



## FCC ID: ZNPWD-R1200U

### RF EXPOSURE EVALUATION

#### 1. Introduction

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency(RF) Radiation as specified in §1.1307(b), a device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 cm is normally maintained between the transmitting antenna and the body of the user or nearby persons. In this context, the term “fixed location” means that the device is physically secured at one location and is not able to be easily moved to another location. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal computer, are considered to be mobile devices if they meet the 20 cm separation requirement. The limits to be used for MPE evaluation are specified in §1.1310. All unlicensed personal communications service (PCS) devices and unlicensed NII devices shall be subject to the limits for general population/uncontrolled exposure.

#### 2.RF Radiation Exposure Limits

According to 47 CFR §1.1310, the criteria listed in below table shall be used to evaluate the environmental impact of human exposure to RF radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093.

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (min)
(A) Limits for Occupational / Controlled Exposures				
0.3 – 3.0	614	1.63	100	6
3.0 – 30	1842/f	4.89/f	900/f <sup>2</sup>	6
30 – 300	61.4	0.163	1.0	6
300 – 1500	-	-	f/300	6
1500 – 100000	-	-	5	6
(B) Limits for General Population / Uncontrolled Exposures				
0.3 – 1.34	614	1.63	100	30
1.34 – 30	824/f	2.19/f	180/f <sup>2</sup>	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	-	-	f/1500	30
1500 – 100000	-	-	1.0	30

#### Limits for maximum permissible exposure (MPE)

Notes: 1. f = frequency in MHz 2. 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 they are made aware of the potential for exposure. 3. 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.



### 3.MPE Assessment Method

Calculations can be made to predict RF field strength and power density levels around typical RF sources. For example, in the case of a single radiating antenna, a prediction for power density in the far-field of the antenna can be made by use of the general Equations below. This equation is generally accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction.

$$\text{Power Density (S)} = \frac{PG}{4\pi R^2} = \frac{\text{EIRP}}{4\pi R^2}$$

Where

S = Power Density, unit in mW/cm<sup>2</sup>

P = Power input to the antenna, unit in mW

G = Power gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna, unit in cm

EIRP = Effective isotropically radiated power

### 4. MPE Calculation for Standalone Operations

Operation Frequency: 2412-2462MHz, 5180-5240MHz, 5745-5825MHz

Power density limited: 1mW/ cm<sup>2</sup>

Antenna Type: Internal antenna

Antenna gain: 2dBi

R=20cm

mW=10<sup>(dBm/10)</sup>

π=3.1415926

2.4g:

	Frequency	Antenna port	Maximum Conducted Output Power(PK)	Total Conducted Output Power(PK)	LIMIT
	(MHz)		(dBm)	(dBm)	dBm
802.11b	2412	Ant.1	13.85	N/A	30
		Ant.2	13.55		
	2437	Ant.1	13.63	N/A	30
		Ant.2	13.45		
	2462	Ant.1	13.57	N/A	30
		Ant.2	13.51		
802.11g	2412	Ant.1	13.86	N/A	30
		Ant.2	13.48		
	2437	Ant.1	13.69	N/A	30
		Ant.2	13.37		
	2462	Ant.1	13.35	N/A	30
		Ant.2	13.05		



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	802.11n20	2412	Ant.1	12.74	15.62	30
			Ant.2	12.48		
		2437	Ant.1	12.39	15.43	30
			Ant.2	12.45		
		2462	Ant.1	12.69	15.49	30
			Ant.2	12.25		
	802.11n40	2422	Ant.1	11.87	14.68	30
			Ant.2	11.46		
		2437	Ant.1	11.57	14.61	30
			Ant.2	11.63		
		2452	Ant.1	11.76	14.72	30
			Ant.2	11.65		

### Test Result of RF Exposure Evaluation

	Target power W/ tolerance (dBm)	Max tune up power tolerance (dBm)	Output power to antenna (mW)	Antenna Gain(dBi)	Power Density at R=20cm (mW/cm <sup>2</sup> )	Total Power Density at R=20cm (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	Result
802.11b ANT1	13±1.0	14.0	25.12	1.58 (2.0dBi)	0.00790	/	1.0	Pass
802.11b ANT2	13±1.0	14.0	25.12	1.58 (2.0dBi)	0.00790	/	1.0	Pass
802.11g ANT1	13±1.0	14.0	25.12	1.58 (2.0dBi)	0.00790	/	1.0	Pass
802.11g ANT2	13±1.0	14.0	25.12	1.58 (2.0dBi)	0.00790	/	1.0	Pass
802.11n20 MHz ANT1	12±1.0	13.0	19.95	3.17 (5.01dBi)	0.01259	0.02518	1.0	Pass
802.11n20 MHz ANT2	12±1.0	13.0	19.95	3.17 (5.01dBi)	0.01259		1.0	Pass
802.11n40 MHz ANT1	11±1.0	12.0	15.85	3.17 (5.01dBi)	0.01000	0.02000	1.0	Pass
802.11n40 MHz ANT2	11±1.0	12.0	15.85	3.17 (5.01dBi)	0.01000		1.0	Pass

Note1: Directional Gain=2dBi+10log(2)=5.01dBi

Note2: The EUT 802.11n (20) and 802.11n(40) is support MIMO mode.



5g

Test Channel	Frequency	Maximum output		Total Power	LIMIT	Result
		(PK) (dBm)		(PK)		
	(MHz)	ANT 1	ANT 2	dBm	dBm	
TX 802.11a Mode						
CH36	5180	13.72	13.68	-	23.98	Pass
CH40	5200	13.69	13.47	-	23.98	Pass
CH48	5240	13.35	13.42	-	23.98	Pass
TX 802.11 n20M Mode						
CH36	5180	13.570	13.280	16.438	23.98	Pass
CH40	5200	13.760	13.170	16.485	23.98	Pass
CH48	5240	14.080	13.070	16.615	23.98	Pass
TX 802.11 n40M Mode						
CH38	5190	13.870	13.150	16.535	23.98	Pass
CH46	5230	13.570	13.070	16.337	23.98	Pass
TX 802.11 AC20M Mode						
CH36	5180	13.840	13.270	16.575	23.98	Pass
CH40	5200	13.540	13.060	16.317	23.98	Pass
CH48	5240	13.250	13.110	16.191	23.98	Pass
TX 802.11 AC40M Mode						
CH38	5190	12.140	12.010	15.086	23.98	Pass
CH46	5230	12.110	12.100	15.115	23.98	Pass
TX 802.11 AC80M Mode						
CH42	5210	10.530	10.420	13.486	23.98	Pass

5.8g

Test Channel	Frequency	Maximum output		Total Power	LIMIT	Result
		(PK) (dBm)		(PK)		
	(MHz)	ANT 1	ANT 2	dBm	dBm	
TX 802.11a Mode						
CH 149	5745	14.15	13.36	-	30	Pass
CH 157	5785	14.29	13.11	-	30	Pass
CH 165	5825	13.38	13.37	-	30	Pass
TX 802.11 n20M Mode						
CH 149	5745	13.31	13.13	16.231	30	Pass
CH 157	5785	13.37	13.29	16.340	30	Pass
CH 165	5825	13.22	13.44	16.342	30	Pass
TX 802.11 n40M Mode						
CH 151	5755	12.28	12.14	15.221	30	Pass
CH 159	5795	12.16	12.03	15.106	30	Pass
TX 802.11 AC20M Mode						
CH 149	5745	13.14	13.05	16.106	30	Pass
CH 157	5785	13.21	13.09	16.161	30	Pass
CH 165	5825	13.22	13.15	16.195	30	Pass
TX 802.11 AC40M Mode						
CH 151	5755	11.58	11.25	14.428	30	Pass
CH 159	5795	11.34	11.28	14.320	30	Pass
TX 802.11 AC80M Mode						
CH 155	5775	10.02	10.1	13.070	30	Pass



## Test Result of RF Exposure Evaluation

5g:

	Target power W/ tolerance (dBm)	Max tune up power tolerance (dBm)	Output power to antenna (mW)	Antenna Gain(dBi)	Power Density at R=20cm (mW/cm <sup>2</sup> )	Total Power Density at R=20cm (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	Result
802.11a ANT1	13±1.0	14.0	25.12	1.58 (2.0dBi)	0.00790	/	1.0	Pass
802.11a ANT2	13±1.0	14.0	25.12	1.58 (2.0dBi)	0.00790	/	1.0	Pass
802.11n 20MHz ANT1	14±1.0	15.0	31.62	3.17 (5.01dBi)	0.01994	0.03988	1.0	Pass
802.11n 20MHz ANT2	14±1.0	15.0	31.62	3.17 (5.01dBi)	0.01994		1.0	Pass
802.11n 40MHz ANT1	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584	0.03168	1.0	Pass
802.11n 40MHz ANT2	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584		1.0	Pass
802.11ac 20MHz ANT1	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584	0.03168	1.0	Pass
802.11ac 20MHz ANT2	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584		1.0	Pass
802.11ac 40MHz ANT1	12±1.0	13.0	19.95	3.17 (5.01dBi)	0.01259	0.02518	1.0	Pass
802.11ac 40MHz ANT2	12±1.0	13.0	19.95	3.17 (5.01dBi)	0.01259		1.0	Pass
802.11ac 80MHz ANT1	10±1.0	11.0	12.59	3.17 (5.01dBi)	0.00794	0.01588	1.0	Pass
802.11ac 80MHz ANT2	10±1.0	11.0	12.59	3.17 (5.01dBi)	0.00794		1.0	Pass

5.8g

	Target power W/ tolerance (dBm)	Max tune up power tolerance (dBm)	Output power to antenna (mW)	Antenna Gain(dBi)	Power Density at R=20cm (mW/cm <sup>2</sup> )	Total Power Density at R=20cm (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	Result
802.11a ANT1	14±1.0	15.0	31.62	1.58 (2.0dBi)	0.00994	/	1.0	Pass
802.11a ANT2	14±1.0	15.0	31.62	1.58 (2.0dBi)	0.00994	/	1.0	Pass
802.11n 20MHz ANT1	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584	0.03168	1.0	Pass
802.11n 20MHz ANT2	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584		1.0	Pass
802.11n 40MHz ANT1	12±1.0	13.0	19.95	3.17 (5.01dBi)	0.01259	0.0518	1.0	Pass
802.11n 40MHz ANT2	12±1.0	13.0	19.95	3.17 (5.01dBi)	0.01259		1.0	Pass
802.11ac 20MHz ANT1	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584	0.03168	1.0	Pass
802.11ac 20MHz ANT2	13±1.0	14.0	25.12	3.17 (5.01dBi)	0.01584		1.0	Pass
802.11ac 40MHz ANT1	11±1.0	12.0	15.85	3.17 (5.01dBi)	0.01000	0.02000	1.0	Pass
802.11ac 40MHz ANT2	11±1.0	12.0	15.85	3.17 (5.01dBi)	0.01000		1.0	Pass
802.11ac 80MHz ANT1	10±1.0	11.0	12.59	3.17 (5.01dBi)	0.00794	0.01588	1.0	Pass
802.11ac 80MHz ANT2	10±1.0	11.0	12.59	3.17 (5.01dBi)	0.00794		1.0	Pass

Note1: Directional Gain=2dBi+10log(2)=5.01dBi

Note2: The EUT 802.11n (20), 802.11n(40) and 802.11ac (20), 802.11ac (40), 802.11ac (80)is support MIMO mode.



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### Simultaneous emission

Power density Limits (mW/cm <sup>2</sup> ) 2.4G WIFI	Power density Limits (mW/cm <sup>2</sup> ) 5G WIFI	Power density Limits (mW/cm <sup>2</sup> ) 5.8G WIFI	Calculate Evaluation result (mW/cm <sup>2</sup> )	Power density Limits (mW/cm <sup>2</sup> )
0.02518	0.03988	0.03168	0.09674	1

### Conclusion:

For the max result :  $0.09674 \leq 1.0$ , compliance with FCC's RF Exposure.

Summary: Since the ERP (effective radiated power) operated at  $< 1.5$  GHz is less than 1.5 watts and  $> 1.5$  GHz is less than 3 watts, the routine environmental evaluation is not required, and the MPE result calculated for this device complies with the MPE limit as specified in 47 CFR §1.1310.