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S. Shekhawat, Gunaram, Vijay Sharma, and D. Bhatnagar

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CPW Fed Implantable Elliptical Patch Antenna for Biomedical Application

S. Shekhawat[1], Gunaram[2], Vijay Sharma[3, a)], and D Bhatnagar[1]

[1]*Department of Physics, University of Rajasthan, Jaipur-302015, India*
[2]*Bhagwant University, Ajmer-305002, Rajasthan, India*
[3]*Department of Physics, Govt. Mahila Engineering College, Ajmer -305002, India*
[a)] Corresponding author: phyvijay@gmail.com

Abstract. Presently microwaves are finding application not only for the purpose of communication but also in medical field for diagnosis as well as treatment purpose due to the advancement in technology. Biotelemetry is one of current area of research which enables the monitoring of human body and cure it immediately thus improve the rate of treatment and decreases the death rate. The structure of a particular radiator is the key aspect of this system. Keeping this in mind a CPW fed dual band patch antenna resonating in L-Band (1.6-1.94) with centre frequency 1.77GHz and C-Band (4.06-5.66 GHz) with centre frequency 4.88 GHz is designed. This antenna structure gives a wide -10 dB impedance bandwidth nearly 20.3 % in L-Band and 32.11 % in C-Band. Performance of this antenna is tested with simulation on human phantom model with HFSS tool. Further the gap between the human model and antenna is optimised to get the best possible matching. The patterns are in acceptable range when studied in free space.

INTRODUCTION

In current scenario fatal diseases are increasing day by day due to unhealthy living habits and poisonous environment giving rise to mortality rate. The only way to alive healthy is regular check-ups and early diagnosis of these fatal diseases. So it is necessary to monitor human bodies regularly, biotelemetry is one of such technique. Pacemakers and the swallow able pills with sensing capabilities are implantable devices enabling the monitoring and the treatment within the human body and these telemetry devices communicate with an external receiver unit. So when we are designing an antenna for biotelemetry it should be dual band one band to collect information from implantable antenna to on body antenna and one band from on body to off body antenna Thus selection of proper antenna is key element for wireless biotelemetry in health monitoring devices [1-2].

Designing an antenna for human body is very tough task as it is composed of various layers having different dielectric properties such as skin, fat, muscles, bone, blood etc. The radiation properties of antenna changes drastically due to this multilayer structure of human body. Badhan et al [3], discuss the detailed analysis of various performance parameters of body wearable antennas and shown that the right choice of antenna design is important to minimize the losses because the body also effects the performance of antenna. Movassaghi et al [4] in proposed a wireless body area network. Kaur et al [5] reviewed various biomedical application of antennas and also studied the techniques to form a bio communication between medical devices and external communication devices. Various types of antennas were proposed for use in biomedical applications like dipole antenna, FIFA antenna, patch antennas etc. In order to check the performance of antenna on human body various body phantoms were developed. In order to be insensitive to the human body effect, compact zeroth-order resonance (ZOR) antennas for implantable and wearable WBAN systems were proposed in [6] by Ha et al. In [7], Tak et al proposed a dual-band on-body repeater antenna for in-on-on WBAN applications. This antenna gives a broadside radiation at 5.8 GHz (ISM) band a dumble like radiation pattern along the surface of the human body for communication in the 2.45 GHz ISM band and shows that biomedical antennas should be broadband so that the effect of frequency shift minimizes. Li et al [8] proposed a compact, broadband and single-fed circularly polarised implantable patch antenna for biomedical telemetry application. In [9], Aadithiya presented simple patch with H Interventional slot for use in body area network. In [10], Gupta et al designed another CPW feed patch antenna for on-off body communication this antenna also shows dual band performance.

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In this paper the design of a CPW feed elliptical patch with L shaped ground is presented, which is operating in dual BAND (L band and C band) configuration as required for the on body antenna. Here L band is used for link between implantable device and on body antenna whereas C band is used for on to off body communication purpose. This antenna can also be used in other biomedical applications.

ANTENNA DESIGN AND ANALYSIS

For use in biomedical applications, coplanar waveguide(CPW) feed microstrip patch antenna as chosen as in this case ground and patch are on same plane which minimizes the volume, and also increases bandwidth and gain. The antenna is designed on glass epoxy FR4 substrate with permittivity εr = 4.4, thickness =1.59mm and loss tangent = 0.025. The electromagnetic software HFSS [11] is used to execute the design and optimization process. The geometry of proposed antenna is shown in Fig 1. The optimized dimension of antenna is given in Table 1. The reflection coefficient and gain variation with frequency for antenna are plotted in a single graph to understand easily as shown in Fig. 2. It is observed from this figure that the gain remains almost same and greater than zero in both bands for the full range of -10 dB IBW. The low value of gain is due to lossy FR4 substrate material.

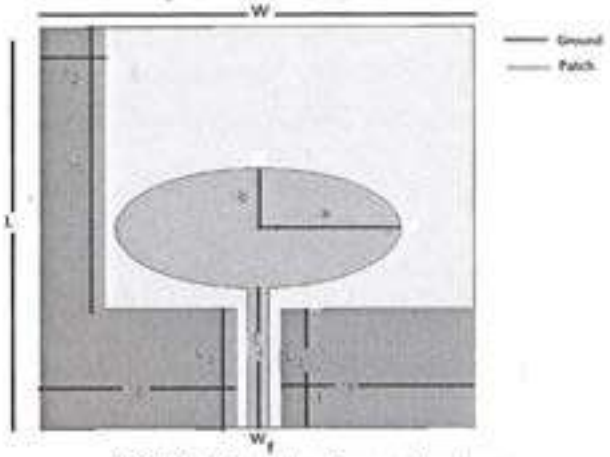

FIGURE 1. Geometry of proposed antenna

TABLE 1. The values of different design parameter (in mm) for proposed antenna

Parameter	Value	Parameter	Value
L	40	L4	12
W	40	Wf	1.9
L1	28	Lf	15
L2	6	a1	13
L3	18	b1	5.98

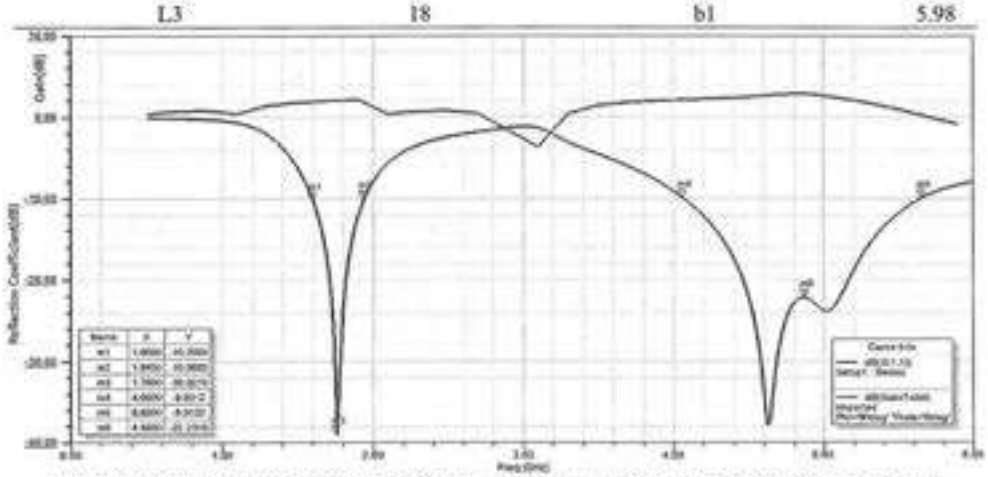

FIGURE 2. Variation of reflection coefficient and gain versus frequency for the proposed antenna

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