

Maximum Permissible Exposure Report

Exposure category: General population/uncontrolled environment

EUT Type: Production Unit

Device Type: Mobile Device

Refer Standard: KDB 447498 D01 General RF Exposure Guidance v06

FCC Part 2 §2.1091

1. Evaluation Method

Systems operating under the provisions of FCC 47 CFR 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.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modelled or measured field strengths or power density, is ≤ 1.0 . The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

2. Limit

Refer Evaluation Method

[ANSI C95.1-2019](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz

[FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1091](#): Radiofrequency radiation exposure evaluation: mobile devices.

3. 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/Uncontrolled 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

4. 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

6. Conducted Power

[2.4G WIFI Max Peak Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)	ANT Max. Tune Up Power (dBm)
IEEE 802.11b	1	2412	14.89	15.0±1.0
	6	2437	15.37	15.0±1.0
	11	2462	15.09	15.0±1.0
IEEE 802.11g	1	2412	18.70	19.0±1.0
	6	2437	19.46	19.0±1.0
	11	2462	18.50	19.0±1.0
IEEE 802.11n HT20 MIMO	1	2412	19.83	20.0±1.0
	6	2437	21.27	21.0±1.0
	11	2462	20.77	21.0±1.0
IEEE 802.11n HT40 MIMO	3	2422	21.65	21.5±1.0
	6	2437	21.84	21.5±1.0
	9	2452	21.79	21.5±1.0

[5.2G WIFI Max Average Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)	ANT Max. Tune Up Power (dBm)
IEEE 802.11a	36	5180	17.72	18.0±1.0
	40	5200	17.94	18.0±1.0
	48	5240	19.83	19.0±1.0
IEEE 802.11n HT20 MIMO	36	5180	18.16	18.0±1.0
	40	5200	19.97	20.0±1.0
	48	5240	21.36	21.0±1.0

IEEE 802.11n HT40 MIMO	38	5190	19.57	19.0±1.0
	46	5230	20.68	20.0±1.0
IEEE 802.11ac HT20 MIMO	36	5180	17.55	17.0±1.0
	40	5200	18.06	18.0±1.0
	48	5240	19.13	19.0±1.0
IEEE 802.11ac HT40 MIMO	38	5190	19.04	19.0±1.0
	46	5230	19.90	20.0±1.0
IEEE 802.11ac HT80 MIMO	42	5210	20.78	21.0±1.0

[5.8G WIFI Max Average Power]

Mode	Channel	Frequency (MHz)	Max Conducted Power(dBm)	ANT Max. Tune Up Power (dBm)
IEEE 802.11a	149	5745	16.469	16.0±1.0
	157	5785	16.159	16.0±1.0
	165	5825	14.408	14.0±1.0
IEEE 802.11n HT20 MIMO	149	5745	17.57	17.0±1.0
	157	5785	17.58	17.0±1.0
	165	5825	15.99	16.0±1.0
IEEE 802.11n HT40 MIMO	151	5755	17.83	18.0±1.0
	159	5795	17.65	18.0±1.0
IEEE 802.11ac HT20 MIMO	149	5745	18.26	18.0±1.0
	157	5785	18.19	18.0±1.0
	165	5825	16.91	17.0±1.0
IEEE 802.11ac HT40 MIMO	151	5755	18.35	18.0±1.0
	159	5795	18.08	18.0±1.0
IEEE 802.11ac HT80 MIMO	155	5775	18.25	18.0±1.0

[LTE Max Average Power]

Test Mode		Channel	Max Average Power (dBm)	ANT Max. Tune Up Power (dBm)
LTE	Band 2	LCH	23.49	23.0±1.0
		MCH	23.03	23.0±1.0
		HCH	22.64	22.5±1.0
	Band 4	LCH	23.45	23.0±1.0
		MCH	23.45	23.0±1.0
		HCH	23.25	23.0±1.0
	Band 5	LCH	23.39	23.0±1.0
		MCH	23.41	23.0±1.0
		HCH	23.18	23.0±1.0
	Band 12	LCH	23.53	23.0±1.0
		MCH	22.96	23.0±1.0
		HCH	22.89	23.0±1.0
	Band 13	LCH	23.42	23.0±1.0
		MCH	23.11	23.0±1.0
		HCH	23.17	23.0±1.0
	Band 14	LCH	23.00	22.5±1.0
		MCH	22.67	22.5±1.0
		HCH	22.48	22.5±1.0

	Band 66	LCH	23.31	23.0±1.0
		MCH	23.42	23.0±1.0
		HCH	23.30	23.0±1.0
	Band 71	LCH	22.74	22.5±1.0
		MCH	23.37	23.0±1.0
		HCH	23.08	22.5±1.0

7. Measurement Results

7.1 Standalone MPE Evaluation

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 refer to antenna information, the RF power density can be obtained.

[2.4G WLAN]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE ratios
	dBm	mW					
IEEE 802.11b	16.0	39.8107	5.13	3.26	0.0258	1.0000	0.0258
IEEE 802.11g	20.0	100.0000	5.13	3.26	0.0648	1.0000	0.0648
IEEE 802.11n HT20 MIMO	22.0	158.4893	7.94	6.22	0.1962	1.0000	0.1962
IEEE 802.11n HT40 MIMO	22.5	177.8279	7.94	6.22	0.2202	1.0000	0.2202

[5.2G WLAN]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE ratios
	dBm	mW					
IEEE 802.11a	20.0	100.0000	5.46	3.52	0.0699	1.0000	0.0699
IEEE 802.11n HT20 MIMO	22.0	158.4893	8.42	6.95	0.2191	1.0000	0.2191
IEEE 802.11n HT40 MIMO	21.0	125.8925	8.42	6.95	0.1741	1.0000	0.1741
IEEE 802.11ac HT20 MIMO	20.0	100.0000	8.42	6.95	0.1383	1.0000	0.1383
IEEE 802.11ac HT40 MIMO	21.0	125.8925	8.42	6.95	0.1741	1.0000	0.1741
IEEE 802.11ac HT80 MIMO	22.0	158.4893	8.42	6.95	0.2191	1.0000	0.2191

[5.8G WLAN]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE ratios
	dBm	mW					
IEEE 802.11a	17.0	50.1187	7.31	5.38	0.0537	1.0000	0.0537
IEEE 802.11n HT20 MIMO	18.0	63.0957	9.56	9.04	0.1134	1.0000	0.1134

IEEE 802.11n HT40 MIMO	19.0	79.4328	9.56	9.04	0.1428	1.0000	0.1428
IEEE 802.11ac HT20 MIMO	19.0	79.4328	9.56	9.04	0.1428	1.0000	0.1428
IEEE 802.11ac HT40 MIMO	19.0	79.4328	9.56	9.04	0.1428	1.0000	0.1428
IEEE 802.11ac HT80 MIMO	19.0	79.4328	9.56	9.04	0.1428	1.0000	0.1428

[LTE]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)	MPE ratios
	dBm	mW					
LTE Band 2	24.0	251.1886	0.77	1.19	0.0597	0.5667	0.0597
LTE Band 4	24.0	251.1886	1.38	1.37	0.0687	1.0000	0.0687
LTE Band 5	24.0	251.1886	1.20	1.32	0.0659	1.0000	0.0659
LTE Band 12	24.0	251.1886	4.05	2.54	0.1270	0.5667	0.1270
LTE Band 13	24.0	251.1886	3.13	2.06	0.1027	1.0000	0.1027
LTE Band 14	23.5	223.8721	2.29	1.69	0.0755	1.0000	0.0755
LTE Band 66	24.0	251.1886	1.38	1.37	0.0687	1.0000	0.0687
LTE Band 71	24.0	251.1886	4.05	2.54	0.1270	1.0000	0.1270

Remark:

1. Output power including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.

8.2 Simultaneous Transmission MPE Evaluation

The sample support one 2.4GWLAN&5.2GWLAN&5.8GWLAN(MPE1) and another one LTE(MPE2) transmit antenna, so need consider simultaneous transmission;

Simultaneous transmission MPE

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

$\sum$ of MPE ratios ≤ 1.0

Mode	MPE1 Max.	MPE2 Max.	$\sum$ MPE ratios	Limit	Results
WIFI+LTE	0.2202	0.1270	0.3472	1.000	Pass

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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