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/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.

Calculated Formulary:

Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = 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:

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

Calculated 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)				
GSM850	824-849	0.61	1.15	26.0	398.11	20	0.0911	0.5493	0.1658
GSM1900	1850-1910	4.18	2.62	23.0	199.53	20	0.1040	1.00	0.1040
WCDMA B2	1850-1910	4.18	2.62	25.0	316.23	20	0.1648	1.00	0.1648
WCDMA B4	1710-1755	3.63	2.31	25.0	316.23	20	0.1453	1.00	0.1453
WCDMA B5	824-849	0.61	1.15	25.0	316.23	20	0.0724	0.5493	0.1318
LTE B2	1850-1910	4.18	2.62	25.0	316.23	20	0.1648	1.00	0.1648
LTE B4	1710-1755	3.63	2.31	25.0	316.23	20	0.1453	1.00	0.1453
LTE B5	824-849	0.61	1.15	25.0	316.23	20	0.0724	0.5493	0.1318
LTE B7	2500-2570	3.72	2.36	25.0	316.23	20	0.1485	1.00	0.1485
LTE B12	699-716	-4.15	0.38	25.0	316.23	20	0.0242	0.466	0.0519
LTE B13	777-787	-4.29	0.37	25.0	316.23	20	0.0234	0.518	0.0452
LTE B25	1850-1915	4.18	2.62	25.0	316.23	20	0.1648	1.00	0.1648
LTE B26 (814-824)	814-824	0.61	1.15	25.0	316.23	20	0.0724	0.5427	0.1334
LTE B26 (824-849)	824-849	0.61	1.15	25.0	316.23	20	0.0724	0.5493	0.1318
LTE B38	2570-2620	2.67	1.85	25.0	316.23	20	0.1164	1.0	0.1164
LTE B41	2496-2690	3.72	2.36	25.0	316.23	20	0.1485	1.0	0.1485
BLE(1Mbps)	2402~2480	2.94	1.97	3.5	2.24	20	0.0009	1.00	0.0009
BLE(2Mbps)		2.94	1.97	2.0	1.58	20	0.0006	1.00	0.0006
NFC	13.56	1.0	1.26	-9.5	0.02	20	0.00003	0.98	0.00003

Note:
(1) The Tune-up output power was declared by the manufacturer.
(2) For NFC mode, ERP= 83.02dBμV/m-95.2 = -12.18dBm.
EIRP= ERP+2.15=-12.18+2.15=-10.03 dBm. The Tune-up EIRP= -8.5 dBm

(3) NFC, LTE and BLE can transmit simultaneously, the worst condition as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.1648+0.0009+0.00003=0.16573 < 1.0$$

Result: The device meets MPE at distance 20cm.