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 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 16dBi for 5GWLAN the RF power density can be obtained.

Frequency Band	Antenna type and antenna number	Maximum antenna gain
5.8GHz	WLAN Antenna	16dBi

4. Estimation Result

4.1 Conducted Power Results

5GHz WIFI

Antenna	Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
Antenna 1	IEEE 802.11a	5180	12.84
		5200	12.25
		5240	11.96
		5745	11.66
		5785	11.78
		5825	10.06
Antenna 2	IEEE 802.11a	5180	11.91
		5200	12.80
		5240	13.39
		5745	11.43
		5785	12.58
		5825	12.07
Antenna 1	IEEE 802.11 HT20	5180	12.78
		5200	11.97
		5240	11.73
		5745	11.40
		5785	11.84
		5825	10.09
Antenna 2	IEEE 802.11 HT20	5180	12.07
		5200	12.57
		5240	13.35
		5745	11.42
		5785	12.56
		5825	10.54
Antenna 1	IEEE 802.11n HT40	5190	12.25
		5230	12.73
		5755	10.78
		5795	10.52
Antenna 2	IEEE 802.11n HT40	5190	11.76
		5230	12.66
		5755	11.70
		5795	11.50
Antenna 1	IEEE 802.11ac 80	5210	11.23
		5775	10.49
Antenna 2	IEEE 802.11ac 80	5210	10.92
		5775	10.33

4.2 Manufacturing tolerance

5GHz WIFI

IEEE 802.11 a (AVG)						
Antenna 1				Antenna 2		
Frequency (MHz)	5180	5200	5240	5180	5200	5240
Target (dBm)	12.0	12.0	11.0	11.0	12.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	5745	5785	5825	5745	5785	5825
Target (dBm)	11.0	11.0	10.0	11.0	12.0	12.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT20 (AVG)						
Antenna 1				Antenna 2		
Frequency (MHz)	5180	5200	5240	5180	5200	5240
Target (dBm)	12.0	11.0	11.0	12.0	12.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Antenna 1				Antenna 2		
Frequency (MHz)	5745	5785	5825	5745	5785	5825
Target (dBm)	10.0	11.0	11.0	11.0	12.0	10.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT40 (Average)						
Antenna 1				Antenna 2		
Frequency (MHz)	5190	---	5230	5190	---	5230
Target (dBm)	12.0		12.0	11.0		12.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Antenna 1				Antenna 2		
Frequency (MHz)	5755	---	5795	5755	---	5795
Target (dBm)	10.0		10.0	11.0		11.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11ac 80 (Average)						
Antenna 1				Antenna 2		
Frequency (MHz)	5210	---	---	5210	---	---
Target (dBm)	11.0			10.0		
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Antenna 1				Antenna 2		
Frequency (MHz)	5775	---	---	5775	---	---
Target (dBm)	10.0			10.0		
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

4.3 Measurement Results

4.3.1 Standalone MPE

5GWLAN

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 a	13.0	19.9526	16.0	39.8107	100%	0.1581	1.0000
IEEE 802.11 n HT20	13.0	19.9526	16.0	39.8107	100%	0.1581	1.0000
IEEE 802.11 n HT40	13.0	19.9526	16.0	39.8107	100%	0.1581	1.0000
IEEE 802.11ac 80	12.0	15.8489	16.0	39.8107	100%	0.1256	1.0000

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 a	14.0	25.1189	16.0	39.8107	100%	0.1990	1.0000
IEEE 802.11 n HT20	14.0	25.1189	16.0	39.8107	100%	0.1990	1.0000
IEEE 802.11 n HT40	13.0	19.9526	16.0	39.8107	100%	0.1581	1.0000
IEEE 802.11ac 80	11.0	12.5893	16.0	39.8107	100%	0.0998	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 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;

$\sum$ of MPE ratios ≤ 1.0

Mode	$\sum$ MPE Antenna 1	$\sum$ MPE Antenna 2	$\sum$ MPE ratios	Limit	Results
IEEE 802.11 a	0.1581	0.1990	N/A	1.000	Pass
IEEE 802.11 n HT20	0.1581	0.1990	0.3571	1.000	Pass
IEEE 802.11 n HT40	0.1581	0.1581	0.3162	1.000	Pass
IEEE 802.11ac 80	0.1256	0.0998	0.2254	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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