

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 a distance of 0.2 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 ²)	Averaging Time E ² , H ² 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 ²)	Averaging Time E ² , H ² 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

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

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=0.2m, 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:

<Ant. 4>:

Antenna Type : Omni-Directional Antenna

Max Conducted Power for IEEE 802.11n MCS8 20MHz: 14.82dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
8.08	6.4269	14.8228	30.3587	0.038836	1	Complies

<Ant. 5>:

Antenna Type : Yagi Antenna

Max Conducted Power for IEEE 802.11a: 13.84dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
9.08	8.0910	13.8400	24.2103	0.038990	1	Complies

Note: Directional Antenna Gain = Test Antenna Gain + 10 log (Antenna quantity)

<Ant. 6>:

Antenna Type : Omni-Directional Antenna

Max Conducted Power for IEEE 802.11n MCS8 20MHz: 10.29dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
12.58	18.1134	10.2854	10.6793	0.038503	1	Complies

<Ant. 10>:

Antenna Type : Dual-band MIMO omni patch array, three 2.4G elements, three 5G element Antenna

Max Conducted Power for IEEE 802.11n MCS8 20MHz: 16.58dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
3.58	2.2803	16.5775	45.4725	0.020640	1	Complies

For 5GHz ISM Band:

<Ant. 5>:

Antenna Type : Yagi Antenna
Max Conducted Power for IEEE 802.11a: 23.35dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
9.08	8.0910	23.3500	216.2719	0.348298	9.08	Complies

Note: Directional Antenna Gain = Test Antenna Gain + 10 log (Antenna quantity)

For 2.4GHz Band:

<Ant. 1>:

Antenna Type : Directional Panel Antenna
Max Conducted Power for IEEE 802.11b: 18.02 dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
17.86	61.0942	18.0205	63.3940	0.770901	1	Complies

Note: Directional Antenna Gain = Test Antenna Gain + 10 log (Antenna quantity)

<Ant. 2>:

Antenna Type : Dipole Omni Antenna
Max Conducted Power for IEEE 802.11g: 23.59 dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
12.36	17.2187	23.5866	228.3794	0.782722	1	Complies

Note: Directional Antenna Gain = Test Antenna Gain + 10 log (Antenna quantity)

<Ant. 3>:

Antenna Type : Patch Antenna

Max Conducted Power for IEEE 802.11b: 25.51 dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
9.86	9.6828	25.5103	355.6597	0.685465	1	Complies

Note: Directional Antenna Gain = Test Antenna Gain + 10 log (Antenna quantity)

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 $0.782722 / 1 + 0.038990 / 1 = 0.821712$, which is less than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.