

RF exposure

According to FCC part 1.1310 : The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in § 1.1307(b)

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength(V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	Average time
(A) Limits for Occupational / Control Exposures				
300 – 1 500	--	--	f/300	6
1 500 - 100000	--	--	5	6
(B) Limits for General Population / Uncontrol Exposures				
300 – 1 500	--	--	f/1500	6
1 500 – 100 000	--	--	1	30

f= frequency in MHz

Friis transmission formula: $P_d = (P_{out} \times G) / (4 \times \pi \times R^2)$

Where,

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = distance between observation point and center of the radiator in cm

P_d the limit of MPE, 1 mW/cm². If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

Results - Worst case

1) BLE (2.4G)

Operation mode		Max tune-up Average power (dBm)	Antenna gain (dBi)	Power density at 20 cm(mW/cm²)	Limit (mW/cm²)
BDR (1 Mbps)	SISO	-6.00	3.18	0.00010	1
EDR (2 Mbps)	SISO	-8.00	3.18	0.00007	1
EDR (3 Mbps)	SISO	-8.00	3.18	0.00007	1

2) WIFI (2.4G)

Operation mode		Max tune-up Average power (dBm)	Antenna gain (dBi)	Power density at 20 cm(mW/cm²)	Limit (mW/cm²)
802.11b	SISO	10.00	3.18	0.00414	1
802.11g	SISO	10.00	3.18	0.00414	1
802.11n(HT20)	SISO	10.00	3.18	0.00414	1
802.11n(HT40)	SISO	9.00	3.18	0.00329	1

3) WIFI(5.2G)

Operation mode		Max tune-up Average power (dBm)	Antenna gain (dBi)	Power density at 20 cm(mW/cm ²)	Limit (mW/cm ²)
802.11a	SISO	2.00	3.52	0.00071	1
802.11n(HT20)	SISO	2.00	3.52	0.00071	1
802.11n(HT40)	SISO	2.00	3.52	0.00071	1
802.11ac(VHT20)	SISO	2.00	3.52	0.00071	1
802.11ac(VHT40)	SISO	2.00	3.52	0.00071	1
802.11ac(VHT80)	SISO	2.00	3.52	0.00071	1

4) WIFI(5.3G)

Operation mode		Max tune-up Average power (dBm)	Antenna gain (dBi)	Power density at 20 cm(mW/cm ²)	Limit (mW/cm ²)
802.11a	SISO	0.00	4.35	0.00054	1
802.11n(HT20)	SISO	0.00	4.35	0.00054	1
802.11n(HT40)	SISO	0.00	4.35	0.00054	1
802.11ac(VHT20)	SISO	1.00	4.35	0.00068	1
802.11ac(VHT40)	SISO	0.00	4.35	0.00054	1
802.11ac(VHT80)	SISO	-1.00	4.35	0.00043	1

5) WIFI(5.5G)

Operation mode		Max tune-up Average power (dBm)	Antenna gain (dBi)	Power density at 20 cm(mW/cm ²)	Limit (mW/cm ²)
802.11a	SISO	-5.40	4.25	0.00015	1
802.11n(HT20)	SISO	-5.40	4.25	0.00015	1
802.11n(HT40)	SISO	-5.00	4.25	0.00017	1
802.11ac(VHT20)	SISO	-4.50	4.25	0.00019	1
802.11ac(VHT40)	SISO	-4.90	4.25	0.00017	1
802.11ac(VHT80)	SISO	-5.00	4.25	0.00017	1

6) WIFI(5.8G)

Operation mode		Max tune-up Average power (dBm)	Antenna gain (dBi)	Power density at 20 cm(mW/cm ²)	Limit (mW/cm ²)
802.11a	SISO	-10.00	3.14	0.00004	1
802.11n(HT20)	SISO	-11.00	3.14	0.00003	1
802.11n(HT40)	SISO	-11.00	3.14	0.00003	1
802.11ac(VHT20)	SISO	-10.00	3.14	0.00004	1
802.11ac(VHT40)	SISO	-11.00	3.14	0.00003	1
802.11ac(VHT80)	SISO	-13.00	3.14	0.00002	1