

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

5.1 Applicable Standards

According to FCC §15.247(i), Radio frequency devices operating under the provisions of this part are subject to the radio frequency radiation exposure requirements specified in §§ 1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of mobile or portable devices operating under this section must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.

According to FCC §2.1091, 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

According to ISED RSS-102 Issue 6:

Field reference level (FRL) exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm (i.e. mobile devices), except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 1 W (adjusted for tune-up tolerance)
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $4.49/f^{0.5} W$ (adjusted for tune-up tolerance), where f is in MHz
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance)
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834} W$ (adjusted for tune-up tolerance), where f is in MHz
- at or above 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 5 W (adjusted for tune-up tolerance)

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the EIRP was derived.

5.2 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

5.3 RF exposure evaluation for FCC

LoRa 1 Worst Case: 918 MHz

<u>Maximum output power at antenna input terminal (dBm):</u>	<u>28.30</u>
<u>Maximum output power at antenna input terminal (mW):</u>	<u>676.08</u>
<u>Prediction distance (cm):</u>	<u>22</u>
<u>Prediction frequency (MHz):</u>	<u>918</u>
<u>Maximum Directional Antenna Gain, typical (dBi):</u>	<u>2.7</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.86</u>
<u>Power density of prediction frequency at 22.0 cm (mW/cm²):</u>	<u>0.250</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>0.612</u>

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 22 cm is 0.250 mW/cm². Limit is 0.612 mW/cm².

LoRa 2 Worst Case: 922 MHz

<u>Maximum output power at antenna input terminal (dBm):</u>	<u>29.05</u>
<u>Maximum output power at antenna input terminal (mW):</u>	<u>647.14</u>
<u>Prediction distance (cm):</u>	<u>22</u>
<u>Prediction frequency (MHz):</u>	<u>922</u>
<u>Maximum Directional Antenna Gain, typical (dBi):</u>	<u>2.7</u>
<u>Maximum Antenna Gain (numeric):</u>	<u>1.86</u>
<u>Power density of prediction frequency at 22.0 cm (mW/cm²):</u>	<u>0.239</u>
<u>FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm²):</u>	<u>0.615</u>

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 22 cm is 0.239 mW/cm². Limit is 0.615 mW/cm².

Colocation at 22cm:

LoRa1 + LoRa2 + Iridium

$$0.250/0.612(41\%)+0.239/0.615(39\%)+0.043/1(4.3\%) = 84.3\% < 100\%$$

Note: Iridium value is from original module certification (FCC ID: Q639603N) from report number 75926443 Report 10 Issue 2. Also note that this is considering new antenna gain.

5.4 RF exposure evaluation for IC***LoRa 1 Worst Case: 918 MHz***

$$28.30\text{dBm} + 2.7\text{dBi} = 31\text{ dBm} < 1.387\text{W} (31.42\text{dBm})$$

LoRa 2 Worst Case: 922 MHz

$$28.11\text{dBm} + 2.7\text{dBi} = 30.81\text{ dBm} < 1.387\text{W} (31.43\text{dBm})$$

Iridium

$$\text{After duty cycle correction (136mW)} 21.34\text{dBm} + 2.8\text{dBi} = 24.14\text{ dBm} < 2.04 (33.1\text{dBm})$$

Therefore, radios are exempt from FRL exposure evaluation.