4 FCC §15.247(i), §2.1091 & IC RSS-102 – RF Exposure

4.1 Applicable Standard

According to FCC §15.247(i) 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

Before equipment certification is granted, the procedure of IC RSS-102 must be followed concerning the exposure of humans to RF field

According to IC RSS-102 Issue 5 section 4, RF limits used for general public will be applied to the EUT.

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

4.2 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

4.3 MPE Results

Antenna gain=2.2 dBi

Maximum peak output power at antenna input terminal (dBm):	24.38
Maximum peak output power at antenna input terminal (mW):	274.16
Prediction distance (cm):	20
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	2.2
Maximum Antenna Gain (numeric):	1.66
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.091
Power density of prediction frequency at 20.0 cm (W/m^2):	0.91
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
IC MPE limit for uncontrolled exposure at prediction frequency (W/m^2):	5.4

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.091 mW/cm^2 (0.91 W/m^2). Limit is 1.0 mW/cm^2 (10.0 W/m^2).

Antenna gain=6.5 dBi

Maximum peak output power at antenna input terminal (dBm):	24.27
Maximum peak output power at antenna input terminal (mW):	267.30
Prediction distance (cm):	20
Prediction frequency (MHz):	2437
Maximum Antenna Gain, typical (dBi):	6.5
Maximum Antenna Gain (numeric):	4.47
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.238
Power density of prediction frequency at 20.0 cm (W/m^2):	2.38
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
IC MPE limit for uncontrolled exposure at prediction frequency (W/m^2):	5.4

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.238 mW/cm^2 (2.38 W/m^2). Limit is 1.0 mW/cm^2 (5.4 W/m^2).

Antenna gain=13 dBi

Maximum peak output power at antenna input terminal (dBm):	18.27
Maximum peak output power at antenna input terminal (mW):	67.14
Prediction distance (cm):	20
Prediction frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	13.0
Maximum Antenna Gain (numeric):	19.95
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.267
Power density of prediction frequency at 20.0 cm (W/m^2):	2.67
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
IC MPE limit for uncontrolled exposure at prediction frequency (W/m^2):	5.4

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.267 mW/cm^2 (2.67 W/m^2). Limit is 1.0 mW/cm^2 (5.4 W/m^2).

Co-location:

2.4 GHz and 5 GHz bands can transmit simultaneously. A certified 2G/3G/4G module (FCC ID: N7NMC7355, IC: 2417C-MC7355) was built in the host. Per FCC KDB 447498, when RF sources have difference frequencies, the fraction of the FCC power density limit shall be determined and the sum of all fractional components shall be less than 1.

WLAN Co-location

Frequency Band	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
2.4 GHz	20	0.246	1.0	24.6 %	57.2 %	100 %
5 GHz	20	0.572	1.0	32.6 %		

2.4 GHz WLAN + 5 GHz WLAN + 850 MHz Co-Location

Frequency Band	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
2.4 GHz	20	0.246	1.0	24.6 %	93.3 %	100 %
5 GHz	20	0.572	1.0	32.6 %		
850 MHz	20	0.198	0.549	36.1 %		

2.4 GHz WLAN + 5 GHz WLAN + 1900 MHz Co-Location

Frequency Band	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
2.4 GHz	20	0.246	1.0	24.6 %	69.8 %	100 %
5 GHz	20	0.572	1.0	32.6 %		
1900 MHz	20	0.126	1.0	12.6 %		

2.4 GHz WLAN + 5 GHz WLAN + 700 MHz Co-Location

Frequency Band	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
2.4 GHz	20	0.246	1.0	24.6 %	99.6 %	100 %
5 GHz	20	0.572	1.0	32.6 %		
700 MHz	20	0.199	0.469	42.4 %		

2.4 GHz WLAN + 5 GHz WLAN + 1700 MHz Co-Location

Frequency Band	Evaluated Distance (cm)	Worst-Case MPE (mW/cm^2)	MPE Limit (mW/cm^2)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
2.4 GHz	20	0.246	1.0	24.6 %	77.1 %	100 %
5 GHz	20	0.572	1.0	32.6 %		
1700 MHz	20	0.199	1.0	19.9 %		

Conclusion: Simultaneous transmission MPE test exclusion applied to this device due to the sum of MPE ratios for all simultaneous transmitting antennas incorporated in the host is less than 1.0.