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Spectrum Management and Telecommunications

Radio Standards Specification

Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

Aussi disponible en français – CNR-102

Canada

Preface

Radio Standards Specification (RSS) 102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*, sets out the requirements and measurement techniques for evaluating radio frequency (RF) exposure compliance of radiocommunication apparatus designed to be used within the vicinity of the human body. RSS-102, issue 6, replaces RSS-102, issue 5, dated March 19, 2015.

The main changes are listed below:

1. **New** architecture that reformats RSS-102 as a series of standards:

    - RSS-102 remains the main standard to which RF exposure compliance is evaluated and to which certification is granted

    - A series of new companion standards that need to be used in conjunction with RSS-102 to assess compliance either via measurements or simulations:
        - RSS-102.NS.MEAS
        - RSS-102.SAR.MEAS
        - RSS-102.APD.MEAS
        - RSS-102.IPD.MEAS
        - RSS-102.FRL
        - RSS-102.NS.SIM
        - RSS-102.SAR.SIM
        - RSS-102.APD.SIM
        - RSS-102.IPD.SIM

    - Existing Supplementary Procedures (SPR) documents will be rescinded, and their contents incorporated into specific parts of RSS-102 measurements or simulations companion standards

    - **New** scopes of recognition for Conformity Assessment Bodies

    - **New** radio scope for Certification Bodies

2. **New** exemption limits for nerve stimulation (NS)
3. **New** exemption limits for absorbed power density (APD)
4. **Revised** exemption limits for specific absorption rate (SAR)
5. **New** requirements to assess compliance of hand SAR during voice calls
6. **Revised** maximum separation distance for SAR
7. **New** requirements for sensor validation

Inquiries may be submitted by one of the following methods:

1. Online using the General Inquiry form. Select the Directorate of Regulatory Standards radio button and specify "RSS-102" in the General Inquiry field in the form.

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 documents related to spectrum and telecommunications referred to in this paper are available on ISED's 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 requirements, measurement and simulation techniques to be employed for evaluating RF exposure compliance of radiocommunication apparatus (Category I and Category II equipment) that are designed to be used within the vicinity of the human body. This standard applies to:

- radiocommunication apparatus having an integral antenna,
- systems requiring licensing with detachable antennas offered with the transmitters, or
- licence-exempt transmitters with detachable antennas, as defined in RSS-Gen.

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

This standard shall be used in conjunction with other applicable RSSs. Before the equipment certificate is granted by ISED or by a recognized certification body (CB), the applicant shall demonstrate compliance with all applicable standards, including this one.

1.1. Regulatory requirements

Manufacturers, importers, distributors and vendors have a legal obligation to ensure that Category I radio apparatus introduced in the Canadian marketplace have been certified and comply with applicable technical standards. As per the requirements set forth in section 4(3) of the Radiocommunication Act, “No person shall manufacture, import, distribute, lease, offer for sale or sell any radio apparatus, interference-causing equipment or radio-sensitive equipment for which technical standards have been established under paragraph 6(1)(a), unless the apparatus or equipment complies with those standards.” As per the requirements set forth in RSS-Gen, *General Requirements for Compliance of Radio Apparatus*, “No person shall import, distribute, lease, offer for sale, or sell Category I radio apparatus in Canada unless they are listed on ISED's radio equipment list (REL).”

It is the responsibility of proponents and operators of antenna system installations to ensure that all radiocommunication and broadcasting installations comply with Health Canada’s Safety Code 6 at all times. This includes the consideration of combined effects of nearby installations within the local radio environment. These requirements are specified in *Client Procedures Circular CPC-2-0-03, Radiocommunication and Broadcasting Antenna Systems*.

Proponent is defined in CPC-2-0-03 as anyone who is planning to install or modify an antenna system, regardless of the type of installation or service. This includes, among

other services, cellular, fixed wireless, broadcasting, land-mobile, licence-exempt and amateur radio services.

1.2. Transition period

RSS-102, issue 6, will be in force as of its publication on Innovation, Science and Economic Development Canada's (ISED) website.

However, a transition period of 12 months following its publication is provided, within which compliance with issue 5 or issue 6 of RSS-102 is accepted. After this period, only applications for the certification of equipment under RSS-102, issue 6, will be accepted. Furthermore, after this transition period, equipment that is manufactured, imported, distributed, leased, offered for sale or sold in Canada shall comply with RSS-102, issue 6.

A copy of RSS-102, issue 5, is available upon request by email.

2. References

This section lists the normative references and other external documents referred to in this standard.

2.1. Normative publications

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

- Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz
- Safety Code 6 Notice, Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz
- Technical Guide for Safety Code 6: Health Canada's Radiofrequency Exposure Guidelines

2.2. Priority of normative references

The applicant shall follow the applicable test methods based on the priority list of documents outlined below:

1. RSS-102;
2. IEC and IEEE standards referenced in this document; and
3. Other recognized procedures, such as FCC RF exposure KDB procedures, referenced on the Acceptable knowledge database, other supplementary procedures and notices on ISED's website.

The applicant can consult with ISED if guidance on the priority list of documents is required for the type of radiocommunication apparatus for which regulatory compliance is sought. Requests may be submitted online through the submission of a General Enquiry or through any other method as outlined in the preface.

2.3. Related documents

The documents that are listed on the RSS-102 applicability page shall be consulted, as applicable and available, in conjunction with this RSS.

Commented [SPG(1]: Link will be added when ready and the web page will replace the text shown immediately below.

- RSS-102.NS.MEAS: Measurement procedure for assessing nerve stimulation (NS) compliance in accordance with RSS-102
- RSS-102.SAR.MEAS: Measurement procedure for assessing specific absorption rate (SAR) compliance in accordance with RSS-102
- RSS-102.APD.MEAS: Measurement procedure for assessing absorbed power density (APD) compliance in accordance with RSS-102 (In development)
- RSS-102.IPD.MEAS: Measurement procedure for assessing incident power density (IPD) compliance in accordance with RSS-102
- RSS-102.FRL: Procedure for assessing field reference level (FRL) compliance in accordance with RSS-102 (In development)
- RSS-102.NS.SIM: Simulation procedure for assessing nerve stimulation (NS) compliance in accordance with RSS-102
- RSS-102.SAR.SIM: Simulation procedure for assessing specific absorption rate (SAR) compliance in accordance with RSS-102 (In development)
- RSS-102.APD.SIM: Simulation procedure for assessing absorbed power density (APD) compliance in accordance with RSS-102 (In development)
- RSS-102.IPD.SIM: Simulation procedure for assessing incident power density (IPD) compliance in accordance with RSS-102

3. Definitions, abbreviations/acronyms and quantities

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

The following terms and definitions apply to RSS-102 and its related documents.

Basic restrictions refers to the electric field, magnetic field, or power density limits that are assessed inside the body that should not be exceeded. The basic restrictions are primarily specified in terms of internal electric field strength, the rate of RF energy absorption (SAR) and absorbed power density.

Body-worn (or body-mounted) radio is a wireless transceiver that is designed to be worn or carried on the body of a person. This could include wireless communication devices that are attached to or integrated in clothing or accessories such as lanyards, clothing-integrated devices, or belts.

Controlled use (controlled environment) is the type of approval given to a device that is intended to be used by persons who are fully aware of, and can exercise control over, their exposure. Controlled use devices are not typically available via sales channels/platforms available to the general public nor intended for use by the general public. In addition, they are not installed in public areas.

Computational electromagnetic modelling is a method consisting of using computer simulations to determine compliance against the RSS-102 limits. In this document, the words computational and simulation are interchangeable.

Device refers to a sample unit that is representative of the equipment for which certification is sought. The actual device may be employed if it is available.

Field reference level (FRL) exposure evaluation is the method employed to evaluate the RF field strength or power density generated by a device. Field reference level exposure evaluation is required if the separation distance between the device and the user or bystander is greater than 20 cm. This was referred to as *RF exposure evaluation* in previous versions of RSS-102.

General public use (uncontrolled environment) is the type of approval given to a device that can be used by the general public.

Mobile device is a transmitting device designed to be used in non-fixed locations such that a separation distance greater than 20 centimeters is normally maintained between the RF source's radiating structure(s) and the body of the user and/or bystander.

Output power is defined as the larger of the maximum conducted power or equivalent isotropic radiated power (EIRP), source-based and time-averaged power.

Operating state is the discrete set of configurations and modes of operation for a specific exposure condition. The operating state contains the following parameters:

- modes of operation (e.g. voice mode, hotspot)
- exposure condition
- SAR averaging volume (1 g or 10 g)
- applicable testing distance

The operating state is also known as a device state index in some implementations.

Portable device is a transmitting device designed to be used in non-fixed locations such that the RF source's radiating structure(s) is (are) at 20 centimetres or less of the body of the user and/or bystander.

Radio frequency (RF) exposure refers to human exposure from any and all combinations of NS, SAR, APD, IPD and FRL from a device.

Reference level refers to the electric field, magnetic field, or power density limits that are assessed external to the body.

Separation distance refers to the minimum test separation distance based on the smallest distance between the antenna and radiating structures or the outer surface of the device, according to the most conservative exposure condition for the applicable module or host platform test procedure requirements, to any part of the body or limb of a user or bystander.

Specific absorption rate (SAR) evaluation is the method used to evaluate the SAR levels from a device by physical measurement or simulation by applying computational electromagnetics modelling techniques. SAR evaluation is required if the separation distance between the user or bystanders and the device is less than or equal to 20 cm.

Specific absorption rate (SAR) limit is the limit pertaining to the rate of RF energy absorbed in tissue, per unit mass and which applies to the SAR evaluation.

Tune-up tolerance is the range of expected maximum output power variations from the rated nominal maximum output power specified for the product or wireless mode.

3.2. Abbreviations/acronyms

This document uses the following abbreviations and acronyms:

APD	Absorbed power density
CB	Certification body
CAB	Conformity assessment bodies
CEM	Computational electromagnetics
EIRP	Effective isotropic radiated power
ER	Exposure ratio
EUT	Equipment under test
FRL	Field reference level
IEC	International Electrotechnical Commission

IEEE	Institute of Electrical and Electronics Engineers
IPD	Incident power density
ISED	Innovation, Science and Economic Development Canada
Hz	Hertz
LPD	Localized power density
Meas	Measurements
N/A	Not applicable
NS	Nerve stimulation
PD	Power density
pPD	spatial peak power density
psPD	peak spatial-average power density
RF	Radio frequency
RL	Reference level
RMS	Root mean square
RSS	Radio standards specification
SAR	Specific absorption rate
SI	International system of units
Sim	Simulations
SPLSR	SAR to peak location separation ratio
TER	Total exposure ratio
TR	Technical report
WPT	Wireless power transfer

3.3. Quantities

Table 1 lists the quantities employed throughout this document along with their internationally accepted SI units (where applicable).

Table 1: Quantities and constants

Quantity	Symbol	Unit
Magnetic flux density	B	tesla (T)
Base unit of length	m	metre (m)
Effective isotropic radiated power	$EIRP$	watts (W)
Electric field strength	E	volt per metre (V/m)

Quantity	Symbol	Unit
Exposure ratio	ER	unitless
Frequency	f	hertz (Hz)
Mass	g	grams (g)
Magnetic field strength	H	ampere per metre (A/m)
Current	I	amperes (A)
Total exposure ratio	TER	unitless
Turns	n	unitless
Permeability of free space	μ_0	$4 \cdot \pi \times 10^{-7}$ (H/m)
Power	W	watts (W)
Specific absorption rate	SAR	watt per kilogram (W/kg)
Voltage	V	volts (V)
Wavelength	λ	metre (m)

Note that common SI prefixes are permitted to be employed with the quantities outlined in table 1 where appropriate.

4. Certification requirements

This section specifies the certification requirements.

4.1. General

Compliance assessments in accordance with the guidance provided herein shall be conducted by a wireless device testing laboratory which is recognized by ISED. A list of these laboratories is available on our website.

Recognition is not required to complete FRL calculations. Similarly, recognition is not required for assessment of exemptions in accordance with section 6.

4.2. Application for certification

Compliance with this RSS shall be evaluated in conjunction with the applicable RSS(s) to the frequency band and/or technology that pertains to the equipment for which certification is sought. Devices with a variety of operating characteristics (i.e. subject to NS, SAR, APD, IPD, and/or FRL) shall require certification through the appropriate combination of this and associated documents as outlined in section 2.

4.3. RF exposure technical brief

This section specifies the requirements for the RF exposure technical brief.

4.3.1. General

The applicant shall prepare an RF exposure technical brief that contains information related to the completed evaluations required for the device. Detailed requirements are provided in each applicable document as outlined in sections 2 and 7.

The RF exposure technical brief shall demonstrate that the requirements of this standard have been met and that the appropriate measurement / simulation methods or calculations have been used.

For devices intended for controlled use, the RF exposure technical brief shall also include device operational guidelines that meet the requirements of section 4.5 for user exposure awareness and control.

4.3.2. RF exposure technical brief cover sheet

The information found in the RF exposure technical brief cover sheet (refer to Annex A) shall be taken from the RF exposure technical brief and associated documents as outlined in section 2. The information provided therein shall clearly support the compliance claim.

4.4. Certification process

To obtain certification under this standard, the certification application shall be accompanied by the duly completed and signed SAR, APD and IPD technical brief cover sheet (refer to A.1) or FRL and/or NS technical brief cover sheet (refer to A.2), or both, as applicable. However, if the device in question meets the exemption from routine evaluation limits of section 6, only a signed declaration of compliance needs to be submitted (refer to Annex B).

In addition, submission of the technical brief(s) is required for certification. The submission shall include the appropriate completed technical brief cover sheet(s).

4.5. Manuals requirements

The following sections outline the requirements associated with the contents of a device's manuals.

4.5.1. User manual requirements

The applicant is responsible for providing proper instructions to the user of the radio device and any usage restrictions including limits of exposure durations. The user

manual shall provide installation and operating instructions, as well as any special usage conditions (e.g. proper accessory requirements, including the proper orientation of the device in the accessory and maximum antenna gain in the case of detachable antenna), in order to ensure compliance with applicable limits. For instance, the compliance separation distance shall be clearly stated in a prominent location in the user manual.

> All device operating instructions and installations shall be supported by the test configurations and the test results. **Applying instructions as a substitute for providing test results is unacceptable**. Caution statements or warning labels are only acceptable for alerting users from certain unintended use conditions that are not required for normal operations.

The user manual of devices intended for controlled use shall include:

- information relating to the operating characteristics of the device,
- the operating instructions to ensure compliance with applicable limits,
- information on the installation and operation of accessories to ensure compliance with applicable limits, and
- contact information where the user can obtain Canadian information on RF exposure and compliance.

4.5.2. Module integration manual

In cases where module integration will be performed by the host manufacturer, the module manufacturer shall provide a detailed module integration manual with specific instructions regarding how to configure all of the control and operating parameters that are accessible by the host product for power control to ensure host compliance with the requirements of RSS-102.

When the module is only approved for use by the module manufacturer or specific host manufacturers with whom the module manufacturer will directly engage, the module integration manual may be simplified. In the certification filing, detailed information, including all key configurable parameters, shall be included in the operational description.

4.6. Quality control and post-certification investigations/audits

ISED conducts market surveillance compliance audits and compliance investigations of radiocommunication apparatus placed on the Canadian market (manufacture, importation, distribution, lease, offering for sale, or sale) after certification. In these cases, the certificate holder may be asked to provide records of the quality control process and any other relevant information that would help identify issues in the event of an investigation of non-compliance to ISED. It is expected that all certificate holders will be able to demonstrate a quality control process used for production inspection and testing in accordance with good engineering practices.

5. Exposure limits

This section outlines the exposure limits.

5.1. General

Through this standard, ISED adopts Health Canada's RF exposure guideline entitled *Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz* (Safety Code 6) and its *Notice: Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz*.

Exposure limits are separated in two categories: (1) basic restrictions and (2) reference levels, which are defined in sections 5.2 and 5.3, respectively. Each of these two categories is further subdivided into two subcategories based on the exposure environment: controlled use and uncontrolled use. Uncontrolled use devices are defined as devices for which users have not received proper RF field awareness/safety training and have no means to assess or, if required, to mitigate their exposure to RF fields.

A device would be considered as a controlled-use device when the following criteria are met.

- The user manual requirements of section 4.5 have been met
- The installation manual has been provided and contains sufficient information to ensure normal usage will be maintained
    - The device will be installed in a location or used in an environment that is either inaccessible to the general public or the proximity between the device and the general public is maintained by the user.
- The device will not be made available or sold to the general public
- The user of the device will undergo proper RF field awareness/safety training

For devices intended for controlled use, the RF exposure technical brief shall also include device operational guidelines that meet the requirements of section 4.5.

5.2. Basic restrictions

The basic restrictions outlined in the following sections are based on Health Canada's Safety Code 6 and its Notice. Any updates to Safety Code 6 and/or its Notice will supersede the values outlined herein.

5.2.1. Internal electric field

The limits for the internal electric field strength are intended to prevent the occurrence of NS. The basic restrictions for internal electric field strengths in excitable tissues, as

shown in table 2, shall not be exceeded for frequencies between 3 kHz and 10 MHz, inclusive.

In situations where the determination of internal electric field strength is not possible or practical by measurement or simulation, external unperturbed field strength assessment shall be carried out and the reference levels outlined in section 5.3 shall be respected.

Table 2: Internal electric field strength basic restrictions (3 kHz – 10 MHz)

Condition	Instantaneous RMS internal electric field strength (V_{RMS}/m) (any part of the body)
Controlled environment	$2.7 \times 10^{-4} f$
Uncontrolled environment	$1.35 \times 10^{-4} f$

Note: f is frequency in Hz.

5.2.2. SAR

The SAR limits are summarized in table 3.

Table 3: SAR basic restrictions limits (100 kHz – 6 GHz)

Body Region	Uncontrolled environment average SAR (W/kg)	Controlled environment average SAR (W/kg)	Averaging time (minutes)	Mass average (g)
Whole body	0.08	0.4	6	whole body
Localized head, neck and trunk	1.6	8	6	1
Localized limbs	4	20	6	10

5.2.3. Localized APD

The localized APD limits are summarized in table 4.

Table 4: Localized APD basic restrictions limits (6 GHz – 300 GHz)

Exposure scenario	Local APD (W/m^2)	Exposure duration (minutes)
Controlled environment	100	6
Uncontrolled environment	20	6

- Local APD is to be averaged over a square 4 cm^2 surface area of the body.

- Above 30 GHz, an additional constraint is imposed, the spatial peak exposure. The spatial peak is:
  - two times the limits of the 4 cm^2 restrictions,
  - not averaged over an area.
- Refer to Health Canada's Safety Code 6 and its Notice for relevant notes and additional information.

5.3. Reference levels

The following sections summarize the reference levels associated with NS, SAR and RF field strengths from 3 kHz to 300 GHz.

5.3.1. Electric and magnetic field strength levels (3 kHz – 10 MHz)

The electric and magnetic field strength reference levels for devices employed by the general public (uncontrolled environment) and controlled use devices (controlled environment) are summarized in table 5 and table 6, respectively.

Table 5: Electric field strength reference levels

Frequency range (MHz)	Reference level basis	Reference level (E_{RL}) for uncontrolled environment (V_{RMS}/m)	Reference level (E_{RL}) for controlled environment (V_{RMS}/m)	Reference period
0.003 – 10	NS	83	170	Instantaneous
1.10 – 10	SAR	$87/f^{0.5}$	N/A	6 minutes
1.29 – 10	SAR	N/A	$193/f^{0.5}$	6 minutes

Note: *f* is frequency in MHz.

Table 6: Magnetic field strength reference levels

Frequency range (MHz)	Reference level basis	Reference level (H_{RL}) for uncontrolled environment (A_{RMS}/m)	Reference level (H_{RL}) for controlled environment (A_{RMS}/m)	Reference period
0.003 – 10	NS	90	180	Instantaneous
0.1 – 10	SAR	$0.73/f$	$1.6/f$	6 minutes

Note: *f* is frequency in MHz.

5.3.2. Electric field strength levels, magnetic field strength levels and power density levels (10 MHz–300 GHz)

The electric and magnetic field strength reference levels, power density reference levels, and associated reference period for devices employed by the general public (uncontrolled environment) and controlled use devices (controlled environment) are specified in table 7 and table 8, respectively. Note that the power density limits specified in these tables apply to whole body exposure conditions.

Table 7: RF field strength and power density limits for devices used by the general public (uncontrolled environment)

Frequency range (MHz)	Electric field (V_{RMS}/m)	Magnetic field (A_{RMS}/m)	Power density (W/m^2)	Reference period (minutes)
10 – 20	27.46	0.0728	2	6
20 – 48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48 – 300	22.06	0.05852	1.291	6
300 – 6 000	$3.142\, f^{0.3417}$	$0.008335\, f^{0.3417}$	$0.02619\, f^{0.6834}$	6
6 000 –15 000	61.4	0.163	10	6
15 000 – 150 000	61.4	0.163	10	$616000/f^{1.2}$
150 000 – 300 000	$0.158\, f^{0.5}$	$4.21 \times 10^{-4}\, f^{0.5}$	$6.67 \times 10^{-5}\, f$	$616000/f^{1.2}$

Note: f is frequency in MHz.

Table 8: RF field strength and power density limits for controlled use devices (controlled environment)

Frequency range (MHz)	Electric field (V_{RMS}/m)	Magnetic field (A_{RMS}/m)	Power density (W/m^2)	Reference period (minutes)
10 – 20	61.4	0.163	10	6
20 – 48	$129.8 / f^{0.25}$	$0.3444 / f^{0.25}$	$44.72 / f^{0.5}$	6
48 – 100	49.33	0.1309	6.455	6
100 – 6 000	$15.60\, f^{0.25}$	$0.04138 f^{0.25}$	$0.6455\, f^{0.5}$	6
6 000 – 15 000	137	0.364	50	6
15 000 – 150 000	137	0.364	50	$616000 / f^{1.2}$
150 000 – 300 000	$0.354 f^{0.5}$	$9.40 \times 10^{-4}\, f^{0.5}$	$3.33 \times 10^{-4}\, f$	$616000 / f^{1.2}$

Note: f is frequency in MHz.

5.3.3. Localized IPD

The localized IPD limits and exposure duration above 6 GHz up to 300 GHz are summarized in table 9.

Table 9: Reference levels for local electromagnetic field exposure above 6 GHz and up to 300 GHz

Exposure scenario	Local incident power density (W/m^2)	Exposure duration (minutes)
Controlled environment	$275/f^{0.177}$	6
Uncontrolled environment	$55/f^{0.177}$	6

Note: f is frequency in GHz.

- Localized IPD is to be averaged over a square 4 cm^2 surface area of the body.
- For frequencies above 30 GHz, the spatial peak exposure is an additional constraint. The spatial peak limit is:
  - two times the limits of the 4 cm^2 restrictions,
  - not averaged over an area.
- Refer to Health Canada's Safety Code 6 and its Notice for relevant notes and additional information.

6. Exemption limits for routine evaluations

This section specifies the exemption limits for routine evaluations.

6.1. General

All transmitters are exempt from routine NS, SAR, APD, IPD and/or FRL exposure evaluations provided that they comply with the appropriate requirements specified in the following sections. If the equipment under test (EUT) meets the appropriate requirements outlined in the following sections, applicants are required to submit a properly signed declaration of compliance (refer to Annex B). In addition, the following information, where applicable, shall also be part of the RF exposure technical brief: the root mean square (RMS) current, the number of turns of the coil, the maximum output power, the information that demonstrates how the maximum output power of the transmitter was derived, and the rationale for the separation distances applied (see table 10, table 11 and table 12), which must be based on the most conservative exposure

condition for the applicable radio apparatus module or host platform test procedure requirements.

For an EUT that overlaps a frequency range with 2 types of evaluation (e.g. below 6 GHz and above 6 GHz), both exemption limits (SAR exemption limit and the APD exemption limit) shall be met to be exempt from the routine evaluation(s).

If the EUT does not meet the appropriate exemption limit, a complete NS, SAR, APD, IPD and/or FRL evaluation shall be performed. However, the exemption limits in table 10, table 11 and table 12 may be applied to reduce the number of test configurations (e.g., possibly eliminating the need for testing of a tablet edge). The RF exposure technical brief (refer to section 4.3) shall include a rationale for the separation distances applied, based on the applicable radio apparatus module or host platform test procedure requirements.

It is emphasized that exemption from routine evaluation is **not** an exemption from compliance with the applicable exposure limit(s) and the other relevant requirements.

6.2. NS exemption limits

This section specifies the NS exemption limits.

6.2.1. General

NS exemption limits are limited to near-field (non-radiative) techniques. The following sections outline exemption limits for inductive and capacitive systems.

6.2.2. Inductive systems

This section specifies the NS exemption limits for inductive systems.

6.2.2.1. Limits

Section 6.2.2 applies to inductively-coupled systems which deliver current to a transmission coil to couple energy through the magnetic field to a receiver (e.g., for wireless power transfer).

An inductively coupled system is exempt from routine NS evaluation when the product of the number of turns, n, and RMS current, I_{RMS} (in amperes), in the transmission coil is less than or equal to the result on the right hand side of equation (1), where x represents the separation distance in millimeters between the coil and exposed tissue.

$$nI_{RMS} \leq 24\left(\frac{7.827}{(x+0.2786)^{0.1557}} - 3.953\right)^{-1} \quad (1)$$

The exemption is only valid when:

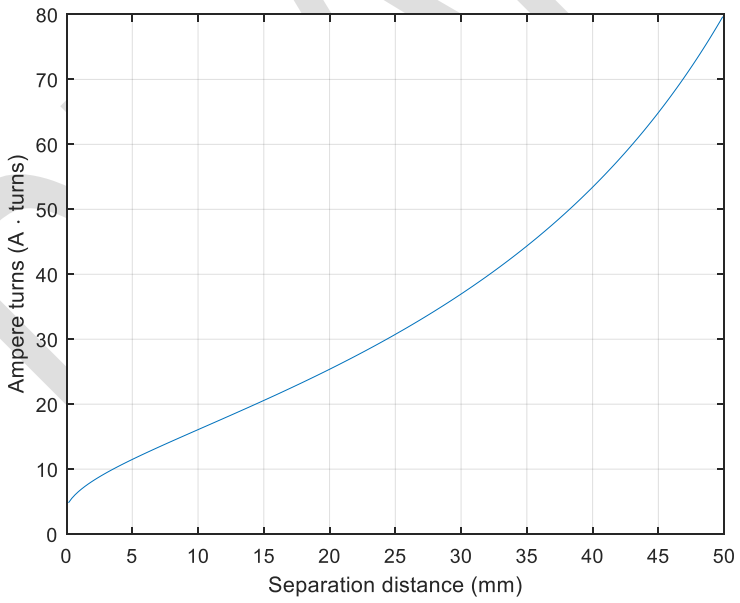
1. the outer dimension of the transmission coil is less than or equal to 100 mm,
2. the geometry of the transmission coil is round or square,
3. the minimum separation distance *x* is greater than or equal to 0.15 mm, and
4. the maximum separation distance *x* is less than or equal to 50 mm.

The thickness of the enclosure is permitted to be included in the separation distance *x*.

This equation is based on an approximation of internal E-fields resulting from general magnetic field sources determined through computational electromagnetic simulations.

Equation (1) is plotted in figure 6-1. Devices with ampere-turns less than or equal to the curve are deemed exempt for the specific separation distances where this occurs. Similarly, the required separation distance for a fixed ampere-turn value corresponds to the appropriate intersection point. Note that the transmitting device might increase the current when the separation distance increases, e.g. based on feedback sent by the receiving device; as such, compliance with the exemption limit needs to be verified for all separation distances allowed in the device's instructions of use.

Figure 6-1: Ampere-turns versus separation for NS exemption limits



The applicable exemption limits for the maximum allowable ampere-turns at specific separation distances is summarized in table 10.

Table 10: NS evaluation exemption limits for routine evaluation

Separation distance (mm)	0.15	5	10	15	20	25	30	35	40	45	50
Maximum ampere-turns ($A \cdot turns$)	4.8	11.4	16.0	20.5	25.3	30.7	36.9	44.3	53.4	64.8	80.0

6.2.3. Capacitive systems

Exemption limits for capacitive systems are not currently available, therefore a detailed NS evaluation as per section 7.3 shall be performed.

6.3. SAR exemption limits

Devices operating at or below the applicable output power level (adjusted for tune-up tolerance) specified in table 11, based on the separation distance, are exempt from SAR evaluation. The separation distance, defined as the distance between the user and/or bystander and the antenna and/or radiating element of the device, shall be less than or equal to 20 cm for these exemption limits to apply.

Table 11: Power limits for exemption from routine SAR evaluation based on the separation distance

Frequency (MHz)	**≤ 5 mm (mW)**	**10 mm (mW)**	**15 mm (mW)**	**20 mm (mW)**	**25 mm (mW)**	**30 mm (mW)**	**35 mm (mW)**	**40 mm (mW)**	**45 mm (mW)**	**> 50 mm (mW)**
≤ 300	45	116	139	163	189	216	246	280	319	362
450	32	71	87	104	124	147	175	208	248	296
835	21	32	41	54	72	96	129	172	228	298
1900	6	10	18	33	57	92	138	194	257	323
2450	3	7	16	32	56	89	128	170	209	245
3500	2	6	15	29	50	72	94	114	134	158
5800	1	5	13	23	32	41	54	74	102	128

The exemption limits in Table 11 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 50 mm from a flat phantom which provides a SAR value of approximately 0.4 W/kg for 1 g of tissue.

For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 11 are multiplied by a factor of 5. For limb-

worn devices where the 10 gram of tissue applies, the exemption limits for routine evaluation in table 11 are multiplied by a factor of 2.5.

When the operating frequency of the device is between two frequencies located in table 11, linear interpolation shall be applied for the applicable separation distance. If the separation distance of the device is between two distances located in table 11, linear interpolation may be applied for the applicable frequency. Alternatively, the closer distance may be employed. For example, the exception value for a 5 mm separation may be employed for a 7 mm separation distance.

For implanted medical devices, the exemption limit for routine SAR evaluation is set at an output power of 1 mW.

The SAR levels from exempted transmitters shall be included in the compliance assessment and the determination of the TER. Detailed guidance is included in sections 7.1.8 and 8.2.2.1.

6.4. Localized APD exemption limits

Devices operating at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distances defined in table 12 are exempt from APD evaluation. The separation distance, defined as the distance between the user and/or bystander and the antenna and/or radiating element of the device, must be less than or equal to 20 cm for these exemption limits to apply.

Table 12: APD evaluation exemption limits for routine evaluation

Freq (GHz)	≤ 5 mm (mW)	10 mm (mW)	15 mm (mW)	20 mm (mW)	25 mm (mW)	30 mm (mW)	35 mm (mW)	40 mm (mW)	45 mm (mW)	> 50 mm (mW)
7	2	13	26	40	57	82	117	161	201	240
9	3	13	21	35	57	80	108	146	186	229
20	3	9	15	24	36	49	65	85	106	131
30	3	14	24	38	56	78	105	137	173	214

The exemption limits in table 12 are based on simulations of half-wave dipole antennas at separation distances of 5 mm to 50 mm from a flat phantom which provides an APD value of approximately 5 W/m^2.

The APD levels from exempted transmitters shall be included in compliance assessments. Detailed guidance is included in sections 7.1.9 and 8.2.2.2.

6.5. IPD exemption limit

A transmitter producing emissions in the 6 – 30 GHz frequency range, i.e. where the occupied bandwidth (99% emission bandwidth) is fully contained within this range, is exempt from routine IPD evaluation if the output power (adjusted for tune-up tolerance) is less than or equal to 1 mW (0 dBm).

IPD from exempted transmitters shall be included in compliance assessments. Detailed guidance is included in section 8.2.2.4.

6.6. Field reference level (FRL) exposure exemption limits

Field reference level (FRL) exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm (i.e. mobile devices), except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}\ W$ (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the EIRP was derived.

7. Evaluation methods

General guidance, evaluation hierarchy, and acceptable evaluation methods for NS, SAR, APD, IPD and FRL are outlined in the following sections.

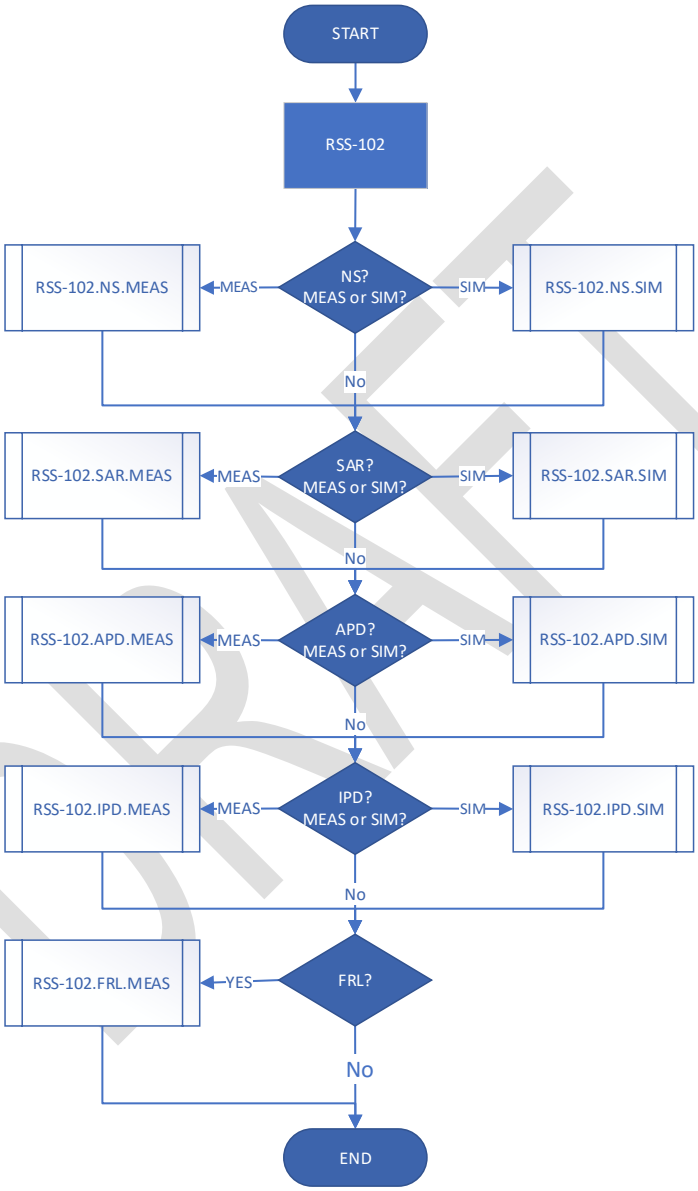
7.1. General guidance

The following sections outline various compliance evaluation methods.

7.1.1. Assessment flowchart

841 Assessments for NS, SAR, APD, IPD and FRL may be completed through any
842 combination of measurements and/or simulations. The flowchart outlined in Figure 7-1
843 provides a method to assess the EUT for each required assessment. Additional details
844 on each assessment method is outlined in the following sections.
845

Figure 7-1: RF exposure assessment flowchart



7.1.2. Measurement-based methods

Measurement-based methods shall include equipment that has a valid calibration certificate for the period during which measurements are completed. Key parameters required to verify the calibration status of each component, devices, apparatus, probes and antennas (*e.g.* dipole antennas) employed during measurements and target values for system validation / system checks shall be recorded in the RF technical brief, this includes calibration certificates for the equipment.

Devices shall be tested with the device transmitting at the nominal rated output power that is defined for post production devices that will be released onto the Canadian market. Tune-up tolerances shall be added to the measured value to obtained the final reported value.

7.1.3. Simulation-based methods

Simulation-based methods include techniques that shall be validated in accordance with international standards, unless stated otherwise. The normative international standards are denoted in the relevant assessment procedure(s).

7.1.4. Test reduction methods

Test reduction methods employed to reduce the testing burden of devices and ensure timely access to the Canadian market are accepted. However, applying test reduction methods does not provide an exemption from compliance with the applicable exposure limit(s) and the other relevant requirements. The use of any test reduction methods for certification purposes does not prevent ISED from employing enforcement measures regarding non-compliances with Health Canada's Safety Code 6 limits specified in this document; including those that are outside of the scope of test reduction methods.

The specific test reduction methods for NS, SAR, APD, IPD and FRL are outlined in each specific standard as summarized in section 2.3.

7.1.5. Devices with multiple transmitters

Devices with multiple transmitters may be subject to evaluation of any combination of the evaluation methods herein.

In addition, all transmitters that transmit simultaneously shall be accounted for in the overall declaration of compliance of the device.

7.1.6. Time-averaged SAR (TAS) algorithms

All new TAS algorithms require approval prior to being added to ISED's list of approved TAS algorithms. ISED approval will be granted following a satisfactory review of the algorithm documentation, and, when deemed necessary, via a physical evaluation.

When submitting an enquiry to ISED, the following information is required:

a. A detailed operational description of the TAS algorithm including any limitations or restrictions on its use (i.e. the TAS algorithm may be limited to use within tablets or laptops and not intended for use in smartphones or small form factor devices such as smart watches etc.).
b. Integration manual which includes a list of all parameters that are configurable for host integration.
c. Validation criteria considerations and validation results on a representative host including detailed descriptions of the procedures and test setup used for validation.

ISED may, at its discretion, request additional information for approval of a TAS algorithm.

The validation criteria shall follow the requirements herein. For implementations falling outside the scope of Annex G of RSS.102.SAR.MEAS, additional validation criteria must be considered to ensure that the implementation can conservatively assess the source-based time-average power over any 6-minute reference period.

TAS algorithm approval packages shall be submitted to ISED via the following email address: certificationbureau-bureauhomologation@ised-isde.gc.ca. It is recommended that “TAS approval package” be included in the subject line of the email.

TAS algorithm approval is a lengthy process which takes **several weeks and in some cases months**, especially, when a physical evaluation is warranted.

Applicants and other responsible parties (e.g. manufacturers, product integrators, CABs) should contact ISED as early as possible to minimize delays.

The TAS algorithm will be listed on ISED's website and an approval letter will be provided to the applicant following a successful review of the TAS approval package. Final products or modules employing the approved TAS algorithm will then be able to undergo the TAS validation procedures outlined in Annex G of RSS-102.SAR.MEAS and other certification requirements. The applicant shall provide the approval letter to the CB. It shall be included as part of the certification filing submitted to ISED for the product to be listed on the REL.

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A similar process is to be followed for Time-averaged PD (TPD) algorithms.

7.1.7. Devices employing sensors or mechanisms to set transmission power levels

RF exposure mitigation strategies employed in devices can include the use of sensors or mechanisms to determine a device operating state. The operating state is employed to select specific output power for transmissions from the device. Sensors or mechanisms used for this purpose shall be validated by the manufacturer where applicable. The implementation of the sensors or mechanisms within a final product shall be validated by an ISED-recognized test laboratory. The validations are required to be completed before a device can be declared compliant to RSS-102.

Examples of sensors or mechanisms that need to be validated include, but are not limited to, the following:

- Proximity sensors
- Motion sensors including, but not limited to, gyroscopes and accelerometers
- Hall effect or gravity sensors
- Voice routing (where the presence of audio is employed to determine operating state)

Requests for guidance may be submitted online through the submission of a general enquiry for situations where ISED approved or standardized test procedures are not available.

7.1.7.1. Manufacturer validation requirements

In the RF exposure technical brief, manufacturers must clearly define which RF exposure mitigation mechanisms are integrated in their device and the validation, which shall include the following:

- The procedures employed to validate the sensor,
- Applicable operating states,
- The threshold(s) or limits used to establish or define a given operating state,
- Details of how the specific threshold(s) was (were) established including how device uncertainties / component specifications were considered in establishing the threshold(s).
    - For example, motion sensors that use accelerometers have a predefined acceleration (in m/s) that is used to distinguish between when a device is in motion and resting on a table.
- Details of all applicable and foreseeable use cases employed to determine thresholds, and
- Measurement results of the validations performed.

The above section (manufacturer validation requirements) applies for all sensor-type validations, except for proximity sensors which shall only be validated using the procedures outlined in section 7.7 of IEC/IEEE 62209-1528.

7.1.7.2. Test laboratory validation requirements

Refer to Annex C for applicable validation procedures that shall be followed. All results shall be reported in the RF exposure technical brief.

7.1.8. SAR estimation for exempted transmitters

SAR values from exempted transmitters must be included in the total exposure assessment. A SAR value of 0.4 W/kg or an estimated SAR value based on the ratio of the power level and the power exemption limit can be used to determine the standalone SAR value for test configurations that do not require a SAR evaluation based on test reductions or on the exemption limits outlined in section 6.3. The estimated SAR value, $SAR_{estimated}$, is calculated using equation (2):

$$SAR_{estimated} = \frac{P_{\max}}{P_{max,exemption}} \times 0.4\ W/kg \quad (2)$$

where:

- P_{max} is the maximum power level including tune-up tolerance for the exempted transmitter,
- $P_{max,exemption}$ is the maximum power level of exemption at the same frequency and distance for the exempted transmitter

For example, transmitter A has a maximum output power of 2 mW and the power exemption threshold is 3 mW at that specific frequency and distance (i.e. 2.45 GHz with a separation distance of 5 mm). The estimated SAR = (2 mW / 3 mW) * 0.4 W/kg = 0.27 W/kg.

The SAR levels from exempted transmitters shall be included in the total exposure ratio assessment. Detailed guidance is included in section 8.2.2.1.

7.1.9. APD estimation for exempted transmitters

APD values from exempted transmitters must be included in the in the total exposure assessment. An APD value of 5 W/m^2 or an estimated APD value based on the ratio of the power level and the power exemption limit can be employed to determine the standalone APD value for test configurations that do not require an APD evaluation based on test reductions or on the exemption limits outlined in section 6.4. The estimated APD value, $APD_{estimated}$, is calculated using equation (3):

$$APD_{estimated} = \frac{P_{\max}}{P_{max,exemption}} \times 5.0\ W/m^2 \quad (3)$$

where:

- P_{max} is the maximum power level including tune-up tolerance for the exempted transmitter,
- $P_{max,exemption}$ is the maximum power level of exemption at the same frequency and distance

For example, transmitter B has a maximum output power of 11 mW and the power exemption threshold is 14 mW at that specific frequency and distance (i.e. 30 GHz with a separation distance of 10 mm). The estimated APD = (11 mW / 14 mW) * 5.0 W/m^2 = 3.9 W/m^2.

The APD levels from exempted transmitters shall be included in the total exposure ratio assessment. Detailed guidance is included in section 8.2.2.2.

7.1.10. Novel products / technologies

An inquiry shall be submitted to ISED for novel products / technologies in the event that published guidance, such as RSSs and/or international standards, is not applicable, available nor listed on ISED list of recognized procedures.

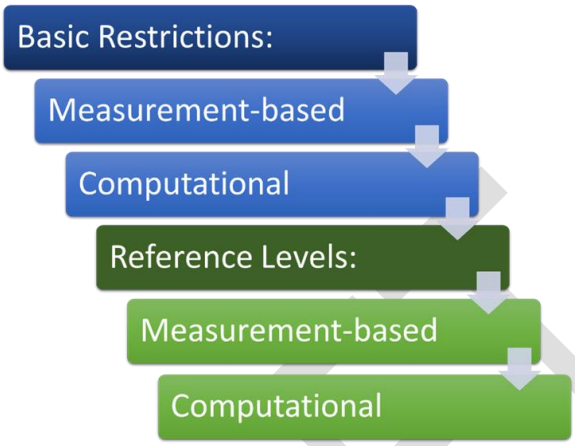
To minimize delay in obtaining regulatory approval, applicants and other responsible parties (e.g. CABs, product integrators) should submit an enquiry to ISED as early as possible. In order for ISED to determine the applicable technical and administrative requirements, the enquiry shall include sufficient information pertaining to the technology and operation of the device such as:

- operational description,
- technologies,
- frequency bands,
- maximum output power specifications,
- intended and foreseeable use cases,
- exposure conditions, and
- proposed method of demonstrating compliance (where possible).

7.2. Assessment Hierarchy

The hierarchy of assessment methods is illustrated in figure 7-2. The requirements relating to each assessment method are provided in the following sections.

Figure 7-2: Assessment method hierarchy



The assessment method hierarchy is based on an approach that is optimized to minimize the amount of analysis required to determine compliance of a device to the exposure limits outlined in section 5. If it is permitted to assess a device against the reference levels, one may choose to perform the assessment via measurements or simulations. If compliance cannot be demonstrated against the reference levels, a subsequent analysis shall be performed against the basic restrictions to demonstrate compliance against the requirements of RSS-102.

7.3. Nerve Stimulation

Devices that operate within the frequency range of 3 kHz to 10 MHz shall have an assessment against NS. Furthermore, portable devices operating between 100 kHz and 10 MHz shall also have an assessment against SAR as outlined in section 7.4.

NS compliance can be determined by measurements or simulations. All measurement-based NS evaluations shall be completed in accordance with RSS-102.NS.MEAS. All computational-based NS evaluations shall be completed in accordance with RSS-102.NS.SIM.

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For NS, a basic restriction assessment is generally preferred, particularly when the exposure region is within the reactive near-field region of the transmitting antenna(s), which is often the case below 10 MHz.

When the practical limitations of the test equipment or tissue-equivalent phantom prohibit a measurement-based assessment, a simulation (computational) assessment against the basic restrictions may be performed.

It is permissible to assess against the reference levels when an assessment against the basic restrictions is not feasible or practical. In these situations, the reference levels become levels that shall not be exceeded.

7.4. SAR

Portable devices operated at 20 cm or less from the body containing a radiating element operating at or below 6 GHz shall undergo a SAR evaluation.

SAR compliance can be determined by measurements or by simulations. All measurement-based SAR evaluations shall be completed in accordance with RSS-102.SAR.MEAS. All computational-based SAR evaluations shall be completed in accordance with RSS-102.SAR.SIM.

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7.5. Localized power density

A power density assessment is required to demonstrate compliance with the requirements of RSS-102. Devices that have a radiating element that operates above 6 GHz and up to 300 GHz shall undergo a power density evaluation. Portable devices operating between 6 GHz and 10 GHz shall normally be assessed in accordance with the requirements for localized APD-based analyses found in section 7.5.1.

Portable devices may be assessed against the reference levels (localized IPD) when an assessment against the basic restrictions is not feasible or practical. In these situations, the reference levels become levels that shall not be exceeded.

Mobile devices should be assessed in accordance with the requirements for localized IPD-based analyses found in section 7.5.2.

7.5.1. Localized absorbed power density

Portable devices operating from 6 GHz to 7.125 GHz shall be assessed in accordance with the requirements outlined in Annex F of RSS-102.SAR.MEAS.

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Localized APD requirements for portable devices operating above 7.125 GHz are currently not available. Meanwhile, these portable devices can be evaluated in accordance with the requirements outlined in section 7.5.2.

7.5.2. Localized incident power density

Localized IPD compliance can be determined by measurements or by simulations. All measurement-based localized IPD evaluations shall be completed in accordance with

RSS-102.IPD.MEAS. All computational-based localized IPD evaluations shall be completed in accordance with RSS-102.IPD.SIM.

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For portable devices operating above 6 GHz, but not in the 60 GHz band, an enquiry shall be submitted to ISED to describe the proposed method and how it can be employed to perform a conservative RF exposure assessment.

7.6. Field reference level (FRL) evaluation

Mobile devices or other apparatus under the scope of RSS-102 requiring an FRL exposure evaluation shall be assessed in accordance with the requirements outlined in the latest version of IEEE C95.3.

If the device is designed such that more than one antenna can transmit at the same time (i.e. simultaneous transmission), the FRL exposure evaluation shall be conducted while all antennas are transmitting. The individual exposure level ratio of each transmitting antenna shall be totalled and used for compliance purposes. Alternatively, a probe shape to the reference levels limits specified in 5.3 with a wide enough bandwidth to capture all the simultaneous transmission can be used to perform the FRL assessment without summing the individual exposure level ratio.

If the device has more than one antenna, but is not designed to have more than one antenna transmit at the same time, the FRL exposure evaluation of the device shall be performed for each of the individually transmitting antennas. The maximum FRL value shall be recorded and used for compliance purposes.

If the device combines groups of simultaneous and non-simultaneous transmitting antennas, the worst-case of the above scenarios applies.

An FRL evaluation is permitted for devices with antennas operating in the far field with separation distance of less than 20 cm; the exposure condition shall be in the far field of the antenna.

8. Total exposure

Compliance with the limits to prevent NS and thermal effects is demonstrated if the worst-case total exposure ratios (TERs) corresponding to each effect are less than or equal to 1. These TERs are evaluated separately, based on the corresponding NS- or thermal-based exposure ratios and in accordance with the following sections.

8.1. NS-based total exposure ratio (3 kHz to 10 MHz)

The frequency range associated with the NS-based limits are outlined in sections 5.2.1 and 5.3.1. As a result, the NS-based TER, denoted by TER_{NS} can be evaluated based on the NS-based exposure ratios obtained in RSS-102.NS.MEAS and/or RSS-102.NS.SIM in equation (4)

$$TER_{\mathrm{NS}} = \sum_{n=1}^{N} ER_{\mathrm{NS-BR},n} + \max\left[\sum_{m=1}^{M} ER_{\mathrm{NS-ERL},m}\,,\ \sum_{m=1}^{M} ER_{\mathrm{NS-HRL},m}\right] \qquad (4)$$

where:

- N is the number of simultaneously operating transmitters for which an assessment against the basic restriction for internal E-field may have been performed,
- $ER_{\mathrm{NS-BR},n}$ is the NS-based exposure ratio of the n-th simultaneously operating transmitter for which an assessment against the basic restriction for internal E-field may have been performed,
- M is the number of simultaneously operating transmitters for which an assessment against the NS-based reference levels may have been performed,
- $ER_{\mathrm{NS-ERL},m}$ is the NS-based exposure ratio of the m-th simultaneously operating transmitter for which an assessment against the NS-based reference level for incident E-field may have been performed and
- $ER_{\mathrm{NS-HRL},m}$ is the NS-based exposure ratio of the m-th simultaneously operating transmitter for which an assessment against the NS-based reference level for incident H-field may have been performed.

The maximum TER_{NS} values shall be provided in the RF exposure technical brief for each exposure condition, and the highest value shall be clearly indicated. Compliance with NS-based limits is demonstrated if the worst-case $TER_{\mathrm{NS}} \leq 1$.

Situations where the $TER_{\mathrm{NS}} > 1$ shall be reported to ISED via an enquiry. Alternative methods considering point-by-point evaluations may be considered on a case-by-case basis.

8.2. Thermal-based total exposure ratio

The thermal-based exposure ratio is divided into two key components: the thermal-based ER at and below 10 MHz, denoted $ER_{\mathrm{therm}\leq 10\ \mathrm{MHz}}$, and the thermal-based ER above 10 MHz, denoted $ER_{\mathrm{therm}>10\ \mathrm{MHz}}$.

The following sections outline these two components.

To evaluate the TER, the NS-based exposure ratio shall not be added to the thermal-based exposure ratios. Each shall be assessed separately.

8.2.1. Thermal-based ER below 10 MHz

The exposure ratio (ER_{EH-SAR}) for transmitters operating between 100 kHz and 10 MHz for which compliance was determined against the SAR-based reference levels for the incident E- and/or H-fields is shown in equation (5)

$$ER_{\mathrm{EH-SAR,a}} = \begin{cases} \left(\frac{H_{SAR,a}}{H_{RL-SAR,a}}\right)^2, & 100\ kHz \le f_a < f_{env} \\ \max\left[\left(\frac{E_{SAR,a}}{E_{RL-SAR,a}}\right)^2, \left(\frac{H_{SAR,a}}{H_{RL-SAR,a}}\right)^2\right], & f_{env} \le f_a < 10\ MHz \end{cases} \quad (5)$$

where:

- $H_{SAR,a}$ is the RMS of the incident H-field from the a-th transmitter, time-averaged in accordance with a SAR-based assessment,
- $H_{RL\text{-}SAR,a}$ is the SAR-based reference level for the incident H-field which is applicable to the a-th transmitter,
- $E_{SAR,a}$ is the RMS of the incident E-field from the a-th transmitter, time-averaged in accordance with a SAR-based assessment,
- $E_{RL\text{-}SAR,a}$ is the SAR-based reference level for the incident E-field that is applicable to the a-th transmitter,
- f_a is the operating frequency of the a-th transmitter and
- f_{env} is 1.10 MHz when considering the limits for uncontrolled environments and 1.29 MHz when considering the limits for controlled environments, in accordance with Health Canada's Safety Code 6.

The exposure ratio resulting from SAR-based assessments on the basic restriction ($ER_{\mathrm{SAR-BR}}$) for transmitters operating at or above 10 MHz is shown in equation (6)

$$ER_{\mathrm{SAR-BR,b}} = \frac{SAR_b}{SAR_{limit-BR}} \quad (6)$$

where:

- SAR_b is the SAR value for the *b*-th transmitter/test frequency and
- $SAR_{limit-BR}$ is the basic restriction limit that is applicable to the *b*-th transmitter / test frequency.

The exposure ratio resulting from a SAR assessments based on the reference level ($ER_{\mathrm{SAR-RL}}$) for transmitters operating at or above 10 MHz is shown in equation (7)

$$ER_{\mathrm{SAR-RL},c} = \frac{SAR_c}{SAR_{limit-RL}} \quad (7)$$

where:

- SAR_c is the SAR value for the *c*-th transmitter/test frequency and
- $SAR_{limit-RL}$ is the basic restriction limit that is applicable to the *c*-th transmitter / test frequency

The ER associated with the thermal-based ER below 10 MHz, $ER_{\mathrm{therm}\leq 10\ \mathrm{MHz}}$ is shown in equation(8)

$$ER_{\mathrm{therm}\leq 10\ \mathrm{MHz}} = \sum_{a=1}^{A} ER_{\mathrm{EH-SAR},a} + \sum_{b=1}^{B} ER_{\mathrm{SAR-BR},b} + \sum_{c=1}^{C} ER_{\mathrm{SAR-RL},c} \quad (8)$$

where:

- *A* is the total number of transmitters for which an assessment against the SAR-based reference levels for the incident E- and H-fields has been performed,
- $ER_{EH\text{-}SAR,a}$ is the exposure ratio contribution from the a-th transmitter for which an assessment against the SAR-based reference levels for the E- and H-fields has been performed as shown in equation (5),
- B is the number of simultaneously operating transmitters for which an assessment against the basic restriction for SAR may have been performed,
- $ER_{\mathrm{SAR-BR},b}$ is the SAR-based exposure ratio of the b-th simultaneously operating transmitter for which an assessment against the basic restriction for SAR may have been performed as shown in equation (6),
- C is the number of simultaneously operating transmitters for which an assessment against the SAR-based reference levels may have been performed and
- $ER_{\mathrm{SAR-RL},c}$ is the SAR-based exposure ratio of the c-th simultaneously operating transmitter for which an assessment against the SAR-based reference levels may have been performed as shown in equation (7).

8.2.2. Thermal-based ER above 10 MHz

Thermal-based ER for transmitters above 10 MHz can be calculated using SAR, APD, and IPD-based measurements/simulation results as outlined in sections 8.2.2.1, 8.2.2.2 and 8.2.2.3, respectively. The exposure from exempted transmitted shall be included in the determination of the thermal-based ER above 10 MHz.

8.2.2.1. SAR-based ER (above 10 MHz to 6 GHz)

The thermal-based ER for transmitters operating above 10 MHz $(ER_{therm>10\ MHz})$ is evaluated based on the operating frequency or test frequency and the type of

measurement or simulation result. The ER resulting from SAR-based measurements/simulations above 10 MHz to 6 GHz can be calculated using equation (9)

$$ER_{therm>10\ MHz,t} = \frac{SAR_t}{SAR_{limit,t}}, 10\ MHz < f_t \leq 6\ GHz \quad (9)$$

where:

- SAR_t is the SAR value of the t-th transmitter/test frequency,
- $SAR_{limit,t}$ is the basic restriction limit that is applicable for the t-th transmitter and
- f_t is the operating frequency / test frequency of the t-th transmitter

The ER resulting from SAR-based exempted transmitters can be calculated using equation (10):

$$ER_{therm>10\ MHz,u} = \frac{SAR_{estimated,u}}{SAR_{limit,u}}, 10\ MHz < f_u \leq 6\ GHz \quad (10)$$

where:

- $SAR_{estimated,u}$ is the SAR value of the exempted u-th transmitter/test frequency (refer to section 7.1.8),
- $SAR_{limit,u}$ is the basic restriction limit that is applicable for the u-th transmitter and
- f_u is the operating frequency / test frequency of the u-th transmitter.

8.2.2.2. APD-based ER (above 6 GHz to 10 GHz)

ER from APD-based measurements above 6 GHz to 10 GHz can be calculated using equation (11):

$$ER_{therm>10\ MHz,v} = \frac{APD_v}{APD_{limit,v}}, 6\ GHz < f_v \leq 10\ GHz \quad (11)$$

where:

- APD_v is the APD value for the v-th transmitter/test frequency,
- $APD_{limit,v}$ is the basic restriction limit that is applicable for the v-th transmitter and
- f_v is the operating frequency / test frequency of the v-th transmitter.

The ER resulting from APD-based exempted transmitters can be calculated using equation (12):

$$ER_{therm>10\ MHz,w} = \frac{APD_{estimated,w}}{APD_{limit,w}}, 6\ GHz < f_w \leq 30\ GHz \quad (12)$$

where:

- $APD_{estimated,w}$ is the APD value of the exempted w-th transmitter/test frequency (refer to section 7.1.9),
- $APD_{limit,w}$ is the basic restriction limit that is applicable for the w-th transmitter and
- f_w is the operating frequency / test frequency of the w-th transmitter.

8.2.2.3. IPD-based ER (above 6 GHz to 300 GHz)

IPD-based measurements above 6 GHz to 30 GHz can be calculated using equation (13):

$$ER_{therm>10\ MHz,x} = \frac{psPD_x}{psPD_{limit,x}}, 6\ GHz < f_x \leq 30\ GHz \quad (13)$$

where:

- $psPD_x$ is the peak spatial-average power density value for the x-th transmitter,
- $psPD_{limit,x}$ is the applicable peak spatial-average power density reference level limit for the x-th transmitter and
- f_x is the operating frequency / test frequency the x-th transmitter.

PD-based measurements above 30 GHz to 300 GHz can be calculated using equation (14):

$$ER_{therm>10\ MHz,y} = \max\left[\frac{psPD_y}{psPD_{limit,y}}, \frac{pPD_y}{pPD_{limit,y}}\right], 30\ GHz < f_y \leq 300\ GHz \quad (14)$$

where:

- $psPD_y$ is the peak spatial-average power density value for the y-th transmitter,
- $psPD_{limit,y}$ is the applicable peak spatial-average power density reference level limit for the y-th transmitter,
- pPD_y is the spatial peak power density value for the y-th transmitter,
- $pPD_{limit,y}$ is the applicable spatial peak power density reference level limit for the y-th transmitter and
- f_y is the operating frequency / test frequency the y-th transmitter.

8.2.2.4. Devices producing emissions in the 6 to 30 GHz range under the 1 mW exemption

The ER for a transmitter producing emissions in the 6 to 30 GHz frequency range and is exempted in accordance with section 6.5 , i.e. where the occupied bandwidth (99% emission bandwidth) and is fully contained within this range shall be accounted for by using equation (15):

$$ER_{exempted_{1mW},z} = 0.1\left(\frac{\max\left[P_{cond,z}, P_{EIRP,z}\right]}{1\ mW}\right) \quad (15)$$

where:

- $ER_{exempted_{1mw},z}$ is the exposure ratio associated with the z-th exempted transmitter,
- $P_{cond,z}$ is the maximum source based, time-averaged conducted power produced by the the z-th exempted transmitter (mW), i.e. delivered to a perfectly matched, load/antenna, adjusted for tune-up tolerance and
- $P_{EIRP,z}$ is the maximum source based, time-averaged EIRP produced by the the z-th exempted transmitter (mW), adjusted for tune-up tolerance.

The exposure ratio contribution from exempted transmitters ($ER_{exempted_{1mW},z}$) shall be included in the TER evaluation for all device surfaces and edges that are within 25 mm of the associated antenna.

8.2.2.5. TER

The various $ER_{therm>10\ MHz}$ from each of the different transmitters and different exposure metrics can be combined to determine the TER for all transmitters ($TER_{therm>10\ MHz}$) using equation (16):

$$\begin{aligned} TER_{therm>10\ MHz} &= ER_{\text{therm}\leq 10\ \text{MHz}} \\ &+ \sum_{t=1}^{T} ER_{therm>10\ MHz,t} + \sum_{u=1}^{U} ER_{therm>10\ MHz,u} \\ &+ \sum_{v=1}^{V} ER_{therm>10\ MHz,v} + \sum_{w=1}^{W} ER_{therm>10\ MHz,w} \\ &+ \sum_{x=1}^{X} ER_{therm>10\ MHz,x} + \sum_{y=1}^{Y} ER_{therm>10\ MHz,y} \\ &+ \sum_{z=1}^{Z} ER_{exempted_{1mW},z} \end{aligned} \quad (16)$$

where:

- T is the number of simultaneously operating transmitters for which an assessment against the basic restriction for SAR may have been performed (refer to section 8.2.2.1),
- U is the number of simultaneously operating exempted transmitters for which an estimate against the basic restriction for SAR may have been performed (refer to section 8.2.2.1),

- V is the number of simultaneously operating transmitters for which an assessment against the basic restriction for APD may have been performed (refer to section 8.2.2.2),
- W is the number of simultaneously operating exempted transmitters for which an estimate against the basic restriction for APD may have been performed (refer to section 8.2.2.2),
- X is the number of simultaneously operating transmitters (operating between 6 GHz and 30 GHz) for which an assessment against the IPD level may have been performed (refer to section 8.2.2.3),
- Y is the number of simultaneously operating transmitters (operating between 30 GHz and 300 GHz) for which an assessment against the IPD level may have been performed (refer to section 8.2.2.3) and
- Z is the number of simultaneously operating transmitters for which the 1 mW exemption as outlined in section 6.5 applies (refer to section 8.2.2.4).

Only contributions from unique transmitters shall be included in the calculation of the $TER_{therm>10\,MHz}$. For instance, both APD and $psPD$ evaluations in the 6 GHz to 10 GHz frequency range for the same transmitter should not be summed; the maximum ER is to be employed in this instance.

Compliance with the SAR-PD-based RF exposure limits is achieved if $TER_{therm>10\,MHz} \leq 1$. Refer to section 8.2.2.6 if $TER_{therm>10\,MHz} > 1$ and if the device contains multiple antennas or multiple transmitters.

8.2.2.6. Devices with multiple antennas or multiple transmitters

The determination of $TER_{therm>10\,MHz}$ in section 8.2.2.5 assumes that all transmitters are simultaneously transmitting from the same location. However, ISED accepts the FCC's SAR to peak location separation ratio (SPLSR) method to determine test reduction for simultaneous transmission when $TER_{therm>10\,MHz} > 1$ for SAR and APD applications (below 10 GHz). The SPLSR is calculated in accordance with equation (17):

$$SPLSR = \frac{\left(\max\left[\frac{SAR_1}{SAR_{limit}}, \frac{APD_1}{APD_{limit}}\right] + \max\left[\frac{SAR_2}{SAR_{limit}}, \frac{APD_2}{APD_{limit}}\right]\right)^{1.5}}{Distance} \qquad (17)$$

where:

- SAR_1 and SAR_2 are the SAR value for the 1st and 2nd transmitter, respectively,
- SAR_{limit} is the applicable basic restriction limit,
- APD_1 and APD_2 is the APD value for the 1st and 2nd transmitter, respectively,
- APD_{limit} is the applicable basic restriction limit and

- *Distance* is the separation distance between the peak exposure location of the 1st and 2nd transmitter in **mm.**

Note: Simultaneously transmitting antenna combinations must be considered one pair at a time to determine SPLSR for test reduction consideration.

Simultaneous transmission testing may be exempted when the transmitters are considered to be spatially separated as follows:

- SPLSR ≤ 0.02 for head, neck and trunk exposure conditions
- SPLSR ≤ 0.013 for limb exposure conditions

To apply SPLSR, the separation distance and configuration for each individual transmitter shall be the same. This may imply conducting additional SAR measurements on test conditions that are normally exempted through test reduction.

All other situations where the TER exceeds unity shall be reported to ISED. Alternative methods considering point-by-point evaluations may be considered on a case-by-case basis. The TER shall be documented in the RF exposure technical brief.

Annex A RF exposure technical brief cover sheet

This annex contains information that shall be included in the technical brief cover sheet.

A.1 SAR, APD and IPD technical brief cover sheet

The worst-case values of SAR, APD and IPD shall be reported in the sections below.

Must report values or enter the following codes: N/A for not applicable, N/P for not performed or N/V for not available. Check the appropriate box where applicable.

Applicant/Product Information			
Company Number:		ISED Certification #:	
PMN:		HMN:	
HVIN:		FVIN:	
Applicant:			

SAR: Head exposure condition			**Test Lab:** _____
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
SAR Value:	_____W/kg	□ Measured	□ Simulated
SAR: Body exposure condition			
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
SAR Value:	_____W/kg	□ Measured	□ Simulated
SAR: Limb exposure condition			
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
SAR Value:	_____W/kg	□ Measured	□ Simulated

APD: Head exposure condition			**Test Lab:** _____
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
APD Value:	_____W/m^2	□ Measured	□ Simulated
APD: Body exposure condition			
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
APD Value:	_____ W/m^2	□ Measured	□ Simulated
APD: Limb exposure condition			
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
APD Value:	_____ W/m^2	□ Measured	□ Simulated

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IPD: Head exposure condition			**Test Lab:** _____
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
IPD Value:	_____ W/m^2	□ Measured	□ Simulated
IPD: Body exposure condition			
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
IPD Value:	_____ W/m^2	□ Measured	□ Simulated
IPD: Limb exposure condition			
Multiple Transmitters:	□ Yes □ No	Duty Cycle:	_____ %
Exposure Limits Used:	□ General Public Use □ Controlled Use	Compliance Dist.:	_____ mm
IPD Value:	_____ W/m^2	□ Measured	□ Simulated

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Declaration of Compliance	
ATTESTATION: I attest that, Annex A and the Technical Brief information was prepared by me and is correct; that the device evaluation was performed or supervised by me; that applicable measurement and evaluation methodologies have been followed; and that the device meets the SAR, APD and/or IPD limits of RSS-102.	
Signature:	
Date:	
Name:	
Title:	

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A.2 Field reference level and/or nerve stimulation technical brief cover sheet

The worst case values of FRL exposure and/or nerve stimulation shall be reported in the sections below. Must report values or enter the following codes: N/A for not applicable, N/P for Not Performed or N/V for Not Available. Check the appropriate box where applicable.

Applicant/Product Information			
Company Number:		ISED Certification #:	
PMN:		HMN:	
HVIN:		FVIN:	
Applicant:			

FRL Exposure Evaluation Information	FRL exposure evaluation Test Lab: _____		
Exposure Limits Used:	□ General Public Use	□ Controlled Use	
Duty Cycle:	_____ %	Compliance Distance: _____	meters(s)
RF Field Strength Value: _____	□ V/m □ A/m □ W/m^2	□ Measured □ Calculated □ Computed	

Nerve Stimulation Exposure Information		NS Test Lab: _____		
Exposure Limits Used:	□ General Public Use	□ Controlled Use		
□ Body/Torso/Head	□ Leg	□ Arm	□ Hand/Foot	
Compliance Distance:	_____ meter(s)			
Electric FS: _____	V/m (RMS)	□ Measured	□ Calculated	□ Simulated
Magnetic FS: _____	A/m (RMS)	□ Measured	□ Calculated	□ Simulated

Declaration of Compliance
ATTESTATION: I attest that the information provided in Annex A2 is correct; that the Technical Brief was prepared and the information contained therein is correct; that the device evaluation was performed or supervised by me; that applicable measurement methods and evaluation methodologies have been followed; and that the device meets the FRL exposure evaluation and/or Nerve Stimulation limits of RSS-102.
Signature:
Date:
Name:
Title:

Annex B Declaration of RF exposure compliance for exemption from routine evaluation limits

Submission of this annex is only required if the device meets the exemption limits for the routine evaluation in section 6 of this standard.

ATTESTATION: I attest that the radiocommunication apparatus meets the exemption from the routine evaluation limits in Section 6 of this standard; that the Technical Brief was prepared and the information contained therein is correct, that the device evaluation was performed or supervised by the undersigned, that applicable measurement methods and evaluation methodologies have been followed and that the device meets the SAR, NS, APD and/or FRL exposure limits of RSS-102.	
Signature	
Date	
Name	
Title	
Company	
Product Marketing Name (PMN)	
Hardware version identification no. (HVIN)	
Firmware version identification no. (FVIN)	
Host marketing name (HMN)	
ISED Certification Number	
Applicable Exemption Limits	☐ NS ☐ APD ☐ FRL ☐ SAR ☐ IPD

Annex C Sensor validation

The following procedures shall be employed for the validation of sensors and/or mechanisms employed for power reduction.

C.1 Proximity sensors

The validation procedures for proximity sensors that shall be followed are outlined in section 7.7 of IEC/IEEE 62209-1528.

C.2 Motion sensors including, but not limited to, gyroscopes and accelerometers

For motion sensors, an enquiry shall be submitted for detailed guidance. Guidance will be based on the draft motion sensor procedures currently being developed in the context of IEC/IEEE 62209-1528.

Upon publication of a revised IEC/IEEE 62209-1528 including the motion sensor procedure, CABs will be able to perform that procedure for device certification in the Canadian market without needing to submit an enquiry to ISED.

C.3 Hall effect or gravity sensors

The following procedure shall be applied for convertible laptops that use Hall effect or gravity sensors to detect lid angle for the purpose of power reduction.

Step 1. With the lid is in closed mode (0 degrees), open the screen in 10 degree increments until a mode transition occurs

Step 2. Lower the screen in 5 degree increments until the previous mode is reobtained.

Step 3. Open the screen in 1 degree increments until the mode transition from step 1 is reobtained.

Step 4. Record the output power measurement and the operating mode.

Step 5. Continue opening the screen in 10 degree increments until the next mode transition occurs.

Step 6. Repeat steps 2 – 5 until all mode transitions have been obtained and evaluated.

Step 7. Reverse this procedure going from tablet mode back to closed mode through all identified modes.

This procedure can be adapted to cover other devices that implement Hall effect or gravity sensors such as folding phones.

C.4 Voice routing (where the presence of audio is employed to determine operating state)

The following procedure shall be employed to verify the differences in device output power during different operating modes. The same technology shall be employed for all of the following steps. Only a single technology / band is required to be tested.

1. Configure the device to be in a call such that voice is routed to the earpiece (e.g. WCDMA AMR voice call)
2. Record the output power and ensure that it is within the specific tune-up tolerance for this operating mode
3. Repeat steps 1 – 2 for any additional configurations involving voice routing to other speakers such as the speakerphone or headsets.

Annex D NS exemption limits examples (informative)

This annex contains two NS exemption limits examples.

D.1 Example I

Consider an inductive WPT system with a planar 10-turn spiral geometry with a maximum outer diameter of 90 mm and driven with a maximum RMS current of 1.0 A. The coil geometry is shown in Figure 8-1: Example I - planar 10-turn spiral inductive WPT coil with an outer diameter of 90 mm. The coil is completely enclosed within an enclosure such that the separation distance between the coil and the nearest outer surface of the enclosure is 5 mm, as shown in Figure 8-3: Example II - planar 25-turn spiral inductive WPT coil with an outer diameter of 60 mm.

Figure 8-1: Example I - planar 10-turn spiral inductive WPT coil with an outer diameter of 90 mm

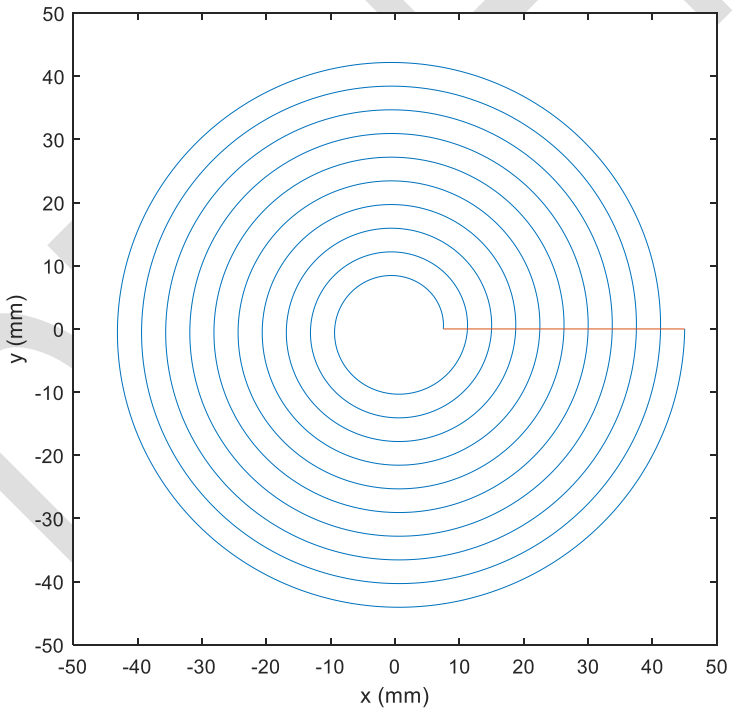
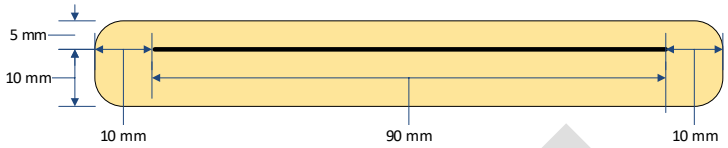


Figure 8-2: Example I - planar 10-turn spiral inductive WPT coil with an outer diameter of 90 mm (side view, through the enclosure)



The product of current and number of turns for this example device is 10 ampere-turns. The minimum separation is 5 mm. The maximum ampere-turns permitted for a separation distance of 5 mm is 11.4 ampere-turns. Consequently, the coil and geometry outlined in this example is exempt since the maximum ampere-turns for the example is less than the exemption limit for the specified separation distance.

D.2 Example II

Consider an inductive WPT system with a planar 25-turn spiral geometry with a maximum outer diameter of 60 mm and driven with a maximum RMS current of 0.5 A. The coil geometry is shown in Figure 8-3: Example II - planar 25-turn spiral inductive WPT coil with an outer diameter of 60 mm. The coil is completely enclosed within an enclosure such that the separation distance between the coil and the nearest outer surface of the enclosure is 2 mm, as shown in Figure 8-3: Example II - planar 25-turn spiral inductive WPT coil with an outer diameter of 60 mm.

Figure 8-3: Example II - planar 25-turn spiral inductive WPT coil with an outer diameter of 60 mm

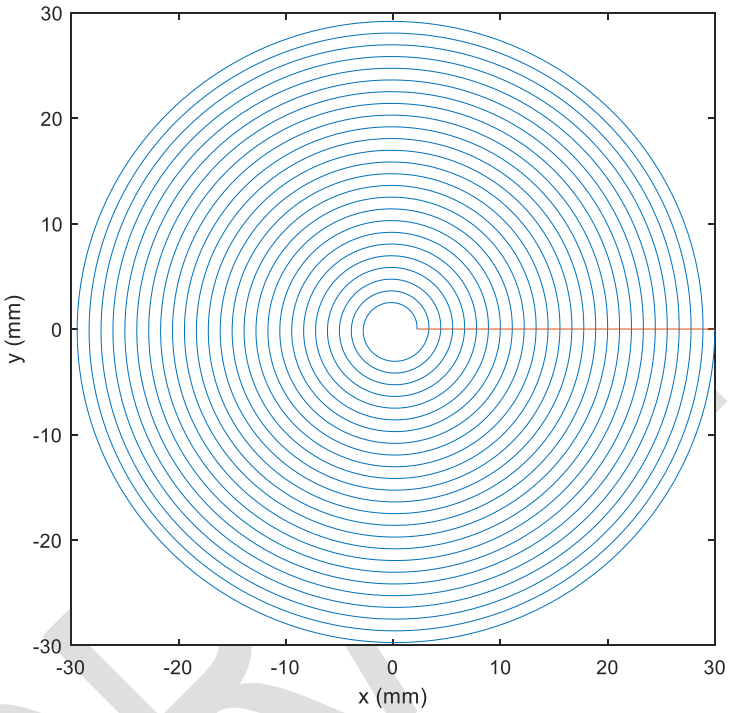
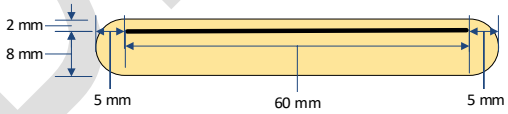


Figure 8-4: Example II - planar 25-turn spiral inductive WPT coil with an outer diameter of 60 mm (side view, through the enclosure)



The product of current and number of turns for this example device is 12.5 ampere-turns. The minimum separation is 2 mm. The maximum ampere-turns permitted for a separation distance of 2 mm is not included in table 10 and difficult to determine from Figure 6-1; therefore equation (1) must be employed to determine if this application is exempt. The right hand side of equation (1) calculated to be 8.2; the product of ampere-turns in this example is greater than the calculated term on the right hand side of equation (1). Consequently, this application is not exempt and a detailed NS evaluation

is required to be completed in accordance with RSS-102.NS.MEAS or RSS-102.NS.SIM.

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