

FCC §1.1310& §2.1091 –MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247(i) and subpart §1.1310, 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 level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/		f/1500	30
1500-100,000	/		1.0	30

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

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

S = PG/4πR² = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Calculated Data:**For LTE mode:**

Mode	Frequency Range (MHz)	Max Antenna Gain		Target Output Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
LTE Band 5	824-849	2.70	1.86	22	158.49	20	0.0587	0.55
LTE Band 41	2516-2670	3.70	2.34	23	199.53	20	0.0930	1.00

For Wi-Fi mode:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11b	2412-2462	2.20	1.66	17.00	50.12	20	0.0165	1.00
802.11g		2.20	1.66	16.00	39.81	20	0.0131	1.00
802.11n-HT20		2.20	1.66	15.00	31.62	20	0.0104	1.00
802.11n-HT40	2422-2452	2.20	1.66	15.00	31.62	20	0.0104	1.00

Mode	Frequency (MHz)	Antenna Gain		Conducted output power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11a	5150-5250	2.20	1.66	14.00	25.12	20	0.0083	1.00
802.11n-HT20		2.20	1.66	15.00	31.62	20	0.0104	1.00
802.11n-HT40		2.20	1.66	15.00	31.62	20	0.0104	1.00
802.11a	5725-5850	2.20	1.66	14.00	25.12	20	0.0083	1.00
802.11n-HT20		2.20	1.66	15.00	31.62	20	0.0104	1.00
802.11n-HT40		2.20	1.66	16.00	39.81	20	0.0131	1.00

Note:

- (1) The target output power was declared by the Manufacturer.
- (2) 2.4GWi-Fi and 5GWi-Fi cannot transmit simultaneously.
- (3) Wi-Fi and LTE can transmit simultaneously, The worst condition is 802.11b of 2.4G Wi-Fi and LTE Band 5, as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0165/1.00 + 0.0587/0.55 = 0.0165 + 0.1067 = 0.1232 < 1.0$$

Result: The device meet FCC MPE at 20 cm distance.