

## 14 MAXIMUM PERMISSIBLE EXPOSURE (MPE)

### 14.1 Standard Applicable

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

This is a Mobile device, the MPE is required.

According to §1.1310 and §2.1093 RF exposure is calculated.

Limits for Maximum Permissive Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	F/1500	30
1500-15000	/	/	1.0	30

F = frequency in MHz

\* = Plane-wave equipment power density

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

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

*\*Please be noted that 2.4G antenna will not transmit together with 5G antenna.*

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## 14.2 Maximum Permissible Exposure (MPE) Evaluation

802.11b_Aux-1						
CH	Frequency (MHz)	Data Rate	Peak Output Power (dBm)	Peak Output Power (mW)	Limit	RESULT
1	2412	1	24.59	287.74	1 Watt = 30.00 dBm	PASS
6	2437	1	<b>24.82</b>	<b>303.39</b>	1 Watt = 30.00 dBm	PASS
11	2462	1	23.14	206.06	1 Watt = 30.00 dBm	PASS
802.11b_Aux-1						
CH	Frequency (MHz)	Data Rate	Avg. Output Power (dBm)	Avg. Output Power (mW)	Limit	RESULT
1	2412	1	22.83	191.87	1 Watt = 30.00 dBm	PASS
6	2437	1	<b>23.18</b>	<b>207.97</b>	1 Watt = 30.00 dBm	PASS
11	2462	1	21.18	131.22	1 Watt = 30.00 dBm	PASS

### MPE Prediction (802.11b 2412~2462)

Max. output power including tune-up tolerancel:	<b>23.18</b>	(dBm)
Max. output power including tune-up tolerancel:	207.96967	(mW)
Duty cycle:	<b>99.6</b>	(%)
Maximum Pav :	207.13779	(mW)
Peak Antenna gain (Maximum):	<b>5.44</b>	(dBi)
Peak Antenna gain (linear):	3.4994517	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	<b>2437</b>	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm <sup>2</sup> )
Power density at predication frequency at 20 (cm)	0.144	(mW/cm <sup>2</sup> )

### Measurement Result

The predicted power density level at 20 cm is 0.144 mW/cm<sup>2</sup>.

This is below the uncontrolled exposure limit of 1 mW/cm<sup>2</sup> at 2437MHz.

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802.11g_Aux-1						
CH	Frequency (MHz)	Data Rate	Peak Output Power (dBm)	Peak Output Power (mW)	Limit	RESULT
1	2412	6	23.77	238.23	1 Watt = 30.00 dBm	PASS
6	2437	6	<b>24.14</b>	<b>259.42</b>	1 Watt = 30.00 dBm	PASS
11	2462	6	23.57	227.51	1 Watt = 30.00 dBm	PASS
802.11g_Aux-1						
CH	Frequency (MHz)	Data Rate	Avg. Output Power (dBm)	Avg. Output Power (mW)	Limit	RESULT
1	2412	6	15.56	35.97	1 Watt = 30.00 dBm	PASS
6	2437	6	<b>16.01</b>	<b>39.90</b>	1 Watt = 30.00 dBm	PASS
11	2462	6	15.46	35.16	1 Watt = 30.00 dBm	PASS

### MPE Prediction (802.11g 2412~2462)

Max. output power including tune-up tolerancel:	<b>16.01</b>	(dBm)
Max. output power including tune-up tolerancel:	39.90249	(mW)
Duty cycle:	<b>96.28</b>	(%)
Maximum Pav :	38.418118	(mW)
Peak Antenna gain (Maximum):	<b>5.44</b>	(dBi)
Peak Antenna gain (linear):	3.4994517	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	<b>2437</b>	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm <sup>2</sup> )
Power density at predication frequency at 20 (cm)	0.027	(mW/cm <sup>2</sup> )

### Measurement Result

The predicted power density level at 20 cm is 0.027 mW/cm<sup>2</sup>.

This is below the uncontrolled exposure limit of 1 mW/cm<sup>2</sup> at 2437MHz.

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802.11n_20M 3TX									
CH	Frequency (MHz)	Data Rate	Peak Output Power (dBm)			Total Peak Output Power (dBm)	Total Peak Output Power (mW)	Limit	RESULT
			CHAIN 1	CHAIN 2	CHAIN 3				
1	2412	mcs16	19.03	19.18	18.92	23.82	240.76	1 Watt = 25.79 dBm	PASS
6	2437	mcs16	19.68	19.83	19.36	24.40	275.36	1 Watt = 25.79 dBm	PASS
11	2462	mcs16	18.36	18.55	18.25	23.16	207.00	1 Watt = 25.79 dBm	PASS
802.11n_20M 3TX									
CH	Frequency (MHz)	Data Rate	Avg. Output Power (dBm)			Total Peak Output Power (dBm)	Total Peak Output Power (mW)	Limit	RESULT
			CHAIN 1	CHAIN 2	CHAIN 3				
1	2412	mcs16	15.34	16.34	14.73	20.29	106.97	1 Watt = 25.79 dBm	PASS
6	2437	mcs16	15.69	16.75	15.15	20.69	117.12	1 Watt = 25.79 dBm	PASS
11	2462	mcs16	15.32	15.39	14.72	19.92	98.28	1 Watt = 25.79 dBm	PASS

### MPE Prediction (802.11n\_HT20 2412~2462)

MIMO gain=  $G+(10 \log N)= 5.44+4.77= 10.21\text{dBm}$

Max. output power including tune-up tolerancel:	20.69	(dBm)
Max. output power including tune-up tolerancel:	117.21954	(mW)
Duty cycle:	89.94	(%)
Maximum Pav :	105.42725	(mW)
Peak Antenna gain (Maximum):	10.21	(dBi)
Peak Antenna gain (linear):	10.495424	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2437	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm^2)
Power density at predication frequency at 20 (cm)	0.220	(mW/cm^2)

### Measurement Result

The predicted power density level at 20 cm is 0.22 mW/cm2.

This is below the uncontrolled exposure limit of 1 mW/cm2 at 2437MHz.

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802.11n_40M 3TX									
CH	Frequency (MHz)	Data Rate	Peak Output Power (dBm)			Total Peak Output Power (dBm)	Total Peak Output Power (mW)	Limit	RESULT
			CHAIN 1	CHAIN 2	CHAIN 3				
3	2422	mcs16	16.84	17.03	16.59	21.59	144.38	1 Watt = 25.79 dBm	PASS
6	2437	mcs16	16.66	16.79	16.55	21.44	139.28	1 Watt = 25.79 dBm	PASS
9	2452	mcs16	16.51	16.62	16.42	21.29	134.54	1 Watt = 25.79 dBm	PASS
802.11n_40M 3TX									
CH	Frequency (MHz)	Data Rate	Avg. Output Power (dBm)			Total Peak Output Power (dBm)	Total Peak Output Power (mW)	Limit	RESULT
			CHAIN 1	CHAIN 2	CHAIN 3				
3	2422	mcs16	13.36	13.42	12.6	17.91	61.85	1 Watt = 25.79 dBm	PASS
6	2437	mcs16	13.29	13.31	12.52	17.83	60.62	1 Watt = 25.79 dBm	PASS
9	2452	mcs16	13.01	13.21	12.22	17.61	57.61	1 Watt = 25.79 dBm	PASS

### MPE Prediction (802.11n\_HT40 2422~2452)

MIMO gain=  $G+(10 \log N)= 5.44+4.77= 10.21\text{dBm}$

Max. output power including tune-up tolerancel:	17.91	(dBm)
Max. output power including tune-up tolerancel:	61.80164	(mW)
Duty cycle:	82	(%)
Maximum Pav :	50.677345	(mW)
Peak Antenna gain (Maximum):	10.21	(dBi)
Peak Antenna gain (linear):	10.495424	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2422	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm <sup>2</sup> )
Power density at predication frequency at 20 (cm)	0.106	(mW/cm <sup>2</sup> )

### Measurement Result

The predicted power density level at 20 cm is 0.106 mW/cm<sup>2</sup>.

This is below the uncontrolled exposure limit of 1 mW/cm<sup>2</sup> at 2422MHz.

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