

FCC ID: 2BBDD-3007

Maximum Permissible Exposure (MPE)

According to FCC 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/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.

BT:

Measurement Result

Operation Frequency: 2402MHz~2480MHz

Power density limited: 1mW/ cm²

Antenna Type: FPC antenna

Antenna gain:1.53dBi;

R=20cm

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

antenna gain Numeric= $10^{(dBi/10)}=10^{(1.53/10)}=1.42$

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
2402	DH5	4.49	4±1	5	3.162	1.53	1.42	0.0009	1
2441		4.35	4±1	5	3.162	1.53	1.42	0.0009	1
2480		4.37	4±1	5	3.162	1.53	1.42	0.0009	1
2402	2DH5	3.29	3±1	4	2.512	1.53	1.42	0.0007	1
2441		3.98	3±1	4	2.512	1.53	1.42	0.0007	1
2480		3.56	3±1	4	2.512	1.53	1.42	0.0007	1
2402	3DH5	3.22	3±1	4	2.512	1.53	1.42	0.0007	1
2441		3.47	3±1	4	2.512	1.53	1.42	0.0007	1
2480		3.49	3±1	4	2.512	1.53	1.42	0.0007	1

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result (mW/cm2)	Power density Limits
		(dBm)		tune-up power		Gain			(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
2402	GFSK(1M)	2.14	2±1	3	1.995	1.53	1.42	0.0006	1
2440		2.79	2±1	3	1.995	1.53	1.42	0.0006	1
2480		2.77	2±1	3	1.995	1.53	1.42	0.0006	1

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain			
				(dBm)	(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)
2404	GFSK(2M)	2.17	2±1	-1	0.794	1.53	1.42	0.0002	1
2440		2.33	2±1	-1	0.794	1.53	1.42	0.0002	1
2478		2.33	2±1	-1	0.794	1.53	1.42	0.0002	1

2.4G WIFI:

Operation Frequency: WIFI 802.11b/g/n HT20: 2412-2462MHz,
WIFI 802.11n HT40:2422-2452MHz
Power density limited: 1mW/ cm²

Antenna Type: FPC antenna

Antenna gain1: 1.53dBi

R=20cm

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

antenna gain Numeric= $10^{(dBi/10)}=10^{(1.53/10)}=1.42$

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
2412	802.11b	12.76	12±1	13	19.953	1.53	1.42	0.0056	1
2437		12.68	12±1	13	19.953	1.53	1.42	0.0056	1
2462		12.47	12±1	13	19.953	1.53	1.42	0.0056	1
2412	802.11g	12.86	12±1	13	19.953	1.53	1.42	0.0056	1
2437		12.59	12±1	13	19.953	1.53	1.42	0.0056	1
2462		12.31	12±1	13	19.953	1.53	1.42	0.0056	1
2412	802.11n H20	12.6	12±1	13	19.953	1.53	1.42	0.0056	1
2437		12.47	12±1	13	19.953	1.53	1.42	0.0056	1
2462		12.22	12±1	13	19.953	1.53	1.42	0.0056	1
2422	802.11n(H T40)	13.09	13±1	14	25.119	1.53	1.42	0.0071	1
2437		12.88	13±1	14	25.119	1.53	1.42	0.0071	1
2452		12.83	13±1	14	25.119	1.53	1.42	0.0071	1

5G WIFI:

Operation Frequency: WIFI 802.11a/ac/n(HT20): 5180-5240MHz;5260-5320MHz;5500-5700MHz;5745-5825MHz;WIFI 802.11ac/n(HT40): 5190-5230MHz;5270-5310MHz;5510-5670MHz5755-5795MHz; WIFI 802.11ac80:5210-5210MHz;5290-5290MHz;5530-5610MHz; 5775-5775MHz

Power density limited: 1mW/cm

Antenna Type: FPC antenna

Antenna gain:2.71dBi

R=20cm

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

antenna gain Numeric= $10^{(dBi/10)}=10^{(2.71/10)}=1.87$

5.2G

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain			
				(dBm)	(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)
5180	802.11a	12.27	12±1	13	19.953	2.71	1.87	0.0074	1
5200		12.41	12±1	13	19.953	2.71	1.87	0.0074	1
5240		12.69	12±1	13	19.953	2.71	1.87	0.0074	1
5180	802.11n20	12.12	12±1	13	19.953	2.71	1.87	0.0074	1
5200		12.25	12±1	13	19.953	2.71	1.87	0.0074	1
5240		12.6	12±1	13	19.953	2.71	1.87	0.0074	1
5190	802.11n40	11.3	11±1	12	15.849	2.71	1.87	0.0059	1
5230		11.56	11±1	12	15.849	2.71	1.87	0.0059	1
5210	802.11ac80	12.27	12±1	13	19.953	2.71	1.87	0.0074	1
5180	802.11ac20	12.34	12±1	13	19.953	2.71	1.87	0.0074	1
5200		12.25	12±1	13	19.953	2.71	1.87	0.0074	1
5240		12.36	12±1	13	19.953	2.71	1.87	0.0074	1
5190	802.11ac40	12.31	12±1	13	19.953	2.71	1.87	0.0074	1
5230		12.33	12±1	13	19.953	2.71	1.87	0.0074	1

5.3G

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain			
				(dBm)	(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)
5260	802.11a	12.81	12±1	13	19.953	2.71	1.87	0.0074	1
5280		12.58	12±1	13	19.953	2.71	1.87	0.0074	1
5320		12.64	12±1	13	19.953	2.71	1.87	0.0074	1
5260	802.11n20	12.57	12±1	13	19.953	2.71	1.87	0.0074	1
5280		12.72	12±1	13	19.953	2.71	1.87	0.0074	1
5320		12.49	12±1	13	19.953	2.71	1.87	0.0074	1
5270	802.11n40	12.42	12±1	13	19.953	2.71	1.87	0.0074	1
5310		12.5	12±1	13	19.953	2.71	1.87	0.0074	1
5260	802.11ac20	12.36	12±1	13	19.953	2.71	1.87	0.0074	1
5280		12.47	12±1	13	19.953	2.71	1.87	0.0074	1
5320		12.31	12±1	13	19.953	2.71	1.87	0.0074	1
5270	802.11ac40	12.42	12±1	13	19.953	2.71	1.87	0.0074	1
5310		12.45	12±1	13	19.953	2.71	1.87	0.0074	1
5290	802.11ac80	12.23	12±1	13	19.953	2.71	1.87	0.0074	1

5.6G

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
5500	802.11a	10.43	10±1	11	12.589	2.71	1.87	0.0047	1
5600		9.69	10±1	11	12.589	2.71	1.87	0.0047	1
5700		10.43	10±1	11	12.589	2.71	1.87	0.0047	1
5500	802.11n20	10.25	10±1	11	12.589	2.71	1.87	0.0047	1
5600		9.41	10±1	11	12.589	2.71	1.87	0.0047	1
5700		10.38	10±1	11	12.589	2.71	1.87	0.0047	1
5510	802.11n40	10.12	10±1	11	12.589	2.71	1.87	0.0047	1
5590		9.59	10±1	11	12.589	2.71	1.87	0.0047	1
5670		10.37	10±1	11	12.589	2.71	1.87	0.0047	1
5500	802.11ac20	10.31	10±1	11	12.589	2.71	1.87	0.0047	1
5600		9.56	10±1	11	12.589	2.71	1.87	0.0047	1
5700		10.37	10±1	11	12.589	2.71	1.87	0.0047	1
5510	802.11ac40	9.95	10±1	11	12.589	2.71	1.87	0.0047	1
5590		9.31	10±1	11	12.589	2.71	1.87	0.0047	1
5670		10.29	10±1	11	12.589	2.71	1.87	0.0047	1
5530	802.11ac80	9.87	9±1	10	10.000	2.71	1.87	0.0037	1
5610		9.7	9±1	10	10.000	2.71	1.87	0.0037	1

5.8G

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
5745	802.11a	10.41	10±1	11	12.589	2.71	1.87	0.0047	1
5785		10.74	10±1	11	12.589	2.71	1.87	0.0047	1
5825		10.43	10±1	11	12.589	2.71	1.87	0.0047	1
5745	802.11n20	10.3	10±1	11	12.589	2.71	1.87	0.0047	1
5785		10.56	10±1	11	12.589	2.71	1.87	0.0047	1
5825		10.55	10±1	11	12.589	2.71	1.87	0.0047	1
5755	802.11n40	10.46	10±1	11	12.589	2.71	1.87	0.0047	1
5795		10.64	10±1	11	12.589	2.71	1.87	0.0047	1
5745	802.11ac20	10.36	10±1	11	12.589	2.71	1.87	0.0047	1
5785		10.63	10±1	11	12.589	2.71	1.87	0.0047	1
5825		10.43	10±1	11	12.589	2.71	1.87	0.0047	1
5755	802.11ac40	10.41	10±1	11	12.589	2.71	1.87	0.0047	1
5795		10.4	10±1	11	12.589	2.71	1.87	0.0047	1
5775	802.11ac80	10.48	10±1	11	12.589	2.71	1.87	0.0047	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 5G Wi-Fi+BT

Band	Mode	Tune up (dBm)	Tune up (mW)	Standalone	Standalone	Simultaneous		Verdict
				Evaluation result	Power density Limits	Evaluation result	Limit	
				(mW/cm2)	(mW/cm2)	raio		
5G Wi-Fi+BT	BT	5	3.16	0.0006	1	0.0046	1	PASS
	5G WIFI	13	19.95	0.0040	1			

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