

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:

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

Calculation Data:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Output Power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)	MPE Ratio
		(dBi)	(numeric)	(dBm)	(mW)				
BT	2402-2480	1.31	1.35	11.5	14.13	20	0.0038	1.0	0.0038
BLE		1.31	1.35	6.5	4.47	20	0.0012	1.0	0.0012
2.4G Wi-Fi	2412-2462	1.31	1.35	24.5	281.84	20	0.0757	1.0	0.0757
5G Wi-Fi	5150-5250	2.87	2.42	14.5	28.18	20	0.0109	1.0	0.0109
	5725-5850	4.09	2.42	13.5	22.39	20	0.0114	1.0	0.0114
GSM850 (GPRS/EGPRS)	824-849	-1.46	0.71	26.24	420.73	20	0.0598	0.5493	0.1089
PCS1900 (GPRS/EGPRS)	1850-1910	0.38	1.09	22.74	187.93	20	0.0407	1.0	0.0407
WCDMA Band II	1850-1910	0.38	1.09	23	199.53	20	0.0433	1.0	0.0433
WCDMA Band IV	1710-1755	1.33	1.36	23	199.53	20	0.0540	1.0	0.0540
WCDMA Band V	824-849	-1.46	0.71	23	199.53	20	0.0284	0.5493	0.0517
LTE Band 2	1850-1910	0.38	1.09	22.5	177.83	20	0.0386	1.0	0.0386
LTE Band 4	1710-1755	1.33	1.36	23	199.53	20	0.0540	1.0	0.0540
LTE Band 5	824-849	-1.46	0.71	22.5	177.83	20	0.0253	0.5493	0.0461
LTE Band 7	2500-2570	1.51	1.42	24	251.19	20	0.0710	1.0	0.0710
LTE Band 12	699-716	-4.98	0.32	23	199.53	20	0.0126	0.466	0.0270
LTE Band 13	777-787	-3.1	0.49	22.5	177.83	20	0.0173	0.518	0.0334
LTE Band 14	788-798	-3.06	0.49	22.5	177.83	20	0.0175	0.5253	0.0333
LTE Band 17	704-716	-4.98	0.32	23.5	223.87	20	0.0141	0.4693	0.0300
LTE Band 25	1850-1915	0.38	1.09	23.5	223.87	20	0.0485	1.0	0.0485
LTE Band 26	814-849	-1.46	0.71	23	199.53	20	0.0284	0.5427	0.0523
LTE Band 66	1710-1780	1.33	1.36	23	199.53	20	0.0540	1.0	0.0540
LTE Band 71	663-698	-6	0.25	22.5	177.83	20	0.0089	0.442	0.0201
LTE Band 38	2570-2620	0.81	1.21	23	199.53	20	0.0480	1.0	0.0480
LTE Band 41	2535-2655	1.41	1.38	23	199.53	20	0.0548	1.0	0.0548
NFC	13.56	0.00	1.00	-13.92	0.04	20	<0.0001	0.98	<0.0001
NFC field strength is 81.28dBμV/m = -13.92dBm (0.04mW) EIRP. That equal to antenna gain is 0dBi and used the EIRP value as conducted power.									

Note:

1. For the above tune up power were declared by the manufacturer.
2. For NFC: EIRP[dBm] = E[dBμV/m]- 95.2 for d = 3 m.

GSM850: Maximum Tune-up output power with 1 slot is 33dBm, 2 slot is 32.00 dBm, 3 slot is 30.50 dBm, 4 slot is 29.00 dBm so the max tune-up time based Ave. power compared to slot Ave. power is 4slot 26.24dBm

PCS1900: Maximum Tune-up output power with 1 slot is 29.50 dBm, 2 slot is 29.0 dBm, 3 slot is 27.0 dBm, 4 slot is 25.5 dBm so the max tune-up time based Ave. power compared to slot Ave. power is 22.74dBm

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:

1. For the above tune up power were declared by the manufacturer.
2. 2.4G Wi-Fi , GSM850 and NFC can transmit simultaneously (worst case) .

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0757 + 0.1089 + 0.0001 = 0.1847 < 1.0$$

Result: The device meet FCC MPE at 20 cm distance.