

RF exposure evaluation

Date	Temperature	Humidity
2022-04-08	22 °C ± 2 °C	33 % ± 5 %

Procedure

The measurements were performed according to 47 CFR 2.1093 Portable devices 47 CFR part 15.247 (i) / KDB 447498 / RSS-102 2.5.1

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess limit for maximum permissible exposure. In accordance with 47 CFR Part 2 Subpart J, section 2.1093 and RSS-102 2.5.1 this device has been defined as a portable device to be used within 20 centimetres of the body of the user.

According to KDB 447498 D01 General RF Exposure Guidance v06.

The product is intended to be used at a distance of < 5 mm from the body.

Limits

47 CFR 2.1093 / KDB 447498 D01 General RF Exposure Guidance v06

4.3.1 Standalone SAR exclusion:

a) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$\left[\frac{\text{max. power of channel, including tune-up tolerance, mW}}{\text{min. test separation distance, mm}} \right] \times [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

RSS-102 Issue 5 cl. 2.5.1 Exemption from Routine Evaluation Limits – 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 in RSS-102.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance

Frequency (MHz)	Exemption Limits (mW)
	At separation distance of ≤ 5 mm
2450	4 mW

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.

Results

Standalone SAR exclusion:

According to RSS-102 clause 2.5.1, 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.

Maximum measured radiated average output power from the Maximum peak output power measurements section above, at 2402 MHz was -14.2 dBm EIRP (81.0 dBuV/m@3m).

Note: The measurements were performed in field strength in dBμV/m. The EIRP level was then calculated by the formula $P = (E_{fd})^2 / 30 \times G$, with G as unity gain of 1.

Maximum measured conducted average output power from the Maximum peak output power measurements section above, at 2402 MHz was -1.2 dBm thus the conducted average output power was used for the RF exposure evaluation.

Step a):

The following formula was used to calculate the RF exposure SAR exclusion threshold,

$$Thld = \frac{P_{out} \sqrt{f}}{r} \text{ were,}$$

Thld= SAR exclusion threshold

Pout = Maximum output power measured with RMS detector, in mW

r = minimum test separation distance, in mm

f=frequency, in GHz

Frequency f, (GHz)	Rated power RMS (dBm) Note 1	Pout acc. to source- based time averaging (dBm) Note 2	RMS output power, tolerance added, Note 3	Distance r, (mm)	Exclusion threshold Thld	Limit Threshold 1-g SAR	Limit Threshold 10-g SAR
2.480	-0.8	-1.1	2.9 dBm =2 mW	5	0.63	< 3	< 7.5

Note 1: Rated peak output power is 0 dBm (Peak). The difference between power measured with peak detector and RMS detector was 0.8 dB, which is used for correction of rated output power (peak) to the RMS output power.

Note 2: The highest measured duty cycle (worst case acc. to the client) in normal operating mode was 93.3%, duty cycle correction (dB)=10 log duty cycle = -0.30 dB.

Note 3: According to KDB 447498 D01 and RSS-102 cl. 2.5.1 the RMS value shall be adjusted for power tolerance. The power tolerance declared by the client is ±4 dB.

Conversion from dBm to mW: $P_{mW} = 10^{(dBm/10)}$

RMS output power including power tolerance correction and correction for duty cycle is 2 mW which is below limit of 4 mW at frequency 2480 MHz to exempt SAR evaluation of devices used at 5 mm or shorter to the body according to RSS-102 .

Test engineer Markel Bertilsson

Compliant?	Yes
------------	-----