



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 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	Internal antenna	Antenna 0	4dBi
2.4GHz		Antenna 1	4dBi
5GHz		Antenna 2	4dBi
5GHz		Antenna 3	4dBi



4. Estimation Result

4.1 Conducted Power Results

2.4GHz WIFI

Antenna	Mode	Frequency(MHz)	Peak Conducted Output Power (dBm)
Antenna 0	IEEE 802.11b	2412	20.95
		2437	19.62
		2462	20.75
	IEEE 802.11g	2412	22.92
		2437	22.27
		2462	20.75
	IEEE 802.11n HT20	2412	22.98
		2437	22.28
		2462	17.68
	IEEE 802.11n HT40	2422	22.77
		2437	22.13
		2452	17.27

Antenna	Mode	Frequency(MHz)	Peak Conducted Output Power (dBm)
Antenna 1	IEEE 802.11b	2412	20.02
		2437	20.27
		2462	19.72
	IEEE 802.11g	2412	22.37
		2437	22.78
		2462	20.88
	IEEE 802.11n HT20	2412	21.93
		2437	22.87
		2462	18.02
	IEEE 802.11n HT40	2422	21.09
		2437	21.88
		2452	17.32

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5GHz WIFI

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)
Antenna 2	IEEE 802.11a	5180	16.55
		5200	16.91
		5240	16.92
		5745	15.77
		5785	15.13
		5825	14.89
	IEEE 802.11n HT20	5180	16.25
		5200	16.51
		5240	16.81
		5745	12.67
		5785	11.84
		5825	11.83
	IEEE 802.11n HT40	5190	17.28
		5230	14.43
		5755	13.25
		5795	12.71
	IEEE 802.11ac 80	5210	16.47
		5775	15.09

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)
Antenna 3	IEEE 802.11a	5180	15.18
		5200	15.14
		5240	14.89
		5745	13.70
		5785	14.14
		5825	14.23
	IEEE 802.11n HT20	5180	15.01
		5200	15.04
		5240	14.89
		5745	12.26
		5785	12.99
		5825	12.86
	IEEE 802.11n HT40	5190	15.89
		5230	12.56
		5755	13.36
		5795	13.57
	IEEE 802.11ac 80	5210	15.83
		5775	15.73

**4.2 Manufacturing tolerance****2.4GHz WIFI**

IEEE 802.11b						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	20.0	19.0	20.0	20.0	20.0	19.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11 g						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	22.0	22.0	20.0	22.0	22.0	20.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11 n HT20						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	22.0	22.0	17.0	21.0	22.0	18.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11 n HT40						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	22.0	22.0	17.0	21.0	21.0	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)	Antenna 2			Antenna 3		
	5180	5200	5240	5180	5200	5240
Target (dBm)	16.0	16.0	16.0	15.0	15.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11 a (Average)						
Frequency (MHz)	Antenna 2			Antenna 3		
	5745	5785	5825	5745	5785	5825
Target (dBm)	15.0	15.0	14.0	13.0	14.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)						
Frequency (MHz)	Antenna 2			Antenna 3		
	5180	5200	5240	5180	5200	5240
Target (dBm)	16.0	16.0	16.0	15.0	15.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)						
Frequency (MHz)	Antenna 2			Antenna 3		
	5745	5785	5825	5745	5785	5825
Target (dBm)	12.0	12.0	11.0	12.0	12.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0



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IEEE 802.11n HT40 (Average)						
Frequency (MHz)	Antenna 2			Antenna 3		
	5190	---	5230	5190	---	5230
Target (dBm)	17.0	---	14.0	15.0	---	12.0
Tolerance $\pm$ (dB)	1.0	---	1.0	1.0	---	1.0
IEEE 802.11n HT40 (Average)						
Frequency (MHz)	Antenna 2			Antenna 3		
	5755	---	5795	5755	---	5795
Target (dBm)	13.0	---	12.0	13.0	---	13.0
Tolerance $\pm$ (dB)	1.0	---	1.0	1.0	---	1.0
IEEE 802.11ac 80 (Average)						
Frequency (MHz)	Antenna 2			Antenna 3		
	5210	---	5775	5210	---	5775
Target (dBm)	16.0	---	15.0	15.0	---	15.0
Tolerance $\pm$ (dB)	1.0	---	1.0	1.0	---	1.0



4.3 Measurement Results

4.3.1 Standalone MPE

2.4GWLAN

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	21.00	125.8925	4	2.5119	100%	0.0629	1.0000
IEEE 802.11 g	23.00	199.5262	4	2.5119	100%	0.0998	1.0000
IEEE 802.11 n HT20	23.00	199.5262	4	2.5119	100%	0.0998	1.0000
IEEE 802.11 n HT40	23.00	199.5262	4	2.5119	100%	0.0998	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	21.00	125.8925	4	2.5119	100%	0.0629	1.0000
IEEE 802.11 g	23.00	199.5262	4	2.5119	100%	0.0998	1.0000
IEEE 802.11 n HT20	23.00	199.5262	4	2.5119	100%	0.0998	1.0000
IEEE 802.11 n HT40	22.00	158.4893	4	2.5119	100%	0.0792	1.0000

5GWLAN

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	17.0	50.1187	4	2.5119	100%	0.0251	1.0000
IEEE 802.11 n HT20	17.0	50.1187	4	2.5119	100%	0.0251	1.0000
IEEE 802.11 n HT40	18.0	63.0957	4	2.5119	100%	0.0315	1.0000
IEEE 802.11 ac 80	17.0	50.1187	4	2.5119	100%	0.0251	1.0000

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 a	16.0	39.8107	4	2.5119	100%	0.0199	1.0000
IEEE 802.11 n HT20	16.0	39.8107	4	2.5119	100%	0.0199	1.0000
IEEE 802.11 n HT40	16.0	39.8107	4	2.5119	100%	0.0199	1.0000
IEEE 802.11 ac 80	16.0	39.8107	4	2.5119	100%	0.0199	1.0000

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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.

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

Band	Mode	MPE Ratio Antenna 0	MPE Ratio Antenna 1	Σ MPE ratios	Limit	Results
2.4G	IEEE 802.11b	0.0629	0.0629	N/A	1.000	Pass
	IEEE 802.11g	0.0998	0.0998	N/A	1.000	Pass
	IEEE 802.11n HT20	0.0998	0.0998	0.1996	1.000	Pass
	IEEE 802.11n HT40	0.0998	0.0792	0.1790	1.000	Pass

Antenna 2 and Antenna 3 for 5GWLAN

Band	Mode	MPE Ratio Antenna 2	MPE Ratio Antenna 3	Σ MPE ratios	Limit	Results
5G	IEEE 802.11a	0.0251	0.0199	N/A	1.000	Pass
	IEEE 802.11n HT20	0.0251	0.0199	0.0450	1.000	Pass
	IEEE 802.11n HT40	0.0315	0.0199	0.0514	1.000	Pass
	IEEE 802.11ac 80	0.0251	0.0199	0.0450	1.000	Pass

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

Maximum MPE Ratio _{2.4GHzWLAN}	Maximum MPE Ratio _{5GHzWLAN}	Σ MPE ratios	Limit	Results
0.1996	0.0514	0.251	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.

----- END OF REPORT -----