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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/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
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 Population/Uncontrolled Exposure				
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.

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:

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

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

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1.2 Results:

The device contains Cellular, Bluetooth, and 802.11 transmitters. The Cellular radio can 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, 802.11, and Bluetooth 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[1].

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 = (CDMA Cell Band Power Density / Limit Cell Band) + (802.11 Power Density / Limit 802.11) + (Bluetooth Power Density / Limit Bluetooth)

Total = (0.12 / 0.54) + (0.09 / 1) + (0.000003 / 1) = 0.312

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.

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Individual Radio Test Results:

CDMA Cell Band Transmitter:

- Maximum Cell Band Conducted Output Power = 300mW
- Maximum Cell Band Antenna Gain = 2.0dBi

Power Density = (300*2mW x 2.0dBi) / 5025.6

Power Density = 0.12mW/cm2

Limit at 824MHz = 0.54mW/cm^2

CDMA PCS Band Transmitter:

- Maximum PCS Conducted Output Power = 274mW
- Maximum PCS Antenna Gain = 2.0dBi

Power Density = (274mW x 2.0dBi) / 5025.6

Power Density = 0.11mW/cm2

Limit at 1.8GHz = 1mW/cm^2

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802.11 Transmitter

- Maximum 802.11 Conducted Output Power = 264mW
- Maximum 802.11 Antenna Gain = 1.8dBi

Power Density = (264mW x 1.8dBi) / 5025.6

Power Density = 0.09mW/cm2

Limit at 2.4GHz = 1mW/cm^2

Bluetooth Transmitter

- Maximum Bluetooth Conducted Output Power = 0.0084mW
- Maximum Bluetooth Antenna Gain = 1.8dBi

Power Density = (0.0084mW x 1.8dBi) / 5025.6

Power Density = 0.000003mW/cm^2

Limit at 2.4GHz = 1mW/cm^2