

FCC ID: 2BOHY-TR5R822S3

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: Rod antenna

Antenna gain: 2.53dBi

R=20cm

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

Max antenna gain Numeric=10^{^(dBi/10)}=10^{^(2.53/10)}=1.79

BR EDR

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result (mW/cm2)	Power density (mW/cm2)
		(dBm)		tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
2402	GFSK	2.25	2±1	3	1.995	2.53	1.79	0.00071	1
2441		1.34	2±1	3	1.995	2.53	1.79	0.00071	1
2480		1.97	2±1	3	1.995	2.53	1.79	0.00071	1
2402	π/4-DQPSK	5.98	5±1	6	3.981	2.53	1.79	0.00142	1
2441		5.24	5±1	6	3.981	2.53	1.79	0.00142	1
2480		5.73	5±1	6	3.981	2.53	1.79	0.00142	1
2402	8-DPSK	6.52	6±1	7	5.012	2.53	1.79	0.00179	1
2441		5.8	6±1	7	5.012	2.53	1.79	0.00179	1
2480		5.85	6±1	7	5.012	2.53	1.79	0.00179	1

BLE

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result (mW/cm2)	Power density (mW/cm2)
		(dBm)		tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
2402	GFSK(1M)	4.44	4±1	5	3.162	2.53	1.79	0.00113	1
2440		4.06	4±1	5	3.162	2.53	1.79	0.00113	1
2480		4.03	4±1	5	3.162	2.53	1.79	0.00113	1

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	GFSK(2M)	3.92	3±1	4	2.512	2.53	1.79	0.00089	1
2440		3.55	3±1	4	2.512	2.53	1.79	0.00089	1
2480		3.5	3±1	4	2.512	2.53	1.79	0.00089	1

2.4G WIFI/5G WIFI:

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

WIFI 802.11n HT40:2422-2452MHz

Power density limited: 1mW/ cm²

Antenna Type: Ant1/2: Rod antenna,

Antenna gain: Ant1/2: 2.53dBi,

Operation Frequency: WIFI 802.11a/ac/n(HT20): 5180-5240MHz; 5745-5825MHz;

WIFI 802.11ac/n(HT40): 5190-5230MHz;5755-5795MHz;

WIFI 802.11ac80:5210-5210MHz;5775-5775MHz

Power density limited: 1mW/cm

Antenna Type: Ant1/2: Rod antenna

Antenna gain: Ant1/2: 3.16dBi

R=20cm

mW=10^(dBm/10)

WLAN2.4G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Ant1	17.12	2.53	20	0.018354	1	Pass
Ant2	16.54	2.53	20	0.016059	1	

WLAN5.2G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Ant1	12.57	3.16	20	0.007443	1	Pass
Ant2	12.66	3.16	20	0.007598	1	

WLAN5.3G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Ant1	13.64	3.16	20	0.009522	1	Pass
Ant2	12.32	3.16	20	0.007026	1	

WLAN5.6G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Ant1	11.98	3.16	20	0.006497	1	Pass
Ant2	12.23	3.16	20	0.006882	1	

WLAN5.8G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Ant1	12.11	3.16	20	0.006995	1	Pass
Ant2	12.62	3.16	20	0.007529	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

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

WLAN2.4G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	2.53	20	0.001785	0.023913	1	Pass
WIFI 2.4G ANT1	12.84	5.54	20	0.013700			
WIFI 2.4G ANT2	10.73	5.54	20	0.008428			

The WIFI2.4G Gain is Directional gain.

WLAN5.2G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	2.53	20	0.001785	0.016842	1	Pass
WIFI 5.2G ANT1	9.59	6.17	20	0.007494			
WIFI 5.2G ANT2	9.63	6.17	20	0.007563			

The WIFI5.2G Gain is Directional gain.

WLAN5.3G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	2.53	20	0.001785	0.01742	1	Pass
WIFI 5.3G ANT1	10.28	6.17	20	0.008785			
WIFI 5.3G ANT2	9.2	6.17	20	0.006850			

The WIFI5.3G Gain is Directional gain.

WLAN5.6G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	2.53	20	0.001785	0.019243	1	Pass
WIFI 5.6G ANT1	8.78	6.17	20	0.006219			
WIFI 5.6G ANT2	11.35	6.17	20	0.011239			

The WIFI5.6G Gain is Directional gain.

WLAN5.8G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	R(cm)	S (mW/cm ²)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	2.53	20	0.001785	0.023451	1	Pass
WIFI 5.8G ANT1	11.24	6.17	20	0.010958			
WIFI 5.8G ANT2	11.14	6.17	20	0.010708			

The WIFI5.8G Gain is Directional gain.

Conclusion:

The conclusion for Max MIMO mode should be $0.023451 < 1$ for Max Power Density, Compliance the RF exposure

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