



## 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 v05r02

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  $\leq 1.0$ . 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 <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> 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

Prediction 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 an isotropic radiator

R=distance to the center of radiation of the antenna

From the peak EUT RF output power, the minimum mobile separation distance,  $d=0.2\text{m}$ , as well as the maximum gain of the used antenna is 2dBi, the RF power density can be obtained.

### 4. Estimation Result

#### 4.1 Conducted Power Results

##### *Bluetooth*

Mode	Channel	Frequency(MHz)	Average Conducted Output Power (dBm)
GFSK-BLE	00	2402	3.12
	19	2440	4.75
	39	2480	4.79
GFSK	00	2402	-6.98
	39	2441	-5.44
	78	2480	-4.77
8DPSK	00	2402	-10.96
	39	2441	-9.40
	78	2480	-8.49
$\pi/4$ DQPSK	00	2402	-10.91
	39	2441	-9.35
	78	2480	-8.43

##### *2.4GHz WIFI*

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)
Antenna 1	IEEE 802.11b	2412	6.14
		2437	5.70
		2462	4.98
Antenna 2		2412	6.01
		2437	5.62
		2462	5.65
Antenna 1	IEEE 802.11g	2412	7.16
		2437	6.59
		2462	5.80
Antenna 2		2412	7.51
		2437	7.18
		2462	6.68
Antenna 1	IEEE 802.11n HT20	2412	5.22
		2437	4.36
		2462	4.00
Antenna 2		2412	4.75

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		2437	4.03
		2462	3.76
Antenna 1	IEEE 802.11n HT40	2422	4.71
		2437	4.58
		2452	4.05
Antenna 2		2422	4.32
		2437	4.07
		2452	3.77

**5GHz WIFI**

Antenna	Mode	Frequency(MHz)	Average Conducted Output Power (dBm)
Antenna 1	IEEE 802.11a	5180	15.79
		5200	15.79
		5240	15.51
		5260	15.49
		5300	15.15
		5320	15.20
		5745	15.26
		5785	15.32
		5825	14.90
Antenna 2		5180	14.32
		5200	15.50
		5240	14.45
		5260	14.33
		5300	14.46
		5320	14.20
		5745	14.41
		5785	15.22
		5825	14.91
Antenna 1	IEEE 802.11n HT20	5180	15.56
		5200	15.42
		5240	15.46
		5260	15.34
		5300	14.04
		5320	15.16
		5745	14.07
		5785	15.12
		5825	14.63
Antenna 2		5180	14.39



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		5200	14.43
		5240	13.34
		5260	14.36
		5300	14.26
		5320	14.22
		5745	15.39
		5785	15.04
		5825	14.54
Antenna 1	IEEE 802.11n HT40	5190	16.21
		5230	15.94
		5270	15.76
		5310	15.70
		5755	15.75
		5795	15.54
Antenna 2		5190	14.90
		5230	14.98
		5270	14.71
		5310	14.86
		5755	16.00
		5795	15.77
Antenna 1	IEEE 802.11ac 80	5210	15.46
		5290	15.17
		5775	14.90
Antenna 2		5210	13.83
		5290	13.89
		5775	15.14

### 4.2 Manufacturing tolerance

#### Bluetooth

GFSK -BLE(Average)			
Channel	Channel 00	Channel 19	Channel 39
Target (dBm)	3.0	4.0	4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
GFSK(Average)			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	-6.0	-5.0	-4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
8DPSK(Average)			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	-10.0	-9.0	-8.0

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Tolerance $\pm$ (dB)	1.0	1.0	1.0
<b><math>\pi/4</math>DQPSK (Average)</b>			
Channel	Channel 00	Channel 39	Channel 78
Target (dBm)	-10.0	-9.0	-8.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

**2.4GHz WIFI**

<b>IEEE 802.11 b (Average)</b>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	6.0	5.0	5.0	6.0	5.0	5.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

<b>IEEE 802.11 g ( Average)</b>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	7.0	7.0	6.0	7.0	7.0	6.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

<b>IEEE 802.11 n HT20(Average)</b>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2412	2437	2462	2412	2437	2462
Target (dBm)	5.0	4.0	4.0	5.0	4.0	4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

<b>IEEE 802.11 n HT40 (Average)</b>						
Frequency (MHz)	Antenna 1			Antenna 2		
	2422	2437	2452	2422	2437	2452
Target (dBm)	4.0	4.0	4.0	4.0	4.0	4.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

**5GHz WIFI**

<b>IEEE 802.11 a (Average)</b>						
Frequency (MHz)	Antenna 1			Antenna 2		
	5180	5200	5240	5180	5200	5240
Target (dBm)	15.0	15.0	15.0	15.0	15.0	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 1			Antenna 2		
	5260	5300	5320	5260	5300	5320
Target (dBm)	15.0	15.0	15.0	15.0	15.0	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

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Frequency (MHz)	Antenna 1			Antenna 2		
	5745	5785	5825	5745	5785	5825
Target (dBm)	15.0	15.0	15.0	15.0	15.0	15.0
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		
	5180	5200	5240	5180	5200	5240
Target (dBm)	15.0	15.0	15.0	14.0	14.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 1			Antenna 2		
	5260	5300	5320	5260	5300	5320
Target (dBm)	15.0	15.0	15.0	14.0	14.0	14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 1			Antenna 2		
	5745	5785	5825	5745	5785	5825
Target (dBm)	15.0	15.0	15.0	15.0	15.0	15.0
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		
	5190	---	5230	5190	---	5230
Target (dBm)	16.0		16.0	15.0		15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 1			Antenna 2		
	5270	---	5310	5270	---	5310
Target (dBm)	15.0		15.0	14.0		14.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (MHz)	Antenna 1			Antenna 2		
	5755	---	5795	5755	---	5795
Target (dBm)	15.0		15.0	16.0		15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0



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IEEE 802.11ac 80 (Average)						
Frequency (MHz)	Antenna 1			Antenna 2		
	5210	5290	5775	5210	5290	5775
Target (dBm)	15.0	15.0	15.0	14.0	14.0	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0	1.0	1.0	1.0

### 4.3 Measurement Results

#### Bluetooth

Mode	Frequency (MHz)	Output power (Including tune-up tolerance) (dBm)	Output power (mW)	Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm <sup>2</sup> )
GFSK-BLE	2402	4.00	2.5119	3.0	1.9953	0.0010
	2440	5.00	3.1623	3.0	1.9953	0.0013
	2480	5.00	3.1623	3.0	1.9953	0.0013
GFSK	2402	-5.00	0.3163	3.0	1.9953	0.0001
	2441	-4.00	0.3981	3.0	1.9953	0.0002
	2480	-3.00	0.5012	3.0	1.9953	0.0002
8DPSK	2402	-9.00	0.1259	3.0	1.9953	0.00005
	2441	-8.00	0.1585	3.0	1.9953	0.00006
	2480	-7.00	0.1995	3.0	1.9953	0.00008
$\pi/4$ DQPSK	2402	-9.00	0.1259	3.0	1.9953	0.00005
	2441	-8.00	0.1585	3.0	1.9953	0.00006
	2480	-7.00	0.1995	3.0	1.9953	0.00008

#### WIFI

##### Antenna 1

Mode	Frequency (MHz)	Output power (Including tune-up tolerance) (dBm)	Output power (mW)	Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm <sup>2</sup> )
IEEE 802.11b	2412	7.00	5.0119	3	1.9953	0.0020
	2437	6.00	3.9811	3	1.9953	0.0016
	2462	6.00	3.9811	3	1.9953	0.0016
IEEE 802.11g	2412	8.00	6.3096	3	1.9953	0.0025
	2437	8.00	6.3096	3	1.9953	0.0025
	2462	7.00	5.0119	3	1.9953	0.0020
IEEE 802.11n HT20	2412	6.00	3.9811	3	1.9953	0.0016
	2437	5.00	3.1623	3	1.9953	0.0013
	2462	5.00	3.1623	3	1.9953	0.0013
	5180	16.00	39.8107	3	1.9953	0.0158



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	5200	16.00	39.8107	3	1.9953	0.0158
	5240	16.00	39.8107	3	1.9953	0.0158
	5260	16.00	39.8107	3	1.9953	0.0158
	5300	16.00	39.8107	3	1.9953	0.0158
	5320	16.00	39.8107	3	1.9953	0.0158
	5745	16.00	39.8107	3	1.9953	0.0158
	5785	16.00	39.8107	3	1.9953	0.0158
	5825	16.00	39.8107	3	1.9953	0.0158
IEEE 802.11n HT40	2422	5.00	3.1623	3	1.9953	0.0013
	2437	5.00	3.1623	3	1.9953	0.0013
	2452	5.00	3.1623	3	1.9953	0.0013
	5190	17.00	50.1187	3	1.9953	0.0199
	5230	17.00	50.1187	3	1.9953	0.0199
	5270	16.00	39.8107	3	1.9953	0.0158
	5310	16.00	39.8107	3	1.9953	0.0158
	5755	16.00	39.8107	3	1.9953	0.0158
	5795	16.00	39.8107	3	1.9953	0.0158
IEEE 802.11ac 80	5210	16.00	39.8107	3	1.9953	0.0158
	5290	16.00	39.8107	3	1.9953	0.0158
	5775	16.00	39.8107	3	1.9953	0.0158
IEEE 802.11a	5180	16.00	39.8107	3	1.9953	0.0158
	5200	16.00	39.8107	3	1.9953	0.0158
	5240	16.00	39.8107	3	1.9953	0.0158
	5260	16.00	39.8107	3	1.9953	0.0158
	5300	16.00	39.8107	3	1.9953	0.0158
	5320	16.00	39.8107	3	1.9953	0.0158
	5745	16.00	39.8107	3	1.9953	0.0158
	5785	16.00	39.8107	3	1.9953	0.0158
	5825	16.00	39.8107	3	1.9953	0.0158

## Antenna 2

Mode	Frequency (MHz)	Output power (Including tune-up tolerance) (dBm)	Output power (mW)	Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm <sup>2</sup> )
IEEE 802.11b	2412	7.00	5.0119	3	1.9953	0.0020
	2437	6.00	3.9811	3	1.9953	0.0016
	2462	6.00	3.9811	3	1.9953	0.0016
IEEE 802.11g	2412	8.00	6.3096	3	1.9953	0.0025
	2437	8.00	6.3096	3	1.9953	0.0025
	2462	7.00	5.0119	3	1.9953	0.0020
IEEE	2412	6.00	3.9811	3	1.9953	0.0016





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802.11n HT20	2437	5.00	3.1623	3	1.9953	0.0013
	2462	5.00	3.1623	3	1.9953	0.0013
	5180	15.00	31.6228	3	1.9953	0.0126
	5200	15.00	31.6228	3	1.9953	0.0126
	5240	15.00	31.6228	3	1.9953	0.0126
	5260	15.00	31.6228	3	1.9953	0.0126
	5300	15.00	31.6228	3	1.9953	0.0126
	5320	15.00	31.6228	3	1.9953	0.0126
	5745	16.00	39.8107	3	1.9953	0.0158
	5785	16.00	39.8107	3	1.9953	0.0158
	5825	16.00	39.8107	3	1.9953	0.0158
IEEE 802.11n HT40	2422	5.00	3.1623	3	1.9953	0.0013
	2437	5.00	3.1623	3	1.9953	0.0013
	2452	5.00	3.1623	3	1.9953	0.0013
	5190	16.00	39.8107	3	1.9953	0.0158
	5230	16.00	39.8107	3	1.9953	0.0158
	5270	15.00	31.6228	3	1.9953	0.0126
	5310	15.00	31.6228	3	1.9953	0.0126
	5755	16.00	39.8107	3	1.9953	0.0158
	5795	17.00	50.1187	3	1.9953	0.0199
IEEE 802.11ac 80	5210	15.00	31.6228	3	1.9953	0.0126
	5290	15.00	31.6228	3	1.9953	0.0126
	5775	16.00	39.8107	3	1.9953	0.0158
IEEE 802.11a	5180	16.00	39.8107	3	1.9953	0.0158
	5200	16.00	39.8107	3	1.9953	0.0158
	5240	16.00	39.8107	3	1.9953	0.0158
	5260	16.00	39.8107	3	1.9953	0.0158
	5300	16.00	39.8107	3	1.9953	0.0158
	5320	16.00	39.8107	3	1.9953	0.0158
	5745	16.00	39.8107	3	1.9953	0.0158
	5785	16.00	39.8107	3	1.9953	0.0158
	5825	16.00	39.8107	3	1.9953	0.0158

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

$\Sigma$  of MPE ratios  $\leq 1.0$

Mode	Frequency (MHz)	$\Sigma$ MPE ratios (mW/cm <sup>2</sup> )	Limit	Results
Antenna 1 and Antenna 2				
GFSK-BLE	2402	N/A	1.000	Pass
	2440	N/A	1.000	Pass

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	2480	N/A	1.000	Pass
GFSK	2402	N/A	1.000	Pass
	2441	N/A	1.000	Pass
	2480	N/A	1.000	Pass
	2480	N/A	1.000	Pass
8DPSK	2402	N/A	1.000	Pass
	2441	N/A	1.000	Pass
	2480	N/A	1.000	Pass
$\pi/4$ DQPSK	2402	N/A	1.000	Pass
	2441	N/A	1.000	Pass
	2480	N/A	1.000	Pass
IEEE 802.11b	2412	N/A	1.000	Pass
	2442	N/A	1.000	Pass
	2462	N/A	1.000	Pass
IEEE 802.11g	2412	N/A	1.000	Pass
	2442	N/A	1.000	Pass
	2462	N/A	1.000	Pass
IEEE 802.11n HT20	2412	0.0032	1.000	Pass
	2442	0.0026	1.000	Pass
	2462	0.0026	1.000	Pass
	5180	0.0284	1.000	Pass
	5200	0.0284	1.000	Pass
	5240	0.0284	1.000	Pass
	5260	0.0284	1.000	Pass
	5300	0.0284	1.000	Pass
	5320	0.0284	1.000	Pass
	5745	0.0316	1.000	Pass
	5785	0.0316	1.000	Pass
	5825	0.0316	1.000	Pass
IEEE 802.11n HT40	2422	0.0026	1.000	Pass
	2442	0.0026	1.000	Pass
	2452	0.0026	1.000	Pass
	5190	0.0357	1.000	Pass
	5230	0.0357	1.000	Pass
	5270	0.0284	1.000	Pass
	5310	0.0284	1.000	Pass
	5755	0.0316	1.000	Pass
	5795	0.0357	1.000	Pass
IEEE 802.11ac 80	5210	0.0284	1.000	Pass
	5290	0.0284	1.000	Pass
	5775	0.0316	1.000	Pass
IEEE 802.11a	5180	N/A	1.000	Pass
	5200	N/A	1.000	Pass



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	5240	N/A	1.000	Pass
	5260	N/A	1.000	Pass
	5300	N/A	1.000	Pass
	5320	N/A	1.000	Pass
	5745	N/A	1.000	Pass
	5785	N/A	1.000	Pass
	5825	N/A	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.