

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: 802C2447

Family Model: N/A

Report No.: S18122100301003

FCC ID: LNQ802C2447

Prepared for

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TEST RESULT CERTIFICATION

Applicant's name : Actiontec Electronics Inc

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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 : 802C2447

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.

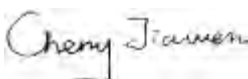
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Date of Test

Date (s) of performance of tests : 27 Dec. 2018 ~ 11 Mar. 2019

Date of Issue : 12 Mar. 2019

Test Result : **Pass**

Prepared By : 
(Test Engineer) : _____
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※ ※ Revision History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	Mar. 12, 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/cm²)

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	802C2447		
Family Model	N/A		
FCC ID	LNQ802C2447		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna Type	Ant 0: PIFA Antenna Ant 1: PIFA Antenna Ant 2: PIFA Antenna		
Antenna Gain	Ant 0: 4.7dBi for WLAN2.4G and 5.5dBi for WLAN5G Ant 1: 3.7dBi for WLAN2.4G and 5.0dBi for WLAN5G Ant 2: 3.6dBi for WLAN2.4G and 5.6dBi for WLAN5G		
Device Operating Configurations			
Supporting Mode(s)	WLAN 2.4G/5.2G/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 5.8G	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°C
Relative Humidity	30% – 70%

2 RF Output Power

Test Channel	Frequency (MHz)	Power Setting	Duty Cycle Factor (dB)	Peak Output Power(dBm)			Total	LIMIT (dBm)	Verdict
				ANT 0	ANT 1	ANT 2	(dBm)		
TX 802.11b Mode									
1	2412	Default	0	23.3	23.2	23.3	-	30	PASS
6	2437	Default	0	23.4	23.3	23.3	-	30	PASS
11	2462	Default	0	23.5	23.4	23.4	-	30	PASS
TX 802.11 g Mode									
1	2412	Default	0	18.2	18.5	18.7	-	30	PASS
6	2437	Default	0	21.1	21.2	21.0	-	30	PASS
11	2462	Default	0	18.5	18.0	17.9	-	30	PASS
TX 802.11 n20M Mode(Single TX)									
1	2412	Default	0	16.9	16.8	17.1	-	30	PASS
6	2437	Default	0	20.8	20.7	20.6	-	30	PASS
11	2462	Default	0	16.7	16.9	16.9	-	30	PASS
TX 802.11 n20M Mode(MIMO TX)									
1	2412	Default	0	13.6	13.5	14.4	18.62	27.2	PASS
6	2437	Default	0	19.8	20.1	20.2	24.81	27.2	PASS
11	2462	Default	0	11.4	11.5	12.1	16.45	27.2	PASS
TX 802.11 n40M Mode(Single TX)									
3	2422	Default	0	18.9	19.0	19.1	-	30	PASS
6	2437	Default	0	20.6	20.6	20.5	-	30	PASS
9	2452	Default	0	15.0	15.3	15.2	-	30	PASS
TX 802.11 n40M Mode(MIMO TX)									
3	2422	Default	0	15.4	14.9	15.7	20.12	27.2	PASS
6	2437	Default	0	19.4	19.4	19.8	24.31	27.2	PASS
9	2452	Default	0	10.2	10.2	10.9	15.22	27.2	PASS

Test Channel	Frequency	Maximum output power. Antenna port			Total Power	LIMIT	Result
		(AV) (dBm)			(AV)		
	(MHz)	ANT 0	ANT 1	ANT 2	dBm	dBm	
TX 802.11a Mode							
CH36	5180	17.4	17.6	18.3	-	30	Pass
CH40	5200	18.6	17.9	18.8	-	30	Pass
CH48	5240	18.4	18.2	18.7	-	30	Pass
TX 802.11 n20M Mode(Single TX)							
CH36	5180	16.6	17.1	18.4	-	30	Pass
CH40	5200	18.4	17.3	18.4	-	30	Pass
CH48	5240	18.4	18.0	18.5	-	30	Pass
TX 802.11 n40M Mode(Single TX)							
CH38	5190	15.6	15.3	15.1	-	30	Pass
CH46	5230	17.0	16.9	17.1	-	30	Pass

TX 802.11 AC20M Mode(Single TX)							
CH36	5180	16.5	17.5	18.3	-	30	Pass
CH40	5200	18.2	17.5	18.2	-	30	Pass
CH48	5240	18.3	17.7	18.2	-	30	Pass
TX 802.11 AC40M Mode(Single TX)							
CH38	5190	15.7	15.3	15.1	-	30	Pass
CH46	5230	16.5	17.1	17.1	-	30	Pass
TX 802.11 AC80M Mode(Single TX)							
CH42	5210	14.2	13.8	14.3	-	30	Pass

Test Channel	Frequency	Maximum output power. Antenna port			Total Power	LIMIT	Result
		(AV) (dBm)			(AV)		
	(MHz)	ANT 0	ANT 1	ANT 2	dBm	dBm	
TX 802.11 n20M Mode(MIMO TX)							
CH36	5180	15.9	16.0	15.1	20.46	25.66	Pass
CH40	5200	15.3	15.3	14.6	19.85	25.66	Pass
CH48	5240	15.3	16.0	14.8	20.17	25.66	Pass
TX 802.11 n40M Mode(MIMO TX)							
CH38	5190	15.8	15.1	15.2	20.15	25.66	Pass
CH46	5230	16.9	17.1	16.7	21.67	25.66	Pass
TX 802.11 AC20M Mode(MIMO TX)							
CH36	5180	14.9	14.9	14.2	19.45	25.66	Pass
CH40	5200	15.6	15.9	15.2	20.35	25.66	Pass
CH48	5240	15.5	15.6	14.7	20.06	25.66	Pass
TX 802.11 AC40M Mode(MIMO TX)							
CH38	5190	15.0	14.9	15.5	19.91	25.66	Pass
CH46	5230	16.7	17.0	16.6	21.54	25.66	Pass
TX 802.11 AC80M Mode(MIMO TX)							
CH42	5210	13.8	13.9	13.3	18.45	25.66	Pass

Test Channel	Frequency	Maximum output power. Antenna port			Total Power	LIMIT	Result
		(AV) (dBm)			(AV)		
	(MHz)	ANT 0	ANT 1	ANT 2	dBm	dBm	
TX 802.11a Mode							
CH149	5745	17.8	18.4	18.6	-	30	Pass
CH157	5785	17.9	18.1	18.5	-	30	Pass
CH165	5825	17.9	19.8	19.0	-	30	Pass
TX 802.11 n20M Mode(Single TX)							
CH149	5745	18.2	18.5	18.3	-	30	Pass
CH157	5785	17.6	18.7	18.6	-	30	Pass
CH165	5825	17.9	19.0	19.1	-	30	Pass
TX 802.11 n40M Mode(Single TX)							
CH151	5755	17.0	17.9	17.8	-	30	Pass
CH159	5795	18.0	18.2	17.5	-	30	Pass

TX 802.11 AC20M Mode(Single TX)							
CH149	5745	18.1	17.9	18.9	-	30	Pass
CH157	5785	18.0	18.0	18.6	-	30	Pass
CH165	5825	17.8	19.0	19.3	-	30	Pass
TX 802.11 AC40M Mode(Single TX)							
CH151	5755	17.3	17.5	17.9	-	30	Pass
CH159	5795	17.5	18.1	18.5	-	30	Pass
TX 802.11 AC80M Mode(Single TX)							
CH155	5775	16.7	17.4	17.7	-	30	Pass

Test Channel	Frequency	Maximum output power. Antenna port			Total Power	LIMIT	Result
		(AV) (dBm)			(AV)		
	(MHz)	ANT 0	ANT 1	ANT 2	dBm	dBm	
TX 802.11 n20M Mode(MIMO TX)							
CH149	5745	17.8	17.9	17.9	22.64	25.66	Pass
CH157	5785	18.5	18.9	19.1	23.61	25.66	Pass
CH165	5825	18.4	18.9	18.5	23.38	25.66	Pass
TX 802.11 n40M Mode(MIMO TX)							
CH151	5755	17.2	18.1	17.3	22.32	25.66	Pass
CH159	5795	17.4	17.5	17.2	22.14	25.66	Pass
TX 802.11 AC20M Mode(MIMO TX)							
CH149	5745	18.6	19.3	19.0	23.75	25.66	Pass
CH157	5785	18.4	19.0	18.9	23.55	25.66	Pass
CH165	5825	17.9	18.4	18.5	23.05	25.66	Pass
TX 802.11 AC40M Mode(MIMO TX)							
CH151	5755	17.7	17.2	18.0	22.42	25.66	Pass
CH159	5795	17.6	18.2	17.0	22.40	25.66	Pass
TX 802.11 AC80M Mode(MIMO TX)							
CH155	5775	16.5	17.2	16.9	21.65	25.66	Pass

3 RF Exposure Evaluation

3.1 Operation in WLAN 2.4G

SISO

Antenna	Maximum output power (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Ant 0	23.5	4.7	28.2	660.7	20	0.131	1	Pass
Ant 1	23.4	3.7	27.1	512.9	20	0.102	1	Pass
Ant 2	23.4	3.6	27.0	501.2	20	0.100	1	Pass

3.2 Operation in WLAN 5G

SISO

Antenna	Maximum output power (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Conclusion
Ant 0	18.6	5.5	24.1	257.0	20	0.051	1	Pass
Ant 1	19.8	5.6	25.4	346.7	20	0.069	1	Pass
Ant 2	19.3	5.6	24.9	309.0	20	0.061	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 5.8G 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
Ant 0	19.8	4.7	24.5	281.8	20	0.056	1	0.152	Pass
Ant 1	20.1	3.7	23.8	239.9	20	0.048	1		
Ant 2	20.2	3.6	23.8	239.9	20	0.048	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
Ant 0	18.6	5.5	24.1	257.0	20	0.051	1	0.169	Pass
Ant 1	19.3	5.6	24.9	309.0	20	0.061	1		
Ant 2	19.0	5.6	24.6	288.4	20	0.057	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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