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

4.1 Applicable Standards

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.

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 ISED RSS-102 Issue 5:

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	-	$0.73/f$	-	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	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

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

Bluetooth Radio

Maximum peak output power at antenna input terminal (dBm):	9.54
Maximum peak output power at antenna input terminal (mW):	8.99
Prediction distance (cm):	20
Maximum Antenna Gain, typical (dBi):	1.4
Maximum Antenna Gain (numeric):	1.38
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.0025
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	1.0
MPE Ratio (numeric):	0.0025

900 MHz Radio (FCC ID: 2AK4V-DT-550, IC: 22517-DT550)

Maximum peak output power at antenna input terminal (dBm):	23.89
Maximum peak output power at antenna input terminal (mW):	244.91
Prediction distance (cm):	20
Prediction frequency (MHz):	906
Maximum Antenna Gain, typical (dBi):	1.2
Maximum Antenna Gain (numeric):	1.31
Power density of prediction frequency at 20.0 cm (mW/cm^2):	0.0642
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	0.604
MPE Ratio (numeric):	0.106

LTE Radio (FCC ID: RI7ME910C1NA, IC: 5131A-ME910C1NA)

Band	Frequency (MHz)	Max Conducted Power (dBm)	Evaluated Distance (cm)	Antenna Gain (dBi)	MPE (mW/cm^2)	MPE Limit (mW/cm^2)	MPE Ratio
FDD4	1710.7	24.00	20	2.5	0.08887	1.00	0.089
FDD2	1850.7	24.00	20	2.5	0.08887	1.00	0.089
FDD12	699.0	24.45	20	-0.4	0.05055	0.466	0.108
FDD13	777.0	24.00	20	-0.4	0.04558	0.518	0.088

Note: antenna gain is information provided by the applicant.

Radio Co-location

Worst Case Co-location Bluetooth Radio, 900 MHz Radio and LTE Band FDD12:

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
Worst Case							
BT EDR	23.00	20	0.0025	1.0	0.25%	21.65%	100%
900MHz Radio	25.09	20	0.0604	0.604	10.6%		
LTE Band FDD12	24.05	20	0.051	0.466	10.8%		

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum MPE ratio at the distance of 20 cm is 21.65% Limit is 100%.

4.4 RF exposure evaluation exemption for IC

Bluetooth

Maximum EIRP power = 9.54 dBm + 1.4 dBi = 10.94 dBm which is less than $1.31\times10^{-2}f^{0.6834}$ = 2.70 W = 34.31 dBm

900 MHz Radio (FCC ID: 2AK4V-DT-550, IC: 22517-DT550)

Worst Case at 906MHz

Maximum EIRP power = 23.89 dBm + 1.2 dBi = 25.09 dBm which is less than $1.31\times10^{-2}f^{0.6834}$ = 1.37 W = 31.38 dBm

LTE Radio (FCC ID: RI7ME910C1NA, IC: 5131A-ME910C1NA)

Band	Frequency (MHz)	Max Conducted Power (dBm)	Evaluated Distance (cm)	Antenna Gain (dBi)	MPE (W/m^2)	MPE Limit (W/m^2)	MPE Ratio
FDD4	1710.7	24.00	20	2.5	0.89	4.24	0.21
FDD2	1850.7	24.00	20	2.5	0.89	4.48	0.20
FDD12	699.0	24.45	20	-0.4	0.51	2.30	0.22
FDD13	777.0	24.00	20	-0.4	0.46	2.47	0.18

Radio Co-location

Worst Case Colocation Bluetooth Radio, 900MHz Radio and LTE Band FDD12:

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
Worst Case							
BT EDR	10.94	20	0.025	5.41	4.6%	50.1%	100%
900MHz Radio	25.09	20	0.64	2.75	23.3%		
LTE Band FDD12	24.05	20	0.51	2.30	22.2%		

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum MPE ratio at the distance of 20 cm is 50.1% Limit is 100%.