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 2dBi for 5GWLAN and 3.0dBi for 2.4GWLAN, the RF power density can be obtained.

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	17.29
		2437	17.26
		2462	15.26
Antenna 1		2412	15.28
		2437	15.48
		2462	15.09
Antenna 0	IEEE 802.11g	2412	15.64
		2437	13.51
		2462	13.26
Antenna 1		2412	17.38
		2437	13.25
		2462	12.81
Antenna 0	IEEE 802.11n HT20	2412	12.25
		2437	11.38
		2462	14.72
Antenna 1		2412	12.27
		2437	12.55
		2462	14.43
Antenna 0	IEEE 802.11n HT40	2422	14.27
		2437	9.86
		2452	9.97
Antenna 1		2422	13.69
		2437	11.53
		2452	11.18

5GHz WIFI

Antenna	Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
Antenna 0	IEEE 802.11a	5180	16.34
		5200	16.26
		5240	16.12
		5260	13.74
		5300	16.29
		5320	13.75
		5500	17.68
		5580	15.45
		5700	15.52
		5745	18.02
		5785	18.08
		5825	14.67
Antenna 1		5180	18.27
		5200	18.17
		5240	18.05
		5260	17.84
		5300	19.13
		5320	15.95
		5500	16.54
		5580	16.57
		5700	16.18
		5745	16.98
		5785	19.14
		5825	16.22
Antenna 0	IEEE 802.11n HT20	5180	16.50
		5200	16.16
		5240	15.64
		5260	15.62
		5300	15.93
		5320	16.15
		5500	16.57
		5580	15.97
		5700	14.66
		5745	15.44
		5785	17.34
		5825	14.28
Antenna 1		5180	18.07

		5200	17.93
		5240	17.97
		5260	18.61
		5300	14.98
		5320	18.95
		5500	16.69
		5580	17.31
		5700	14.69
		5745	14.91
		5785	18.45
		5825	15.15
Antenna 0	IEEE 802.11n HT40	5190	14.39
		5230	16.18
		5270	16.76
		5310	16.43
		5510	16.38
		5550	18.89
		5670	17.01
		5755	17.70
		5795	15.62
Antenna 1		5190	15.10
		5230	18.92
		5270	15.41
		5310	15.19
		5510	15.24
		5550	19.93
		5670	16.85
		5755	15.56
		5795	15.56
Antenna 0	IEEE 802.11ac 80	5210	13.77
		5290	14.10
		5530	15.61
		5775	15.10
Antenna 1		5210	14.09
		5290	14.81
		5530	15.41
		5775	16.31

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	17.0	15.0	15.0	15.0	15.0
Tolerance ±(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)	15.0	13.0	13.0	17.0	13.0	12.0
Tolerance ±(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	11.0	14.0	12.0	12.0	14.0
Tolerance ±(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)	14.0	9.0	9.0	13.0	11.0	11.0
Tolerance ±(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)	16.0	16.0	16.0	18.0	18.0	18.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5260	5300	5320	5260	5300	5320
Target (dBm)	13.0	16.0	13.0	17.0	19.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5500	5580	5700	5500	5580	5700
Target (dBm)	17.0	15.0	15.0	16.0	16.0	16.0
Tolerance ±(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)	18.0	18.0	14.0	16.0	19.0	16.0
Tolerance ±(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)	15.5	15.5	15.5	17.5	17.5	17.5
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5260	5300	5320	5260	5300	5320
Target (dBm)	16.0	16.0	16.0	19.0	15.0	19.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5500	5580	5700	5500	5580	5700
Target (dBm)	18.0	16.0	15.0	20.0	17.0	15.0
Tolerance ±(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)	15.0	17.0	14.0	14.0	18.0	15.0
Tolerance ±(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)	14.0		15.5	15.0		18.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5270	---	5310	5270	---	5310
Target (dBm)	16.0		16.0	15.0		15.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 0			Antenna 1		
	5510	5550	5670	5510	5550	5670
Target (dBm)	16.0	18.0	17.0	15.0	19.0	16.0

Tolerance ±(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		15.0	15.0		15.0
Tolerance ±(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	---	5290	5210	---	5290
Target (dBm)	13.0		14.0	14.0		14.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
IEEE 802.11ac 80 (AVG)						
Frequency (MHz)	Antenna 0			Antenna 1		
	5530	---	5775	5530	---	5775
Target (dBm)	15.0		15.0	15.0		16.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

4.3 Measurement Results

Antenna 1

2.4GWLAN

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
IEEE 802.11 b	18.0	79.4328	3.0	1.9953	100%	0.0251
IEEE 802.11 g	16.0	39.8107	3.0	1.9953	100%	0.0158
IEEE 802.11 n HT20	15.0	31.6228	3.0	1.9953	100%	0.0126
IEEE 802.11 n HT40	15.0	31.6228	3.0	1.9953	100%	0.0126

5GWLAN

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
IEEE 802.11 a	19.0	79.4328	2.0	1.5849	100%	0.0251
IEEE 802.11 n HT20	19.0	79.4328	2.0	1.5849	100%	0.0251
I IEEE 802.11 n HT40	18.0	63.0957	2.0	1.5849	100%	0.0199
IEEE 802.11 ac 80	16.0	39.8107	2.0	1.5849	100%	0.0126

Antenna 2

2.4GWLAN

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
IEEE 802.11 b	16.0	39.8107	3.0	1.9953	100%	0.0158
IEEE 802.11 g	18.0	79.4328	3.0	1.9953	100%	0.0251
IEEE 802.11 n HT20	15.0	31.6228	3.0	1.9953	100%	0.0126
IEEE 802.11 n HT40	14.0	25.1189	3.0	1.9953	100%	0.0100

5GWLAN

Mode	Output power (Including tune-up tolerance)		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm^2)
	(dBm)	(mW)				
IEEE 802.11 a	20.0	100.0000	2.0	1.5849	100%	0.0315
IEEE 802.11 n HT20	21.0	125.8925	2.0	1.5849	100%	0.0397
I IEEE 802.11 n HT40	19.0	79.4328	2.0	1.5849	100%	0.0251
IEEE 802.11 ac 80	17.0	50.1187	2.0	1.5849	100%	0.0158

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;
$\sum$ of MPE ratios ≤ 1.0

Mode	MPE $_{Antenna\ 1}$ (mW/cm^2)	MPE $_{Antenna\ 2}$ (mW/cm^2)	$\sum$ MPE ratios	Limit	Results
IEEE 802.11b	0.0251	0.0158	N/A	1.000	Pass
IEEE 802.11g	0.0158	0.0251	N/A	1.000	Pass
IEEE 802.11n HT20	0.0251	0.0397	0.0648	1.000	Pass
IEEE 802.11n HT40	0.0199	0.0251	0.0450	1.000	Pass
IEEE 802.11a	0.0251	0.0315	N/A	1.000	Pass
IEEE 802.11ac 80	0.0126	0.0158	0.0284	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.