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

Applicable Standard

According to subpart 15.247 (i) and subpart 1.1310, 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				
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/f²)	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

Calculated Formulary:

Predication of MPE limit at a given distance

S = PG/4πR² = power density (in appropriate units, e.g. mW/cm^2);
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 (worst case):

Mode	Frequency (MHz)	Maximum Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
802.11b	2412-2462	4.7	2.95	18.50	70.79	20	0.0415	1.0
802.11g		4.7	2.95	21.00	125.89	20	0.0739	1.0
802.11n-HT20		4.7	2.95	22.00	158.49	20	**0.0930**	**1.0**
802.11n-HT40	2422-2452	4.7	2.95	21.50	141.25	20	0.0829	1.0
BLE(1Mbps)	2402-2480	0	1.00	0	1.00	20	0.0002	1.0
BLE(2Mbps)	2402-2480	0	1.00	0	1.00	20	**0.0002**	**1.0**
Zigbee	2405~2480	0	1.00	19.50	89.13	20	**0.0177**	**1.0**

Mode	Frequency Range (MHz)	Maximum Antenna Gain		Tune-up EIRP		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
Z-wave	908.4	0	1.00	-1.50	0.71	20	**0.0001**	**0.61**

Mode	Frequency Range (MHz)	Maximum Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
GPRS 850	824.2-848.8	4	2.51	27.50	562.34	20	**0.2810**	**0.55**
GPRS 1900	1850.2-1909.8	4	2.51	26.50	446.68	20	0.2232	1.00
LTE Band 2	1850.7-1909.3	4	2.51	24	251.19	20	0.1255	1.00
LTE Band 4	1710.7-1754.3	4	2.51	23	199.53	20	0.0997	1.00
LTE Band 5	824.7-848.3	4	2.51	24	251.19	20	0.1255	0.55
LTE Band 12	699.7-715.3	4	2.51	24	251.19	20	0.1255	0.47
LTE Band 13	779.5~784.5	4	2.51	24	251.19	20	0.1255	0.52
LTE Band 25	1850.7~1914.3	4	2.51	25	316.23	20	0.1579	1.00

Note 1:
GPRS 850: Tune-up maximum output power with 1 slot is 32.50 dBm, 2 slots is 32.50 dBm, 3 slots is 31.50 dBm, 4 slots is 30.50 dBm, so the tune-up time based Ave. power compared to sloted Ave. power is 27.50dBm.
EGPRS 850: Tune-up maximum output power with 1 slot is 27.00 dBm, 2 slots is 27.00 dBm, 3 slots is 26.50 dBm, 4 slots is 26.50 dBm so the tune-up time based Ave. power compared to sloted Ave. power is 23.50 dBm.
GPRS 1900: Tune-up maximum output power with 1 slot is 30.00 dBm, 2 slots is 30.00 dBm, 3 slots is 30.00 dBm, 4 slots is 29.50 dBm so the tune-up time based Ave. power compared to sloted Ave. power is 26.50 dBm.
EGPRS 1900: Tune-up maximum output power with 1 slot is 26.50 dBm, 2 slots is 26.00 dBm, 3 slots is 26.00 dBm, 4 slots is 26.00 dBm so the tune-up time based Ave. power compared to sloted Ave. power is 23.00 dBm.

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	-4.26 dB	-3 dB

Note 2:
For Z-wave:
ERP=91.53 dB μ V/m-95.2=-3.67dBm
EIRP=ERP+2.15=-1.52 dBm
Tune-up EIRP=-1.5dBm
Note 3:
The LTE module FCC ID: XMR201707BG96(Grant:03/28/2019).
Wi-Fi & BLE & Zigbee & Z-wave & GPRS 850 can transmit simultaneously; the worst condition as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0930/1.00+0.0002/1.00+0.0177/1.00+0.0001/0.61+0.2810/0.55=0.6220 < 1.0$$

Conclusion: The device meets MPE at distance 20cm.