

4 FCC §2.1091 & ISEDC RSS-102 – RF Exposure

4.1 Applicable Standards

According to FCC §2.1091 and §1.1310(e)(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 ISEDC RSS-102 Issue 6 Section 6.6: Field reference level exposure exemption limits

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 $4.49/f$ 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 $1.31 \times 10^{-2}/f$ 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.

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 FCC MPE Results

Radio	Frequency (MHz)	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	Maximum EIRP (mW)	Power Density at 20cm (mW/cm ²)	Limit (mW/cm ²)
LoRa	925	-	-	-1.8	0.66	0.00013	0.6
BT	2402	3.3	12.8	16.1	40.74	0.008	1.0
5 GHz Wi-Fi	5745	6.31	24.9	31.21	1321.3	0.26	1.0
2.4 GHz Wi-Fi	2437	5.01	24.2	29.21	833.7	0.17	1.0
LTE	1710	4	25	29	794.33	0.158	1.0

NOTE: LoRa determined from original test report's (SER17109769001E by NTEK) field strength measurement of 91.3dBuV/m at 3meters distance. 91.3dBuV/m @3m – 95.2dB = -3.9dBm.

NOTE: Maximum EIRP determined by adding LoRa with the difference between old and new antenna. -3.9dBm + 2.1dB = -1.8dBm.

NOTE: 2.4GGHz and 5GHz Wi-Fi cannot transmit simultaneously.

NOTE: Wi-Fi antenna gain is considering worst-case MIMO antenna gain. i.e. single antenna gain + 10*log(2)

Worst Case Sum of Ratios:

LoRa + BT + 2.4Wi-Fi + LTE: 0.00013/0.6+0.008/1.0+0.17/1.0+0.158/1.0 = 0.336< 1

LoRa + BT + 5Wi-Fi + LTE: 0.00013/0.6+0.008/1.0+0.26/1.0+0.158/1.0 = 0.426< 1

For the different combination of transmitters, a separation distance of 20 cm complies with the MPE simultaneous transmission limit of ≤ 1.0 .

4.4 IC Exemption

2.4 GHz Wi-Fi

The EIRP of this device is 29.21 dBm (833.7 mW) which is less than the exemption threshold, i.e., $1.31 \times 10^{-2} \times f^{(0.6834)} = 2.70\text{W}$. Therefore, the RF exposure evaluation is exempt.

BT

The EIRP of this device is 16.1 dBm (40.74 mW) which is less than the exemption threshold, i.e., $1.31 \times 10^{-2} \times f^{(0.6834)} = 2.68\text{W}$. Therefore, the RF exposure evaluation is exempt.

5 GHz Wi-Fi

The EIRP of this device is 31.21 dBm (1321.3 mW) which is less than the exemption threshold, i.e., $1.31 \times 10^{-2} \times f^{(0.6834)} = 4.86\text{W}$. Therefore, the RF exposure evaluation is exempt.

LoRa

The EIRP of this device is -1.8 dBm (0.66 mW) which is less than the exemption threshold, i.e., $1.31 \times 10^{-2} \times f^{(0.6834)} = 1.39\text{W}$. Therefore, the RF exposure evaluation is exempt.

LTE

The EIRP of this device is 29 dBm (794.33 mW) which is less than the exemption threshold, i.e., $1.31 \times 10^{-2} \times f^{(0.6834)} = 2.12\text{W}$. Therefore, the RF exposure evaluation is exempt.

Worst Case Sum of Ratios:

LoRa + BT + 2.4 Wi-Fi + LTE: $0.00066/1.39 + 0.04074/2.68 + 0.8337/2.7 + 0.79433/2.12 = 0.699 < 1$

LoRa + BT + 5 Wi-Fi + LTE: $0.00066/1.39 + 0.04074/2.68 + 1.3213/4.86 + 0.79433/2.12 = 0.662 < 1$