Scalp – Implantable Antenna for Biomedical Applications

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***Abstract*:** This paper presents implantable antenna systems which are miniaturized and it is proposed for biomedical applications, particularly for scalp administration. The advanced prototypes reveal the broad band features on the industrial, scientific, and medical (ISM) bands. Every structure is concatenated with the microelectronic constituents and a battery. The methodology and the operation are discussed briefly in this paper. The results of scalp implantable antenna produces a band from 0.9GHz to 0.92GHz. The measurements are fulfilled in an isotonic solution of sodium chloride for validation. The antenna proposes a fine accordance between the simulated and firmed results and to examine the range of the data transmission, a link budget is calculated.

Index Terms: *Biomedical applications, Microstrip Antenna ,dual-band and link budget etc.*

I.INTRODUCTION

Technology is increasing day by day, so that in biomedical applications compact and systematic devices are required due to the developments. In past, implantable medical devices are used to serve and detector different psychological signals in the human body[1]. Now a day's wireless systems are available to communicate with the outside world. An implantable antenna incorporated in an IMD is the key component for the proposed antenna. While designing the antenna, remarkable research has developed to avoid these problems. During the proposal of this antenna, there is a chance to occur some concerns and provocations[2]-[4].

The resonating frequency of an implantable antenna is ISM Band and it is used to serve the psychological signals like the brain implant technology. For example the applications are used to study the assess levels of consciousness[5]-[9]. The proposed antenna has an advantage because of its small volume compared to other antennas and it also decreases the complexity. An accordance between firmed and simulated results was noticed. The construction achieves the resonant gain of -16dBi.

In this work, proposes the patch antenna and it is in the shape of scalp antenna is used in bio-medical research and it has the frequency range of (902 – 915 MHz) ISM band. The patch antenna is taken with microstrip feed to get high frequency values. The presented arrangement is made with the Roger material substrate, it taken 10.2 as the dielectric constant and it has 0.635 mm of thickness also.

II. GEOMETRICAL VIEW OF ANTENNA

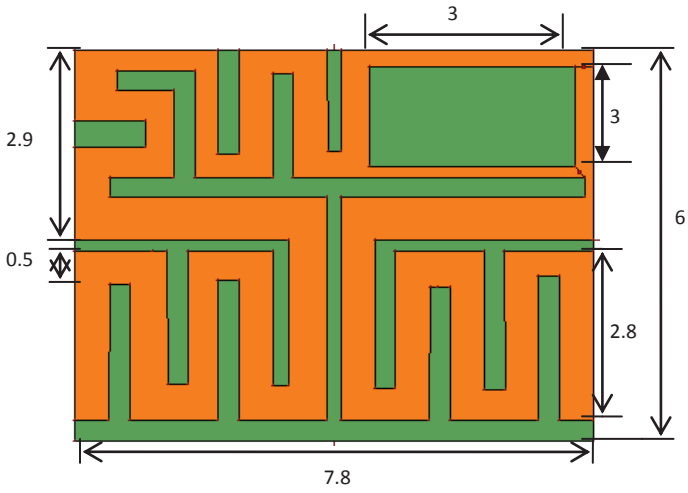
The structure of scalp-implantable antenna having the dimensions of 6×7.8 mm^2 is as shown in below Fig.1. To design the scalp-implantable antenna Rogers 6010 substrate of 0.635 is used and εr is 10.2 and with $\tan\delta$ of 0.0023. To design the antenna, the required dimensions are discussed below. And for implementing and simulating purpose IE3D software is used. Here the two systems are designed according to the various scenarios in mind and that are shown in Fig.1. System A is intended for the surface-based studies. On the other hand , system B is used to study the skull of human head in depth. Both systems occupies the two different volumes.

The presented arrangement designed with microstrip feed to obtain the more frequency. The proposed antenna has been simulated with Mentor Graphics IE3D simulator version15. After completing the design restrictions the presented antenna with the given εr, σ and then it can be used to test with the tissue of human models like skin, fat and muscle.

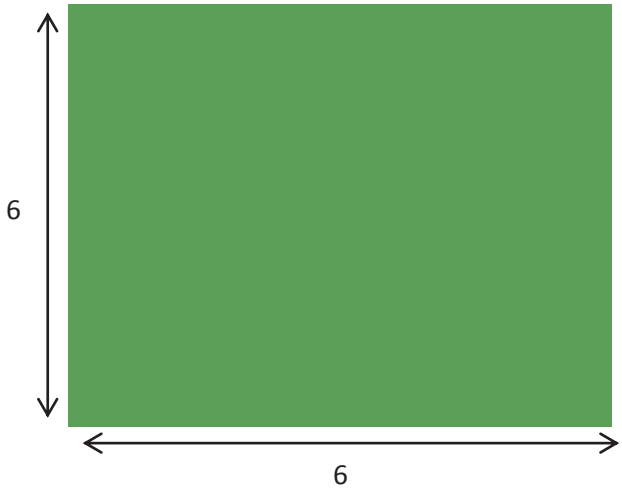
TISSUE	Permittivity	Conductivity	Dimension in "mm"
SKN	ε_r=38	σ=1.46	4
FAT	ε_r=5.28	σ =0.10	4
ANTENNA	ε_r=10.2	σ =0.0023	0.635
MUSCLE	ε_r=52.7	σ=1.73	8

Table 1: Dielectric properties of human tissues

The Roger substrate is used to fabricate the presented antenna. It should have the dielectric constant to protect the effectiveness of the antenna and coplanar wave guide construction must be limited. Simulation of proposed antenna with three layer model as shown in Table 1.



(a) Top view



(b) Bottom view

Fig.1. Antenna Structure

III. RESULTS AND DISCUSSION

The proposal and study of scalp-implantable antenna is simulated by using the IE3D simulator. The operating frequency of the designed antenna is from 0.9 GHz to 0.92GHz and having the return loss value of -19dB and by investigating it is showing that the scalp-implantable antenna operates at 0.91GHz and with a return loss value of -19dB as shown in Fig.2. To connect the feed point to the patch, above the copper patch antenna a soldering bump is present. To implement this antenna PEC surface is used.

The Roger substrate was cared by the cube of four sides with the help of a milling machine. This helps to fabrication process becomes simple. The sides of the cube are attached together by using copper tapes, while the sheets of copper were patched on the sides to near the cubic arrangement.

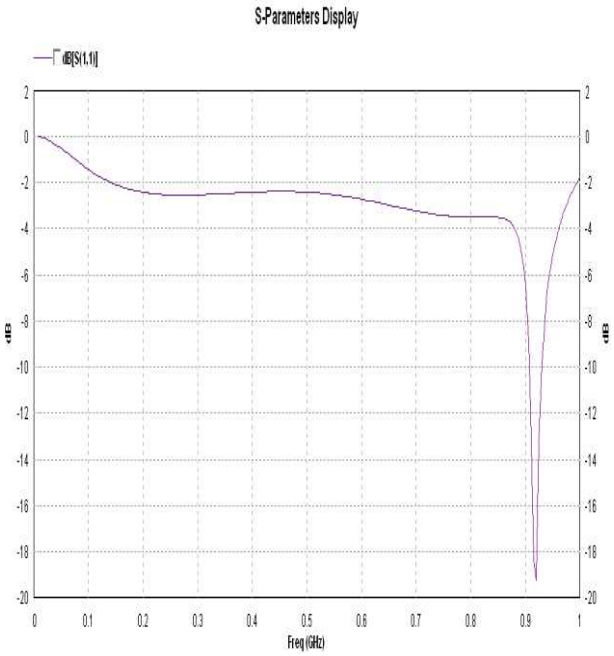


Fig.2. Return Loss characteristics

For an ideal antenna, VSWR must lie in the range of 1:2 ratios; which is achieved at 910MHz for ISM Band and it has shown in Fig.3. Characteristics impedance of scalp exhibited in Fig.4 and it has shown perfect matching at 50Ω impedance. The radiation system of proposed antenna shows maximum radiation at 910MHz is -16dBi for both elevation and azimuth pattern. The proposed antenna pattern E plane and H plane pattern shows -16dBi gain as shown in Fig.5 and Fig.6. The whole frequency band of the antenna radiation efficiency shows very peak level.

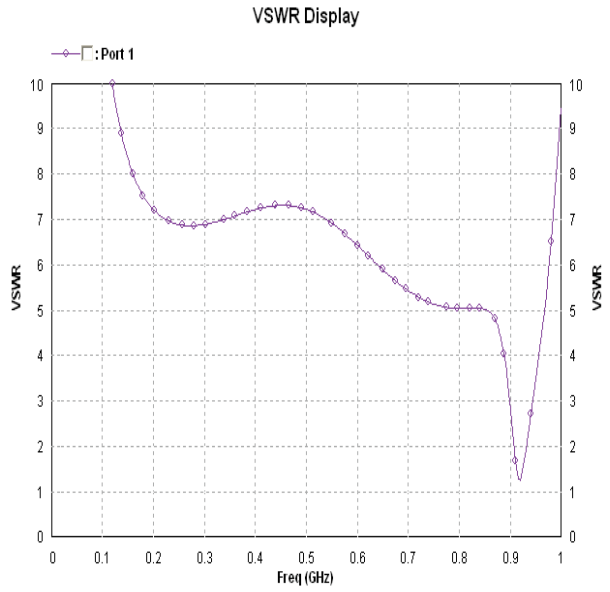


Fig.3. VSWR Characteristics

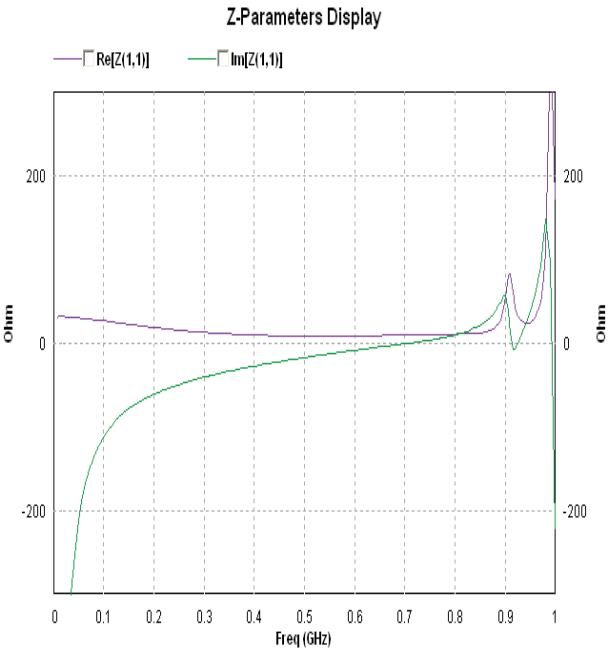


Fig.4. Z-Parameters

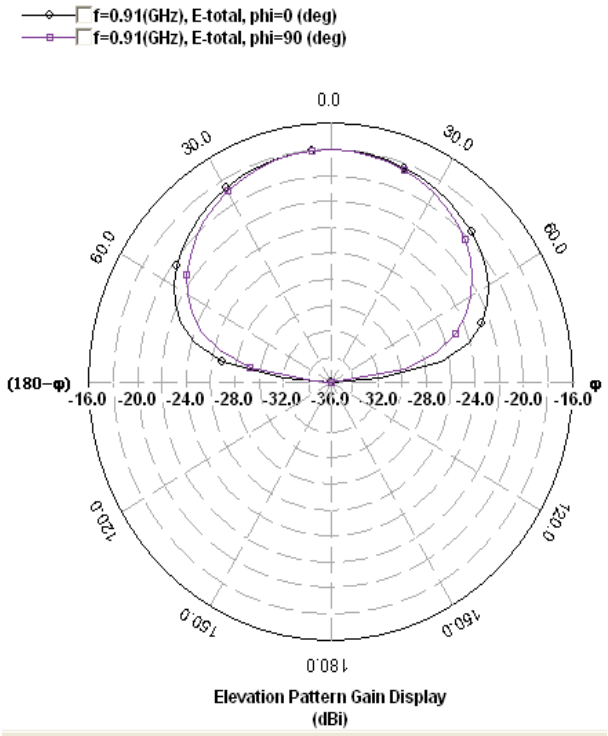


Fig.5. Elevation Pattern

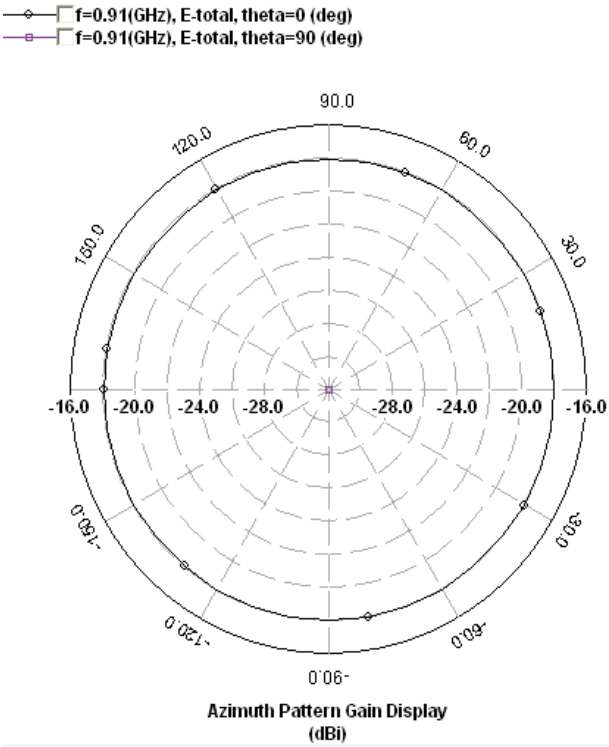


Fig.6. Azimuth Pattern

IV.CONCLUSION

The prototype of miniaturized ISM band implantable antenna system is presented in this paper and which is used for biomedical applications. Each system is concatenated with a battery. Sufficient return loss value of -19dB is obtained. To stay away from the straight connection with the human tissue, in the design an ROGER material is used. Based on the value of bit rate the disclosed antenna can carry the data transmission at an incredible area. Finally good simulated results were observed from scalp simulated model. An implantable antenna which is different from the current one was designed and it has the less weight and bandwidth is more compared to the actual antenna.

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