



## 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  $\leq 1.0$ . 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

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



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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 EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the maximum gain of the used antenna is 2.15dBi for 2.4G WLAN and BT and 1dBi for ZigBee the RF power density can be obtained.

Frequency Band	Antenna type and antenna number	Maximum antenna gain
2.4GHz	WLAN Antenna	2.15dBi
BT4.0		
ZigBee	PCB Antenna	1dBi



## 4. Estimation Result

### 4.1 Conducted Power Results

#### *Bluetooth*

Mode	Channel	Frequency(MHz)	AVG Conducted Output Power (dBm)
GFSK-BLE	00	2402	7.40
	19	2442	7.00
	39	2480	6.50

#### *ZigBee*

Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
IEEE 802.15.4	2405	8.30
	2440	8.70
	2480	8.80

#### *2.4GHz WIFI*

Mode	Frequency(MHz)	AVG Conducted Output Power (dBm)
IEEE 802.11b	2412	13.90
	2437	13.70
	2462	13.50
IEEE 802.11g	2412	9.80
	2437	9.40
	2462	9.30
IEEE 802.11n HT20	2412	9.90
	2437	9.50
	2462	9.30

### 4.2 Manufacturing tolerance

#### *Bluetooth*

GFSK -BLE(AVG)			
Channel	Channel 00	Channel 19	Channel 39
Target (dBm)	7.0	7.0	6.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

#### *ZigBee*

IEEE 802.15.4 (AVG)			
Frequency (MHz)	2412	2437	2462
Target (dBm)	8.0	8.0	8.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0



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### 2.4GHz WIFI

IEEE 802.11 b (AVG)			
Frequency (MHz)	2412	2437	2462
Target (dBm)	13.0	13.0	13.0
Tolerance ±(dB)	1.0	1.0	1.0

IEEE 802.11 g ( Average)			
Frequency (MHz)	2412	2437	2462
Target (dBm)	9.0	9.0	9.0
Tolerance ±(dB)	1.0	1.0	1.0

IEEE 802.11 n HT20 (AVG)			
Frequency (MHz)	2412	2437	2462
Target (dBm)	9.0	9.0	9.0
Tolerance ±(dB)	1.0	1.0	1.0



## 4.3 Measurement Results

### 4.3.1 Standalone MPE

#### Bluetooth

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm <sup>2</sup> )	MPE Limits (mW/cm <sup>2</sup> )
	(dBm)	(mW)					
2402	8.0	6.3096	2.15	1.6406	100%	0.00206	1.0000
2442	8.0	6.3096	2.15	1.6406	100%	0.00206	1.0000
2480	7.0	5.0119	2.15	1.6406	100%	0.00164	1.0000

#### ZigBee

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm <sup>2</sup> )	MPE Limits (mW/cm <sup>2</sup> )
	(dBm)	(mW)					
2405	9.0	7.9433	1	1.2589	100%	0.00199	1.0000
2440	9.0	7.9433	1	1.2589	100%	0.00199	1.0000
2480	9.0	7.9433	1	1.2589	100%	0.00199	1.0000

#### 2.4G WLAN

Mode	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm <sup>2</sup> )	MPE Limits (mW/cm <sup>2</sup> )
	(dBm)	(mW)					
IEEE 802.11 b	14.0	125.3141	2.15	1.6406	100%	0.04092	1.0000
IEEE 802.11 g	10.0	10.0000	2.15	1.6406	100%	0.00327	1.0000
IEEE 802.11 n HT20	10.0	10.0000	2.15	1.6406	100%	0.00327	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 2402 MHz for Bluetooth and 2405MHz for Zigbee and 2412(lowest frequency operate at 2.4GHz) to calculate MPE limit as higher frequency will have higher MPE limits

### 4.3.2 Simultaneous MPE

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

#### Maximum Simultaneous transmission MPE Ratio for WLAN and ZigBee

Maximum MPE ratio WLAN	Maximum MPE ratio ZigBee	$\Sigma$ MPE ratios	Limit	Results
0.04092	0.00199	0.04291	1.000	Pass

**Maximum Simultaneous transmission MPE Ratio for Bluetooth and ZigBee**

Maximum MPE ratio WLAN	Maximum MPE ratio ZigBee	$\Sigma$ MPE ratios	Limit	Results
0.00206	0.00199	0.00405	1.000	Pass

Note:

- 1, WLAN and Bluetooth share the same antenna, they can't transmit Simultaneously.
- 2, 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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