Testing Laboratory 3787

RADIO EXPOSURE TEST REPORT

FCC ID	: MSQ-RTAX6100
Equipment	: AX5400 Dual Band Wi-Fi Router
Brand Name	: ASUS
Model Name	: RT-AX82U V2, RT-AX5400
Applicant	: ASUSTeK COMPUTER INC. 1F., No. 15, Lide Rd., Beitou, Taipei City 112, Taiwan
Manufacturer(1)	: Compal Networking(KunShan) CO., LTD No.520,Nan Bang RD., Economic & Technical Development Zone, KunShan,JiangSu,China
Manufacturer(2)	: Datamax Electronics (DongGuan) Co., Ltd. Niu Shan Foreign Economic Industrial Park, Dong Cheng District, Dong Guan City, Guang Dong, China
Manufacturer(3)	: ARCADYAN TECHNOLOGY (VIETNAM) CO., LTD. Land plot No. D4-5-6, Thang Long Industrial Park (Vinh Phuc), Thien Ke Commune, Binh Xuyen District, Vinh Phuc Province, Vietnam
Manufacturer(4)	: Lih Rong Electronic Enterprise Co.,Ltd. No. 486, Sec. 1, Wanshou Road, Guishan District, , Taoyuan City, Taiwan
Standard	: 47 CFR Part 2.1091

The product was received on May 30, 2022, and testing was started from May 30, 2022 and completed on Sep. 24, 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 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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Photographs of EUT v01

History of this test report

Report No.	Version	Description	Issued Date
FA231808	01	Initial issue of report	Sep. 28, 2022

Summary of Test Result

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

Declaration of Conformity:
1. The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers. It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results. 2. The measurement uncertainty please refer to report "Measurement Uncertainty".
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Reviewed by: Sam Chen

Report Producer: Vicky 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) VHT: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM)
5GHz WLAN	5150-5250 5250-5350 5470-5725 5725-5850	5180-5250 5250-5320 5500-5720 5745-5825	802.11a/n: OFDM (BPSK, QPSK, 16QAM, 64QAM) 802.11ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM) 802.11ax: OFDMA (BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM)

1.2 Antenna Information

Set	Ant.	Port		Brand	Model Name	Antenna Type	Connector	Gain (dBi)
		2.4GHz	5GHz					
1	1	2	2	PSA	RFDPA161314IMLB701	Dipole Antenna	I-PEX	Note1
	2	-	1	PSA	RFDPA161311IM5B702	Dipole Antenna	I-PEX	
	3	-	4	PSA	RFDPA161310IM5B701	Dipole Antenna	I-PEX	
	4	1	3	PSA	RFDPA161316IMLB701	Dipole Antenna	I-PEX	
2	1	2	2	PSA	RFDPA171314IMLB701	Dipole Antenna	I-PEX	Note1
	2	-	1	PSA	RFDPA171311IM5B702	Dipole Antenna	I-PEX	
	3	-	4	PSA	RFDPA171310IM5B702	Dipole Antenna	I-PEX	
	4	1	3	PSA	RFDPA171316IMLB701	Dipole Antenna	I-PEX	
3	1	2	2	PSA	RFDPA141514IMLB701	Dipole Antenna	I-PEX	Note1
	2	-	1	PSA	RFDPA141511IM5B701	Dipole Antenna	I-PEX	
	3	-	4	PSA	RFDPA141510IM5B701	Dipole Antenna	I-PEX	
	4	1	3	PSA	RFDPA141516IMLB701	Dipole Antenna	I-PEX	
4	1	2	2	WHA YU	C660-510468-A	Dipole Antenna	I-PEX	Note1
	2	-	1	WHA YU	C660-510469-A	Dipole Antenna	I-PEX	
	3	-	4	WHA YU	C660-510470-A	Dipole Antenna	I-PEX	
	4	1	3	WHA YU	C660-510471-A	Dipole Antenna	I-PEX	
5	1	2	2	WHA YU	C660-510472-A	Dipole Antenna	I-PEX	Note1
	2	-	1	WHA YU	C660-510473-A	Dipole Antenna	I-PEX	
	3	-	4	WHA YU	C660-510474-A	Dipole Antenna	I-PEX	
	4	1	3	WHA YU	C660-510475-A	Dipole Antenna	I-PEX	
6	1	2	2	WHA YU	C660-510495-A	Dipole Antenna	I-PEX	Note1
	2	-	1	WHA YU	C660-510496-A	Dipole Antenna	I-PEX	
	3	-	4	WHA YU	C660-510497-A	Dipole Antenna	I-PEX	
	4	1	3	WHA YU	C660-510498-A	Dipole Antenna	I-PEX	

Note1:

Set	Ant.	Antenna Gain (dBi)				
		2.4GHz	5GHz UNII 1	5GHz UNII 2A	5GHz UNII 2C	5GHz UNII 3
1	1	1.71	1.75	1.89	1.88	1.7
	2	-	1.93	1.93	1.92	1.95
	3	-	1.75	1.85	1.83	1.89
	4	1.63	1.92	1.88	1.9	1.87
2	1	1.7	1.74	1.74	1.82	1.68
	2	-	1.86	1.9	1.64	1.9
	3	-	1.48	1.6	1.46	1.88
	4	1.61	1.63	1.71	1.81	1.86
3	1	1.7	1.75	1.75	1.78	1.67
	2	-	1.82	1.93	1.58	1.92
	3	-	1.75	1.46	1.18	1.14
	4	1.61	1.86	1.6	1.89	1.05
4	1	1.61	1.74	1.84	1.86	1.67
	2	-	1.76	1.8	1.87	1.87
	3	-	1.66	1.72	1.69	1.84
	4	1.6	1.88	1.82	1.85	1.86
5	1	1.7	1.71	1.85	1.85	1.68
	2	-	1.68	1.73	1.8	1.85
	3	-	1.63	1.74	1.76	1.77
	4	1.62	1.67	1.74	1.79	1.85
6	1	1.59	1.72	1.82	1.84	1.66
	2	-	1.74	1.79	1.86	1.86
	3	-	1.61	1.69	1.68	1.82
	4	1.58	1.77	1.81	1.82	1.85

Note2: Directional gain information for antenna set 1

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 ;

G1 = 10 ; G2 = 10

2.4GHz G1 = 1.71 dBi; G2 = 1.63 dBi;2T1S DG = 4.68 dBi

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)= $10^{G2/20}$; NSS1(g1,2)= $10^{G3/20}$; NSS1(g1,2)= $10^{G4/20}$

gj,k =(Nss1(g1,1) + Nss1(g1,2) + Nss1(g1,3) + Nss1(g1,4))^2

DG = 10 log[(Nss1(g1,1) + Nss1(g1,2) + Nss1(g1,3) + Nss1(g1,4))^2 / N_{ANT}] => 10 log[($10^{G1/20}$ + $10^{G2/20}$ + $10^{G3/20}$ + $10^{G4/20}$)^2 / N_{ANT}]

Where ;

G1 = 10 ; G2 = 10 ; G3 = 10 ; G4 = 10 ;

5GHz Band1 G1 = 1.75 dBi; G2 = 1.93 dBi; G3 = 1.75 dBi; G4 = 1.92 dBi;4T1S DG = 7.86 dBi 4T2S=4.85

5 GHz Band2 G1 = 1.89 dBi; G2 = 1.93 dBi; G3 = 1.85 dBi; G4 = 1.88 dBi; 4T1S DG = 7.91 dBi 4T2S=4.90

5GHz Band3 G1 = 1.88 dBi; G2 = 1.92 dBi; G3 = 1.83 dBi; G4 = 1.90 dBi; 4T1S DG = 7.90 dBi 4T2S=4.89

5 GHz Band4 G1 = 1.70 dBi; G2 = 1.95 dBi; G3 = 1.89 dBi; G4 = 1.87 dBi; 4T1S DG = 7.87 dBi 4T2S=4.86

Note3: The EUT has six sets of antenna, and each set contains four antennas.

Note4: Set 1~6 are the same type antenna. Only the highest gain “set 1” antenna was selected to test and record in this report.

Note5: The above information was declared by manufacturer.

For 2.4GHz function:
For IEEE 802.11b/g/n/VHT/ax mode (2TX/2RX)
Port 1 and Port 2 can be used as transmitting/receiving antenna.
Port 1 and Port 2 could transmit/receive simultaneously.
For 5GHz function:
For IEEE 802.11a/n/ac/ax mode (2TX, 4TX/4RX)
For 2TX
Port 1 and Port 4 can be used as transmitting antenna.
Port 1 and Port 4 could transmit simultaneously.
For 4TX
Port 1, 2, 3 and Port 4 can be used as transmitting antenna.
Port 1, 2, 3 and Port 4 could transmit simultaneously.
For 4RX:
Port 1, 2, 3 and Port 4 can be used as receiving antenna.
Port 1, 2, 3 and Port 4 could receive simultaneously.

1.3 Table for Multiple Listing

The model names in the following table are all refer to the identical product.

Model Name	Description
RT-AX82U V2	All the models are identical, the difference model served as marketing strategy.
RT-AX5400	

Note 1: From the above models, model: RT-AX82U V2 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 EUT Information

EUT	Special Effects of Light Board	Description
1	V	EUT 2 is the same as EUT 1. The difference is the design of the light board and exterior of the EUT.
2	X	

Note1: From the above, EUT 1 was selected as representative model for the test and its data was recorded in this report

Note2: The above information was declared by manufacturer.

1.5 Table for EUT Supports Function

Function	Supports type
AP Router	Master
Bridge	Client without radar detection
Repeater	Master
Mesh	Master

1.6 Accessories

Accessories			
Equipment Name	**Brand Name**	**Model Name**	**Rating**
Adapter 1	DELTA	ADP-33AW Y	INPUT:100-240V~1.0A, 50-60Hz OUTPUT:19.0V, 1.75A, 33.0W
Adapter 2	DELTA	ADP-33AW Y	INPUT:100-240V~1.0A, 50-60Hz OUTPUT:19.0V, 1.75A, 33.0W
Adapter 3	PI	AD2131320	INPUT:100-240V~50-60Hz, 0.8A OUTPUT:19.0V, 1.75A, 33.0W
Adapter 4	PI	AD2131320	INPUT:100-240V~50-60Hz, 0.8A OUTPUT:19.0V, 1.75A, 33.0W
Other			
RJ-45 cable*1, non-shielded, 1.5m			

Note 1: The difference between Adapter 1 & Adapter 2 is only for labels.
Note 2: The difference between Adapter 3 & Adapter 4 is only for labels.

1.7 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

1.8 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 51 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

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	4.68	29.51	34.19	0.50	34.69	2.94442	51	0.09008	1.00000
5.2G;D1D	7.86	28.04	35.90	0.09	35.99	3.97192	51	0.12152	1.00000
5.3G;D1D	7.91	22.05	29.96	0.03	29.99	0.99770	51	0.03401	1.00000
5.6G;D1D	7.90	22.04	29.94	0.05	29.99	0.99770	51	0.03386	1.00000
5.8G;D1D	7.87	28.11	35.98	0.01	35.99	3.97192	51	0.12152	1.00000

MPE Exemption Option C							
Frequency (MHz)	λ/2π (m)	R (m)	Tune-up EIRP (dBm)	Tune-up ERP (dBm)	Tune-up ERP (W)	ERP Threshold (W)	MPE Exemption
2437	0.0196	0.51	34.69	32.54	1.795	4.994	Complies
5240	0.0091		35.99	33.84	2.421	4.994	Complies

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

Simultaneous Transmissions Option C							
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	0.51	34.69	32.54	1.795	4.994	0.84	<= 1
5240		35.99	33.84	2.421	4.994		

———THE END———