

RF Exposure evaluation

FCC ID: T58N3R

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

1. Reference

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission’s guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

447498 D01 General RF Exposure Guidance v06: RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices

2. Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
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 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 30	824/f	2.19/f	(180/f ²)*	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	/	/	f/1500	30
1500 – 100,000	/	/	1.0	30

F=frequency in MHz

*=Plane-wave equivalent power density

3. MPE Calculation Method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S=PG/4\pi R^2$$

Where: S=power density

P=power input to antenna

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

4. Antenna Information

N3 can only use antennas certificated as follows provided by manufacturer.

Internal Identification	Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Directional gain:
WIFI ANT 1	FPC antenna	2.4GHz – 2.5 GHz 5.1GHz – 5.8 GHz	5.00dBi	8.01dBi
WIFI ANT 2	FPC antenna	2.4GHz – 2.5 GHz 5.1GHz – 5.8 GHz	5.00dBi	

5. Conducted power

[2.4GHz WLAN SISO Mode]

Mode	Channel	Frequency	Peak Conducted Output Power (dBm)		Tune_Up	
			Antenna1	Antenna2	Antenna1	Antenna2
<i>IEEE 802.11b</i>	1	2412	17.06	16.54	17±1	17±1
	7	2437	16.16	16.74	17±1	17±1
	13	2462	17.40	17.06	17±1	17±1
<i>IEEE 802.11g</i>	1	2412	19.24	19.04	19±1	19±1
	7	2437	19.50	19.16	19±1	19±1
	13	2462	19.71	19.57	19±1	19±1
<i>IEEE 802.11n HT20</i>	1	2412	18.90	18.87	19±1	19±1
	7	2437	19.25	19.09	19±1	19±1
	13	2462	19.49	19.33	19±1	19±1
<i>IEEE 802.11n HT40</i>	3	2422	18.56	18.42	19±1	19±1
	7	2437	18.74	18.50	19±1	19±1
	11	2452	18.90	18.67	19±1	19±1

[2.4GHz WLAN MIMO Mode]

Mode	Channel	Frequency	Peak Conducted Output Power (dBm)		Tune_Up	
			Antenna1	Antenna2	Antenna1	Antenna2
<i>IEEE 802.11n HT20</i>	1	2412	18.51	18.51	18±1	18±1
	7	2437	18.70	18.58	18±1	18±1
	13	2462	18.83	18.87	18±1	18±1
<i>IEEE 802.11n HT40</i>	3	2422	18.26	17.60	18±1	18±1
	7	2437	18.45	17.85	18±1	18±1
	11	2452	18.30	18.04	18±1	18±1

[5GHz WLAN Band 1 SISO Mode]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)		Tune_Up	
			Antenna1	Antenna2	Antenna1	Antenna2
IEEE 802.11a	36	5180	13.78	14.45	14.5±1	14.5±1
	40	5200	14.06	14.72	14.5±1	14.5±1
	48	5240	14.62	15.42	14.5±1	14.5±1
IEEE 802.11n HT20	36	5180	13.83	14.57	14.5±1	14.5±1
	40	5200	14.08	14.71	14.5±1	14.5±1
	48	5240	14.59	15.21	14.5±1	14.5±1
IEEE 802.11n HT40	38	5190	13.73	14.37	14±1	14±1
	46	5230	14.12	14.74	14±1	14±1
IEEE 802.11ac VHT20	36	5180	13.84	14.53	14.5±1	14.5±1
	40	5200	14.10	14.72	14.5±1	14.5±1
	48	5240	14.61	15.26	14.5±1	14.5±1
IEEE 802.11ac VHT40	38	5190	13.69	14.14	14±1	14±1
	46	5230	14.03	14.51	14±1	14±1
IEEE 802.11ac VHT80	42	5210	11.78	13.01	12.5±1	12.5±1

[5GHz WLAN Band 1 MIMO Mode]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)		Tune_Up	
			Antenna1	Antenna2	Antenna1	Antenna2
IEEE 802.11n HT20	36	5180	12.38	12.78	12.5±1	12.5±1
	40	5200	12.35	12.87	12.5±1	12.5±1
	48	5240	12.82	13.36	12.5±1	12.5±1
IEEE 802.11n HT40	38	5190	11.85	12.80	12.5±1	12.5±1
	46	5230	12.24	13.09	12.5±1	12.5±1
IEEE 802.11ac VHT20	36	5180	11.64	13.07	12.5±1	12.5±1
	40	5200	11.96	12.92	12.5±1	12.5±1
	48	5240	12.65	13.22	12.5±1	12.5±1
IEEE 802.11ac VHT40	38	5190	12.37	12.66	12.5±1	12.5±1

	46	5230	11.95	12.96	12.5±1	12.5±1
IEEE 802.11ac VHT80	42	5210	11.85	12.79	12.5±1	12.5±1

[5GHz WLAN Band 3 SISO Mode]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)		Tune_Up	
			Antenna1	Antenna2	Antenna1	Antenna2
IEEE 802.11a	149	5745	13.27	13.47	14±1	14±1
	157	5785	13.77	13.83	14±1	14±1
	165	5825	14.85	14.81	14±1	14±1
IEEE 802.11n HT20	149	5745	13.24	13.35	14±1	14±1
	157	5785	13.74	13.77	14±1	14±1
	165	5825	14.89	14.78	14±1	14±1
IEEE 802.11n HT40	151	5755	13.51	13.52	13±1	13±1
	159	5795	13.90	12.43	13±1	13±1
IEEE 802.11ac VHT20	149	5745	13.28	13.32	14±1	14±1
	157	5785	13.74	13.49	14±1	14±1
	165	5825	14.87	14.36	14±1	14±1
IEEE 802.11ac VHT40	151	5755	13.38	13.31	13±1	13±1
	159	5795	13.80	13.51	13±1	13±1
IEEE 802.11ac VHT80	155	5775	13.38	13.34	13±1	13±1

[5GHz WLAN Band 3 MIMO Mode]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)		Tune_Up	
			Antenna1	Antenna2	Antenna1	Antenna2
IEEE 802.11n HT20	149	5745	11.57	11.47	12±1	12±1
	157	5785	11.99	11.83	12±1	12±1
	165	5825	13.09	13.04	12.5±1	12.5±1
IEEE 802.11n HT40	151	5755	11.69	11.87	12±1	12±1
	159	5795	12.04	12.04	12.5±1	12.5±1
IEEE 802.11ac VHT20	149	5745	11.33	11.88	12±1	12±1
	157	5785	12.03	12.03	12±1	12±1
	165	5825	12.86	13.34	12.5±1	12.5±1
IEEE 802.11ac VHT40	151	5755	11.31	12.15	12±1	12±1
	159	5795	11.95	11.82	12.5±1	12.5±1
IEEE 802.11ac VHT80	155	5775	11.62	11.55	12.5±1	12.5±1

6. Standalone MPE Result

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r=20\text{cm}$, as well as the gain of the used antenna, the RF power density can be obtained.

2.4GHz WLAN SISO MODE ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	18.00	63.0957	5.00	3.1623	0.0397	1.0000
IEEE 802.11g	20.00	100.0000	5.00	3.1623	0.0629	1.0000
IEEE 802.11n HT20	20.00	100.0000	5.00	3.1623	0.0629	1.0000
IEEE 802.11n HT40	20.00	100.0000	5.00	3.1623	0.0629	1.0000

2.4GHz WLAN SISO MODE ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	18.00	63.0957	5.00	3.1623	0.0397	1.0000
IEEE 802.11g	20.00	100.0000	5.00	3.1623	0.0629	1.0000
IEEE 802.11n HT20	20.00	100.0000	5.00	3.1623	0.0629	1.0000
IEEE 802.11n HT40	20.00	100.0000	5.00	3.1623	0.0629	1.0000

2.4GHz WLAN MIMO MODE ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11n HT20	19.00	79.4328	5.00	3.1623	0.0500	1.0000
IEEE 802.11n HT40	19.00	79.4328	5.00	3.1623	0.0500	1.0000

2.4GHz WLAN MIMO MODE ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11n HT20	19.00	79.4328	5.00	3.1623	0.0500	1.0000
IEEE 802.11n HT40	19.00	79.4328	5.00	3.1623	0.0500	1.0000

5GHz WLAN Band 1 SISO MODE ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	15.50	35.4813	5.00	3.1623	0.0223	1.0000
IEEE 802.11n HT20	15.50	35.4813	5.00	3.1623	0.0223	1.0000
IEEE 802.11n HT40	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11ac VHT20	15.50	35.4813	5.00	3.1623	0.0223	1.0000
IEEE 802.11ac VHT40	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11ac VHT80	13.50	22.3872	5.00	3.1623	0.0141	1.0000

5GHz WLAN Band 1 SISO MODE ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	15.50	35.4813	5.00	3.1623	0.0223	1.0000
IEEE 802.11n HT20	15.50	35.4813	5.00	3.1623	0.0223	1.0000
IEEE 802.11n HT40	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11ac VHT20	15.50	35.4813	5.00	3.1623	0.0223	1.0000
IEEE 802.11ac VHT40	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11ac VHT80	13.50	22.3872	5.00	3.1623	0.0141	1.0000

5GHz WLAN Band 1 MIMO MODE ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11n HT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11n HT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT80	13.50	22.3872	5.00	3.1623	0.0141	1.0000

5GHz WLAN Band 1 MIMO MODE ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11n HT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11n HT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT80	13.50	22.3872	5.00	3.1623	0.0141	1.0000

5GHz WLAN Band 3 SISO MODE ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11n HT20	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11n HT40	14.00	25.1189	5.00	3.1623	0.0158	1.0000
IEEE 802.11ac VHT20	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11ac VHT40	14.00	25.1189	5.00	3.1623	0.0158	1.0000
IEEE 802.11ac VHT80	14.00	25.1189	5.00	3.1623	0.0158	1.0000

5GHz WLAN Band 3 SISO MODE ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11n HT20	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11n HT40	14.00	25.1189	5.00	3.1623	0.0158	1.0000
IEEE 802.11ac VHT20	15.00	31.6228	5.00	3.1623	0.0199	1.0000
IEEE 802.11ac VHT40	14.00	25.1189	5.00	3.1623	0.0158	1.0000
IEEE 802.11ac VHT80	14.00	25.1189	5.00	3.1623	0.0158	1.0000

5GHz WLAN Band 3 MIMO MODE ANT1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11n HT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11n HT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT80	13.50	22.3872	5.00	3.1623	0.0141	1.0000

5GHz WLAN Band 3 MIMO MODE ANT2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11n HT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11n HT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT20	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT40	13.50	22.3872	5.00	3.1623	0.0141	1.0000
IEEE 802.11ac VHT80	13.50	22.3872	5.00	3.1623	0.0141	1.0000

Remark: Output power including turn-up tolerance.

7. Summary simultaneous transmission information

Synchronization transmitting between WIFI ANT1 and ANT2

Modulation Type	Work Frequency Band	Transmit Antenna		Synchronization transmitting
		Ant1	Ant2	
IEEE 802.11a	5.8G/5.2GHz	Yes	Yes	No
IEEE 802.11b	2.4GHz	Yes	Yes	No
IEEE 802.11g	2.4GHz	Yes	Yes	No
IEEE 802.11n HT20	2.4GHz	Yes	Yes	Yes
IEEE 802.11n HT20	5.8G/5.2GHz	Yes	Yes	Yes
IEEE 802.11n HT40	2.4GHz	Yes	Yes	Yes
IEEE 802.11n HT40	5.8G/5.2GHz	Yes	Yes	Yes
IEEE 802.11ac VHT20	5.8G/5.2GHz	Yes	Yes	Yes
IEEE 802.11ac VHT40	5.8G/5.2GHz	Yes	Yes	Yes
IEEE 802.11ac VHT80	5.8G/5.2GHz	Yes	Yes	Yes

Synchronization transmitting between WIFI 2.4GHz and 5.8G/5.2GHz

Work Frequency Band	Synchronization transmitting
2.4GHz + 5.8G/5.2GHz	Yes

8. Summary simultaneous transmission results

Ant1 and Ant2 for 2.4GWLAN

Modulation Type	MPE _{Ant1} (mW/cm ²)	MPE _{Ant2} (mW/cm ²)	ΣMPE ratios	Limit	Results
IEEE 802.11n HT20	0.0500	0.0500	0.1000	1.0	PASS
IEEE 802.11n HT40	0.0500	0.0500	0.1000	1.0	PASS

Ant1 and Ant2 for 5GWLAN Band 1

Modulation Type	MPE _{Ant1} (mW/cm ²)	MPE _{Ant2} (mW/cm ²)	ΣMPE ratios	Limit	Results
IEEE 802.11n HT20	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11ac VHT20	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11n HT40	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11ac VHT40	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11ac VHT80	0.0141	0.0141	0.0282	1.0	PASS

Ant1 and Ant2 for 5GWLAN Band 3

Modulation Type	MPE _{Ant1} (mW/cm ²)	MPE _{Ant2} (mW/cm ²)	ΣMPE ratios	Limit	Results
IEEE 802.11n HT20	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11ac VHT20	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11n HT40	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11ac VHT40	0.0141	0.0141	0.0282	1.0	PASS
IEEE 802.11ac VHT80	0.0141	0.0141	0.0282	1.0	PASS

2.4GWLAN+5GWLAN

Max. MPE _{2.4G WLAN} (mW/cm ²)	Max. MPE _{5G WLAN} (mW/cm ²)	ΣMPE ratios	Limit	Results
0.1000	0.0282	0.1282	1.0	PASS

Note: Σ MPE ratio =MPE1/Limit1+MPE2/Limit2

9. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

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