



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 4dBi for 2.4GWLAN and 5GWLAN the RF power density can be obtained.

Frequency Band	Antenna type and antenna number	Internal Identification	Maximum antenna gain
2.4GHz	Antenna 0, Embedded Antenna	Antenna 0	4.0dBi
	Antenna 1, Embedded Antenna	Antenna 1	4.0dBi
5GHz	Antenna 0, Embedded Antenna	Antenna 2	4.0dBi
	Antenna 1, Embedded Antenna	Antenna 3	4.0dBi

**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	12.80
		2437	12.00
		2462	12.30
Antenna 1		2412	12.10
		2437	12.20
		2462	12.00
Antenna 0	IEEE 802.11g	2412	13.20
		2437	12.10
		2462	12.30
Antenna 1		2412	12.40
		2437	12.50
		2462	12.30
Antenna 0	IEEE 802.11n HT20	2412	12.90
		2437	12.10
		2462	12.40
Antenna 1		2412	12.20
		2437	12.00
		2462	11.90
Antenna 0	IEEE 802.11n HT40	2422	12.90
		2437	11.70
		2452	12.20
Antenna 1		2422	11.50
		2437	11.80
		2452	12.20

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5GHz WIFI

Antenna	Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
Antenna 0	IEEE 802.11a	5180	15.10
		5200	15.40
		5240	14.80
		5745	20.80
		5785	20.70
		5825	21.10
Antenna 1		5180	16.20
		5200	16.10
		5240	16.00
		5745	15.60
		5785	16.00
		5825	16.10
Antenna 0	IEEE 802.11n HT20	5180	14.80
		5200	14.90
		5240	14.20
		5745	20.30
		5785	20.40
		5825	20.50
Antenna 1		5180	15.30
		5200	15.70
		5240	14.50
		5745	14.80
		5785	15.00
		5825	15.10
Antenna 0	IEEE 802.11n HT40	5190	15.10
		5230	13.90
		5755	21.00
		5795	20.40
Antenna 1		5190	15.50
		5230	14.10
		5755	20.90
		5795	20.30
Antenna 0	IEEE 802.11ac 80	5210	16.30
		5775	18.70
Antenna 1		5210	16.40
		5775	18.00

**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)	12.0	12.0	12.0	12.0	12.0	12.0
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
Target (dBm)	13.0	12.0	12.0	12.0	12.0	12.0
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)	12.0	12.0	12.0	12.0	12.0	11.0
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)	12.0	11.0	12.0	11.0	11.0	12.0
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)	15.0	15.0	14.0	16.0	16.0	16.0
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)	20.0	20.0	21.0	15.0	16.0	16.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

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IEEE 802.11n HT20 (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5180	5200	5240	5180	5200	5240
Target (dBm)	14.0	14.0	14.0	15.0	15.0	14.0
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)	20.0	20.0	20.0	14.0	15.0	15.0
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)	15.0		13.0	15.0		14.0
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)	21.0		20.0	20.0		20.0
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)	16.0		18.0	16.0		18.0
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	13.0	19.9526	4.0	2.5119	100%	0.0100	1.0000
IEEE 802.11 g	14.0	25.1189	4.0	2.5119	100%	0.0126	1.0000
IEEE 802.11 n HT20	13.0	19.9526	4.0	2.5119	100%	0.0100	1.0000
IEEE 802.11 n HT40	13.0	19.9526	4.0	2.5119	100%	0.0100	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	13.0	19.9526	4.0	2.5119	100%	0.0100	1.0000
IEEE 802.11 g	13.0	19.9526	4.0	2.5119	100%	0.0100	1.0000
IEEE 802.11 n HT20	13.0	19.9526	4.0	2.5119	100%	0.0100	1.0000
IEEE 802.11 n HT40	13.0	19.9526	4.0	2.5119	100%	0.0100	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	22.0	158.4893	4.0	2.5119	100%	0.0792	1.0000
IEEE 802.11 n HT20	21.0	125.8925	4.0	2.5119	100%	0.0629	1.0000
IEEE 802.11 n HT40	22.0	158.4893	4.0	2.5119	100%	0.0792	1.0000
IEEE 802.11 ac 80	19.0	79.4328	4.0	2.5119	100%	0.0397	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	17.0	50.1187	4.0	2.5119	100%	0.0251	1.0000
IEEE 802.11 n HT20	16.0	39.8107	4.0	2.5119	100%	0.0199	1.0000
IEEE 802.11 n HT40	21.0	125.8925	4.0	2.5119	100%	0.0629	1.0000
IEEE 802.11 ac 80	19.0	79.4328	4.0	2.5119	100%	0.0397	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 ≤ 1.0

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

Antenna 0 and Antenna 1 for 2.4G WLAN

Band	Mode	MPE _{Antenna 0} (mW/cm ²)	MPE _{Antenna 1} (mW/cm ²)	$\sum$ MPE ratios	Limit	Results
2.4G	IEEE 802.11b	0.0100	0.0100	N/A	1.000	Pass
	IEEE 802.11g	0.0126	0.0100	N/A	1.000	Pass
	IEEE 802.11n HT20	0.0100	0.0100	0.0200	1.000	Pass
	IEEE 802.11n HT40	0.0100	0.0100	0.0200	1.000	Pass

Antenna 2 and Antenna 3 for 5G WLAN

Band	Mode	MPE _{Antenna 2} (mW/cm ²)	MPE _{Antenna 3} (mW/cm ²)	$\sum$ MPE ratios	Limit	Results
5G	IEEE 802.11a	0.0792	0.0251	N/A	1.000	Pass
	IEEE 802.11n HT20	0.0629	0.0199	0.0828	1.000	Pass
	IEEE 802.11n HT40	0.0792	0.0629	0.1421	1.000	Pass
	IEEE 802.11ac 80	0.0397	0.0397	0.0794	1.000	Pass

Maximum Simultaneous transmission MPE Ratio for 2.4G WLAN and 5G WLAN

Maximum MPE ratio 2.4G WLAN	Maximum MPE ratio 5G WLAN	$\sum$ MPE ratios	Limit	Results
0.0200	0.1421	0.2	1.0	Pass

Note: The estimation distance is 20cm



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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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