment of the related IEEE TC34 SC2 subcommittee and IEC PT62704-2 working group. The benefits to the user include standardized and accepted protocols, standardized anatomical models, validation techniques, benchmark data, reporting format, means for estimating the overall uncertainty in order to produce valid, accurate, repeatable, and reproducible results.

The results obtained by following the protocols specified in this document represent a conservative estimate of the peak spatial-average and whole-body average SAR induced in the standard human body models and exposure conditions established for this document inside or nearby the vehicles representing typical use cases with transmitting mobile radios. The protocols set forth in this document produce results subject to modelling, simulations and other uncertainties that are defined in this document.

The standardized vehicle and human models, test configurations, and related results are representative of the typical exposure conditions expected by the passengers and bystanders near the vehicle with vehicle mounted antennas. It is not the intent of this document to provide a result representative of the absolute maximum SAR value possible under every conceivable combination of body size, posture, vehicle model, and distance from the vehicle and antenna. The following items are described in detail: simulation concepts, simulation techniques, finite difference time domain (FDTD) numerical method, benchmarking techniques, standardized anatomically correct human body models of the passenger and bystander, exposure conditions, reference exposure configurations for validation of the SAR simulation software, and the limitations of these models and tools when used for simulating the peak spatial-average and whole-body average SAR. Procedures for validating the numerical tools used for SAR simulations and assessing the SAR simulation uncertainties are provided. This document is intended primarily for use by engineers and other specialists who are familiar with electromagnetic (EM) theory, numerical methods, and, in particular, FDTD techniques. This document does not recommend specific SAR limit values since these are found in other documents.

1 Scope

This part of IEC/IEEE 62704 establishes the concepts, techniques, validation procedures, uncertainties and limitations of the finite difference time domain technique (FDTD) when used for determining the peak spatial-average and whole-body average specific absorption rate (SAR) in a standardized human anatomical model exposed to the electromagnetic field emitted by vehicle mounted antennas in the frequency range from 30 MHz to 1 GHz, which covers typical high power mobile radio products and applications. This document specifies and provides the test vehicle, human body models and the general benchmark data for those models. It defines antenna locations, operating configurations, exposure conditions, and positions that are typical of persons exposed to the fields generated by vehicle mounted antennas. The extended frequency range up to 6 GHz will be considered in future revisions of this document. This document does not recommend specific peak spatial-average and whole-body average SAR limits since these are found in other documents, e.g. IEEE C95.1-2005, ICNIRP (1998).

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 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at: http://www.electropedia.org)

IEC/IEEE 62704-1:~~—[2]~~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 62704-1:— [3], *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*

IEEE Standards Dictionary Online (subscription available at: http://ieeexplore.ieee.org/xpls/dictionary.jsp)

~~[2] Under preparation. Stage at time of publication: IEC/IEEE FDIS 62704-1:2016.~~

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[1] A list of IEEE participants can be found at the following URL: http://standards.ieee.org/downloads/24748-5/24748-5-2017/24748-5-2017_wg-participants.pdf

INTRODUCTION

Computational techniques have reached a level of maturity which allows their use in compliance assessments of wireless communication devices with vehicle mounted antennas. The increasing complexity of assessing product compliance with exposure standards according to specific absorption rate (SAR) limits calls for new compliance techniques. This technique should be time efficient and cost effective. Experimental compliance assessments for wireless communication devices used in combination with vehicles are extremely complex to perform or even not possible at all. National regulatory bodies (e.g. US Federal Communications Commission) encouraged the development of consensus standards as well as the establishment of the related IEEE TC34 SC2 subcommittee and IEC PT62704-2 working group. The benefits to the user include standardized and accepted protocols, standardized anatomical models, validation techniques, benchmark data, reporting format, means for estimating the overall uncertainty in order to produce valid, accurate, repeatable, and reproducible results.

The results obtained by following the protocols specified in this document represent a conservative estimate of the peak spatial-average and whole-body average SAR induced in the standard human body models and exposure conditions established for this document inside or nearby the vehicles representing typical use cases with transmitting mobile radios. The protocols set forth in this document produce results subject to modelling, simulations and other uncertainties that are defined in this document.

The standardized vehicle and human models, test configurations, and related results are representative of the typical exposure conditions expected by the passengers and bystanders near the vehicle with vehicle mounted antennas. It is not the intent of this document to provide a result representative of the absolute maximum SAR value possible under every conceivable combination of body size, posture, vehicle model, and distance from the vehicle and antenna. The following items are described in detail: simulation concepts, simulation techniques, finite difference time domain (FDTD) numerical method, benchmarking techniques, standardized anatomically correct human body models of the passenger and bystander, exposure conditions, reference exposure configurations for validation of the SAR simulation software, and the limitations of these models and tools when used for simulating the peak spatial-average and whole-body average SAR. Procedures for validating the numerical tools used for SAR simulations and assessing the SAR simulation uncertainties are provided. This document is intended primarily for use by engineers and other specialists who are familiar with electromagnetic (EM) theory, numerical methods, and, in particular, FDTD techniques. This document does not recommend specific SAR limit values since these are found in other documents.

1 Scope

This part of IEC/IEEE 62704 establishes the concepts, techniques, validation procedures, uncertainties and limitations of the finite difference time domain technique (FDTD) when used for determining the peak spatial-average and whole-body average specific absorption rate (SAR) in a standardized human anatomical model exposed to the electromagnetic field emitted by vehicle mounted antennas in the frequency range from 30 MHz to 1 GHz, which covers typical high power mobile radio products and applications. This document specifies and provides the test vehicle, human body models and the general benchmark data for those models. It defines antenna locations, operating configurations, exposure conditions, and positions that are typical of persons exposed to the fields generated by vehicle mounted antennas. The extended frequency range up to 6 GHz will be considered in future revisions of this document. This document does not recommend specific peak spatial-average and whole-body average SAR limits since these are found in other documents, e.g. IEEE C95.1-2005, ICNIRP (1998).

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 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at: http://www.electropedia.org)

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 62704-1:— [2], *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*

IEEE Standards Dictionary Online (subscription available at: http://ieeexplore.ieee.org/xpls/dictionary.jsp)

[2] Under preparation. Stage at time of publication: IEC/IEEE CDV 62704-1:2023.