RF Exposure evaluation

FCC ID: 2AR24-AI-BOX-01

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

1. Reference

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

KDB447498 D01: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

2. Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
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 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 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

F=frequency in MHz

*=Plane-wave equivalent power density

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modelled or measured field strengths or power density, is $\leqslant$ 1.0.

3. MPE Calculation Method

Predication of MPE limit at a given distance
Equation from page 18 of OET Bulletin 65, Edition 97-01

$S=PG/4\pi R^2$

Where: S=power density

P=power input to antenna

G=power gain of the antenna in the direction of interest relative to an isotropic radiator

R=distance to the center of radiation of the antenna

4. Result

4.1 **Standalone MPE**

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, r =20cm, as well as the gain of the used antenna is -2dBi for BT, 2.5dBi for WIFI SISO Mode, 5.51dBi for WIFI MIMO mode, the RF power density can be obtained.

WIFI SISO Antenna 1

Modulation Type	Target power W/ tolerance (dBm)	Max tune up power tolerance(dBm)	Max Output power to antenna (mW)	Antenna Gain (Numeric)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11b	17±1.0	18	63.0957	1.7783	0.0223	1.0	Pass
802.11g	20±1.0	21	125.8925	1.7783	0.0445	1.0	Pass
802.11n (HT20)	20±1.0	21	125.8925	1.7783	0.0445	1.0	Pass
802.11n (HT40)	20±1.0	21	125.8925	1.7783	0.0445	1.0	Pass

WIFI SISO Antenna 2

Modulation Type	Target power W/ tolerance (dBm)	Max tune up power tolerance(dBm)	Max Output power to antenna (mW)	Antenna Gain (Numeric)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11b	18±1.0	19	79.4328	1.7783	0.0281	1.0	Pass
802.11g	21±1.0	22	158.4893	1.7783	0.0561	1.0	Pass
802.11n (HT20)	21±1.0	22	158.4893	1.7783	0.0561	1.0	Pass
802.11n (HT40)	20±1.0	21	125.8925	1.7783	0.0445	1.0	Pass

BT

Modulation Type	Target power W/ tolerance (dBm)	Max tune up power tolerance(dBm)	Max Output power to antenna (mW)	Antenna Gain (Numeric)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
BLE	-3±1.0	-2	0.6310	1.0000	0.0001	1.0	Pass

4.2 **Simultaneous Transmission MPE**

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

∑ of MPE ratios ≤ 1.0

Antenna 1 and Antenna 2 for 2.4GWLAN

Modulation Type	MPE Antenna1 (mW/cm^2)	MPE Antenna2 (mW/cm^2)	∑MPE ratios	Limit	Result
802.11n (HT20)	0.0445	0.0561	0.1006	1.0	Pass
802.11n (HT40)	0.0445	0.0445	0.0890	1.0	Pass

The respectively antenna used by WIFI and BT , Simultaneous transmission can operating at WIFI and BT.

Simultaneous transmission MPE

Max.Power Density At 20 cm WIFI (mW/cm^2)	Max.Power Density At 20 cm BTLE (mW/cm^2)	Max.sum of the MPE ratios	Limit	Test Results
0.1006	0.0001	0.1007	1.0	PASS

5. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.