

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: Multi-band Wireless Access Point

Trademark: NRadio

Model Name: N3600

Family Model: N3680, N3690, N3300, N3900, N2700, N2200,
N6800, R2000, R3000, C3000, C2000

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TEST RESULT CERTIFICATION

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Product description

Product name : Multi-band Wireless Access Point

Trademark : NRadio

Model and/or type reference : N3600

Family Model : N3680, N3690, N3300, N3900, N2700, N2200, N6800, R2000, R3000, C3000, C2000

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 : 12 Apr. 2019 ~ 17 May. 2019

Date of Issue : 22 May. 2019

Test Result : **Pass**

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※※ Revision History ※※

REV.	DESCRIPTION	ISSUED DATE	REMARK
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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	Multi-band Wireless Access Point		
Trade Name	NRadio		
Model Name	N3600		
Family Model	N3680, N3690, N3300, N3900, N2700, N2200, N6800, R2000, R3000, C3000, C2000		
FCC ID	2ATDI-N3600		
Device Phase	Identical Prototype		
Exposure Category	General population / Uncontrolled environment		
Antenna Type	PCB Antenna		
Antenna Gain	Ant A: 2dBi for WLAN2.4G and WLAN5G Ant B: 2dBi for WLAN2.4G and 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 (dBm)	LIMIT (dBm)	Verdict
				Main ANT A	Aux ANT A	Main ANT B	Aux ANT B			
802.11b										
1	2412	Default	0	15.4	16.3	-	-	-	-	30 PASS
6	2437	Default	0	15.8	16.0	-	-	-	-	30 PASS
11	2462	Default	0	-	-	15.3	15.9	-	-	30 PASS
802.11g										
1	2412	Default	0	15.9	16.1	-	-	-	-	30 PASS
6	2437	Default	0	15.8	15.9	-	-	-	-	30 PASS
11	2462	Default	0	-	-	15.2	15.9	-	-	30 PASS
802.11n HT20										
1	2412	Default	0	13.9	14.0	-	-	16.96	30	PASS
6	2437	Default	0	13.7	13.8	-	-	16.76	30	PASS
11	2462	Default	0	-	-	13.2	13.7	16.47	30	PASS
802.11n HT40										
3	2422	Default	0	13.2	13.8	-	-	16.52	30	PASS
6	2437	Default	0	13.1	13.5	-	-	16.31	30	PASS
9	2452	Default	0	-	-	13.4	13.9	16.67	30	PASS

Test Channel	Frequency (MHz)	Power Setting	Duty Cycle Factor (dB)	Peak Output Power(dBm)				Total (dBm)	LIMIT (dBm)	Verdict
				Main ANT A	Aux ANT A	Main ANT B	Aux ANT B			
802.11b										
1	2412	Default	0	15.9	16.3	-	-	-	-	30 PASS
6	2437	Default	0	15.8	16.0	-	-	-	-	30 PASS
11	2462	Default	0	-	-	15.3	15.9	-	-	30 PASS
802.11g										
1	2412	Default	0	15.4	16.1	-	-	-	-	30 PASS
6	2437	Default	0	15.8	15.9	-	-	-	-	30 PASS
11	2462	Default	0	-	-	15.2	15.9	-	-	30 PASS
802.11n HT20										
1	2412	Default	0	13.9	14.0	-	-	16.96	30	PASS
6	2437	Default	0	13.7	13.8	-	-	16.76	30	PASS
11	2462	Default	0	-	-	13.2	13.7	16.47	30	PASS
802.11n HT40										
3	2422	Default	0	13.2	13.8	-	-	16.52	30	PASS
6	2437	Default	0	13.1	13.5	-	-	16.31	30	PASS
9	2452	Default	0	-	-	13.4	13.9	16.67	30	PASS

Test Channel	Frequency	Maximum output power. Antenna port		Total Power (AV) (dBm)	LIMIT (AV)	Result
		(MHz)	Main ANT D			
	(MHz)		Aux ANT D	dBm	dBm	
TX 802.11a Mode						
CH 149	5745	15.6	15.70	—	30	Pass
CH 157	5785	15.4	15.90	—	30	Pass
CH 165	5825	15.3	16.10	—	30	Pass
TX 802.11 n20M Mode						
CH 149	5745	13.5	13.50	16.51	30	Pass
CH 157	5785	13.4	13.70	16.56	30	Pass
CH 165	5825	13.2	13.80	16.52	30	Pass
TX 802.11 n40M Mode						
CH 151	5755	13.8	13.80	16.81	30	Pass
CH 159	5795	13.5	14.10	16.82	30	Pass
TX 802.11 ac20M Mode						
CH 149	5745	13.7	13.8	16.76	30	Pass
CH 157	5785	13.3	13.5	16.41	30	Pass
CH 165	5825	13.5	13.7	16.61	30	Pass
TX 802.11 ac40M Mode						
CH 151	5755	13.9	13.7	16.81	30	Pass
CH 159	5795	13.7	13.9	16.81	30	Pass
TX 802.11 ac80M Mode						
CH 155	5775	13.7	13.7	16.71	30	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 A _{Main}	15.9	2	17.9	61.66	20	0.0123	1	Pass
Ant A _{Aux}	16.3	2	18.3	67.61	20	0.0134	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 C _{Main}	15.6	2	17.6	57.54	20	0.0114	1	Pass
Ant C _{Aux}	15.6	2	17.6	57.54	20	0.0114	1	Pass
Ant D _{Main}	15.6	2	17.6	57.54	20	0.0114	1	Pass
Ant D _{Aux}	16.1	2	18.1	64.57	20	0.0128	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 B _{Main}	12.5	2	15.29	33.81	20	0.0067	1	0.0131	Pass
Ant B _{Aux}	12.3	2	15.09	32.28	20	0.0064	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 C _{Main}	13.9	2	15.9	44.16	20	0.0077	1	0.0153	Pass
Ant C _{Aux}	13.8	2	15.8	42.17	20	0.0076	1		
Ant D _{Main}	13.9	2	15.9	44.16	20	0.0077	1	0.0154	Pass
Ant D _{Aux}	13.9	2	15.9	44.16	20	0.0077	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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