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

RSS-102.NS.SIM
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Spectrum Management and Telecommunications

Radio Standards Specification

Simulation procedure for assessing nerve stimulation (NS) compliance in accordance with RSS-102

Aussi disponible en français – CNR-102.SN.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 from 3 kHz to 10 MHz. 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.NS, issue 1, *Assessing NS compliance in accordance with RSS-102,* replaces the following document:

i. 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. All NS-related procedures using simulations are consolidated into this document to simplify the identification of procedures related to NS testing.

The content is nearly identical to SPR-002 issue 2, except for:

1. requirements for SN measurements are now located in RSS-102.NS.MEAS;
2. requirements for SAR-related measurements are now located in RSS-102.SAR.MEAS;
3. requirements for SAR-related simulations will be located in RSS-102.SAR.SIM;
4. requirements for calculation of the uncertainty were clarified; and
5. various editorial changes.

Issued under the authority of the Minister of Industry

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Martin Proulx
Director General
Engineering, Planning and Standards Branch

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 Street
   Ottawa ON K1A 0H5
   Canada
3. By email to consultationradiostandards-consultationnormesradio@ised-isde.gc.ca

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 spectrum and telecommunications related documents are available on ISED’s Spectrum Management and Telecommunications website.

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1. Scope

RSS-102.NS.SIM, issue 1, sets out the computational electromagnetics simulation methods for assessing compliance of equipment operating in the frequency range from 3 kHz to 10 MHz with the RF exposure limits to prevent nerve stimulation (NS) as outlined in RSS-102.

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.NS.SIM provides general requirements for computational electromagnetics-based assessments of RF exposure in the range of 3 kHz to 10 MHz.

The annexes of RSS-102.NS.SIM are normative. References to annexes in RSS-102.NS.MEAS within this document are normative to this standard.

ISED may consider assessment methods not covered by RSS-102.NS.SIM or the normative references listed in section 2. For more information regarding the acceptability of alternative assessment methods, consult the following website. Alternatively, detailed inquiries relating to measurement methods may be submitted to certificationbureau-bureauhomologation@ised-isde.gc.ca, while those relating to computational methods may be submitted to consultationradiostandards-consultationnormesradio@ised-isde.gc.ca.

1.2. Transition period

This document will be in force upon publication on Innovation, Science and Economic Development Canada's (ISED) website. RSS-102.NS.SIM is neither adding nor resetting the transition period for SPR-002 issue 2 that was initiated in October 2022; consequently, the transition period ends on October 4, 2023. Before this date, certification using the requirements of SPR-002, issue 1 or issue 2 will be accepted. After this period, only applications for certification of equipment using RSS-102.NS.MEAS or RSS-102.NS.SIM issue 1, will be accepted and equipment manufactured, imported, distributed, leased, offered for sale, or sold in Canada, shall comply with this issue.

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

2. Normative references

The following documents shall be consulted for the application of RSS-102.NS.SIM. Unless an edition is specified, the most recent versions of these publications shall be considered.

- *Safety Code 6 — Health Canada's Radiofrequency Exposure Guidelines*
- *Technical Guide for Interpretation and Compliance Assessment of Health Canada's Radiofrequency Exposure Guidelines*
- Radio Standards Specification RSS-102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*
- IEC/IEEE 62704-1, Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 1: General requirements for using the finite-difference time-domain (FDTD) method for SAR calculations
- IEC/IEEE 62704-4, Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 4: General requirements for using the finite element method for SAR calculations

3. Definitions, abbreviations and symbols/units

This section provides definitions and abbreviations/acronyms for terms used in this document, as well as the symbols/units used for quantities.

3.1. Definitions

In addition to the definitions in RSS-102, the following definitions are applicable to this standard.

Evaluation surface: The surface upon which incident fields are evaluated in assessments against the reference levels.

Exposure region: The region in space over which an RF exposure assessment is performed. For assessments against the basic restrictions, the exposure region corresponds to the volume of space that would be occupied by a tissue-equivalent phantom, whereas for assessments against the reference levels, it corresponds to the evaluation surface.

Far-field (region): The space around an antenna or other radiating structure where the angular field distribution begins to be essentially independent of the distance from the antenna. In this space, the field has a predominantly plane-wave character. Please refer to TN-261 for further details regarding antenna field regions.

Instantaneous root-mean-square (RMS) value: The square root of the average of the square of the instantaneous waveform amplitude taken throughout one period of the highest frequency component associated with the waveforms generated by a transmitter of the EUT.

Maximum instantaneous root-mean-square (RMS) value: The temporal maximum instantaneous RMS value.

Near-field (region): The volume of space surrounding an antenna or other radiating structure in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point at the same distance from the source. Please refer to TN-261 for further details regarding antenna field regions.

Power transfer management: Capability of some WPT devices to exchange information related to the power transfer operation between the source and client devices for purposes such as detecting invalid client devices or objects, communicating status information, sending commands from the source to the client and sending acknowledgements from the client to the source.

Reactive near-field (region): Sub-region within the near-field region of an antenna or other radiating structure where evanescent fields are dominant. The reactive near-field region extends to a distance of at least $\lambda/2\pi$ from the antenna, where λ is the wavelength in meters. Please refer to TN-261 for further details regarding antenna field regions.

Wireless power transfer (WPT): The transfer of energy from one or more source devices to one or more client devices through electromagnetic waves or fields using magnetic field (inductive or resonant), electric field (capacitive or resonant), or radiative means, with no electrical contact between the source device(s) and client device(s), for the purpose of powering and/or charging the client device(s) wirelessly.

WPT client: A device capable of receiving power wirelessly from a WPT source.

WPT source: A device directly connected (i.e. through a wired connection) to a power source, e.g. AC mains, a battery or some other source of internal or external electrical power, which is capable of wireless power transfer to one or more WPT clients.

3.2. Abbreviations and acronyms

This document uses the following abbreviations and acronyms:

EUT	Equipment under test
EV	Electric vehicle
FDTD	Finite-difference time-domain
FEM	Finite element method
FFT	Fast Fourier transform
FIT	Finite integration technique
ISED	Innovation, Science and Economic Development Canada
NS	Nerve stimulation
OBW	Occupied bandwidth
RBW	Resolution bandwidth
RF	Radio frequency
RMS	Root mean square
SAR	Specific absorption rate
WPT	Wireless power transfer

3.3. Quantities

Table 3-1 lists the quantities used throughout this document along with their internationally accepted SI units.

Table 3-1 – Quantities and constant

Quantity	Symbol	Unit
Magnetic Flux Density	B	tesla (T)
Electric Field Strength	E	volt per meter (V/m)
Frequency	f	hertz (Hz)
Magnetic Field Strength	H	ampere per meter (A/m)
Specific Absorption Rate	SAR	watt per kilogram (W/kg)
Wavelength	λ	metre (m)
Permeability (free space)	μ_0	$4 \cdot \pi \times 10^{-7}$ (H/m)

4. General requirements

The general requirements summarized in section 4 of RSS-102.NS.MEAS apply for simulation-based analyses. The following requirements are in addition to those outlined in section 4 of RSS-102.NS.MEAS.

4.1. Operational description – Antennas

The following operational description of each antenna shall be provided in the RF exposure technical brief in addition to those outlined in section 4.3.2 in RSS-102.NS.MEAS:

- the input impedance, inductance or capacitance of each element, as applicable;
- the method(s) of shielding or field shaping; and
- all relevant material properties, including those of the enclosure(s).

5. Computational assessments

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

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 acceptable for electrically small applications in the frequency range of this document.

Otherwise, an [inquiry]() 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

The excitation(s) applied to the EUT model must match the corresponding transmit waveforms as closely as possible. If these consist of unmodulated or narrowband modulated carriers, i.e. the requirements for a frequency-domain assessment outlined in section 5.3.3 of RSS-102.NS.MEAS are met, the spectrum of the simulated emissions shall include all frequency components for which the field levels exceed the corresponding sensitivity levels specified in section 5.3.5.1 of RSS-102.NS.MEAS. These shall be identified through preliminary measurements, using a field probe which meets the requirements outlined in sections 5.3.5.1, 5.3.5.2, 5.3.5.3 and 5.3.6.2 of RSS-102.NS. MEAS. Relative agreement between the levels of simulated and measured frequency components shall be demonstrated in the RF exposure technical brief. This may be done either by showing:

- plots illustrating good correlation between the simulated and measured values or

- the deviation between the simulated and measured values are within the combined uncertainty using equations 15 and 8 of IEC/IEEE 62704-1 and IEC/IEEE 62704-4, respectively.

If the EUT includes components which are loaded, e.g. a WPT client or an RFID tag, the impact of loading on the emission spectra shall be modelled as closely as possible to ensure that the computational model is able to capture the worst-case exposure ratio(s).

It should be noted that additional requirements related to WPT implementations are provided in Annex B.

For aperiodic or broadband-modulated EUT emissions, an inquiry proposing a conservative excitation and/or load modelling approach shall be submitted to ISED.

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

For assessments against the basic restrictions, it is necessary to model a tissue-equivalent phantom within which the induced SAR and/or internal E-field can be evaluated. At the time of this writing, a general and internationally accepted approach for modelling the interaction between human tissue and RF fields below 10 MHz is not yet available.

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 5-1, 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.

Otherwise, a detailed inquiry proposing a conservative phantom definition shall be submitted to ISED for approval.

Table 5-1 – Tissue-equivalent material properties for a flat and homogeneous phantom intended for assessing local exposure in the body / torso.

Property	Symbol	Value
Dielectric constant	ε_r	55 (-)
Electrical conductivity	σ	0.75 S/m

Mass density	ρ	1000 kg/m^3

Note: The material properties in Table 5-1 stem from IEC/IEEE 62209-1528. Although the requirements in IEC/IEEE 62209-1528 are limited to ≥ 4 MHz, the material properties may be used below 4 MHz for the purposes of RSS-102.NS.SIM.

5.3.5. Uncertainty

This section provides the requirements related to computational uncertainty analysis.

5.3.5.1. General requirements

A complete uncertainty analysis shall be conducted and presented in accordance with the international standard that most closely aligns with the chosen computational method, e.g. IEC/IEEE 62704-1 for FDTD/FIT or IEC/IEEE 62704-4 for FEM. The uncertainty budget, which shall be provided in the RF exposure technical brief, should demonstrate that the expanded (k = 2) uncertainty of the computational model is $\leq 30\%$. Otherwise, an inquiry shall be submitted to ISED.

The steps taken in evaluating each component of the uncertainty budget shall be provided in the RF exposure technical brief.

5.3.5.2. Simulation uncertainty

Deviations from the prescribed procedures for evaluating the various simulation uncertainties may be necessary, as international standards such as IEC/IEEE 62704-1/-4 were not developed for the frequency range covered here. For example:

i. Mesh resolution (FDTD / FIT) – if the requirements provided in section 7.2.3 of IEC/IEEE 62704-1 are too computationally burdensome, this uncertainty may instead be evaluated by increasing the total number of mesh cells by a factor 2 or, when applying sub-gridding, by a factor of 4 in the region of highest exposure (including the source antenna(s)).

ii. Boundary conditions (FDTD / FIT / FEM) – if the requirements provided in section 7.2.4 of IEC/IEEE 62704-1 or section 7.2.3 of IEC/IEEE 62704-4 are too computationally burdensome, this uncertainty may instead be evaluated by increasing the size of the bounding box by 50% in all directions.

iii. Convergence (FDTD / FIT) – if the requirements provided in section 7.2.6 of IEC/IEEE 62704-1 are too computationally burdensome, the following may be applied: the simulation time required for convergence, T_{conv}, shall be long enough to ensure that the maximum RMS field level remains in the same voxel when the simulation time is increased to $1.5\ T_{\mathrm{conv}}$, i.e. that the location of the maximum RMS field level does not change. In addition, the field level associated with this voxel shall not change by more than 2%. Either the E- or H-field may be considered, whichever is dominant in the context of exposure. The percent change in the maximum RMS field level when increasing from T_{conv} to $1.5\ T_{\mathrm{conv}}$ shall be taken as the convergence uncertainty, with a rectangular distribution.

iv. Phantom dielectrics (FDTD / FIT / FEM) – when using the flat and homogeneous phantom with the material properties summarized in Table 5-1, this uncertainty may be set to zero.

For all other deviations, an inquiry shall be submitted to ISED.

5.3.5.3. EUT model uncertainty and validation

A complete uncertainty analysis involves performing measurements to validate the EUT model and determine its uncertainty. For emissions above 4 MHz, this shall be performed in accordance with section 7.3 in IEC/IEEE 62704-1 (FDTD/FIT) or IEC/IEEE 62704-4 (FEM), with IEC/IEEE 62209-1528 serving as a reference for SAR measurements. This extends to emissions below 4 MHz, with the exception of section 7.3.3 in IEC/IEEE 62704-1/-4, which prescribes SAR measurements for validation. While these requirements form the basis for the approach, modifications may be necessary for practical reasons. The following requirements may be applied in lieu of section 7.3.3 in IEC/IEEE 62704-1/-4:

i. Instead of SAR measurements, incident field measurements may be performed throughout the exposure region. This may be limited to either the E- or H-field, if it is demonstrated that the other field does not contribute to the resulting exposure ratio.

ii. Where possible, the worst-case exposure scenario and separation distance(s) shall be considered.

iii. Field probes used to perform the measurements shall meet the requirements outlined in sections 5.3.4, 5.3.5.1, 5.3.5.2 and 5.3.5.3 of RSS-102.NS.MEAS. They should also meet the requirements outlined in sections 5.3.6 of RSS-102.NS.MEAS, otherwise, the effects of spatial averaging and anisotropy shall be incorporated into the validation, either by post-processing the simulated field results or including the probe antenna(s) in the computational model for validation.

iv. When defining the points in space at which measurements will be compared with simulation results, the following considerations apply:

a. Measurements shall be performed at no fewer than 25 points. If possible, these shall be distributed over at least two surfaces, with one being at the separation distance, i.e. on the evaluation surface or nearest surface of the exposure region.
b. If possible, one of the measurement points shall capture the maximum field level within the exposure region.
c. The distance between neighboring measurement points shall not exceed 100 mm, and should be small enough that the difference in neighbouring field levels is less than 6 dB.
d. If possible, the spatial distribution of the measurement points shall be such that a good spread of field levels within 20 dB of the maximum field level is obtained.

v. With regard to the uncertainty budget:
a. The uncertainty of the EUT model may be calculated in accordance with section 7.3.3 in IEC/IEEE 62704-1/-4, but with squared field values, e.g. $|E|^2$ or $|H|^2$, being used in place of SAR values.

The uncertainty of the EUT model based on E-field measurements only may be evaluated according to

$$U_{E,d}[\%] = 100 \times \max \frac{\left|E_{ref}(n) - E_{num}(n)\right|}{E_{refmax}} \quad (1)$$

where
$E_{ref}(n)$ is the experimentally determined local E-field value at position n or its accurate reference solution;
$E_{num}(n)$ is the numerically determined E-field value at position n; and
E_{refmax} is the experimentally determined maximum E-field value of all measured positions or its accurate reference solution.

The E-field values may be replaced with H-field values for the calculation of the H-field uncertainty $U_{H,d}$.
b. The uncertainty of the flat phantom model is zero. If other phantoms are used, a detailed inquiry proposing conservative phantom uncertainty shall be submitted to ISED for approval.
c. The uncertainty of the measurement equipment and procedure shall be estimated as closely as possible based on information provided by the test equipment manufacturer, field probe positioning, etc.

vi. The procedure found in section 7.3.4 of IEC/IEEE 62704-1 (FDTD/FIT) or section 7.3.5 of IEC/IEEE 62704-4 (FEM) shall be followed to demonstrate that the EUT model is valid.

If measurements within the exposure region are prohibited by physical constraints, minor modifications may be applied to the EUT to allow access, provided that they do not have a significant impact on the assessment results. For example, non-conductive enclosure materials may be displaced or removed if it is demonstrated, via simulation or otherwise, that they do not significantly impact the field distribution within the exposure region. Alternatively, individual portions of the EUT may be modelled and validated independently, if it is demonstrated that the overall fields produced by the EUT are equivalent to the superposition of the fields produced by each portion in isolation. If neither option is viable, an inquiry shall be submitted to ISED.

A detailed description of the EUT model validation procedure shall be provided in the RF exposure technical brief, along with model validation results and plots or tables demonstrating agreement between measured and simulated results.

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. Number of assessments

Assessments shall be performed for each exposure scenario and separation distance identified in sections 4.1 and 4.2 of RSS-102.NS.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 sub-section provides the requirements for computational assessments against the basic restrictions.

5.4.2.1. Phantom

When performing an exposure assessment against the basic restrictions, a tissue-equivalent phantom shall be added to the computational model at the corresponding separation distance, and oriented to yield worst-case exposure.

For the flat phantom defined in section 5.3.4, one of the larger surfaces shall face the EUT such that it captures the highest incident fields. 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.

5.4.2.2. Internal E-field

The spatial-peak RMS E-field strength within the phantom shall be identified using the meshing approach of IEC/IEEE 62704-1 for FDTD/FIT or IEC/IEEE 62704-4 for FEM, **but without performing any spatial averaging**. The transmit duty cycle(s) employed by the EUT shall not be incorporated into the assessment as the NS limits are based on instantaneous exposure.

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

$$ER_{\mathrm{NS-BR}} = \sum_{m=1}^{M} \frac{E_{\mathrm{int}}(f_m)}{E_{\mathrm{BR}}(f_m)} \tag{2}$$

where:

- M is the number of frequency components associated with the internal E-field assessment;
- $E_{\mathrm{int}}(f_m)$ is the internal E-field contribution of the m-th frequency component, and
- $E_{\mathrm{BR}}(f_m)$ is the appliable basic restriction for the internal E-field of the m-th frequency component.

Particular care should be taken when evaluating the spatial-peak (maximum internal E-field) as this value may be subject to discretization uncertainties. It is necessary to determine if the spatial-peak obtained is sufficiently converged. This may be evaluated by additional simulations with refined mesh resolution at the location of the spatial-peak. In situations where the spatial-peak is sufficiently converged, an increase of the mesh resolution by a factor of two, should lead to a negligible difference between the original and the new simulation. Where the spatial-peak is not sufficiently converged, there will be a large deviation between the spatial-peaks recorded for both simulations.

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

It is important to note when evaluating internal E-field, the duty cycle(s) employed by the WPT source(s) shall not be incorporated as the corresponding basic restrictions are for instantaneous exposure.

5.4.3. Assessments against reference levels

When neither an assessment against the basic restrictions, nor a measurement-based assessment against the reference levels are 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 in accordance with section 5.3.2.

Based on the relevant requirements provided in section 5 of RSS-102.NS.MEAS, excluding section 5.4.3 of RSS-102.NS.MEAS, the values of $ER_{\mathrm{NS-ERL}}$ and $ER_{\mathrm{NS-HRL}}$ 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:

i. 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;

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

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

5.5. Total exposure

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

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.

If the EUT produces emissions above 10 MHz, additional assessments are required to fully demonstrate compliance. In this case, the RF exposure technical brief shall accommodate any additional reporting requirements identified in the RSS-102 series of standards.

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 RF exposure technical brief to demonstrate compliance with RSS-102.NS.SIM.

A.1. General information

Table A-1 summarizes the general information to be included in the RF exposure technical brief.

Table A-1 – General information to be included in the RF exposure technical brief

Item description	Related section(s)
Test laboratory information, including ISED recognition and accreditation, as well as the evaluation dates	
EUT use-cases and key RF exposure conditions	4
List of the NS-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 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% 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 NS-based limits with sufficient rationale as required	4
Summary of the exposure ratio results obtained for each assessment along with the worst-case NS-based TERs	5.5

A.2. Computational assessments

Table A-2 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 A-2 – 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: i. Computational resources used to perform the assessment ii. Minimum computational requirements to reproduce the results iii. Conditions for simulation completion, and total simulation time iv. Boundary conditions and the size of the computational domain v. Mesh type, mesh settings (density/step sizes, optimization criteria, etc.) and total number of mesh cells vi. 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: i. Complete uncertainty budget in accordance with the applicable international standard, e.g. IEC/IEEE 62704-1 or 62704-4 ii. Description of how each uncertainty value was obtained, including any deviations from the above standards iii. Detailed description and illustration of the EUT model validation procedure and results	5.3.5.1 and 5.3.5.2

iv. Statement of the expanded uncertainty, which should be $\leq 30\%$	
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: i. Illustration(s) showing the relative positions and orientations of the EUT and tissue-equivalent phantom ii. Detailed description of the evaluation procedure for internal E-field within the phantom iii. Plot(s) of the internal E-field within the phantom iv. Locations and values of the maximum NS-based exposure ratios, i.e. $ER_{\mathrm{NS-BR}}$.	5.4.2.1 and 5.4.2.2
For assessments against the reference levels, include: i. Illustration(s) showing the relative positions and orientations of the EUT and evaluation surface(s) ii. Plots of the E- and H-field levels on the evaluation surface(s) iii. Locations and values of the maximum NS-based exposure ratio(s), i.e. $ER_{\mathrm{NS-ERL}}$ and/or $ER_{\mathrm{NS-HRL}}$	5.4.3

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

This annex provides additional requirements specific to WPT implementations.

All the requirements stated in Annex D of RSS-102.NS.MEAS are applicable in the context of RSS-102.NS.SIM; they are not repeated here for brevity. However, additional requirements specific to simulation-based assessments are listed below.

B.1. Computational assessments for small WPT implementations

A simplified and conservative computational assessment method may be applied for devices with WPT source capabilities that meet the following conditions:

- $D_s \leq 20$ cm, where D_s is the maximum linear dimension of the WPT source antenna. If the antenna consists of an array of elements, e.g. coils, electrodes, etc., the entire array needs to meet this condition.

- the device enclosure on the side associated with WPT, e.g. the charging surface, is flat, thus accommodating a flat phantom.

If this is the case, the following procedure may be applied when performing a computational assessment:

i. The EUT may be limited to the WPT source device, i.e. a representative WPT client would not be considered part of the EUT.

ii. The WPT source antenna shall be continuously driven by the maximum current level that the transmitter is capable of supplying.

iii. A flat homogeneous phantom shall be employed at touch position (0 cm), i.e. the outer surface of the phantom is in contact with the enclosure of the WPT source, with the WPT source's charging surface facing the phantom. In addition:
    a. The material properties of Table 5-1 should be used.
    b. The dimensions of the phantom shall be large enough that increasing them in any direction has no measurable impact of the assessment results. They should be more than twice the value of D_s in each direction; however, the depth of the phantom may be smaller if this is demonstrated not to have a measurable impact on the results.
    c. The phantom shall be positioned to ensure maximum exposure, e.g. centred on the WPT source antenna.

iv. Uncertainty analysis and model validation shall be performed as per section 5.3.5.

v. The values of $ER_{\mathrm{SAR-BR}}$ and $ER_{\mathrm{NS-BR}}$ shall be evaluated in accordance with section 5.5, and the corresponding TERs shall be calculated.

Compliance may be demonstrated in this way, provided the following conditions are met:

- $ER_{\mathrm{SAR-BR}} < 0{,}75$ (nominal)
- $ER_{\mathrm{NS-BR}} < 0{,}75$ (nominal)
- $TER_{\mathrm{therm}} \leq 1$
- $TER_{\mathrm{NS}} \leq 1$

Rationale for the use of this method shall be documented in the RF exposure technical brief, along with the assessment results. When the conditions above cannot be met, a full computational analysis as per section 5 shall be provided.