RF Exposure evaluation

FCC ID: 2A3BL-G1

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

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

G1 can only use antennas certificated as follows provided by manufacturer;

Antenna No.	Model No. of antenna:	Type of antenna:	Gain of the antenna (Max.)	Frequency range:
Bluetooth	/	FPC Antenna	-2.31dBi for 2402-2480MHz;	
2.4G&5GWIFI	/	FPC Antenna	-2.31dBi for 2412-2462MHz for ant 0 and ant 1	
			1.81dBi for 5150-5250MHz for ant 0 and ant 1	
			1.81dBi for 5725-5875MHz for ant 0 and ant 1	

5. Conducted power

Bluetooth

Mode	Channel	Frequency	Peak Conducted Output Power (dBm)
GFSK	00	2402	6.37
	39	2441	5.59
	78	2480	5.63
Π/4DQPSK	00	2402	6.27
	39	2441	5.92
	78	2480	5.14
8DPSK	00	2402	6.48
	39	2441	6.2
	78	2480	5.38
GFSK BLE	00	2402	-4.92
	19	2440	-5.17
	39	2480	-5.74

[2.4GHz WLAN Antenna 0]

Mode	Channel	Frequency	Peak Conducted Output Power (dBm)
IEEE 802.11b	1	2412	16.19
	6	2437	16.37
	11	2462	16.89
IEEE 802.11g	1	2412	15.86
	6	2437	16.28
	11	2462	16.85
IEEE 802.11n HT20	1	2412	13.57
	6	2437	14.64
	11	2462	13.81
IEEE 802.11n HT40	3	2422	12.88
	6	2437	12.63
	9	2452	12.92

[2.4GHz WLAN Antenna 1]

Mode	Channel	Frequency	Peak Conducted Output Power (dBm)
IEEE 802.11b	1	2412	16.45
	6	2437	16.32
	11	2462	16.59
IEEE 802.11g	1	2412	16.13
	6	2437	16.48
	11	2462	16.22
IEEE 802.11n HT20	1	2412	13.89
	6	2437	14.33
	11	2462	14.12
IEEE 802.11n HT40	3	2422	12.47
	6	2437	12.64
	9	2452	12.71

[5.2GHz WLAN]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)	
			Antenna 0	Antenna 1
802.11a	36	5180	16.55	16.23
	40	5200	16.28	16.14
	48	5240	16.62	16.55
802.11n(HT20)	36	5180	15.31	15.26
	40	5200	15.58	15.83
	48	5240	15.78	15.92
802.11n(HT40)	38	5190	16.76	16.44
	46	5230	16.70	16.35
802.11ac(HT20)	36	5180	14.84	14.99
	40	5200	15.27	15.14
	48	5240	15.71	15.68
802.11ac(HT40)	38	5190	16.17	16.35
	46	5230	16.72	16.49
802.11ac(HT80)	42	5210	16.24	16.42

[5.8GHz WLAN]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)	
			Antenna 0	Antenna 1
802.11a	149	5745	16.99	16.68
	157	5785	16.48	16.27
	165	5825	16.57	16.43
802.11n(HT20)	149	5745	16.87	16.59
	157	5785	16.82	16.71
	165	5825	16.59	16.44
802.11n(HT40)	151	5755	15.99	16.05
	159	5795	16.09	16.18
802.11ac(HT20)	149	5745	16.72	16.66
	157	5785	16.82	16.47
	165	5825	16.23	16.54
802.11ac(HT40)	151	5755	16.57	16.36
	159	5795	16.77	16.59
802.11ac(HT80)	155	5775	16.86	16.62

6. Manufacturing Tolerance

<BT LE>

GFSK (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	-4.0	-5.0	-5.0
Tolerance ±(dB)	1.0	1.0	1.0

<BT Classics>

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	6.0	5.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0
π/4DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	6.0	5.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0
8DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	6.0	6.0	5.0
Tolerance ±(dB)	1.0	1.0	1.0

[2.4GHz WLAN Antenna 0]

IEEE 802.11b (Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11g(Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT20 (Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	14.0	14.0	14.0	14.0	14.0	14.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT40 (Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2422	2437	2452	2422	2437	2452
Target (dBm)	13.0	13.0	13.0	13.0	13.0	13.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0

5GHz WLAN Band 1

IEEE 802.11a (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5180	5200	5240	5180	5200	5240
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5180	5200	5240	5180	5200	5240
Target (dBm)	15.0	15.0	15.0	15.0	15.0	15.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5180	5200	5240	5180	5200	5240
Target (dBm)	15.0	15.0	15.0	15.0	15.0	15.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5190		5230	5190		5230
Target (dBm)	16.0		16.0	16.0		16.0
Tolerance ± (dB)	1.0		1.0	1.0		1.0
IEEE 802.11ac VHT40 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5190		5230	5190		5230
Target (dBm)	16.0		16.0	16.0		16.0
Tolerance ± (dB)	1.0		1.0	1.0		1.0
IEEE 802.11ac VHT80 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5210			5210		
Target (dBm)	16.0			16.0		
Tolerance ± (dB)	1.0			1.0		

5GHz WLAN Band 3

IEEE 802.11a (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5745	5785	5825	5745	5785	5825
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5745	5785	5825	5745	5785	5825
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5745	5785	5825	5745	5785	5825
Target (dBm)	16.0	16.0	16.0	16.0	16.0	16.0
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5755		5795	5755		5795
Target (dBm)	16.0		16.0	16.0		16.0
Tolerance ± (dB)	1.0		1.0	1.0		1.0
IEEE 802.11ac VHT40 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5755		5795	5755		5795
Target (dBm)	16.0		16.0	16.0		16.0
Tolerance ± (dB)	1.0		1.0	1.0		1.0
IEEE 802.11ac VHT80 (Average)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5775			5775		
Target (dBm)	16.0			16.0		
Tolerance ± (dB)	1.0			1.0		

7. Standalone MPE Result

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 WIFI antenna is 0dBi, the gain of BT antenna is 0dBi.the RF power density can be obtained.

[2.4GHz Bluetooth]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
GFSK	7.0	5.0119	-2.31	0.5875	0.0006	1.0000
π/4DQPSK	7.0	5.0119	-2.31	0.5875	0.0006	1.0000
8DPSK	7.0	5.0119	-2.31	0.5875	0.0006	1.0000
GFSK(BT-LE)	-3.0	0.5012	-2.31	0.5875	0.0001	1.0000

[2.4GHz WLAN Antenna 0]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11b	17.0	50.1187	-2.31	0.5875	0.0059	1.0000
IEEE 802.11g	17.0	50.1187	-2.31	0.5875	0.0059	1.0000
IEEE 802.11n HT20	15.0	31.6228	-2.31	0.5875	0.0037	1.0000
IEEE 802.11n HT40	14.0	25.1189	-2.31	0.5875	0.0029	1.0000

[2.4GHz WLAN Antenna 1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
IEEE 802.11b	17.0	50.1187	-2.31	0.5875	0.0059	1.0000
IEEE 802.11g	17.0	50.1187	-2.31	0.5875	0.0059	1.0000
IEEE 802.11n HT20	15.0	31.6228	-2.31	0.5875	0.0037	1.0000
IEEE 802.11n HT40	14.0	25.1189	-2.31	0.5875	0.0029	1.0000

[5.2GHz WLAN Antenna 0]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
802.11a	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11n(HT20)	16.0	39.8107	1.81	1.5171	0.0120	1.0000
802.11n (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT20)	16.0	39.8107	1.81	1.5171	0.0120	1.0000
802.11ac (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT80)	17.0	50.1187	1.81	1.5171	0.0151	1.0000

[5.2GHz WLAN Antenna 1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
802.11a	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11n(HT20)	16.0	39.8107	1.81	1.5171	0.0120	1.0000
802.11n (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT20)	16.0	39.8107	1.81	1.5171	0.0120	1.0000
802.11ac (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT80)	17.0	50.1187	1.81	1.5171	0.0151	1.0000

[5.8GHz WLAN Antenna 0]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
802.11a	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11n(HT20)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11n (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT20)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT80)	17.0	50.1187	1.81	1.5171	0.0151	1.0000

[5.8GHz WLAN Antenna 1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm^2)	MPE Limits (mW/cm^2)
	dBm	mW				
802.11a	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11n(HT20)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11n (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT20)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT40)	17.0	50.1187	1.81	1.5171	0.0151	1.0000
802.11ac (HT80)	17.0	50.1187	1.81	1.5171	0.0151	1.0000

Remark:

1. Output power (Peak) 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.

8. Summary simultaneous transmission results

The sample supports 2 antennas for 2.4G WLAN and 5G WLAN. The antenna 0 and antenna 1 can transmit simultaneous.

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

Antenna 0 and Antenna 1 for 2.4GWLAN and 5G WALN

Modulation Type	MPE $_{ant0}$ (mW/cm^2)	MPE $_{ant1}$ (mW/cm^2)	∑MPE ratios	Limit	Results
WIFI	0.0151	0.0151	0.0302	1.0	PASS

9. Conclusion

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

----------THE END OF REPORT----------