Industry Canada Industrie Canada

RSS-102
Issue 4
March 2010

Spectrum Management and Telecommunications

Radio Standards Specification

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

Footnote 13 was updated in December 2010.

Aussi disponible en français - CNR-102

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 4, will be in force as of the publication date of *Canada Gazette* notice SMSE-002-10, after which the public has 120 days to submit comments. Comments received will be considered and a new issue or revised version of this issue may be developed.

Changes:

(1) **Section 1.1:** Definition of *body-supported device* has been added, and definition of s*pecific absorption rate (SAR) evaluation* has been revised

(2) **Section 2.4:** The submission of the RF Exposure Technical Brief is now required for certification

(3) **Section 2.6:** Clarification related to the User Manual

(4) **Section 2.7:** New section on Quality Control and Post-Certification Investigations/Audits

(5) **Section 3:** Clarification on sections related to Test Reductions and Fast SAR evaluation within IEC 62209

(6) **Section 3.1.1:** Clarification related to SAR measurement for 3 GHz-6 GHz

(7) **Section 3.1.4:** SAR test procedures for 802.16e/WiMAX devices and the link to complete list of accepted FCC's KDBs

(8) **Section 3.3:** Clarification for Computational Modeling

(9) **Annex A:** Additional subsections for SAR evaluation of Limb-Worn Devices

(10) **Annex C:** Declaration of RF Exposure Compliance for exempt radiocommunication apparatus under Section 2.5

(11) **Annex E:** Information for documenting SAR compliance in the RF Exposure Technical Brief

Issued under the authority of
the Minister of Industry

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Marc Dupuis
Director General
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Contents

1. Scope

This Radio Standards Specification (RSS) sets out the requirements and measurement techniques used to evaluate RF exposure compliance of radiocommunication apparatus designed to be used within the vicinity of the human body. This includes mobile, portable and fixed transmitters 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 equipment certification is granted by Industry Canada, 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 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.

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 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.

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 uncertainties, 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. Close-up photos of the actual device in the various test positions shall also be included.

The RF exposure technical brief shall demonstrate that the requirements of this standard have been met and that 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 2.5 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 from Routine Evaluation Limits

All transmitters are exempt from routine SAR and RF exposure evaluations provided that output power complies with the power levels 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 information that demonstrates how the output power of the transmitter was derived.

If the EUT does not meet the appropriate exemption limit, a complete SAR or RF exposure evaluation shall be performed.

It must be emphasized that the above exemption from routine evaluation is **not** an exemption from compliance.

2.5.1 Exemption from Routine Evaluation Limits – SAR Evaluation

SAR evaluation is required if the separation distance between the user and the radiating element of the device is less than or equal to 20 cm, except when the device operates as follows:

- from 3 kHz up to 1 GHz inclusively, and with output power (i.e. the higher of the conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 200 mW for general public use and 1000 mW for controlled use;

- above 1 GHz and up to 2.2 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 100 mW for general public use and 500 mW for controlled use;

- above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use and 100 mW for controlled use;

- above 3 GHz and up to 6 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is less than or equal to 10 mW for general public use and 50 mW for controlled use.

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

2.5.2 Exemption from Routine Evaluation Limits – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 2.5 W;
- at or above 1.5 GHz and the maximum e.i.r.p. of the device is equal to or less than 5 W.

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, as well as any special usage conditions, 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 radio apparatus intended for sale in Canada. In the event of an investigation of non-compliance, the certificate holder will be asked to provide to the Department 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. Measurement 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 the device, shall undergo a SAR evaluation. Devices operating above 6 GHz shall undergo an RF exposure evaluation.

SAR evaluations shall be made in accordance with the latest version of IEEE 1528[3] and/or IEC 62209.[4] However, the applicant shall consult with Industry Canada prior to initiating the certification process if the sections on test reductions[5] and fast SAR evaluations within IEC 62209 are to be applied for the determination of regulatory compliance of the radiocommunication apparatus.

For SAR probe calibration and system verification for measurements between 150 MHz and 300 MHz, the procedures[6] 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.

Devices that have a radiating element normally operating at separation distances greater than 20 cm between the user and the device shall undergo an RF exposure evaluation. 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 the device.

RF exposure evaluation shall be made in accordance with the latest version of IEEE C95.3.[7]

3.1 SAR Measurements

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

- If a device has push-to-talk capability, a minimum duty cycle of 50% (on-time) shall be used in the evaluation. A lower duty cycle is permitted only if the transmission duty cycle is an inherent property of the technology or of the design of the equipment and 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 SAR evaluation. Maximum average power levels shall be used to determine compliance.

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

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

5 *The applicant is not required to consult with Industry Canada if the test reductions are based on the Federal Communications Commission (FCC) KDB procedures referenced in this standard.*

6 FCC KDB Publication 450824: *SAR Probe Calibration and System Verification considerations for measurements from 150 MHz to 3 GHz* (http://www.fcc.gov/oet/ea/eameasurements.html)

7 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*

- 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 possible, the transmitter shall be set to the maximum output power for which it is rated, before the SAR evaluation. If the antenna length is variable, the tests shall generally be performed with an antenna length that maximizes the peak SAR, such as fully retracted and again fully extended. The device shall be in the normal operating position, as recommended by the manufacturer, when evaluating the SAR.

- Multi-mode transmitters operating in the same frequency band are to be evaluated in the mode that is expected to yield the greatest SAR. Devices that are capable of operating in multiple bands shall be evaluated against all these bands.

- If the device is designed to operate in front of the mouth, it shall be evaluated with the front of the device positioned at 2.5 cm from a flat phantom. If it is also designed to operate when placed next to the cheek and ear, it shall also be tested in that position.

- SAR evaluation of medical implant communication system (MICS) and medical implant telemetry system (MITS) devices shall be performed by physical measurement or computational modelling.

3.1.1 SAR Measurement for 3 GHz-6 GHz

SAR measurements for devices operating between 3 GHz and 6 GHz are not currently covered by the international standards in Section 3. Until these standards are revised to include the extended frequency range, the FCC's published procedures[8] can be used as an interim measure. In addition, other recognized methods could 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.

3.1.2 SAR Measurement of Body-Worn Devices

The following requirements shall be considered when performing SAR measurements for body-worn devices. Otherwise, compliance of body-worn devices shall be assessed using internationally recognized methods proven to provide a conservative estimate of the SAR value.

- A flat phantom shall be used.

- 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 contain no metallic component, the device shall be tested with the accessory that provides the shortest separation distance between the device and the body.

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[8] FCC KDB Publication 865664: *SAR Measurement Requirements for 3 to 6 GHz* (http://www.fcc.gov/oet/ea/eameasurements.html)

- When multiple accessories supplied with 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 not supplied or available, a separation distance of 1.5 cm between the device and the phantom is recommended. Although other separation distances may be used, the measurement distance used in the evaluation shall not exceed 2.5 cm. The device shall be positioned with either its back face or front face 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 two SAR values shall be included in the RF technical brief cover sheet.

- 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.

3.1.3 SAR Measurement of Devices Containing Multiple Transmitters

Compliance of devices with multiple transmitters capable of simultaneous transmission shall be assessed using recognized methods, such as the procedures[9] published by the FCC, proven to provide a conservative estimate of the SAR value. Applicants shall include in the RF exposure technical brief all information relevant to the exact test methodology used.

3.1.4 SAR Measurement of Other Types of Devices

SAR measurements for certain types of 3G devices[10] (e.g. CDMA2000, Ev-Do, WCDMA), 802.11 a/b/g transmitters,[11] 802.16e/WiMAX devices,[12] laptop computers with built-in antennas on display screens[13] or located within the chassis, as well as licensed and licence-exempt modular transmitters,[14] are not covered by the current international standards in Section 3. Until these standards contain the

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9 FCC KDB Publication 648474: *SAR Evaluation Considerations for Handsets with Multiple Transmitters and Antenna* (http://www.fcc.gov/oet/ea/eameasurements.html)

10 FCC KDB Publication 941225: *SAR Measurement Procedures for 3G Devices* (http://www.fcc.gov/oet/ea/eameasurements.html)

11 FCC KDB Publication 248227: *SAR Measurement Procedures for 802.11 a/b/g Transmitters* (http://www.fcc.gov/oet/ea/eameasurements.html)

12 FCC KDB Publication 615223: 802.16e/WiMAX *SAR Measurement Guidance* (http://www.fcc.gov/oet/ea/eameasurements.html)

13 FCC KDB Publication 616217: *SAR Evaluation Considerations for Laptop Computers with Antennas Built-in on Display Screens* (http://www.fcc.gov/oet/ea/eameasurements.html) and measurement method for bystander requirement (http://www.ic.gc.ca/eic/site/ceb-bhst.nsf/eng/h_tt00080.html)

14 FCC KDB 447498: *Mobile and Portable Device RF Exposure, Equipment Authorization Procedures* (http://fjallfoss.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?id=20676&switch=P)

measurement procedures for these 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.[15] In addition, other recognized methods could 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 with Multiple Transmitters

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 levels shall be summed 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 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 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.[16]

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[15] List of accepted KDB procedures for SAR measurements (http://www.ic.gc.ca/eic/site/ceb-bhst.nsf/eng/h_tt00080.html)

[16] 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-eng.php)

4.1 SAR Limits for Devices Used by the General Public (Uncontrolled Environment)

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

4.2 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)	Averaging Time (minutes)
0.003-1	280	2.19	-	6
1-10	$280/f$	$2.19/f$	-	6
10-30	28	$2.19/f$	-	6
30-300	28	0.073	2*	6
300-1500	$1.585\ f^{0.5}$	$0.0042\ f^{0.5}$	$f/150$	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\ f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
***** Power density limit is applicable at frequencies greater than 100 MHz.

4.3 SAR Limits for Controlled Use Devices (Controlled Environment)

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

4.4 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)	Averaging Time (minutes)
0.003-1	600	4.9	-	6
1-10	$600/f$	$4.9/f$	-	6
10-30	60	$4.9/f$	-	6
30-300	60	0.163	10*	6
300-1500	$3.54\ f^{0.5}$	$0.0094\ f^{0.5}$	$f/30$	6
1500-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/f^{1.2}$
150000-300000	$0.354\ f^{0.5}$	$9.4 \times 10^{-4}\ f^{0.5}$	$3.33 \times 10^{-4}\ f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Power density limit is applicable at frequencies greater than 100 MHz.

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. MODEL NUMBER: _____

3. MANUFACTURER: _____

4. 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 used for evaluation: _____**
- **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 used for evaluation: _____**
- **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 used for evaluation: _____**
- **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 used for evaluation: _____**
- **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): _____

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): _____

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 that should be Included in the RF Exposure Technical Brief to Document SAR Compliance

INFORMATION ON THE TEST DEVICE AND EXPOSURE CATEGORY
(1) General information
IC Certification ID
Model Number
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: - operating modes and operating frequency range(s) - maximum output power of the device for each operating mode and frequency range - operating tolerances - 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 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
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 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

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