10. RADIO FREQUENCY EXPOSURE

10.1. Limit

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

Table: Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Power Density (S) (mW/cm2)
0.3–1.34	*(100)
1.34–30	*($180/f^2$)
30–300	0.2
300–1500	f/1500
1500–100,000	1.0

F = frequency in MHz
* = Plane-wave equivalent power density

Maximum Permissible Exposure

The MPE was calculated at 20cm to show compliance with the power density limit.

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

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.

Note:

1. Manufacturer declared that the maximum antenna gain for BT is 2.5dBi(Max.)
2.4G & 5.2G Wi-Fi is 2.5dBi(max)

2. Manufacturer declared that the nearest distance between human and the EUT is 20cm.

3. Only record worst case data.

2.4GHz Band

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)	Power Tune Up (dBm)
Antenna 0	BT LE	2402	-3.624	-3.0±1.0
		2440	-3.733	-3.0±1.0
		2480	-3.941	-3.0±1.0
Antenna 0	IEEE 802.11b	2412	15.30	15.0±1.0
		2437	15.03	15.0±1.0
		2462	14.80	15.0±1.0
Antenna 1		2412	14.88	15.0±1.0
		2437	14.94	15.0±1.0
		2462	14.67	15.0±1.0
Antenna 0	IEEE 802.11g	2412	14.83	14.0±1.0
		2437	14.20	14.0±1.0
		2462	14.64	14.0±1.0
Antenna 1		2412	14.61	14.0±1.0
		2437	13.97	14.0±1.0
		2462	14.37	14.0±1.0
Antenna 0	IEEE 802.11n HT20	2412	11.77	11.0±1.0
		2437	11.28	11.0±1.0
		2462	11.62	11.0±1.0
Antenna 1		2412	11.64	11.0±1.0
		2437	11.14	11.0±1.0
		2462	11.43	11.0±1.0
Antenna 0	IEEE 802.11n HT40	2422	10.29	11.0±1.0
		2437	10.30	11.0±1.0
		2452	10.48	11.0±1.0
Antenna 1		2422	10.14	11.0±1.0
		2437	10.34	11.0±1.0
		2452	10.43	11.0±1.0

5GHz Band

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)	Power Tune Up (dBm)
Antenna 0	IEEE 802.11a	5180	14.78	15.0±1.0
		5200	14.76	15.0±1.0
		5240	**15.09**	15.0±1.0
Antenna 1		5180	14.82	15.0±1.0
		5200	14.19	15.0±1.0
		5240	14.54	15.0±1.0

Antenna 0	IEEE 802.11n HT20	5180	14.12	14.0±1.0
		5200	14.02	14.0±1.0
		5240	14.25	14.0±1.0
Antenna 1		5180	13.87	14.0±1.0
		5200	13.73	14.0±1.0
		5240	13.60	14.0±1.0
Antenna 0	IEEE 802.11n HT40	5190	14.31	14.0±1.0
		5230	14.25	14.0±1.0
Antenna 1		5190	13.97	14.0±1.0
		5230	13.71	14.0±1.0
Antenna 0	IEEE 802.11ac VHT20	5180	14.06	14.0±1.0
		5200	14.10	14.0±1.0
		5240	14.70	14.0±1.0
Antenna 1		5180	13.79	14.0±1.0
		5200	13.49	14.0±1.0
		5240	13.98	14.0±1.0
Antenna 0	IEEE 802.11ac VHT40	5190	14.27	14.0±1.0
		5230	14.23	14.0±1.0
Antenna 1		5190	13.92	14.0±1.0
		5230	14.16	14.0±1.0
Antenna 0	IEEE 802.11ac VHT80	5210	14.07	14.0±1.0
Antenna 1		5210	13.55	14.0±1.0

10.2 Test Results

Antenna 0

2.4GHz Band

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
BT LE	-2.00	0.6310	2.5	1.7783	100%	0.0002
IEEE 802.11 b	16.00	39.8107	2.5	1.7783	100%	0.0141
IEEE 802.11 g	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11 n HT20	12.00	15.8489	2.5	1.7783	100%	0.0056
IEEE 802.11 n HT40	12.00	15.8489	2.5	1.7783	100%	0.0056

5GHz Band

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
IEEE 802.11 a	16.00	39.8107	2.5	1.7783	100%	0.0141
IEEE 802.11 n HT20	15.00	31.6228	2.5	1.7783	100%	0.0112
I IEEE 802.11 n HT40	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11ac VHT20	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11ac VHT40	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11ac VHT80	15.00	31.6228	2.5	1.7783	100%	0.0112

Antenna 1

2.4GHz Band

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
IEEE 802.11 b	16.00	39.8107	2.5	1.7783	100%	0.0141
IEEE 802.11 g	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11 n HT20	12.00	15.8489	2.5	1.7783	100%	0.0056
IEEE 802.11 n HT40	12.00	15.8489	2.5	1.7783	100%	0.0056

5GHz Band

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
IEEE 802.11 a	16.00	39.8107	2.5	1.7783	100%	0.0141
IEEE 802.11 n HT20	15.00	31.6228	2.5	1.7783	100%	0.0112
I IEEE 802.11 n HT40	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11ac VHT20	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11ac VHT40	15.00	31.6228	2.5	1.7783	100%	0.0112
IEEE 802.11ac VHT80	15.00	31.6228	2.5	1.7783	100%	0.0112

Remark:

1. *Maximum average power including tune-up tolerance;*
2. *MPE use distance is 20cm from manufacturer declaration of user manual.*

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations; ∑ of MPE ratios ≤ 1.0

Mode	MPE $_{Antenna\ 0}$ (mW/cm^2)	MPE $_{Antenna\ 1}$ (mW/cm^2)	∑ MPE ratios	Limit	Results
BT LE	0.0002	N/A	N/A	1.000	Pass
IEEE 802.11b	0.0141	0.0141	N/A	1.000	Pass
IEEE 802.11g	0.0112	0.0112	N/A	1.000	Pass
IEEE 802.11n HT20	0.0056	0.0056	0.0112	1.000	Pass
IEEE 802.11n HT40	0.0056	0.0056	0.0112	1.000	Pass
IEEE 802.11a	0.0141	0.0141	N/A	1.000	Pass
IEEE 802.11n HT20	0.0112	0.0112	0.0224	1.000	Pass
IEEE 802.11n HT40	0.0112	0.0112	0.0224	1.000	Pass
IEEE 802.11ac VHT20	0.0112	0.0112	0.0224	1.000	Pass
IEEE 802.11ac VHT40	0.0112	0.0112	0.0224	1.000	Pass
IEEE 802.11ac VHT80	0.0112	0.0112	0.0224	1.000	Pass

Note: The estimation distance is 20cm

Conclusion

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