

FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

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)
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

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Mode	Frequency (MHz)	Antenna Gain*		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
BLE	2402-2480	1.75	1.50	3.5	2.24	20	0.001	1.0
Wi-Fi	2412-2462	1.75	1.50	18.5	70.79	20	0.021	1.0
Lora	923.3-927.5	2.3	1.70	13.0	19.95	20	0.007	0.6
WCDMA Band II	1850-1910	2.3	1.70	25.0	316.23	20	0.107	1.0
WCDMA Band IV	1710-1755	3.4	2.19	25.0	316.23	20	0.138	1.0
WCDMA Band V	824-849	1.0	1.26	25.0	316.23	20	0.079	0.55
LTE Band 2	1850-1910	2.3	1.70	25.0	316.23	20	0.107	1.0
LTE Band 4	1710-1755	3.4	2.19	25.0	316.23	20	0.138	1.0
LTE Band 5	824-849	1.0	1.26	25.0	316.23	20	0.079	0.55
LTE Band 12	699-716	2.9	1.95	25.0	316.23	20	0.123	0.466
LTE Band 13	777-787	2.9	1.95	25.0	316.23	20	0.123	0.518

- Note: 1. The tune up conducted power was declared by the applicant
2. Lora, BLE, Wi-Fi and WCDMA/LTE can transmit simultaneously for this device.
3. Please refer to the MPE report of the FCC ID: 2AF6B-RAK2247 for the Lora output power.
4. Please refer to the MPE report of the FCC ID: XMR201807EG95NA for the WCDMA/LTE output power.
5. The antenna gain was provided by the applicant.

So the worst simultaneous transmitting consideration:

$$\text{The ratio} = \text{MPE}_{\text{BLE}}/\text{limit} + \text{MPE}_{\text{Wi-Fi}}/\text{limit} + \text{MPE}_{\text{Lora}}/\text{limit} + \text{MPE}_{\text{LTE}}/\text{limit} \\ = 0.001/1.0 + 0.021/1.0 + 0.007/0.6 + 0.123/0.466 = 0.298 < 1.0$$

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliance