Innovation, Science and Economic Development Canada
Innovation, Sciences et Développement économique Canada

RSS-102.SAR.SIM
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Draft

Spectrum Management and Telecommunications

Radio Standards Specification

Simulation Procedure for Assessing Specific Absorption Rate (SAR) Compliance in Accordance with RSS-102

Aussi disponible en français – CNR-102.DAS.SIM

Canada

Preface

This Innovation, Science and Economic Development Canada (ISED) radio standard describes the technical requirements and assessment procedures for demonstrating compliance of radio apparatus with the radiofrequency (RF) exposure limits outlined in RSS-102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*, from 100 kHz to 6 GHz. It applies to all radio apparatus producing RF emissions in this range. It also applies to some interference-causing equipment, specifically Industrial, Scientific and Medical (ISM) equipment.

Radio Standards Specification RSS-102.SAR.SIM, issue 1, *Simulation Procedure for Assessing Specific Absorption Rate (SAR) Compliance in Accordance with RSS-102,* replaces Supplementary Procedure SPR-002, issue 2, *Supplementary Procedure for Assessing Compliance of Equipment Operating from 3 kHz to 10 MHz with RSS-102*, dated October 2022.

This document is associated with the modernization of RSS-102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*. All specific absorption rate (SAR)-related procedures using simulations are consolidated into this document to simplify the identification of procedures related to SAR simulation testing.

The content is nearly identical to SPR-002 issue 2, with the following exceptions:

1. the requirements for SAR measurements are located in RSS-102.SAR.MEAS, *Measurement Procedure for Assessing Specific Absorption Rate (SAR) Compliance in Accordance with RSS-102*

2. the requirements for nerve stimulation (NS)-related measurements are located in RSS-102.NS.MEAS, *Measurement Procedure for Assessing Nerve Stimulation (NS) Compliance in Accordance with RSS-102*

3. the requirements for NS-related simulations are located in RSS-102.NS.SIM, *Simulation Procedure for Assessing Nerve Stimulation (NS) Compliance in Accordance with RSS-102*

4. the frequency range is extended from 100 kHz to 6 GHz and the dielectric properties are adjusted, accordingly

5. the SAM phantom is introduced

6. the requirements for calculation of the uncertainty are clarified

7. various editorial changes

Inquiries may be submitted by one of the following methods:

1. Online using the General Inquiry form (in the form, select the Directorate of Regulatory Standards radio button and specify “RSS-102” in the General Inquiry field)

2. By mail to the following address:

   Innovation, Science and Economic Development Canada
   Engineering, Planning and Standards Branch
   Attention: Regulatory Standards Directorate
   235 Queen St
   Ottawa ON K1A 0H5
   Canada

3. By email to consultationradiostandards-consultationnormesradio@ised-isde.gc.ca

Additional information and guidance are available on the Innovation, Science and Economic Development Canada (ISED) web pages Common Questions and Answers and General notices.

Comments and suggestions for improving this standard may be submitted online using the Standard Change Request form, or by mail or email to the above addresses.

All ISED publications related to spectrum and telecommunications are available on the Spectrum management and telecommunications website.

Issued under the authority of
the Minister of Innovation, Science and Industry

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Martin Proulx
Director General
Engineering, Planning and Standards Branch

Contents

1. Scope

This Radio Standards Specification (RSS) sets out the computational electromagnetics simulation methods for assessing compliance of equipment operating in the frequency range from 100 kHz to 6 GHz with specific absorption rate (SAR) limits as outlined in RSS-102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*.

The requirements within this document also apply to wireless power transfer (WPT) source subassemblies, including Type 1, which are classified as interference-causing equipment.

1.1. Purpose and application

RSS-102.SAR.SIM provides general requirements for computational electromagnetics simulation based assessments of RF exposure in the range of 100 kHz to 6 GHz. In this document, the terms computational and simulation are being used interchangeably; they all refer to computational electromagnetics simulations.

The annexes of RSS-102.SAR.SIM are normative. References to annexes in all other documents within this document are normative to this standard.

1.2. Transition period

This document will be in force as of the date of its publication on Innovation, Science and Economic Development Canada's (ISED) website.

A copy of SPR-002, issue 2, may be requested by emailing consultationradiostandards-consultationnormesradio@ised-isde.gc.ca.

2. Normative references

The documents that are listed on the Acceptable Knowledge Database, Other Supplementary Procedures and Notices web page shall be consulted as applicable and available, in conjunction with this RSS.

ISED may consider assessment methods not covered by RSS-102.SAR.SIM or the referenced publications. Consult ISED's Certification and Engineering Bureau website to determine the acceptability of any alternative measurement methods, or send an inquiry by emailing consultationradiostandards-consultationnormesradio@ised-isde.gc.ca with detailed information on the alternative assessment method(s).

3. Definitions, abbreviations/acronyms and quantities

Refer to RSS-102.SAR.MEAS, RSS-102.NS.MEAS, and RSS-102.NS.SIM for the relevant abbreviations/acronyms and quantities.

4. General requirements

The general requirements summarized in section 4 of RSS-102.SAR.MEAS apply for simulation-based analyses. In addition, the requirements in section 4.3 of RSS-102.NS.MEAS are also applicable and shall be applied in RSS-102.SAR.SIM.

5. Computational assessments

This section provides the requirements that are specific to SAR simulation assessments, whether they are performed against the basic restrictions or reference levels.

Its content matches SPR-002 issue 2, published in October 2022, **but excludes NS-related items**.

5.1. Computational tool and method

The computational tool shall be clearly identified in the RF exposure technical brief. Ideally, it should employ one of the following full-wave computational methods:

- finite difference time domain (FDTD)/ finite integration technique (FIT)
- finite element method (FEM)

Computational methods employing quasi-static approximations of Maxwell equations are only acceptable for electrically small applications in the frequency range of 3 kHz to 10 MHz. They shall not be used for EUT operating above 10 MHz.

If a different computational method from the ones identified above is being considered, an inquiry form shall be submitted to ISED, which describes the proposed method and how it can be used to perform a conservative RF exposure assessment.

5.2. Code verification

The selected tool shall be demonstrated to meet the code verification requirements outlined in the international standard that most closely aligns with the chosen technique (e.g. IEC/IEEE 62704-1 for FDTD/FIT or IEC/IEEE 62704-4 for FEM).

5.3. Computational model

This section provides the requirements related to the computational model.

5.3.1. EUT model

The procedure for modelling the EUT shall be described in the RF exposure technical brief. Relevant mechanical dimensions and material properties shall be provided, along with the associated tolerances.

It is often necessary to simplify, omit or substitute certain aspects of the EUT model to reduce simulation times and accommodate memory limitations. A description of these modifications and the expected impact on the assessment results shall be provided in the RF exposure technical brief.

5.3.2. EUT excitation and loading

Refer to 5.3.2 of RSS-102.NS.SIM as the requirements are identical.

5.3.3. Simulation parameters and computational resources

All relevant simulation parameters, such as those related to the meshing, boundary conditions, convergence, etc., as well as the computational resources required to reproduce the simulation results, shall be provided in the RF exposure technical brief.

5.3.4. Phantom properties

The requirements in SPR-002 issue 2, including Section 5.3.4 of RSS-102.NS.SIM, were adapted below in the context of SAR evaluation.

For assessments against the basic restrictions, it is necessary to model a tissue-equivalent phantom within which the induced SAR can be evaluated.

When assessing local exposure in the body, torso or limbs, the flat elliptical phantom defined in IEC/IEEE 62209-1528, with the material properties summarized in table 2 (of IEC/IEEE 62209-1528), may be used. The dimensions of the phantom may be reduced, provided that there is no measurable effect on the assessment results. This shall be demonstrated in the RF exposure technical brief.

When assessing local exposure in the head, the SAM phantom defined in IEC/IEEE 62704-1 or IEC/IEEE 62704-4, with the material properties summarized in table 2 of IEC/IEEE 62209-1528, shall be used. The dimensions of the phantom shall not be altered. This shall be demonstrated in the RF exposure technical brief.

5.3.5. Uncertainty analysis

Refer to 5.3.5 of RSS-102.NS.SIM as the requirements are identical, but with one change outline below.

For the uncertainty of the EUT model calculation in section 5.3.5.3 of RSS-102.NS.SIM, for SAR assessments, the provisions in section 7.3.3 of the IEC/IEEE 62704-1 or IEC/IEEE 62704-4 shall be applied directly.

5.4. Exposure assessments

Once the computational model has been validated, exposure assessments can be performed. This section provides the requirements in this regard.

5.4.1. Exposure scenarios and separation distances

Assessments shall be performed for each exposure scenario and separation distance identified in sections 4.1 and 4.2 of RSS-102.SAR.MEAS, respectively, unless sufficient rationale is provided for a reduced set of worst-case exposure scenarios and separation distances in the RF exposure technical brief.

5.4.2. Assessments against the basic restrictions

This section provides the requirements for computational assessments against the basic restrictions.

5.4.2.1. Phantoms

When performing an exposure assessment against the basic restrictions, a tissue-equivalent phantom as referred to in section 5.3.4 of this document shall be added to the computational model at the corresponding separation distance, and oriented to yield worst-case exposure.

Particular attention shall be given to discontinuities at the head phantom intersections around neck and nose regions. Additional guidance will be given on this matter in subsequent issues of RSS-102.SAR.SIM.

Care should be taken to ensure that the edges and corners of the phantom are not placed in high-field regions, as the induced quantities may become artificially high in these areas.

For the flat phantom, one of the larger surfaces (of the phantom) shall face the EUT such that it captures the highest incident fields.

5.4.2.2. SAR assessment

The 1-g or 10-g averaged SAR shall be evaluated within the phantom in accordance with the relevant international standard (e.g. IEC/IEEE 62704-1 for FDTD/FIT or IEC/IEEE 62704-4 for FEM). The transmit duty cycle(s) that is an inherent property of the technology or of the design of the EUT and is not under user control may be incorporated into the assessment, provided the maximum six-minute-averaged result is captured. Otherwise, a duty cycle of 100% shall be used.

Assuming the associated EUT emissions meet the conditions for a frequency-domain assessment, the SAR-based exposure ratio, $ER_{\mathrm{SAR-BR}}$, can be calculated as follows:

$$ER_{\mathrm{SAR-BR}} = \frac{1}{SAR_{BR}} \sum_{n=1}^{N} SAR(f_n) \quad (1)$$

where:

- SAR_{BR} is the applicable basic restriction for SAR (e.g. 1.6 W/kg averaged in 1-g for head, neck and trunk, 4 W/kg averaged in 10-g for limbs)
- N is the number of frequency components associated with the SAR assessment
- $SAR(f_n)$ is the SAR contribution of the n-th frequency component

One or more plots demonstrating the SAR or $ER_{\mathrm{SAR-BR}}$ distribution within the phantom shall be provided, and the maximum value should be clearly identified. The maximum $ER_{\mathrm{SAR-BR}}$ result shall be reported.

5.4.3. Assessments against reference levels

When neither an assessment against the basic restrictions nor a measurement-based assessment against the reference levels is feasible, a computational assessment against the reference levels shall be performed. This section provides the requirements in this regard, provided that the emissions consist of unmodulated or narrowband modulated carriers, i.e. they meet the requirements for a frequency-domain assessment outlined in section 5.3.3 of RSS-102.NS.MEAS. Otherwise, an inquiry shall be submitted to ISED.

Based on the relevant requirements provided in section 5.4 of RSS-102.NS.MEAS, excluding 5.4.3, the values of $ER_{\mathrm{SAR-ERL}}$ and $ER_{\mathrm{SAR-HRL}}$ shall be computed on the evaluation surface (i.e. at the corresponding separation distance) for each user-accessible side of the EUT.

In addition, plots of the RMS E- and H-fields on each evaluation surface shall be provided. The maximum RMS field level should be clearly indicated on each plot. When the excitation and loading produce multiple frequency components to be included in the assessment, the following procedures shall be followed:

a. if a fixed fundamental, carrier or pulse repetition frequency is employed, provide plots for this frequency and a table summarizing the maximum RMS field levels on the evaluation surface for each frequency component included in the assessment

b. if a variable fundamental, carrier or pulse repetition frequency is employed, follow the requirements in (a) for the frequency yielding the worst-case exposure

c. if multiple fundamental, carrier or pulse repetition frequencies are employed simultaneously, follow the requirements in (a) for each of these frequencies

5.5. Total exposure

Compliance with the limits to prevent the thermal effects is demonstrated if the worst-case total exposure ratios (TERs) corresponding to effect are less than or equal to 1. SAR- and NS-based TERs are evaluated separately, based on the corresponding SAR- or NS-based exposure ratios. Refer to section 8 of RSS-102.

6. RF exposure technical brief

The RF exposure technical brief shall include all information required to reproduce the simulation results, including information related to the test configurations, methods and equipment. Annex A provides a comprehensive list of the required information.

Annex A. Summary of required information for the RF exposure technical brief (normative)

This annex provides a comprehensive summary of the information that must be included in the radio frequency (RF) exposure technical brief to demonstrate compliance with RSS-102.SAR.SIM.

A.1. General information

Table A1 summarizes the general information to be included in the RF exposure technical brief.

Table A1: General information to be included in the RF exposure technical brief

Item description	Related section(s)
Test laboratory information, including Innovation, Science and Economic Development Canada (ISED) recognition and accreditation, as well as the evaluation dates	-
Equipment under test (EUT) use-cases and key RF exposure conditions	4
List of the specific absorption rate (SAR)-based separation distances associated with each individual assessment with sufficient rationale as required	4
Description of the nature, intended purpose and theory of operation of the equipment under test (EUT), including information related to certification (i.e. ISED certification number, HVIN, PMN, HMN etc.)	4
Description of each antenna within the EUT, including the number of elements, element type, input impedance/inductance/capacitance, shielding/field shaping, relevant dimensions and material properties, etc.	4
Description of the waveforms generated by each transmitter within the EUT, including the fundamental wave shape (sinusoidal, triangular, rectangular or otherwise) and frequency, applied modulation and 99% occupied bandwidth (OBW), duty factor, etc.	4
Description of EUT behaviour in each operating state, and the triggering conditions and timings for state transitions	4
Description of the conducted power of excitation level applied to each antenna based on the applicable use-cases and operating states	4

List of the methods used for each assessment against the SAR-based limits with sufficient rationale as required	4
Summary of the exposure ratio results obtained for each assessment along with the worst-case SAR-based total exposure ratios (TERs)	5.5

A.2. Computational assessments

Table A2 summarizes the information to be included in the RF exposure technical brief for computational assessments, whether they be against the basic restrictions or the reference levels.

Table A2: Information to be included in the RF exposure technical brief regarding computational assessments against the basic restrictions and/or reference levels

Item description	Related section(s)
Computational tool and method (i.e. FDTD/FIT and FEM)	5.1
Code verification results (may be included in a separate attachment)	5.2
Description and illustrations of the EUT model, including mechanical dimensions, material properties, tolerances and any simplifications made to achieve practical memory requirements and simulation times	5.3.1
Description and illustrations of the excitation and loading applied to the model, and a comparison between measured and simulated excitations	5.3.2
Summary of the simulation parameters and computational resource requirements, including: a. Computational resources used to perform the assessment b. Minimum computational requirements to reproduce the results c. Conditions for simulation completion, and total simulation time d. Boundary conditions and the size of the computational domain e. Mesh type, mesh settings (density/step sizes, optimization criteria, etc.) and total number of mesh cells f. Any other relevant parameters required to reproduce the results	5.3.3
Shape, dimensions and material properties of the tissue-equivalent phantom for assessments against the basic restrictions	5.3.4

Detailed uncertainty analysis, including: a. Complete uncertainty budget in accordance with the applicable international standard (e.g. IEC/IEEE 62704-1 or 62704-4) b. Description of how each uncertainty value was obtained, including any deviations from the above standards c. Detailed description and illustration of the EUT model validation procedure and results d. Statement of the expanded uncertainty, which should be $\leq 30\%$	**Error! Reference source not found.**
Detailed description of the exposure assessment procedure and results, including all exposure conditions and separation distances, with rationale for reduction to the worst-case configurations	5.4.1
For assessments against the basic restrictions, include: a. Illustration(s) showing the relative positions and orientations of the EUT and tissue-equivalent phantom b. Detailed description of the evaluation procedure for SAR within the phantom c. Plot(s) of the SAR within the phantom d. Locations and values of the maximum SAR-based exposure ratios(i.e. $ER_{\mathrm{SAR-BR}}$)	5.4.2.1 and **Error! Reference source not found.**
For assessments against the reference levels, include: a. Illustration(s) showing the relative positions and orientations of the EUT and evaluation surface(s) b. Plots of the E- and H-field levels on the evaluation surface(s) c. Locations and values of the maximum SAR-based exposure ratio(s) (i.e. $ER_{\mathrm{SAR-RL}}$)	5.4.3

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Annex B. Additional requirements for wireless power transfer (WPT) implementations (normative)

All the requirements stated in annex B of RSS-102.NS.SIM, including annex D of RSS-102.NS.MEAS, are applicable in the context of RSS-102.SAR.SIM.

Rationale for the use of the methods outlined in the above (annex B of RSS-102.NS.SIM and annex D of RSS-102.NS.MEAS) shall be documented in the RF exposure technical brief, along with the assessment results. When the conditions stated in annex B of RSS-102.NS.SIM and/or annex D of RSS-102.NS.MEAS cannot be met, a full computational analysis as per section 5 of this document shall be provided.