

RF Exposure evaluation

FCC ID: 2AVG5-X12

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

$$S = \frac{PG}{4\pi R^2}$$

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

X12 use one antenna certificated as follows provided by manufacturer;

Antenna Identification in Internal photos	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Maximum Directional antenna gain
2.4GWIFI ANT1	External Antenna	2.4GHz – 2.5 GHz	2.0 dBi	5.01 dBi
2.4GWIFI ANT2	External Antenna	2.4GHz – 2.5 GHz	2.0 dBi	
5GWIFI ANT1	External Antenna	5.0GHz – 6.0 GHz	2.0 dBi	5.01 dBi
5GWIFI ANT2	External Antenna	5.0GHz – 6.0 GHz	2.0 dBi	

5. Conducted power

[2.4GHz WLAN]

Mode	Channel	Frequency	Peak Conducted Output Power (dBm)	
			Antenna 1	Antenna 2
<i>IEEE 802.11b</i>	1	2412	13.60	13.35
	6	2437	13.92	13.07
	11	2462	14.27	13.49
<i>IEEE 802.11g</i>	1	2412	13.86	12.64
	6	2437	14.04	13.02
	11	2462	14.02	13.26
<i>IEEE 802.11n HT20</i>	1	2412	11.87	12.75
	6	2437	12.43	14.00
	11	2462	11.63	13.34

[5GWLAN Band 1]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)	
			Antenna 1	Antenna 2
<i>IEEE 802.11a</i>	36	5180	14.03	13.59
	40	5200	13.76	12.93
	48	5240	13.28	12.83
<i>IEEE 802.11n HT20</i>	36	5180	13.39	12.97
	40	5200	13.32	13.49
	48	5240	13.20	13.27
<i>IEEE 802.11ac VHT20</i>	36	5180	13.65	13.67
	40	5200	13.48	13.54
	48	5240	13.46	13.66
<i>IEEE 802.11n HT40</i>	40	5190	13.18	12.89
	48	5230	13.18	12.78
<i>IEEE 802.11ac VHT40</i>	40	5190	13.61	13.24
	48	5230	13.47	13.10
<i>IEEE 802.11ac VHT80</i>	42	5210	14.01	13.63

[5GWLAN Band 3]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)	
			Antenna 1	Antenna 2
<i>IEEE 802.11a</i>	149	5745	13.38	13.65
	157	5785	13.29	14.05
	165	5825	13.23	14.47
<i>IEEE 802.11n HT20</i>	149	5745	12.35	13.06
	157	5785	13.69	12.96
	165	5825	14.19	13.49
<i>IEEE 802.11ac VHT20</i>	149	5745	14.61	14.12
	157	5785	13.53	14.15
	165	5825	12.37	13.07
<i>IEEE 802.11n HT40</i>	151	5755	12.59	13.01
	159	5795	12.72	13.32
<i>IEEE 802.11ac VHT40</i>	151	5755	13.41	14.12
	159	5795	13.49	14.06
<i>IEEE 802.11ac VHT80</i>	155	5775	14.72	14.92

6. Manufacturing Tolerance

2.4GWIFI ANT1

802.11B(2.4G WIFI)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.0	13.0	14.0
Tolerance \pm (dB)	1.0	1.0	1.0
802.11G(2.4G WIFI)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.0	14.0	14.0
Tolerance \pm (dB)	1.0	1.0	1.0
802.11N20(2.4G WIFI)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	11.0	12.0	11.0
Tolerance \pm (dB)	1.0	1.0	1.0

2.4GWIFI ANT2

802.11B(2.4G WIFI)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	13.0	13.0	13.0
Tolerance \pm (dB)	1.0	1.0	1.0
802.11G(2.4G WIFI)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	12.0	13.0	13.0
Tolerance \pm (dB)	1.0	1.0	1.0
802.11N20(2.4G WIFI)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	12.0	13.5	13.0
Tolerance \pm (dB)	1.0	1.0	1.0

[5GWLAN Band 1] 5GWIFI ANT1

IEEE 802.11a (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	14.0	13.0	13.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	13.0	13.0	13.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	13.0	13.0	13.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Channel	Channel 38	---	Channel 46
Target (dBm)	13.0	---	13.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 38	---	Channel 46
Target (dBm)	13.0	---	13.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT80 (Average)			
Channel	---	Channel 42	---
Target (dBm)	---	14.0	---
Tolerance \pm (dB)	---	1.0	---

[5GWLAN Band 1] 5GWIFI ANT2

IEEE 802.11a (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	13.0	12.0	12.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	12.0	13.0	13.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	13.0	12.0	12.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Channel	Channel 38	---	Channel 46
Target (dBm)	13.0	---	13.0

Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 38	---	Channel 46
Target (dBm)	13.0	---	13.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT80 (Average)			
Channel	---	Channel 42	---
Target (dBm)	---	13.0	---
Tolerance \pm (dB)	---	1.0	---

[5GWLAN Band 3] 5GWIFI ANT1

IEEE 802.11a (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	13.0	13.0	13.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	12.0	13.0	14.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	12.0	12.0	12.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Channel	Channel 151	---	Channel 159
Target (dBm)	14.0	---	13.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 151	---	Channel 159
Target (dBm)	13.0	---	13.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT80 (Average)			
Channel	---	Channel 155	---
Target (dBm)	---	14.0	---
Tolerance \pm (dB)	---	1.0	---

[5GWLAN Band 3] 5GWIFI ANT2

IEEE 802.11a (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	13.0	14.0	14.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165

Target (dBm)	12.0	13.0	14.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	12.0	12.0	12.0
Tolerance \pm (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Channel	Channel 151	---	Channel 159
Target (dBm)	14.0	---	13.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT40 (Average)			
Channel	Channel 151	---	Channel 159
Target (dBm)	13.0	---	13.0
Tolerance \pm (dB)	1.0	---	1.0
IEEE 802.11ac VHT80 (Average)			
Channel	---	Channel 155	---
Target (dBm)	---	14.0	---
Tolerance \pm (dB)	---	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, $r=20\text{cm}$, as well as the gain of the used antenna is 2dBi, the RF power density can be obtained.

2.4GWIFI ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11b	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000
IEEE 802.11g	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000
IEEE 802.11n HT20	13.0	19.9526	2.0	1.5849	100%	0.00629	1.0000

2.4GWIFI ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11b	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11g	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11n HT20	14.5	28.1838	2.0	1.5849	100%	0.00889	1.0000

[5GWLAN Band 1] 5GWIFI ANT1

Modulation Type	Output power		Antenna Gain	Antenna Gain	Duty Cycle	MPE (mW/cm ²)	MPE Limits
	dBm	mW					

			(dBi)	(linear)			(mW/cm ²)
IEEE 802.11a	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000
IEEE 802.11n HT20	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT20	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11n HT40	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT40	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT80	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000

[5GWLAN Band 1] 5GWIFI ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11n HT20	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT20	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11n HT40	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT40	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT80	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000

[5GWLAN Band 3] 5GWIFI ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11n HT20	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT20	13.0	19.9526	2.0	1.5849	100%	0.00629	1.0000
IEEE 802.11n HT40	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000
IEEE 802.11ac VHT40	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT80	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000

[5GWLAN Band 3] 5GWIFI ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000
IEEE 802.11n HT20	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000
IEEE 802.11ac VHT20	13.0	19.9526	2.0	1.5849	100%	0.00629	1.0000
IEEE 802.11n HT40	15.0	31.6228	2.0	1.5849	100%	0.00998	1.0000
IEEE 802.11ac VHT40	14.0	25.1189	2.0	1.5849	100%	0.00792	1.0000
IEEE 802.11ac VHT80	15.0	31.6228	2.0	1.5849	100%	0.00998	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. Simultaneous Transmission MPE

The sample supports 2 antennas for 2.4GHz WLAN and 2 antennas for 5G WLAN. According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
 Σ of MPE ratios ≤ 1.0

8.1 Summary simultaneous transmission results

Maximum Simultaneous transmission MPE Ratios for 2.4GWIFI ANT1, 2.4GWIFI ANT2 and 5GWIFI ANT1, 5WIFI ANT2

2.4GWIFI		5GWIFI		Σ MPE ratios	Limit	Results
Maximum MPE ratio ANT1	Maximum MPE ratio ANT2	Maximum MPE ratio ANT1	Maximum MPE ratio ANT2			
0.00998	0.00889	0.00998	0.00998	0.03883	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.

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