

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 WiFi | 22.91 | 20 | 0.0708 | 1.0 | 7.08% | 13.844% | 100% |
| Radio 2 2.4 GHz WiFi | 23.02 | 20 | 0.0604 | 1.0 | 6.04% | | |
| 2.4 GHz Classic BT | 13.81 | 20 | 0.00724 | 1.0 | 0.724% | | |