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

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Spectrum Management and Telecommunications

Supplementary Procedure

Time-Averaged Specific Absorption Rate (TAS) Assessment Procedures for Wireless Devices Operating in the 4 MHz to 6 GHz Frequency Band

Aussi disponible en français – PRS-004

Canada

Preface

This Innovation, Science and Economic Development Canada supplementary procedure describes the various technical requirements and processes to be followed when carrying out radio frequency exposure compliance assessments of wireless devices implementing device-based time-averaging methods.

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

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Contents

1. Scope

Supplementary Procedure SPR-004, issue 1, for Radio Standards Specification RSS-102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*, sets out the general test methods to be followed when carrying out an RF exposure compliance assessment of wireless devices implementing device-based time-averaging methods for the management and/or mitigation of specific absorption rate (SAR) in the 4 MHz to 6 GHz frequency band. It does not cover requirements that are based on power density above 6 GHz or requirements to protect against nerve stimulation for the frequency range from 3 kHz to 10 MHz. A full compliance assessment of a device under test (DUT), including other transmitters within the device, must consider all exposure limits and requirements set forth in RSS-102.

2. Purpose and application

This supplementary procedure sets out the general test methods to use in assessing the compliance of final products implementing time-averaged specific absorption rate (TAS) algorithms approved by ISED. A list of approved TAS algorithms can be found on ISED's website. The test methods in SPR-004 cannot be used to assess final products for algorithms not found on that list.

The test methods are to be used for devices enabled for wireless wide area networks (WWANs) implementing device-based time-averaging methods in the 4 MHz to 6 GHz frequency band intended to be used at 20 cm or less from the user and/or bystander.

Devices enabled for wireless local area networks (WLANs) as well as devices operating above 6 GHz will require additional instructions on test set-up, specific test procedures and/or technical requirements. As such, prior to assessing RF exposure compliance for these devices, an inquiry must be submitted to the Certification and Engineering Bureau of Innovation, Science and Economic Development Canada (ISED), using the online form. The inquiry shall include sufficient information pertaining to the technology and operation of the device in order for ISED to determine the applicable technical and administrative requirements.

2.1 Consultation with ISED prior to seeking equipment certification for new and emerging technologies

When there are no standardized test procedures explicitly defined for new and emerging technologies, ISED shall be consulted to determine the required test methodologies for demonstrating compliance with applicable requirements (e.g. RF exposure limits).

To minimize delay in obtaining regulatory approval, applicants and other responsible parties (e.g. recognized test laboratories, certification bodies, product integrators) should submit a general inquiry to ISED as early as possible.

2.2 ISED regulatory requirements

Manufacturers, importers, distributors and vendors have a legal obligation to ensure that Category I radio apparatus introduced in the Canadian marketplace have been certified and comply with applicable technical standards.

As per the requirements set forth in section 4(3) of the *Radiocommunication Act*, “No person shall manufacture, import, distribute, lease, offer for sale or sell any radio apparatus, interference-causing equipment or radio-sensitive equipment for which technical standards have been established under paragraph 6(1)(a), unless the apparatus or equipment complies with those standards.”

As per the requirements set forth in Radio Standards Specification RSS-Gen, *General Requirements for Compliance of Radio Apparatus*, “No person shall import, distribute, lease, offer for sale, or sell Category I radio apparatus in Canada unless they are listed on ISED's REL [radio equipment list].”

3. Normative references

The following documents shall be consulted for the application of SPR-004. The most recent versions of these reference publications shall be used for showing compliance:

- Radio Standards Specification RSS-102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*
- International Electrotechnical Commission/Institute of Electrical and Electronics Engineers (IEC/IEEE) 62209-1528, *Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-worn wireless communication devices – Human models, instrumentation and procedures (Frequency range of 4 MHz to 10 GHz)*

  Note: The principles supporting TAS are outlined in section 7.6 and annex Q of IEC/IEEE 62209-1528. However, ISED does not accept the TAS methodologies of IEC/IEEE 62209-1528 for compliance assessment. Guidance is hereby provided to meet ISED requirements.

- Health Canada’s Safety Code 6, *Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz*
- *Technical Guide for Interpretation and Compliance Assessment of Health Canada’s Radiofrequency Exposure Guidelines*
- Radio Standards Specification RSS-Gen, *General Requirements for Compliance of Radio Apparatus*
- Radio Standards Specification RSP-100, *Certification of Radio Apparatus and Broadcasting Equipment*

Annexes within SPR-004 are normative.

ISED may accept assessment methods not covered by SPR-004 or the referenced publications. Consult ISED's Certification and Engineering Bureau website to determine the acceptability of any alternative assessment methods, or send an inquiry with detailed information on the alternative assessment method(s).

4. Definitions and abbreviations

This section contains definitions and explanations for terms, acronyms, abbreviations and the International System of Units (SI) units used throughout SPR-004.

4.1 Definitions

Conducted power
Power delivered by the RF transmitter within the device to a matched load, e.g. 50 Ω.

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

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

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

Output power
Power delivered by the RF transmitter within the device to the antenna or to a load with the same input impedance as the antenna. Below 6 GHz, output power is assumed to be equivalent to conducted power.

Reference period
The time period (of 360 seconds) used for averaging temporally non-uniform RF field exposures. Exposures lasting less than the reference period may exceed the RF exposure limits, provided that the averaged exposure over the reference period does not exceed the RF exposure limits.

Single point specific absorption rate
A measured SAR value at a single or local point. Single point SAR is not averaged within a local region based on a mass of tissue (1 g or 10 g).

Tune-up tolerance
The range of expected maximum output power variations from the nominal maximum output power specified for a given wireless mode.

4.2 Abbreviations and acronyms

SPR-004 uses the following abbreviations and acronyms:

dB decibel(s)

dBm dB relative to 1 milliwatt

DUT device under test

IEC International Electrotechnical Commission

IEEE Institute of Electrical and Electronics Engineers

ISED Innovation, Science and Economic Development Canada

FDD frequency-division duplexing

psSAR peak spatial-averaged specific absorption rate

QAM quadrature amplitude modulation

QPSK quadrature phase shift keying

RF radio frequency

RSS Radio Standards Specification

SAR specific absorption rate

TAS time-averaged specific absorption rate

TDD time-division duplexing

TDMA time-division multiple access

5. Approach to SAR compliance assessment

The SAR limits are defined as specific thresholds averaged over any 6-minute (360-second) reference period (see RSS-102 or Health Canada's Safety Code 6). While the limits are intrinsically based on SAR averaged over a 6-minute period, devices were not previously capable of continuously calculating and limiting their time-averaged output power. As a result, SAR assessments have historically been conducted with wireless devices transmitting continuously at maximum allowable power or at a fixed power based on sensor inputs (e.g. proximity sensors).

In reality, wireless devices operate at much lower power levels to preserve battery life, maximize call time and optimize network performance. Evaluating wireless devices using methods supporting device-based TAS would enable a more representative assessment of the SAR levels a user may be exposed to during normal daily use.

5.1 Time-averaging period

For compliance with the SAR limits set forth in Safety Code 6, the following requirements shall be met at all times:

- A reference period of 6 minutes (360 seconds) shall be used; and
- Compliance shall be demonstrated over any 360-second time interval (rolling time averaging window).

Products using a different averaging period may be considered on a case-by-case basis provided the TAS implementation yields equivalent or more conservative results than 360 seconds. A related inquiry must be submitted to ISED.

5.2 Averaging methodology

As per Health Canada's Technical Guide for Safety Code 6, the arithmetic mean shall be used in averaging SAR to demonstrate compliance with the RF exposure limits.

6. TAS implementation and validation considerations

The following are the criteria that shall be considered for proper validation of TAS implementations.

6.1 Key parameters

While the SAR compliance assessment is performed using static power settings, the TAS algorithm is validated using dynamic power settings. Applicants are responsible for characterizing the DUTs and identifying the key parameters of the TAS implementation. As part of this characterization, the tolerance(s) associated with the TAS implementation shall be conservatively assessed, with modular and host contributions taken into account, as well as other considerations, including, but not limited to:

- the output power measurement and/or estimation accuracy for all modes of operation and across all applicable frequency bands
- the near-field coupling effects, e.g. the linearity of the output power-to-SAR relationship
- tune-up tolerance(s)

The following parameters shall be identified for the TAS implementation:

- $\boldsymbol{P_{\mathrm{max}}}$**:** the maximum instantaneous output power that the transmitter is capable of producing. For ease of presentation, P_{max} is expressed in watts throughout SPR-004, unless otherwise stated. Internally, the DUT may associate a certain nominal maximum output power level with a given operating state, denoted by $P_{\mathrm{max,nom}}$. In the context of SPR-004, P_{max} is obtained by scaling up $P_{\mathrm{max,nom}}$ in accordance with all applicable tolerances and uncertainties.

- $\boldsymbol{P_{\mathrm{limit}}}$**:** the maximum time-averaged output power specified to ensure SAR compliance for a given DUT operating state. For ease of presentation, P_{limit} is expressed in watts throughout SPR-004, unless otherwise stated. Internally, the DUT may associate a certain nominal time-averaged output power limit with a given operating state, denoted by $P_{\mathrm{limit,nom}}$. In the context of SPR-004, P_{limit} is obtained by scaling up $P_{\mathrm{limit,nom}}$ in accordance with all applicable tolerances and uncertainties. This may be expressed as:

$$P_{\mathrm{limit}} = P_{\mathrm{limit,nom}} \cdot 10^{\frac{u_{\mathrm{limit,dB}}}{10}} \qquad \mathbf{1.}$$

  where $u_{\mathrm{limit,dB}}$ is the total positive uncertainty or tolerance associated with $P_{\mathrm{limit,nom}}$, in dB.

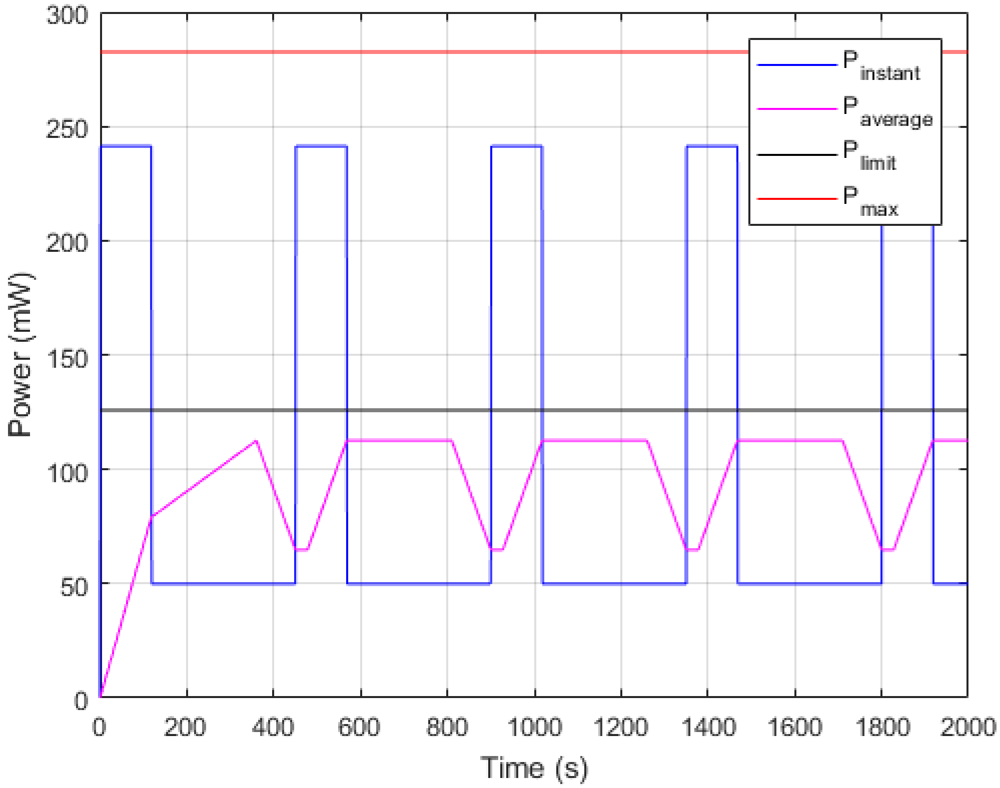
- $\boldsymbol{SAR_{\mathrm{target}}}$**:** the maximum 1 g or 10 g peak spatial-averaged SAR (psSAR) target specified to ensure SAR compliance for a given DUT operating state. Its value directly corresponds to P_{limit} or P_{max}, whichever is lower. The SAR_{target} value shall be defined in such a way that the device remains compliant in simultaneous transmission scenarios.

- Any other relevant power levels or parameters used by the TAS algorithm, e.g. to switch between power control states.

The applicant shall define all DUT operating states, along with the corresponding values of P_{max}, P_{limit} and SAR_{target}. In addition, the applicant shall clearly define the mechanisms and sensors used to trigger operating state transitions.

Figure 1 illustrates the output power characteristics of a simple TAS implementation.

Figure 1: Illustration of the output power characteristics of a simple TAS implementation

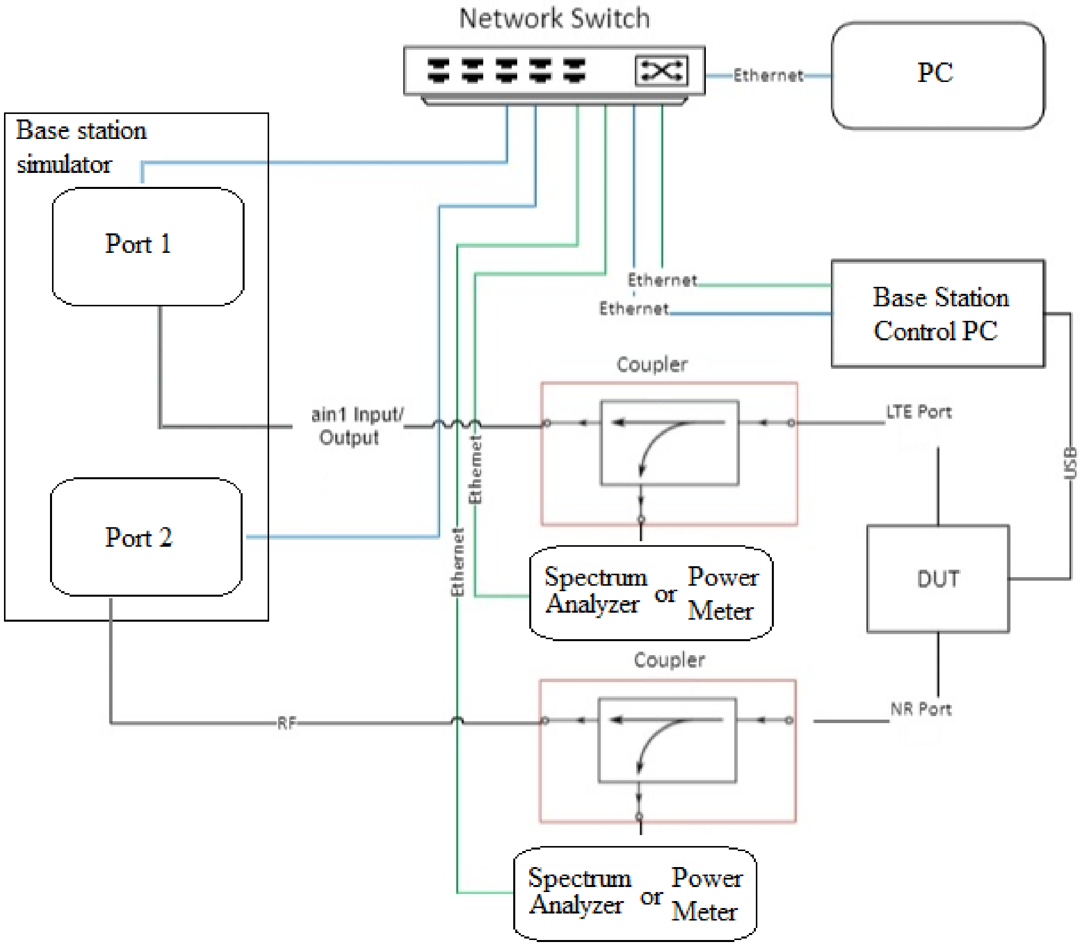


6.2 Validation criteria

The TAS implementation shall be validated to ensure that, accurately and consistently, the device-based TAS does not exceed the corresponding SAR_{target} values. This validation shall be achieved using a calibrated and reproducible measurement set-up.

Figure 2 illustrates a calibrated and reproducible measurement set-up. All tests shall be performed over a sufficient amount of time to ensure that the maximum time-averaged results have been captured. Two or more reference periods may be required to capture the maximum results.

Figure 2: Illustration of a calibrated and reproducible measurement set-up



In addition to the RF technical brief requirements set forth in RSS-102, a separate TAS validation report shall be provided in accordance with annex B. The report shall clearly identify the pass/fail criteria for each validation step in accordance with the guidance provided in the following sections.

The $P_{limit,nom}$ values used for TAS validation shall be the same as those used for SAR compliance testing.

The technologies and associated operating states for which P_{limit} is several dB lower than P_{max} (i.e. 2 to 4 dB lower) should be considered for each validation criterion, unless instructions indicate otherwise. Within this subset of configurations, those yielding the highest psSAR results, as per the RF exposure technical brief, should be favoured.

6.2.1 Validation through conducted power and SAR measurements

Conducted power measurements in accordance with the guidance provided below shall be performed to validate all TAS implementations; however, conducted power measurements may not capture the near-field coupling and associated radiating characteristics of the device. In other words, a relative change in conducted power may not always translate into an equivalent change in SAR. As a result, single point SAR measurements shall be performed to validate the TAS algorithm for a reduced number of test cases, as outlined in section 6.2.1.2.

6.2.1.1 Considerations for conducted power measurements

For each of the test cases described in sections 6.2.2 to 6.2.9, the TAS algorithm shall be validated by demonstrating that the time-averaged conducted power remains less than or equal to P_{limit} over any complete reference period. The measured instantaneous conducted power at the n-th time step can be written as $P_{\text{meas}}[n]$. A complete reference period consists of M time steps:

$$M = \frac{T_{\text{ref}}}{T_{\text{meas}}} \qquad \textbf{2.}$$

where T_{meas} is the time interval between subsequent power measurements (typically much less than 1 second) and T_{ref} is the reference period, i.e. 360 seconds. The rolling time-averaged conducted power at the n-th time step, $P[n]$, is obtained by summing the current (n-th) and $M - 1$ previous values of P_{meas}, and dividing the result by M. This can be expressed analytically as:

$$P[n] = \frac{1}{M}\sum_{m=0}^{M-1} P_{\text{meas}}[n-m] \qquad \textbf{3.}$$

where m is the index of the rolling time-averaging window. In test cases where P_{limit} remains constant throughout, the TAS algorithm should be validated by demonstrating that $P[n] \leq P_{\text{limit}}$ for all n, i.e. for every time step associated with the test. Otherwise, $P_{\text{meas}}[n]$ shall be normalized by $P_{\text{limit}}[n]$ prior to applying the rolling time-average. The normalized, rolling time-averaged conducted power, given by $p[n]$, can be expressed analytically as:

$$p[n] = \frac{1}{M}\sum_{m=0}^{M-1} \frac{P_{\text{meas}}[n-m]}{P_{\text{limit}}[n-m]} \qquad \textbf{4.}$$

in which case the TAS algorithm is validated by demonstrating that $p[n] \leq 1$ for all n, i.e. for every time step associated with the test.

6.2.1.2 Considerations for single point SAR measurements

Single point SAR measurements shall be performed to validate the TAS algorithm; however, compared with the requirements for conducted power measurements, fewer test cases are required:

a. Single point SAR measurements need be performed only for changes in requested power, as described in section 6.2.2.
b. To account for linearity, single point SAR measurements shall be performed on each antenna for at least one frequency. If possible, each antenna should be validated using a different frequency.
c. Single point SAR measurements shall be performed only for configurations involving a single transmitter, i.e. not for simultaneous transmission.

The configurations and operating states selected for single point SAR measurements shall match those selected for conducted power measurements and for SAR compliance assessment. This requirement facilitates the correlation of the single point SAR results with both the conducted power measurements and the psSAR results in the RF exposure technical brief.

SAR measurements shall be performed in accordance with the following requirements to ensure a high level of accuracy and repeatability in the TAS algorithm validation:

a. Measurements shall be performed in an environment that prevents uncontrolled variations in the link budget over time, i.e. time-varying multipath.
b. The configuration and positioning of the device shall remain consistent and repeatable throughout the measurement process. This consistency is especially important in situations where the device needs to be configured using test mode software and/or charged in between measurements.
c. The separation distance for TAS validation shall be the same as the compliance distance.

The following steps shall be applied during single point SAR evaluations:

a. **Determine the location of maximum SAR:** With the TAS algorithm disabled and the DUT output power set to $P_{\text{limit,nom}}$, perform an area scan in accordance with IEC/IEEE 62209-1528 to identify the location of maximum SAR. The remaining measurements shall be performed at this location.
b. **Perform a reference measurement:** Perform a single point SAR measurement with the TAS algorithm disabled and the DUT output power set to $P_{\text{limit,nom}}$. The result can be denoted by $pointSAR_{\text{Plimit}}$.
c. **Perform relative instantaneous measurements:** Enable the TAS algorithm and perform the given validation step while measuring the single point SAR. As in section 6.2.1.1, $pointSAR[n]$ is used to denote the single point SAR at the n-th time step.
d. **TAS evaluation:** The instantaneous 1 g or 10 g SAR at the n-th step, denoted by $SAR[n]$, can be expressed as:

$$SAR[n] = \left(\frac{pointSAR[n]}{pointSAR_{\text{Plimit}}}\right) \cdot psSAR \qquad \textbf{5.}$$

where $psSAR$ is the corresponding psSAR value in the RF exposure technical brief. The reference period consists of M time steps, where M is defined in equation 2. As a result, the TAS value at the n-th time step, $TAS[n]$, is given by:

$$TAS[n] = \frac{1}{M} \sum_{m=0}^{M-1} SAR[n-m] \qquad \textbf{6.}$$

where m is the index of the rolling time-averaging window. The TAS algorithm shall be validated by demonstrating that $TAS[n] \leq psSAR$ for all n, i.e. for every time step associated with the test.

6.2.2 Changes in requested power

The TAS algorithm shall be validated when the base station requests different power levels to manage the link budget.

Conducted power measurements shall be performed for at least one band per technology. The P_{limit} value associated with the chosen band should be several dB lower than the corresponding value of P_{max}, i.e. 2 to 4 dB lower. Whenever possible, the same band should not be repeated for different technologies. FDD and TDD configurations shall be treated as separate technologies.

In addition to conducted power measurements, single point SAR measurements shall be performed in accordance with section 6.2.1.2.

6.2.2.1 Start-up test sequences

Two distinct sequences shall be applied to validate the start-up behaviour of the TAS algorithm:

a. Upon start-up, request a power level of $P_{\text{max,nom}}$ for a period of at least 400 seconds, followed by $0.5 \cdot P_{\text{limit,nom}}$ for a period of at least 400 seconds.
b. Upon start-up, request a power level of 1 mW (0 dBm) for a period of at least 400 seconds, followed by $P_{\text{max,nom}}$ for a period of at least 400 seconds.

Note: For TDD and TDMA, $P_{\text{max,nom}}$ and $P_{\text{limit,nom}}$ may be expressed as frame-averaged or burst-power levels. Care must be taken to ensure that the requested power levels are interpreted consistently to avoid unintended offsets or discrepancies in the validation results.

6.2.2.2 Pseudo-random test sequence

A pseudo-random sequence of power requests shall be applied to validate the dynamic behaviour of the TAS algorithm. Each test shall be performed with a unique sequence of 150 independent power requests. These power levels are calculated as follows:

$$P_{\text{req}} = P_{\text{max,nom}} \left(\frac{P_{\text{limit,nom}}}{P_{\text{max,nom}}} \right)^{x} \quad \mathbf{7.}$$

where P_{req} is the requested power in watts and x is a random value drawn from the Weibull distribution with shape and scale parameters of 2.0 and 0.8 respectively. These values were chosen to ensure that P_{req} exceeds $P_{\text{limit,nom}}$ on average, while maintaining a reasonable likelihood that some P_{req} values will sometimes fall well below $P_{\text{limit,nom}}$. The corresponding request durations are given by:

$$T_{\text{req}} = 2(1 + 2y) \quad \mathbf{8.}$$

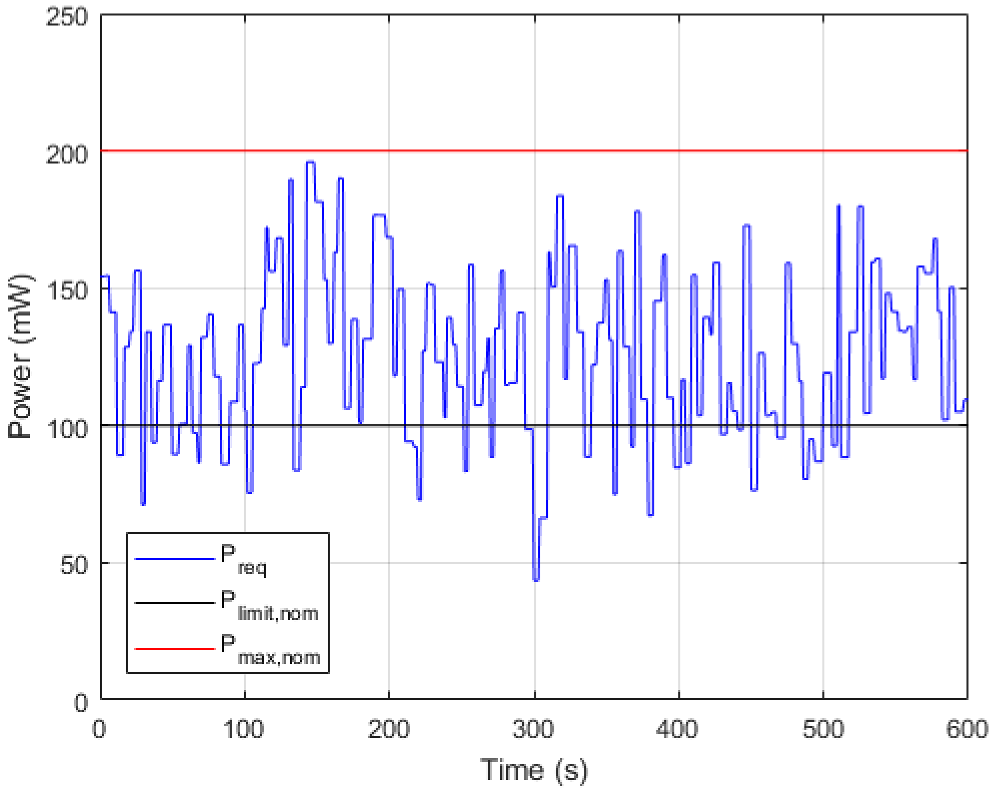
where T_{req} is the duration of the power request in seconds and y is a uniformly distributed random value between 0 and 1.

Notes:

- For TDD and TDMA, $P_{\text{max,nom}}$ and $P_{\text{limit,nom}}$ may be expressed as frame-averaged or burst-power levels. Care must be taken to ensure that P_{req} is interpreted consistently to avoid unintended offsets or discrepancies in the validation results.
- P_{req} may be converted to dBm, and rounded to the nearest 0.5 dB. In addition, a lower bound may be applied to ensure continuous and reliable communication with the base station, e.g. $P_{\text{req}} \geq 1$ mW (0 dBm).
- Values for x can be generated (e.g. in Microsoft Excel) using the following syntax: =0.8*(-LN(1-RAND()))^0.5.
- If necessary, T_{req} may be rounded to the nearest second.
- Values for y can be generated (e.g. in Microsoft Excel) using the following syntax: =RAND().

Figure 3 illustrates a requested power sequence for $P_{\text{limit,nom}} = 100$ mW (20 dBm), $P_{\text{max,nom}} = 200$ mW (23 dBm) and $P_{\text{req}} \geq 1$ mW (0 dBm). The request durations have been rounded to the nearest second. As per annex B, similar plots of P_{req} versus time shall be included in the TAS validation report, along with tabulated summaries of the P_{req} and T_{req} values.

Figure 3: Illustration of a requested power sequence for $P_{limit,nom} = 100$ mW and $P_{max,nom} = 200$ mW



6.2.3 Antenna switching

Conducted power measurements shall be performed to validate the TAS algorithm in antenna-switching scenarios. Maximum power shall be requested from the DUT throughout the test. The switch between antennas shall occur once the TAS algorithm has reached steady state for the first antenna, and the test shall conclude once the algorithm has reached steady state for the second antenna.

When different P_{limit} and P_{max} values are associated with each transmitting antenna, consideration shall be given to the combinations of antennas and operating state(s) for which the P_{limit} values are several dB below the corresponding P_{max} values, i.e. 2 to 4 dB lower. Of these combinations, the performance of the TAS algorithm shall be validated when the DUT switches from the antenna with the highest P_{limit} value to that with the lowest.

This requirement may be waived if the same P_{limit} and P_{max} values apply to each antenna and if it can be demonstrated that the performance of the TAS algorithm is not affected by antenna switching. In cases where the requirement is waived, the remaining validation steps may be performed for a single antenna; however, simultaneous transmission shall be considered separately.

6.2.4 Change in operating state

Conducted power measurements shall be performed to validate the TAS algorithm when the DUT changes between operating states with different P_{limit} values, e.g. when sensors or other mechanisms are used to change operating states. Maximum power shall be requested from the DUT throughout the test. The change in operating state shall occur once the TAS algorithm has reached steady state for the first operating state, and the test shall conclude once the algorithm has reached steady state for the second operating state.

The TAS algorithm shall be validated for the following changes in operating state:

- among the operating states for which the P_{limit} values are several dB below the corresponding P_{max} values, i.e. 2 to 4 dB lower, changing from one operating state to another with a lower P_{limit} value
- if applicable, changing from an operating state for which the TAS algorithm is transparent, i.e. $P_{\text{limit}} \geq P_{\text{max}}$, to one for which P_{limit} is several dB below P_{max}, i.e. 2 to 4 dB lower

When proximity sensors are used, the energy accumulated prior to the proximity sensors being triggered shall be taken into account. Worst-case exposure (highest SAR) shall be assumed prior to the sensor being triggered, which typically occurs when the user is just beyond the triggering distance.

Note: Implementations where TAS is enabled at the proximity sensor level will continue to be evaluated on a case-by-case basis following the relevant principles outlined in SPR-004 until sufficient data is available for ISED to provide detailed guidance.

6.2.5 Frequency band hand-off or redirect

Conducted power measurements shall be performed to validate the TAS algorithm when the DUT switches between frequency bands with different P_{limit} values. Maximum power shall be requested from the DUT throughout the test. The change in frequency band shall occur once the TAS algorithm has reached steady state for the first band, and the test shall conclude once the algorithm has reached steady state for the second band.

The TAS algorithm shall be validated for the following changes in frequency band:

- among the frequency band configurations for which the P_{limit} values are several dB below the corresponding P_{max} values, i.e. 2 to 4 dB lower, changing from one frequency band to another with a lower P_{limit} value
- if applicable, changing from a frequency band for which the TAS algorithm is transparent, i.e. $P_{\text{limit}} \geq P_{\text{max}}$, to one for which P_{limit} is several dB below P_{max}, i.e. 2 to 4 dB lower

6.2.6 Technology hand-off

Conducted power measurements shall be performed to validate the TAS algorithm when the DUT switches between technologies with different P_{limit} values. Maximum power shall be requested from the DUT throughout the test. The technology hand-off shall occur once the TAS algorithm has reached steady state for the first technology, and the test shall conclude once the algorithm has reached steady state for the second technology.

Among the technology configurations for which the P_{limit} values are several dB below the corresponding P_{max} values, i.e. 2 to 4 dB lower, the test shall consist of changing from one technology to another with a lower P_{limit} value.

6.2.7 Switching between time division duplexing and frequency division duplexing

Conducted power measurements shall be performed to validate the TAS algorithm when the DUT switches between TDD and FDD configurations with different P_{limit} values, both of which should be several dB lower than the corresponding P_{max} values, i.e. 2 to 4 dB lower. Maximum power shall be requested from the DUT throughout the test. The switch between configurations shall occur once the TAS algorithm has reached steady state for the first configuration, and the test shall conclude once the algorithm has reached steady state for the second configuration.

Note: P_{max} and P_{limit} may be expressed differently for TDD relative to FDD, i.e. as frame-averaged or burst-power levels. Care must be taken to ensure that the power levels are interpreted consistently to avoid unintended offsets or discrepancies in the validation results.

6.2.8 Change in modulation scheme

Conducted power measurements shall be performed to validate the TAS algorithm when the DUT changes between modulation schemes with different P_{limit} values. For example, measurements would be required to validate a change from a higher order, e.g. 64 QAM (quadrature amplitude modulation), to a lower order, e.g. QPSK (quadrature phase shift keying) and vice versa. Both P_{limit} values should be several dB lower than the corresponding P_{max} values, i.e. 2 to 4 dB lower. Maximum power shall be requested from the DUT throughout the test. The switch between modulation schemes shall occur once the TAS algorithm has reached steady state for the first scheme, and the test shall conclude once the algorithm has reached steady state for the second scheme.

This requirement may be waived if the same P_{limit} value is applied for all modulation schemes associated with a specific communication technology.

6.2.9 Dropped connection

Conducted power measurements shall be performed to validate the TAS algorithm during dropped connections to ensure the algorithm is able to account for previous connection states. Only one test is required with one of the configurations for which P_{limit} is 2 to 4 dB below P_{max}. Maximum power shall be requested from the DUT throughout the test. The dropped connection shall occur once the TAS algorithm has reached steady state, and the test shall conclude once steady state has been regained after the dropped connection.

6.3 TAS validation data re-use and test reduction

ISED may accept data re-use or test reduction within a product line. In the context of SPR-004, a product line is defined as a set of products with the same form factor and using the same key RF chipset and TAS algorithm.

6.3.1 Data re-use

Data re-use may be applicable if the following conditions are met:

a. The initial reference model is certified prior to the variant models. It is also possible for the reference model to be certified in Canada within the same time frame.
b. Each variant has the same transmit chain (i.e. components and layout) as the reference model.
c. Each variant has the same output power characteristics (e.g. P_{max}, P_{limit}, tolerances) as the reference model.

If the listed conditions are met, an inquiry shall be submitted to the Certification and Engineering Bureau, using the online form, requesting further guidance for data re-use.

6.3.2 Test reduction

Test reduction may be considered when the data re-use conditions above cannot be met due to a product's:

- physical design characteristics;
- modes of operation; or
- variants having additional options that would result in different P_{limit} values (from those of the reference model) for common technologies and frequency bands.

If the listed requirements cannot be met, an inquiry shall be submitted to the Certification and Engineering Bureau, using the online form, requesting further guidance regarding TAS validation test reduction.

7. Uncertainty

In the context of SAR compliance testing, i.e. under static power conditions, the uncertainty budget shall be based on the requirements of IEC/IEEE 62209-1528.

For TAS validation, the uncertainties in both the conducted power and single point SAR measurements should be considered. The corresponding uncertainty budgets should be included in the TAS validation report.

8. Certification requirements

The following certification requirements are applicable to TAS implementations.

8.1 Laboratory accreditation

All testing performed to demonstrate compliance of a radio apparatus with the requirements set forth in RSS-102, including its referenced and accepted normative standards and test procedures, shall be carried out by an ISED-recognized testing laboratory.

It is critical that all device-specific evaluation parameters used for compliance evaluations are assessed by an ISED-recognized test laboratory including, but not limited to:

- factors and methods used to determine applicable exposure conditions and operational modes
- proximity or other sensors used for power reduction
- output power
- dynamic antenna tuning
- SAR evaluations

TAS algorithm validations shall also be performed by an ISED-recognized testing laboratory in accordance with section 6.2. In addition, the laboratory shall demonstrate that its personnel has been properly trained and qualified to carry out validations on specific TAS implementations.

For proprietary test procedures and validation protocols that have been accepted by ISED, the recognized test laboratory shall demonstrate that they have been approved by the TAS algorithm developer to assess their technology. An approval letter from the TAS algorithm developer shall be provided in the certification filing. A TAS algorithm developer's in-house test laboratory is not required to submit an approval letter.

8.2 Modular approval

Provided the requirements in RSP-100 are met, the applicant may obtain approval for a TAS-enabled module intended for installation in a host product. As per section 8.2 of RSP-100, modular approvals are not applicable for small, portable, hand-held and wearable devices with an overall diagonal dimension of less than 20 cm.

Where modular approval is permitted, conducted power measurements should be performed to validate the TAS algorithm at the module level. Where modular approval is not permitted, the measurements shall be performed at the host level.

Single point SAR measurements shall be performed on representative hosts to validate the TAS algorithm. The Class 4 Permissive Change (C4PC) shall be applied to validate each host. ISED shall be notified, and an updated RF exposure technical brief shall be provided.

8.2.1 Requirements for the module

The module manufacturer shall validate the full range of parameters which could be implemented by the host manufacturer.

Module validation shall be performed in accordance with section 6.2; however, with a sufficient rationale, ISED may consider exclusions based on host-specific implementations, as well as limitations on the operating states and applicable exposure conditions. An inquiry with ISED is required for these exceptions to be considered.

For validation steps that are not carried out at the module level, or when the range of TAS parameters implemented within the host fall outside the scope of validations carried out on the module, the requirements in section 8.2.3 apply.

8.2.2 Module integration manual

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

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

8.2.3 Requirements for the host

The host manufacturer shall ensure that the implementation satisfies all of the validation criteria set forth in section 6.2. Any validation steps that are not carried out at the module level shall be validated at the host level. If the host uses parameters outside of those validated by the module manufacturer, additional testing will be required for proper validation and certification.

8.2.4 Enabling TAS post-certification

For pre-certified modules that did not implement TAS upon original certification, the requirements are as follows when firmware updates are applied to implement TAS:

a. A Class 3 Permissive Change (C3PC) application shall be submitted for the pre-certified module with the new firmware version identification number (FVIN) of the firmware intended to enable the TAS algorithm.
b. A Class 4 Permissive Change (C4PC) shall be applied to certify each new host product. A complete RF exposure technical brief and TAS validation report for the new host shall be included in the certification filing.
c. For existing host products that were certified without the TAS algorithm enabled, a C4PC application shall be submitted prior to enabling the algorithm. A supplemental TAS validation report shall be provided if the RF output power measurement is no different from the one originally listed. Otherwise, RF exposure shall be reassessed, and both an updated RF exposure technical brief and TAS validation report shall be provided.

The TAS validation report shall contain configurations previously evaluated by the TAS algorithm designer/manufacturer, along with any additional host-specific configurations and modes of operation that have not been previously assessed, including, but not limited to:

- simultaneous transmission
- additional TAS parameters not already evaluated or characterized
- change in exposure conditions
- proximity sensor(s) operating in conjunction with the TAS algorithm
- other sensors used to determine the exposure condition or mode of operation

8.3 Information to provide to ISED

In addition to the reporting requirements set forth in RSS-102, information detailed in these annexes shall be provided with the certification filing package sent to ISED:

- Annex A: Time-averaged specific absorption rate validation checklist; and
- Annex B: Information to include in the time-averaged specific absorption rate validation report.

If nerve stimulation and/or power density measurements are also required to assess the full compliance of the DUT, the reporting requirements shall include the items set forth in other applicable IEC standard(s), including any additional reporting requirements identified in RSS-102, SPR-002 and SPR-003.

9. Future considerations

ISED will be updating the guidance in SPR-004 to:

- expand the SAR validation beyond single point SAR;
- consider TAS implementations for WLAN (802.11); and
- TAS implemented at the proximity sensor level.

ISED is analyzing how device-based time-averaging can be implemented to manage compliance with other RF exposure requirements, such as power density above 6 GHz.

As TAS technologies enable a more representative assessment of the SAR levels to which a user may be exposed during normal daily use, ISED is considering revising the separation distance provided in the compliance assessment procedures of wireless devices. Further guidance will be provided on this matter.

If you have any questions or require additional guidance, please contact ISED by submitting a general inquiry.

Annex A: Time-averaged specific absorption rate validation checklist

This annex contains a list of tests that shall be performed to validate the time-averaged specific absorption rate (TAS) algorithm. The first column shows the type of test to be performed; in the second column, the result of the test is to be added in the empty cell next to each test; and, if a test was not performed, a reason to justify the omission of that test is to be added in the corresponding empty cell of the third column.

Table A1: TAS validation checklist

TAS algorithm validation test (see section 6.2)	**Test result (pass, fail, n/a)**	**Justification for omission of test**
Changes in requested power		
Antenna switching		
Change in operating state		
Frequency band hand-off or redirect		
Technology hand-off		
Switching between time division duplexing (TDD) and frequency division duplexing (FDD) configurations		
Change in modulation scheme		
Dropped connection		

Annex B: Information to include in the time-averaged specific absorption rate validation report

This annex contains a list of items to be provided in the time-averaged specific absorption rate (TAS) validation report, which shall be submitted as part of the certification filing.

B1. Items to include in the TAS validation report
1. General information
a. Test laboratory information, including ISED recognition and accreditation information
b. Evaluation dates
c. General description of the device including information related to certification, i.e. ISED certification number, hardware version identification number (HVIN), product marketing name (PMN), host marketing name (HMN), etc.
d. Brief description of the TAS implementation, including the model number (of the chipset and/or module, if different from the model number of the host device) and TAS version number
2. Validation test procedure, operating configurations and test conditions
a. Detailed description of all key parameters identified in section 6.1
b. Description of the set-up and procedures for conducted power and single point specific absorption rate (SAR) measurements
c. SAR measurement system check and dielectric parameter measurement results (when different from those provided in the radio frequency exposure technical brief)
d. Description of all applicable TAS operating states and configurations, as well as the selection criteria used to satisfy all test considerations detailed in section 6.2
e. P_{limit} and P_{max} values for all operating states and configurations selected for validation testing
f. Description of the pass/fail criteria established for each validation step
g. Summary of the TAS validation criteria evaluated, i.e. a copy of the checklist from annex A
3. Test results
a. Tabulated summary of the test results including a clear determination of the pass/fail results
b. Tabulated summary of P_{req} and T_{req} values generated for the pseudo-random test sequence described in section 6.2.2, along with plots of P_{req} versus time

c. Test plots for each validation criterion that demonstrate that the established thresholds have been adhered to, where each shall clearly indicate if normalization has been applied and shall display the following: i. The rolling time-averaged conducted power and SAR (if applicable) ii. The instantaneous conducted power and SAR (if applicable) iii. The power requested by the base station simulator iv. All applicable reference lines, such as those corresponding to P_{limit} and P_{max} for conducted power measurements and *psSAR* for single point SAR measurements v. The maximum time-averaged conducted power; or, if applicable, TAS value observed vi. Any other information necessary to demonstrate that the algorithm is functioning as intended and correlation with the compliance assessment results has been clearly established
4. Uncertainty budget
a. Uncertainty components associated with the conducted power and single point SAR measurements