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.*

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

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 logN)= 5.01+4.77= 9.78dBm

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/cm2)
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 5240MHz.

MPE Prediction (802.11ac_VHT20 5725~5850)

MIMO gain= G+(10 logN)= 5.07+4.77= 9.84dBm

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/cm2)
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.

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 logN)= 5.01+4.77= 9.78dBm

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/cm2)
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/cm2.
This is below the uncontrolled exposure limit of 1 mW/cm2 at 5230MHz.

MPE Prediction (802.11ac_VHT40 5725~5850)

MIMO gain= G+(10 logN)= 5.07+4.77= 9.84dBm

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/cm2)
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.

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 logN)= 5.01+4.77= 9.78dBm

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/cm2)
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/cm2.
This is below the uncontrolled exposure limit of 1 mW/cm2 at 5210MHz.

MPE Prediction (802.11ac_VHT80 5725~5850)

MIMO gain= G+(10 logN)= 5.07+4.77= 9.84dBm

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