5 FCC §2.1091, §15.407(f) & ISEDC RSS-102 - RF Exposure

5.1 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

According to ISED RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

5.2 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

5.3 MPE Results for FCC

Radio Standalone RF Exposure Configuration

2.4 GHz Wi-Fi: 802.11g, Mid Channel 2442 MHz

Maximum output power at antenna input terminal (dBm):	19.8
Maximum output power at antenna input terminal (mW):	95.50
Prediction distance (cm):	30
Prediction frequency (MHz):	2442
Maximum Antenna Gain, typical (dBi):	9
Maximum Antenna Gain (numeric):	7.94
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.067
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

2.4 GHz Wi-Fi ChillWave: 802.11g, Low Channel 2412 MHz

Maximum output power at antenna input terminal (dBm):	9.2
Maximum output power at antenna input terminal (mW):	8.32
Prediction distance (cm):	30
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	7
Maximum Antenna Gain (numeric):	5.012
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.004
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

5 GHz Wi-Fi: 802.11a, Low Channel 5745 MHz

Maximum output power at antenna input terminal (dBm):	21.67
Maximum output power at antenna input terminal (mW):	146.89
Prediction distance (cm):	30
Prediction frequency (MHz):	5745
Maximum Antenna Gain, typical (dBi):	11
Maximum Antenna Gain (numeric):	12.59
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.164
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

5 GHz Wi-Fi ChillWave: 802.11a, Middle Channel 5560 MHz

Maximum output power at antenna input terminal (dBm):	9.8
Maximum output power at antenna input terminal (mW):	9.55
Prediction distance (cm):	30
Prediction frequency (MHz):	5560
Maximum Antenna Gain, typical (dBi):	10
Maximum Antenna Gain (numeric):	10
Power density of prediction frequency at 30.0 cm (mW/cm^2):	0.008
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

BLE: Low Channel 2402 MHz

Maximum output power at antenna input terminal (dBm):	2.4
Maximum 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):	1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure at 30 cm distance.

Radio Co-location RF Exposure Configuration

Standalone MPE (mW/cm^2)					Total MPE Ratio	Limit
BLE	2.4 GHz ChillWave	5 GHz ChillWave	2.4 GHz	5 GHz		
0.0006	0.004	0.008	0.067	0.164	0.244	1

5.4 RF exposure evaluation exemption for IC

2.4 GHz Wi-Fi: 802.11g, Mid Channel 2442 MHz

Maximum EIRP power = 19.8 dBm + 9 dBi = 28.8 dBm, which is less than $1.31\times10^{-2}f^{0.6834}$ = 2.70 W = 34.31 dBm

2.4 GHz Wi-Fi ChillWave: 802.11g, Low Channel 2412 MHz

Maximum EIRP power = 9.2 dBm + 7 dBi = 16.2 dBm, which is less than $1.31\times10^{-2}f^{0.6834}$ = 2.70 W = 34.31 dBm

5 GHz Wi-Fi: 802.11ax80, Low Channel 5745 MHz

Maximum EIRP power = 21.67 dBm + 11 dBi = 32.67 dBm, which is less than $1.31\times10^{-2}f^{0.6834}$ = 4.86 W = 36.87 dBm

5 GHz Wi-Fi ChillWave: 802.11a, Middle Channel 5560 MHz

Maximum EIRP power = 9.8 dBm + 10 dBi = 19.80 dBm, which is less than $1.31\times10^{-2}f^{0.6834}$ = 4.75 W = 36.77 dBm

BLE: Low Channel 2402 MHz

Maximum EIRP power = 2.4 dBm + 6 dBi = 8.4 dBm, which is less than $1.31\times10^{-2}f^{0.6834}$ = 2.68 W = 34.3 dBm

Therefore, the RF exposure Evaluation is not required.