

RF Exposure evaluation

FCC ID: SMC-U2

Exposure category: General population/uncontrolled environment

EUT Type: Mobile Device

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.

KDB447498 D01: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies

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

$$S = \frac{PG}{4\pi R^2}$$

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

Internal Identification	Antenna Identification in Internal photos	Antenna type and antenna number	Operate frequency band	Maximum antenna gain
Antenna 1	2.4G/5G Wifi Chain 0	Integral Antenna	2.4GHz – 2.5 GHz	2 dBi
			5.1GHz – 5.8 GHz	2 dBi
Antenna 2	2.4G/5G Wifi Chain 1	Integral Antenna	2.4GHz – 2.5 GHz	2 dBi
			5.1GHz – 5.8 GHz	2 dBi
Antenna 3	BT	Ceramic Antenna	2.4GHz – 2.5 GHz	1 dBi

5. Conducted power

Bluetooth

Mode	Channel	Frequency(MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	3.97
	39	2441	4.67
	78	2480	4.85
$\pi/4$ DQPSK	0	2402	6.49
	39	2441	7.18
	78	2480	7.3
8-DPSK	0	2402	6.77
	39	2441	7.43
	78	2480	7.57
BLE 1M	0	2402	3.87
	19	2440	4.56
	39	2480	4.72
BLE 2M	0	2402	3.88
	19	2440	4.58
	39	2480	4.76

[2.4GHz WLAN]

Mode	Channel	Frequency	Peak Conducted Output Power (dBm)	
			Antenna1	Antenna2
<i>IEEE 802.11b</i>	1	2412	22.57	23.57
	6	2437	22.92	23.66
	11	2462	23.17	23.82
<i>IEEE 802.11g</i>	1	2412	24.88	23.51
	6	2437	24.96	23.65
	11	2462	24.93	23.83
<i>IEEE 802.11n HT20</i>	1	2412	23.84	22.43
	6	2437	22.72	22.47
	11	2462	22.76	22.64
<i>IEEE 802.11n HT40</i>	3	2422	20.87	19.61
	6	2437	20.80	19.46
	9	2452	20.69	19.49

[5GHz U-NII-1]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)	
			Antenna1	Antenna2
IEEE 802.11a	36	5180	12.31	14.76
	40	5200	12.78	15.42
	48	5240	13.28	15.40
IEEE 802.11n HT20	36	5180	16.80	13.64
	40	5200	11.25	14.33
	48	5240	17.76	14.43
IEEE 802.11ac VHT20	36	5180	12.31	13.67
	40	5200	12.63	14.30
	48	5240	13.14	14.40
IEEE 802.11n HT40	38	5190	16.32	13.71
	46	5230	12.73	13.95
IEEE 802.11ac VHT40	38	5190	11.67	13.72
	46	5230	11.99	14.02
IEEE 802.11ac VHT80	42	5210	10.47	14.98

[5GHz U-NII-3]

Mode	Channel	Frequency	Average Conducted Output Power (dBm)	
			Antenna1	Antenna2
			IEEE 802.11a	149
157	5785	11.66		15.72
165	5825	12.50		17.77
IEEE 802.11n HT20	149	5745	10.20	13.88
	157	5785	10.52	14.61
	165	5825	11.36	16.55
IEEE 802.11ac VHT20	149	5745	10.48	14.52
	157	5785	9.94	14.64
	165	5825	11.82	16.59
IEEE 802.11n HT40	151	5755	10.71	13.95
	159	5795	10.85	14.42
IEEE 802.11ac VHT40	151	5755	9.86	14.00
	159	5795	10.04	14.45
IEEE 802.11ac VHT80	155	5775	8.85	12.06

6. Standalone MPE Result

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, $r = 20\text{cm}$, the RF power density can be obtained.

Bluetooth

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
GFSK	4.85	3.0549	1	1.2589	0.0008	1.0000
$\pi/4$ DQPSK	7.3	5.3703	1	1.2589	0.0013	1.0000
8-DPSK	7.57	5.7148	1	1.2589	0.0014	1.0000
BLE 1M	4.72	2.9648	1	1.2589	0.0007	1.0000
BLE 2M	4.76	2.9923	1	1.2589	0.0007	1.0000

2.4GHz WLAN

Antenna 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	23.17	207.4914	2	1.5849	0.0654	1.0000
IEEE 802.11g	24.96	313.3286	2	1.5849	0.0988	1.0000
IEEE 802.11n HT20	23.84	242.1029	2	1.5849	0.0763	1.0000
IEEE 802.11n HT40	20.87	122.1800	2	1.5849	0.0385	1.0000

Antenna 2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11b	23.82	240.9905	2	1.5849	0.0760	1.0000
IEEE 802.11g	23.83	241.5461	2	1.5849	0.0762	1.0000
IEEE 802.11n HT20	22.64	183.6538	2	1.5849	0.0579	1.0000
IEEE 802.11n HT40	19.49	88.9201	2	1.5849	0.0280	1.0000

5GHz U-NII-1

Antenna 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	13.28	21.2814	2	1.5849	0.0067	1.0000
IEEE 802.11n HT20	17.76	59.7035	2	1.5849	0.0188	1.0000
IEEE 802.11ac VHT20	13.14	20.6063	2	1.5849	0.0065	1.0000
IEEE 802.11n HT40	16.32	42.8549	2	1.5849	0.0135	1.0000
IEEE 802.11ac VHT40	11.99	15.8125	2	1.5849	0.0050	1.0000
IEEE 802.11ac VHT80	10.47	11.1429	2	1.5849	0.0035	1.0000

Antenna 2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	15.42	34.8337	2	1.5849	0.0110	1.0000
IEEE 802.11n HT20	14.43	27.7332	2	1.5849	0.0087	1.0000
IEEE 802.11ac VHT20	14.40	27.5423	2	1.5849	0.0087	1.0000
IEEE 802.11n HT40	13.95	24.8313	2	1.5849	0.0078	1.0000
IEEE 802.11ac VHT40	14.02	25.2348	2	1.5849	0.0080	1.0000
IEEE 802.11ac VHT80	14.98	31.4775	2	1.5849	0.0099	1.0000

5GHz U-NII-3

Antenna 1

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	12.50	17.7828	2	1.5849	0.0056	1.0000
IEEE 802.11n HT20	11.36	13.6773	2	1.5849	0.0043	1.0000
IEEE 802.11ac VHT20	11.82	15.2055	2	1.5849	0.0048	1.0000
IEEE 802.11n HT40	10.85	12.1619	2	1.5849	0.0038	1.0000
IEEE 802.11ac VHT40	10.04	10.0925	2	1.5849	0.0032	1.0000
IEEE 802.11ac VHT80	8.85	7.6736	2	1.5849	0.0024	1.0000

Antenna 2

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW				
IEEE 802.11a	17.77	59.8412	2	1.5849	0.0189	1.0000
IEEE 802.11n HT20	16.55	45.1856	2	1.5849	0.0142	1.0000
IEEE 802.11ac VHT20	16.59	45.6037	2	1.5849	0.0144	1.0000
IEEE 802.11n HT40	14.42	27.6694	2	1.5849	0.0087	1.0000
IEEE 802.11ac VHT40	14.45	27.8612	2	1.5849	0.0088	1.0000
IEEE 802.11ac VHT80	12.06	16.0694	2	1.5849	0.0051	1.0000

Remark:

1. MPE evaluate distance is 20cm from user manual provide by manufacturer.

7. Summary simultaneous transmission information

Synchronization transmit between WIFI Ant1 and Ant2

Modulation Type	Work Frequency Band	Transmit Antenna		Antenna 1 Antenna 2 Synchronization transmit
		Antenna 1	Antenna 2	
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	5.8G/5.2GHz	Yes	Yes	Yes

VHT40				
IEEE 802.11ac VHT80	5.8G/5.2GHz	Yes	Yes	Yes

Synchronization transmit between WIFI and BT

Modulation Type	Modulation Type	Synchronization transmit
IEEE 802.11a	BT	Yes
IEEE 802.11b	BT	Yes
IEEE 802.11g	BT	Yes
IEEE 802.11n HT20	BT	Yes
IEEE 802.11n HT20	BT	Yes
IEEE 802.11n HT40	BT	Yes
IEEE 802.11n HT40	BT	Yes
IEEE 802.11ac VHT20	BT	Yes
IEEE 802.11ac VHT40	BT	Yes
IEEE 802.11ac VHT80	BT	Yes

8. Summary simultaneous transmission results

Antenna 1 and Antenna 2 for 2.4G WLAN

Modulation Type	MPE _{Antenna1} (mW/cm ²)	MPE _{Antenna2} (mW/cm ²)	ΣMPE ratios	Limit	Results
IEEE 802.11n HT20(2412MHz)	0.0763	0.0552	0.1315	1.0	PASS
IEEE 802.11n HT40 (2422MHz)	0.0385	0.0288	0.0673	1.0	PASS

Antenna 1 and Antenna 2 for 5GHz U-NII-1

Modulation Type	MPE _{Antenna1} (mW/cm ²)	MPE _{Antenna2} (mW/cm ²)	ΣMPE ratios	Limit	Results
IEEE 802.11n HT20(5240MHz)	0.0188	0.0087	0.0275	1.0	PASS
IEEE 802.11ac VHT20(5240MHz)	0.0065	0.0087	0.0152	1.0	PASS
IEEE 802.11n HT40(5190MHz)	0.0135	0.0074	0.0209	1.0	PASS
IEEE 802.11ac VHT40(5230MHz)	0.0050	0.0080	0.013	1.0	PASS
IEEE 802.11ac VHT80(5210MHz)	0.0035	0.0099	0.0134	1.0	PASS

Antenna 1 and Antenna 2 for 5GHz U-NII-3

Modulation Type	MPE Antenna1 (mW/cm ²)	MPE Antenna2 (mW/cm ²)	ΣMPE ratios	Limit	Results
IEEE 802.11n HT20(5825MHz)	0.0043	0.0142	0.0185	1.0	PASS
IEEE 802.11ac VHT20(5825MHz)	0.0048	0.0144	0.0192	1.0	PASS
IEEE 802.11n HT40(5795MHz)	0.0038	0.0087	0.0125	1.0	PASS
IEEE 802.11ac VHT40 HT40(5795MHz)	0.0032	0.0088	0.012	1.0	PASS
IEEE 802.11ac VHT80(5775MHz)	0.0024	0.0051	0.0075	1.0	PASS

Synchronization transmit between WIFI and BT

Max. ΣMPE _(wifi) (mW/cm ²)	MPE _(BT) (mW/cm ²)	ΣMPE _(WIFI+BT) ratios	Limit	Results
0.1315	0.0014	0.1329	1.0	PASS

9. Conclusion

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

-----THE END OF REPORT-----