FCC RF Exposure Evaluation

1. Product Information

FCC ID	SMQAX8AX9
Product Name	WIFI Module
Test Model	AX8AX9
Power Supply	Input: 100-240V~ 50/60Hz 0.6A Output: 12V-1.5A
Modulation Type	2.4G WIFI: IEEE 802.11b: DSSS IEEE 802.11/g/n: OFDM 5G WIFI : IEEE 802.11a/ac/n: OFDM
Antenna Type	WIFI ANT 1: FPC Antenna WIFI ANT 2: FPC Antenna
Antenna Gain	2.4G WIFI ANT 1: 2.11dBi 2.4G WIFI ANT 2: -0.74dBi 5G WIFI ANT 1: 4.56dBi 5G WIFI ANT 2: 0.37dBi
Frequency Range	2.4G WIFI: 2412MHz~2462MHz 5G WIFI: 5180MHz – 5240MHz/ 5260MHz - 5320MHz/ 5500MHz - 5700MHz/ 5745MHz - 5825MHz
Exposure Category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Device

2. Evaluation Method and Limit

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 $\leqslant$ 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.

3. Limit

3.1 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 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

3. 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

4. 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

5. Antenna Information

CPW-1 can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Note
FPC Antenna	2412MHz-2462MHz 5180MHz - 5240MHz 5260MHz - 5320MHz 5500MHz - 5700MHz 5745MHz - 5825MHz	2.4G WIFI ANT 1: 2.11dBi 2.4G WIFI ANT 2: -0.74dBi 5G WIFI ANT 1: 4.56dBi 5G WIFI ANT 2: 0.37dBi	WLAN Antenna

6.Conducted Power Results

[2.4GWIFI Max Conducted Power]

Mode	Frequency (MHz)	Maximum Average Conducted Output Power (dBm)	
		ANT1	ANT2
802.11b	2412	13.80	15.19
	2437	14.24	14.83
	2462	15.29	14.73
802.11g	2412	13.46	15.03
	2437	13.94	15.21

	2462	15.19	14.66
802.11n (HT20)	2412	13.23	14.83
	2437	13.78	14.99
	2462	14.99	14.43
802.11n (HT40)	2422	13.72	15.01
	2437	14.34	15.13
	2452	14.92	14.98

[U-NII-1 Max Conducted Power]

Mode	Frequency (MHz)	Maximum Average Conducted Output Power (dBm)	
		ANT1	ANT2
802.11a	5180	11.99	11.14
	5200	11.83	11.13
	5240	11.95	11.20
802.11n (HT20)	5180	11.85	11.15
	5200	11.88	11.11
	5240	11.76	11.09
802.11n (HT40)	5190	12.12	11.19
	5230	11.78	11.20
802.11ac (VHT20)	5180	12.07	11.12
	5200	11.91	11.00
	5240	11.80	11.05
802.11ac (VHT40)	5190	12.09	11.22
	5230	11.74	11.14
802.11ac (VHT80)	5210	12.02	11.40

[U-NII-2A Max Conducted Power]

Mode	Frequency (MHz)	Maximum Average Conducted Output Power (dBm)	
		ANT1	ANT2
802.11a	5260	11.52	10.35
	5300	10.88	10.01
	5320	11.14	10.63
802.11n (HT20)	5260	11.30	10.26
	5300	10.61	9.92
	5320	10.87	10.62
802.11n (HT40)	5270	11.23	10.06
	5310	10.84	10.41
802.11ac (VHT20)	5260	11.22	10.19
	5300	10.66	9.84
	5320	10.72	10.32
802.11ac (VHT40)	5270	11.26	10.01
	5310	10.82	10.53
802.11ac (VHT80)	5290	10.92	9.50

[U-NII-2C Max Conducted Power]

Mode	Frequency (MHz)	Maximum Average Conducted Output Power (dBm)	
		ANT1	ANT2
802.11a	5500	12.69	13.09
	5580	13.03	13.18
	5700	11.77	12.37
802.11n (HT20)	5500	12.35	12.73
	5580	12.62	12.88
	5700	11.72	12.06
802.11n (HT40)	5510	12.73	12.94
	5550	12.24	12.68
	5670	12.50	12.91
802.11ac (VHT20)	5500	12.34	12.74
	5580	12.67	12.91
	5700	11.64	12.02
802.11ac (VHT40)	5510	12.72	13.04
	5550	12.20	12.83
	5670	12.62	12.92
802.11ac (VHT80)	5530	12.50	12.86
	5610	12.60	13.16

[U-NII-3 Max Conducted Power]

Mode	Frequency (MHz)	Maximum Average Conducted Output Power (dBm)	
		ANT1	ANT2
802.11a	5745	11.65	13.62
	5785	11.61	13.06
	5825	11.62	13.57
802.11n (HT20)	5745	11.64	13.36
	5785	11.75	13.47
	5825	11.43	13.67
802.11n (HT40)	5755	11.60	12.78
	5795	11.70	12.95
802.11ac (VHT20)	5745	11.70	12.57
	5785	11.68	13.18
	5825	11.16	13.24
802.11ac (VHT40)	5755	11.40	12.54
	5795	11.57	12.68
802.11ac (VHT80)	5775	10.97	12.45

7.Manufacturing Tolerance

<2.4G WIFI >

11B (Average)			
Channel	2412MHz	2437MHz	2462MHz
Target (dBm)	16.0	15.0	16.0
Tolerance ±(dB)	1.0	1.0	1.0
11G (Average)			

Channel	2412MHz	2437MHz	2462MHz
Target (dBm)	16.0	16.0	16.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20 (Average)			
Channel	2412MHz	2437MHz	2462MHz
Target (dBm)	15.0	15.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	2422MHz	2437MHz	2452MHz
Target (dBm)	16.0	16.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0

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11A (Average)			
Channel	5180MHz	5200MHz	5240MHz
Target (dBm)	12.0	12.0	12.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20 (Average)			
Channel	5180MHz	5200MHz	5240MHz
Target (dBm)	12.0	12.0	12.0
Tolerance ±(dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	5190MHz	5230MHz	
Target (dBm)	13.0	12.0	
Tolerance ±(dB)	1.0	1.0	
11AC20 (Average)			
Channel	5180MHz	5200MHz	5240MHz
Target (dBm)	13.0	12.0	12.0
Tolerance ±(dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	5190MHz	5230MHz	
Target (dBm)	13.0	12.0	
Tolerance ±(dB)	1.0	1.0	
11AC80 (Average)			
Channel	5210MHz		
Target (dBm)	13.0		
Tolerance ±(dB)	1.0		

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11A (Average)			
Channel	5260MHz	5300MHz	5320MHz
Target (dBm)	12.0	11.0	12.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20 (Average)			
Channel	5260MHz	5300MHz	5320MHz
Target (dBm)	12.0	11.0	11.0

Tolerance ±(dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	5270MHz	5310MHz	
Target (dBm)	12.0	11.0	
Tolerance ±(dB)	1.0	1.0	
11AC20 (Average)			
Channel	5260MHz	5300MHz	5320MHz
Target (dBm)	12.0	11.0	11.0
Tolerance ±(dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	5270MHz	5310MHz	
Target (dBm)	12.0	11.0	
Tolerance ±(dB)	1.0	1.0	
11AC80 (Average)			
Channel	5290MHz		
Target (dBm)	11.0		
Tolerance ±(dB)	1.0		

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11A (Average)			
Channel	5500MHz	5580MHz	5700MHz
Target (dBm)	14.0	14.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20 (Average)			
Channel	5500MHz	5580MHz	5700MHz
Target (dBm)	13.0	13.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	5510MHz	5550MHz	5670MHz
Target (dBm)	13.0	13.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0
11AC20 (Average)			
Channel	5500MHz	5580MHz	5700MHz
Target (dBm)	13.0	13.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	5510MHz	5550MHz	5670MHz
Target (dBm)	14.0	13.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0
11AC80 (Average)			
Channel	5530MHz		5610MHz
Target (dBm)	13.0		14.0
Tolerance ±(dB)	1.0		1.0

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11A (Average)			
Channel	5745MHz	5785MHz	5825MHz
Target (dBm)	14.0	14.0	14.0
Tolerance ±(dB)	1.0	1.0	1.0
11N20 (Average)			
Channel	5745MHz	5785MHz	5825MHz
Target (dBm)	14.0	14.0	14.0
Tolerance ±(dB)	1.0	1.0	1.0
11N40 (Average)			
Channel	5755MHz	5795MHz	
Target (dBm)	13.0	13.0	
Tolerance ±(dB)	1.0	1.0	
11AC20 (Average)			
Channel	5745MHz	5785MHz	5825MHz
Target (dBm)	13.0	14.0	14.0
Tolerance ±(dB)	1.0	1.0	1.0
11AC40 (Average)			
Channel	5755MHz	5795MHz	
Target (dBm)	13.0	13.0	
Tolerance ±(dB)	1.0	1.0	
11AC80 (Average)			
Channel	5775MHz		
Target (dBm)	13.0		
Tolerance ±(dB)	1.0		

8. Evaluation Results

8.1 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.

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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	16.0	39.8107	2.11	1.6255	100%	0.0129	1.0000
IEEE 802.11g	16.0	39.8107	-0.74	0.8433	100%	0.0067	1.0000
IEEE 802.11n HT20	15.0	31.6228	-0.74	0.8433	100%	0.0053	1.0000
IEEE 802.11n HT40	16.0	39.8107	-0.74	0.8433	100%	0.0067	1.0000

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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	12.0	15.8489	4.56	2.8576	100%	0.0090	1.0000
IEEE 802.11 n HT20	12.0	15.8489	4.56	2.8576	100%	0.0090	1.0000
IEEE 802.11 n HT40	13.0	19.9526	4.56	2.8576	100%	0.0113	1.0000
IEEE 802.11	13.0	19.9526	4.56	2.8576	100%	0.0113	1.0000

ac20							
IEEE 802.11 ac40	13.0	19.9526	4.56	2.8576	100%	0.0113	1.0000
EEE 802.11 Ac80	13.0	19.9526	4.56	2.8576	100%	0.0113	1.0000

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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	12.0	15.8489	4.56	2.8576	100%	0.0090	1.0000
IEEE 802.11 n HT20	12.0	15.8489	4.56	2.8576	100%	0.0090	1.0000
IEEE 802.11 n HT40	12.0	15.8489	4.56	2.8576	100%	0.0090	1.0000
IEEE 802.11 ac20	12.0	15.8489	4.56	2.8576	100%	0.0090	1.0000
IEEE 802.11 ac40	12.0	15.8489	4.56	2.8576	100%	0.0090	1.0000
EEE 802.11 Ac80	11.0	25.1189	4.56	2.8576	100%	0.0072	1.0000

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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	0.37	1.0889	100%	0.0054	1.0000
IEEE 802.11 n HT20	13.0	19.9526	0.37	1.0889	100%	0.0043	1.0000
IEEE 802.11 n HT40	13.0	19.9526	0.37	1.0889	100%	0.0043	1.0000
IEEE 802.11 ac20	13.0	19.9526	0.37	1.0889	100%	0.0043	1.0000
IEEE 802.11 ac40	14.0	25.1189	0.37	1.0889	100%	0.0054	1.0000
EEE 802.11 Ac80	14.0	25.1189	0.37	1.0889	100%	0.0054	1.0000

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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	0.37	1.0889	100%	0.0054	1.0000
IEEE 802.11 n HT20	14.0	25.1189	0.37	1.0889	100%	0.0054	1.0000
IEEE 802.11 n HT40	13.0	19.9526	0.37	1.0889	100%	0.0043	1.0000
IEEE 802.11 ac20	14.0	25.1189	0.37	1.0889	100%	0.0054	1.0000
IEEE 802.11 ac40	13.0	19.9526	0.37	1.0889	100%	0.0043	1.0000
EEE 802.11 Ac80	13.0	19.9526	0.37	1.0889	100%	0.0043	1.0000

Emark:
1. Output power including tune-up tolerance;
2. MPE evaluate distance is 20cm from user manual provide by manufacturer;

8.2 Simultaneous Transmission MPE

Simultaneous transmission MPE

2.4G WIFI MPE	5G WIFI MPE	Max.sum of the	Limit	Test Results

(mW/cm^2)	(mW/cm^2)	MPE ratios		
0.0129	0.0113	0.0242	1.0000	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.....