5 FCC §2.1091, §15.247(i) & ISEDC RSS-102 - RF Exposure

5.1 Applicable Standards

According to FCC §1.1307(b)(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.

According to KDB 447 498 Section (7.2), "simultaneous transmission of MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on calculated or measured field strengths or power density, is ≤ 1.0. The MPE ratio of each antenna is determined at the minimum *test separation distance* required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency.

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

Where: f = frequency in MHz
* = Plane-wave equivalent power density

Before equipment certification is granted, the procedure of IC RSS-102 must be followed concerning the exposure of humans to RF field.

According to ISED RSS-102 Issue 6:

Table 7: RF field strength and power density limits for devices used by the general public (uncontrolled environment)

Frequency range (MHz)	Electric field (V_{RMS}/m)	Magnetic field (A_{RMS}/m)	Power density (W/m^2)	Reference period (minutes)
10-20	27.46	0.0728	2	6
20-48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/ f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21\times10^{-4} f^{0.5}$	$6.67\times10^{-5} f$	$616000/ f^{1.2}$

Note: f is frequency in MHz.

5.2 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

5.3 RF exposure evaluation for FCC

Worst Case: 925.5 MHz

Maximum output power at antenna input terminal (dBm):	15.26
Maximum output power at antenna input terminal (mW):	33.57
Prediction distance (cm):	23
Prediction frequency (MHz):	925.5
Maximum Directional Antenna Gain, typical (dBi):	2.5
Maximum Antenna Gain (numeric):	1.778
Power density of prediction frequency at 23.0 cm (mW/cm^2):	0.009
FCC MPE limit for uncontrolled exposure at prediction frequency (mW/cm^2):	0.617

The device is compliant with the requirement FCC MPE limit for uncontrolled exposure. The maximum power density at the distance of 23 cm is 0.009 mW/cm^2. Limit is 0.617 mW/cm^2.

Worst Case Co-location MPE Calculation:

Worst Case: LoRa High Channel 925.5 MHz

Radio	Max EIRP (dBm)	Evaluated Distance (cm)	Worst-Case Exposure Level (mW/cm^2)	Limit (mW/cm^2)	Worst-Case Ratios (%)	Sum of Ratios (%)	Limit (%)
Worst Case							
Lora	17.76	23	0.009	0.617	1.5	44.52	100
LTE	28	23	0.095	0.5197	18.3		
WIFI	32.15	23	0.247	1.0	24.7		
Logitech Dongle	1.47	23	0.0002	1.0	0.02		

5.4 RF exposure evaluation for IC

Worst Case: 925.5 MHz

Maximum output power at antenna input terminal (dBm):	15.26
Maximum output power at antenna input terminal (mW):	33.57
Prediction distance (cm):	23
Prediction frequency (MHz):	925.5
Maximum Directional Antenna Gain, typical (dBi):	2.5
Maximum Antenna Gain (numeric):	1.778
Power density of prediction frequency at 23.0 cm (W/m^2):	0.09
IC MPE limit for uncontrolled exposure at prediction frequency (W/m^2):	2.788

The device is compliant with the requirement IC MPE limit for uncontrolled exposure. The maximum power density at the distance of 23 cm is 0.09 mW/cm^2. Limit is 2.788 W/m^2.

Worst Case Co-location MPE Calculation:

Worst Case: LoRa High Channel 925.5 MHz

Radio	Max EIRP (dBm)	Evaluated Distance (cm)	Worst-Case Exposure Level (W/m^2)	Limit (W/m^2)	Worst-Case Ratios (%)	Sum of Ratios (%)	Limit (%)
Worst Case							
Lora	17.76	23	0.09	2.788	3.23	89.13	100
LTE	28	23	0.95	2.48	39.5		
WIFI	32.15	23	2.47	5.37	46		
Logitech Dongle	1.47	23	0.002	5.35	0.4		