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 0.25 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/ cm²)	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/ cm²)	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 (V/m) = $\frac{\sqrt{30 \times P \times G}}{d}$ Power Density: *Pd* (W/m²) = $\frac{E^2}{377}$

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: (15.407)

<Radio 2: 2.4GHz + 5GHz>

<Ant. 2>

Antenna Type : Embedded Antenna

Max Conducted Power for IEEE 802.11a: 12.57dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
9.58	9.0782	12.5703	18.0732	0.020901	1	Complies

NOTE: Directional gain = 7.5 dBi + 10log(2) = 9.58dBi

<Ant. 7>

Antenna Type : Dipole Antenna

Max Conducted Power for IEEE 802.11n MCS0 20MHz: 13.99dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
9.00	7.9433	13.9900	25.0611	0.025359	1	Complies

<Ant. 8>

Antenna Type : Patch Antenna

Max Conducted Power for IEEE 802.11n MCS0 20MHz: 15.34dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
4.60	2.8840	15.3407	34.2033	0.012566	1	Complies

<Ant. 9>

Antenna Type : Panel Antenna

Max Conducted Power for IEEE 802.11a: 10.49dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
12.50	17.7828	10.4900	11.1944	0.025359	1	Complies

<Ant. 10>

Antenna Type : Yagi Antenna

Max Conducted Power for IEEE 802.11n MCS0 20MHz: 11.87dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
11.00	12.5893	11.8700	15.3815	0.024668	1	Complies

For 5GHz ISM Band: (15.247)

<Radio 2: 2.4GHz + 5GHz>

<Ant. 2>

Antenna Type : Embedded Antenna

Max Conducted Power for IEEE 802.11a: 24.56dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
9.58	9.0782	24.5600	285.7574	0.330467	1	Complies

NOTE: Directional gain = 7.5 dBi + 10log(2) = 9.58dBi

<Ant. 7>

Antenna Type : Dipole Antenna

Max Conducted Power for IEEE 802.11a: 23.57dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
9.00	7.9433	23.5698	227.5008	0.230204	1	Complies

<Ant. 8>

Antenna Type : Patch Antenna

Max Conducted Power for IEEE 802.11a: 23.57dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
4.60	2.8840	23.5698	227.5008	0.083582	1	Complies

<Ant. 9>

Antenna Type : Panel Antenna

Max Conducted Power for IEEE 802.11n MCS0 20MHz: 22.30dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
12.50	17.7828	22.3000	169.8244	0.384707	1	Complies

<Ant. 10>

Antenna Type : Yagi Antenna

Max Conducted Power for IEEE 802.11n MCS0 20MHz: 22.30dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
11.00	12.5893	22.3000	169.8244	0.272352	1	Complies

For 2.4GHz Band:

<Radio 1: 2.4GHz>

<Ant. 1>

Antenna Type : Embedded Antenna

Max Conducted Power for IEEE 802.11g: 26.35dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
6.86	4.8529	26.3474	431.2657	0.266609	1	Complies

NOTE: Directional gain = 3.92dBi + 10log(2) = 6.86dBi

<Ant. 3>

Antenna Type : Dipole Antenna

Max Conducted Power for IEEE 802.11g: 23.96dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
11.51	14.1579	23.9561	248.6641	0.448480	1	Complies

NOTE: Directional gain = 8.5dBi + 10log(2) = 11.51dBi

<Ant. 4>

Antenna Type : Patch Antenna

Max Conducted Power for IEEE 802.11n MCS0 20MHz: 24.70dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
6.51	4.4771	24.6975	294.9505	0.168221	1	Complies

NOTE: Directional gain = 3.5dBi + 10log(2) = 6.51dBi

<Ant. 5>

Antenna Type : Panel Antenna

Max Conducted Power for IEEE 802.11b: 20.04dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
10.90	12.3027	20.0400	100.9253	0.158172	1	Complies

<Ant. 6>

Antenna Type : Yagi Antenna

Max Conducted Power for IEEE 802.11b: 22.79dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
11.10	12.8825	22.7900	190.1078	0.311983	1	Complies

<Radio 2: 2.4GHz + 5GHz>

<Ant. 2>

Antenna Type : Embedded Antenna

Max Conducted Power for IEEE 802.11n MCS0 20MHz: 26.93dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
7.27	5.3333	26.9322	493.4245	0.335236	1	Complies

NOTE: Directional gain = 4.44dBi + 10log(2) = 7.27dBi

<Ant. 3>

Antenna Type : Dipole Antenna

Max Conducted Power for IEEE 802.11b: 23.22dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
8.50	7.0795	23.2200	209.8940	0.189291	1	Complies

<Ant. 4>

Antenna Type : Patch Antenna

Max Conducted Power for IEEE 802.11g: 25.41dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
6.51	4.4771	25.4128	347.7589	0.198339	1	Complies

NOTE: Directional gain = 3.5dBi + 10log(2) = 6.51dBi

<Ant. 5>

Antenna Type : Panel Antenna

Max Conducted Power for IEEE 802.11b: 18.65dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
10.90	12.3027	18.6500	73.2825	0.114850	1	Complies

<Ant. 6>

Antenna Type : Yagi Antenna

Max Conducted Power for IEEE 802.11b: 18.22dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Output Power (dBm)	Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
11.10	12.8825	18.2200	66.3743	0.108926	1	Complies

CONCULSION:

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

CPD1 / LPD1 + CPD2 / LPD2 + ...etc. < 1

CPD = Calculation power density

LPD = Limit of power density

Therefore, the worst-case situation is 0.448480 / 1 + 0.384707 / 1 = 0.833187, which isless than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.

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

CPD1 / LPD1 + CPD2 / LPD2 + ...etc. < 1

CPD = Calculation power density

LPD = Limit of power density

Therefore, the worst-case situation is 0.448480 / 1 + 0.335236 / 1 = 0.783716, which isless than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.