

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)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	14.47	27.990	23.98	PASS
44	5220	14.46	27.925	23.98	PASS
48	5240	14.43	27.733	23.98	PASS
52	5260	14.41	27.606	23.98 or 11+10log(B) 24.37	PASS
60	5300	14.48	28.054	23.98 or 11+10log(B) 24.34	PASS
64	5320	14.40	27.542	23.98 or 11+10log(B) 24.34	PASS
100	5500	14.42	27.669	23.98 or 11+10log(B) 24.31	PASS
116	5580	14.43	27.733	23.98 or 11+10log(B) 24.33	PASS
140	5700	14.47	27.990	23.98 or 11+10log(B) 24.37	PASS
149	5745	14.42	27.669	30	PASS
157	5785	14.39	27.479	30	PASS
165	5825	14.45	27.861	30	PASS

MPE Prediction (802.11a 5150~5250)

Average output power at antenna input terminal:	14.47	(dBm)
Average output power at antenna input terminal:	27.989813	(mW)
Duty cycle:	95.1	(%)
Maximum Pav :	26.618312	(mW)
Peak Antenna gain (Maximum):	4.61	(dBi)
Peak Antenna gain (linear):	2.8906799	(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)	0.015	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.015 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:	14.48	(dBm)
Average output power at antenna input terminal:	28.054336	(mW)
Duty cycle:	95.1	(%)
Maximum Pav :	26.679674	(mW)
Peak Antenna gain (Maximum):	4.61	(dBi)
Peak Antenna gain (linear):	2.8906799	(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)	0.015	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.015 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5300MHz.		

MPE Prediction (802.11a 5470~5725)

Average output power at antenna input terminal:	14.47	(dBm)
Average output power at antenna input terminal:	27.989813	(mW)
Duty cycle:	95.1	(%)
Maximum Pav :	26.618312	(mW)
Peak Antenna gain (Maximum):	4.45	(dBi)
Peak Antenna gain (linear):	2.7861212	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5700	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.015	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.015 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5700MHz.		

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MPE Prediction (802.11a 5725~5850)

Average output power at antenna input terminal:	14.45	(dBm)
Average output power at antenna input terminal:	27.861212	(mW)
Duty cycle:	95.1	(%)
Maximum Pav :	26.496012	(mW)
Peak Antenna gain (Maximum):	3.42	(dBi)
Peak Antenna gain (linear):	2.1978599	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5825	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.012	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.012 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5825MHz.

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802.11n_HT20M Max. output power

802.11n_HT20_MIMO

CH	Frequency (MHz)	AVERAGE POWER (dBm)		TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)		RESULT
		CHAIN 0	CHAIN 1					
36	5180	15.51	12.99	17.44	55.470	22.36		PASS
44	5220	15.16	12.98	17.22	52.670	22.36		PASS
48	5240	15.17	12.88	17.18	52.294	22.36		PASS
52	5260	15.43	13.25	17.49	56.049	22.36 or 11+10log(B)	24.31	PASS
60	5300	15.23	13.4	17.42	55.220	22.36 or 11+10log(B)	24.32	PASS
64	5320	15.24	13.55	17.49	56.066	22.36 or 11+10log(B)	24.36	PASS
100	5500	14.38	14.39	17.40	54.895	22.52 or 11+10log(B)	24.39	PASS
116	5580	13.85	14.49	17.19	52.385	22.52 or 11+10log(B)	24.32	PASS
140	5700	13.82	14.90	17.40	55.002	22.52 or 11+10log(B)	24.40	PASS
149	5745	13.93	14.62	17.30	53.691	29.57		PASS
157	5785	13.86	14.55	17.23	52.832	29.57		PASS
165	5825	13.97	14.53	17.27	53.325	29.57		PASS

MPE Prediction (802.11n_HT20 5150~5250)

MIMO gain= G+(10 logN)= 4.61+3.01= 7.62dBm

Average output power at antenna input terminal:	17.44	(dBm)
Average output power at antenna input terminal:	55.462571	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	52.800368	(mW)
Peak Antenna gain (Maximum):	7.62	(dBi)
Peak Antenna gain (linear):	5.7809605	(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)	0.061	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.061 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5180MHz.

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MPE Prediction (802.11n_HT20 5250~5350)

MIMO gain= $G+(10 \log N)= 4.61+3.01= 7.62\text{dBm}$

Average output power at antenna input terminal:	17.49	(dBm)
Average output power at antenna input terminal:	56.104798	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	53.411767	(mW)
Peak Antenna gain (Maximum):	7.62	(dBi)
Peak Antenna gain (linear):	5.7809605	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5320	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.061	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.061 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5320MHz.

MPE Prediction (802.11n_HT20 5470~5725)

MIMO gain= $G+(10 \log N)= 4.45+3.01= 7.46\text{dBm}$

Average output power at antenna input terminal:	17.40	(dBm)
Average output power at antenna input terminal:	54.954087	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	52.316291	(mW)
Peak Antenna gain (Maximum):	7.46	(dBi)
Peak Antenna gain (linear):	5.5718575	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5700	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.058	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.058 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5700MHz.

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MPE Prediction (802.11n_HT20 5725~5850)

MIMO gain= $G+(10 \log N)= 3.42+3.01= 6.43\text{dBm}$

Average output power at antenna input terminal:	17.30	(dBm)
Average output power at antenna input terminal:	53.70318	(mW)
Duty cycle:	95.2	(%)
Maximum Pav :	51.125427	(mW)
Peak Antenna gain (Maximum):	6.43	(dBi)
Peak Antenna gain (linear):	4.3954162	(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)	0.045	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.045 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)	AVERAGE POWER (dBm)		TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
		CHAIN 0	CHAIN 1				
38	5190	14.89	12.73	16.95	49.582	22.36	PASS
46	5230	15.58	12.99	17.49	56.048	22.36	PASS
54	5270	15.28	13.19	17.37	54.574	22.36 or 11+10log(B) 27.02	PASS
62	5310	15.18	13.07	17.26	53.238	22.36 or 11+10log(B) 27.04	PASS
102	5510	12.15	12.22	15.20	33.078	22.52 or 11+10log(B) 27.05	PASS
110	5550	14.28	14.44	17.37	54.589	22.52 or 11+10log(B) 27.03	PASS
134	5670	14.05	14.77	17.44	55.401	22.52 or 11+10log(B) 27.09	PASS
151	5755	10.47	11.26	13.89	24.509	29.57	PASS
159	5795	13.84	14.43	17.16	51.943	29.57	PASS

MPE Prediction (802.11n_HT40 5150~5250)

MIMO gain= $G+(10 \log N)= 4.61+3.01= 7.62\text{dBm}$

Average output power at antenna input terminal:	17.49	(dBm)
Average output power at antenna input terminal:	56.104798	(mW)
Duty cycle:	90.4	(%)
Maximum Pav :	50.718737	(mW)
Peak Antenna gain (Maximum):	7.62	(dBi)
Peak Antenna gain (linear):	5.7809605	(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)	0.058	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.058 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5230MHz.		

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MPE Prediction (802.11n_HT40 5250~5350)

MIMO gain= $G+(10 \log N)= 4.61+3.01= 7.62\text{dBm}$

Average output power at antenna input terminal:	17.37	(dBm)
Average output power at antenna input terminal:	54.575786	(mW)
Duty cycle:	90.4	(%)
Maximum Pav :	49.336511	(mW)
Peak Antenna gain (Maximum):	7.62	(dBi)
Peak Antenna gain (linear):	5.7809605	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5270	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.057	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.057 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5270MHz.		

MPE Prediction (802.11n_HT40 5470~5725)

MIMO gain= $G+(10 \log N)= 4.45+3.01= 7.46\text{dBm}$

Average output power at antenna input terminal:	17.44	(dBm)
Average output power at antenna input terminal:	55.462571	(mW)
Duty cycle:	90.4	(%)
Maximum Pav :	50.138164	(mW)
Peak Antenna gain (Maximum):	7.46	(dBi)
Peak Antenna gain (linear):	5.5718575	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5670	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.056	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.056 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5670MHz.		

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MPE Prediction (802.11n_HT40 5725~5850)

MIMO gain= $G+(10 \log N)= 3.42+3.01= 6.43\text{dBm}$

Average output power at antenna input terminal:	17.16	(dBm)
Average output power at antenna input terminal:	51.9996	(mW)
Duty cycle:	90.4	(%)
Maximum Pav :	47.007638	(mW)
Peak Antenna gain (Maximum):	6.43	(dBi)
Peak Antenna gain (linear):	4.3954162	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5795	(MHz)
MPE limit for uncontrolled exposure at prediction	1	(mW/cm ²)
Power density at predication frequency at 20 (cm)	0.041	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.041 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5795MHz.

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802.11ac VHT80M Max. output power

802.11ac VHT80 MIMO

CH	Frequency (MHz)	AVERAGE POWER (dBm)		TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
		CHAIN 0	CHAIN 1				
42	5210	13.54	11.36	15.60	36.272	22.36	PASS
58	5290	13.7	10.75	15.48	35.327	22.36 or 11+10log(B) 30.06	PASS
106	5530	8.29	8.5	11.41	13.825	22.52 or 11+10log(B) 30.04	PASS
155	5775	9.54	10.4	13.00	19.960	29.57	PASS

MPE Prediction (802.11ac_VHT80 5150~5250)

MIMO gain= G+(10 logN)= 4.61+3.01= 7.62dBm

Average output power at antenna input terminal:	15.60	(dBm)
Average output power at antenna input terminal:	36.307805	(mW)
Duty cycle:	94	(%)
Maximum Pav :	34.129337	(mW)
Peak Antenna gain (Maximum):	7.62	(dBi)
Peak Antenna gain (linear):	5.7809605	(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)	0.039	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.039 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5210MHz.		

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MPE Prediction (802.11ac_VHT80 5250~5350)

MIMO gain= $G+(10 \log N)= 4.61+3.01= 7.62\text{dBm}$

Average output power at antenna input terminal:	15.48	(dBm)
Average output power at antenna input terminal:	35.318317	(mW)
Duty cycle:	94	(%)
Maximum Pav :	33.199218	(mW)
Peak Antenna gain (Maximum):	7.62	(dBi)
Peak Antenna gain (linear):	5.7809605	(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)	0.038	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.038 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= $G+(10 \log N)= 4.45+3.01= 7.46\text{dBm}$

Average output power at antenna input terminal:	11.41	(dBm)
Average output power at antenna input terminal:	13.835664	(mW)
Duty cycle:	94	(%)
Maximum Pav :	13.005524	(mW)
Peak Antenna gain (Maximum):	7.46	(dBi)
Peak Antenna gain (linear):	5.5718575	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	5530	(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/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5530MHz.		

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MPE Prediction (802.11ac_VHT80 5725~5850)

MIMO gain= $G+(10 \log N)= 3.42+3.01= 6.43\text{dBm}$

Average output power at antenna input terminal:	13.00	(dBm)
Average output power at antenna input terminal:	19.952623	(mW)
Duty cycle:	94	(%)
Maximum Pav :	18.755466	(mW)
Peak Antenna gain (Maximum):	6.43	(dBi)
Peak Antenna gain (linear):	4.3954162	(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)	0.016	(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 5775MHz.

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