

## MPE Calculation

**§ 1.1310:** The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

### Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
<b>(A) Limits for Occupational/Controlled Exposures</b>				
0.3–3.0 .....	614	1.63	*(100)	6
3.0–30 .....	1842/f	4.89/f	*(900/f <sup>2</sup> )	6
30–300 .....	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3–1.34 .....	614	1.63	*(100)	30
1.34–30 .....	824/f	2.19/f	*(180/f <sup>2</sup> )	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

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

### 1.1 Test Procedure

An MPE evaluation for was performed in order to show that the device was compliant with §2.1091. The maximum power density was calculated for each transmitter at a separation distance of 20cm.

For each transmitter the maximum RF exposure at a 20 cm distance using the formula:

$$ConductedPower_{mW} = 10^{ConductedPower(dBm)/10}$$

$$PowerDensity = \frac{ConductedPower_{mW} \times Ant.Gain}{4\pi \times (20_{cm})^2}$$



## 1.2 Results:

The device contains Cellular, Zigbee, and 802.11 transmitters which can transmit simultaneously. The following calculations show that the total power density from each transmitter at 20cm is less than the limit for general population / un-controlled exposure. With the Cellular, 802.11, and Zigbee modules transmitting simultaneously, the worse case MPE calculations are less than 20% of the applicable limit. The device meets the RF exposure limit at a 20cm separation distance as required by part 2.1091 of the FCC rules with all modules transmitting simultaneously.

### Burst Average Conducted Output Power of Cellular Module

Band	Channel	Frequency (MHz)	GSM	GPRS - 1 Tx Slot	GPRS - 2 Tx Slots	GPRS - 3 Tx Slots	GPRS - 4 Tx Slots	EDGE - 1 Tx Slot	EDGE - 2 Tx Slots	EDGE - 3 Tx Slots	EDGE - 4 Tx Slots
GSM 850	128	824.2	32.85	33	31.34	29.57	27.45	27.66	25.5	23.6	21.6
	190	836.6	32.75	32.89	31.26	29.47	27.36	27.62	25.45	23.61	21.57
	251	848.8	32.61	32.7	31.13	29.36	27.24	27.49	25.36	23.41	21.49
	512	1850.2	29.23	29.3	27.24	25.44	23.62	25.2	23.41	21.6	19.77
	661	1880	29.03	29.17	27.07	25.27	23.47	24.99	23.22	21.43	19.59
GSM 1900	810	1909.8	28.8	28.9	26.94	25.04	23.22	24.81	23.02	21.22	19.33

### Time Average Conducted Output Power of Cellular Module (Duty Cycle (10\*Log(Tx Slots/8) Included)

Band	Channel	Frequency (MHz)	GSM	GPRS - 1 Tx Slot	GPRS - 2 Tx Slots	GPRS - 3 Tx Slots	GPRS - 4 Tx Slots	EDGE - 1 Tx Slot	EDGE - 2 Tx Slots	EDGE - 3 Tx Slots	EDGE - 4 Tx Slots
GSM 850	128	824.2	23.82	23.97	25.32	25.31	24.44	18.63	19.48	19.34	18.59
	190	836.6	23.72	23.86	25.24	25.21	24.35	18.59	19.43	19.35	18.56
	251	848.8	23.58	23.67	25.11	25.10	24.23	18.46	19.34	19.15	18.48
	512	1850.2	20.20	20.27	21.22	21.18	20.61	16.17	17.39	17.34	16.76
	661	1880	20.00	20.14	21.05	21.01	20.46	15.96	17.20	17.17	16.58
GSM 1900	810	1909.8	19.77	19.87	20.92	20.78	20.21	15.78	17.00	16.96	16.32

## Test Summary

### GSM 850 Band Transmitter:

Frequency	824.2	MHz
Limit	0.549	mW/cm <sup>2</sup>
Distance	20	cm
Power	25.32	dBm
TX Ant Gain	-0.12	dBi
EIRP	25.2	331.1311 mW
Power Density	<b>0.0659</b>	mW/cm <sup>2</sup> at 20cm
% of MPE Limit	<b>11.99</b>	



### GSM 1900 Band Transmitter:

Frequency	1850.2	MHz
Limit	1.000	mW/cm <sup>2</sup>
Distance	20	cm
Power	21.22	dBm
TX Ant Gain	2.09	dBi
EIRP	23.31	214.2891 mW
Power Density	<b>0.0426</b>	mW/cm <sup>2</sup> at 20cm
% of MPE Limit	<b>4.26</b>	

**802.11**

Frequency Limit	2412	MHz
Distance Power	1.000	mW/cm^2
TX Ant Gain	20	cm
EIRP	17.71	dBm
	1.87	dBi
	19.58	90.78205 mW
Power Density % of MPE Limit	<b>0.0181</b>	mW/cm^2 at 20cm
	<b>1.81</b>	

**Zigbee Transmitter**

Frequency Limit	2450	MHz
Distance Power	1.000	mW/cm^2
TX Ant Gain	20	cm
EIRP	18.87	dBm
	1.92	dBi
	20.79	119.9499 mW
Power Density % of MPE Limit	<b>0.0239</b>	mW/cm^2 at 20cm
	<b>2.39</b>	