

FCC §15.247 (i) , §1.1310 , §2.1091& RSS-102 § 4- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247(i)and subpart §1.1310, 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.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) 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;

According to §1.1310 and §2.1091 RF exposure is calculated.

According to RSS-102 § 4Table 4, RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ f ^{0.5}	-	-	6**
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}	0.02619f ^{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 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/ f ^{1.2}

Note: f is frequency in MHz.
 *Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

Calculation Formula:

Prediction of power density at the distance of the applicable MPE limit:

$S = PG/4\pi R^2$ = 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:

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

Calculated Data:

Mode	Frequency (MHz)	Antenna Gain		Tune-up Power		Evaluation Distance (cm)	Power Density		MPE Limit	
		(dBi)	(numeric)	(dBm)	(mW)		(mW/cm ²)	(W/m ²)	FCC (mW/cm ²)	RSS-102 (W/m ²)
WLAN 2.4GHz	2412-2462	2	1.58	28	630.96	20.00	0.1990	1.99	1.0	5.37
WLAN 5GHz	5150-5850	2	1.58	18	63.10	20.00	0.02	0.2	1.0	9.05
LTE Band 7	2500-2570	3	2.00	24	251.19	20.00	0.10	1.0	1.0	5.50
LTE Band 40	2305-2315	3	2.00	19	79.43	20.00	0.032	0.32	1.0	5.20
	2350-2360	3	2.00	19	79.43	20.00	0.032	0.32	1.0	5.27
LTE Band 41	2500-2690	3	2.00	25	316.23	20.00	0.1256	1.256	1.0	5.49
LTE Band 43	3650-3700	3	2.00	23	199.53	20.00	0.0792	0.792	1.0	7.12

The WLAN 2.4GHz, 5GHz and LTE can transmit simultaneously:

For FCC:

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

$$\begin{aligned}
 &= S_{2.4}/S_{limit-2.4} + S_5/S_{limit-5} + S_{LTE}/S_{limit-LTE} \\
 &= 0.199/1 + 0.02/1 + 0.1256/1 \\
 &= 0.3446 \\
 &< 1.0
 \end{aligned}$$

For RSS-102:

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

$$\begin{aligned} &= S_{2.4}/S_{limit-2.4} + S_5/S_{limit-5} + S_{LTE}/S_{limit-LTE} \\ &= 1.99/5.37 + 0.2/9.05 + 1.256/5.49 \\ &= 0.621 \\ &< 1.0 \end{aligned}$$

Result: Compliance, The device meets MPE requirement for Devices Used by the General Public (Uncontrolled Environment) at distance ≥ 20 cm.