FCC Maximum Permissible RF Exposure (MPE) Estimation Report

In accordance with the requirements of

FCC 47 CFR Part 2(2.1091), ANSI/IEEE C95.1-1992 and

KDB 447498 D01

Product Name:	802.11ac WiFi Module
Trademark:	Actiontec
Model Name:	802R8822
Family Model:	N/A
Report No.:	S18122100304003
FCC ID:	LNQ802R8822

Prepared for

Actiontec Electronics Inc

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Prepared by

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TEST RESULT CERTIFICATION

Applicant's name ..... : Actiontec Electronics Inc

Address ..... : 3301 Olcott St Santa Clara, CA 95054 United States

Manufacturer's Name ..... : Actiontec Electronics Inc

Address ..... : 3301 Olcott St Santa Clara, CA 95054 United States

Product description

Product name ..... : 802.11ac WiFi Module

Trademark ..... : Actiontec

Model and/or type reference : 802R8822

Family Model ..... : N/A

Standards ..... : FCC 47 CFR Part 1(1.1310)
FCC 47 CFR Part 2(2.1091)
ANSI/IEEE C95.1-1992
KDB 447498 D01

This device described above has been tested by Shenzhen NTEK. Testing has shown that this device is capable of compliance with MPE specified in FCC 47 CFR Part 2(2.1091) and ANSI/IEEE C95.1-1992. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

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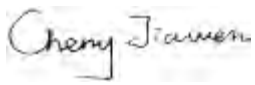
Date of Test

Date (s) of performance of tests ..... : Dec. 27, 2018 ~ Feb. 25, 2019

Date of Issue ..... : Feb. 26, 2019

Test Result ..... : **Pass**

Prepared By
(Test Engineer) : 
(Cheng Jiawen)

Approved By
(Lab Manager) : 
(Sam Chen)

※ ※ Revision History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	Feb. 26, 2019	Cheng Jiawen

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1 General Information

1.1 RF Exposure Requirements

1.1.1 RF Exposure Limits

Table - Limits For Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) 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
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
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
300-1,500			f/1500	30
1,500-100,000			1.0	30
f = frequency in MHz * = Plane-wave equivalent power density				

A rough estimation of the expected exposure in power flux density on a given point can be made with the following equation:

$$S = \frac{P_t * G_t}{4 * \pi * R^2}$$

Where:

S = Power density (mW/cm^2)
P_t = Conducted output power (dBm)
G_t = numeric gain of the antenna in the direction of interest relative to an isotropic radiator (dBi)
R= distance to the centre of radiation of the antenna (cm)
EIRP = $P_t * G_t$

The antenna of the product, under normal use condition is at least 20 cm away from the body of the user. Warning statement to the user for keeping at least 20cm separation distance and the prohibition of operating to a person has been printed on the user's manual. Therefore, the S of the device is calculated with R=20cm, and if it is below the limit S, then we can conclude the device complies with the rules.

1.1.2 Additional Description

An estimation of MPE in this application for product is used to ensure if it complies to the rules of the standard in the regulation list above.

Maximum permissible exposure (MPE) refers to the RF energy that is acceptable for human exposure. It is broken down into two categories, Occupational/controlled and General population/uncontrolled.

Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

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.

We analysis if it comply with the limits for General population/uncontrolled exposure. The FCC's MPE limits for field strength and power density are given in 47CFR 1.1310(Table below).These limits are generally based on recommended exposure guidelines published by the National Council on Radiation Protection and Measurements (NCRP), and also partly based on guidelines recommended by the American National Standards Institute (ANSI) in Section 4.1 of ANSI/IEEE C95.1.

1.2 EUT Description

Device Information			
Product Name	802.11ac WiFi Module		
Trade Name	Actiontec		
Model Name	802R8822		
Family Model	N/A		
FCC ID	LNQ802R8822		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna Type	Type 1(A(main) and B(aux)): PIFA Antenna Type 2(A(main) and B(aux)): Dipole Antenna		
Antenna Gain	Type 1 Ant A(main): 4.9dBi for WLAN2.4G and 5.6dBi for WLAN5G Type 1 Ant B(aux): 3.6dBi for WLAN2.4G and 4.4dBi for WLAN5G Type 2 Ant A(main): 1.8dBi for WLAN2.4G and 2dBi for WLAN5G Type 2 Ant B(aux): 1.8dBi for WLAN2.4G and 2dBi for WLAN5G		
Device Operating Configurations			
Supporting Mode(s)	WLAN 2.4G/5.2G/5.3G/5.6G/5.8G		
Test Modulation	WLAN(DSSS/OFDM)		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	WLAN 2.4G	2412-2462	
	WLAN 5.2G	5180-5240	
	WLAN 5.3G	5260-5320	
	WLAN 5.6G	5500-5700	
	WLAN 5.8G	5745-5825	

1.3 Test specification(s)

FCC 47 CFR Part 1(1.1310)
FCC 47 CFR Part 2(2.1091)
ANSI/IEEE C95.1-1992
KDB 447498 D01 General RF Exposure Guidance

1.4 Ambient Condition

Ambient temperature	20°C – 24℃
Relative Humidity	30% – 70%

2 RF Output Power

Test Channel	Frequency (MHz)	Peak Output Power(dBm)		Total	Tune-up (dBm)		LIMIT (dBm)	Verdict
		ANT A	ANT B	(dBm)	ANT A	ANT B		
TX 802.11b Mode								
1	2412	20.4	21.5	-	21	22	30	PASS
6	2437	20.7	21.6	-	21	22	30	PASS
11	2462	20.5	21.8	-	21	22	30	PASS
TX 802.11 g Mode								
1	2412	17.4	17.9	-	18	19	30	PASS
6	2437	18.3	19.5	-	19	20	30	PASS
11	2462	17.3	18.5	-	18	19	30	PASS
TX 802.11 n20M Mode(Single TX)								
1	2412	16.7	17.6	-	18	19	30	PASS
6	2437	17.8	18.7	-	18	19	30	PASS
11	2462	16.9	18.4	-	18	19	30	PASS
TX 802.11 n20M Mode(MIMO TX)								
1	2412	11.6	11.9	14.76	15		28.69	PASS
6	2437	16.2	18.0	20.20	21		28.69	PASS
11	2462	12.2	13.6	15.97	16		28.69	PASS
TX 802.11 n40M Mode(Single TX)								
3	2422	14.9	16.8	-	16	17	30	PASS
6	2437	18.5	16.4	-	19	17	30	PASS
9	2452	15.8	16.4	-	16	17	30	PASS
TX 802.11 n40M Mode(MIMO TX)								
3	2422	11.5	13.1	15.38	16		28.69	PASS
6	2437	17.1	18.5	20.87	21		28.69	PASS
9	2452	12.6	14.3	16.54	17		28.69	PASS

Test Channel	Frequency	Maximum output power. Antenna port AV (dBm)		Total Power	Tune-up (dBm)		LIMIT	Result
	(MHz)	ANT A	ANT B	dBm	ANT A	ANT B	dBm	
TX 802.11a Mode								
CH52	5260	16.8	16.4	-	17	17	23.98	Pass
CH56	5280	16.9	16.6	-	17	17	23.98	Pass
CH64	5320	16.0	16.1	-	17	17	23.98	Pass
TX 802.11 n20M Mode(Single TX)								
CH52	5260	17.0	16.8	-	18	18	23.98	Pass
CH56	5280	17.1	17.1	-	18	18	23.98	Pass
CH64	5320	16.6	17.2	-	18	18	23.98	Pass

TX 802.11 n20M Mode(MIMO TX)							
CH52	5260	12.0	13.0	15.54	16	21.93	Pass
CH56	5280	12.0	13.0	15.54	16	21.93	Pass
CH64	5320	11.1	12.1	14.64	16	21.93	Pass
TX 802.11 n40M Mode(Single TX)							
CH54	5270	19.5	19.0	-	20	20	23.98	Pass
CH62	5310	16.1	15.4	-	17	17	23.98	Pass
TX 802.11 n40M Mode(MIMO TX)							
CH54	5270	13.8	15.8	17.92	18	21.93	Pass
CH62	5310	14.1	15.6	17.92	18	21.93	Pass
TX 802.11 AC20M Mode(Single TX)							
CH52	5260	17.6	17.3	-	18	18	23.98	Pass
CH56	5280	17.4	17.2	-	18	18	23.98	Pass
CH64	5320	17.1	17.7	-	18	18	23.98	Pass
TX 802.11 AC20M Mode(MIMO TX)							
CH52	5260	10.8	12.8	14.92	16	21.93	Pass
CH56	5280	11.8	12.6	15.23	16	21.93	Pass
CH64	5320	11.5	12.9	15.27	16	21.93	Pass
TX 802.11 AC40M Mode(Single TX)							
CH54	5270	19.0	19.8	-	20	20	23.98	Pass
CH62	5310	15.4	15.5	-	16	16	23.98	Pass
TX 802.11 AC40M Mode(MIMO TX)							
CH54	5270	15.6	16.6	19.14	20	21.93	Pass
CH62	5310	14.5	15.7	18.15	20	21.93	Pass
TX 802.11 AC80M Mode(Single TX)							
CH58	5290	14.2	14.2	-	15	15	23.98	Pass
TX 802.11 AC80M Mode(MIMO TX)							
CH58	5290	13.6	14.2	16.92	17	21.93	Pass

Test Channel	Frequency	Maximum output power. Antenna port AV (dBm)		Total Power	Tune-up (dBm)		LIMIT	Result
	(MHz)	ANT A	ANT B	dBm	ANT A	ANT B	dBm	
TX 802.11a Mode								
CH100	5500	16.5	17.0	-	18	18	23.98	Pass
CH120	5600	17.2	17.0	-	18	18	23.98	Pass
CH140	5700	17.1	17.0	-	18	18	23.98	Pass
TX 802.11 n20M Mode(Single TX)								
CH100	5500	17.1	17.5	-	18	18	23.98	Pass
CH120	5600	17.4	18.1	-	18	19	23.98	Pass
CH140	5700	16.8	17.0	-	18	18	23.98	Pass
TX 802.11 n20M Mode(MIMO TX)								
CH100	5500	12.0	12.7	15.37	16		21.93	Pass
CH120	5600	11.4	12.1	14.77	16		21.93	Pass

CH140	5700	12.2	12.1	15.16	16	21.93	Pass
TX 802.11 n40M Mode(Single TX)							
CH102	5510	14.5	14.9	-	16	16	23.98	Pass
CH118	5590	19.2	19.1	-	20	20	23.98	Pass
CH134	5670	18.8	18.6	-	20	20	23.98	Pass
TX 802.11 n40M Mode(MIMO TX)							
CH102	5510	14.3	14.5	17.41	19	21.93	Pass
CH118	5590	14.7	15.3	18.02	19	21.93	Pass
CH134	5670	15.1	16.0	18.58	19	21.93	Pass
TX 802.11 AC20M Mode(Single TX)							
CH100	5500	17.3	17.1	-	18	18	23.98	Pass
CH120	5600	16.9	16.7	-	18	18	23.98	Pass
CH140	5700	17.4	16.1	-	18	18	23.98	Pass
TX 802.11 AC20M Mode(MIMO TX)							
CH100	5500	11.2	11.7	14.47	16	21.93	Pass
CH120	5600	11.3	12.3	14.84	16	21.93	Pass
CH140	5700	12.9	12.6	15.76	16	21.93	Pass
TX 802.11 AC40M Mode(Single TX)							
CH102	5510	13.7	15.1	-	15	16	23.98	Pass
CH118	5590	19.5	18.5	-	20	20	23.98	Pass
CH134	5670	18.6	17.8	-	19	19	23.98	Pass
TX 802.11 AC40M Mode(MIMO TX)							
CH102	5510	14.0	14.6	17.32	18	21.93	Pass
CH118	5590	15.6	15.9	18.76	19	21.93	Pass
CH134	5670	17.4	16.8	20.12	21	21.93	Pass
TX 802.11 AC80M Mode(Single TX)							
CH 106	5530	14.3	14.3	-	15	15	23.98	Pass
CH 122	5610	18.1	18.4	-	19	19	23.98	Pass
TX 802.11 AC80M Mode(MIMO TX)							
CH 106	5530	14.6	15.0	17.81	18	21.93	Pass
CH 122	5610	18.2	17.8	21.01	22	21.93	Pass

Test Channel	Frequency	Maximum output power. Antenna port AV (dBm)		Total Power	Tune-up (dBm)		LIMIT	Result
	(MHz)	ANT A	ANT B	dBm	ANT A	ANT B	dBm	
TX 802.11a Mode								
CH149	5745	17.7	17.5	-	17	17	30	Pass
CH157	5785	18.5	18.3	-	17	17	30	Pass
CH165	5825	18.8	18.6	-	17	17	30	Pass
TX 802.11 n20M Mode(Single TX)								
CH149	5745	17.6	17.5	-	18	18	30	Pass
CH157	5785	18.3	18.2	-	18	18	30	Pass
CH165	5825	17.9	18.6	-	18	18	30	Pass

TX 802.11 n20M Mode(MIMO TX)								
CH149	5745	16.9	17.0	19.96	16		27.95	Pass
CH157	5785	18.3	18.5	21.41	16		27.95	Pass
CH165	5825	18.3	18.4	21.36	16		27.95	Pass
TX 802.11 n40M Mode(Single TX)								
CH151	5755	17.1	17.6	-	20	20	30	Pass
CH159	5795	18.5	18.8	-	17	17	30	Pass
TX 802.11 n40M Mode(MIMO TX)								
CH151	5755	17.5	17.6	20.56	21		27.95	Pass
CH159	5795	18.1	18.3	21.21	22		27.95	Pass
TX 802.11 AC20M Mode(Single TX)								
CH149	5745	17.5	17.6	-	18	18	30	Pass
CH157	5785	18.2	18.2	-	18	18	30	Pass
CH165	5825	18.4	18.5	-	18	18	30	Pass
TX 802.11 AC20M Mode(MIMO TX)								
CH149	5745	17.1	17.9	20.53	21		27.95	Pass
CH157	5785	18.0	18.6	21.32	22		27.95	Pass
CH165	5825	18.5	18.8	21.66	22		27.95	Pass
TX 802.11 AC40M Mode(Single TX)								
CH151	5755	17.4	17.7	-	18	18	30	Pass
CH159	5795	18.7	18.4	-	19	19	30	Pass
TX 802.11 AC40M Mode(MIMO TX)								
CH151	5755	17.6	18.1	20.87	21		27.95	Pass
CH159	5795	18.2	18.3	21.26	22		27.95	Pass
TX 802.11 AC80M Mode(Single TX)								
CH155	5775	18.0	17.9	-	15	15	30	Pass
TX 802.11 AC80M Mode(MIMO TX)								
CH155	5775	17.5	17.9	20.71	21		27.95	Pass

3 RF Exposure Evaluation

3.1 Operation in WLAN 2.4G

SISO

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm^2)	MPE Limit (mW/cm^2)	Conclusion
Type 1 Ant A(main)	21	4.9	25.9	389.0	20	0.077	1	Pass
Type 1 Ant B(aux)	22	3.6	25.6	363.1	20	0.072	1	Pass

3.2 Operation in WLAN 5G

SISO

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm^2)	MPE Limit (mW/cm^2)	Conclusion
Type 1 Ant A(main)	20	5.6	25.6	363.1	20	0.072	1	Pass
Type 1 Ant B(aux)	20	4.4	24.4	275.4	20	0.055	1	Pass

4 Exposure calculations for multiple sources

When a number of sources at different frequencies, and/or broadband sources, contribute to the total exposure, it becomes necessary to weigh each contribution relative to the MPE in accordance with the provisions of Table (A) and Table (B). To comply with the MPE, the fraction of the MPE in terms of E^2, H^2 (or power density) incurred within each frequency interval should be determined and the sum of all such fractions should not exceed unity.

In order to ensure compliance with the MPE for a controlled environment, the sum of the ratios of the power density to the corresponding MPE should not exceed unity. That is

$$\sum_{i=1}^{n} \frac{S_i}{MPE_i}$$

The product also has multiple transmitters The Simultaneous Transmission Possibilities are as below:

Simultaneous Tx Combination	Configuration
1	WLAN 2.4G MIMO
2	WLAN 5.2G MIMO
3	WLAN 5.3G MIMO
4	WLAN 5.6G MIMO
5	WLAN 5.8G MIMO

4.1 Estimation for WLAN2.4G MIMO

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm^2)	MPE Limit (mW/cm^2)	Calculation result	Conclusion
Type 1 Ant A(main)	17.4	4.9	22.3	169.824	20	0.034	1	0.066	Pass
Type 1 Ant B(aux)	18.5	3.6	22.1	162.181	20	0.032	1		

4.2 Estimation for WLAN5G MIMO

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm^2)	MPE Limit (mW/cm^2)	Calculation result	Conclusion
Type 1 Ant A(main)	19	5.6	24.6	288.403	20	0.057	1	0.101	Pass
Type 1 Ant B(aux)	19	4.4	23.4	218.776	20	0.044	1		

According to the Table above, we can conclude that the calculation results of all simultaneous transmission possibilities are less than 1, so it is into compliance.
Therefore the product also meets the requirements under multiple sources condition.

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