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 0.3 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=0.3m, 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

Test Mode : Mode 1

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 10.18dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
12.77	18.9287	10.18	10.4232	0.017454	1	Complies

Antenna Type : Patch Antenna

Test Mode : Mode 2

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 15.89dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
7.07	5.0947	15.89	38.8150	0.017489	1	Complies

Antenna Type : Panel Antenna

Test Mode : Mode 3

Max Conducted Power for IEEE 802.11n 40MHz MCS0 (1TX) : 12.46dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
10.50	11.2202	12.46	17.6198	0.017489	1	Complies

Antenna Type : Yagi Antenna

Test Mode : Mode 4

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 10.18dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
12.77	18.9287	10.18	10.4232	0.017454	1	Complies

Antenna Type Facade Antenna

Test Mode : Mode 5

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 15.64dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
7.27	5.3348	15.64	36.6438	0.017289	1	Complies

For 5GHz ISM Band:

Antenna Type : Dipole Antenna

Test Mode : Mode 6

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 23.22dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
12.77	18.9287	23.22	209.8940	0.351373	1	Complies

Antenna Type : Patch Antenna

Test Mode : Mode 7

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 23.67dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
7.07	5.0947	23.67	232.8091	0.104898	1	Complies

Antenna Type : Panel Antenna

Test Mode : Mode 8

Max Conducted Power for IEEE 802.11n 40MHz MCS8 (3TX) : 22.30dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
13.50	22.3872	22.30	169.8244	0.336332	1	Complies

Antenna Type : Yagi Antenna

Test Mode : Mode 9

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 23.22dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
12.77	18.9287	23.22	209.8940	0.351373	1	Complies

Antenna Type : Façade Antenna

Test Mode : Mode 10

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 23.67dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
7.27	5.3348	23.67	232.8091	0.109842	1	Complies

For 2.4GHz Band:

Antenna Type : Dipole Antenna

Test Mode : Mode 1

Max Conducted Power for IEEE 802.11b (2TX) : 23.67 dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
12.01	15.8866	23.67	232.8091	0.327166	1	Complies

Antenna Type : Patch Antenna

Test Mode : Mode 2

Max Conducted Power for IEEE 802.11b (2TX): 29.82 dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
6.01	3.9905	29.82	959.4006	0.338663	1	Complies

Antenna Type : Panel Antenna

Test Mode : Mode 3

Max Conducted Power for IEEE 802.11b (3TX) 17.12 dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
18.77	75.3566	17.12	51.5229	0.343374	1	Complies

Antenna Type : Yagi Antenna

Test Mode : Mode 4

Max Conducted Power for IEEE 802.11b (3TX) : 17.53 dBm

Directional Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
18.27	67.1616	17.53	56.6239	0.336332	1	Complies

Antenna Type : Facade Antenna

Test Mode : Mode 5

Max Conducted Power for IEEE 802.11n 20MHz MCS0 (3TX) : 27.25 dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
7.27	5.3348	27.25	530.8844	0.250477	1	Complies

Test Mode : USB Dongle (2.4G)

Max Conducted Power : 25.02 dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
8.25	6.6834	25.02	317.6874	0.187831	1	Complies

Test Mode : USB Dongle (5G)

Max Conducted Power : 25.41 dBm

Antenna Gain (dBi)	Antenna Gain (numeric)	Average Output Power (dBm)	Average Output Power (mW)	Power Density (S) (mW/cm²)	Limit of Power Density (S) (mW/cm²)	Test Result
8.69	7.3961	25.41	347.5362	0.227388	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 0.343374 / 1 + 0.351373 / 1 = 0.694747, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

Radio 1 (2.4G)+ Ant. 3 +Radio 2 (5G)+ Ant. 8 + Adapter

Therefore, the worst-case situation is 0.343374 / 1 + 0.351373 / 1 = 0.694747, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

Radio 1 (2.4G) + Ant. 3 + USB Dongle left (5G)

Therefore, the worst-case situation is 0.343374 / 1 + 0.227388 / 1 = 0.570762, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

Radio 1 (2.4G) + Ant. 3 + USB Dongle left (2.4G)

Therefore, the worst-case situation is 0.343374 / 1 + 0.187831 / 1 = 0.531205, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

Radio 1 (5G) + Ant. 8 + USB Dongle right (5G)

Therefore, the worst-case situation is 0.351373 / 1 + 0.227388 / 1 = 0.578761, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

Radio 1 (5G) + Ant. 8 + USB Dongle right (2.4G)

Therefore, the worst-case situation is 0.351373 / 1 + 0.187831 / 1 = 0.539204, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

Radio 1 (2.4G) + Ant. 3 + Radio 2 (2.4G) + Ant. 4

Therefore, the worst-case situation is 0.343374 / 1 + 0.343374 / 1 = 0.686748, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.

Radio 1 (5G) + Ant. 6 + Radio 1 (5G) + Ant. 8

Therefore, the worst-case situation is 0.351373 / 1 + 0.351373 / 1 = 0.702746, which isless than “1”. This confirmed that the device comply with FCC 1.1310 MPE limit.