

4 FCC §1.1307(b) (1), §2.1091 &§90.223 & ISEDC RSS-102 - RF Exposure

4.1 Applicable Standards

FCC §2.1091, (a) Requirements of this section are a consequence of Commission responsibilities under the National Environmental Policy Act to evaluate the environmental significance of its actions. See subpart I of part 1 of this chapter, in particular §1.1307(b).

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f ²)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-3.0	614	1.63	*(100)	<30
3.0-30	824/f	2.19/f	*(900/f ²)	<30
30-300	27.5	0.073	1.0	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

Note: f = frequency in MHz

* = Plane-wave equivalent power density

According to ISED RSS-102:

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/ $f^{0.5}$	-	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 x 10 ⁻⁴ $f^{0.5}$	6.67 x 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 RF exposure evaluation exemption for FCC and IC

Radio 1: 15dBi antenna gain

<u>Maximum tune up power at antenna input terminal (dBm):</u>	<u>15.5</u>
<u>Maximum tune up power at antenna input terminal (mW):</u>	<u>35.48</u>
<u>Prediction frequency (MHz):</u>	<u>4950</u>
<u>Antenna Gain, maximum (dBi):</u>	<u>15</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>31.6</u>
<u>Prediction distance (cm):</u>	<u>40</u>
<u>Power density of prediction frequency at 40 cm (mW/cm²):</u>	<u>0.056</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

Radio 2: 15dBi antenna gain

<u>Maximum tune up power at antenna input terminal (dBm):</u>	<u>15.5</u>
<u>Maximum tune up power at antenna input terminal (mW):</u>	<u>35.48</u>
<u>Prediction frequency (MHz):</u>	<u>4950</u>
<u>Antenna Gain, maximum (dBi):</u>	<u>15</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>31.6</u>
<u>Prediction distance (cm):</u>	<u>40</u>
<u>Power density of prediction frequency at 40 cm (mW/cm²):</u>	<u>0.056</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>1.0</u>

Radio 1: 15dBi antenna gain

Maximum tune up power at antenna input terminal (dBm): 15.5
Maximum tune up power at antenna input terminal (W): 0.03548
Prediction (minimum separation) distance (m): 0.4
Prediction frequency (MHz): 4950
Maximum Antenna Gain, typical (dBi): 15
Maximum Antenna Gain (numeric): 31.6
Power density of prediction frequency at 0.4m (W/m²): 0.558
Limit for uncontrolled exposure at prediction frequency (W/m²): 8.77

Radio 2: 15dBi antenna gain

Maximum tune up power at antenna input terminal (dBm): 15.5
Maximum tune up power at antenna input terminal (W): 0.03548
Prediction (minimum separation) distance (m): 0.4
Prediction frequency (MHz): 4950
Maximum Antenna Gain, typical (dBi): 15
Maximum Antenna Gain (numeric): 31.6
Power density of prediction frequency at 0.4m (W/m²): 0.558
Limit for uncontrolled exposure at prediction frequency (W/m²): 8.77

Radio 1: 3dBi antenna gain

Maximum tune up power at antenna input terminal (dBm): 15.5
Maximum tune up power at antenna input terminal (mW): 35.48
Prediction frequency (MHz): 4950
Antenna Gain, maximum (dBi): 3
Maximum Antenna Gain (numeric): 2
Prediction distance (cm): 40
Power density of prediction frequency at 40 cm (mW/cm²): 0.04
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²): 1.0

Radio 2: 3dBi antenna gain

Maximum tune up power at antenna input terminal (dBm): 20.5
Maximum tune up power at antenna input terminal (mW): 112.2
Prediction frequency (MHz): 4950
Antenna Gain, maximum (dBi): 3
Maximum Antenna Gain (numeric): 2
Prediction distance (cm): 40
Power density of prediction frequency at 40 cm (mW/cm²): 0.011
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²): 1.0

Radio 1: 3dBi antenna gain

Maximum tune up power at antenna input terminal (dBm): 15.5
Maximum tune up power at antenna input terminal (W): 0.03548
Prediction (minimum separation) distance (m): 0.4
Prediction frequency (MHz): 4950
Maximum Antenna Gain, typical (dBi): 3
Maximum Antenna Gain (numeric): 2
Power density of prediction frequency at 0.4m (W/m²): 0.035
Limit for uncontrolled exposure at prediction frequency (W/m²): 8.77

Radio 2: 3dBi antenna gain

Maximum tune up power at antenna input terminal (dBm): 20.5
Maximum tune up power at antenna input terminal (W): 0.1122
Prediction (minimum separation) distance (m): 0.4
Prediction frequency (MHz): 4950
Maximum Antenna Gain, typical (dBi): 3
Maximum Antenna Gain (numeric): 2
Power density of prediction frequency at 0.4m (W/m²): 0.1116
Limit for uncontrolled exposure at prediction frequency (W/m²): 8.77

4.4 RF exposure Simultaneous Transmission evaluation for FCC

Total Power Densities (Percentages) = 5GHz Radio 1 Power Density % + 5GHz Radio 2 Power Density % + BLE Power Density % + 4.9GHz Radio 1

Total Relative Power Densities (Percentages) = (0.140/1.0) *100 + (0.176/1.0) *100 + (0.001/1)*100 + (0.056/1.0)*100= = 14 % + 17.6 % + 1% + 5.6 % = 38.2%