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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/cm²)	Averaging time (minutes)
(A) Lim	nits for Occupationa	I/Controlled Exposul	res	
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits	for General Populati	ion/Uncontrolled Exp	oosure	
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
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.



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:

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

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



















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1.2 Results:

The device contains Cellular and Wifi 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 worst case Cellular and Wifi radios transmitting simultaneously, the MPE calculations are less than 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.

The total sum of the ratio of the power densities to the corresponding limit for all radios capable of transmitting simultaneously was computed as follows:

Total = (GSM Power Density / Limit GSM) + (Wifi Power Density / Limit Wifi)

Total = 0.2616 + 0.0250 = 0.2866

Compliance is shown by the sum of the radio of the power densities for all radios that can transmit simultaneously being less than 1.

















¹ The cellular radio is only capable of transmitting in one mode at a time (Cell band or PCS band).







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Individual Radio Test Results: Worst Case Band from each Radio

GSM 850	Value	Unit	Comments
Frequency	824.2	MHz	
Distance	20	cm	
Maximum Scaled Power	32.92	dBm	Measured conducted power
TX Antenna Gain	4.7	dBi	From datasheet, or calculated from peak radiated field strength
			and measured conducted power
Source Based Duty Cycle	12.5	%	Percent of time transmitter is active
EIRP	37.62	dBm	Maximum Scaled Power x Antenna Gain
Source Based Output Power	28.6	dBm	EIRP x Duty Cycle
Power Density @ Distance	0.1438	mW/cm ²	(Source Based Output Power, mW) / (4π x (distance, cm) ²)
FCC Limit	0.5495	mW/cm ²	.0007 x f ⁴ 1
Ratio of Power Density to Limit	0.2616		Power Density / FCC Limit
Maximum Permissible Antenna Gain	10.52	dBi	((Limit, mW/cm²) x 4π x (distance, cm)²) / ((Maximum Scaled
			Power, mW) x Source Based Duty Cycle)
Wifi 2.4GHz	Value	Unit	Comments
Frequency	2441	MHz	
Distance	20	cm	
Maximum Scaled Power	21	dBm	Measured conducted power
TX Antenna Gain	0	dBi	From datasheet, or calculated from peak radiated field strength
			and measured conducted power
Source Based Duty Cycle	100	%	,
Source Based Duty Cycle EIRP		% dBm	and measured conducted power
	21		and measured conducted power Percent of time transmitter is active
EIRP	21 21.0	dBm	and measured conducted power Percent of time transmitter is active Maximum Scaled Power x Antenna Gain
EIRP Source Based Output Power	21 21.0 0.0250	dBm dBm mW/cm ²	and measured conducted power Percent of time transmitter is active Maximum Scaled Power x Antenna Gain EIRP x Duty Cycle
EIRP Source Based Output Power Power Density @ Distance	21 21.0 0.0250 1.0000	dBm dBm mW/cm ² mW/cm ²	and measured conducted power Percent of time transmitter is active Maximum Scaled Power x Antenna Gain EIRP x Duty Cycle (Source Based Output Power, mW) / (4π x (distance, cm)²)
EIRP Source Based Output Power Power Density @ Distance FCC Limit	21 21.0 0.0250 1.0000	dBm dBm mW/cm ² mW/cm ²	and measured conducted power Percent of time transmitter is active Maximum Scaled Power x Antenna Gain EIRP x Duty Cycle (Source Based Output Power, mW) / $(4_{\pi} \text{ x (distance, cm)}^2)$ 1. x f/0













