

## RF Exposure evaluation

FCC ID: 2A54Y-X1MAX

### 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 <sup>2</sup> )	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 <sup>2</sup> )*	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 <sup>2</sup> )	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 <sup>2</sup> )*	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

X1 max 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:
BT	/	PCB ANT	2.54dBi for 2400-2500MHz	
2.4GWIFI	/	FPC ANT	Ant 1: 1.58dBi for 2400-2500MHz Ant 2: 1.64dBi for 2400-2500MHz	
5GWIFI	/	FPC ANT	Ant 1: 3.32dBi for 5150-5250MHz Ant 2: 3.45dBi for 5150-5250MHz	
			Ant 1: 2.74dBi for 5725-5875MHz Ant 2: 2.58dBi for 5725-5875MHz	

### 5. Manufacturing Tolerance

BLE(Peak)

BLE			
Channel	Channel 00	Channel 19	Channel 39
Target (dBm)	3.0	3.0	3.0
Tolerance ±(dB)	1.0	1.0	1.0

BR/EDR(Peak)

GFSK			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	6.0	6.0	6.0
Tolerance ±(dB)	1.0	1.0	1.0
π/4QPSK			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	8.0	8.0	8.0
Tolerance ±(dB)	1.0	1.0	1.0
8DPSK			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	8.0	8.0	8.0
Tolerance ±(dB)	1.0	1.0	1.0

For ANT1

2.4GWIFI(Peak)

802.11b			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	15.0	15.0	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
802.11g			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	16.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
802.11n(HT20)			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	16.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
802.11n(HT40)			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	16.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

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

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

For ANT2

2.4GWIFI(Peak)

802.11b			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	15.0	15.0	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
802.11g			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	16.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
802.11n(HT20)			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	16.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
802.11n(HT40)			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	16.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

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IEEE 802.11a			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	12.0	12.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20			
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			
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			
Channel	Channel 38	---	Channel 46
Target (dBm)	12.0	---	12.0
Tolerance $\pm$ (dB)	1.0	---	1.0
IEEE 802.11ac VHT40			
Channel	Channel 38	---	Channel 46
Target (dBm)	12.0	---	12.0
Tolerance $\pm$ (dB)	1.0	---	1.0
IEEE 802.11ac VHT80			
Channel	---	Channel 42	---
Target (dBm)	---	12.0	---
Tolerance $\pm$ (dB)	---	1.0	---

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

Channel	Channel 151	---	Channel 159
Target (dBm)	14.0	---	14.0
Tolerance $\pm$ (dB)	1.0	---	1.0
IEEE 802.11ac VHT80			
Channel	---	Channel 155	---
Target (dBm)	---	14.0	---
Tolerance $\pm$ (dB)	---	1.0	---

For MIMO:

#### 2.4GWIFI

802.11n(HT20)			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	19.0	19.0	19.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
802.11n(HT40)			
Channel	Channel 01	Channel 6	Channel 11
Target (dBm)	19.0	19.0	19.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

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IEEE 802.11n HT20			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	16.5	16.5	16.5
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	16.5	16.5	16.5
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT40			
Channel	Channel 38	---	Channel 46
Target (dBm)	16.0		16.0
Tolerance $\pm$ (dB)	1.0	---	1.0
IEEE 802.11ac VHT40			
Channel	Channel 38	---	Channel 46
Target (dBm)	16.0		16.0
Tolerance $\pm$ (dB)	1.0	---	1.0
IEEE 802.11ac VHT80			
Channel	---	Channel 42	---
Target (dBm)	---	15.0	---
Tolerance $\pm$ (dB)	---	1.0	---

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IEEE 802.11n HT20			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	17.0	17.0	17.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	17.0	17.0	17.0
Tolerance ±(dB)	1.0	1.0	1.0
IEEE 802.11n HT40			
Channel	Channel 151	---	Channel 159
Target (dBm)	16.0	---	16.0
Tolerance ±(dB)	1.0	---	1.0
IEEE 802.11ac VHT40			
Channel	Channel 151	---	Channel 159
Target (dBm)	16.0	---	16.0
Tolerance ±(dB)	1.0	---	1.0
IEEE 802.11ac VHT80			
Channel	---	Channel 155	---
Target (dBm)	---	16.0	---
Tolerance ±(dB)	---	1.0	---

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

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm <sup>2</sup> )	MPE Limits (mW/cm <sup>2</sup> )
	dBm	mW				
BT	9.0	7.9433	2.54	1.7947	0.0028	1.0000
BLE	4.0	2.5119	2.54	1.7947	0.0009	1.0000
2.4GWIFI ANT 1	17.0	50.1187	1.58	1.4388	0.0143	1.0000
2.4GWIFI ANT 2	17.0	50.1187	1.64	1.4588	0.0145	1.0000
5GWIFI U-NII 1 ANT 1	15.0	31.6228	3.32	2.1478	0.0135	1.0000
5GWIFI U-NII 1 ANT 2	14.0	25.1189	3.45	2.2131	0.0111	1.0000
5GWIFI U-NII 3 ANT 1	15.0	31.6228	2.74	1.8793	0.0118	1.0000
5GWIFI U-NII 3 ANT 2	15.0	31.6228	2.58	1.8113	0.0114	1.0000

Remark:

1. Output power (Peak) including turn-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer.

**Simultaneous Evaluation**

Bluetooth MPE (mW/cm <sup>2</sup> )	WIFI ANT 1 MPE (mW/cm <sup>2</sup> )	WIFI ANT 2 MPE (mW/cm <sup>2</sup> )	MPE	MPE Limits
0.0028	0.0143	0.0145	0.0316	1.0000

**7. 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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