Testing Laboratory 3787

RADIO EXPOSURE TEST REPORT

FCC ID	:	TLZ-XM9098
Equipment	:	IEEE 802.112X2 WiFi 6 SU and MU-MIMO DBC Wireless LAN + Bluetooth 5.1 Combo Module
Brand Name	:	AzureWave
Model Name	:	AW-XM458, AW-XM369, AW-XM458MA-XXX, AW-XM369MA-XXX
Applicant	:	AzureWave Technologies, Inc. 8F., No.94, Baozhong Rd. , Xindian Dist., New Taipei City , Taiwan 231
Manufacturer	:	AzureWave Technologies (Shanghai) Inc. No. 1355, Jiaxin Road, Malu Twon, Jiading District Shanghai, P.R. China
Standard	:	47 CFR Part 2.1091

The product was received on Apr. 13, 2021, and testing was started from May 28, 2021 and completed on May 11, 2022. We, Sporton International Inc. Hsinchu Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in 47 CFR Part 2.1091 and shown compliance with the applicable technical standards.

The test results in this variant report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. Hsinchu Laboratory, the test report shall not be reproduced except in full.

Approved by: Sam Chen

Sporton International Inc. Hsinchu Laboratory
No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)

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History of this test report

Report No.	Version	Description	Issued Date
FA132339-07	01	Initial issue of report	May 02, 2023

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
2	-	Exposure evaluation	PASS	-

Conformity Assessment Condition:
1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account. 2. The measurement uncertainty please refer to each test result in the chapter "Measurement Uncertainty".
Disclaimer:
The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Sam Chen

Report Producer: Viola Huang

1 General Description

1.1 EUT General Information

RF General Information			
Evaluation Mode	**Frequency Range (MHz)**	**Operating Frequency (MHz)**	**Modulation Type**
2.4GHz WLAN	2400-2483.5	2412-2462	802.11b: DSSS (DBPSK, DQPSK, CCK) 802.11g/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM)
5GHz WLAN	5150-5250 5250-5350 5470-5725 5725-5850	5180-5240 5260-5320 5500-5700 5745-5825	802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM)
Bluetooth	2400-2483.5	2402-2480	BR / EDR: FHSS (GFSK / π/4-DQPSK / 8DPSK) LE: GFSK

1.2 Antenna Information

Ant.	Port			Brand	Model Name	Antenna Type	Connector	Gain (dBi)
	2.4GHz	5GHz	Bluetooth					
1	1	1	-	MAG. LAYERS	MSA-4008-25GC1-A2	PIFA	I-PEX	Note 1
2	2	2	-	MAG. LAYERS	MSA-4008-25GC1-A2	PIFA	I-PEX	
3	-	-	1	MAG. LAYERS	MSA-4008-25GC1-A2	PIFA	I-PEX	
4	1/2	1/2	1	Inpaq	WA-P-LB-02-587	PCB	I-PEX	
5	1/2	1/2	1	Inpaq	WA-P-LB-03-129	PCB	I-PEX	
6	-	-	-	Inpaq	WA-P-LB-03-130	PCB	I-PEX	
7	-	-	-	Inpaq	WA-F-LB-03-110	PCB	I-PEX	
8	-	-	-	Inpaq	WA-F-LB-02-187	PCB	I-PEX	
9	-	-	-	Inpaq	WA-F-LA-01-015	PCB	I-PEX	
10	-	-	-	TE Connectivity	2195501-2	PCB	I-PEX	
11	-	-	-	TE Connectivity	2195505-2	PCB	I-PEX	
12	-	-	-	LUXSHARE-ICT	SA37A47021	Dipole	I-PEX	Note 2
13	-	-	-	LUXSHARE-ICT	SA37A47021	Dipole	I-PEX	
14	-	-	-	LUXSHARE-ICT	SA37A47025	PIFA	I-PEX	Note 1

Note1:

Ant.	Port			Antenna Gain (dBi)		
	2.4GHz	5GHz	Bluetooth	WLAN 2.4GHz	WLAN 5GHz	Bluetooth
1	1	1	-	2.98	5.16	-
2	2	2	-	2.98	5.16	-
3	-	-	1	-	-	2.98
4	1/2	1/2	1	4.43	7.52	4.43
5	1/2	1/2	1	6.51	3.2	6.51
6	-	-	-	4.91	5.84	4.91
7	-	-	-	-0.27	2.74	-0.27
8	-	-	-	0.07	2.39	0.07
9	-	-	-	5.66	-	5.66
10	-	-	-	0.47	1.88	0.47
11	-	-	-	0.77	0.96	0.77
14	-	-	-	-	-	-1.1

Note2:

Ant.	Port		Cable Length	Antenna Gain (dBi)		Cable Loss (dB)		True Gain (dBi)	
	2.4GHz	5GHz		WLAN 2.4GHz	WLAN 5GHz	WLAN 2.4GHz	WLAN 5GHz	WLAN 2.4GHz	WLAN 5GHz
12	-	-	450mm	2.8	2.6	1.1	1.9	1.7	0.7
13	-	-	470mm	2.8	2.6	1.2	2	1.6	0.6

Note3: The above information was declared by manufacturer.

Note4: There are 14 antennas listed on the antenna table. The EUT has two types of antenna.

Note5: Directional gain information.

For ant. 1~ant. 2

Type	Maximum Output Power	Power Spectral Density
Non-BF	Directional gain = Max.gain + array gain. For power measurements on IEEE 802.11 devices Array Gain = 0 dB (i.e., no array gain) for N ANT ≤ 4	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left[\sum_{k=1}^{N_{ANT}} g_{j,k}\right]^2}{N_{ANT}}\right]$
BF	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left[\sum_{k=1}^{N_{ANT}} g_{j,k}\right]^2}{N_{ANT}}\right]$	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left[\sum_{k=1}^{N_{ANT}} g_{j,k}\right]^2}{N_{ANT}}\right]$

Ex.

Directional Gain (NSS1) formula : $DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left[\sum_{k=1}^{N_{ANT}} g_{j,k}\right]^2}{N_{ANT}}\right]$

NSS1(g1,1) = $10^{G1/20}$; NSS1(g1,2)= $10^{G2/20}$

gj,k =(Nss1(g1,1) + Nss1(g1,2))^2

DG = 10 log[(Nss1(g1,1) + Nss1(g1,2)))^2 / N_{ANT}] => 10 log[($10^{G1/20}$ + $10^{G2/20}$)^2 / N_{ANT}]

Where ;

2.4G G1 = 2.98 ; G2 = 2.98 ; DG=5.99

5G G1 = 5.16; G2 = 5.16 ; DG=8.17

For ant. 4~ant. 5

Type	Maximum Output Power	Power Spectral Density
Non-BF	Directional gain = Max.gain + array gain. For power measurements on IEEE 802.11 devices Array Gain = 0 dB (i.e., no array gain) for N ANT ≤ 4	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{ANT}} g_{j,k}\right\}^2}{N_{ANT}}\right]$
BF	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{ANT}} g_{j,k}\right\}^2}{N_{ANT}}\right]$	$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{ANT}} g_{j,k}\right\}^2}{N_{ANT}}\right]$

Ex.

Directional Gain (NSS1) formula : $DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{ANT}} g_{j,k}\right\}^2}{N_{ANT}}\right]$

NSS1(g1,1) = $10^{G1/20}$; NSS1(g1,2)= $10^{G2/20}$

gj,k =(Nss1(g1,1) + Nss1(g1,2))^2

DG = 10 log[(Nss1(g1,1) + Nss1(g1,2)))^2 / N_{ANT}] => 10 log[($10^{G1/20}$ + $10^{G2/20}$)^2 / N_{ANT}]

Where ;

For ant. 5

2.4G G1 = 6.51 ; G2 = 6.51 ; DG=9.52

For ant. 4

5G G1 = 7.52 ; G2 = 7.52 ; DG=10.53

<WLAN 2.4GHz Function>

For IEEE 802.11b/g/n/ax (2TX/2RX):

Port 1 and Port 2 can be used as transmitting/receiving antenna.

Port 1 and Port 2 could transmit/receive simultaneously.

<WLAN 5GHz Function>

For IEEE 802.11a/n/ac/ax (2TX/2RX):

Port 1 and Port 2 can be used as transmitting/receiving antenna.

Port 1 and Port 2 could transmit/receive simultaneously.

<Bluetooth Function> (1TX/1RX)

Only Port 1 can be used as transmitting/receiving.

1.3 Table for Multiple Listing

EUT	Model No.	GPIO	Antenna	Description
1	AW-XM458, AW-XM369	Without GPIO	PIFA, PCB, Dipole	All the model names are identical, the difference model names served as marketing strategy.
2	AW-XM458MA-XXX, AW-XM369MA-XXX	With GPIO		1. All the model names are identical, the difference model names served as marketing strategy. 2. The difference between this two EUTs are RF connector trace and RF connector type.
3				

Note 1: From the above models, model: AW-XM458MA-XXX (EUT 2, EUT 3) was selected as representative model for the test and its data was recorded in this report.

Note 2: The above information was declared by manufacturer.

1.4 Table for Permissive Change

This product is an extension of original one reported under Sporton project number: FA132339-01.

Below is the table for the change of the product with respect to the original one.

Modifications	Performance Checking
1. Adding antenna type for WLAN 2.4GHz/5GHz: Dipole antenna (Set 12~13). 2. Adding 1 set of PIFA antenna (Set 14) for bluetooth. The antenna type is the same as the original and the gain is lower than the original report. 3. Adding 2 same PCB type antenna (Ant. 10~11) with lower gain than the original report for all EUT. 4. Adding PCB type antenna for EUT 2. 5. Adding PIFA type antenna for EUT 3.	Do not have to retest assessed.

Note: RF Exposure Evaluation of 5GHz UNII 1, UNII 3 and 2.4GHz Band are based on original test report.

1.5 Accessories

N/A

1.6 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 2.1091
- KDB 447498 D04 Interim General RF Exposure Guidance v01

The following reference test guidance is not within the scope of accreditation of TAF.

- 47 CFR Part 1.1307
- 47 CFR Part 1.1310

1.7 Testing Location

Testing Location Information		
Test Lab.：Sporton International Inc. Hsinchu Laboratory		
Hsinchu	ADD: No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)	
(TAF: 3787)	TEL: 886-3-656-9065	FAX: 886-3-656-9085
	Test site Designation No. TW3787 with FCC.	
	Conformity Assessment Body Identifier (CABID) TW3787 with ISED.	

2 Maximum Permissible Exposure

2.1 Limit of Maximum Permissible Exposure

(A) Limits for Occupational / Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm²)	Averaging Time |E|²,|H|² or S (minutes)
0.3-3.0	614	1.63	*(100)	<6
3.0-30	1842/f	4.89/f	*(900/f²)	<6
30-300	61.4	0.163	1.0	<6
300-1500	-	-	f/300	<6
1500-100,000	-	-	5	<6

(B) 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/ cm²)	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/f²)	<30
30-300	27.5	0.073	0.2	<30
300-1500	-	-	f/1500	<30
1500-100,000	-	-	1.0	<30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

2.2 MPE Calculation Method

The MPE was calculated at 20 cm to show compliance with the power density limit.

The following formula was used to calculate the Power Density:

E (V/m) = $\frac{\sqrt{30 \times P \times G}}{d}$ Power Density: *Pd* (W/m²) = $\frac{E^2}{377}$

E = Electric field (V/m)

P = RF output power (W)

G = EUT Antenna numeric gain (numeric)

d = Separation distance between radiator and human body (m)

The formula can be changed to

Pd = $\frac{30 \times P \times G}{377 \times d^2}$

2.3 MPE Exemption

Option (A): 1.1307(b)(3)(i)(A): Available maximum time-averaged power is < 1 mW

Option (B): 1.1307(b)(3)(i)(B): Device operates between 300 MHz and 6 GHz and the maximum time-averaged power or effective radiated power (ERP), whichever is greater, <= Pth.

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

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);

Option (C): 1.1307(b)(3)(i)(C): ERP is below a threshold calculated based on the distance R between the person and the antenna / radiating structure, where R > λ / 2 π.

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.
Note: R is in meters, f is in MHz.	

2.4 Calculated Result and Limit

Exposure Environment: General Population / Uncontrolled Exposure

For EUT 2 with PIFA

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2.4G;G1D	2.98	22.18	25.16	0.50	25.66	0.36813	20	0.07324	1.00000
5.2G;D1D	8.17	21.75	29.92	0.07	29.99	0.99770	20	0.19849	1.00000
5.3G;D1D	8.17	21.61	29.78	0.21	29.99	0.99770	20	0.19849	1.00000
5.6G;D1D	8.17	21.70	29.87	0.12	29.99	0.99770	20	0.19849	1.00000
5.8G;D1D	8.17	23.64	31.81	0.50	32.31	1.70216	20	0.33863	1.00000
2.4G;BT-BR	2.98	2.44	5.42	0.50	5.92	0.00391	20	0.00078	1.00000
2.4G;BT-LE	2.98	3.66	6.64	0.50	7.14	0.00518	20	0.00103	1.00000

For EUT 3 with PCB

Mode	DG (dBi)	Power (dBm)	EIRP (dBm)	Tolerance (dB)	Tune-up EIRP (dBm)	Tune-up EIRP (W)	Distance (cm)	S (mW/cm^2)	S Limit (mW/cm^2)
2.4G;D1D	6.51	21.95	28.46	0.50	28.96	0.78705	20	0.15658	1.00000
5.2G;D1D	10.53	19.41	29.94	0.05	29.99	0.99770	20	0.19849	1.00000
5.3G;D1D	10.53	19.34	29.87	0.12	29.99	0.99770	20	0.19849	1.00000
5.6G;D1D	10.53	19.39	29.92	0.07	29.99	0.99770	20	0.19849	1.00000
5.8G;D1D	10.53	23.31	33.84	0.50	34.34	2.71644	20	0.54042	1.00000
2.4G;BT-BR	6.51	2.10	8.61	0.50	9.11	0.00815	20	0.00162	1.00000
2.4G;BT-LE	6.51	3.62	10.13	0.50	10.63	0.01156	20	0.00230	1.00000

For EUT 2 with PIFA

MPE Exemption Option B						
Frequency (MHz)	R (m)	Tune-up EIRP (dBm)	Tune-up ERP (dBm)	Tune-up ERP (W)	ERP Threshold (W)	MPE Exemption
2437	0.2	25.66	23.51	0.224	3.060	Complies
2402		7.14	4.99	0.003	3.060	Complies
5745		32.31	30.16	1.038	3.060	Complies

For EUT 3 with PCB

MPE Exemption Option B						
Frequency (MHz)	R (m)	Tune-up EIRP (dBm)	Tune-up ERP (dBm)	Tune-up ERP (W)	ERP Threshold (W)	MPE Exemption
2437	0.2	28.96	26.81	0.480	3.060	Complies
2402		10.63	8.48	0.007	3.060	Complies
5745		34.34	32.19	1.656	3.060	Complies

Simultaneous Transmission Analysis Mode: WLAN 2.4GHz + WLAN 5GHz + Bluetooth

For EUT 2 with PIFA

Simultaneous Transmissions Option B							
Frequency (MHz)	R (m)	Tune-up EIRP (dBm)	Tune-up ERP (dBm)	Tune-up ERP (W)	ERP Threshold (W)	Simultaneous Transmissions	Simultaneous Transmissions Limit
2437	0.2	25.66	23.51	0.224	3.060	0.41	<= 1
2402		7.14	4.99	0.003	3.060		
5745		32.31	30.16	1.038	3.060		

For EUT 3 with PCB

Simultaneous Transmissions Option B							
Frequency (MHz)	R (m)	Tune-up EIRP (dBm)	Tune-up ERP (dBm)	Tune-up ERP (W)	ERP Threshold (W)	Simultaneous Transmissions	Simultaneous Transmissions Limit
2437	0.2	28.96	26.81	0.480	3.060	0.70	<= 1
2402		10.63	8.48	0.007	3.060		
5745		34.34	32.19	1.656	3.060		

———THE END———