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:

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

Calculated Data:

The worst case as below:

Mode	Frequency (MHz)	Antenna Gain		Max Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
LoRa	923.3-927.5	5.0	3.16	11	12.59	20	0.008	0.616
WiFi	2412-2462	2.0	1.58	13	19.95	20	0.006	1.0
WCDMA B2	1850-1910	0.5	1.12	23.5	223.87	20	0.050	1.0
WCDMA B5	824-849	-1.1	0.78	23.5	223.87	20	0.035	0.549
LTE B2	1850-1910	0.5	1.12	24	251.19	20	0.056	1.0
LTE B4	1710-1755	0.1	1.02	24	251.19	20	0.051	1.0
LTE B12	699-716	-1.4	0.72	24	251.19	20	0.036	0.466

The power data of WCDMA and LTE refer to FCC ID: XMR201605EC25A

Simultaneous transmitting consideration:

For LoRa + WiFi + WCDMA:
The ratio = $MPE/limit_{LoRa}+MPE/limit_{WiFi}+MPE/limit_{WCDMA}=0.008/0.616+0.006/1+0.035/0.549=0.08<1.0$,

For LoRa + WiFi + LTE:
The ratio = $MPE/limit_{LoRa}+MPE/limit_{WiFi}+MPE/limit_{LTE}=0.008/0.616+0.006/1+0.036/0.466=0.10<1.0$,

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

Result: Compliance