Maximum Permissible Exposure Report

Product	:	PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module
Model Name	:	ACB-QCA6391
Series Model	:	ACB-QCA6391-WX1, ACB-QCA6391-WX2, ACB-QCA6391-WX4, ACB-QCA6391-WX5, ACB-QCA6391-WI1, ACB-QCA6391-WI2, ACB-QCA6391-WI4, ACB-QCA6391-WI5
FCC ID	:	2AE3B-ACB-QCA6391
Test Regulation	:	47 CFR FCC Part 2.1091
Received Date	:	2021/5/18
Test Date	:	2023/6/1 ~ 2023/8/16
Issued Date	:	2023/9/12
Applicant	:	VOXMICRO LTD 20955 Pathfinder Rd., STE 100, Diamond Bar, California 91765, USA
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Testing Laboratory
3398

REVISION HISTORY

Original Test Report No.: 4789913232-US-R5-V0

Revision	Test report No.	Date	Page revised	Contents
Original	4789913232-US-R5-V0	2023/9/12	-	Initial issue

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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/ax 2.4GHz/5GHz+USB/UART BT 5.2 module
BRAND:	AIRETOS
MODEL:	ACB-QCA6391
SERIES MODEL:	ACB-QCA6391-WX1, ACB-QCA6391-WX2, ACB-QCA6391-WX4, ACB-QCA6391-WX5, ACB-QCA6391-WI1, ACB-QCA6391-WI2, ACB-QCA6391-WI4, ACB-QCA6391-WI5
SAMPLE STAGE:	Design 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:

Sally Lu Date : 2023/9/12
Project Handler

Approved and Authorized By:

Eric Lee Date : 2023/9/12
Senior Laboratory Engineer

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 A, B and 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.

4. Equipment Under Test

4.1. Description of EUT

Product Name	PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module	
Brand Name	AIRETOS	
Model Name	ACB-QCA6391	
Series Model	ACB-QCA6391-WX1, ACB-QCA6391-WX2, ACB-QCA6391-WX4, ACB-QCA6391-WX5, ACB-QCA6391-WI1, ACB-QCA6391-WI2, ACB-QCA6391-WI4, ACB-QCA6391-WI5	
Operating Frequency	Bluetooth EDR	2402MHz ~ 2480MHz
	Bluetooth LE	2402MHz ~ 2480MHz
	WLAN	**2.4GHz:** 2412MHz ~ 2462MHz **5GHz:** 5180MHz ~ 5240MHz 5260MHz ~ 5320MHz 5500MHz ~ 5700MHz 5745MHz ~ 5825MHz
Modulation	Bluetooth EDR	GFSK, π/4-DQPSK, 8DPSK
	Bluetooth LE	GFSK
	WLAN	CCK, DQPSK, DBPSK for DSSS 1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK
Number of Channel	Bluetooth EDR	79
	Bluetooth LE	40

Number of Channel	2.4G WLAN 2412 ~ 2462 MHz	11 for 802.11b, 802.11g, 802.11n (HT20), 802.11ax (HE20) 7 for 802.11n (HT40), 802.11ax (HE40)
	5G WLAN 5180 ~ 5240 MHz	4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11 ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)
	5G WLAN 5260 ~ 5320 MHz	4 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11 ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)
	5G WLAN 5500 ~ 5700 MHz	11 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		5 for 802.11n (HT40), 802.11 ac (VHT40), 802.11ax (HE40)
		2 for 802.11ac (VHT80), 802.11ax (HE80)
	5G WLAN 5745 ~ 5825 MHz	5 for 802.11a, 802.11n (HT20), 802.11ac (VHT20), 802.11ax (HE20)
		2 for 802.11n (HT40), 802.11 ac (VHT40), 802.11ax (HE40)
		1 for 802.11ac (VHT80), 802.11ax (HE80)
Normal Voltage	3.7Vdc	
S/N	E63B	
Sample ID	3920615	

Note:

1. The models difference table as below:

Brand	Model	Difference
AIRETOS	ACB-QCA6391	-
	ACB-QCA6391-WX1	Market assignment classification for application and grade finish
	ACB-QCA6391-WX2	
	ACB-QCA6391-WX4	
	ACB-QCA6391-WX5	
	ACB-QCA6391-WI1	
	ACB-QCA6391-WI2	
	ACB-QCA6391-WI4	
	ACB-QCA6391-WI5	

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

Modulation Mode	Tx,Rx Function
802.11a	2TX,2RX
802.11b	2TX,2RX
802.11g	2TX,2RX
802.11n (HT20)	2TX,2RX
802.11n (HT40)	2TX,2RX
802.11ac (VHT20)	2TX,2RX
802.11ac (VHT40)	2TX,2RX
802.11ac (VHT80)	2TX,2RX
802.11ax (HE20)	2TX,2RX
802.11ax (HE40)	2TX,2RX
802.11ax (HE80)	2TX,2RX

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual, the laboratory shall not be held responsible.

4.2. Description of Available Antennas

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

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, the laboratory shall not be held responsible.

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/cm^2)
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)

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:

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

Where

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

and

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

d = the separation distance (cm);

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.

7. Radio Frequency Radiation Exposure Evaluation

(1) General RF Exposure Test Exemption

Option	Evaluation Method	Clause
☐	Blanket Exempt	47 CFR 1.1307(b)(3)(i)(A)
☐	SAR Exempt	47 CFR 1.1307(b)(3)(i)(B)
☒	MPE Exempt	47 CFR 1.1307(b)(3)(i)(C)

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

Bluetooth EDR

Evaluation Frequency	λ/2π	R	Max. ERP	Max. ERP	Threshold ERP
(MHz)	(m)	(m)	(dBm)	(W)	(W)
2402 ~ 2480	0.0199	0.2	9.41	0.009	0.768

Bluetooth LE

Evaluation Frequency	λ/2π	R	Max. ERP	Max. ERP	Threshold ERP
(MHz)	(m)	(m)	(dBm)	(W)	(W)
2402 ~ 2480	0.0199	0.2	6.38	0.004	0.768

WLAN 2.4GHz

Evaluation Frequency	λ/2π	R	Max. ERP	Max. ERP	Threshold ERP
(MHz)	(m)	(m)	(dBm)	(W)	(W)
2412 ~ 2462	0.0198	0.2	26.85	0.484	0.768

WLAN 5GHz

Evaluation Frequency	λ/2π	R	Max. ERP	Max. ERP	Threshold ERP
(MHz)	(m)	(m)	(dBm)	(W)	(W)
5180 ~ 5240	0.0092	0.2	22.48	0.177	0.768
5260 ~ 5320	0.0091	0.2	23.77	0.238	0.768
5500 ~ 5700	0.0087	0.2	27.63	0.579	0.768
5745 ~ 5825	0.0084	0.2	27.98	0.628	0.768

(2) Simultaneously transmission condition:

Condition	Technology	
1	BT-GFSK	WLAN (2.4GHz)
2	BT-GFSK	WLAN (5GHz)

Condition 1	R	Max. ERP	Threshold ERP	Transmit Simultaneously	Transmit Simultaneously Limit
	(m)	(W)	(W)		
BT-GFSK	0.2	0.009	0.768	0.642	≦1
WLAN (2.4GHz)	0.2	0.484	0.768		

Condition 2	R	Max. ERP	Threshold ERP	Transmit Simultaneously	Transmit Simultaneously Limit
	(m)	(W)	(W)		
BT-GFSK	0.2	0.009	0.768	0.829	≦1
WLAN (5GHz)	0.2	0.628	0.768		

Conclusion:

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

END OF REPORT