1   FCC §2.1091, §15.407(f), & LP0002-2018 §5.20.2 - RF Exposure

1.1   Applicable Standards

According to FCC §15.247(i), §15.407(f) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
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
1500-100,000	/	/	1.0	30

   f = frequency in MHz
  * = Plane-wave equivalent power density

1.2   MPE Prediction

Predication of MPE limit at a given distance, Equation from 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

1.3   MPE Results for FCC

BLE:

Maximum average output power at antenna input terminal (dBm):	2.4
Maximum average output power at antenna input terminal (mW):	1.74
Prediction distance (cm):	30
Prediction frequency (MHz):	2402
Maximum Antenna Gain, typical (dBi):	6
Maximum Antenna Gain (numeric):	3.98
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.0006
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

2.4 GHz Do1 Wi-Fi (4x4):

Maximum average output power at antenna input terminal (dBm):	20.5
Maximum average output power at antenna input terminal (mW):	112.20
Prediction distance (cm):	30
Prediction frequency (MHz):	2437
Maximum Antenna Gain, typical (dBi):	12
Maximum Antenna Gain (numeric):	15.85
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.16
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

2.4 GHz ChillWave Wi-Fi (SISO):

Maximum average output power at antenna input terminal (dBm):	9.2
Maximum average output power at antenna input terminal (mW):	8.32
Prediction distance (cm):	30
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	6
Maximum Antenna Gain (numeric):	3.98
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.003
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do1 Wi-Fi (4x4)-5.2 GHz band:

Maximum average output power at antenna input terminal (dBm):	18
Maximum average output power at antenna input terminal (mW):	63.10
Prediction distance (cm):	30
Prediction frequency (MHz):	5230
Maximum Antenna Gain, typical (dBi):	8.77
Maximum Antenna Gain (numeric):	7.53
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.04
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do1 Wi-Fi (4x4)-5.3 GHz band:

Maximum average output power at antenna input terminal (dBm):	17.61
Maximum average output power at antenna input terminal (mW):	57.68
Prediction distance (cm):	30
Prediction frequency (MHz):	5270
Maximum Antenna Gain, typical (dBi):	12.02
Maximum Antenna Gain (numeric):	15.92
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.08
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do1 Wi-Fi (4x4)-5.6 GHz band:

Maximum average output power at antenna input terminal (dBm):	17.82
Maximum average output power at antenna input terminal (mW):	60.53
Prediction distance (cm):	30
Prediction frequency (MHz):	5550
Maximum Antenna Gain, typical (dBi):	12.02
Maximum Antenna Gain (numeric):	15.92
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.09
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do1 Wi-Fi (4x4)-5.8 GHz band:

Maximum average output power at antenna input terminal (dBm):	22.5
Maximum average output power at antenna input terminal (mW):	177.83
Prediction distance (cm):	30
Prediction frequency (MHz):	5755
Maximum Antenna Gain, typical (dBi):	12.02
Maximum Antenna Gain (numeric):	15.92
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.25
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do2 Wi-Fi (4x4)-5.2 GHz band:

Maximum average output power at antenna input terminal (dBm):	19.72
Maximum average output power at antenna input terminal (mW):	93.76
Prediction distance (cm):	30
Prediction frequency (MHz):	5230
Maximum Antenna Gain, typical (dBi):	8.77
Maximum Antenna Gain (numeric):	7.53
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.06
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do2 Wi-Fi (4x4)-5.3 GHz band:

Maximum average output power at antenna input terminal (dBm):	18.4
Maximum average output power at antenna input terminal (mW):	69.18
Prediction distance (cm):	30
Prediction frequency (MHz):	5270
Maximum Antenna Gain, typical (dBi):	10.77
Maximum Antenna Gain (numeric):	11.94
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.07
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do2 Wi-Fi (4x4)-5.6 GHz band:

Maximum average output power at antenna input terminal (dBm):	18.96
Maximum average output power at antenna input terminal (mW):	78.70
Prediction distance (cm):	30
Prediction frequency (MHz):	5550
Maximum Antenna Gain, typical (dBi):	10.77
Maximum Antenna Gain (numeric):	11.94
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.08
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Do2 Wi-Fi (4x4)-5.8 GHz band:

Maximum average output power at antenna input terminal (dBm):	21.9
Maximum average output power at antenna input terminal (mW):	154.88
Prediction distance (cm):	30
Prediction frequency (MHz):	5795
Maximum Antenna Gain, typical (dBi):	12.02
Maximum Antenna Gain (numeric):	15.92
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.22
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Wi-Fi (8x8)-5.2 GHz band:

Maximum average output power at antenna input terminal (dBm):	21.14
Maximum average output power at antenna input terminal (mW):	130.02
Prediction distance (cm):	30
Prediction frequency (MHz):	5240
Maximum Antenna Gain, typical (dBi):	13.78
Maximum Antenna Gain (numeric):	23.88
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.27
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Wi-Fi (8x8)-5.3 GHz band:

Maximum average output power at antenna input terminal (dBm):	16.01
Maximum average output power at antenna input terminal (mW):	39.90
Prediction distance (cm):	30
Prediction frequency (MHz):	5270
Maximum Antenna Gain, typical (dBi):	13.78
Maximum Antenna Gain (numeric):	23.88
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.08
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Wi-Fi (8x8)-5.6 GHz band:

Maximum average output power at antenna input terminal (dBm):	15.42
Maximum average output power at antenna input terminal (mW):	34.83
Prediction distance (cm):	30
Prediction frequency (MHz):	5610
Maximum Antenna Gain, typical (dBi):	13.78
Maximum Antenna Gain (numeric):	23.88
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.07
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz Wi-Fi (8x8)-5.8 GHz band:

Maximum average output power at antenna input terminal (dBm):	22.16
Maximum average output power at antenna input terminal (mW):	164.44
Prediction distance (cm):	30
Prediction frequency (MHz):	5775
Maximum Antenna Gain, typical (dBi):	13.78
Maximum Antenna Gain (numeric):	23.88
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.35
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz ChillWave Wi-Fi (SISO)-5.2 GHz band:

Maximum average output power at antenna input terminal (dBm):	9.1
Maximum average output power at antenna input terminal (mW):	8.13
Prediction distance (cm):	30
Prediction frequency (MHz):	5180
Maximum Antenna Gain, typical (dBi):	6
Maximum Antenna Gain (numeric):	3.98
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.003
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz ChillWave Wi-Fi (SISO)-5.3 GHz band:

Maximum average output power at antenna input terminal (dBm):	8.7
Maximum average output power at antenna input terminal (mW):	7.41
Prediction distance (cm):	30
Prediction frequency (MHz):	5260
Maximum Antenna Gain, typical (dBi):	6
Maximum Antenna Gain (numeric):	3.98
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.003
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz ChillWave Wi-Fi (SISO)-5.6 GHz band:

Maximum average output power at antenna input terminal (dBm):	9.8
Maximum average output power at antenna input terminal (mW):	9.55
Prediction distance (cm):	30
Prediction frequency (MHz):	5560
Maximum Antenna Gain, typical (dBi):	6
Maximum Antenna Gain (numeric):	3.98
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.003
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

5 GHz ChillWave Wi-Fi (SISO)-5.8 GHz band:

Maximum average output power at antenna input terminal (dBm):	7.2
Maximum average output power at antenna input terminal (mW):	5.25
Prediction distance (cm):	30
Prediction frequency (MHz):	5745
Maximum Antenna Gain, typical (dBi):	6
Maximum Antenna Gain (numeric):	3.98
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.002
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1

Radio Co-location

Case	Standalone MPE (mW/cm^2)							Total MPE Ratio	Limit
	BLE	2.4 GHz ChillWave	5 GHz ChillWave	2.4 GHz Do1	5 GHz Do1	5 GHz Do2	5 GHz 8x8		
1	0.0006	0.003	-	0.16	0.25	0.22	-	0.634	1
2	0.0006	-	0.003	0.16	0.25	0.22	-	0.634	1
3	0.0006	0.003	-	-	-	-	0.35	0.354	1
4	0.0006	-	0.003	-	-	-	0.35	0.354	1

Conclusion

The device is compliant with the requirement MPE limit for uncontrolled exposure. All transceiver modules must be installed with a separation distance of no less than **30** cm from all persons.
less than **30** cm from all persons.