

RF Exposure Measurement

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 his 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 : $P_d = (P_{out} * G) / (4 * \pi * r^2)$

Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = distance between observation point and center of the radiator in cm

P_d is the limit of MPE, 1 mW/cm^2 . 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

A Software provided by 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

6.1 Output Power Into Antenna & RF Exposure Distance:

CHANNEL	Channel Frequency (MHz)	Output Power To Antenna (mW)	Minimum Allowable Distance From Skin(cm)
1013	824.70	235	5.83
363	835.89	253	6.05
0777	848.31	252	6.03

The distance r (4th column) calculated from the Friis transmission formula is far shorter than 20cm separation requirement. So, RF exposure limit warning or SAR test are not required.