

RF Exposure Evaluation

Reference: CFR 47 FCC Part 1.1310
 RSS-102. Issue 5

Description: All 3 transmitters in the device have the possibility of transmitting simultaneously. The worst-case exposure for each transmitter was used to calculate the percentage of the allowable limit that each transmitter contributed. All of the percentages were then added together to verify that at the specified operating distance, they were below the allowable limit.

All measurements were peak or RMS power readings taken from test reports from accredited test labs. Antenna gains were taken from the manufacturer’s specifications.

Limits: Maximum exposure limits from CFR 47, FCC Part 1.1310:

Table 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)
(A) 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
(B) 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

Summation of RF exposure values from each radio:

Radio	Test Mode	Frequency Band (MHz)	Conducted peak output power (mW)	Maximum EIRP (mW)	Maximum EIRP (mW) with +10% tolerance	Power Density at R = 20 cm (mW/cm ²)	Limit (mW/cm ²)	Max EIRP / Limit (%)
1	Bluetooth	2402 ~ 2480	5.38	12.32	13.55	0.002697	1	0.28%
1	NRF	2403 ~ 2480	5.55	12.71	13.98	0.002783	1	
2	Bluetooth	2404 ~ 2480	5.21	11.93	13.12	0.002612	1	0.29%
2	NRF	2405 ~ 2480	5.76	13.19	14.51	0.002888	1	
3	Bluetooth	2402 ~ 2480	3.20	7.33	8.06	0.001604	1	12.11%
3	802.11b/g/n	2412 ~ 2462	241.50	553.04	608.34	0.121086	1	
3	802.11a/n/ac	5180 ~ 5825	30.30	98.17	107.99	0.021495	1	

SUM	12.68%
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DSS modulation is not use in radio 3.

Antenna gain was used to calculate EIRP based on conducted power. EIRP = conducted output power (mW) x numeric antenna gain

3.6 dBi = 2.29 numeric gain

5.1 dBi = 3.24 numeric gain

Power density = EIRP (mW) / (4*3.14*R²) R=20cm

Frequency (GHz)	2.400 – 2.485	5.150 – 5.825
Peak Gain	3.6 dBi	5.1 dBi

Using RSS-102, Issue 5, Section 2.5.2

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

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{(0.6834)}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance). In these cases, the information contained in the RF exposure

Radio	Test Mode	Frequency Band (MHz)	Conducted peak output power (mW)	Maximum EIRP (mW)	Maximum EIRP (mW) with +10% tolerance	Power Limit (mW)	Max EIRP / Limit (%)
1	Bluetooth	2402 ~ 2480	5.38	8.98	13.55	2676.42	0.38%
1	NRF	2403 ~ 2480	5.55	9.15	13.98	2676.42	
2	Bluetooth	2404 ~ 2480	5.21	8.81	13.12	2676.42	0.38%
2	NRF	2405 ~ 2480	5.76	9.36	14.51	2676.42	
3	Bluetooth	2402 ~ 2480	3.20	6.8	8.06	2676.42	10.04%
3	802.11b/g/n	2412 ~ 2462	241.50	245.1	608.34	2684.03	
3	802.11a/n/ac	5180 ~ 5825	30.30	35.4	107.99	4525.27	

SUM	10.80%
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