



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

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 an isotropic radiator

R=distance to the center of radiation of the antenna

From the EUT RF output power, the minimum mobile separation distance, $d=0.2m$, as well as the maximum gain of the used antenna is 5dBi for 2.4GWLAN and 5GWLAN, the RF power density can be obtained.

4. Estimation Result

4.1 Conducted Power Results

2.4GHz WIFI

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)
Antenna 1	IEEE 802.11b	2412	4.55
		2437	4.88
		2462	4.07
Antenna 2		2412	7.41
		2437	6.62
		2462	6.15
Antenna 1	IEEE 802.11g	2412	4.39
		2437	5.42
		2462	5.17
Antenna 2		2412	8.76
		2437	8.36
		2462	7.97
Antenna 1	IEEE 802.11n HT20	2412	3.76
		2437	5.54
		2462	5.27
Antenna 2		2412	8.58
		2437	8.20
		2462	7.71
Antenna 1	IEEE 802.11n HT40	2422	5.14
		2437	5.41
		2452	5.41
Antenna 2		2422	8.35
		2437	8.61
		2452	8.28



5GHz WIFI

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)	
Antenna 1	IEEE 802.11a	5745	20.38	
		5785	20.91	
		5825	20.91	
Antenna 2		5745	22.73	
		5785	21.81	
		5825	21.81	
Antenna 1		IEEE 802.11n HT20	5745	20.38
			5785	20.39
			5825	20.45
Antenna 2	5745		22.67	
	5785		21.99	
	5825		21.64	
Antenna 1	IEEE 802.11n HT40		5755	20.39
			5795	20.44
Antenna 2			5755	22.49
		5795	21.72	
Antenna 1		IEEE 802.11ac 80	5775	21.15
Antenna 2			5775	22.39

4.2 Manufacturing tolerance

2.4GHz WIFI

IEEE 802.11 b (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
		2412	2437	2462	2412	2437
Target (dBm)	4.00	4.00	4.00	7.00	6.00	6.00
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 g (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
		2412	2437	2462	2412	2437
Target (dBm)	4.00	5.00	5.00	8.00	8.00	7.00
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 n HT 20 (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
		2412	2437	2462	2412	2437
Target (dBm)	3.00	5.00	5.00	8.00	8.00	7.00
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0



IEEE 802.11 n HT 40 (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
		2412	2437	2462	2412	2437
Target (dBm)	5.00	5.00	5.00	8.00	8.00	8.00
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 1			Antenna 2		
		5745	5785	5825	5745	5785
Target (dBm)	20.00	20.00	20.00	22.00	21.00	21.00
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT20 (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
		5745	5785	5825	5745	5785
Target (dBm)	20.00	20.00	20.00	22.00	21.00	21.00
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT40 (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
		5755	---	5795	5755	---
Target (dBm)	20.00		20.00	22.00		21.00
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11ac 80 (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
		5775	---	---	5775	---
Target (dBm)	21.00			22.00		
Tolerance \pm (dB)	1.0	1.0	1.0	1.0	1.0	1.0

4.3 Measurement Results**4.3.1 Standalone MPE**

**2.4GWLAN****Antenna 1**

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 b	5.0	3.1623	5.0	3.1623	100%	0.0020	1.000
IEEE 802.11 g	6.0	3.9811	5.0	3.1623	100%	0.0025	1.000
IEEE 802.11 n HT20	6.0	3.9811	5.0	3.1623	100%	0.0025	1.000
IEEE 802.11 n HT40	6.0	3.9811	5.0	3.1623	100%	0.0025	1.000

Antenna 2

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 b	8.0	6.3096	5.0	3.1623	100%	0.0040	1.000
IEEE 802.11 g	9.0	7.9433	5.0	3.1623	100%	0.0050	1.000
IEEE 802.11 n HT20	9.0	7.9433	5.0	3.1623	100%	0.0050	1.000
IEEE 802.11 n HT40	9.0	7.9433	5.0	3.1623	100%	0.0050	1.000

5GWLAN**Antenna 3**

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 a	21.00	125.8925	5.0	3.1623	100%	0.0792	1.000
IEEE 802.11 n HT20	21.00	125.8925	5.0	3.1623	100%	0.0792	1.000
IEEE 802.11 n HT40	21.00	125.8925	5.0	3.1623	100%	0.0792	1.000
IEEE 802.11 ac 80	22.00	158.4893	5.0	3.1623	100%	0.0998	1.000

Antenna 4

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	(dBm)	(mW)					
IEEE 802.11 a	23.0	199.5263	5.0	3.1623	100%	0.1256	1.000
IEEE 802.11 n HT20	23.0	199.5263	5.0	3.1623	100%	0.1256	1.000
IEEE 802.11 n HT40	23.0	199.5263	5.0	3.1623	100%	0.1256	1.000
IEEE 802.11 ac 80	23.0	199.5263	5.0	3.1623	100%	0.1256	1.000

**4.3.2 Simultaneous transmission MPE**

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

Σ of MPE ratios \leq 1.0

Antenna 1 and Antenna 2 for 2.4GWLAN

Mode	MPE _{Antenna 1} (mW/cm ²)	MPE _{Antenna 2} (mW/cm ²)	Σ MPE ratios	Limit	Results
IEEE 802.11b	0.0020	0.0040	N/A	1.000	Pass
IEEE 802.11g	0.0025	0.0050	N/A	1.000	Pass
IEEE 802.11n HT20	0.0025	0.0050	0.0075	1.000	Pass
IEEE 802.11n HT40	0.0025	0.0050	0.0075	1.000	Pass

Antenna 3 and Antenna 4 for 5GWLAN

Mode	MPE _{Antenna 3} (mW/cm ²)	MPE _{Antenna 4} (mW/cm ²)	Σ MPE ratios	Limit	Results
IEEE 802.11n HT20	0.0792	0.1256	0.2048	1.000	Pass
IEEE 802.11n HT40	0.0792	0.1256	0.2048	1.000	Pass
IEEE 802.11a	0.0792	0.1256	N/A	1.000	Pass
IEEE 802.11ac 80	0.0998	0.1256	0.2254	1.000	Pass

Maximum Simultaneous transmission MPE Ratio for 2.4GWLAN and 5GWLAN

Maximum MPE ratio _{2.4GWLAN}	Maximum MPE ratio _{5GWLAN}	Σ MPE ratios	Limit	Results
0.0075	0.2254	0.2329	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.