EESTI STANDARD EVS-EN IEC/IEEE 63195-1:2023

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



EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

| See Eesti standard EVS-EN IEC/IEEE 63195-1:2023 sisaldab Euroopa standardi EN IEC/IEEE 63195-1:2023 ingliskeelset teksti. | This Estonian standard EVS-EN IEC/IEEE 63195-1:2023 consists of the English text of the European standard EN IEC/IEEE 63195-1:2023. |
|---|--|
| 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 and Accreditation. |
| Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 13.01.2023. | Date of Availability of the European standard is 13.01.2023. |
| Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest. | The standard is available from the Estonian Centre for Standardisation and Accreditation. |
| | |

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

ICS 17.220.20

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele

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

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardimis-ja Akrediteerimiskeskusega: Koduleht <u>www.evs.ee</u>; telefon 605 5050; e-post <u>info@evs.ee</u>

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

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 and Accreditation.

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

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

EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM

EN IEC/IEEE 63195-1

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 1: Measurement procedure (IEC/IEEE 63195-1:2022)

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 1: Procédure de mesure (IEC/IEEE 63195-1:2022) 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 1: Messverfahren (IEC/IEEE 63195-1:2022)

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

© 2023 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

European foreword

This document (EN IEC/IEEE 63195-1:2023) consists of the text of document IEC/IEEE 63195-1:2022, 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.

Endorsement notice

The text of the International Standard IEC/IEEE 63195-1:2022 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:

| | ISO/IEC 17025:2017 | NOTE | Harmonized as EN ISO/IEC | 17025:2017 | (not modified) |
|--|--------------------|------|--------------------------|------------|----------------|
|--|--------------------|------|--------------------------|------------|----------------|

IEC 62311:2019 NOTE Harmonized as EN IEC 62311:2020 (not modified)

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





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 1: Measurement 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 1: Procédure de mesure





THIS PUBLICATION IS COPYRIGHT PROTECTED Copyright © 2022 IEC, Geneva, Switzerland Copyright © 2022 IEEE

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing being secured. Requests for permission to reproduce should be addressed to either IEC at the address below or IEC's member National Committee in the country of the requester or from IEEE.

IEC Secretariat 3, rue de Varembé CH-1211 Geneva 20 Switzerland Tel.: +41 22 919 02 11 info@iec.ch www.iec.ch Institute of Electrical and Electronics Engineers, Inc. 3 Park Avenue New York, NY 10016-5997 United States of America stds.ipr@ieee.org www.ieee.org

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.





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 1: Measurement 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 1: Procédure de mesure

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 17.220.20

ISBN 978-2-8322-0123-7

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.

 Registered trademark of the International Electrotechnical Commission Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

| FC | DREWO | RD | 9 |
|----|-------|--|------------|
| IN | TRODU | ICTION | 11 |
| 1 | Scop | e | 12 |
| 2 | Norm | ative references | 13 |
| 3 | Term | s and definitions | 13 |
| • | 3.1 | Exposure metrics and parameters | 13 |
| | 3.2 | Spatial physical and geometrical parameters associated with exposure | |
| | 0.2 | metrics | 16 |
| | 3.3 | Measurement instrumentation, field probe, and data-processing parameters | 17 |
| | 3.4 | RF power parameters | 20 |
| | 3.5 | Test device technical operating and antenna parameters | 21 |
| | 3.6 | Test device physical configurations | 23 |
| | 3.7 | Uncertainty parameters | 24 |
| 4 | Syml | ools and abbreviated terms | 25 |
| | 4.1 | Symbols | 25 |
| | 4.1.1 | Physical quantities | 25 |
| | 4.1.2 | Constants | 26 |
| | 4.2 | Abbreviated terms | 26 |
| 5 | Quic | k start guide and application of this document | 27 |
| | 5.1 | Quick start guide | 27 |
| | 5.2 | Application of this document | 30 |
| | 5.3 | Stipulations | 30 |
| 6 | Meas | surement system and laboratory requirements | 30 |
| | 6.1 | General requirements | 30 |
| | 6.2 | Laboratory requirements | 31 |
| | 6.3 | Field probe requirements | 32 |
| | 6.4 | Measurement instrumentation requirements | 32 |
| | 6.5 | Scanning system requirements | 33 |
| | 6.5.1 | Single-probe systems | 33 |
| | 6.5.2 | Multiple field-probe systems | 33 |
| | 6.6 | Device holder requirements | 34 |
| | 6.7 | Post-processing quantities, procedures, and requirements | 35 |
| | 6.7.1 | Formulas for calculation of <i>sPD</i> | 35 |
| | 6.7.2 | Post-processing procedure | 37 |
| _ | 6.7.3 | Requirements | 38 |
| 7 | Proto | ocol for PD assessment | 39 |
| | 7.1 | General | 39 |
| | 7.2 | Measurement preparation | 39 |
| | 7.2.1 | Relative system check | 39 |
| | 7.2.2 | DUT requirements | 39 |
| | 7.2.3 | DUI preparation | 40 |
| | 7.2.4 | Selecting evaluation surfaces | 41 |
| | 7.3 | Tests to be performed | 44 |
| | 7.3.1 | | 44 |
| | 7.3.2 | lests to be performed when supported by simulations of the antenna array | ∆ 6 |
| | 733 | Tests to be performed by measurements of the antenna array | 48 |
| | 1.0.0 | . eete te se perfermed sy medeuremente er the antenna array | |

| | 7.4 | Measurement procedure | 48 |
|---|-------|--|----|
| | 7.4.1 | General measurement procedure | 48 |
| | 7.4.2 | Power density assessment methods | 49 |
| | 7.4.3 | Power scaling for operating mode and channel | 51 |
| | 7.4.4 | Correction for DUT drift | 53 |
| | 7.5 | Exposure combining | 54 |
| | 7.5.1 | General | 54 |
| | 7.5.2 | Combining power density and SAR results | 55 |
| 8 | Unce | rtainty estimation | 58 |
| 1 | 8.1 | General | 58 |
| 1 | 8.2 | Requirements for uncertainty evaluations | 58 |
| ł | 8.3 | Description of uncertainty models | 58 |
| ł | 8.4 | Uncertainty terms dependent on the measurement system | 59 |
| | 8.4.1 | CAL – Calibration of the measurement equipment | 59 |
| | 8.4.2 | COR – Probe correction | 59 |
| | 8.4.3 | FRS – Frequency response | 59 |
| | 8.4.4 | SCC – Sensor cross coupling | 60 |
| | 8.4.5 | ISO – Isotropy | 61 |
| | 8.4.6 | <i>LIN</i> – System linearity error | 61 |
| | 8.4.7 | PSC – Probe scattering | 61 |
| | 8.4.8 | PPO – Probe positioning offset | 62 |
| | 8.4.9 | PPR – Probe positioning repeatability | 62 |
| | 8.4.1 | 0 SMO – Sensor mechanical offset | 63 |
| | 8.4.1 | 1 PSR – Probe spatial resolution | 63 |
| | 8.4.1 | 2 FLD – Field impedance dependence (ratio E / H) | 63 |
| | 8.4.1 | 3 <i>MED</i> – Measurement drift | 63 |
| | 8.4.1 | 4 <i>APN</i> – Amplitude and phase noise | 64 |
| | 8.4.1 | 5 <i>TR</i> – Measurement area truncation | 64 |
| | 8.4.1 | 6 <i>DAQ</i> – Data acquisition | 64 |
| | 8.4.1 | 7 SMP – Sampling | 64 |
| | 8.4.1 | 8 REC – Field reconstruction | 64 |
| | 8.4.1 | 9 SNR – Signal-to-noise ratio | 65 |
| | 8.4.2 | 0 TRA – Forward transformation and backward transformation | 65 |
| | 8.4.2 | 1 SCA – Power density scaling | 66 |
| | 8.4.2 | 2 SAV – Spatial averaging | 66 |
| | 8.4.2 | 3 COM – Exposure combining | 66 |
| ł | 8.5 | Uncertainty terms dependent on the DUT and environmental factors | 66 |
| | 8.5.1 | PC – Probe coupling with DUT | 66 |
| | 8.5.2 | MOD – Modulation response | 67 |
| | 8.5.3 | <i>IT</i> – Integration time | 67 |
| | 8.5.4 | <i>RT</i> – Response time | 68 |
| | 8.5.5 | DH – Device holder influence | 68 |
| | 8.5.6 | DA – DUT alignment | 68 |
| | 8.5.7 | <i>AC</i> – RF ambient conditions | 68 |
| | 8.5.8 | <i>TEM</i> – Laboratory temperature | 68 |
| | 8.5.9 | <i>REF</i> – Reflections in laboratory | 69 |
| | 8.5.1 | 0 <i>MSI</i> – Measurement system immunity/secondary reception | 69 |
| | 8.5.1 | 1 DRI – DUT drift | 69 |
| ł | 8.6 | Combined and expanded uncertainty | 69 |

| 9 Measur | ement report | 73 |
|--|---|----------------------|
| 9.1 G | eneral | 73 |
| 9.2 Ite | ems to be recorded in measurement reports | 73 |
| Annex A (no | rmative) Measurement system check and system validation tests | 76 |
| A.1 O | verview | 76 |
| A.2 N | ormalization to total radiated power | 77 |
| A.2.1 | General | 77 |
| A.2.2 | Option 1: Accepted power measurement | 77 |
| A.2.3 | Option 2: Total radiated power measurement | 81 |
| A.3 R | elative system check | 82 |
| A.3.1 | Purpose | 82 |
| A.3.2 | Antenna and test conditions | 82 |
| A.3.3 | Procedure | 83 |
| A.3.4 | Acceptance criteria | 83 |
| A.4 A | osolute system check | 85 |
| A.4.1 | Purpose | 85 |
| A.4.2 | Antenna and test conditions | 85 |
| A.4.3 | Procedure | 85 |
| A.4.4 | Acceptance criteria | 85 |
| A.5 S | vstem validation | 86 |
| A.5.1 | Purpose | 86 |
| A.5.2 | Procedure | 86 |
| A.5.3 | Validation of modulation response | 87 |
| A.5.4 | Acceptance criteria | 87 |
| | | |
| Annex B (no | rmative) Antennas for system check and system validation tests | 89 |
| Annex B (no B.1 G | rmative) Antennas for system check and system validation tests | 89 89 |
| Annex B (no B.1 G B.2 P | rmative) Antennas for system check and system validation tests eneral yramidal horn antennas for system checks | 89 89 90 |
| Annex B (no B.1 G B.2 P B.3 C | rmative) Antennas for system check and system validation tests eneral ramidal horn antennas for system checks avity-fed dipole arrays for system validation | 89 89 90 91 |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 | rmative) Antennas for system check and system validation tests eneral ramidal horn antennas for system checks avity-fed dipole arrays for system validation Description | |
| Annex B (no B.1 G B.2 P B.3 C B.3.1 B.3.2 | rmative) Antennas for system check and system validation tests eneral yramidal horn antennas for system checks avity-fed dipole arrays for system validation Description Numerical target values for cavity-fed dipole arrays | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 | rmative) Antennas for system check and system validation tests eneral yramidal horn antennas for system checks avity-fed dipole arrays for system validation Description Numerical target values for cavity-fed dipole arrays Field and power density distribution patterns | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 | rmative) Antennas for system check and system validation tests eneral gramidal horn antennas for system checks avity-fed dipole arrays for system validation Description Numerical target values for cavity-fed dipole arrays Field and power density distribution patterns Far-field radiation patterns | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P | rmative) Antennas for system check and system validation tests eneral vramidal horn antennas for system checks avity-fed dipole arrays for system validation Description Numerical target values for cavity-fed dipole arrays Field and power density distribution patterns Far-field radiation patterns | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 | rmative) Antennas for system check and system validation tests eneral vramidal horn antennas for system checks avity-fed dipole arrays for system validation Description Numerical target values for cavity-fed dipole arrays Field and power density distribution patterns Far-field radiation patterns vramidal horns with slot arrays for system validation Description | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 | rmative) Antennas for system check and system validation tests eneral vramidal horn antennas for system checks avity-fed dipole arrays for system validation Description Numerical target values for cavity-fed dipole arrays Field and power density distribution patterns Far-field radiation patterns vramidal horns with slot arrays for system validation Description Numerical target values for pyramidal horns loaded with a slot array . | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 | rmative) Antennas for system check and system validation tests eneral vramidal horn antennas for system checks | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.3 B.4.4 B.5 A | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.3 B.4.4 B.5 A B.5.1 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.1 B.5.2 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.2 B.5.3 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.1 B.5.2 B.5.3 B.5.4 | rmative) Antennas for system check and system validation tests eneral vramidal horn antennas for system checks | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.2 B.5.3 B.5.4 B.5.5 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.3 B.4.4 B.5 A B.5.1 B.5.1 B.5.2 B.5.3 B.5.4 B.5.5 B.5.6 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nd B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.1 B.5.2 B.5.3 B.5.4 B.5.5 B.5.6 B.5.7 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.2 B.5.3 B.5.4 B.5.5 B.5.6 B.5.7 B.6 V | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (no B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.2 B.5.3 B.5.4 B.5.5 B.5.6 B.5.7 B.6 V B.6.1 | rmative) Antennas for system check and system validation tests eneral | |
| Annex B (nc B.1 G B.2 P B.3 C B.3.1 B.3.2 B.3.3 B.3.4 B.4 P B.4.1 B.4.2 B.4.3 B.4.4 B.5 A B.5.1 B.5.2 B.5.3 B.5.4 B.5.5 B.5.6 B.5.7 B.6 V B.6.1 B.6.2 | rmative) Antennas for system check and system validation tests eneral | |

| B.6.4 | Target values for validation antennas transmitting wideband signals | 112 |
|------------|--|-----|
| B.6.5 | Wideband signal uncertainty | 112 |
| B.6.6 | Validation procedure | 113 |
| Annex C | normative) Calibration and characterization of measurement probes | 114 |
| C.1 | General | 114 |
| C.2 | Calibration of waveguide probes | 114 |
| C.2.1 | General | 114 |
| C.2.2 | 2 Sensitivity | 114 |
| C.2.3 | Linearity | 114 |
| C.2.4 | Lower detection limit | 115 |
| C.2.5 | is Isotropy | 115 |
| C.2.6 | Response time | 115 |
| C.3 | Calibration for isotropic scalar E-field or H-field probes | 115 |
| C.3.1 | General | 115 |
| C.3.2 | 2 Sensitivity | 115 |
| C.3.3 | lsotropy | 115 |
| C.3.4 | Linearity | 116 |
| C.3.5 | Lower detection limit | 116 |
| C.3.6 | Response time | 116 |
| C.4 | Calibration of phasor E-field or H-field probes | 116 |
| C.4.1 | General | 116 |
| C.4.2 | 2 Sensitivity | 116 |
| C.4.3 | lsotropy | 117 |
| C.4.4 | Linearity | 117 |
| C.4.5 | 5 Lower detection limit | 117 |
| C.5 | Calibration uncertainty parameters. | 117 |
| C.5.1 | General | 117 |
| C.5.2 | Input power to the antenna | 117 |
| C.5.3 | Mismatch effect (input power measurement) | 117 |
| C.5.4 | Gain and offset distance | 118 |
| C.5.5 | 5 Signal spectrum | 118 |
| C.5.6 | Setup stability | 118 |
| C.5.7 | Uncertainty for field impedance variations | 119 |
| C.6 | Uncertainty budget template | 119 |
| Annex D | informative) Information on use of square or circular shapes for power | |
| density av | veraging area in conformity evaluations | 121 |
| D.1 | General | 121 |
| D.2 | Method using computational analysis | 121 |
| D.3 | Areas averaged with square and circular shapes on planar evaluation | |
| | surface | 121 |
| D.4 | Areas averaged with square and circular shapes on nonplanar evaluation | 100 |
| | surface | 123 |
| Annex E (| informative) Reconstruction algorithms | 125 |
| E.1 | General | 125 |
| E.2 | Methodologies to extract local field components and power densities | 125 |
| E.2.1 | General | 125 |
| E.2.2 | Phase-less approaches | 126 |
| E.2.3 | Approaches using E-field polarization ellipse measurements | 126 |
| E.2.4 | Direct near-field measurements | 126 |

| E.3 | Forward transformation (propagation) of the fields | 127 |
|-------------------------|--|------------|
| E.3.1 | General | 127 |
| E.3.2 | P Field expansion methods | 128 |
| E.3.3 | B Field integral equation methods | 128 |
| E.4 | Backward transformation (propagation) of the fields | 129 |
| E.4.1 | General | 129 |
| E.4.2 | Field expansion methods – the plane wave expansion | 129 |
| E.4.3 | B Inverse source methods | 130 |
| E.5 | Analytical reference functions | 131 |
| Annex F (| normative) Interlaboratory comparisons | 133 |
| F 1 | Purpose | 133 |
| F 2 | Reference devices | 133 |
| F 3 | Power setun | 133 |
| F 4 | Interlaboratory comparison – procedure | 133 |
| Anney G | (informative) PD test and verification example | 13/ |
| | | 404 |
| G.I | | 134 |
| G.Z | | 134 |
| G.3 | lest system verification | 134 |
| G.4 | lest setup | 134 |
| G.5 | Power density results | 134 |
| G.6 | Combined exposure (Total Exposure Ratio) | 134 |
| Annex H | (informative) Applicability of plane-wave equivalent approximations | 135 |
| H.1 | Objective | 135 |
| H.2 | Method | 135 |
| H.3 | Results | 135 |
| H.4 | Discussion | 137 |
| Annex I (i and IEC/I | nformative) Rationales for concepts and methods applied in this document EEE 63195-2 | 138 |
| I.1 | Frequency range | 138 |
| I.2 | Calculation of <i>sPD</i> | 138 |
| I.2.1 | Application of the Poynting vector for calculation of incident power density | 138 |
| 1.2.2 | Averaging area | 139 |
| Bibliograp | ohy | 140 |
| | | |
| Figure 1 - | - Quick Start Guide | 29 |
| Figure 2 - reconstru | Simplified view of a generic measurement setup involving the use of ction algorithms | 38 |
| Figure 3 - plane, as | - Cross-sectional view of SAM phantom for SAR evaluations at the reference described in IEC/IEEE 62209-1528:2020 | 42 |
| Figure 4 - reference | Cross-sectional view of SAM virtual phantom for PD evaluations at the plane (shell thickness is 2 mm everywhere, including at the pinna) | 42 |
| Figure 5 - phantom | - Example reference coordinate system for the left-ear ERP of the SAM | |
| Figure 6 - | - Example reference points and vertical and horizontal lines on a DUT | 44 |
| - Figure 7 - | - Flow chart for test procedure in 7.3 | 46 |
| Figure 8 - | - Flow chart for general measurement procedure in 7.4.1 | <u>4</u> 0 |
| Eiguro 0 | Flow chart for power density assessment methods in 7.4.2 | 5ب |
| i igule 9 - | - now chart for power density assessment methods III 7.4.2 | |

- 6 -

| Figure 10 – SAR and power density evaluation at a point <i>r</i> | 57 |
|---|-----|
| Figure 11 – Combining SAR (top) and power density (bottom) for the SAM phantom | 57 |
| Figure A.1 – Recommended accepted power measurement setup for relative system check, absolute system check and system validation | 78 |
| Figure A.2 – Equipment setup for measurement of forward power P_{f} and forward | |
| coupled power P _{fc} | 78 |
| Figure A.3 – Equipment setup for measuring the shorted reverse coupled power P_{rcs} | 78 |
| Figure A.4 – Equipment setup for measuring the power with the reference antenna | 79 |
| Figure A.5 – Port numbering for the <i>S</i> -parameter measurements of the directional coupler | 80 |
| Figure B.1 – Main dimensions for the cavity-fed dipole arrays – 30 GHz design | 92 |
| Figure B.2 – 10 GHz patterns of $ E_{total} $ and Re{S} _{total} for the cavity-fed dipole arrays | |
| at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the dielectric substrate | 95 |
| Figure B.3 – 30 GHz patterns of $ E_{total} $ and Re{S} _{total} for the cavity-fed dipole arrays | |
| at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the dielectric substrate | 96 |
| Figure B.4 – 60 GHz patterns of $ E_{total} $ and Re{S}total for the cavity-fed dipole arrays | |
| at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the dielectric substrate | 97 |
| Figure B.5 – 90 GHz patterns of $ E_{total} $ and $Re{S}_{total}$ for the cavity-fed dipole arrays | |
| at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the dielectric substrate | 98 |
| Figure B.6 – Far-field radiation patterns of a) 10 GHz, b) 30 GHz, c) 60 GHz, and d) 90 GHz cavity-fed dipole arrays | 100 |
| Figure B.7 – Main dimensions for the 0,15 mm stainless steel stencil with slot array | 101 |
| Figure B.8 – Main dimensions for the pyramidal horn antennas | 102 |
| Figure B.9 – 10 GHz patterns of $ E_{total} $ and Re{S} _{total} for the pyramidal horn loaded | |
| with a slot array at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the slot array | 105 |
| Figure B.10 – 30 GHz patterns of $ E_{total} $ and Re{S} _{total} for the pyramidal horn loaded | |
| with a slot array at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the slot array | 106 |
| Figure B.11 – 60 GHz patterns of $ E_{total} $ and Re{S}total for the pyramidal horn loaded | |
| with a slot array at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the slot array | 107 |
| Figure B.12 – 90 GHz patterns of $ E_{total} $ and Re{S} _{total} for the pyramidal horn loaded | |
| with a slot array at distances of a) 2 mm, b) 5 mm, c) 10 mm, and d) 50 mm from the upper surface of the slot array | 108 |
| Figure B.13 – Far-field radiation patterns of a) 10 GHz, b) 30 GHz, c) 60 GHz, and d) 90 GHz pyramidal horn loaded with a slot array | 110 |
| Figure D.1 – Schematic view of the assessment of the variation of <i>sPD</i> using square shape by rotating AUT (antenna under test) | 121 |
| Figure D.2 – Comparison of <i>psPD</i> averaged using square versus circular shaped areas on planar evaluation surfaces | 122 |
| Figure D.3 – Example <i>PD</i> distributions with device next to ear evaluation surface | 123 |
| Figure D.4 – Comparison of $psPD$ averaged using cube cross-section (square-like) | |
| evaluation surface | 124 |

| Figure E.1 – Simulation (left) and forward transformation from measurements applying methods described in [29] (right) of power density in the <i>xz</i> -plane (above) and <i>yz</i> -plane (below) at a distance of 2 mm for a cavity-fed dipole array at 30 GHz (see Annex B) |
|--|
| Figure H.1 – $psPD_{pwe}$ / $psPD_{tot}$ as function of distance (in units of λ) from cavity-fed dipole array (CDA##G, left-side) and pyramidal horn with slot arrays (SH##G, right- |
| side) operating at 10 GHz, 30 GHz, 60 GHz, and 90 GHz137 |
| Table 1 – Evaluation plan check-list |
| Table 2 – Minimum evaluation distance between the DUT antenna and the evaluationsurface for which the plane wave equivalent approximation applies50 |
| Table 3 – Template of measurement uncertainty for power density measurements |
| Table 4 – Example measurement uncertainty budget for power density measurement results |
| Table A.1 – Example of power measurement uncertainty 81 |
| Table A.2 – Communication signals for modulation response test 87 |
| Table B.1 – Target values for pyramidal horn antennas at different frequencies |
| Table B.2 – Main dimensions for the cavity-fed dipole arrays at each frequency of interest 91 |
| Table B.3 – Geometrical parameters of the cavity-fed dipole arrays at each frequency of interest |
| Table B.4 – Substrate and metallic block parameters for the cavity-fed dipole arrays ateach frequency of interest |
| Table B.5 – Target values for the cavity-fed dipole arrays at 10 GHz, 30 GHz, 60 GHz,and 90 GHz |
| Table B.6 – Main dimensions for the stencil with slot array for each frequency 102 |
| Table B.7 – Primary dimensions for the corresponding pyramidal horns at eachfrequency |
| Table B.8 – Target values for the pyramidal horns loaded with slot arrays at 10 GHz,30 GHz, 60 GHz, and 90 GHz104 |
| Table C.1 – Uncertainty analysis of the probe calibration 119 |
| Table D.1 – Phase shift values for the array antenna 123 |
| Table E.1 – List of analytical reference functions and associated $psPD_{n+}$ target values131 |
| Table E.2 – List of analytical reference functions and associated $psPD_{tot+}$ target values |
| Table E.3 – List of analytical reference functions and associated $nsPD_{model}$ target |
| values |
| 6 |
| |
| |
| C, |

- 8 -

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 1: Measurement 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 63195-1 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 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 in the form of analytical reference functions for validation of the reconstruction algorithms in Annex E. Download links for these files can be found in Clause E.5.

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

| Draft | Report on voting |
|--------------|------------------|
| 106/565/FDIS | 106/570/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. The main document types developed by IEC are described in greater detail at 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 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 methods to evaluate incident power density exposures due to any electromagnetic field (EMF) transmitting device intended to be used at a position near the human head or body, or mounted on the body, combined with other transmitters within a product, or embedded in garments. The device categories covered include but are not limited to mobile telephones, radio transmitters in personal computers, and desktop and laptop devices. This document also addresses multi-band and multi-antenna devices. The overall applicable frequency range is from 6 GHz to 300 GHz. This document specifies:

- measurement system (Clause 6); •
- power density measurement protocols (Clause 7);
- uncertainty evaluation (Clause 8); .
- measurement report (Clause 9); .
- system checks and system validation (Annex B). •

To develop this document, IEC Technical Committee 106 (TC 106) and Technical Committee 34 (TC 34) Subcommittee 1 (SC 1) of IEEE International Committee on Electromagnetic Safety (ICES) formed Joint Working Group 12 (JWG 12) on measurement methods to assess the power density of electromagnetic fields from wireless devices in close proximity to the head and body.

This document is partly based on IEC TR 63170:2018.

NOTE System validation tests are specified in Annex B for 10 GHz, 30 GHz, 60 GHz, and 90 GHz to cover the frequency range from 6 GHz to 110 GHz. Additional validation antennas to cover the frequency range up to 300 GHz will be developed in a future revision of this document. Further discussion on rationales is given in Annex I.

n in in in in in in it is in i

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

1 Scope

This document specifies protocols and test procedures for repeatable and reproducible measurements of power density (PD) that provide conservative estimates of exposure incident to a human head or body due to radio-frequency (RF) electromagnetic field (EMF) transmitting communication devices, with a specified measurement uncertainty. These protocols and procedures apply for exposure evaluations of a significant majority of the population during the use of hand-held and body-worn RF transmitting communication devices. The methods apply for devices that can feature single or multiple transmitters or antennas, and can be operated with their radiating structure(s) at distances up to 200 mm from a human head or body.

The methods of this document can be used to determine conformity with applicable maximum PD requirements of different types of RF transmitting communication devices being used in close proximity to the head and body, including if combined with other RF transmitting or non-transmitting devices or accessories (e.g. belt-clip), or embedded in garments. The overall applicable frequency range of these protocols and procedures is from 6 GHz to 300 GHz.

The RF transmitting communication device categories covered in this document include but are not limited to mobile telephones, radio transmitters in personal computers, desktop and laptop devices, and multi-band and multi-antenna devices.

NOTE 1 System validation tests are specified in Annex B for 10 GHz, 30 GHz, 60 GHz, and 90 GHz to cover the frequency range from 6 GHz to 110 GHz. Additional validation antennas to cover the frequency range up to 300 GHz will be developed in a future revision of this document. Further discussion on rationales is given in Annex I.

NOTE 2 The protocols and test procedures in this document can be adapted to evaluate exposure also due to noncommunication types of devices operating in close proximity to the head and body, but these devices are not in the scope of this document.

NOTE 3 For the assessment of the combined exposure from simultaneous transmitters operating on frequencies below 6 GHz, the relevant standards for SAR measurements are IEC/IEEE 62209-1528:2020 and IEC/IEEE 62209-3:2019 [1].

NOTE 4 Between 6 GHz and 10 GHz, the scopes of this document and IEC/IEEE 62209-1528:2020 overlap. According to ICNIRP [2] guidelines and IEEE ICES C95.1 [3] standard, power density is the conformity metric in this frequency range. SAR can be used as conformity metric if local regulatory requirements allow it. (e.g. in case where a single transmit band includes test channels at both below and above 6 GHz).

The procedures of this document do not apply for EMF measurements of devices or objects intended to be implanted in the body.

EVS-EN IEC/IEEE 63195-1:2023 - 13 -

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 – Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)

IEC/IEEE 63195-2:2021¹, 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

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 http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp
- IEEE Dictionary Online: available at http://dictionary.ieee.org

3.1 Exposure metrics and parameters

3.1.1 power density PD local power density

function of the complex Poynting vector S at the location r that is integrated over a surface to calculate the sPD

Note 1 to entry: Specifications of power density in terms of the integrands of Formula (4), Formula (5), and Formula (8) are provided in 6.7.1. See also rationales provided in Annex I for the PD specifications of 6.7.1.

Note 2 to entry: The formula used to calculate PD can depend on the applicable exposure guidelines or national regulations.

Note 3 to entry: Power density is also referred to as power flux density.

Note 4 to entry: The associated term incident power density refers to quantity of power per unit area that impinges on the body surface. The incident power density just outside the body surface is used to establish local exposure reference levels, which apply at frequencies above 6 GHz in some jurisdictions.

3.1.2 spatial-average power density *sPD*

PD (3.1.1) averaged over a surface of area A_{av}

Note 1 to entry: sPD is a function of the location vector r. It is defined on the evaluation surface, except for the edges where no averaging area can be constructed.

Note 2 to entry: Example averaging area sizes specified in exposure limits are 1 cm² and/or 4 cm².

¹ To be published.