FUZZY LOGIC SHIELDING AND EMI EFFECT ON EXPERIMENTAL ANIMALS USING HFSS

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Abstract

In this research fuzzy logic based monitoring of interference effects on experimental animals, was planned to evaluate the effect of two different electromagnetic fields exposure on (Mice), at different exposure levels. The strengths used were chosen because they are estimated as the effective doses almost similar to the level of human exposure to EMF.

Keywords: *EMI, EMC, Electromagnetic, HFSS, Radiation.*

1. Introduction

The effects of electro-magentic Interference on experimental animals using HFSS, has been evaluated, the effect of two different electric-field and magnetic-field on (Mice). Effective doses similar to the level of human exposure to EMF has been posed. The specimen was exposed to iso-thermal non-ionizing radiations, (artificial visible light of intensity of 77 mW/cm2 on the area of 72.5 cm2 and frequency of EM radiation between (1GHz and 1.5GHz) .

2. Maxwell

Maxwell's equations take the form of an electromagnetic wave in an area that is very far away from any charges or currents (free space) - that is, where ρ and **J** are zero. It can be shown, that, under these conditions, the electric and magnetic fields satisfy the electromagnetic wave equation: The electromagnetic wave equation is a second-order partial differential equation that describes the propagation of electromagnetic waves through a medium or in a vacuum. The homogeneous form of the equation, written in terms of either the electric field **E** or the magnetic field **B**, takes the form:

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right) E = 0$$

$$\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right) B = 0$$

It should also be noted that in most older literature, (**B**) is called the Magnetic flux density or Magnetic induction (Jordan).
Electromagnetic radiation can be classified into ionizing radiation and non-ionizing radiation.

Electromagnetic-interference[1]is an unwanted or undesired signal that influences the normal operation of the system, leading to the malfunctioning or collapse of the system. It is also known as Radio frequency Interference. It is a phenomenon where one electromagnetic field interferes with another resulting in the distortion of both fields. we can widely categorize electromagnetic-interference[1] into two major groups as emissions and susceptibility.

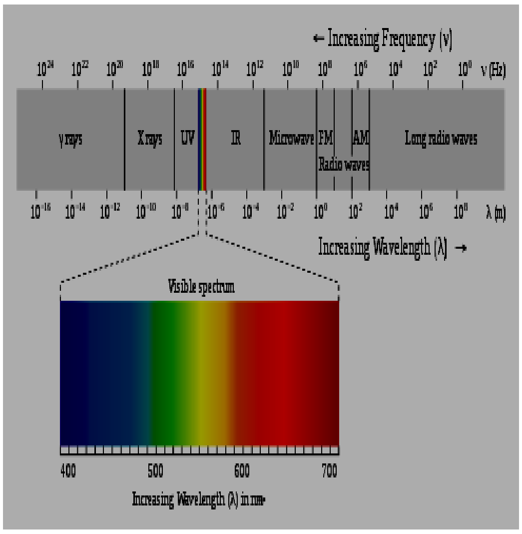


Figure (1): Complete spectrum of electromagnetic radiation

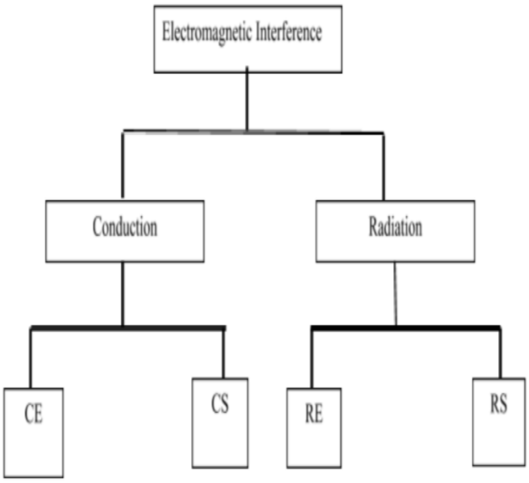


Figure (2): Types of electromagnetic radiation

Classification of Electromagnetic Interference[1].

It is further classified as,

- CE-Conducted emission
- RE-Radiated emission
- CS-Conducted susceptibility
- RE-Radiated susceptibility

The CE and RE deals with undesirable emissions from a device as internal sources of noise. Similarly, CS and RS deals with a device as external sources of noise.[1]

3. Experimental setup:

The propagation of electromagnetic wave system has taken a form shown in figure(3).

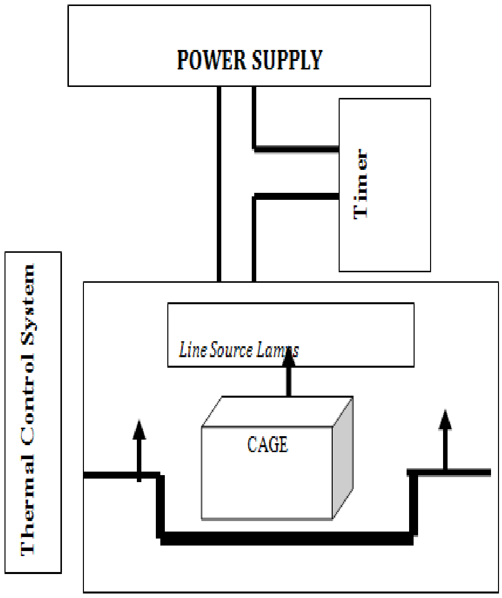


Figure (3): Arrangement for application of electromagnetic field

Mice exposure cage was prepared from a polymer, which is not dielectric material. Cages with dimensions of (45 x 25 x 30 cm) were designed to obtain optimum condition and constitute the optimum area for irradiation for about 20 mice in the same time. **Figure (4)** shows the propagation of electromagnetic wave system, which assures the above conditions.

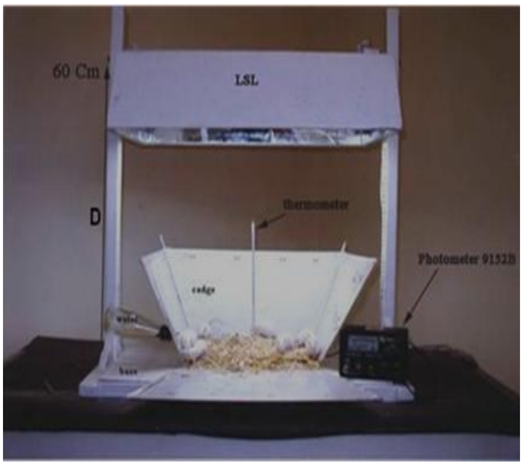


Figure (4): The instrument applied for electromagnetic field.

4 Calculation of Length and Width of the inductor and capacitor

We are going to use FR4 Epoxy as substrate .The dielectric permittivity of dielectric substrate is 4.4.The thickness of substrate is h=0.5mm.The dielectric permittivity is represented as εr.

Now, we have to calculate width and length for Microstrip filter. we can calculate width of microstrip line by equations. Equations for calculation of width and length are as given below.

If $\frac{W_0}{h} = \frac{8exp\,(A)}{expexp\,(2A) - 2}$

(3)

Where A= $\frac{z_0}{60}\sqrt{\frac{\varepsilon r+1}{2}} + \frac{\varepsilon r+1}{\varepsilon r-1}$

(4)

W0 = width

h =height of the substrate

Z0=impedance

Guided wavelength λgl= $\frac{300}{f\sqrt{\varepsilon reff}}$

(5)

For calculation of physical length

lL= $\frac{\lambda gl}{60} \times \left(\frac{WcLi}{Z0L}\right)$

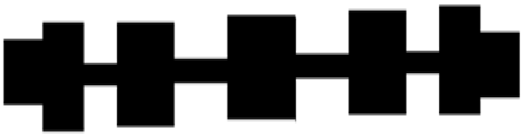
(6)

lC= $\frac{\lambda gl}{60} \times (wcCiZoc)$

(7)

Elements	Length	Width
Impedance 50ohms	10	0.5626
C1	4.4919	1.2560
L2	16.3217	0.1542
C3	22.7199	1.2560
L4	41.9236	0.1542
C5	36.8974	1.2560
L6	41.9236	0.1542
C7	22.7199	1.2560
L8	16.3217	0.1542
C9	4.4919	1.2560
Impedance 50ohms	10	0.5626

TABLE (1): Lengths and widths of the elements



Figure(5) The design of ninth order low pass filter is as shown

5 Procedure

The Microstrip Low Pass Filter filters the incoming signal.It removes the unwanted electromagnetic signal from the incoming signal.The capacitor C1 does most of the filtering in the circuit and the remaining ripples removed by the L-section filter (L2-C3-L4-C5-L6-C7-L8-C9). C1 is selected to provide very low reactance to the ripple frequency. The output signal is filtered signal. The total design of Microstrip Low Pass Filter is as shown.

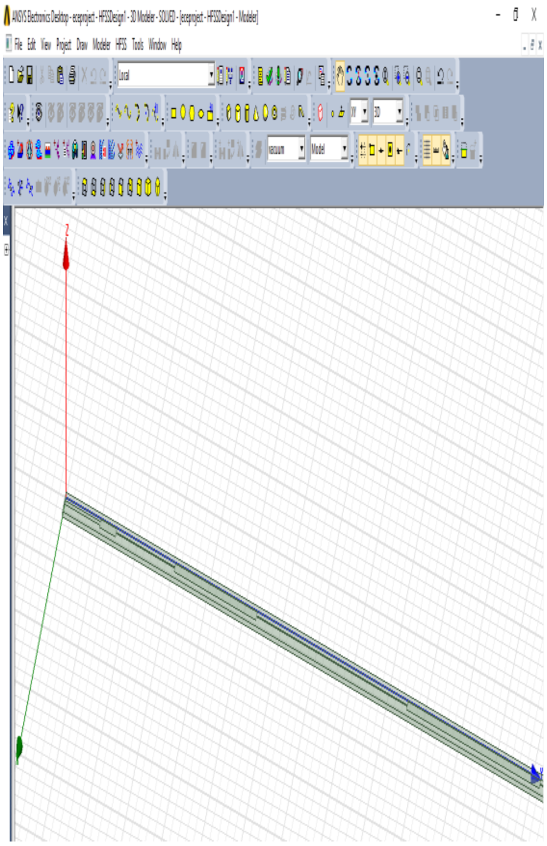


Figure (6) The HFSS layout design of order low pass filter

The top view of design is as shown

Figure (7) Top View of HFSS layout design of order low pass filter

6 Results

To check results select Results>right click>create terminal solution data report>rectangular port.St (cap1_T1,cap2_T2) indicates the insertion loss. Insertion loss is the loss of signal power resulting from the insertion of a device in a transmission line

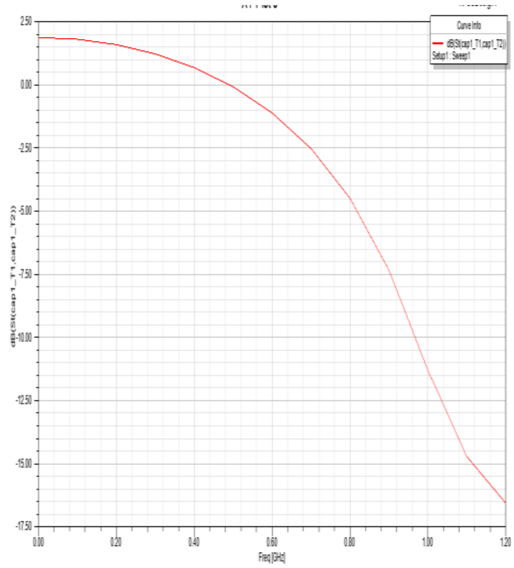


Figure (8) plot of microstrip filter

The plot shows the gain value at a resonant frequency. The red color is the peak gain achieved. This is a 3 dimensional plot with 2 independent variables (theta and phi). Therefore there is a Primary and Secondary sweep that must be defined.

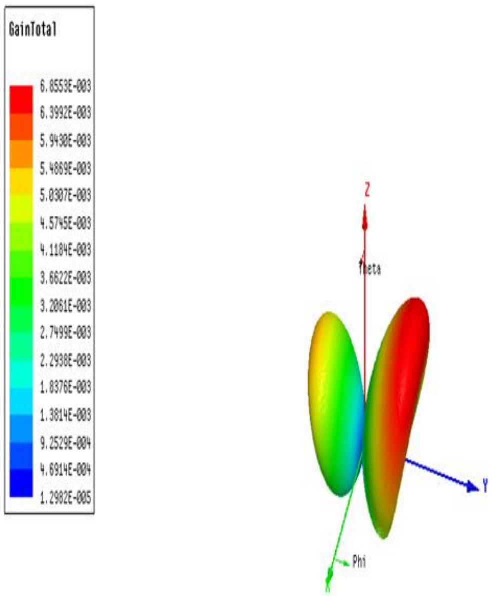


Figure (9) plot shows the radiation pattern

7 Conclusion

The main focus has been to reduce the effect of Electromagnetic-interference using micro strip filter, on experimental animals. Initially, investigated to understand animals and electromagnetic-interference. The causes of EMI due to various sources, like passive and active components are investigated. The influence of frequency is very high on the experimental animals, hence the low pass micro-strip filter of order, N=9 resonant frequency of 1GHz is designed. The simulation results for N=9 is very close to the cutoff frequency. So it removes the unwanted electromagnetic signals.

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8.1 Book

[1] *A book titled "EMI-EMC Analysis"published by S.Vardarajan and Dola Sanjay S.*

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