

8. RADIO FREQUENCY EXPOSURE

8.1. 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/cm ²)
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 is 4.0dBi(Max.) for 2412~2462MHz and 7.0dBi(Max.) for 5150.00~5250.00MHz/5725.00~5850.00MHz when single antenna transmits.

Because signal is correlated, the maximum antenna gain when two antennas simultaneously transmit is 7.01dBi(Max.) for 2412~2462MHz and 10.01dBi(Max.) for 5150.00~5250.00MHz/5725.00~5850.00MHz by calculating.

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

3. Only record worst case data.

8.2 Test Results

Standalone MPE

5G WIFI

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11a	Chain 0	36	13.29	13.0±1.0	25.1189	0.0501	1.0
		40	12.78	13.0±1.0	25.1189	0.0501	1.0
		48	12.90	13.0±1.0	25.1189	0.0501	1.0
		149	13.96	13.0±1.0	25.1189	0.0501	1.0
		157	13.28	13.0±1.0	25.1189	0.0501	1.0
		165	13.13	13.0±1.0	25.1189	0.0501	1.0
	Chain 1	36	13.31	13.0±1.0	25.1189	0.0501	1.0
		40	12.95	13.0±1.0	25.1189	0.0501	1.0
		48	12.86	13.0±1.0	25.1189	0.0501	1.0
		149	13.76	13.0±1.0	25.1189	0.0501	1.0
		157	13.16	13.0±1.0	25.1189	0.0501	1.0
		165	13.06	13.0±1.0	25.1189	0.0501	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11n20	Chain 0	36	13.05	13.0±1.0	25.1189	0.0501	1.0
		40	12.55	13.0±1.0	25.1189	0.0501	1.0
		48	13.23	13.0±1.0	25.1189	0.0501	1.0
		149	12.64	13.0±1.0	25.1189	0.0501	1.0
		157	12.73	13.0±1.0	25.1189	0.0501	1.0
		165	12.57	13.0±1.0	25.1189	0.0501	1.0
	Chain 1	36	13.06	13.0±1.0	25.1189	0.0501	1.0
		40	12.59	13.0±1.0	25.1189	0.0501	1.0
		48	13.20	13.0±1.0	25.1189	0.0501	1.0
		149	12.55	13.0±1.0	25.1189	0.0501	1.0
		157	12.52	13.0±1.0	25.1189	0.0501	1.0
		165	12.62	13.0±1.0	25.1189	0.0501	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11n40	Chain 0	38	13.02	13.0±1.0	25.1189	0.0501	1.0
		46	13.37	13.0±1.0	25.1189	0.0501	1.0
		151	13.50	13.0±1.0	25.1189	0.0501	1.0
		159	12.78	13.0±1.0	25.1189	0.0501	1.0
	Chain 1	38	13.15	13.0±1.0	25.1189	0.0501	1.0
		46	13.44	13.0±1.0	25.1189	0.0501	1.0
		151	13.15	13.0±1.0	25.1189	0.0501	1.0
		159	12.64	13.0±1.0	25.1189	0.0501	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11ac20	Chain 0	36	12.59	13.0±1.0	25.1189	0.0501	1.0
		40	12.89	13.0±1.0	25.1189	0.0501	1.0
		48	13.28	13.0±1.0	25.1189	0.0501	1.0
		149	12.42	13.0±1.0	25.1189	0.0501	1.0
		157	12.69	13.0±1.0	25.1189	0.0501	1.0
		165	12.60	13.0±1.0	25.1189	0.0501	1.0
	Chain 1	36	12.38	13.0±1.0	25.1189	0.0501	1.0
		40	12.63	13.0±1.0	25.1189	0.0501	1.0
		48	13.12	13.0±1.0	25.1189	0.0501	1.0
		149	12.39	13.0±1.0	25.1189	0.0501	1.0
		157	12.63	13.0±1.0	25.1189	0.0501	1.0
		165	12.43	13.0±1.0	25.1189	0.0501	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11ac40	Chain 0	38	12.55	13.0±1.0	25.1189	0.0501	1.0
		46	12.93	13.0±1.0	25.1189	0.0501	1.0
		151	13.19	13.0±1.0	25.1189	0.0501	1.0
		159	12.73	13.0±1.0	25.1189	0.0501	1.0
	Chain 1	38	12.63	13.0±1.0	25.1189	0.0501	1.0
		46	12.64	13.0±1.0	25.1189	0.0501	1.0
		151	13.10	13.0±1.0	25.1189	0.0501	1.0
		159	12.71	13.0±1.0	25.1189	0.0501	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11ac80	Chain 0	42	12.14	13.0±1.0	25.1189	0.0501	1.0
		155	13.09	13.0±1.0	25.1189	0.0501	1.0
	Chain 1	42	12.02	13.0±1.0	25.1189	0.0501	1.0
		155	13.25	13.0±1.0	25.1189	0.0501	1.0

2.4G wifi:

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11b	Chain 0	1	15.00	14.0±1.0	31.6228	0.0316	1.0
		6	14.20	14.0±1.0	31.6228	0.0316	1.0
		11	14.49	14.0±1.0	31.6228	0.0316	1.0
	Chain 1	1	14.97	14.0±1.0	31.6228	0.0316	1.0
		6	14.21	14.0±1.0	31.6228	0.0316	1.0
		11	14.45	14.0±1.0	31.6228	0.0316	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11g	Chain 0	1	13.35	13.0±1.0	25.1189	0.0251	1.0
		6	13.75	13.0±1.0	25.1189	0.0251	1.0
		11	13.53	13.0±1.0	25.1189	0.0251	1.0
	Chain 1	1	13.60	13.0±1.0	25.1189	0.0251	1.0
		6	13.86	13.0±1.0	25.1189	0.0251	1.0
		11	13.51	13.0±1.0	25.1189	0.0251	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11n20	Chain 0	1	13.49	13.0±1.0	25.1189	0.0251	1.0
		6	13.51	13.0±1.0	25.1189	0.0251	1.0
		11	13.37	13.0±1.0	25.1189	0.0251	1.0
	Chain 1	1	13.64	13.0±1.0	25.1189	0.0251	1.0
		6	13.44	13.0±1.0	25.1189	0.0251	1.0
		11	13.33	13.0±1.0	25.1189	0.0251	1.0

Test	Mode	Channel	ANT Power (dBm)	ANT Max. Tune Up Power (dBm)	ANT Max. Tune Up Power (mW)	ANT MPE (mW/cm ²)	Limit (mW/cm ²)
802.11n40	Chain 0	3	12.45	12.0±1.0	19.9526	0.0199	1.0
		6	12.88	12.0±1.0	19.9526	0.0199	1.0
		9	12.52	12.0±1.0	19.9526	0.0199	1.0
	Chain 1	3	12.34	12.0±1.0	19.9526	0.0199	1.0
		6	12.82	12.0±1.0	19.9526	0.0199	1.0
		9	12.24	12.0±1.0	19.9526	0.0199	1.0

Simultaneous transmission MPE

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

Mode	Channel No.	Frequency (MHz)	Σ MPE ratios	Limit	Results
Chain 0+Chain 1					
IEEE 802.11a	36	5180	N/A	1.000	Pass
	40	5200	N/A	1.000	Pass
	48	5240	N/A	1.000	Pass
	149	5745	N/A	1.000	Pass
	157	5785	N/A	1.000	Pass
	165	5825	N/A	1.000	Pass
IEEE 802.11n20	36	5180	0.1002	1.000	Pass
	40	5200	0.1002	1.000	Pass
	48	5240	0.1002	1.000	Pass
	149	5745	0.1002	1.000	Pass
	157	5785	0.1002	1.000	Pass
	165	5825	0.1002	1.000	Pass
IEEE 802.11n40	38	5190	0.1002	1.000	Pass
	46	5230	0.1002	1.000	Pass
	151	5755	0.1002	1.000	Pass
	159	5795	0.1002	1.000	Pass
IEEE 802.11ac20	36	5180	0.1002	1.000	Pass
	40	5200	0.1002	1.000	Pass
	48	5240	0.1002	1.000	Pass
	149	5745	0.1002	1.000	Pass
	157	5785	0.1002	1.000	Pass
	165	5825	0.1002	1.000	Pass
IEEE 802.11ac40	38	5190	0.1002	1.000	Pass
	46	5230	0.1002	1.000	Pass
	151	5755	0.1002	1.000	Pass
	159	5795	0.1002	1.000	Pass
IEEE 802.11ac80	42	5210	0.1002	1.000	Pass
	155	5775	0.1002	1.000	Pass
IEEE 802.11b	1	2412	N/A	1.000	Pass
	6	2442	N/A	1.000	Pass
	11	2462	N/A	1.000	Pass
IEEE 802.11g	1	2412	N/A	1.000	Pass
	6	2442	N/A	1.000	Pass
	11	2462	N/A	1.000	Pass
IEEE 802.11n HT20	1	2412	0.0502	1.000	Pass
	6	2442	0.0502	1.000	Pass

	11	2462	0.0502	1.000	Pass
IEEE 802.11n HT40	3	2422	0.0238	1.000	Pass
	6	2442	0.0238	1.000	Pass
	9	2452	0.0238	1.000	Pass

Mode	Channel No.	Frequency (MHz)	Σ MPE ratios	Limit	Results
Chain0(IEEE802.11b-2.4GHz)+Chain1(IEEE802.11b-2.4GHz)+Chain0(5GHz)+Chain1(5GHz)					
IEEE 802.11a+ IEEE 802.11b	36	5180	0.0817	1.000	Pass
	40	5200	0.0817	1.000	Pass
	48	5240	0.0817	1.000	Pass
	149	5745	0.0817	1.000	Pass
	157	5785	0.0817	1.000	Pass
	165	5825	0.0817	1.000	Pass
IEEE 802.11n20 IEEE 802.11b	36	5180	0.1318	1.000	Pass
	40	5200	0.1318	1.000	Pass
	48	5240	0.1318	1.000	Pass
	149	5745	0.1318	1.000	Pass
	157	5785	0.1318	1.000	Pass
	165	5825	0.1318	1.000	Pass
IEEE 802.11n40 +IEEE 802.11b	38	5190	0.1318	1.000	Pass
	46	5230	0.1318	1.000	Pass
	151	5755	0.1318	1.000	Pass
	159	5795	0.1318	1.000	Pass
IEEE 802.11ac20 + IEEE 802.11b	36	5180	0.1318	1.000	Pass
	40	5200	0.1318	1.000	Pass
	48	5240	0.1318	1.000	Pass
	149	5745	0.1318	1.000	Pass
	157	5785	0.1318	1.000	Pass
	165	5825	0.1318	1.000	Pass
IEEE 802.11ac40 + IEEE 802.11b	38	5190	0.1318	1.000	Pass
	46	5230	0.1318	1.000	Pass
	151	5755	0.1318	1.000	Pass
	159	5795	0.1318	1.000	Pass
IEEE 802.11ac80 + IEEE 802.11b	42	5210	0.1318	1.000	Pass
	155	5775	0.1318	1.000	Pass

Mode	Channel No.	Frequency (MHz)	∑ MPE ratios	Limit	Results
Chain0(IEEE802.11g-2.4GHz)+Chain1(IEEE802.11g-2.4GHz)+Chain0(5GHz)+Chain1(5GHz)					
IEEE 802.11a+ IEEE 802.11g	36	5180	0.0752	1.000	Pass
	40	5200	0.0752	1.000	Pass
	48	5240	0.0752	1.000	Pass
	149	5745	0.0752	1.000	Pass
	157	5785	0.0752	1.000	Pass
	165	5825	0.0752	1.000	Pass
IEEE 802.11n20 IEEE 802.11g	36	5180	0.1253	1.000	Pass
	40	5200	0.1253	1.000	Pass
	48	5240	0.1253	1.000	Pass
	149	5745	0.1253	1.000	Pass
	157	5785	0.1253	1.000	Pass
	165	5825	0.1253	1.000	Pass
IEEE 802.11n40 +IEEE 802.11g	38	5190	0.1253	1.000	Pass
	46	5230	0.1253	1.000	Pass
	151	5755	0.1253	1.000	Pass
	159	5795	0.1253	1.000	Pass
IEEE 802.11ac20 + IEEE 802.11g	36	5180	0.1253	1.000	Pass
	40	5200	0.1253	1.000	Pass
	48	5240	0.1253	1.000	Pass
	149	5745	0.1253	1.000	Pass
	157	5785	0.1253	1.000	Pass
	165	5825	0.1253	1.000	Pass
IEEE 802.11ac40 + IEEE 802.11g	38	5190	0.1253	1.000	Pass
	46	5230	0.1253	1.000	Pass
	151	5755	0.1253	1.000	Pass
	159	5795	0.1253	1.000	Pass
IEEE 802.11ac80 + IEEE 802.11g	42	5210	0.1253	1.000	Pass
	155	5775	0.1253	1.000	Pass

Mode	Channel No.	Frequency (MHz)	Σ MPE ratios	Limit	Results
Chain0(IEEE802.11n20-2.4GHz)+Chain1(IEEE802.11n20-2.4GHz)+Chain0(5GHz)+Chain1(5GHz)					
IEEE 802.11a +IEEE 802.11n20	36	5180	0.1003	1.000	Pass
	40	5200	0.1003	1.000	Pass
	48	5240	0.1003	1.000	Pass
	149	5745	0.1003	1.000	Pass
	157	5785	0.1003	1.000	Pass
	165	5825	0.1003	1.000	Pass
IEEE 802.11n20 +IEEE 802.11n20	36	5180	0.1504	1.000	Pass
	40	5200	0.1504	1.000	Pass
	48	5240	0.1504	1.000	Pass
	149	5745	0.1504	1.000	Pass
	157	5785	0.1504	1.000	Pass
	165	5825	0.1504	1.000	Pass
IEEE 802.11n40 + IEEE 802.11n20	38	5190	0.1504	1.000	Pass
	46	5230	0.1504	1.000	Pass
	151	5755	0.1504	1.000	Pass
	159	5795	0.1504	1.000	Pass
IEEE 802.11ac20 + IEEE 802.11n20	36	5180	0.1504	1.000	Pass
	40	5200	0.1504	1.000	Pass
	48	5240	0.1504	1.000	Pass
	149	5745	0.1504	1.000	Pass
	157	5785	0.1504	1.000	Pass
	165	5825	0.1504	1.000	Pass
IEEE 802.11ac40 + IEEE 802.11n20	38	5190	0.1504	1.000	Pass
	46	5230	0.1504	1.000	Pass
	151	5755	0.1504	1.000	Pass
	159	5795	0.1504	1.000	Pass
IEEE 802.11ac80 + IEEE 802.11n20	42	5210	0.1504	1.000	Pass
	155	5775	0.1504	1.000	Pass

Mode	Channel No.	Frequency (MHz)	Σ MPE ratios	Limit	Results
Chain0(IEEE802.11n40-2.4GHz)+Chain1(IEEE802.11n40-2.4GHz)+Chain0(5GHz)+Chain1(5GHz)					
IEEE 802.11a +IEEE 802.11n20	36	5180	0.0739	1.000	Pass
	40	5200	0.0739	1.000	Pass
	48	5240	0.0739	1.000	Pass
	149	5745	0.0739	1.000	Pass
	157	5785	0.0739	1.000	Pass
	165	5825	0.0739	1.000	Pass
IEEE 802.11n20 +IEEE 802.11n20	36	5180	0.1240	1.000	Pass
	40	5200	0.1240	1.000	Pass
	48	5240	0.1240	1.000	Pass
	149	5745	0.1240	1.000	Pass
	157	5785	0.1240	1.000	Pass
	165	5825	0.1240	1.000	Pass
IEEE 802.11n40 + IEEE 802.11n20	38	5190	0.1240	1.000	Pass
	46	5230	0.1240	1.000	Pass
	151	5755	0.1240	1.000	Pass
	159	5795	0.1240	1.000	Pass
IEEE 802.11ac20 + IEEE 802.11n20	36	5180	0.1240	1.000	Pass
	40	5200	0.1240	1.000	Pass
	48	5240	0.1240	1.000	Pass
	149	5745	0.1240	1.000	Pass
	157	5785	0.1240	1.000	Pass
	165	5825	0.1240	1.000	Pass
IEEE 802.11ac40 + IEEE 802.11n20	38	5190	0.1240	1.000	Pass
	46	5230	0.1240	1.000	Pass
	151	5755	0.1240	1.000	Pass
	159	5795	0.1240	1.000	Pass
IEEE 802.11ac80 + IEEE 802.11n20	42	5210	0.1240	1.000	Pass
	155	5775	0.1240	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.