**Project #: PRJ0040425**

**Company: American Innovations**

**Models (HVINs): RM520S, RM540S**

# RF Exposure Evaluation Report

Prepared for:

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October 24, 2023

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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**

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

**Where:**

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

**$ERP_{20cm}$ Calculation**

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

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

## 1.5 TCB Guidance for Collocate Radios Transmitting Simultaneously

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

- P / Pth for transmitters meeting exclusion thresholds of option B
- ERP / ERPth 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<br>- | Band<br>- | Frequency<br>MHz | Conducted Power<br>dBm | Antenna Gain<br>dBi | P(EIRP)<br>mW | Power Density<br>mW/cm² | Uncontrolled PD Limit<br>mW/cm² | $P/P_{limit}$<br>- |
|---|---|---|---|---|---|---|---|---|
| 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 se 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 | $3.142f^{0.3417}$ | $0.008335f^{0.3417}$ | $0.02619f^{0.6834}$ | 6 |
| 6000-15000 | 61.4 | 0.163 | 10 | 6 |
| 15000-150000 | 61.4 | 0.163 | 10 | $616000/f^{1.2}$ |
| 150000-300000 | $0.158f^{0.5}$ | $4.21 \times 10^{-4}f^{0.5}$ | $6.67 \times 10^{-5}f$ | $616000/f^{1.2}$ |

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

Table 4: RSS-102 RF Exposure Limits

## 1.8 ISED Collocation Evaluation

| Radio<br>- | Band<br>- | Frequency<br>MHz | Conducted Power<br>dBm | Antenna Gain<br>dBi | P(EIRP)<br>mW | Power Density<br>W/m² | Uncontrolled PD Limit<br>W/m² | $P/P_{limit}$<br>- |
|---|---|---|---|---|---|---|---|---|
| 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**