

## Appendix B. Maximum Permissible Exposure

## 1. Maximum Permissible Exposure

### 1.1. Applicable Standard

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 levels in excess limit for maximum permissible exposure. In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as a mobile device whereby that distance of at least 0.25 m is normally maintained between the user and the device.

#### (A) Limits for Occupational / Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842 / f	4.89 / f	(900 / f)*	6
30-300	61.4	0.163	1.0	6
300-1500			F/300	6
1500-100,000			5	6

#### (B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; \*Plane-wave equivalent power density

Note: f = frequency in MHz ; \*Plane-wave equivalent power density

### 1.2. MPE Calculation Method

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d}$$

$$\text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

E = Electric field (V/m)

P = Average RF output power (W)

G = EUT Antenna numeric gain (numeric)

d = Separation distance between radiator and human body (m)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$

From the EUT RF output power, the minimum mobile separation distance, d=0.25m, as well as the gain of the used antenna, the RF power density can be obtained.

### 1.3. Calculated Result and Limit

**Exposure Environment: General Population / Uncontrolled Exposure**

**For 5GHz Band**

**For Radio 2 :**

**Antenna Type : PIFA Antenna**

**Conducted Power for IEEE 802.11ac VHT20MHz : 26.60 dBm**

Distance (m)	Test Freq. (MHz)	Directional Gain	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
0.25	5240	8.54	7.1470	26.6014	457.2328	0.416283	1	Complies

**Note:** 
$$Directional\ lGain = 10 \cdot \log \left[ \frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

**For Radio 3 :**

**Antenna Type : PIFA Antenna**

**Conducted Power for IEEE 802.11a : 13.98dBm**

Distance (m)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
0.25	5500	5.59	3.6224	13.9800	25.0035	0.011538	1	Complies

**For 2.4GHz Band**

**For Radio 1:**

**Antenna Type : PIFA Antenna**

**Conducted Power for IEEE 802.11ac VHT20MHz : 25.51dBm**

Distance (m)	Test Freq. (MHz)	Directional Gain (dBi)	Antenna Gain (numeric)	The maximum combined Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
0.25	2437	7.18	5.2254	25.5117	355.7709	0.236822	1	Complies

**Note:** 
$$Directional\ lGain = 10 \cdot \log \left[ \sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2 \right]$$

**For Radio 3:**
**Antenna Type : PIFA Antenna**
**Conducted Power for IEEE 802.11ac VHT20MHz : 16.72dBm**

Distance (m)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
0.25	2437	3.33	2.1528	16.7200	46.9894	0.012886	1	Complies

**For Bluetooth function**
**For Radio 4:**
**Antenna Type : PIFA Antenna**
**Conducted Power for Bluetooth 4.0 : 2.74 dBm**

Distance (m)	Test Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power		Power Density (S) (mW/cm <sup>2</sup> )	Limit of Power Density (S) (mW/cm <sup>2</sup> )	Test Result
				(dBm)	(mW)			
0.25	2402	3.48	2.2284	2.7400	1.8793	0.000533	1	Complies

### **Conclusion:**

Both of the Radio 1 (2.4GHz WLAN function) + Radio 2 (5GHz WLAN function) + Radio 3 (2.4GHz WLAN function) + Bluetooth can transmit simultaneously, the formula of calculated the MPE is:

$$\text{CPD1 / LPD1 + CPD2 / LPD2 + .....etc.} < 1$$

**CPD = Calculation power density**

**LPD = Limit of power density**

Therefore, the worst-case situation is  $0.236822 / 1 + 0.416283 / 1 + 0.012886 / 1 + 0.000533 / 1 = 0.666525$ , which is less than "1". This confirmed that the device complies.

### **Conclusion:**

Both of the Radio 1 (2.4GHz WLAN function) + Radio 2 (5GHz WLAN function) + Radio 3 (5GHz WLAN function) + Bluetooth can transmit simultaneously, the formula of calculated the MPE is:

$$\text{CPD1 / LPD1 + CPD2 / LPD2 + .....etc.} < 1$$

**CPD = Calculation power density**

**LPD = Limit of power density**

Therefore, the worst-case situation is  $0.236822 / 1 + 0.416283 / 1 + 0.011538 / 1 + 0.000533 / 1 = 0.665177$ , which is less than "1". This confirmed that the device complies.