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 anisotropic radiator

R=distance to the center of radiation of the antenna

From the EUT RF output power, the minimum mobile separationdistance, d=0.2m, as well as the maximumgain of the used as follows, the RF powerdensity can be obtained.

Frequency Band	Antenna type and antenna number	Internal Identification	Maximum antenna gain
2.4GHz	WLAN Antenna	Antenna 0	4.00 dBi
		Antenna 1	4.01 dBi
5GHz	WLAN Antenna	Antenna 0	5.98 dBi
		Antenna 1	4.97 dBi

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	24.18
		2437	24.27
		2462	24.79
Antenna 1		2412	24.73
		2437	24.81
		2462	24.78
Antenna 0	IEEE 802.11g	2412	27.01
		2437	27.12
		2462	27.18
Antenna 1		2412	27.29
		2437	27.35
		2462	27.31
Antenna 0	IEEE 802.11n HT20	2412	22.87
		2437	23.70
		2462	23.09
Antenna 1		2412	23.14
		2437	23.29
		2462	23.58
Antenna 0	IEEE 802.11n HT40	2422	22.10
		2437	22.77
		2452	22.38
Antenna 1		2422	22.03
		2437	21.99
		2452	22.02

5GHz WIFI

Antenna	Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
Antenna 0	IEEE 802.11a	5180	17.80
		5200	17.99
		5240	17.66
		5745	16.47
		5785	15.96
		5825	15.19
Antenna 1		5180	18.05
		5200	18.14
		5240	18.11
		5745	16.00
		5785	15.98
		5825	15.74
Antenna 0	IEEE 802.11n HT20	5180	18.05
		5200	18.00
		5240	17.73
		5745	16.59
		5785	16.37
		5825	15.59
Antenna 1		5180	18.07
		5200	18.17
		5240	18.11
		5745	16.16
		5785	15.99
		5825	15.81
Antenna 0	IEEE 802.11n HT40	5190	16.28
		5230	15.92
		5755	14.03
		5795	13.62
Antenna 1		5190	15.69
		5230	15.76
		5755	13.94
		5795	13.81

Antenna 0	IEEE 802.11ac 80	5210	15.20
		5775	14.87
Antenna 1		5210	13.17
		5775	12.79

4.2 Manufacturing tolerance

2.4GHz WIFI

IEEE 802.11 b (Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	24.0	24.0	24.0	24.0	24.0	24.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 g (Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	27.0	27.0	27.0	27.0	27.0	27.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 n HT20 (Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2412	2437	2462	2412	2437	2462
Target (dBm)	22.0	23.0	23.0	23.0	23.0	23.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11 n HT40 (Peak)						
Frequency (MHz)	Antenna 0			Antenna 1		
	2422	2437	2452	2422	2437	2452
Target (dBm)	22.0	22.0	22.0	22.0	21.0	22.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

5GHz WIFI

IEEE 802.11 a (AVG)						
Frequency	Antenna 0			Antenna 1		
(MHz)	5180	5200	5240	5180	5200	5240
Target (dBm)	17.0	17.0	17.0	18.0	18.0	18.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency	Antenna 0			Antenna 1		
(MHz)	5745	5785	5825	5745	5785	5825
Target (dBm)	16.0	15.0	15.0	16.0	15.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT20 (AVG)						
Frequency	Antenna 0			Antenna 1		
(MHz)	5180	5200	5240	5180	5200	5240
Target (dBm)	18.0	18.0	17.0	18.0	18.0	18.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency	Antenna 0			Antenna 1		
(MHz)	5745	5785	5825	5745	5785	5825
Target (dBm)	16.0	16.0	15.0	16.0	15.0	15.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0

IEEE 802.11n HT40 (AVG)						
Frequency	Antenna 0			Antenna 1		
(MHz)	5190	---	5230	5190	---	5230
Target (dBm)	16.0		15.0	15.0		15.0
Tolerance ±(dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency	Antenna 0			Antenna 1		
(MHz)	5755	---	5795	5755	---	5795
Target (dBm)	14.0		13.0	13.0		13.0
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	---	5775	5210	---	5775
Target (dBm)	15.0		14.0	13.0		12.0
Tolerance ±(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 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	25	316.2278	4.00	2.5119	100%	0.1581	1.0000
IEEE 802.11 g	28	630.9573	4.00	2.5119	100%	0.3155	1.0000
IEEE 802.11 n HT20	24	251.1886	4.00	2.5119	100%	0.1256	1.0000
IEEE 802.11 n HT40	23	199.5262	4.00	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	25	316.2278	4.01	2.5177	100%	0.1585	1.0000
IEEE 802.11 g	28	630.9573	4.01	2.5177	100%	0.3162	1.0000
IEEE 802.11 n HT20	24	251.1886	4.01	2.5177	100%	0.1259	1.0000
IEEE 802.11 n HT40	23	199.5262	4.01	2.5177	100%	0.1000	1.0000

5GWLAN

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	18	63.0957	5.98	3.9628	100%	0.0498	1.0000
IEEE 802.11 n HT20	19	79.4328	5.98	3.9628	100%	0.0627	1.0000
IEEE 802.11 n HT40	17	50.1187	5.98	3.9628	100%	0.0395	1.0000
IEEE 802.11 ac 80	16	39.8107	5.98	3.9628	100%	0.0314	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 a	19	79.4328	4.97	3.1405	100%	0.0497	1.0000
IEEE 802.11 n HT20	19	79.4328	4.97	3.1405	100%	0.0497	1.0000
IEEE 802.11 n HT40	16	39.8107	4.97	3.1405	100%	0.0249	1.0000
IEEE 802.11 ac 80	14	25.1189	4.97	3.1405	100%	0.0157	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;

∑of MPE ratios≤ 1.0

Antenna 0 and Antenna 1 for 2.4GWLAN and 5GWLAN

Band	Mode	MPE Ratio Antenna 0	MPE Ratio Antenna 1	∑ MPE ratios	Limit	Results
2.4G	IEEE 802.11b	0.1581	0.1585	N/A	1.000	Pass
	IEEE 802.11g	0.3155	0.3162	N/A	1.000	Pass
	IEEE 802.11n HT20	0.1256	0.1259	0.2515	1.000	Pass
	IEEE 802.11n HT40	0.0998	0.1000	0.1998	1.000	Pass
5G	IEEE 802.11a	0.0498	0.0497	N/A	1.000	Pass
	IEEE 802.11n HT20	0.0627	0.0497	0.1124	1.000	Pass
	IEEE 802.11n HT40	0.0395	0.0249	0.0644	1.000	Pass
	IEEE 802.11ac 80	0.0314	0.0157	0.0471	1.000	Pass

Maximum MPE Radios for 2.4GWLAN and 5GWLAN simultaneous transmission

Antenna type	Maximum MPE $Ratio_{2.4GHzWLAN}$	Maximum MPE $Ratio_{5GHzWLAN}$	∑ MPE ratios	Limit	Results
Internal Antenna	0.2515	0.1124	0.3639	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.

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