



Test report No. : 4790224862-US-R3-V0
Page : 1 of 14
Issued date : 2022/9/30
FCC ID : 2AE3B-AEX-QCA98X

Maximum Permissible Exposure Report

Product : PCIE 802.11a/b/g/n/ac 2.4GHz/5GHz DB module

Model Name : AEX-QCA98x0

Series Model : AEX-QCA98X, AEX-QCA9880-NX, AEX-QCA9890-NX,
AEX-QCA9890-NI

FCC ID : 2AE3B-AEX-QCA98X

Test Regulation : 47 CFR FCC Part 2.1091

Received Date : 2021/12/14

Test Date : 2022/8/15 ~ 2022/8/30

Issued Date : 2022/9/30

Applicant : VOXMICRO LTD
20955 Pathfinder Rd., STE 100, Diamond Bar, California
91765, USA

Issued By : Underwriters Laboratories Taiwan Co., Ltd.
Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd.,
Zhudong Township, Hsinchu County, Taiwan



The results reported herein have been performed in accordance with the laboratory's terms of accreditation. This report shall not be reproduced except in full without the written approval of the Laboratory. The results in this report are responsible of the test sample(s) provided by the client only and are not to be used to indicate applicability to other similar products.

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Doc No: 17-EM-F0864 / 5.0



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1. Attestation of Test Results

APPLICANT: VOXMICRO LTD
 20955 Pathfinder Rd., STE 100, Diamond Bar, California 91765, USA

MANUFACTURER: VOXMICRO LTD
 8F.-3, No.5, Aly. 22, Ln. 513, Rueiguang Rd., Neihu Dist., Taipei City 114, Taiwan

EUT DESCRIPTION: PCIE 802.11a/b/g/n/ac 2.4GHz/5GHz DB module

BRAND: AIRETOS

MODEL: AEX-QCA98x0

SERIES MODEL: AEX-QCA98X, AEX-QCA9880-NX, AEX-QCA9890-NX, AEX-QCA9890-NI

SAMPLE STAGE: Engineering Verification Test sample

APPLICABLE STANDARDS	
STANDARD	Test Results
47 CFR FCC PART 2.1091	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

Cindy Hsin
 Project Handler

Date : 2022/9/30

Approved and Authorized By:

Kent Liu
 Senior Laboratory Engineer

Date : 2022/9/30

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2. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with KDB 447498 D04 Interim General RF Exposure Guidance v01.

3. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

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4. Equipment Under Test

4.1. Description of EUT

Product Name	PCIE 802.11a/b/g/n/ac 2.4GHz/5GHz DB module
Brand Name	AIRETOS
Model Name	AEX-QCA98x0
Series Model	AEX-QCA98X, AEX-QCA9880-NX, AEX-QCA9890-NX, AEX-QCA9890-NI
Operating Frequency	2.4GHz: 2412MHz ~ 2462MHz 5GHz: 5180MHz ~ 5240MHz 5260MHz ~ 5320MHz 5500MHz ~ 5700MHz 5745MHz ~ 5825MHz
Modulation	CCK, DQPSK, DBPSK for DSSS 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM

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Number of Channel	2.4G WLAN 2412 ~ 2462 MHz	11 for 802.11b, 802.11g, 802.11n (HT20), TurboQAM (VHT20)
		7 for 802.11n (HT40), TurboQAM (VHT40)
	5G WLAN 5180 ~ 5240 MHz	4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20)
		2 for 802.11n (HT40), 802.11ac (VHT40)
		1 for 802.11ac (VHT80)
	5G WLAN 5260 ~ 5320 MHz	4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20)
		2 for 802.11n (HT40), 802.11ac (VHT40)
		1 for 802.11ac (VHT80)
	5G WLAN 5500 ~ 5700 MHz	11 for 802.11a, 802.11n (HT20), 802.11ac (VHT20)
		5 for 802.11n (HT40), 802.11ac (VHT40)
		2 for 802.11ac (VHT80)
	5G WLAN 5745 ~ 5825 MHz	5 for 802.11a, 802.11n (HT20), 802.11ac (VHT20)
		2 for 802.11n (HT40), 802.11ac (VHT40)
		1 for 802.11ac (VHT80)
	Normal Voltage	3.3Vdc
S/N	E98X	
Sample ID	5189932	

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Note:

1. The models difference table as below:

Model	Difference
AEX-QCA98x0	Market assignment classification for application and grade finish
AEX-QCA98X	
AEX-QCA9880-NX	
AEX-QCA9890-NX	
AEX-QCA9890-NI	

2. The EUT provides three completed transmitters and three receivers.

Modulation Mode	Tx,Rx Function
802.11a	3TX,3RX
802.11b	3TX,3RX
802.11g	3TX,3RX
802.11n (HT20)	3TX,3RX
802.11n (HT40)	3TX,3RX
TurboQAM (VHT20) / 802.11ac (VHT20)	3TX,3RX
TurboQAM (VHT40) / 802.11ac (VHT40)	3TX,3RX
802.11ac (VHT80)	3TX,3RX

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

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4.2. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)	Remark
1	Chain (0)+(1)+(2)	ethertronics	M830520	Chip	2.4GHz: 1 5GHz: 2.6	MHF4
2	Chain (0)+(1)+(2)	OXFORDTEC	WAFH-2DBI-15	FPC	2.4GHz: 2.7 5GHz: 2.6	UFL
3	Chain (0)+(1)+(2)	OXFORDTEC	WAND2DBI-SMA	Dipole	2.4GHz: 2 5GHz: 3	RP-SMA
4	Chain (0)+(1)+(2)	OXFORDTEC	WAND5DBI-SMA	Dipole	2.4GHz: 3 5GHz: 5	RP-SMA
5	Chain (0)+(1)+(2)	OXFORDTEC	WAPH2DB4-15	PCB	2.4GHz:2.18 5GHz: 2.69	MHF4

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual.

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5. Requirement

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	*100	30
1.34-30	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

Note 1: f = frequency in MHz, * means Plane-wave equivalent power density

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

Power Density (S) is calculated by the following formula:

$$S = (P * G) / 4\pi R^2$$

where: S = power density (in appropriate units, e.g. mW/ cm²)

P = power input to the antenna (in appropriate units, e.g., mW)

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 (appropriate units, e.g., cm)

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6. General RF Exposure Test Exemption

The corresponding Exclusion Threshold condition, listed below:

- 1) Blanket Exempt: Following 47 CFR 1.1307(b)(3)(i)(A), the available maximum time-averaged power is no more than 1 mW.
- 2) SAR Exempt: Following 47 CFR 1.1307(b)(3)(i)(B), the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz};$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

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- 3) MPE Exempt: Following 47 CFR 1.1307(b)(3)(i)(C), using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	$1,920 R^2$.
1.34-30	$3,450 R^2/f^2$.
30-300	$3.83 R^2$.
300-1,500	$0.0128 R^2f$.
1,500-100,000	$19.2R^2$.

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7. Radio Frequency Radiation Exposure Evaluation

(1) Exposure environment

Non-Beamforming mode

WLAN 2.4GHz

Evaluation Frequency	Max. Average power	Directional Gain	Max. EIRP	Max. EIRP	Power density @ 30 cm	Limit
(MHz)	(dBm)	(dBi)	(dBm)	(mW)	(mW/cm ²)	(mW/cm ²)
2412 ~ 2462	25.22	7.77	32.99	1990.673	0.17601	1

WLAN 5GHz

Evaluation Frequency	Max. Average power	Directional Gain	Max. EIRP	Max. EIRP	Power density @ 30 cm	Limit
(MHz)	(dBm)	(dBi)	(dBm)	(mW)	(mW/cm ²)	(mW/cm ²)
5180 ~ 5240	21.24	9.77	31.01	1261.828	0.11157	1
5260 ~ 5320	21.17	9.77	30.94	1241.652	0.10979	1
5500 ~ 5700	19.00	9.77	28.77	753.356	0.06661	1
5745 ~ 5825	19.09	9.77	28.86	769.130	0.06801	1

Beamforming mode

WLAN 2.4GHz

Evaluation Frequency	Max. Average power	Directional Gain	Max. EIRP	Max. EIRP	Power density @ 30 cm	Limit
(MHz)	(dBm)	(dBi)	(dBm)	(mW)	(mW/cm ²)	(mW/cm ²)
2412 ~ 2462	23.07	7.77	30.84	1213.389	0.10729	1

WLAN 5GHz

Evaluation Frequency	Max. Average power	Directional Gain	Max. EIRP	Max. EIRP	Power density @ 30 cm	Limit
(MHz)	(dBm)	(dBi)	(dBm)	(mW)	(mW/cm ²)	(mW/cm ²)
5180 ~ 5240	20.03	9.77	29.80	954.993	0.08444	1
5260 ~ 5320	19.97	9.77	29.74	941.890	0.08328	1
5500 ~ 5700	18.85	9.77	28.62	727.780	0.06435	1
5745 ~ 5825	19.09	9.77	28.86	769.130	0.06801	1

Note:

1. Max. EIRP (dBm) = Max. Average power (dBm) + Antenna Gain (dBi)
2. Max. EIRP (mW) = $10^{(\text{Max. EIRP (dBm)} / 10)}$
3. Power density (mW/cm²) = Max. EIRP (mW) / [$4 \times \pi \times (\text{calculated distance})^2$], the calculated distance is 30 cm.

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(2) General RF Exposure Test Exemption

Option	Evaluation Method	Clause
<input type="checkbox"/>	Blanket Exempt	47 CFR 1.1307(b)(3)(i)(A)
<input type="checkbox"/>	SAR Exempt	47 CFR 1.1307(b)(3)(i)(B)
<input checked="" type="checkbox"/>	MPE Exempt	47 CFR 1.1307(b)(3)(i)(C)

Note: Max. ERP (dBm) = Max. Average power (dBm) + Antenna Gain (dBi) - 2.15 (dB)

Non-Beamforming mode

WLAN 2.4GHz

Evaluation Frequency (MHz)	$\lambda/2\pi$ (m)	R (m)	Max. ERP (dBm)	Max. ERP (W)	Threshold ERP (W)
2412 ~ 2462					

WLAN 5GHz

Evaluation Frequency (MHz)	$\lambda/2\pi$ (m)	R (m)	Max. ERP (dBm)	Max. ERP (W)	Threshold ERP (W)
5180 ~ 5240	0.0092	0.3	28.86	0.769	1.728
5260 ~ 5320	0.0091	0.3	28.79	0.757	1.728
5500 ~ 5700	0.0087	0.3	26.62	0.459	1.728
5745 ~ 5825	0.0083	0.3	26.71	0.469	1.728

Beamforming mode

WLAN 2.4GHz

Evaluation Frequency (MHz)	$\lambda/2\pi$ (m)	R (m)	Max. ERP (dBm)	Max. ERP (W)	Threshold ERP (W)
2412 ~ 2462	0.0198	0.3	30.84	1.213	1.728

WLAN 5GHz

Evaluation Frequency (MHz)	$\lambda/2\pi$ (m)	R (m)	Max. ERP (dBm)	Max. ERP (W)	Threshold ERP (W)
5180 ~ 5240	0.0092	0.3	27.65	0.582	1.728
5260 ~ 5320	0.0091	0.3	27.59	0.574	1.728
5500 ~ 5700	0.0087	0.3	26.47	0.444	1.728
5745 ~ 5825	0.0083	0.3	26.71	0.469	1.728

Conclusion:

According to 47 CFR §2.1091, the RF exposure analysis concludes that the RF Exposure is FCC compliant.

END OF REPORT

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