

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

Applicable Standard

According to subpart §2.1091 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/cm²)	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

$S = PG/4\pi R^2$ = 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:**2.4G WiFi:**

Mode	Frequency Range (MHz)	Maximum 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	3.58	2.28	26.50	446.68	20	0.2026	1.0
802.11g		3.58	2.28	27.00	501.19	20	0.2273	1.0
802.11n-HT20		3.58	2.28	26.00	398.11	20	0.1806	1.0
802.11n-HT40	2422-2452	3.58	2.28	20.00	100.00	20	0.0454	1.0

5G Wi-Fi/WCDMA/LTE:

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)			
802.11a	5150~5250	4.97	3.14	25.0	316.23	20	0.1975	1.0
	5725~5850	4.98	3.15	24.0	251.19	20	0.1573	1.0
802.11ac20	5150~5250	4.97	3.14	24.0	251.19	20	0.1569	1.0
	5725~5850	4.98	3.15	25.5	354.81	20	0.2222	1.0
802.11n20	5150~5250	4.97	3.14	22.0	158.49	20	0.0990	1.0
	5725~5850	4.98	3.15	25.5	354.81	20	0.2222	1.0
802.11ac40	5150~5250	4.97	3.14	24.5	281.84	20	0.1760	1.0
	5725~5850	4.98	3.15	26.0	398.11	20	0.2493	1.0
802.11n40	5150~5250	4.97	3.14	24.0	251.19	20	0.1569	1.0
	5725~5850	4.98	3.15	25.5	354.81	20	0.2222	1.0
802.11ac80	5210	4.97	3.14	21.0	125.89	20	0.0786	1.0
	5775	4.98	3.15	25.0	316.23	20	0.1980	1.0
WCDMA Band II	1850-1910	2.32	1.71	22.5	177.83	20	0.0603	1.0
WCDMA Band IV	1710-1755	3.53	2.25	22.5	177.83	20	0.0796	1.0
WCDMA Band V	824-849	2.61	1.82	22.5	177.83	20	0.0645	0.55
LTE Band 2	1850-1910	2.32	1.71	23.0	199.53	20	0.0679	1.0
LTE Band 4	1710-1755	3.53	2.25	22.5	177.83	20	0.0796	1.0
LTE Band 12	699-716	1.34	1.36	22.5	177.83	20	0.0482	0.47
LTE Band 13	777-787	2.25	1.68	22.5	177.83	20	0.0594	0.52
LTE Band 14	788-798	2.25	1.68	22.5	177.83	20	0.0594	0.53
LTE Band 66	1710-1780	3.53	2.25	23.0	199.53	20	0.0893	1.0
LTE Band 71	663-698	1.93	1.56	22.5	177.83	20	0.0552	0.44

Note:

1. For the above tune up power were declared by the manufacturer.
2. 2.4G Wi-Fi, 5G Wi-Fi and LTE can transmit simultaneously, The worst condition is 802.11g of 2.4G Wi-Fi, 802.11ac 40 of 5G Wi-Fi Band 4 & LTE Band 71, as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.2273/1.00 + 0.2493/1.0 + 0.0552/0.44 = 0.6021 < 1.0$$

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