



MPE 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 modeled 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. Limits for General Population/Uncontrolled Exposure

(B) Limits for General Population / Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note: f = frequency in MHz ; *Plane-wave equivalent power density

3. 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 anisotropic radiator

R=distance to the center of radiation of the antenna

From the EUT RF output power, the minimum mobile separation distance, $d=0.2\text{m}$, as well as the maximum gain of the used as following information, the RF power density can be obtained.

Frequency Band	Antenna type and antenna number	Internal Identification	Maximum antenna gain
2.4GHz	WLAN Antenna	Internal Antenna 0	4.68dBi
5GHz			6.10dBi
2.4GHz		Internal Antenna 1	3.64dBi
2.4GHz		External Antenna 2	3.98dBi
5GHz			4.82dBi
2.4GHz		External Antenna 3	3.98dBi

4. Estimation Result

4.1 Conducted Power Results

2.4GHz WIFI

Antenna	Mode	Frequency(MHz)	Peak Conducted Output Power (dBm)
Internal Antenna 0 / External Antenna 2	IEEE 802.11b	2412	14.50
		2437	14.30
		2462	13.93
	IEEE 802.11g	2412	18.16
		2437	18.71
		2462	17.62
	IEEE 802.11n HT20	2412	17.73
		2437	18.75
		2462	17.95
	IEEE 802.11n HT40	2422	17.96
		2437	17.91
		2452	17.95

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Antenna	Mode	Frequency(MHz)	Peak Conducted Output Power (dBm)
Internal Antenna 1 / External Antenna 3	IEEE 802.11b	2412	14.35
		2437	12.79
		2462	11.81
	IEEE 802.11g	2412	18.20
		2437	18.46
		2462	18.93
	IEEE 802.11n HT20	2412	17.16
		2437	17.64
		2462	17.87
	IEEE 802.11n HT40	2422	17.43
		2437	16.98
		2452	17.41

5GHz WIFI

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)
Internal Antenna 0 / External Antenna 2	IEEE 802.11a	5180	18.89
		5200	18.73
		5240	18.21
		5745	17.10
		5785	17.08
		5825	17.12
	IEEE 802.11n HT20	5180	17.12
		5200	17.96
		5240	17.36
		5745	16.12
		5785	16.47
		5825	16.02
	IEEE 802.11n HT40	5190	17.84
		5230	17.35
		5755	15.83
		5795	15.76
	IEEE 802.11ac 80	5210	6.94
		5775	7.32



4.2 Manufacturing tolerance

2.4GHz WIFI

IEEE 802.11b (Peak)						
Frequency (MHz)	Internal Antenna 0 / External Antenna 2			Internal Antenna 1/External Antenna 3		
	2412	2437	2462	2412	2437	2462
Target (dBm)	14.0	14.0	13.0	14.0	12.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11 g (Peak)						
Frequency (MHz)	Internal Antenna 0 / External Antenna 2			Internal Antenna 1/External Antenna 3		
	2412	2437	2462	2412	2437	2462
Target (dBm)	18.0	18.0	17.0	18.0	18.0	18.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11 n HT20 (Peak)						
Frequency (MHz)	Internal Antenna 0 / External Antenna 2			Internal Antenna 1/External Antenna 3		
	2412	2437	2462	2412	2437	2462
Target (dBm)	17.0	18.0	17.0	17.0	17.0	17.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11 n HT40 (Peak)						
Frequency (MHz)	Internal Antenna 0 / External Antenna 2			Internal Antenna 1/External Antenna 3		
	2412	2437	2462	2412	2437	2462
Target (dBm)	17.0	17.0	17.0	17.0	16.0	17.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

5GHz WIFI

IEEE 802.11 a (Average)						
Frequency (MHz)	5180	5200	5240	5745	5785	5825
Target (dBm)	18.0	18.0	18.0	17.0	17.0	17.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)						
Frequency (MHz)	5180	5200	5240	5745	5785	5825
Target (dBm)	17.0	17.0	17.0	16.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)						
Frequency (MHz)	5190	---	5230	5755	---	5795
Target (dBm)	17.0	---	17.0	15.0	---	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11ac 80 (Average)						
Frequency (MHz)	5210	---	---	---	---	5775
Target (dBm)	6.0	---	---	---	---	7.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0



4.3 Measurement Results

4.3.1 Standalone MPE

2.4G WLAN

Internal Antenna 0

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 b	15.00	31.6228	4.68	2.9376	100%	0.0185	1.0000
IEEE 802.11 g	19.00	79.4328	4.68	2.9376	100%	0.0464	1.0000
IEEE 802.11 n HT20	19.00	79.4328	4.68	2.9376	100%	0.0464	1.0000
IEEE 802.11 n HT40	18.00	63.0957	4.68	2.9376	100%	0.0369	1.0000

Internal Antenna 1

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 b	15.00	31.6228	3.64	2.3121	100%	0.0146	1.0000
IEEE 802.11 g	19.00	79.4328	3.64	2.3121	100%	0.0366	1.0000
IEEE 802.11 n HT20	19.00	79.4328	3.64	2.3121	100%	0.0366	1.0000
IEEE 802.11 n HT40	18.00	63.0957	3.64	2.3121	100%	0.0290	1.0000

External Antenna 2

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 b	15.00	31.6228	3.98	2.5003	100%	0.0157	1.0000
IEEE 802.11 g	19.00	79.4328	3.98	2.5003	100%	0.0395	1.0000
IEEE 802.11 n HT20	19.00	79.4328	3.98	2.5003	100%	0.0395	1.0000
IEEE 802.11 n HT40	18.00	63.0957	3.98	2.5003	100%	0.0314	1.0000

External Antenna 3

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 b	15.00	31.6228	3.98	2.5003	100%	0.0157	1.0000
IEEE 802.11 g	19.00	79.4328	3.98	2.5003	100%	0.0395	1.0000
IEEE 802.11 n HT20	19.00	79.4328	3.98	2.5003	100%	0.0395	1.0000
IEEE 802.11 n HT40	18.00	63.0957	3.98	2.5003	100%	0.0314	1.0000

**5GWLAN****Internal Antenna 0**

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 a	19.0	79.4328	6.10	4.0738	100%	0.0644	1.0000
IEEE 802.11 n HT20	18.0	63.0957	6.10	4.0738	100%	0.0512	1.0000
IEEE 802.11 n HT40	18.0	63.0957	6.10	4.0738	100%	0.0512	1.0000
IEEE 802.11 ac 80	8.0	6.3096	6.10	4.0738	100%	0.0051	1.0000

External Antenna 2

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 a	19.0	79.4328	4.82	3.0339	100%	0.0480	1.0000
IEEE 802.11 n HT20	18.0	63.0957	4.82	3.0339	100%	0.0381	1.0000
IEEE 802.11 n HT40	18.0	63.0957	4.82	3.0339	100%	0.0381	1.0000
IEEE 802.11 ac 80	8.0	6.3096	4.82	3.0339	100%	0.0038	1.0000

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;

$\sum$ of MPE ratios $\leq$ 1.0

We first evaluate WLAN simultaneous transmission and later evaluate BT and WLAN simultaneous transmission;

Antenna 0 and Antenna 1 for 2.4GWLAN

Band	Mode	MPE Ratio Antenna 0	MPE Ratio Antenna 1	$\sum$ MPE ratios	Limit	Results
2.4G	IEEE 802.11b	0.0185	0.0146	N/A	1.000	Pass
	IEEE 802.11g	0.0464	0.0366	N/A	1.000	Pass
	IEEE 802.11n HT20	0.0464	0.0366	< 0.1	1.000	Pass
	IEEE 802.11n HT40	0.0369	0.0290	< 0.1	1.000	Pass

Antenna 2 and Antenna 3 for 2.4GWLAN

Band	Mode	MPE Ratio Antenna 2	MPE Ratio Antenna 3	$\sum$ MPE ratios	Limit	Results
2.4G	IEEE 802.11b	0.0157	0.0157	N/A	1.000	Pass
	IEEE 802.11g	0.0395	0.0395	N/A	1.000	Pass
	IEEE 802.11n HT20	0.0395	0.0395	< 0.1	1.000	Pass
	IEEE 802.11n HT40	0.0314	0.0314	< 0.1	1.000	Pass



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Remark:

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

Maximum MPE Ratios for 2.4GHz and 5GHz WLAN simultaneous transmission

Antenna type	Maximum MPE Ratio _{2.4GHzWLAN}	Maximum MPE Ratio _{5GHzWLAN}	Σ MPE ratios	Limit	Results
Internal Antenna	0.0644	0.0464	< 0.2	1.000	Pass
External Antenna	0.0480	0.0395	< 0.2	1.000	Pass

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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