ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 8, August 2014

Reflection and Transmission Coefficients of Different Biological Tissues

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ABSTRACT: The Electromagnetic waves show different characteristics of different homogeneous materials. As Electromagnetic waves incident on a perfect conductor they are entirely reflected, whereas on good conductor they are completely transmitted. But one incident on a medium which is neither a good conductor nor a good dielectric they are partially reflected and partially transmitted. In case of a non-homogeneous media like human body the reflection and transmission coefficients, depending upon permittivity, conductivity, permeability and frequency, vary in different tissues. So that it is complex to estimate the characteristics of Electromagnetic waves. In this paper, the analysis is made and the data on reflection and transmission coefficients of few biological tissues is presented.

KEYWORDS: Electromagnetic waves, perfect conductor, non-homogeneous media, permittivity, conductivity, permeability and frequency

I. INTRODUCTION

As Electromagnetic waves propagate from one homogeneous medium to another, they experience a change of the wave impedance at the interface [1]. The impedance mismatch generally leads to the reflection, absorption, and transmission of Electromagnetic waves [2]. Power reflection and transmission coefficients are found for linearly and circularly polarized plane electromagnetic waves, normally incident on a plasma slab, moving uniformly along a magneto static field, normal to the slab boundaries [3]. The study of electromagnetic interaction with moving bounded media, in particular plasmas, due to applications in space exploration has received considerable attention in recent literature. Here one requires the knowledge of electrodynamics of moving media and electromagnetic boundary- conditions at a moving boundary. Review of the electrodynamics of moving media was recently presented by Tai [4], and a review and kinematic formulation of electromagnetic boundary conditions at a moving boundary were presented by Costen and Adamson [5].

When an Electromagnetic wave is incident on human tissues some of the energy is transmitted and some is reflected back, because of impedance mismatches. So it is necessary to study the reflection and transmission coefficients of biological tissues. In this unit expressions for and reflection and transmission coefficients are derived from conducting and dielectric media for different incidence cases

II. WAVES ON A PERFECT CONDUCTOR-NORMAL INCIDENCE

1. When a wave in air is incident on perfect conductor normally, it is entirely reflected.
2. As neither E nor H can exist in a perfect conductor, none of the energy is transmitted through it.
3. As there are no losses within a perfect conductor, no energy is absorbed in it.

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4. When an EM wave travelling in one medium is incident upon a second medium, it is partially reflected and partially transmitted.

When an EM wave is incident normally on the surface of a dielectric then reflection and transmission take place. For a perfect dielectric, σ=0. Hence, there is no loss or no absorption of energy in it.
Expressions for reflection and transmission coefficients are:

$$\acute{\Gamma}_E = \frac{E_r}{E_i} = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} \quad (1.1)$$

$$\acute{\Gamma}_H = \frac{H_r}{H_i} = \frac{\eta_1 - \eta_2}{\eta_1 + \eta_2} \quad (1.2)$$

$$T_E = \frac{E_t}{E_i} = \frac{2\eta_2}{\eta_1 + \eta_2} \quad (1.3)$$

$$\acute{\Gamma}_H = \frac{H_t}{H_i} = \frac{2\eta_1}{\eta + \eta_2} \quad (1.4)$$

Where n_1 And η_2 are intrinsic impedances of medium 1 and medium 2 respectively.

III. RESULTS

Here the analysis of two adjacent tissues is carried out and one tissue blood is common. The reflection and transmission coefficients as a function of frequency from 10Hz to 10GHz of two adjacent tissues presented in figures. Different tissues presented here are Aorta and blood, blood vessel and blood, Body fluid and Blood.

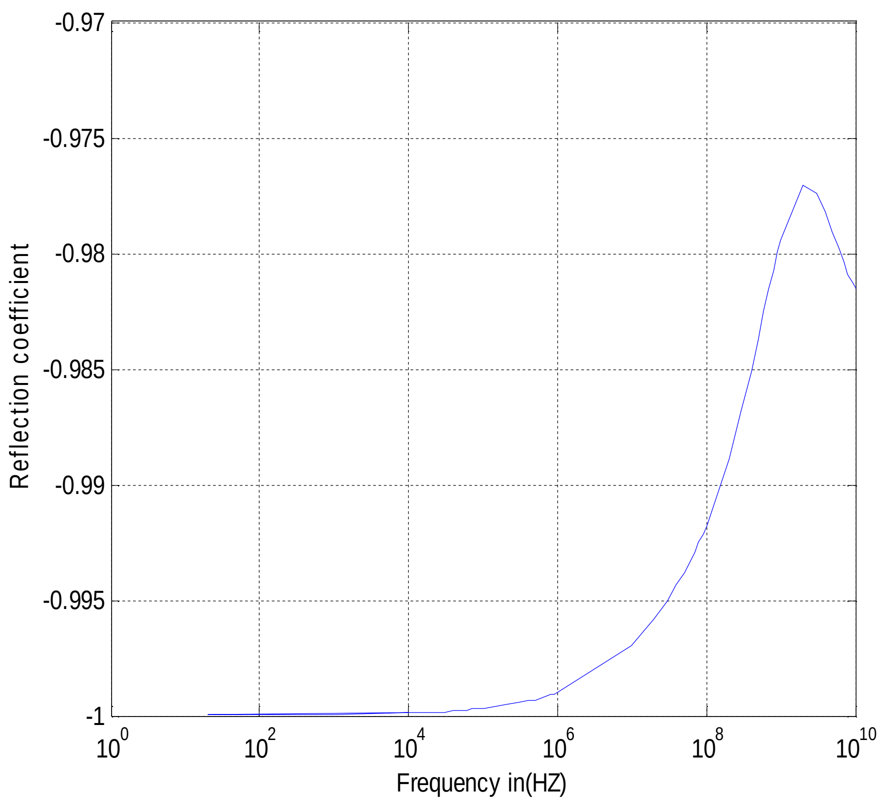

Fig1.1: Reflection coefficient of Aorta /Blood vs. Frequency

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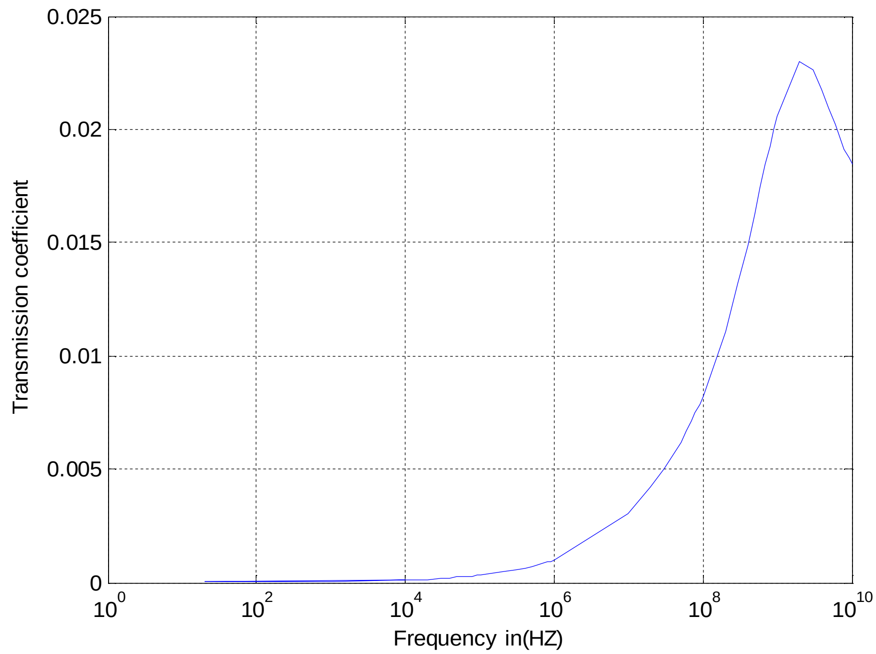

Fig1.2: Transmission coefficient of Aorta /Blood vs. Frequency

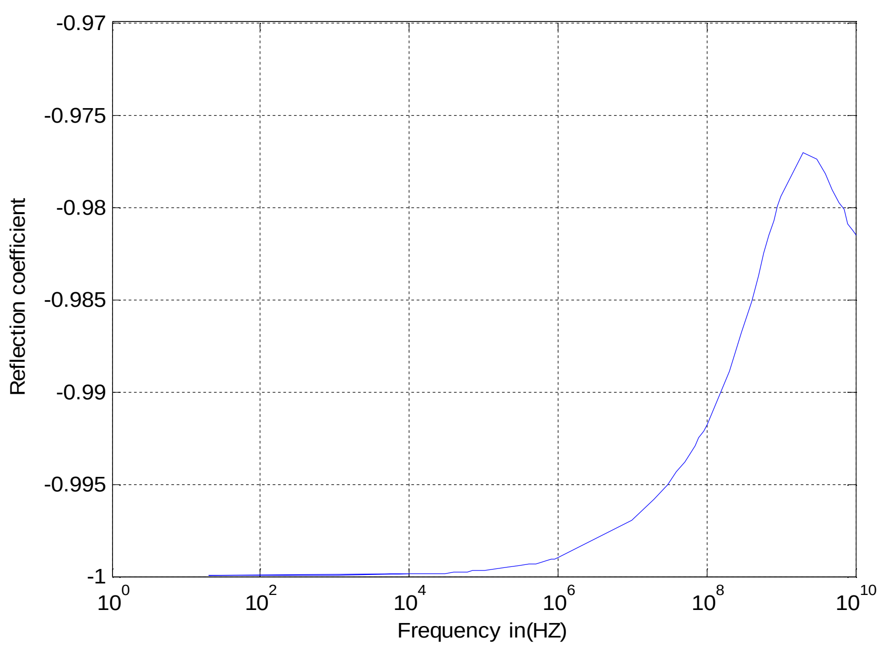

Fig1.3: Reflection coefficient of Blood vessel/Blood vs. Frequency

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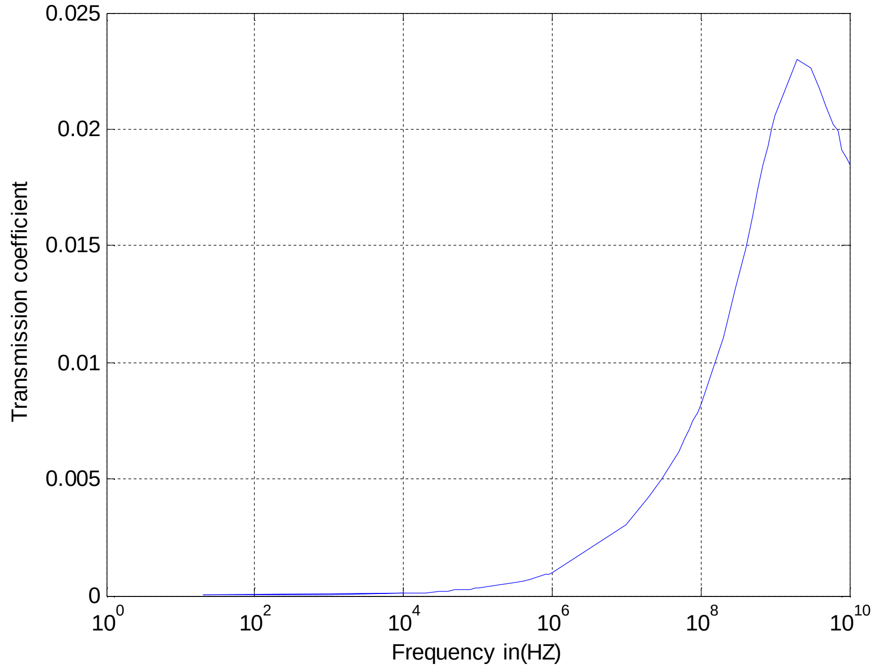

Fig1.4: Transmission coefficient of Blood vessel/Blood vs. Frequency

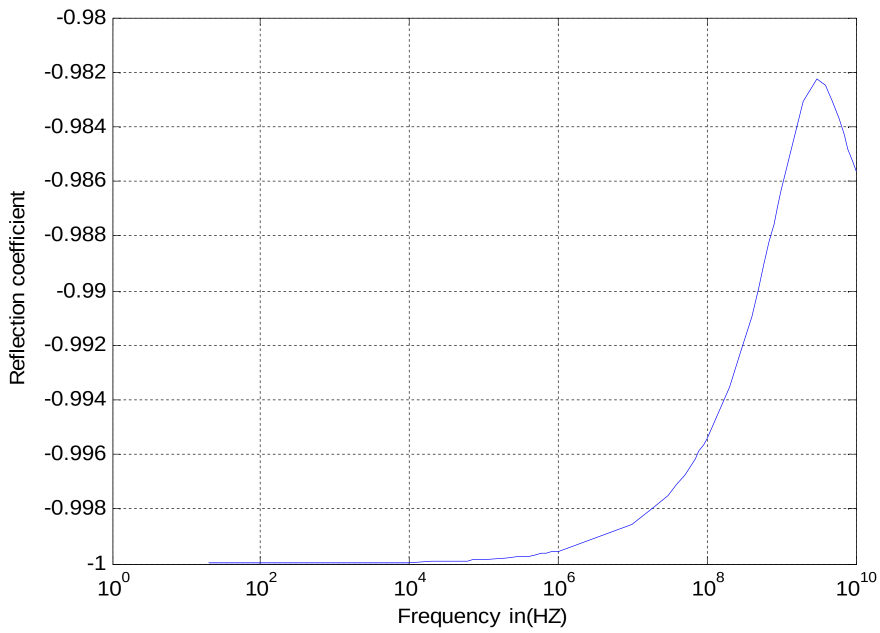

Fig1.5: Reflection coefficient of Body fluid/Blood vs. Frequency

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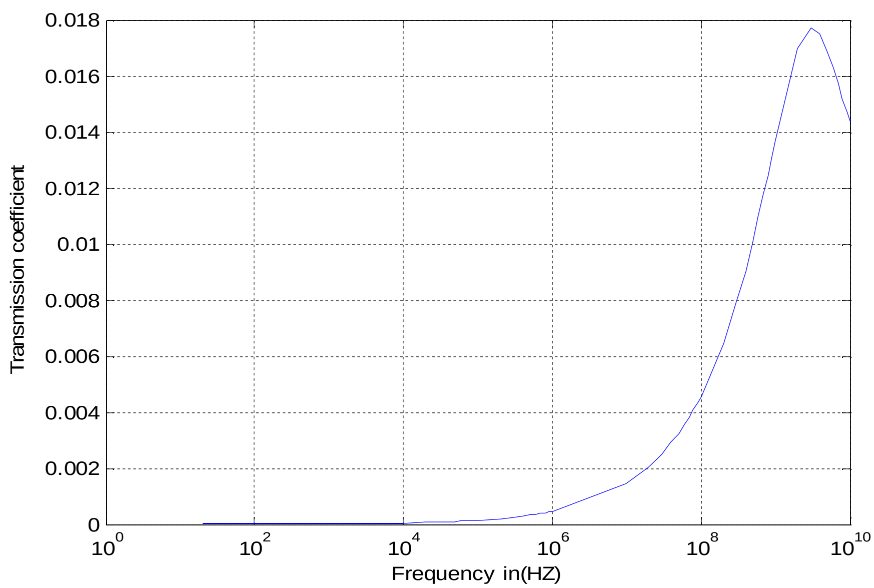

Fig1.6: Transmission coefficient of Body fluid/Blood vs. Frequency

IV. CONCLUSIONS

From the results it is observed that the Reflection coefficient of all adjacent tissues value is '-1' at very low frequencies. The transmission coefficient value is '0' from very low frequencies to 10 KHz frequency. The highest reflection and transmission coefficients observed from 1GHz to 5GHz microwave frequency range. Further, the reflection and transmission coefficients decreased at 10GHz frequency for all tissues.

REFERENCES

1. C.L. Palombini, K. E. Oughstun "Reflection and Transmission of pulsed Electromagnetic fields through Multilayered biological Media" 978-1-61284-978-2/11 IEEE 2011.
2. H.C. Kim, J. P. Verboncoeur "Reflection, Absorption and transmission of TE electromagnetic Wave propagation in a nonuniform plasma slab" Elsevier, 31 January 2007.
3. B. R. Chawla and Hillel Unz "Reflection and Transmission of Electromagnetic Waves Normally Incident on a Plasma Slab Moving Uniformly Along a Magnetostatic Field" IEEE Transactions on Antennas and propagation, Vol-no. 6 November 1969.
4. C. T. Tai, "A study of electrodynamics of moving media," Proc. IEEE, vol. 52, pp. 685-689, June 1964.
5. C. T. Tai, "A study of electrodynamics of moving media," Proc. IEEE, vol. 52, pp. 685-689, June 1964.

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