



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



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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

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 antenna is 5dBi for 2.4GWLAN and 6dBi for 5GWLAN the RF power density can be obtained.

Frequency Band	Antenna type and antenna number	Maximum antenna gain
2.4GHz	WLAN Antenna	5dBi
5.8GHz	WLAN Antenna	6dBi

**4. Estimation Result****4.1 Conducted Power Results****2.4GHz WIFI**

Antenna	Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
Antenna 0	IEEE 802.11b	2412	17.50
		2437	16.70
		2462	16.50
Antenna 1		2412	16.30
		2437	16.20
		2462	16.20
Antenna 0	IEEE 802.11g	2412	16.40
		2437	16.70
		2462	16.40
Antenna 1		2412	15.90
		2437	15.10
		2462	15.30
Antenna 0	IEEE 802.11n HT20	2412	16.60
		2437	16.80
		2462	16.50
Antenna 1		2412	16.10
		2437	15.40
		2462	15.40
Antenna 0	IEEE 802.11n HT40	2422	16.50
		2437	16.40
		2452	16.40
Antenna 1		2422	15.40
		2437	14.80
		2452	15.10

5GHz WIFI

Antenna	Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
Antenna 0	IEEE 802.11a	5180	18.90
		5200	18.80
		5240	18.00
		5745	17.80
		5785	16.80
		5825	16.90
Antenna 0		5180	19.10
		5200	19.10
		5240	18.60

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		5745	15.50
		5785	16.20
		5825	15.80
Antenna 0	IEEE 802.11n HT20	5180	18.50
		5200	17.40
		5240	16.50
		5745	17.50
		5785	17.30
		5825	17.70
Antenna 0	IEEE 802.11n HT20	5180	19.00
		5200	18.90
		5240	18.60
		5745	17.60
		5785	17.00
		5825	17.30
Antenna 0	IEEE 802.11n HT40	5190	17.30
		5230	16.30
		5755	17.10
		5795	17.10
Antenna 0	IEEE 802.11n HT40	5190	17.90
		5230	17.90
		5755	17.20
		5795	17.00
Antenna 0	IEEE 802.11ac 80	5210	11.30
		5775	17.50
Antenna 0		5210	11.00
		5775	10.70

4.2 Manufacturing tolerance**2.4GHz WIFI**

IEEE 802.11 b (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	17.0	16.0	16.0	16.0	16.0	16.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 g (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462

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Target (dBm)	16.0	16.0	16.0	15.0	15.0	15.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 n HT20 (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	16.0	16.0	16.0	16.0	15.0	15.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 n HT40 (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2422	2437	2452	2422	2437	2452
Target (dBm)	16.0	16.0	16.0	15.0	14.0	15.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

5GHz WIFI

IEEE 802.11 a (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5180	5200	5240	5180	5200	5240
Target (dBm)	18.0	18.0	18.0	19.0	19.0	18.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5745	5785	5825	5745	5785	5825
Target (dBm)	17.0	16.0	16.0	15.0	16.0	15.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT20 (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5180	5200	5240	5180	5200	5240
Target (dBm)	18.0	17.0	16.0	19.0	18.0	18.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5745	5785	5825	5745	5785	5825
Target (dBm)	17.0	17.0	17.0	17.0	17.0	17.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT40 (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5190	---	5230	5190	---	5230
Target (dBm)	17.0		16.0	17.0		17.0



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Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5755	---	5795	5755	---	5795
Target (dBm)	17.0		17.0	17.0		17.0
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11ac 80 (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5210	---	5775	5210	---	5775
Target (dBm)	11.0		17.0	11.0		10.0
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

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	18.0	63.0957	5.0	3.1623	100%	0.03971	1.0000
IEEE 802.11 g	17.0	50.1187	5.0	3.1623	100%	0.03155	1.0000
IEEE 802.11 n HT20	17.0	50.1187	5.0	3.1623	100%	0.03155	1.0000
IEEE 802.11 n HT40	17.0	50.1187	5.0	3.1623	100%	0.03155	1.0000

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	17.0	50.1187	5.0	3.1623	100%	0.03155	1.0000
IEEE 802.11 g	16.0	39.8107	5.0	3.1623	100%	0.02506	1.0000
IEEE 802.11 n HT20	17.0	50.1187	5.0	3.1623	100%	0.03155	1.0000
IEEE 802.11 n HT40	16.0	39.8107	5.0	3.1623	100%	0.02506	1.0000

5G WLAN

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	6.0	3.9811	100%	0.06294	1.0000
IEEE 802.11 n HT20	19.0	79.4328	6.0	3.9811	100%	0.06294	1.0000
IEEE 802.11 n HT40	18.0	63.0957	6.0	3.9811	100%	0.05000	1.0000
IEEE 802.11 ac 80	18.0	63.0957	6.0	3.9811	100%	0.05000	1.0000



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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 a	20.0	100.0000	6.0	3.9811	100%	0.07924	1.0000
IEEE 802.11 n HT20	20.0	100.0000	6.0	3.9811	100%	0.07924	1.0000
IEEE 802.11 n HT40	18.0	63.0957	6.0	3.9811	100%	0.05000	1.0000
IEEE 802.11 ac 80	12.0	15.8489	6.0	3.9811	100%	0.01256	1.0000

Remark:

1. Maximum average power including tune-up tolerance;
2. MPE use distance is 20cm from manufacturer declaration of user manual.
3. We choose 2412MHz (lowest frequency operate at 2.4GHz) and 5180MHz (lowest frequency operate at 5GHz) to calculate MPE limit as higher frequency will have higher MPE limits.

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

Σ of MPE ratios ≤ 1.0

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

Antenna 0 and Antenna 1 for 2.4GWLAN and 5GWLAN

Band	Mode	MPE _{Antenna 0} (mW/cm ²)	MPE _{Antenna 1} (mW/cm ²)	Σ MPE ratios	Limit	Results
2.4G	IEEE 802.11b	0.03971	0.03155	N/A	1.000	Pass
	IEEE 802.11g	0.03155	0.02506	N/A	1.000	Pass
	IEEE 802.11n HT20	0.03155	0.03155	0.06310	1.000	Pass
	IEEE 802.11n HT40	0.03155	0.02506	0.05661	1.000	Pass
5G	IEEE 802.11a	0.06294	0.07924	N/A	1.000	Pass
	IEEE 802.11n HT20	0.06294	0.07924	0.14218	1.000	Pass
	IEEE 802.11n HT40	0.05000	0.05000	0.10000	1.000	Pass
	IEEE 802.11ac 80	0.05000	0.01256	0.06256	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.

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