

RF Exposure Evaluation

Limit

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 1.1310 & 2.1091

Table 1-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 Exposures				
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
300–1500	-	-	f/300	6
1500–100,000	-	-	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
300–1500	-	-	f/1500	30
1500–100,000	-	-	1.0	30

Note: f = frequency in MHz

Evaluation Method

Transmission formula: $P_d = (P_{out} * G) / (4 * \pi * R^2)$

Where

P_d = power density in mW/cm², P_{out} = output power to antenna in mW, G = gain of antenna in linear scale; $P_i = 3.1416$, R = distance between observation point and center of the radiator in cm

Conducted Power Results

2.4G WIFI

Mode	Conducted Peak Output Power (dBm)
802.11b	14.64
802.11g	14.65
802.11n(HT20)	14.58
802.11n(HT40)	14.6

BT+EDR

Mode	Conducted Peak Output Power (dBm)
GFSK	4.18
$\pi/4$ DQPSK	5.57
8DPSK	6.4

BLE

Mode	Conducted Peak Output Power (dBm)
BLE_125K	6.77
BLE_1M	6.85

BLE_2M	6.76
BLE_500K	6.83

5G WIFI

Mode	Conducted Peak Output Power (dBm)
11a	16.27
802.11n(HT20)	16.25
802.11n(HT40)	15.65
	15.92
11ac(VHT20)	15.65
11ac(VHT80)	13.59

Manufacturing tolerance**2.4G WIFI**

Mode	802.11b	802.11g	802.11n20	802.11n40
Target (dBm)	14	14	14	14
Tolerance \pm (dB)	1	1	1	1

BT+EDR

Mode	GFSK	$\pi/4$ DQPSK	8DPSK
Target (dBm)	4	5	6
Tolerance \pm (dB)	1	1	1

BLE

Mode	BLE_125K	BLE_1M	BLE_2M	BLE_500K
Target (dBm)	6	6	6	6
Tolerance \pm (dB)	1	1	1	1

5G WIFI

Mode	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Target (dBm)	16	16	15	15	15	13
Tolerance \pm (dB)	1	1	1	1	1	1

Evaluation Results**2.4G WIFI**

Band/Mode	Antenna Distance (cm)	Conducted Output Power		Gain of antenna in linear scale	Power Density (mW/cm ²)	Limit (mW/cm ²)	Result
		dBm	mW				
802.11b	20	15	31.62	1.58	0.0100	1	Pass
802.11g	20	15	31.62	1.58	0.0100	1	Pass
802.11n20	20	15	31.62	1.58	0.0100	1	Pass
802.11n40	20	15	31.62	1.58	0.0100	1	Pass

BLE

Band/Mode	Antenna Distance (cm)	Conducted Output Power		Gain of antenna in linear scale	Power Density (mW/cm ²)	Limit (mW/cm ²)	Result
		dBm	mW				
BLE_125K	20	7	5.01	1.58	0.0016	1	Pass
BLE_1M	20	7	5.01	1.58	0.0016	1	Pass
BLE_2M	20	7	5.01	1.58	0.0016	1	Pass
BLE_500K	20	7	5.01	1.58	0.0016	1	Pass

BT+EDR

Band/Mode	Antenna Distance (cm)	Conducted Output Power		Gain of antenna in linear scale	Power Density (mW/cm ²)	Limit (mW/cm ²)	Result
		dBm	mW				
GFSK	20	5.00	3.16	1.58	0.0010	1	Pass
π /4DQPSK	20	6.00	3.98	1.58	0.0013	1	Pass
8DPSK	20	7.00	5.01	1.58	0.0016	1	Pass

5G WIFI

Band/Mode	Antenna Distance (cm)	Conducted Output Power		Gain of antenna in linear scale	Power Density (mW/cm ²)	Limit (mW/cm ²)	Result
		dBm	mW				
802.11a	20	17.00	50.12	1.58	0.016	1	Pass
802.11n(HT20)	20	17.00	50.12	1.58	0.016	1	Pass
802.11n(HT40)	20	16.00	39.81	1.58	0.013	1	Pass
11ac(VHT20)	20	16.00	39.81	1.58	0.013	1	Pass
11ac(VHT40)	20	16.00	39.81	1.58	0.013	1	Pass
11ac(VHT80)	20	14.00	25.12	1.58	0.008	1	Pass

Remark:

1. Output power including tune up tolerance;
2. The maximum antenna gain for is 2dBi
3. The exposure safety distance is 20cm.

Simulation Transmission

EUT can only work in 2.4G WiFi+ Bluetooth mode or 5G WiFi+ Bluetooth mode

The formula of calculated the Simulation Transmission MPE is:

$$CPD1 /LPD1 + CPD2 /LPD2 + \dots \text{ etc.} < 1$$

CPD = Calculation Maximum Power Density

LPD = Limit of Power Density

Mode	Evaluation Value	Limit	Result
2.4G WiFi + Bluetooth	0.0116	1	PASS
5G WiFi + Bluetooth mode	0.0174	1	PASS

Conclusion

The measurement results comply with the FCC Limit per 47 CFR 1.1310 & 2.1091 for the uncontrolled RF Exposure and MPE comppliance per KDB 447498 v06.