

FCC §1.1310 & §2.1091 – MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart §2.1091 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/cm²)	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.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = 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 Range (MHz)	Maximum Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)	MPE ratio
		(dBi)	(numeric)	(dBm)	(mW)				
BLE	2402-2480	4.56	2.86	4.50	2.82	20	0.0016	1.00	0.0016
GPRS/EGPRS 850	824.2-848.8	2.07	1.61	27.50	562.34	20	0.1802	0.5493	0.3281
GPRS/EGPRS 1900	1850.2-1909.8	3.81	2.40	26.50	446.68	20	0.2132	1.00	0.2132
LTE Band 2	1850.7-1909.3	3.81	2.40	24.00	251.19	20	0.1199	1.00	0.1199
LTE Band 4	1710.7-1754.3	3.87	2.44	23.00	199.53	20	0.0968	1.00	0.0968
LTE Band 5	824.7-848.3	2.07	1.61	24.00	251.19	20	0.0805	0.5493	0.1466
LTE Band 12	699.7-715.3	-1.85	0.65	24.00	251.19	20	0.0326	0.4665	0.0699
LTE Band 13	779.5~784.5	-0.30	0.93	24.00	251.19	20	0.0466	0.4665	0.0999
LTE Band 25	1850.7~1914.3	3.81	2.40	25.00	316.23	20	0.1510	1.00	0.1510

Note:

- (1) The tune-up output power was declared by the manufacturer.
 (2) The LTE module FCC: XMR201707BG96(Grant:03/28/2019)
 (3) BLE, GPRS/EGPRS can transmit simultaneously; the worst condition is below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0016 + 0.3281 = 0.3297 < 1.0$$

- (4) For GPRS/EGPRS Mode, the time based average power is relevant, the difference in between depends on the duty cycle of the TDMA signal.

The Tune-up output power:

GPRS 850: Tune-up maximum power: 1 slot 32.50dBm, 2 slots 32.50dBm, 3 slots 31.50dBm, 4 slots 30.50dBm, tune-up max time based Ave. power 27.50dBm

GPRS 1900: Tune-up maximum power: 1 slot 30.00dBm, 2slots 30.00dBm, 3 slots 30.00dBm, 4 slots 29.50dBm, tune-up max time based Ave. power 26.50dBm

Number of Time slot	1	2	3	4
Duty Cycle	1:8	1:4	1:2.66	1:2
Time based Ave. power compared to slotted Ave. power	-9 dB	-6 dB	-4.25 dB	-3 dB

Conclusion: The device meets FCC MPE at 20 cm distance.