

15. MAXIMUM PERMISSIBLE EXPOSURE (MPE)

15.1 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

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

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802.11a Main

CH	Frequency (MHz)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	16.75	47.315	23.98	PASS
44	5220	17.76	59.704	23.98	PASS
48	5240	21.54	142.561	23.98	PASS
149	5745	16.52	44.875	30	PASS
157	5785	19.75	94.406	30	PASS
165	5825	18.95	78.524	30	PASS

MPE Prediction (802.11a 5150~5250)

Max. output power including tune-up tolerancel:	21.54	(dBm)
Max. output power including tune-up tolerancel:	142.56076	(mW)
Duty cycle:	86.37	(%)
Maximum Pav :	123.12973	(mW)
Peak Antenna gain (Maximum):	9.78	(dBi)
Peak Antenna gain (linear):	9.5060479	(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)	0.233	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.233 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5240MHz.		

MPE Prediction (802.11a 5725~5850)

Max. output power including tune-up tolerancel:	19.75	(dBm)
Max. output power including tune-up tolerancel:	94.406088	(mW)
Duty cycle:	96.37	(%)
Maximum Pav :	90.979147	(mW)
Peak Antenna gain (Maximum):	9.84	(dBi)
Peak Antenna gain (linear):	9.6382902	(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)	0.175	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.175 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5785MHz.		

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802.11ac_VHT20_MIMO

CH	Frequency (MHz)	AVERAGE POWER (dBm)			TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
		CHAIN 0	CHAIN 1	CHAIN 2				
36	5180	12.97	9.4	12.18	16.54	45.045	20.2	PASS
44	5220	12.98	9.2	11.75	16.35	43.141	20.2	PASS
48	5240	14.01	9.92	12.24	17.14	51.744	20.2	PASS
149	5745	18.15	17.82	14.72	21.92	155.495	26.16	PASS
157	5785	17.43	17.29	14.45	21.36	136.776	26.16	PASS
165	5825	17.01	16.89	13.38	20.82	120.877	26.16	PASS

MPE Prediction (802.11ac_VHT20 5150~5250)

MIMO gain= $G+(10 \log N)= 5.01+4.77= 9.78\text{dBm}$

Average output power at antenna input terminal:	17.14	(dBm)
Average output power at antenna input terminal:	51.760683	(mW)
Duty cycle:	59.51	(%)
Maximum Pav :	30.802783	(mW)
Peak Antenna gain (Maximum):	9.78	(dBi)
Peak Antenna gain (linear):	9.5060479	(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)	0.058	(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 5240MHz.		

MPE Prediction (802.11ac_VHT20 5725~5850)

MIMO gain= $G+(10 \log N)= 5.07+4.77= 9.84\text{dBm}$

Max. output power including tune-up tolerancel:	21.92	(dBm)
Max. output power including tune-up tolerancel:	155.59656	(mW)
Duty cycle:	89.51	(%)
Maximum Pav :	139.27448	(mW)
Peak Antenna gain (Maximum):	9.84	(dBi)
Peak Antenna gain (linear):	9.6382902	(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)	0.267	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.267 mW/cm².

This is below the uncontrolled exposure limit of 1 mW/cm² at 5745MHz.

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802.11ac_VHT40_MIMO

CH	Frequency (MHz)	AVERAGE POWER (dBm)			TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
		CHAIN 0	CHAIN 1	CHAIN 2				
38	5190	12.65	8.96	11.68	16.13	41.001	20.2	PASS
46	5230	16.62	12.01	15.26	19.79	95.379	20.2	PASS
151	5755	14.21	14.09	10.79	18.06	64.003	26.16	PASS
159	5795	16.62	16.54	13.64	20.57	114.122	26.16	PASS

MPE Prediction (802.11ac_VHT40 5150~5250)

MIMO gain= $G+(10 \log N)= 5.01+4.77= 9.78\text{dBm}$

Average output power at antenna input terminal:	19.79	(dBm)
Average output power at antenna input terminal:	95.279616	(mW)
Duty cycle:	82.32	(%)
Maximum Pav :	78.43418	(mW)
Peak Antenna gain (Maximum):	9.78	(dBi)
Peak Antenna gain (linear):	9.5060479	(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)	0.148	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.148 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5230MHz.		

MPE Prediction (802.11ac_VHT40 5725~5850)

MIMO gain= $G+(10 \log N)= 5.07+4.77= 9.84\text{dBm}$

Average output power at antenna input terminal:	20.57	(dBm)
Average output power at antenna input terminal:	114.02498	(mW)
Duty cycle:	82.32	(%)
Maximum Pav :	93.865363	(mW)
Peak Antenna gain (Maximum):	9.84	(dBi)
Peak Antenna gain (linear):	9.6382902	(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)	0.180	(mW/cm ²)

Measurement Result

The predicted power density level at 20 cm is 0.18 mW/cm².

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

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802.11ac_VHT80_MIMO

CH	Frequency (MHz)	AVERAGE POWER (dBm)			TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
		CHAIN 0	CHAIN 1	CHAIN 2				
42	5210	14.3	10.57	13.21	17.73	59.259	20.2	PASS
155	5775	13.48	13.37	10.29	17.38	54.702	26.16	PASS

MPE Prediction (802.11ac_VHT80 5150~5250)

MIMO gain= $G+(10 \log N)= 5.01+4.77= 9.78\text{dBm}$

Average output power at antenna input terminal:	17.73	(dBm)
Average output power at antenna input terminal:	59.292532	(mW)
Duty cycle:	72.73	(%)
Maximum Pav :	43.123459	(mW)
Peak Antenna gain (Maximum):	9.78	(dBi)
Peak Antenna gain (linear):	9.5060479	(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)	0.082	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.082 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5210MHz.		

MPE Prediction (802.11ac_VHT80 5725~5850)

MIMO gain= $G+(10 \log N)= 5.07+4.77= 9.84\text{dBm}$

Average output power at antenna input terminal:	17.38	(dBm)
Average output power at antenna input terminal:	54.701596	(mW)
Duty cycle:	72.73	(%)
Maximum Pav :	39.784471	(mW)
Peak Antenna gain (Maximum):	9.84	(dBi)
Peak Antenna gain (linear):	9.6382902	(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)	0.076	(mW/cm ²)
Measurement Result		
The predicted power density level at 20 cm is 0.076 mW/cm ² .		
This is below the uncontrolled exposure limit of 1 mW/cm ² at 5775MHz.		

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