

1 MAXIMUM PERMISSIBLE EXPOSURE (MPE)

1.1 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 ²)	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 ²)	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

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802.11a Max. output power

802.11a_Main

CH	Frequency (MHz)	Data Rate	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	MCS0	13.98	25.003	23.98	PASS
44	5220	MCS0	13.96	24.889	23.98	PASS
48	5240	MCS0	13.92	24.660	23.98	PASS
52	5260	MCS0	13.76	23.768	23.98 or $11+10\log(B) = 24.54$	PASS
60	5300	MCS0	13.78	23.878	23.98 or $11+10\log(B) = 23.92$	PASS
64	5320	MCS0	13.70	23.442	23.98 or $11+10\log(B) = 24.01$	PASS
100	5500	MCS0	11.49	14.093	23.98 or $11+10\log(B) = 23.84$	PASS
116	5580	MCS0	13.71	23.496	23.98 or $11+10\log(B) = 23.89$	PASS
140	5700	MCS0	12.33	17.100	23.98 or $11+10\log(B) = 23.79$	PASS
149	5745	MCS0	13.94	24.774	30	PASS
157	5785	MCS0	13.98	25.003	30	PASS
165	5825	MCS0	13.86	24.322	30	PASS

MPE Prediction (802.11a 5150~5250)

Average output power at antenna input terminal:	13.98	(dBm)
Average output power at antenna input terminal:	25.003454	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	23.803288	(mW)
Peak Antenna gain (Maximum):	5.35	(dBi)
Peak Antenna gain (linear):	3.4276779	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5180	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.016	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.016 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5180MHz.		

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MPE Prediction (802.11a 5250~5350)

Average output power at antenna input terminal:	13.78	(dBm)
Average output power at antenna input terminal:	23.878113	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	22.731963	(mW)
Peak Antenna gain (Maximum):	5.35	(dBi)
Peak Antenna gain (linear):	3.4276779	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5300	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.016	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.016 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5300MHz.

MPE Prediction (802.11a 5470~5725)

Average output power at antenna input terminal:	13.71	(dBm)
Average output power at antenna input terminal:	23.496328	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	22.368504	(mW)
Peak Antenna gain (Maximum):	4.05	(dBi)
Peak Antenna gain (linear):	2.5409727	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5580	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.011	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.011 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5580MHz.

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MPE Prediction (802.11a 5725~5850)

Average output power at antenna input terminal:	13.98	(dBm)
Average output power at antenna input terminal:	25.003454	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	23.803288	(mW)
Peak Antenna gain (Maximum):	4.57	(dBi)
Peak Antenna gain (linear):	2.864178	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5785	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.014	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.014 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5785MHz.

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802.11n_HT20M Max. output power

802.11n_HT20_MIMO

CH	Frequency (MHz)	Data Rate	RAGE POWER (dBm)		TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)		RESULT
			CH 0	CH 1					
36	5180	MCS8	9.72	9.65	12.70	18.601		21.62	PASS
44	5220	MCS8	9.69	9.62	12.67	18.473		21.62	PASS
48	5240	MCS8	9.98	9.91	12.96	19.749		21.62	PASS
52	5260	MCS8	9.99	9.89	12.95	19.727	21.62	or $11+10\log(B) = 23.94$	PASS
60	5300	MCS8	10.04	9.88	12.97	19.820	21.62	or $11+10\log(B) = 23.93$	PASS
64	5320	MCS8	9.98	9.77	12.89	19.438	21.62	or $11+10\log(B) = 23.95$	PASS
100	5500	MCS8	9.94	9.65	12.81	19.089	22.92	or $11+10\log(B) = 23.99$	PASS
116	5580	MCS8	10.28	9.61	12.97	19.807	22.92	or $11+10\log(B) = 23.95$	PASS
140	5700	MCS8	10.27	9.34	12.84	19.232	22.92	or $11+10\log(B) = 23.95$	PASS
149	5745	MCS8	10.23	9.27	12.79	18.997		28.42	PASS
157	5785	MCS8	10.22	9.21	12.75	18.856		28.42	PASS
165	5825	MCS8	10.14	9.23	12.72	18.703		28.42	PASS

MPE Prediction (802.11n_HT20 5150~5250)

MIMO gain= $G+(10\log N) = 5.35+3.01=8.36\text{dBm}$

Average output power at antenna input terminal:	12.96	(dBm)
Average output power at antenna input terminal:	19.769696	(mW)
Duty cycle:	94.9	(%)
Maximum Pav :	18.761442	(mW)
Peak Antenna gain (Maximum):	8.36	(dBi)
Peak Antenna gain (linear):	6.8548823	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5240	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.026	(mW/cm ²)

Measurement Result
The predicted power density level at 20 cm is 0.026 mW/cm².
This is below the uncontrolled exposure limit of 1 mW/cm² at 5240MHz.

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MPE Prediction (802.11n_HT20 5250~5350)

MIMO gain= G+(10 logN)= 5.35+3.01= 8.36dBm

Average output power at antenna input terminal:	12.97	(dBm)
Average output power at antenna input terminal:	19.81527	(mW)
Duty cycle:	94.9	(%)
Maximum Pav :	18.804691	(mW)
Peak Antenna gain (Maximum):	8.36	(dBi)
Peak Antenna gain (linear):	6.8548823	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5300	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.026	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.026 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5300MHz.

MPE Prediction (802.11n_HT20 5470~5725)

MIMO gain= G+(10 logN)= 4.05+3.01= 7.06dBm

Average output power at antenna input terminal:	12.97	(dBm)
Average output power at antenna input terminal:	19.81527	(mW)
Duty cycle:	94.9	(%)
Maximum Pav :	18.804691	(mW)
Peak Antenna gain (Maximum):	7.06	(dBi)
Peak Antenna gain (linear):	5.0815944	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5580	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.019	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.019 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5580MHz.

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MPE Prediction (802.11n_HT20 5725~5850)**MIMO gain= G+(10 logN)= 4.57+3.01= 7.58dBm**

Average output power at antenna input terminal:	12.79	(dBm)
Average output power at antenna input terminal:	19.010783	(mW)
Duty cycle:	94.9	(%)
Maximum Pav :	18.041233	(mW)
Peak Antenna gain (Maximum):	7.58	(dBi)
Peak Antenna gain (linear):	5.7279603	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5745	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.021	(mW/cm ²)

Measurement ResultThe predicted power density level at 20 cm is 0.021 mW/cm².This is below the uncontrolled exposure limit of 1 mW/cm² at 5745MHz.

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802.11n_HT40M Max. output power

802.11n_HT40_MIMO

CH	Frequency (MHz)	Data Rate	RAGE POWER (dBm)		TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)		RESULT
			CH 0	CH 1					
38	5190	MCS8	8.61	8.59	11.61	14.489	21.62		PASS
46	5230	MCS8	8.66	8.58	11.63	14.556	21.62		PASS
54	5270	MCS8	8.61	8.53	11.58	14.390	21.62 or 11+10log(B) =	27.02	PASS
62	5310	MCS8	8.93	8.88	11.92	15.543	21.62 or 11+10log(B) =	27.17	PASS
102	5510	MCS8	9.17	8.66	11.93	15.606	22.92 or 11+10log(B) =	27.16	PASS
110	5550	MCS8	9.32	8.59	11.98	15.778	22.92 or 11+10log(B) =	27.03	PASS
134	5670	MCS8	9.22	8.38	11.83	15.243	22.92 or 11+10log(B) =	27.20	PASS
151	5755	MCS8	9.19	8.36	11.81	15.153	28.42		PASS
159	5795	MCS8	9.08	8.33	11.73	14.899	28.42		PASS

MPE Prediction (802.11n_HT40 5150~5250)

MIMO gain= G+(10 logN)= 5.35+3.01= 8.36dBm

Average output power at antenna input terminal:	11.63	(dBm)
Average output power at antenna input terminal:	14.554591	(mW)
Duty cycle:	90.44	(%)
Maximum Pav :	13.163172	(mW)
Peak Antenna gain (Maximum):	8.36	(dBi)
Peak Antenna gain (linear):	6.8548823	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5230	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.018	(mW/cm ²)

Measurement Result
The predicted power density level at 20 cm is 0.018 mW/cm².
This is below the uncontrolled exposure limit of 1 mW/cm² at 5230MHz.

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MPE Prediction (802.11n-HT40 5250~5350)

MIMO gain= G+(10 logN)= 5.35+3.01= 8.36dBm

Average output power at antenna input terminal:	11.92	(dBm)
Average output power at antenna input terminal:	15.559656	(mW)
Duty cycle:	90.44	(%)
Maximum Pav :	14.072153	(mW)
Peak Antenna gain (Maximum):	8.36	(dBi)
Peak Antenna gain (linear):	6.8548823	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5310	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.019	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.019 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5310MHz.		

MPE Prediction (802.11n-HT40 5470~5725)

MIMO gain= G+(10 logN)= 4.05+3.01= 7.06dBm

Average output power at antenna input terminal:	11.98	(dBm)
Average output power at antenna input terminal:	15.776113	(mW)
Duty cycle:	90.44	(%)
Maximum Pav :	14.267916	(mW)
Peak Antenna gain (Maximum):	7.06	(dBi)
Peak Antenna gain (linear):	5.0815944	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5550	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.014	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.014 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5550MHz.

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MPE Prediction (802.11n-HT40 5725~5850)

MIMO gain= G+(10 logN)= 4.57+3.01= 7.58dBm

Average output power at antenna input terminal:	11.81	(dBm)
Average output power at antenna input terminal:	15.170504	(mW)
Duty cycle:	90.44	(%)
Maximum Pav :	13.720204	(mW)
Peak Antenna gain (Maximum):	7.58	(dBi)
Peak Antenna gain (linear):	5.7279603	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5755	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.016	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.016 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5755MHz.

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802.11ac VHT80M Max. output power

802.11ac VHT80 MIMO

CH	Frequency (MHz)	Data Rate	RAGE POWER (dBm)		TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)		RESULT
			CH 0	CH 1					
42	5210	MCS8	5.94	5.63	8.80	7.582		21.62	PASS
58	5290	MCS8	5.94	5.63	8.80	7.582	21.62	or $11+10\log(B) = 30.08$	PASS
106	5530	MCS8	6.02	5.3	8.69	7.388	22.92	or $11+10\log(B) = 30.07$	PASS
122	5610	MCS8	6.41	5.28	8.89	7.748	22.92	or $11+10\log(B) = 30.12$	PASS
155	5775	MCS8	6.21	5.28	8.78	7.551		28.42	PASS

MPE Prediction (802.11ac_VHT80 5150~5250)

MIMO gain= G+(10 logN)= 5.35+3.01= 8.36dBm

Average output power at antenna input terminal:	8.80	(dBm)
Average output power at antenna input terminal:	7.5857758	(mW)
Duty cycle:	82.93	(%)
Maximum Pav :	6.2908838	(mW)
Peak Antenna gain (Maximum):	8.36	(dBi)
Peak Antenna gain (linear):	6.8548823	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5210	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.009	(mW/cm ²)

Measurement Result
The predicted power density level at 20 cm is 0.009 mW/cm².
This is below the uncontrolled exposure limit of 1 mW/cm² at 5210MHz.

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MPE Prediction (802.11ac_VHT80 5250~5350)

MIMO gain= G+(10 logN)= 5.35+3.01= 8.36dBm

Average output power at antenna input terminal:	8.80	(dBm)
Average output power at antenna input terminal:	7.5857758	(mW)
Duty cycle:	82.93	(%)
Maximum Pav :	6.2908838	(mW)
Peak Antenna gain (Maximum):	8.36	(dBi)
Peak Antenna gain (linear):	6.8548823	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5290	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.009	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.009 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5290MHz.		

MPE Prediction (802.11ac_VHT80 5470~5725)

MIMO gain= G+(10 logN)= 4.05+3.01= 7.06dBm

Average output power at antenna input terminal:	8.89	(dBm)
Average output power at antenna input terminal:	7.744618	(mW)
Duty cycle:	82.93	(%)
Maximum Pav :	6.4226117	(mW)
Peak Antenna gain (Maximum):	7.06	(dBi)
Peak Antenna gain (linear):	5.0815944	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5610	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.006	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.006 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5610MHz.

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MPE Prediction (802.11ac_VHT80 5725~5850)

MIMO gain= G+(10 logN)= 4.57+3.01= 7.58dBm

Average output power at antenna input terminal:	8.78	(dBm)
Average output power at antenna input terminal:	7.5509223	(mW)
Duty cycle:	82.93	(%)
Maximum Pav :	6.2619798	(mW)
Peak Antenna gain (Maximum):	7.58	(dBi)
Peak Antenna gain (linear):	5.7279603	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5775	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.007	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.007 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5775MHz.

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