
Project #: PRJ0040425

Company: American Innovations

Models (HVINs): RM520S, RM540S

RF Exposure Evaluation Report

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1.0 Maximum Permissible Exposure Evaluation (Supplements the test report.)

The measured power is considered for the intended use of the device and resulting RF exposure to the user.

1.1 Applicable Documents

Table 1.1.1: Applicable Documents

Document	Title
RSS-102 Issue 5 am1	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
KDB 447498 D04 Interim General RF Exposure Guidance v01	RF EXPOSURE PROCEDURES AND EQUIPMENT AUTHORIZATION POLICIES FOR MOBILE AND PORTABLE DEVICES
OET Bulletin 65 Edition 97-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

1.2 Criteria

Section Reference	Test Detail
FCC 47 CFR Part 1 I, 1.1310 // RSS-102, Issue 5 am1	Radiofrequency radiation exposure limits

1.3 Report Summary

This report summarizes RF Exposure evaluation of collocated radios in the RM520S and RM540S device. The following two radios are collocated in the device:

BLE (2.4GHz) transmitter – FCC ID DJU626734, IC ID: 2466B-626734

Iridium Satellite Transmitter – FCC ID Q639603N, IC ID: 4629A-9603N

The EUT is fixed when operated, with the user no closer than 20cm from the antenna during transmission. Worst case duty cycle operation and antenna gains were considered for this evaluation.

1.4 FCC RF Exposure Exemption

447498 D04 Interim General RF Exposure Guidance v01 was used as a basis for RF exposure requirements. The SAR-Based Exemption per 1.1307(b)(3)(i)(B) was considered for each radio based on the calculations below. Maximum power (P, EIRP) was obtained from the MPE and Test reports for each of the radios being considered. Table 1 below outlines the Maximum Permissible Exposure Limits (MPE).

Table 1 to § 1.1310(e)(1)—Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*(100)	≤6
3.0–30	1842/f	4.89/f	*(900/f ²)	<6
30–300	61.4	0.163	1.0	<6
300–1,500			f/300	<6
1,500–100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	<30
1.34–30	824/f	2.19/f	*(180/f ²)	<30
30–300	27.5	0.073	0.2	<30
300–1,500			f/1500	<30
1,500–100,000			1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.

Table 1: FCC Limits for RF Exposure

Threshold Power

$$P_{th(mW)} = \begin{cases} ERP_{20cm} \left(\frac{d}{20cm} \right)^x & \text{for } d \leq 20cm \\ ERP_{20cm} & \text{for } 20cm < d \leq 40cm \end{cases}$$

Where:

$$x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right) \text{ where } f \text{ is in GHz}$$

ERP_{20cm} Calculation

$$ERP_{20cm(mW)} = \begin{cases} 2040f & \text{for } 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & \text{for } 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

$$\text{Threshold } ERP_w = \begin{cases} 1920R^2 & \text{for } 0.3 \text{ MHz} \leq f < 1.34 \text{ MHz} \\ 3450 \frac{R^2}{f^2} & \text{for } 1.34 \text{ MHz} \leq f < 30 \text{ MHz} \\ 3.83R^2 & \text{for } 30 \text{ MHz} \leq f < 300 \text{ MHz} \\ 0.0128R^2 f & \text{for } 300 \text{ MHz} \leq f < 1500 \text{ MHz} \\ 19.2R^2 & \text{for } 1500 \text{ MHz} \leq f < 100000 \text{ MHz} \end{cases}$$

1.5 TCB Guidance for Collocate Radios Transmitting Simultaneously

For all transmitters that operate simultaneously, sum the following ratios of the individual transmitters:

- P / P_{th} for transmitters meeting exclusion thresholds of option B
- ERP / ERP_{th} for transmitters meeting exclusion thresholds of option C
- RF Exposure measured value / RF Exposure limit for transmitters evaluated through measurement

The total must be less than 1.0

- If not then it will require measurements one or more of the excluded transmitters

1.6 FCC Collocation Evaluation

Radio	Band	Frequency	Conducted Power	Antenna Gain	P(EIRP)	Power Density	Uncontrolled PD Limit	P/P _{limit}
-	-	MHz	dBm	dBi	mW	mW/cm ²	mW/cm ²	-
Q639603N	Iridium	1616	31.7	3	295.12*	0.059	1.000	0.059
DJU-626733	2.4GHz	2400	13.826	1.7	35.69	0.01	1.000	0.007

*Power corrected for 10% duty cycle of Iridium device (Worst-case transmission)

Table 2: Worst-Case Collocation Radio Combination

The highlighted lines above in Table 2 represent the worst-case combination of simultaneously transmitting collocated radios.

Radio	Q639603N	DJU626733	Total Exposure Ratio (TER)	Limit	Result
Band	Iridium	WLAN 2.4GHz,			
P/P _{limit}	0.059	0.007	0.066	1	Pass

Table 3: Total Exposure Ratio (TER)

Table 3 shows the summation of the exposure ratios (P/P_{limit}). The total summation of all P/P_{limit} values is < 1, as such, the device meets RF exposure requirements.

1.7 ISED RF Exposure Limits

For compliance to Canada, RF Exposure levels were evaluated against the limits set forth in RSS -102. Power Density limits were used per Table 4 of RSS-102. Each collocated radio was evaluated against the power density limit, and the ratio of power density to power density limits were summed. A total value of less than 1 is considered a passing result, as the total RF exposure is under the exemption limit.

**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	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

Table 4: RSS-102 RF Exposure Limits

1.8 ISED Collocation Evaluation

Radio	Band	Frequency	Conducted Power	Antenna Gain	P(EIRP)	Power Density	Uncontrolled PD Limit	P/P _{limit}
-	-	MHz	dBm	dBi	mW	W/m ²	W/m ²	-
4629A-9603N	Iridium	1616	31.7	3	295.12*	0.59	4.081	0.144
2466B-626734	2.4GHz	2400	13.826	1.7	35.69	0.07	5.348	0.013

*Power corrected for 10% duty cycle of Iridium device (Worst-case transmission)

Table 5: Worst-Case Collocation Radio Combination

The highlighted lines above in Table 5 represent the worst-case combination of simultaneously transmitting collocated radios.

Radio	4629A-9603N	2466B-626734	Total Exposure Ratio (TER)	Limit	Result
Band	Iridium	WLAN 2.4GHz,			
P/P _{limit}	0.144	0.013	0.157	1	Pass

Table 6: Total Exposure Ratio (TER)

Table 6 shows the summation of the exposure ratios (P/P_{limit}). The total summation of all P/P_{limit} values is < 1, as such, the device meets RF exposure requirements for ISED (Canada).

End of Report