

5.5. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091]

5.5.1. Limits

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) 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

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

5.5.2. Method of Measurements

Calculation Method of Power Density/RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where,
 P: power input to the antenna in mW
 EIRP: Equivalent (effective) isotropic radiated power.
 S: power density mW/cm²
 G: numeric gain of antenna relative to isotropic radiator
 r: distance to centre of radiation in cm

5.5.3. RF Evaluation

Pursuant to FCC KDB 447498 D01 General RF Exposure Guidance v06, Section 7.2:

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0, according to calculated/estimated, numerically modeled, or measured field strengths or power density.

The EUT consisted of a LoRa Transmitter and a certified u-blox AG SARA-R410M LTE Cat M1 module (FCC ID: XPY2AGQN4NNN, IC: 8595A-2AGQN4NNN). The table below is a summary of the calculated MPE ratios for co-location at an evaluation distance of 20 cm.

Source	Maximum MPE Ratio
LoRa 915 MHz Transmitter	0.019
u-blox AG SARA-R410M LTE Cat M1 module	0.324
Sum of the MPE ratios from all sources	0.343

The sum of the MPE ratios from all sources is < 1. Thus, in compliant with general population/uncontrolled exposure MPE limit.

For detailed MPE ratio calculation for LoRa Transmitter and certified u-blox AG LTE Cat M1 module, refer to the following tables.

Calculated MPE Ratio for LoRa Transmitter (EUT) with 2.5 dBi Antenna							
Frequency (MHz)	Maximum Conducted EUT Power (dBm)	Maximum Antenna Gain (dBi)	Maximum EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)	MPE Ratio
915	17.33	2.5	96.161	20	0.019	1.000	0.019

Calculated MPE Ratio for u-blox AG SARA-R410M LTE Cat-M1 Module									
LTE Band	Frequency (MHz)	¹ Input Power of the Antenna (dBm)	² Antenna Gain (dBi)	Max. E.I.R.P. (dBm)	Max. E.I.R.P. (mW)	Evaluation Distance (cm)	Calculation (mW/cm ²)	Limit (mW/cm ²)	MPE Ratio
B12	699.7	25.0	3.67	28.67	736.21	20	0.146	0.466467	0.314
B2	1909.3	25.0	7.12	32.12	1629.30	20	0.324	1.0	0.324
¹ Data derived from u-blox AG SARA-R410M LTE Cat-M1 Module MPE test report is the worst case, Test Report No. N/A (FCC ID: XPY2AGQN4NNN, IC: 8595A-2AGQN4NNN). ² Maximum permitted antenna gain.									