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Radio Standards Specification

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

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Canada

Preface

Radio Standards Specification 102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*, sets out the requirements and measurement techniques used to evaluate radio frequency (RF) exposure compliance of radiocommunication apparatus designed to be used within the vicinity of the human body.

RSS-102, Issue 5, will be in force immediately for the purposes of certifying new equipment. All devices currently certified that are manufactured, imported or sold in Canada must be in compliance with the revised standard 180 days after its publication on the Industry Canada website — no matter when they were originally certified. Some requirements will not be in force immediately as outlined in Notice 2015-DRS001 available at http://www.ic.gc.ca/eic/site/ceb-bhst.nsf/eng/h_tt00080.html.

Changes:

(1) **Section 1:** Clarification related to the scope of the standard has been made.

(2) **Section 1.1:** The definitions of *limb-worn devices* and *separation distance* have been added, and the definition of *RF exposure evaluation* and *controlled use* has been revised.

(3) **Section 2.2:** Clarification related to the RF exposure technical brief has been made.

(4) **Section 2.5.1:** Exemption limits for routine evaluation -SAR evaluation have been revised.

(5) **Section 2.5.2:** Exemption limits for routine evaluation -RF exposure evaluation have been added.

(6) **Section 2.6:** Clarification related to the user manual has been made.

(7) **Section 3:** Clarification on test reduction and fast SAR methods and on the priority list of documents has been made.

(8) **Section 3.1:** Clarification on the following items has been made: devices with push-to-talk capability; on the test distance for certain types of devices; for devices with a very low transmission duty factor; and on the test channel to first be tested in a SAR evaluation.

(9) **Section 3.1.1:** The SAR measurement method for body-worn devices has been revised.

(10) **Section 3.1.2:** The SAR Measurement of Devices Containing Multiple Transmitters has been revised.

(11) **Section 3.1.3:** Clarification has been made on the SAR measurement for specific technology and other types of devices.

(12) **Section 4:** The Safety Code 6 limits have been revised and clarification on the averaging time for SAR evaluation has been made.

(13**) Annex A:** Clarification has been made related to the standard(s) and/or procedure(s) used for the evaluation and an addition of the Industry Canada (IC) Certification Number and the name of the SAR/RF exposure testing laboratory has been entered.

(14) **Annex B:** A revision has been made to add the Product Marketing Name (PMN), Hardware Version Identification Number (HVIN), Firmware Version Identification Number (FVIN), Host Marketing Number (HMN) and the IC Certification Number.

(15) **Annex C:** A revision has been made to add the Product Marketing Name (PMN), Hardware Version Identification Number (HVIN), Firmware Version Identification Number (FVIN), Host Marketing Number (HMN) and the IC Certification Number; clarification has been made related to the submission.

(16) **Annex E:** Clarification has been made related to operating tolerance and the local SAR measurement; additional reporting requirements for test reduction and fast SAR methods were added.

Issued under the authority of
the Minister of Industry

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DANIEL DUGUAY
Acting Director General
Engineering, Planning and Standards Branch

Contents

1. Scope

This Radio Standards Specification (RSS) sets out the requirements and measurement techniques used to evaluate 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 sold with the transmitters or licence-exempt transmitters with detachable antennas, as defined in RSS-Gen.

This standard shall be used in conjunction with other applicable RSSs. Before the equipment certificate is granted by Industry Canada or by a recognized Certification Body (CB), the applicant shall demonstrate compliance with all applicable departmental standards.

It is the responsibility of proponents[1] and operators of antenna system installations to ensure that all radiocommunication and broadcasting installations comply at all times with Health Canada's Safety Code 6, including 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*.

1.1 Definitions

The following terms and definitions apply to this standard:

Body-supported device is a device whose intended use includes transmitting with any portion of the device being held directly against a user's body.[2]

Body-worn (or body-mount) radio is a wireless transceiver that is normally operated (or intended to be used) while it is placed in the pocket of a garment, or is maintained close to the body by means of a belt clip, holster, pouch, lanyard or similar mechanism.

Controlled use 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 typically installed in non-public areas and are not intended for use by members of the general public.

Controlled use limit refers to the SAR and RF field strength limits that apply to devices approved for controlled use (controlled environment).

Device refers to a sample unit, representative of the equipment for which certification is sought.

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1 "Proponent" is defined 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, Personal Communications Services (PCS) and cellular, fixed wireless, broadcasting, land-mobile, licence-exempt and amateur radio services.

2 This differs from a body-worn or body-mount radio in that it is not attached to a user's body by means of a carry accessory. A portable computer with an external antenna plug-in radio card (e.g. PCMCIA card) and a portable computer with an antenna located in the screen section are examples of body-supported devices.

General public limit refers to the SAR and RF field strength limits that apply to devices approved for general public use (uncontrolled environment).

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

Limb-Worn Device refers to a device[3] containing one or more wireless transmitters or transceivers that is designed or intended for use on or to be operated only by the limbs. It includes being strapped to the arm or leg of the user while transmitting (except in idle mode).

RF exposure evaluation is the method used to evaluate the RF field strength levels generated by a device. RF exposure evaluation is required if the separation distance between the user or bystander and the device is greater than 20 cm.

RF field strength limit refers to the limit pertaining to an electric field, a magnetic field or a power density that applies to the RF exposure evaluation.

Separation distance (per the power exemption limits) 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 extremity of a user or bystander (refer to Table 1).

Specific absorption rate (SAR) evaluation is the method used to evaluate the SAR levels from a device by physical measurement or computational 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.

2. Certification Requirements

2.1 Application for Certification

Compliance with this RSS shall be evaluated in the context of an application for certification submitted under the RSS(s) applicable to the frequency band and/or technology that pertains to the equipment for which certification is sought.

2.2 RF Exposure Technical Brief

The applicant shall prepare an RF exposure technical brief that contains information related to the SAR evaluation (see Annex E) or RF exposure evaluation of the device, including the exact test configuration(s), equipment calibrations, equipment and measurement/computational uncertainty budgets, system validation/system check, tissue dielectric parameters, maximum output power or single

[3] The localized limb limits are typically applicable to limb-worn devices.

point SAR measured before and after each SAR measurement (drift), test reduction and fast SAR techniques, as well as all other relevant technical information. Device test positions shall be documented, including graphical representations showing separation distances and tilt angles used during the evaluation. The rationale for the selection of the separation distance(s) between the device and the phantom shall be included in the RF exposure technical brief. Close-up photos of the actual device in the various test positions shall also be included. The reported SAR or field strength/power density values shall be scaled to the maximum tune-up tolerance of the device.

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

For devices approved for controlled use, the RF exposure technical brief shall also include device operational guidelines that meet the requirements of Section 2.6 for user exposure awareness and control.

2.3 RF Technical Brief Cover Sheet

The information found in the RF technical brief cover sheet (see Annex A) shall be taken from the RF exposure technical brief. The information provided therein shall clearly support the compliance claim.

2.4 Approval Process

To obtain approval under this standard, the above-mentioned application for certification shall be accompanied by the duly completed RF technical brief cover sheet (see Annex A) and a properly signed declaration of compliance (see Annex B). However, if the device in question meets the exemption from routine evaluation limits of sections 2.5.1 or 2.5.2, only a signed declaration of compliance needs to be submitted (see Annex C).

In addition, submission of the RF exposure technical brief is now required for certification. It shall be accompanied by the completed RF technical brief cover sheet.

2.5 Exemption Limits for Routine Evaluation

All transmitters are exempt from routine SAR and RF exposure evaluations provided that they comply with the requirements of sections 2.5.1 or 2.5.2. If the equipment under test (EUT) meets the requirements of sections 2.5.1 or 2.5.2, applicants are only required to submit a properly signed declaration of compliance (see Annex C). The information contained in the RF exposure technical brief may be limited to the value(s) of 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 1), which must be based on the most conservative exposure condition for the applicable module or host platform test procedure requirements.

If the EUT does not meet the appropriate exemption limit, a complete SAR or RF exposure evaluation shall be performed. However, the power exemption limits in Table 1 can be applied to reduce the number of test configurations (e.g. testing of a tablet edge). The RF exposure technical brief (see

Section 2.2) must include a rationale for the separation distances applied based on the applicable module or host platform test procedure requirements.
It must be emphasized that the above exemption from routine evaluation is **not** an exemption from compliance.

2.5.1 Exemption Limits for Routine Evaluation – SAR Evaluation

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance[4,5]

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

4 The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

5 Transmitters operating between 0.003-10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF 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, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. 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 e.i.r.p. 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 e.i.r.p. 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 e.i.r.p. 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 e.i.r.p. 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 e.i.r.p. was derived.

2.6 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 operation instructions,[7] as well as any special usage conditions (e.g. proper accessory required, including the proper orientation of the device in the accessory, maximum antenna gain in the case of detachable

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6 Transmitters operating between 0.003-10 MHz, meeting the exemption from routine RF Exposure evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

7 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.

antenna), in order to ensure compliance with SAR and/or RF field strength limits. For instance, compliance distance shall be clearly stated in the user manual.

The user manual of devices intended for controlled use shall also include information relating to the operating characteristics of the device; the operating instructions to ensure compliance with SAR and/or RF field strength limits; information on the installation and operation of accessories to ensure compliance with SAR and/or RF field strength limits; and contact information where the user can obtain Canadian information on RF exposure and compliance. Other related information may also be included.

2.7 Quality Control and Post-Certification Investigations/Audits

Industry Canada will conduct market surveillance compliance audits and compliance investigations from time to time, after certification, of radiocommunication apparatus intended for sale in Canada. In the event of an investigation of non-compliance, the certificate holder will be asked to provide to Industry Canada records of the quality control process and any relevant information that would help identify issues related to compliance. 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.

3. Evaluation Methods

Devices that have a radiating element normally operating at or below 6 GHz, with a separation distance of up to 20 cm between the user and/or bystander and the device, shall undergo a SAR evaluation. Devices that have a radiating element normally operating at or below 6 GHz, with a separation distance greater than 20 cm between the user and/or bystander and the device shall undergo an RF exposure evaluation. However, a SAR evaluation may be performed in lieu of an RF exposure evaluation for devices operating below 6 GHz with a separation distance of greater than 20 cm between the user and/or bystander and the device. Devices operating above 6 GHz regardless of the separation distance shall undergo an RF exposure evaluation.

SAR evaluations shall be made in accordance with the latest version of IEEE 1528[8] and/or IEC 62209.[9] However, the applicant shall consult with Industry Canada prior to initiating the certification process if the sections on test reductions[10] and fast SAR evaluations[11] within IEC 62209 are to be applied for the determination of regulatory compliance of the radiocommunication apparatus.

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8 IEEE 1528: *Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques*.

9 IEC 62209: *Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures*.

10 The applicant is not required to consult with Industry Canada if the test reductions or fast SAR methods are based on the normative sections of the IEEE 1528 standard. The applicant is not required to consult with Industry Canada if the test reductions are based on the Federal Communications Commission (FCC) Knowledge Database (KDB) procedures referenced in this standard.

For SAR probe calibration and system verification for measurements between 100 MHz and 300 MHz, the procedures[12] established by the U.S. Federal Communications Commission (FCC) can be used as an interim measure until IEEE 1528 and IEC 62209 have incorporated the extended frequency range.

RF exposure evaluation shall be made in accordance with the latest version of IEEE C95.3.[13]

Note: The applicant must follow the applicable test methods based on the priority list of documents. The priority list[14] is as follows:

(1) RSS-102,
(2) IEC and IEEE standards referenced in this document, and
(3) Other recognized procedures, such as the FCC RF exposure KDB procedures referenced in this document.

3.1 SAR Measurements

In addition to the above-mentioned SAR standards, the following provisions shall apply when performing a SAR evaluation:

- If a device has push-to-talk capability,[15] a minimum duty cycle of 50% (on-time) shall be used in the evaluation. A duty cycle lower than 50% is permitted only if the transmission duty cycle is an inherent property of the technology or of the design of the equipment and is not under user control. Proof of the various on-off durations and a detailed method of calculation of the average power shall be included in the RF exposure technical brief. Maximum average power levels shall be used to determine compliance.

- For devices without push-to-talk capability, the duty cycle used in the evaluation shall be based on the inherent property of the transmission technology or of the design of the equipment.

- If the device is designed to operate in front of the mouth, such as PTT radio, it shall be evaluated with the front of the device positioned at 2.5 cm from a flat phantom. For wristwatch and wrist–worn transmitters in speaker mode for voice communication, evaluations shall be conducted with the front

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11 *Ibid.*

12 List of accepted FCC RF exposure KDB procedures, other applicable procedures and notices related to SAR measurements can be found at the following link: http://www.ic.gc.ca/eic/site/ceb-bhst.nsf/eng/h_tt00080.html.

13 IEEE C95.3-2002: *IEEE recommended practice for measurements and computations of radio frequency electromagnetic fields with respect to human exposure to such fields, 100 kHz-300 GHz*.

14 The applicant can consult with Industry Canada if guidance on the priority list of documents is required for the type of radiocommunication apparatus for which regulatory compliance is sought.

15 List of accepted FCC RF exposure KDB procedures, other applicable procedures and notices related to SAR measurements can be found at the following link: http://www.ic.gc.ca/eic/site/ceb-bhst.nsf/eng/h_tt00080.html.

of the devices positioned at 1.0 cm from the flat phantom. If the device is also designed to operate when placed next to the cheek and ear, it shall also be tested against the SAM phantom.

- For low transmission duty factor devices (e.g. point-of–sale (POS) devices, black and white e-readers, and location trackers) that only transmit intermittently in data mode, without voice capability, an exemption from routine SAR evaluation is deemed acceptable if the exemption limits from routine evaluation (Table 1) are met by applying the worst-case or most conservative transmission duty factor. The supporting details for determining the duty factor with respect to the design, implementation, operating configurations and exposure conditions of the devices must be fully documented in the RF exposure brief.

- SAR evaluation of medical implants (e.g. Medical Implant Communication Systems (MICS) and Medical Implant Telemetry System (MITS)) devices shall be performed by physical measurement or by computational modelling.

- The mid-channel of a transmission band shall first be tested in the SAR evaluation. However, if the variation of the maximum output power across the required test channels is more than 0.5 dB above the output power of the mid-channel, the channel with the highest output power shall first be tested (if different from the mid-channel). The method for determining the maximum output power, as well as the value of each channel, shall be documented in the RF exposure technical brief.

3.1.1 SAR Measurement of Body-Worn Devices

In addition to the SAR standards mentioned in Section 3, the following provisions shall apply when performing SAR measurements for body-worn devices:

- Body-worn accessories (e.g. belt clips and holsters) shall be attached to the device and positioned against the flat phantom in normal use configurations.

- When multiple accessories supplied with the device or made available by the manufacturer for the device contain no metallic component, the device shall be tested with the accessory that provides the shortest separation distance between the device and the body.

- When multiple accessories supplied with the device or made available by the manufacturer for the device contain metallic components, the device shall be tested with each accessory containing a unique metallic component. If multiple accessories share the same metallic component, only the accessory providing the shortest separation distance between the device and the body shall be tested.

- If accessories are neither supplied nor made available by the manufacturer, a conservative minimum separation distance based on off-the-shelf body-worn accessories should be used to test body-worn devices. A separation distance of 15 mm or less between the device and the phantom is required. The device shall be positioned with either its back surface or front surface toward the phantom, whichever will result in the higher SAR value. If this cannot be determined, both positions shall be tested and the higher of the two SAR values shall be included in the RF technical brief cover sheet. The selected separation distance shall be clearly explained in the RF exposure technical brief to support the body-worn accessory test configurations.

- Body-worn devices that are designed to operate on the body using lanyards or straps shall be tested using a test separation distance of 5 mm or less.

- The head or body tissue equivalent liquid (see Annex D) for SAR measurement of body-worn devices shall be used. Information related to the tissue equivalent liquid shall be included in the RF exposure technical brief.

3.1.2 SAR Measurement of Devices Containing Multiple Transmitters

Compliance of devices with multiple transmitters capable of simultaneous transmission shall be assessed in accordance with the latest version of IEEE 1528. However, other recognized methods — such as the procedures[16] published by the FCC proven to provide a conservative estimate of the SAR value — can also be used. Applicants shall include in the RF exposure technical brief all information relevant to the exact test methodology used.

3.1.3 Other SAR Measurement Procedures Related to Specific Technologies and Types of Devices

SAR measurement procedures related to specific technology (e.g. 3G and other technologies, such as CDMA2000, Ev-Do, WCDMA and LTE), 802.11 a/b/g transmitters, 802.16e/WiMAX devices, and different types of devices (such as tablets, notebooks, netbooks and laptop computers with built-in antennas on display screens or located within the chassis), as well as licensed and licence-exempt modular transmitters, are not covered by the current international standards in Section 3. Until these standards contain the measurement procedures for these specific technologies and types of devices, the FCC's published procedures can be used as an interim measure. A complete list of accepted FCC's KDB procedures related to SAR measurements can be found on Industry Canada's Certification and Engineering Bureau website.[17] In addition, other recognized methods can be used, if deemed acceptable by Industry Canada, prior to initiating the certification process. Applicants shall include all information relevant to the exact method used in the RF exposure technical brief.

3.2 RF Exposure Evaluation of Devices

A device requiring an RF exposure evaluation shall be made in accordance with the latest version of IEEE C95.3.

If the device is designed such that more than one antenna can functionally transmit at the same time, the RF exposure evaluation shall be conducted while all antennas are transmitting. The individual exposure level ratios shall be totalled and used for compliance purposes.

If the device has more than one antenna, but is not designed to have more than one antenna functionally transmit at the same time, the RF exposure evaluation of the device shall be performed for each of the

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16 List of accepted FCC RF exposure KDB procedures, other applicable procedures and notices related to SAR measurements can be found at the following link: http://www.ic.gc.ca/eic/site/ceb-bhst.nsf/eng/h_tt00080.html.

17 *Ibid.*

individually transmitting antennas. The maximum RF field strength 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.

3.3 Computational Modelling

Computational modelling, such as finite-difference-time-domain (FDTD), may be used to demonstrate compliance with SAR and/or RF field strength limits. However, the applicant shall consult with Industry Canada to determine if computational modelling is deemed acceptable for the type of radiocommunication apparatus for which regulatory compliance is sought, prior to initiating the certification process. The applicant shall submit all information (see Annex E) relevant to the modelling, including an electronic copy of the simulation and modelling information necessary to reproduce the results. The applicant is responsible for compliance with the limits specified in this RSS, regardless of the computational model used.

Refer to IEEE C95.3-2002 for general information on computational modelling.

4. Exposure Limits

For the purpose of this standard, Industry Canada has adopted the SAR and RF field strength limits established in Health Canada's RF exposure guideline, Safety Code 6.[18]

Table 2: Internal Electric Field Strength Basic Restrictions (3 kHz-10 MHz)

Condition[19]	**Internal Electric Field Strength* (V/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. *Instantaneous, RMS values apply.	

[18] Health Canada's Safety Code 6: *Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz* (http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct/index-eng.php).

[19] For provisions related to instantaneous nerve stimulation measurements see Notice 2015-DRS001.

Table 3: SAR Limits for Devices Used by the General Public (Uncontrolled Environment)

Body Region	Average SAR (W/kg)	Averaging Time (minutes)[20]	Mass Average (g)
Whole Body	0.08	6	Whole Body
Localized Head, Neck and Trunk	1.6	6	1
Localized Limbs	4	6	10

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
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
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

[20] Compliance measurements are carried out while the device under test is generally configured to continuously transmit at its highest output power. In addition, the SAR measurement procedures adopted within this standard ensure that the exposure intensity variations are within the standardized power fluctuation requirements. Therefore, the six-minute time-averaging is not required when demonstrating compliance with the applicable localized SAR limits for the device under test.

[21] For provisions related to instantaneous nerve stimulation measurements see Notice 2015-DRS001.

Table 5: SAR Limits for Controlled Use Devices (Controlled Environment)

Body Region	Average SAR (W/kg)	Averaging Time (minutes) [22]	Mass Average (g)
Whole Body	0.4	6	Whole Body
Localized Head, Neck and Trunk	8	6	1
Localized Limbs	20	6	10

Table 6: RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[23]	170	180	-	Instantaneous*
1-10	-	$1.6/f$	-	6**
1.29-10	$193/f^{0.5}$	-	-	6**
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
100-6000	$15.60\,f^{0.25}$	$0.04138\,f^{0.25}$	$0.6455f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/f^{1.2}$
150000-300000	$0.354\,f^{0.5}$	$9.40 \times 10^{-4}\,f^{0.5}$	$3.33 \times 10^{-4}\,f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

[22] Compliance measurements are carried out while the device under test is generally configured to continuously transmit at its highest output power. In addition, the SAR measurement procedures adopted within this standard ensure that the exposure intensity variations are within the standardized power fluctuation requirements. Therefore, the six-minute time-averaging is not required when demonstrating compliance with the applicable localized SAR limits for the device under test.

[23] For provisions related to instantaneous nerve stimulation measurements see Notice 2015-DRS001.

Annex A — RF Technical Brief Cover Sheet

All fields must be completed with the requested information or the following codes: N/A for Not Applicable, N/P for Not Performed or N/V for Not Available. Where applicable, check appropriate box.

1. COMPANY NUMBER: _____

2. PRODUCT MARKETING NAME (PMN):_____

3. HARDWARE VERSION IDENTIFICATION NO. (HVIN): _____

4. FIRMWARE VERSION IDENTIFICATION NO. (FVIN):_____

5. HOST MARKETING NAME (HMN):_____

6. IC CERTIFICATION NUMBER:_____

7. APPLICANT: _____

8. SAR/RF EXPOSURE TEST LABORATORY:__ _____

9. TYPE OF EVALUATION: (Complete the applicable sections: (a) SAR Evaluation: Device Used in the Vicinity of the Human Head; (b) SAR Evaluation: Body-Worn Device/Body-Supported Device; (c) SAR Evaluation: Limb-Worn Device; (d) RF Exposure Evaluation).

Note: The worst-case scenario (i.e. highest measured value obtained) shall be reported.

(a) SAR Evaluation: Device Used in the Vicinity of the Human Head

- **Multiple transmitters: Yes ☐ No ☐**
- **Evaluated against exposure limits: General Public Use ☐ Controlled Use ☐**
- **Duty cycle used in evaluation: _____%**
- **Standard(s)/Procedure(s) used for evaluation (e.g. IEEE 1528, KDB 447498):_____**
- **SAR value: _____W/kg Measured ☐ Computed ☐ Calculated ☐**

(b) SAR Evaluation: Body-Worn Device and Body-Supported Device

- **Multiple transmitters: Yes ☐ No ☐**
- **Evaluated against exposure limits: General Public Use ☐ Controlled Use ☐**
- **Duty cycle used in evaluation: _____%**
- **Standard(s)/Procedure(s) used for evaluation (e.g. IEC62209-2):_____**
- **SAR value: _____W/kg Measured ☐ Computed ☐ Calculated ☐**

(c) SAR Evaluation: Limb-Worn Device

- **Multiple transmitters: Yes ☐ No ☐**
- **Evaluated against exposure limits: General Public Use ☐ Controlled Use ☐**
- **Duty cycle used in evaluation: _____%**
- **Standard(s)/Procedure(s) used for evaluation (e.g. IEC62209-2):_____**
- **SAR value: _____W/kg Measured ☐ Computed ☐ Calculated ☐**

(d) RF Exposure Evaluation

- **Evaluated against exposure limits: General Public Use ☐ Controlled Use ☐**
- **Duty cycle used in evaluation: _____%**
- **Standard(s)/Procedure(s) used for evaluation (e.g. IEEE C95.3):_____**
- **Measurement distance: _____ m**
- **RF field strength value: _____ V/m ☐ A/m ☐ W/m^2 ☐**

Measured ☐ Computed ☐ Calculated ☐

Annex B — Declaration of RF Exposure Compliance

ATTESTATION: I attest that the information provided in Annex A 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 SAR and/or RF field strength limits of RSS-102.

Signature: _____ Date: _____

NAME (Please print or type): _____

TITLE (Please print or type): _____

COMPANY (Please print or type): _____

PRODUCT MARKETING NAME (PMN)
(Please print or type): _____

HARDWARE VERSION IDENTIFICATION NO. (HVIN)
(Please print or type):_____

FIRMWARE VERSION IDENTIFICATION NO. (FVIN)
(Please print or type): _____

HOST MARKETING NAME (HMN)
(Please print or type): _____

IC CERTIFICATION NUMBER (Please print or type):_____

Annex C — Declaration of RF Exposure Compliance for Exemption from Routine Evaluation Limits

ATTESTATION: I attest that the radiocommunication apparatus meets the exemption from the routine evaluation limits in Section 2.5 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 me; that applicable measurement methods and evaluation methodologies have been followed; and that the device meets the SAR and/or RF field strength limits of RSS-102.

Signature: _____ **Date:** _____

NAME (Please print or type): _____

TITLE (Please print or type): _____

COMPANY (Please print or type): _____

PRODUCT MARKETING NAME (PMN)
(Please print or type): _____

HARDWARE VERSION IDENTIFICATION NO. (HVIN)
(Please print or type): _____

FIRMWARE VERSION IDENTIFICATION NO. (FVIN)
(Please print or type): _____

HOST MARKETING NAME (HMN)
(Please print or type): _____

IC CERTIFICATION NUMBER (Please print or type): _____

Note: The submission of Annex C is only required if the device meets the exemption limits for the routine evaluation in Section 2.5 of this standard.

Annex D — Body Tissue Equivalent Liquid

Target Frequency (MHz)	Body	
	ε_r	σ (S/m)
150	61.9	0.8
300	58.2	0.92
450	56.7	0.94
835	55.2	0.97
900	55.0	1.05
915	55.0	1.06
1450	54.0	1.30
1610	53.8	1.40
1800-2000	53.3	1.52
2450	52.7	1.95
3000	52.0	2.73
5800	48.2	6.00

(ε_r = relative permittivity, σ= conductivity and ρ = 1000 kg/m^3)

Annex E — Information to be Included in the RF Exposure Technical Brief, as applicable, to Document SAR Compliance

INFORMATION ON THE TEST DEVICE AND EXPOSURE CATEGORY
(1) General information
IC Certification ID
Product Marketing Name (PMN)
Hardware Version Identification Number (HVIN)
Firmware Version Identification Number (FVIN)
Host Marketing Name (HMN)
RF exposure environment (General Public/Controlled Use)
(2) Device operating configurations and test conditions
Test device is a production unit or an *identical* prototype
Brief description of the test device operating configurations, including: - illustration(s) of the antenna position(s) relative to the device under test, including dimensions and separation distances (for multiple transmitters/antennas), as applicable - operating modes and operating frequency range(s) - maximum output power of the device for each operating mode and frequency range - maximum tune-up tolerances (e.g. variation in output power of the applicable test channels) - antenna type with gain and operating positions - applicable head, body-worn or body-supported configurations - battery options that could affect the SAR results
Procedures used to establish the test signals
Detailed description of the communication protocols used during the evaluation
Applicable source-based time-averaging duty factor and the duty factor used in the tests
Maximum output power or local SAR measured before and after each SAR test

SPECIFIC INFORMATION FOR SAR MEASUREMENTS
(1) Measurement system and site description
Brief description of the SAR measurement system
Brief description of the test setup
(2) Electric field probe calibration
Description of the probe, its dimensions and sensor offset, etc.
Description of the probe measurement errors
Most recent calibration date
(3) SAR measurement system check
Description of system check procedure, including any non-standardized methods/calculations used to determine the system check target value(s).
Brief description of the RF radiating source used to verify the SAR system performance within the operating frequency range of the test device
List of the tissue dielectric parameters, ambient and tissue temperatures, output power, peak and one-gram averaged SAR for the measured and expected target test configurations
List of the error components contributing to the total measurement uncertainty
(4) Phantom description
Description of the head and/or body phantoms used in the tests, including shell thickness and other

tolerances
(5) Tissue dielectric property
Composition of ingredients for the tissue material used in the SAR tests
Tissue dielectric parameters measured at the low, middle and high frequency of each operating frequency range of the test device
Temperature range and operating conditions of the tissue material during each SAR measurement
(6) Device positioning
Description of the dielectric holder or similar mechanisms used to position the test device in the specific test configurations
Description of the positioning procedures used to evaluate the highest exposure expected under normal operating configurations
Sketches and illustrations showing the device positions with respect to the phantom, including separation distances and angles, as appropriate
Description of the antenna operating positions — extended, retracted or stowed, etc., and the configurations tested in the SAR evaluation
(7) Peak SAR locations
Description of the coarse resolution, surface or area scan procedures used to search for all possible peak SAR locations within the phantom
Description of the interpolation procedures applied to the measured points to identify the peak SAR locations at a finer spatial resolution
Description, illustration and SAR distribution plots showing the peak SAR locations with respect to the phantom and the test device
Identifying the peak SAR locations used to evaluate the highest one-gram averaged SAR
(8) One-gram averaged SAR
Description of the fine resolution, volume or zoom scan procedures used to determine the highest one-gram averaged SAR in the shape of a cube
Description of the extrapolation procedures used to estimate the SAR value of points close to the phantom surface that are not measurable
Description of the interpolation procedures applied to the measured and extrapolated points to obtain SAR values at a finer spatial resolution within the zoom scan volume
Description of the integration procedures applied to the interpolated SAR values within the zoom scan volume to determine the highest one-gram SAR in the shape of a cube
(9) Total measurement uncertainty
Tabulated list of the error components and uncertainty values contributing to the total measurement uncertainty
Combined standard uncertainty and expanded uncertainty (for $k \geq 2$) of each measurement
If the expanded measurement uncertainty is greater than the target value per the referenced standard (e.g. IEEE 1528), an explanation of the procedures that have been used to reduce the measurement uncertainty shall be provided
(10) Test Reduction
All information, including description (with drawings and photograph, if required) and rationale, related to specific test reduction procedures
(11) Fast SAR Techniques
Description of measurement system main components and software; equipment list of the test equipment and accessories used to perform fast SAR measurements and used to verify the fast SAR

system, as well as to characterize the tissue dielectric parameters.
Detailed calibration data relevant to critical fast SAR measurement system components
Description of the interpolations and extrapolations algorithms used in the area scans and zoom scans
Description of the fast SAR method validation, including results of the computations and measurements to validate the fast SAR method. Radiating source description and SAR distribution for each frequency band, SAR tolerance and details of any modifications to post-processing algorithms.
Results of the system check for each frequency band, deviation from target value and radiating source description.
Measurement uncertainty budget for each frequency band, system validation uncertainty evaluation, and system check uncertainty evaluation, including any other relevant information pertaining to measurement uncertainty.
Tabulated list of all frequency bands, modulation, test configurations testing using a fast SAR method with SAR results. Tabulated and graphical results for the highest fast SAR measurement for each frequency band and modulation.
Results of all full SAR tests performed, which include the peak spatial-average SAR value for each required test and graphical representation of the scans with respect to the device.
A systematic rationale for excluding full SAR measurements.
(12) Test results for determining SAR compliance
If the channels tested for each configuration (left, right, cheek, tilt/ear, extended, retracted, etc.) have similar SAR distributions, a plot of the highest SAR for each test configuration should be sufficient; otherwise, additional plots should be included to document the differences.
All of the measured SAR values should be documented in a tabulated format with respect to the test configurations. The reported SAR shall be scaled to the maximum tune-up tolerance of the device.

SPECIFIC INFORMATION FOR SAR COMPUTATIONAL MODELLING
(1) Computational resources
Summary of the computational resources required to perform the SAR computations for the test transmitter and phantom configurations
Summary of the computational requirements with respect to modelling and computing parameters for determining the highest exposure expected for normal device operation, such as minimal computational requirements and those used in the computation
(2) FDTD algorithm implementation and validation
Summary of the basic algorithm implementation applicable to the particular SAR evaluation, including absorbing boundary conditions, source excitation methods, certain standard algorithms for handling thin metallic wires, sheets or dielectric materials, etc.
Descriptions of the procedures used to validate the basic computing algorithms and analysis of the computing accuracy based on these algorithms for the particular SAR evaluation
(3) Computational parameters
Tabulated list of computational parameters such as cell size, domain size, time-step size, tissue and device model separation from the absorbing boundaries, and other essential parameters relating to the computational setup requirements for the SAR evaluation
Description of the procedures used to handle computation efficiency and modelling accuracy for the phantom and the test device
(4) Phantom model implementation and validation
Identify the source of the phantom model, its original resolution and the procedures used to code and assign tissue dielectric parameters for the SAR evaluation
Verify that the phantom model is appropriate for determining the highest exposure expected for normal device operation
Describe procedures used to verify that the particular phantom model has been correctly constructed for making SAR computations, such as comparing computed and measured SAR results of a dipole source
(5) Tissue dielectric parameters
Description of the types of tissues used in the phantom models and the sources of tissue dielectric parameters used in the computations
Verify that the tissue types and dielectric parameters used in the SAR computation are appropriate for determining the highest exposure expected for normal device operation
Tabulated list of the dielectric parameters used in the device and phantom models
(6) Transmitter model implementation and validation
Description of the essential features that must be modelled correctly for the particular test device model to be valid
Descriptions and illustrations showing the correspondence between the modelled test device and the actual device with respect to shape, size, dimensions and near-field radiating characteristics
Verify that the test device model is equivalent to the actual device for predicting the SAR distributions
Verify the SAR distribution at the high, middle and low channels, similar to those considered in SAR measurements for determining the highest SAR

(7) Test device positioning
Description of the device test positions (left, right, cheek, tilt/ear, extended and retracted, etc.) used in the SAR computations
Illustrations showing the separation distances between the test device and the phantom for the tested configurations, similar to the reporting procedures used in SAR measurements
(8) Steady state termination procedures
Description of the criteria and procedures used to determine that sinusoidal steady state conditions have been reached throughout the computational domain for terminating the computations
Reporting the number of time steps or sinusoidal cycles executed to reach steady state
Description of the expected error margin provided by the termination procedures
(9) Computing peak SAR from field components
Description of the procedures used to compute the sinusoidal steady total electric field with selected field components at each tissue location
Description of the expected error margin provided by the algorithms used to compute the SAR at each tissue location according to the selected field components and tissue dielectric parameter
(10) One-gram averaged SAR procedures
Description of the procedures used to search for the highest one-gram averaged SAR, including the procedures for handling inhomogeneous tissues within the one-gram cube
Specify the weight and dimensions of the one-gram cube of tissue
Description of the expected error margin provided by the algorithms used in computing the one-gram SAR
(11) Total computational uncertainty
Description of the expected error and computational uncertainty for the test device and tissue models, test configurations and numerical algorithms, etc.
(12) Test results for determining SAR compliance
Illustrations showing the SAR distribution of dominant peak locations produced by the test transmitter with respect to the phantom and the test device, similar to those reported in SAR measurements
Description of how the maximum device output rating is determined and used to normalize the SAR values for each test configuration
Description of the procedures used to compute source-based time-averaged SAR