# 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 ($mW/cm^2$) | 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

## 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

| | |
|---|---|
| Maximum output power at antenna input terminal (dBm): | 26.0103 |
| Maximum output power at antenna input terminal (mW): | 399.052467 |
| Tuned up output power at antenna input terminal (dBm): | 27.0103 |
| Tuned up output power at antenna input terminal (mW): | 502.3772913 |
| Prediction distance (cm): | 20 |
| Prediction frequency (MHz): | 2412 |
| Maximum Antenna Gain, typical (dBi): | 1.5 |
| Maximum Antenna Gain (numeric): | 1.4125375 |
| Power density of prediction frequency at 20.0 cm (mW/cm$^2$): | 0.141247365 |
| FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm$^2$): | 1.0 |

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$^2$. Limit is 1.0 mW/cm$^2$.

### 2.4 GHz BLE

| | |
|---|---|
| Maximum peak output power at antenna input terminal (dBm): | 13.2 |
| Maximum peak output power at antenna input terminal (mW): | 20.892961 |
| Tuned up output power at antenna input terminal (dBm): | 14.2 |
| Tuned up output power at antenna input terminal (mW): | 26.30267992 |
| Prediction distance (cm): | 20 |
| Prediction frequency (MHz): | 2402 |
| Maximum Antenna Gain, typical (dBi): | 1.5 |
| Maximum Antenna Gain (numeric): | 1.4125375 |
| Power density of prediction frequency at 20.0 cm (mW/cm$^2$): | 0.007395207 |
| FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm$^2$): | 1.0 |

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$^2$. Limit is 1.0 mW/cm$^2$.

### 5 GHz Wi-Fi Radio 1

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

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$^2$. Limit is 1.0 mW/cm$^2$.

**5 GHz Wi-Fi Radio 2**

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

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$^2$. Limit is 1.0 mW/cm$^2$.

**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