

4 FCC §2.1091 & §15.407(f) - RF Exposure

4.1 Applicable Standards

According to FCC §15.407(f) and §1.1307(b)(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 level in excess of the Commission's guidelines.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
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
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

4.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density

P = power input to antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

4.3 MPE Results

Radio 1

5 GHz Wi-Fi

<u>Maximum output power at antenna input terminal (dBm):</u>	<u>21.91</u>
<u>Tuned up maximum output power at antenna input terminal (dBm):</u>	<u>22.91</u>
<u>Tuned up maximum output power at antenna input terminal (mW):</u>	<u>195.4339</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>5745</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>2.6</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.82</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm²):</u>	<u>0.0708</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0708 mW/cm². Limit is 1.0 mW/cm².

2.4 GHz Wi-Fi

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>22.47</u>
<u>Tuned up maximum output power at antenna input terminal (dBm):</u>	<u>23.47</u>
<u>Tuned up maximum output power at antenna input terminal (mW):</u>	<u>222.331</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>2437</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>1.8</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.51</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm²):</u>	<u>0.0670</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0670 mW/cm². Limit is 1.0 mW/cm².

Radio 2

5 GHz Wi-Fi

<u>Maximum output power at antenna input terminal (dBm):</u>	<u>19.18</u>
<u>Tuned up maximum output power at antenna input terminal (dBm):</u>	<u>20.18</u>
<u>Tuned up maximum output power at antenna input terminal (mW):</u>	<u>104.232</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>5745</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>2.6</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.82</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm²):</u>	<u>0.0378</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0378 mW/cm². Limit is 1.0 mW/cm².

2.4 GHz Wi-Fi

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>22.02</u>
<u>Tuned up maximum output power at antenna input terminal (dBm):</u>	<u>23.02</u>
<u>Tuned up maximum output power at antenna input terminal (mW):</u>	<u>200.45</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>2412</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>1.8</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.51</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm²):</u>	<u>0.0604</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.0604 mW/cm². Limit is 1.0 mW/cm².

2.4 GHz Classic Bluetooth

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>12.81</u>
<u>Tuned up maximum output power at antenna input terminal (dBm):</u>	<u>13.81</u>
<u>Tuned up maximum output power at antenna input terminal (mW):</u>	<u>24.04</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>2402</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>1.8</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.51</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm²):</u>	<u>0.00724</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.00724mW/cm². Limit is 1.0 mW/cm².

Worst case colocation Radio 1 5 GHz Wi-Fi, Radio 2 2.4 GHz Wi-Fi and 2.4 GHz Classic Bluetooth:

Frequency Band	Tuned up Max Conducted Power(dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm ²)	MPE Limit (mW/cm ²)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
Worst Case							
Radio 1 5 GHz Wi-Fi	22.91	20	0.0708	1.0	7.08%	13.844%	100%
Radio 2 2.4 GHz Wi-Fi	23.02	20	0.0604	1.0	6.04%		
2.4 GHz Classic BT	13.81	20	0.00724	1.0	0.724%		