

## 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 <sup>2</sup> ) | Averaging Time (minute) |
|----------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|-------------------------|
| <b>(A) Limits for Occupational/Controlled Exposure</b>         |                               |                               |                                     |                         |
| 0.3-3.0                                                        | 614                           | 1.63                          | *(100)                              | ≤6                      |
| 3.0-30                                                         | 1842/f                        | 4.89/f                        | *(900/f <sup>2</sup> )              | <6                      |
| 30-300                                                         | 61.4                          | 0.163                         | 1.0                                 | <6                      |
| 300-1,500                                                      |                               |                               | f/300                               | <6                      |
| 1,500-100,000                                                  |                               |                               | 5                                   | <6                      |
| <b>(B) Limits for General Population/Uncontrolled Exposure</b> |                               |                               |                                     |                         |
| 0.3-3.0                                                        | 614                           | 1.63                          | *(100)                              | <30                     |
| 3.0-30                                                         | 824/f                         | 2.19/f                        | *(900/f <sup>2</sup> )              | <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 ISSED 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 <sup>2</sup> ) | Reference Period (minutes) |
| 0.003-10 <sup>21</sup>                                                                              | 83                        | 90                                       | -                                 | Instantaneous*             |
| 0.1-10                                                                                              | -                         | 0.73/ f                                  | -                                 | 6**                        |
| 1.1-10                                                                                              | 87/ f <sup>0.5</sup>      | -                                        | -                                 | 6**                        |
| 10-20                                                                                               | 27.46                     | 0.0728                                   | 2                                 | 6                          |
| 20-48                                                                                               | 58.07/ f <sup>0.25</sup>  | 0.1540/ f <sup>0.25</sup>                | 8.944/ f <sup>0.5</sup>           | 6                          |
| 48-300                                                                                              | 22.06                     | 0.05852                                  | 1.291                             | 6                          |
| 300-6000                                                                                            | 3.142 f <sup>0.3417</sup> | 0.008335 f <sup>0.3417</sup>             | 0.02619 f <sup>0.6834</sup>       | 6                          |
| 6000-15000                                                                                          | 61.4                      | 0.163                                    | 10                                | 6                          |
| 15000-150000                                                                                        | 61.4                      | 0.163                                    | 10                                | 616000/ f <sup>1.2</sup>   |
| 150000-300000                                                                                       | 0.158 f <sup>0.5</sup>    | 4.21 x 10 <sup>-4</sup> f <sup>0.5</sup> | 6.67 x 10 <sup>-5</sup> f         | 616000/f <sup>1.2</sup>    |

**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/cm<sup>2</sup>):</u>                  | <u>0.056</u> |
| <u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>):</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/cm<sup>2</sup>):</u>                  | <u>0.056</u> |
| <u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>):</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/m<sup>2</sup>): 0.558  
Limit for uncontrolled exposure at prediction frequency (W/m<sup>2</sup>): 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/m<sup>2</sup>): 0.558  
Limit for uncontrolled exposure at prediction frequency (W/m<sup>2</sup>): 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/cm<sup>2</sup>): 0.04  
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>): 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/cm<sup>2</sup>): 0.011  
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm<sup>2</sup>): 1.0

## Radio 1: 3dBi 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 (W):</u>                       | <u>0.03548</u> |
| <u>Prediction (minimum separation) distance (m):</u>                              | <u>0.4</u>     |
| <u>Prediction frequency (MHz):</u>                                                | <u>4950</u>    |
| <u>Maximum Antenna Gain, typical (dBi):</u>                                       | <u>3</u>       |
| <u>Maximum Antenna Gain (numeric):</u>                                            | <u>2</u>       |
| <u>Power density of prediction frequency at 0.4m (W/m<sup>2</sup>):</u>           | <u>0.035</u>   |
| <u>Limit for uncontrolled exposure at prediction frequency (W/m<sup>2</sup>):</u> | <u>8.77</u>    |

## Radio 2: 3dBi antenna gain

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

**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) =  $(0.140/1.0) * 100 + (0.176/1.0) * 100 + (0.001/1) * 100 + (0.056/1.0) * 100 = 14 \% + 17.6 \% + 1\% + 5.6 \% = 38.2\%$