

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

$$E \text{ (V/m)} = \frac{\sqrt{30 * P * G}}{d} \quad \text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

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: 2402-2480MHz,

Power density limited: $1\text{mW}/\text{cm}^2$

Power density limited: $1\text{mW}/\text{cm}$

Antenna Type: PCB Antenna

Antenna :4.2dBi

R=20cm

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

Mode	Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result
			(dBm)		tune-up power		Gain		(mW/cm2)
					(dBm)	(mW)	(dBi)	Numeric	
BT	2402	GFSK	-1.13	-1±1	0	1.000	4.20	2.63	0.0005
	2441		-1.1	-1±1	0	1.000	4.20	2.63	0.0005
	2480		-1.27	-1±1	0	1.000	4.20	2.63	0.0005
BT	2402	π/4-DQPSK	-0.18	0±1	1	1.259	4.20	2.63	0.0007
	2441		-0.26	0±1	1	1.259	4.20	2.63	0.0007
	2480		-0.43	0±1	1	1.259	4.20	2.63	0.0007
BT	2402	8-DPSK	0.22	0±1	1	1.259	4.20	2.63	0.0007
	2441		0.12	0±1	1	1.259	4.20	2.63	0.0007
	2480		-0.1	0±1	1	1.259	4.20	2.63	0.0007
BLE	2402	GFSK	-0.76	-1±1	0	1.000	4.20	2.63	0.0005
	2440		-0.56	-1±1	0	1.000	4.20	2.63	0.0005
	2480		-1.18	-1±1	0	1.000	4.20	2.63	0.0005
BLE 2M	2402	802.11n20	-0.67	-1±1	0	1.000	4.20	2.63	0.0005
	2440		-0.47	-1±1	0	1.000	4.20	2.63	0.0005
	2480		-1.1	-1±1	0	1.000	4.20	2.63	0.0005

2.4G WIFI:

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

Power density limited: 1mW/cm

Antenna Type: PCB Antenna

2.4G WIFI Antenna:4.2dBi;

R=20cm

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

WLAN2.4G SISO Max power MODE

Antenna	Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result
			(dBm)		tune-up power		Gain		(mW/cm2)
					(dBm)	(mW)	(dBi)	Numeric	
Ant 1	2412	802.11b	15.45	15±1	16	39.811	4.20	2.63	0.0208
Ant 1	2437		14.02	15±1	16	39.811	4.20	2.63	0.0208
Ant 1	2462		15.08	15±1	16	39.811	4.20	2.63	0.0208
Ant 1	2412	802.11g	13.9	13±1	14	25.119	4.20	2.63	0.0131
Ant 1	2437		13.45	13±1	14	25.119	4.20	2.63	0.0131
Ant 1	2462		12.86	13±1	14	25.119	4.20	2.63	0.0131
Ant 1	2412	802.11n20	12.29	12±1	13	19.953	4.20	2.63	0.0104
Ant 1	2437		12.04	12±1	13	19.953	4.20	2.63	0.0104
Ant 1	2462		11.28	12±1	13	19.953	4.20	2.63	0.0104
Ant 1	2422	802.11n40	12.01	12±1	13	19.953	4.20	2.63	0.0104
Ant 1	2437		11.67	12±1	13	19.953	4.20	2.63	0.0104
Ant 1	2452		12.24	12±1	13	19.953	4.20	2.63	0.0104

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 E², H² (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

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

Max. SIMULTANEOUS TRANSMISSIONS for BT + Wi-Fi Module

Band	mode	MAX. EIRP (dBm)	EIRP (mW)	Standalone	Standalone	Simultaneous		Verdict
				Evaluation result	Power density	Evaluation result	Power density	
				(mW/cm2)	(mW/cm2)	(mW/cm2)	(mW/cm2)	
BT + Wi-Fi Module	Wi-Fi	20.2	184.5	0.0208	1	0.021490	1	PASS
	BT	5.2	3.31	0.0007	1			

Conclusion:

For the max result : $0.021490 \leq 1.0$, SAR is not required.

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