

## Appendix C. 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 a distance of 0.25 m normally can be 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

### 1.2. MPE Calculation Method

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d} \quad \text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

**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

For 5GHz UNII Band:

Antenna Type : Dipole Antenna

Conducted Power for IEEE 802.11ac VHT 20 : 26.11dBm

| Directional 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)     |                                         |                                                  |             |
| 9.26                   | 8.4345                 | 26.1090              | 408.2233 | 0.438620                                | 1                                                | Complies    |

Note:  $Directional\ gain = G_{ANT} + 10 \log(N_{ANT}/N_{SS})$

For 5GHz ISM Band:

Antenna Type : Dipole Antenna

Conducted Power for IEEE 802.11ac VHT 40: 26.14dBm

| Directional 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)     |                                         |                                                  |             |
| 9.31                   | 8.5322                 | 26.1441              | 411.5381 | 0.447302                                | 1                                                | Complies    |

Note:  $Directional\ gain = G_{ANT} + 10 \log(N_{ANT}/N_{SS})$

For 2.4GHz Band:

Antenna Type : Dipole Antenna

Conducted Power for IEEE 802.11ac VHT 20: 27.29 dBm

| Directional 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)     |                                         |                                                  |             |
| 8.43                   | 6.9682                 | 27.2863              | 535.3373 | 0.475203                                | 1                                                | Complies    |

Note:  $Directional\ gain = G_{ANT} + 10 \log(N_{ANT}/N_{SS})$

#### CONCLUSION:

Both of the WLAN 2.4GHz Band and WLAN 5GHz Band can transmit simultaneously, the formula of calculated the MPE is:

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

CPD = Calculation power density

LPD = Limit of power density

Therefore, the worst-case situation is  $0.447302 / 1 + 0.475203 / 1 = 0.922505$ , which is less than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.