Maximum Permissible Exposure Report

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

Refer Standard: KDB 447498 D01 General RF Exposure Guidance v06

FCC Part 2 §2.1091

FCC ID: 2AR9I-ZGV300

1. Evaluation Method

Systems operating under the provisions of FCC 47 CFR 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.
In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.
In accordance with KDB447498D01 for 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 ≤ 1.0. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

2. Limit

2. 1 Refer evaluation method

ANSI C95.1–1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.
FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.
FCC CFR 47 part1 1.1310: Radiofrequency radiation exposure limits.
FCC CFR 47 part2 2.1091: Radiofrequency radiation exposure evaluation: mobile devices.

2. 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

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. Antenna Information

use antennas certificated as follows provided by manufacturer;

Internal Identification	Antenna Identification in Internal photos	Antenna type and antenna number	Operate frequency band	Maximum antenna gain
Antenna A	2.4G/5G Wifi Chain 0	Internal Antenna	2.4GHz – 2.4835 GHz 5GHz – 6 GHz	2.0 dBi
Antenna B	2.4G/5G Wifi Chain 1	Internal Antenna	2.4GHz – 2.4835 GHz 5GHz – 6 GHz	2.0 dBi
Antenna C	BT Antenna	Internal Antenna	2.4GHz – 2.4835 GHz	2.0 dBi

5. Measurement Results

5.1 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 refer to antenna information, the RF power density can be obtained.

2.4GHz WIFI Antenna A

Modulation Type	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11b	17±1.0	18	63.096	2	0.01989	1.0	Pass
802.11g	16±1.0	17	50.119	2	0.01580	1.0	Pass
802.11n (HT20)	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11n (HT40)	14±1.0	15	31.623	2	0.00997	1.0	Pass

2.4GHz WIFI Antenna B

Modulation Type	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11b	17±1.0	18	63.096	2	0.01989	1.0	Pass
802.11g	16±1.0	17	50.119	2	0.01580	1.0	Pass
802.11n (HT20)	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11n (HT40)	14±1.0	15	31.623	2	0.00997	1.0	Pass

5.2G WIFI Antenna A

Modulation Type	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11a	16±1.0	17	50.119	2	0.01580	1.0	Pass
802.11ac20	15±1.0	16	39.811	2	0.01255	1.0	Pass
802.11ac40	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11ac80	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11n40	14±1.0	15	31.623	2	0.00997	1.0	Pass

5.2G WIFI Antenna B

Modulation Type	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11a	16±1.0	17	50.119	2	0.01580	1.0	Pass
802.11ac20	14±1.0	16	39.811	2	0.01255	1.0	Pass
802.11ac40	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11ac80	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11n40	14±1.0	15	31.623	2	0.00997	1.0	Pass

5.8G WIFI Antenna A

Modulation Type	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11a	17±1.0	18	63.096	2	0.01989	1.0	Pass
802.11ac20	15±1.0	16	39.811	2	0.01255	1.0	Pass
802.11ac40	15±1.0	16	39.811	2	0.01255	1.0	Pass
802.11ac80	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11n40	14±1.0	15	31.623	2	0.00997	1.0	Pass

5.8G WIFI Antenna B

Modulation Type	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11a	17±1.0	18	63.096	2	0.01989	1.0	Pass
802.11ac20	15±1.0	16	39.811	2	0.01255	1.0	Pass
802.11ac40	15±1.0	16	39.811	2	0.01255	1.0	Pass
802.11ac80	14±1.0	15	31.623	2	0.00997	1.0	Pass
802.11n40	14±1.0	15	31.623	2	0.00997	1.0	Pass

BT EDR Antenna C

Freq. (MHz)	Output Power (dBm)	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
GFSK								
2402	5.051	5±1.0	6	3.981	2	0.00126	1.0	Pass
2441	5.023	5±1.0	6	3.981	2	0.00126	1.0	Pass
2480	4.984	5±1.0	6	3.981	2	0.00126	1.0	Pass
π/4DQPSK								
2402	3.845	4±1.0	5	3.162	2	0.00100	1.0	Pass
2441	3.987	4±1.0	5	3.162	2	0.00100	1.0	Pass
2480	4.329	4±1.0	5	3.162	2	0.00100	1.0	Pass
8DPSK								

2402	4.014	4±1.0	5	3.162	2	0.00100	1.0	Pass
2441	4.214	4±1.0	5	3.162	2	0.00100	1.0	Pass
2480	4.358	4±1.0	5	3.162	2	0.00100	1.0	Pass

BT LE Antenna C

Freq. (MHz)	Output Power (dBm)	Target power/ tolerance (dBm)	Max Output power including tune up(dBm)	Max Output power including tune up (mW)	Antenna Gain (dBi)	Power Density at R=20cm (mW/cm2)	Limit (mW/ cm2)	Result
GFSK								
2402	3.22	3±1.0	4	2.512	2	0.00079	1	Pass
2440	3.01	3±1.0	4	2.512	2	0.00079	1	Pass
2480	3.56	3±1.0	4	2.512	2	0.00079	1	Pass

Remark:
1. Output power (Average) including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer;

5.2 Simultaneous Transmission MPE

The sample use 3 Internal antennas meet FCC Part 15.203 requirement, One Bluetooth antenna and two WIFI antennas, the Bluetooth antenna maximum gain is 2.0dBi; The WIFI support 2*2MIMO technology, the maximum gain is 2.0dBi for 2.4GHz and 2.0dBi for 5G.

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
∑ of MPE ratios ≤ 1.0

5.2.1 Summary simultaneous transmission information

Modulation Type	Work Frequency Band	Transmit Antenna			Antenna A Antenna B Synchronization transmit	Antenna A Antenna B Antenna C Synchronization transmit
		Antenna A	Antenna B	Antenna C		
IEEE 802.11a	5.8G/5.2GHz	Yes	Yes	No	No	Yes
IEEE 802.11b	2.4GHz	Yes	Yes	No	No	
IEEE 802.11g	2.4GHz	Yes	Yes	No	No	
IEEE 802.11n HT20	2.4GHz	Yes	Yes	No	Yes	
IEEE 802.11n HT40	2.4GHz	Yes	Yes	No	Yes	
IEEE 802.11n HT40	5.8G/5.2GHz	Yes	Yes	No	Yes	
IEEE 802.11ac VHT20	5.8G/5.2GHz	Yes	Yes	No	Yes	
IEEE 802.11ac VHT40	5.8G/5.2GHz	Yes	Yes	No	Yes	
IEEE 802.11ac VHT80	5.8G/5.2GHz	Yes	Yes	No	Yes	
BT	2.4GHz	No	No	Yes	No	

5.2.2 Summary simultaneous transmission results

Antenna A and Antenna B for 2.4G WIFI

Modulation Type	MPE Antenna A (mW/cm^2)	MPE Antenna B (mW/cm^2)	∑MPE ratios	Limit	Results
802.11b	0.01989	0.01989	/	1.0	PASS
802.11g	0.01580	0.01580	/	1.0	PASS
802.11n20	0.00997	0.00997	0.01994	1.0	PASS
802.11n40	0.00997	0.00997	0.01994	1.0	PASS

Antenna A and Antenna B for 5.2G WIFI

Modulation Type	MPE Antenna A (mW/cm^2)	MPE Antenna B (mW/cm^2)	∑MPE ratios	Limit	Results
802.11a	0.01580	0.01580	/	1.0	PASS
802.11ac20	0.01255	0.01255	0.0251	1.0	PASS
802.11ac40	0.00997	0.00997	0.0199	1.0	PASS
802.11ac80	0.00997	0.00997	0.0199	1.0	PASS
802.11n40	0.00997	0.00997	0.0199	1.0	PASS

Antenna A and Antenna B for 5.8G WIFI

Modulation Type	MPE Antenna A (mW/cm^2)	MPE Antenna B (mW/cm^2)	∑MPE ratios	Limit	Results
802.11a	0.01989	0.01989	/	1.0	PASS
802.11ac20	0.01255	0.01255	0.0251	1.0	PASS
802.11ac40	0.01255	0.01255	0.0251	1.0	PASS
802.11ac80	0.00997	0.00997	0.0199	1.0	PASS
802.11n40	0.00997	0.00997	0.0199	1.0	PASS

Maximum Simultaneous transmission MPE Ratios for Antenna A, Antenna B and Antenna C Synchronization transmit

Maximum MPE ratio Antenna A and Antenna B	Maximum MPE ratio Antenna C	∑MPE ratios	Limit	Results
0.0251	0.00126	0.02636	1.0	PASS

6. Conclusion

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

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