RF Exposure Evaluation - Maximum Permissible Exposure (MPE)

1. Introduction

2.4 GHz frequency band is regarded specially as a dangerous band for its heating harmfulness to the human body. That's why microwave oven is operating in this frequency band. The manufacturer whose product is working in this frequency band is obligatory to prove the harmfulness of this product.
In this document, we try to prove the safety of radiation harmfulness to the human body. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1210 is followed. The Gain of the antenna used in this product is measured by power meter. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

2. RF Exposure Limit

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures				
300-1500	…	…	F/300	6
1500-100,000	…	…	5	6
(B) Limits For General Population / Uncontrolled Exposure				
300-1500	…	…	F/1500	6
1500-100,000	…	…	1.0	30

F = Frequency in MHz

3. Friis Formula

Friis transmission formula: $Pd = (Pout*G) / (4\pi r^2)$

Where
Pd = power density in mW/cm^2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi = 3.1416$
R = distance between observation point and center of the radiator in cm
Pd is the limit of MPE, 1 mW/cm2. If we know the maximum Gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

Ref.: David K. Cheng, Field and Wave Electromagnetics, Second Edition, Page 640, Eq. (11.133)

4. EUT Operating Condition

Software provided by the client enabled the EUT to transmit and receive data at lowest, middle, and highest channel individually.

5. Climate Condition

The temperature and related humidity: 22˚C and 78% RH

6. Test Results (Antenna Configuration)

6.1 Output Power into Antenna & RF Exposure Distance: (CDMA)

Channel	Channel Frequency (MHz)	Output Power (mW)	Minimum Allowable Distance from Skin (cm)
1013	824.70	252	4.479
0363	835.89	252	4.479
0777	848.31	252	4.479

6.2 Output Power into Antenna & RF Exposure Distance: (PCS CDMA)

Channel	Channel Frequency (MHz)	Output Power (mW)	Minimum Allowable Distance from Skin (cm)
0025	1851.25	400	5.0643
0600	1880.00	400	5.0643
1175	1908.75	400	5.0643

*Note: 3 dB was added to the output power, since the conducted is 23 dBm, to show the maximum antenna gain that can be used for this device.

7. Conclusion

The device meets the mobile 20cm. separation distance as specified in Section 2.1091 of the FCC Rules and an appropriate RF exposure compliance statement will be placed in the users manual.