1   FCC §2.1091, & LP0002-2018 §5.20.2 - RF Exposure

1.1   Applicable Standards

According to FCC §15.247(i), §15.407(f), §1.1307(b)(1), and LP0002-2018 §5.20.2, 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):	5.27
Maximum average output power at antenna input terminal (mW):	3.37
Prediction distance (cm):	30.00
Prediction frequency (MHz):	2402
Maximum Antenna Gain, typical (dBi):	4.00
Maximum Antenna Gain (numeric):	2.51
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.0007
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

2.4 GHz XOR Wi-Fi (4x4):

Maximum average output power at antenna input terminal (dBm):	23.70
Maximum average output power at antenna input terminal (mW):	234.42
Prediction distance (cm):	30.00
Prediction frequency (MHz):	2437
Maximum Antenna Gain, typical (dBi):	10.00
Maximum Antenna Gain (numeric):	10.00
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.21
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

2.4 GHz ChillWave Wi-Fi (SISO):

Maximum average output power at antenna input terminal (dBm):	20.10
Maximum average output power at antenna input terminal (mW):	102.33
Prediction distance (cm):	30.00
Prediction frequency (MHz):	2437
Maximum Antenna Gain, typical (dBi):	5.00
Maximum Antenna Gain (numeric):	3.16
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.03
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

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

Maximum average output power at antenna input terminal (dBm):	20.70
Maximum average output power at antenna input terminal (mW):	117.49
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5200
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):	0.17
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

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

Maximum average output power at antenna input terminal (dBm):	17.28
Maximum average output power at antenna input terminal (mW):	53.46
Prediction distance (cm):	30.00
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	17.95
Maximum average output power at antenna input terminal (mW):	62.37
Prediction distance (cm):	30.00
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	22.62
Maximum average output power at antenna input terminal (mW):	182.81
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5775
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):	0.26
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

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

Maximum average output power at antenna input terminal (dBm):	21.63
Maximum average output power at antenna input terminal (mW):	145.55
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5230
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):	0.20
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

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

Maximum average output power at antenna input terminal (dBm):	18.44
Maximum average output power at antenna input terminal (mW):	69.82
Prediction distance (cm):	30.00
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	17.32
Maximum average output power at antenna input terminal (mW):	53.95
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5670
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	21.21
Maximum average output power at antenna input terminal (mW):	132.13
Prediction distance (cm):	30.00
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):	0.19
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

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

Maximum average output power at antenna input terminal (dBm):	23.23
Maximum average output power at antenna input terminal (mW):	210.38
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5200
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):	0.30
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

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

Maximum average output power at antenna input terminal (dBm):	23.14
Maximum average output power at antenna input terminal (mW):	206.06
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5270
Maximum Antenna Gain, typical (dBi):	6.58
Maximum Antenna Gain (numeric):	4.55
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	23.08
Maximum average output power at antenna input terminal (mW):	203.24
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5510
Maximum Antenna Gain, typical (dBi):	6.58
Maximum Antenna Gain (numeric):	4.55
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	25.74
Maximum average output power at antenna input terminal (mW):	374.97
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5785
Maximum Antenna Gain, typical (dBi):	10.26
Maximum Antenna Gain (numeric):	10.62
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	19.70
Maximum average output power at antenna input terminal (mW):	93.33
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5240
Maximum Antenna Gain, typical (dBi):	6.00
Maximum Antenna Gain (numeric):	3.98
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.03
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.00

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

Maximum average output power at antenna input terminal (dBm):	20.20
Maximum average output power at antenna input terminal (mW):	104.71
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5300
Maximum Antenna Gain, typical (dBi):	6.00
Maximum Antenna Gain (numeric):	3.98
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	20.10
Maximum average output power at antenna input terminal (mW):	102.33
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5560
Maximum Antenna Gain, typical (dBi):	6.00
Maximum Antenna Gain (numeric):	3.98
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):	1.00

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

Maximum average output power at antenna input terminal (dBm):	20.20
Maximum average output power at antenna input terminal (mW):	104.71
Prediction distance (cm):	30.00
Prediction frequency (MHz):	5745
Maximum Antenna Gain, typical (dBi):	6.00
Maximum Antenna Gain (numeric):	3.98
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):	1.00

Radio Co-location

Case	Standalone MPE (mW/cm^2)							Total MPE Ratio	Limit
	BLE	2.4 GHz ChillWave	5 GHz ChillWave	2.4 GHz XOR	5 GHz XOR	5 GHz Regular	5 GHz 8x8		
1	0.0007	0.03	-	0.21	0.26	0.20	-	0.701	1
2	0.0007	-	0.04	0.21	0.26	0.20	-	0.711	1
3	0.0007	0.03	-	-	-	-	0.35	0.381	1
4	0.0007	-	0.04	-	-	-	0.35	0.391	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.