

FCC §1.1037 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 1.1037 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

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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:

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

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)			
Wi-Fi	2412-2462	1.5	1.41	18.0	63.10	20	0.018	1.0
LoRa(External transmit antenna)	923.3-927.5	1.5	1.41	12.0	15.85	20	0.0044	0.6
LoRa(Internal transmit antenna)	923.3-927.5	0	1	12.0	15.85	20	0.0032	0.6
WCDMA B2	1850-1910	1.5	1.41	23	200	20	0.056	1.0
WCDMA B4	1710-1755	1.5	1.41	23	200	20	0.056	1.0
WCDMA B5	824-849	1.5	1.41	23	200	20	0.056	0.549
LTE B2	1850-1910	1.5	1.41	23.5	223.87	20	0.063	1.0
LTE B4	1710-1755	1.5	1.41	23.5	223.87	20	0.063	1.0
LTE B5	824-849	1.5	1.41	23.5	223.87	20	0.063	0.549
LTE B12	699-716	1.5	1.41	23.5	223.87	20	0.063	0.466
LTE B13	777-787	1.5	1.41	23.5	223.87	20	0.063	0.518
LTE B14	788-798	1.5	1.41	23.5	223.87	20	0.063	0.525
LTE B66	1710-1780	1.5	1.41	23.5	223.87	20	0.063	1.0
LTE B71	663-698	1.5	1.41	23.5	223.87	20	0.063	0.422

Note: 1. The tune up conducted power was declared by the applicant
 2. LoRa, Wi-Fi and LTE can transmit simultaneously for this device..

So the worst simultaneous transmitting consideration:

$$\text{The ratio} = \text{MPE}_{\text{LoRa}}/\text{limit} + \text{MPE}_{\text{Wi-Fi}}/\text{limit} + \text{MPE}_{\text{LTE}}/\text{limit} \\ = 0.018/1.0 + 0.0044/0.6 + 0.063/0.422 = 0.175 < 1.0$$

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

Result: Compliance