

4 FCC §2.1091, §15.407(f) & ISED RSS-102 - RF Exposure

4.1 Applicable Standards

According to FCC §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.

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

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

According to ISSED RSS-102 Issue 5: For the purpose of this standard, Industry Canada has adopted the SAR and RF field strength limits established in Health Canada's RF exposure guideline.

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
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/ <i>f</i>	-	6**
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6**
10-20	27.46	0.0728	-2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}
Note: <i>f</i> 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

5 GHz Wi-Fi

Worst Case: 802.11ac40, 5795 MHz

FCC:

<u>Maximum peak output power at 3 antenna input terminal (total) (dBm):</u>	29.1
<u>Maximum peak output power at antenna input terminal (mW):</u>	812.83
<u>Prediction distance (cm):</u>	20
<u>Predication frequency (MHz):</u>	5795
<u>Maximum Antenna Gain, typical (dBi):</u>	6.9
<u>Maximum Antenna Gain (numeric):</u>	4.90
<u>Power density of prediction frequency at prediction distance (mW/cm²):</u>	0.79
<u>FCC limit (mW/cm²):</u>	1.00

For the MIMO system, the sum conducted output power 29.1 dBm is considered as the worst case, with the separation distance of 20 cm, the power density is 0.79 mW/cm², which complies with the MPE limit of ≤ 1.0 .

IC:

<u>Maximum peak output power at antenna input terminal (total) (dBm):</u>	29.1
<u>Maximum peak output power at antenna input terminal (W):</u>	0.813
<u>Prediction distance (cm):</u>	20
<u>Predication frequency (MHz):</u>	5795
<u>Maximum Antenna Gain, typical (dBi):</u>	6.9
<u>Maximum Antenna Gain (numeric):</u>	4.90
<u>Power density of prediction frequency at prediction distance (W/m²):</u>	7.92
<u>IC limit (W/m²):</u>	9.77

For the MIMO system, the sum conducted output power 30 dBm is considered as the worst case, with the separation distance of 20 cm, the power density is 7.92 W/m², which complies with the MPE limit of ≤ 9.77 .

Cellular Module Standalone**FCC ID: N7NEM75S**

Band	Frequency (MHz)	Max Conducted Power (dBm)	Evaluated Distance (cm)	Antenna ¹ Gain (dBi)	Antenna Cable Loss (dB)	MPE (mW/cm ²)	MPE Limit (mW/cm ²)	MPE Ratio (%)
WCDMA Band II/ LTE Band 2	1850	24.00	20	1.07	2.5	0.036	1	3.595
WCDMA Band IV/ LTE Band 4	1710	24.00	20	1.07	2.5	0.036	1	3.595
WCDMA Band V/ LTE Band 5	824	24.00	20	1	2.5	0.035	0.549	6.440
LTE Band 7	2500	23.80	20	2.16	2.5	0.044	1	4.413
LTE Band 12	699	24.00	20	1	2.5	0.035	0.466	7.592
LTE Band 13	777	24.00	20	1	2.5	0.035	0.518	6.830
LTE Band 26	814	24.00	20	1	2.5	0.035	0.543	6.519
LTE Band 30	2305	23.00	20	1.48	2.5	0.031	1	3.139
LTE Band 41	2496	23.80	20	1.48	2.5	0.038	1	3.773
LTE Band 14	788	24.00	20	1	2.5	0.035	0.525	6.734
LTE Band 66	1710	24.00	20	1.07	2.5	0.036	1	3.595

IC: 2417C-EM75S

Band	Frequency (MHz)	Max Conducted Power (dBm)	Evaluated Distance (cm)	Antenna ¹ Gain (dBi)	Antenna Cable Loss (dB)	MPE (W/m ²)	MPE Limit (W/m ²)	MPE Ratio (%)
WCDMA Band II/ LTE Band 2	1850	24.00	20	1.07	2.5	0.360	4.476	8.032
WCDMA Band IV/ LTE Band 4	1710	24.00	20	1.07	2.5	0.360	4.242	8.475
WCDMA Band V/ LTE Band 5	824	24.00	20	1	2.5	0.354	2.576	13.734
LTE Band 7	2500	23.80	20	2.16	2.5	0.441	5.499	8.025
LTE Band 12	699	24.00	20	1	2.5	0.354	2.302	15.368
LTE Band 13	777	24.00	20	1	2.5	0.354	2.474	14.300
LTE Band 26	814	24.00	20	1	2.5	0.354	2.554	13.852
LTE Band 30	2305	23.00	20	1.48	2.5	0.314	5.202	6.033
LTE Band 41	2496	23.80	20	1.48	2.5	0.377	5.493	6.869
LTE Band 14	788	24.00	20	1	2.5	0.354	2.498	14.162
LTE Band 66	1710	24.00	20	1.07	2.5	0.360	4.242	8.475

Note¹: multi band swivel mount dipole antenna part number: W5095X by PulseLARSSEN Antennas.

Radio Co-location**Worst Case Co-location 5 GHz Wi-Fi Radio, and LTE Band FDD12:**

FCC

Frequency Band	Max EIRP Power (dBm)	Evaluated Distance (cm)	Worst-Case MPE (mW/cm ²)	MPE Limit (mW/cm ²)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
5 GHz Wi-Fi	36	20	0.792	1.0	79.20%	86.792%	100%
LTE Band FDD12	25	20	0.063	0.466	7.592%		

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum MPE ratio at the distance of 20 cm is 86.792% Limit is 100%.

IC

Frequency Band	Max EIRP Power (dBm)	Evaluated Distance (cm)	Worst-Case MPE (W/cm ²)	MPE Limit (W/cm ²)	Worst-Case MPE Ratios	Sum of MPE Ratios	Limit
5 GHz Wi-Fi	36	20	7.92	9.77	81.06%	96.43%	100%
LTE Band FDD12	25	20	0.354	2.302	15.37%		

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum MPE ratio at the distance of 20 cm is 96.43% Limit is 100%.