

RF EXPOSURE EVALUATION

According to FCC 1.1310 and KDB 447498 D01 V06, 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/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*100	6
3.0-30	1842/f	4.89/f	*900/f ²	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
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
300-1,500			f/1500	30
1,500-100,000			1.0	30

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

MPE Calculation Method

$$E \text{ (V/m)} = \frac{\sqrt{30 * P * G}}{d}$$

$$\text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

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

$$Pd = \frac{30 * P * G}{377 * D^2}$$

From the EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the gain of the used antenna, the RF power density can be obtained.

Measurement Result

BT:

Operation Frequency: 2402MHz~2480MHz

Power density limited: 1mW/ cm²

Antenna Type: ceramic antenna

Antenna gain: 1.5 dBi;

R=20cm

mW=10^{^(dBm/10)}

antenna gain Numeric=10^{^(dBi/10)}

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
2402	DH5	0.05	0±1	1	1.259	1.50	1.41	0.0004	1
2441		0.35	0±1	1	1.259	1.50	1.41	0.0004	1
2480		0.11	0±1	1	1.259	1.50	1.41	0.0004	1
2402	2DH5	-0.6	0±1	1	1.259	1.50	1.41	0.0004	1
2441		-0.29	0±1	1	1.259	1.50	1.41	0.0004	1
2480		-0.59	0±1	1	1.259	1.50	1.41	0.0004	1
2402	3DH5	-0.23	0±1	1	1.259	1.50	1.41	0.0004	1
2441		0.06	0±1	1	1.259	1.50	1.41	0.0004	1
2480		-0.19	0±1	1	1.259	1.50	1.41	0.0004	1

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain			
				(dBm)	(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)
2402	BLE 1M	-0.06	0±1	1	1.259	1.50	1.41	0.0004	1
2440		0.1	0±1	1	1.259	1.50	1.41	0.0004	1
2480		-0.15	0±1	1	1.259	1.50	1.41	0.0004	1
2402	BLE 2M	-0.17	0±1	1	1.259	1.50	1.41	0.0004	1
2440		-0.06	0±1	1	1.259	1.50	1.41	0.0004	1
2480		-0.34	0±1	1	1.259	1.50	1.41	0.0004	1

2.4G WIFI

Operation Frequency:

WIFI 802.11b/g/n HT20/ax20: 2412-2462MHz,

WIFI 802.11n HT40/ax40:2422-2452MHz

Power density limited: 1mW/ cm²

Antenna Type: PCB antenna

Antenna gain: 1.5 dBi;

R=20cm

mW=10^{^(dBm/10)}

Antenna gain Numeric=10^{^(dBi/10)}

Antenna	Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
			(dBm)		tune-up power		Gain			
					(dBm)	(mW)	(dBi)	Numeric		
Ant 1	2412	802.11b	12.56	13±1	14	25.119	1.50	1.41	0.0071	1
Ant 1	2437		13.27	13±1	14	25.119	1.50	1.41	0.0071	1
Ant 1	2462		12.65	13±1	14	25.119	1.50	1.41	0.0071	1
Ant 1	2412	802.11g	11.29	12±1	13	19.953	1.50	1.41	0.0056	1
Ant 1	2437		11.56	12±1	13	19.953	1.50	1.41	0.0056	1
Ant 1	2462		11.99	12±1	13	19.953	1.50	1.41	0.0056	1
Ant 1	2412	802.11n H20	11.22	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2437		11.54	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2462		11.38	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2422	802.11n H40	11.12	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2437		11.39	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2452		11.07	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2412	802.11ax20	11.02	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2437		11.81	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2462		11.24	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2422	802.11ax40	11.46	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2437		11.43	11±1	12	15.849	1.50	1.41	0.0045	1
Ant 1	2452		11.02	11±1	12	15.849	1.50	1.41	0.0045	1

5G WIFI

802.11a/n20/ac/ax20: 5180-5240MHz,5260-5320MHz,5500-5700MHz,5745-5825MHz

802.11n/ac/ax40:5190-5230MHz,5270-5310MHz,5510-5670MHz,5755-5795MHz

Power density limited: 1mW/cm

Antenna Type: PCB antenna

Antenna: 1.5dBi;

R=20cm

mW=10^{^(dBm/10)}

antenna 1gain Numeric=10^{^(dBi/10)}

5.2G

Antenna	Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
			(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
					(dBm)	(mW)	(dBi)	Numeric		
Ant1	5180	802.11a	10.78	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5200		11.26	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5240		11.07	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5180	802.11n H20	10.61	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5200		11.56	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5240		11.25	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5190	802.11n H40	9.56	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5230		10.28	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5180	802.11ac20	10.68	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5200		11.31	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5240		11.18	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5190	802.11ac40	9.52	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5230		10.36	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5180	802.11ax20	10.63	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5200		11.22	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5240		10.93	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5190	802.11ax40	9.48	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5230		10.22	10±1	11	12.589	1.50	1.41	0.0035	1

5.3G

Antenna	Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
			(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
					(dBm)	(mW)	(dBi)	Numeric		
Ant1	5260	802.11a	11.52	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5280		11.25	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5320		10.12	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5260	802.11n20	11.76	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5280		11.35	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5320		10.16	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5270	802.11n40	10.55	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5310		10.09	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5260	802.11ac20	11.53	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5280		11.24	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5320		10.23	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5270	802.11ac40	10.84	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5310		10.08	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5260	802.11ac20	11.73	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5280		11.40	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5320		10.08	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5270	802.11ac40	10.82	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5310		9.07	10±1	11	12.589	1.50	1.41	0.0035	1

5.6G

			(dBm)		(dBm)	(mW)	(dBi)	Numeric	(mW/cm ²)	(mW/cm ²)
Ant1	5500	802.11a	11.19	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5600		10.23	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5700		10.11	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5500	802.11n20	11.00	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5600		10.32	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5700		10.08	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5510	802.11n40	9.43	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5590		10.04	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5670		10.66	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5500	802.11ac20	11.36	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5600		10.18	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5700		10.09	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5510	802.11ac40	9.41	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5590		10.07	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5670		10.54	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5500	802.11ax20	11.08	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5600		10.28	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5700		10.05	11±1	12	15.849	1.50	1.41	0.0045	1
Ant1	5510	802.11ax40	9.35	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5590		9.84	10±1	11	12.589	1.50	1.41	0.0035	1
Ant1	5670		10.75	10±1	11	12.589	1.50	1.41	0.0035	1

5.8G

Antenna	Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
			(dBm)		tune-up power		Gain			
					(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)	(mW/cm2)
Ant 1	5745	802.11a	10.34	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5785		10.49	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5825		10.41	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5745	802.11n20	10.32	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5785		10.51	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5825		10.56	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5755	802.11n40	10.42	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5795		10.38	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5745	802.11ac20	10.01	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5785		10.48	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5825		10.61	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5755	802.11ac40	10.07	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5795		10.40	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5745	802.11ax20	10.26	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5785		10.53	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5825		10.48	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5755	802.11ax40	10.40	10±1	11	12.589	1.50	1.41	0.0035	1
Ant 1	5795		10.51	10±1	11	12.589	1.50	1.41	0.0035	1

SIMULTANEOUS TRANSMISSIONS

When a number of sources at different frequencies, and/or broadband sources, contribute to the total exposure, it becomes necessary to weigh each contribution relative to the MPE. To comply with the MPE, the fraction of the MPE in terms of E^2 , H^2 (or power density) incurred within each frequency interval should be determined and the sum of all such fractions should not exceed unity. In order to ensure compliance with the MPE for a controlled environment, the sum of the ratios of the power density to the corresponding MPE should not exceed unity. That is

$$\sum_{i=1}^n \frac{S_i}{MPE_i} \leq 1$$

Worst case is Simultaneous Transmissions for 2.4G Wi-Fi +BT

Band	Mode	EIRP (dBm)	EIRP (mW)	Standalone	Standalone	Simultaneous		Verdict
				Evaluation result	Power density	Evaluation result	Power density	
				(mW/cm ²)	(mW/cm ²)	(mW/cm ²)	(mW/cm ²)	
2.4G Wi-Fi+BT	BT	2.5	1.78	0.0004	1	0.0074	1	PASS
	2.4G WIFI	15.5	35.48	0.0071	1			

Signature:

Date: 2025-03-07

Alex Li

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