5 FCC §2.1091, FCC §15.247(i) – RF Exposure

5.1 Applicable Standards

According to FCC §15.247(i) 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.

According to KDB 447 498 Section (7.2), "simultaneous transmission of MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum *test separation distance* required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency.

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

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

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

Note: According to MIMOFCC KDB 662911 D02 MIMO with Cross Polarized Antenna v01, Where an FCC rule specifies limits in radiated terms such as EIRP or ERP, the limits apply to the maximum emission that would be observed by a linearly polarized measurement antenna. Therefore, the highest output power from single antenna power was selected to calculate in this section.

5.3 RF exposure evaluation

Worst Case: 802.11b, 2412 MHz

Maximum output power at antenna input terminal (dBm):	16.23
Maximum output power at antenna input terminal (mW):	41.98
Prediction distance (cm):	20
Prediction frequency (MHz):	2412
Maximum Directional Antenna Gain, typical (dBi):	0
Maximum Antenna Gain (numeric):	1
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.00835
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 20cm is 0.00835 mW/cm^2. Limit is 1.0 mW/cm^2.

Worst Case: BLE, 2402 MHz

Maximum output power at antenna input terminal (dBm):	0.93
Maximum output power at antenna input terminal (mW):	1.239
Prediction distance (cm):	20
Prediction frequency (MHz):	2402
Maximum Directional Antenna Gain, typical (dBi):	-1.5
Maximum Antenna Gain (numeric):	0.708
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.0001745
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 20cm is 0.0001745 mW/cm^2. Limit is 1.0 mW/cm^2.

Worst case colocation: BT ratio + 2.4Wifi ratio + LTE ratio. 0.0001745/1 +0.00835/1 + 0.0353/1.0 = 0.0439 < 1

NOTE: For worst-case LTE Power, please refer to original LTE certification report number "NIE: 59675RAN.002A1" page 9(i.e. 24dBm for Band 2). Per client, their antenna gain is as follows:

Frequency [MHz]	Max gain [dBi]
725	-4.0
770	-4.0
860	-1.9
1745	-2.1
1880	**-1.5**
1970	-3.1
2135	-5.2