

RF Exposure evaluation

FCC ID: 2A5M7-IN-TVH4K

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

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:
2.4GWIFI	/	PIFA Antenna	4.5dBi for 2412-2462MHz for Ant1&2	
2.4GWIFI module 2	/	PIFA Antenna	4.5dBi for 2412-2462MHz	
BLE	/	PIFA Antenna	4.5dBi for 2402-2480MHz;	
5GWIFI	/	PIFA Antenna	4.5dBi for 5180-5825MHz for Ant1&2	

5. Manufacturing Tolerance

WIFI(Peak) for WiFi_2 module

IEEE 802.11b (PEAK)						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	16	16	16	/	/	/
Tolerance ± (dB)	1.0	1.0	1.0	/	/	/
IEEE 802.11g (PEAK)						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	15	15	15	/	/	/
Tolerance ± (dB)	1.0	1.0	1.0	/	/	/
IEEE 802.11n HT20 (PEAK)						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	12	12	12	/	/	/
Tolerance ± (dB)	1.0	1.0	1.0	/	/	/
IEEE 802.11n HT40 (PEAK)						
Frequency (MHz)	Antenna 1			Antenna 2		
	2422	2437	2452	2422	2437	2452
Target (dBm)	12	12	12	/	/	/
Tolerance ± (dB)	1.0	1.0	1.0	/	/	/

WiFi(Peak) for WiFi_2 module

<i>IEEE 802.11b (PEAK)</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	15	15	15	14	14	14
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11g (PEAK)</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	14	14	14	14	14	14
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT20 (PEAK)</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	11	11	11	11	11	11
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT40 (PEAK)</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2422	2437	2452	2422	2437	2452
Target (dBm)	12	12	12	10	10	10
Tolerance ± (dB)	1.0	1.0	1.0	1.0	1.0	1.0

WIFI 5G Band 1

<i>IEEE 802.11a</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5180	5200	5240	5180	5200	5240
Target (dBm)	15	15	15	14	14	14
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5180	5200	5240	5180	5200	5240
Target (dBm)	11	11	11	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5190	5230	/	5190	5230	/
Target (dBm)	11	11	/	11	11	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5180	5200	5240	5180	5200	5240
Target (dBm)	11	11	11	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11ac HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5190	5230	/	5190	5230	/
Target (dBm)	11	11	/	11	11	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT80</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5210	/	/	5210	/	/
Target (dBm)	11	/	/	11	/	/
Tolerance $\pm$ (dB)	1.0	/	/	1.0	/	/

WIFI 5G Band 2

<i>IEEE 802.11a</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5260	5280	5320	5260	5280	5320
Target (dBm)	15	15	15	14	14	14
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	/	5280	5320	/	5280	5320
Target (dBm)	/	11	11	/	11	11
Tolerance $\pm$ (dB)	/	1.0	1.0	/	1.0	1.0
<i>IEEE 802.11n HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5270	5310	/	5270	5310	/
Target (dBm)	11	11	/	11	11	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	/	5280	5320	/	5280	5320
Target (dBm)	/	11	11	/	11	11
Tolerance $\pm$ (dB)	/	1.0	1.0	/	1.0	1.0
<i>IEEE 802.11ac HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5270	5310	/	5270	5310	/
Target (dBm)	11	11	/	11	11	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT80</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5290	/	/	5290	/	/
Target (dBm)	11	/	/	11	/	/
Tolerance $\pm$ (dB)	1.0	/	/	1.0	/	/

WIFI 5G Band 3

<i>IEEE 802.11a</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5500	5600	5700	5500	5600	5700
Target (dBm)	14	14	14	14	14	14
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5500	5600	5700	5500	5600	5700
Target (dBm)	11	11	11	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5510	5670	/	5510	5670	/
Target (dBm)	11	11	/	11	11	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5500	5600	5700	5500	5600	5700
Target (dBm)	11	11	11	11	11	11
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11ac HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5510	5670	/	5510	5670	/
Target (dBm)	11	11	/	11	11	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT80</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5530	5610	/	5530	5610	/
Target (dBm)	10	10	/	10	10	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/

WIFI 5G Band 4

<i>IEEE 802.11a</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5745	5785	5825	5745	5785	5825
Target (dBm)	10	10	10	10	10	10
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5745	5785	5825	5745	5785	5825
Target (dBm)	7	7	5	6	6	6
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11n HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5755	5795	/	5755	5795	/
Target (dBm)	7	6	/	6	6	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT20</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5745	5785	5825	5745	5785	5825
Target (dBm)	7	7	5	6	6	6
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
<i>IEEE 802.11ac HT40</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5755	5795	/	5755	5795	/
Target (dBm)	7	6	/	6	6	/
Tolerance $\pm$ (dB)	1.0	1.0	/	1.0	1.0	/
<i>IEEE 802.11ac HT80</i>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5775	/	/	5775	/	/
Target (dBm)	6	/	/	5	/	/
Tolerance $\pm$ (dB)	1.0	/	/	1.0	/	/

BLE

GFSK 1Mbps(Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	2	2	2
Tolerance $\pm$ (dB)	1.0	1.0	1.0

BT

GFSK 1Mbps(Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	0	0	0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
$\pi/4$ DQPSK 2Mbps(Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1	1	1
Tolerance $\pm$ (dB)	1.0	1.0	1.0
8DPSK 3Mbps(Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1	1	1
Tolerance $\pm$ (dB)	1.0	1.0	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 is 4.5dBi, the RF power density can be obtained.

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
BT	3.0	1.9953	4.5	2.818	0.0011	1.0000
BLE	4.0	2.5119	4.5	2.818	0.0014	1.0000
2.4GWIFI Ant 1 for WiFi_1 module	17.0	50.119	4.5	2.818	0.0281	1.0000
2.4GWIFI Ant 1 for WiFi_2 module	16.0	39.8107	4.5	2.818	0.0223	1.0000
2.4GWIFI Ant 2 for WiFi_2 module	16.0	39.8107	4.5	2.818	0.0223	1.0000
5GWIFI Ant 1	16.0	39.8107	4.5	2.818	0.0223	1.0000
5GWIFI Ant 2	16.0	39.8107	4.5	2.818	0.0223	1.0000

Remark:

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

7. simultaneous MPE Result

ANT1 for WiFi_2 module MPE (Ratio)	ANT1 for WiFi_1 module MPE (Ratio)	ANT2 for WiFi_1 module MPE (Ratio)	simultaneous MPE (Ratio)	MPE Limits (Ratio)
0.0281	0.0223	0.0223	0.0727	1.0000

8. 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-----