

## 5 FCC §2.1091 & §15.407(f) - RF Exposure

### 5.1 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 <sup>2</sup> )	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 <sup>2</sup> )	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

### 5.2 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

### 5.3 MPE Results

#### 2.4 GHz Wi-Fi

<u>Maximum output power at antenna input terminal (dBm):</u>	<u>26.0103</u>
<u>Maximum output power at antenna input terminal (mW):</u>	<u>399.052467</u>
<u>Tuned up output power at antenna input terminal (dBm):</u>	<u>27.0103</u>
<u>Tuned up output power at antenna input terminal (mW):</u>	<u>502.3772913</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>1.5</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.4125375</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm<sup>2</sup>):</u>	<u>0.141247365</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The tuned up power density at the distance of 20 cm is 0.1412 mW/cm<sup>2</sup>. Limit is 1.0 mW/cm<sup>2</sup>.

#### 2.4 GHz BLE

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>13.2</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>20.892961</u>
<u>Tuned up output power at antenna input terminal (dBm):</u>	<u>14.2</u>
<u>Tuned up output power at antenna input terminal (mW):</u>	<u>26.30267992</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>1.5</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.4125375</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm<sup>2</sup>):</u>	<u>0.007395207</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The tuned up power density at the distance of 20 cm is 0.0074 mW/cm<sup>2</sup>. Limit is 1.0 mW/cm<sup>2</sup>.

#### 5 GHz Wi-Fi Radio 1

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>22.09899</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>162.143297</u>
<u>Tuned up output power at antenna input terminal (dBm):</u>	<u>23.09899</u>
<u>Tuned up output power at antenna input terminal (mW):</u>	<u>204.1263171</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>5240</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>1.5</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.4125375</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm<sup>2</sup>):</u>	<u>0.057391735</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The tuned up power density at the distance of 20 cm is 0.0574 mW/cm<sup>2</sup>. Limit is 1.0 mW/cm<sup>2</sup>.

**5 GHz Wi-Fi Radio 2**

<u>Maximum peak output power at antenna input terminal (dBm):</u>	<u>22.66065</u>
<u>Maximum peak output power at antenna input terminal (mW):</u>	<u>184.52916</u>
<u>Tuned up output power at antenna input terminal (dBm):</u>	<u>23.66065</u>
<u>Tuned up output power at antenna input terminal (mW):</u>	<u>232.3084462</u>
<u>Prediction distance (cm):</u>	<u>20</u>
<u>Prediction frequency (MHz):</u>	<u>5795</u>
<u>Maximum Antenna Gain, typical (dBi):</u>	<u>1.5</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.4125375</u>
<u>Power density of prediction frequency at 20.0 cm (mW/cm<sup>2</sup>):</u>	<u>0.065315365</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>):</u>	<u>1.0</u>

The device is compliant with the requirement MPE limit for uncontrolled exposure. The tuned up power density at the distance of 20 cm is 0.0653 mW/cm<sup>2</sup>. Limit is 1.0 mW/cm<sup>2</sup>.

**Worst case colocation****2.4 GHz Wi-Fi, b mode, 2412 MHz, Radio 1; and BLE, 2402 MHz, Radio 2**

Sum of MPE Ratios:  $0.1412/1+0.0074/1=0.1486<1$

**5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2**

Sum of MPE Ratios:  $0.0574/1+0.0653/1=0.1227<1$

**5.2 GHz Wi-Fi, a mode, 5240 MHz, Radio 1; and BLE, 2402 MHz, Radio 2**

Sum of MPE Ratios:  $0.0574/1+0.0074/1=0.0648<1$

**2.4 GHz Wi-Fi, b mode, 2412 MHz, Radio 1; and 5.8 GHz Wi-Fi, ac40 mode, 5795 MHz, Radio 2**

Sum of MPE Ratios:  $0.1412/1+0.0653/1=0.2065<1$