Rectangular Patch with H Interventional slot for WBAN Applications

B. Neeththi Aadithiya, B. Elizabeth Caroline

Abstract*: As the world is moving faster with the new technologies, the prevalence of chronic diseases is also increasing rapidly. The rapid rise in diseases required continuous monitoring of cardiogram, euthermia, regulation of blood sugar. Timely disease detection can lower the mortality rate. There are plenty of advantages with e-health care, such as offering rural areas medical solutions, quick diagnosis. Wireless body area network allows wireless wireless techniques to monitor human signals with sensors and transfers. Sensors, communicating nodes and communication media, receiver end devices for analysis are the main components present in the WBAN. These implantable devices reduce the patient's time for hospitaliz ation. The implantable devices communicate through antennas w ith the environment. In this work patch with H, interventional slot implantable antenna is proposed and designed using the ADS. The patch is designed to operate at 4.8 GHz. Simulation results shows that the antenna offers better Return loss value of -33db.

Index Terms*: E-health care, Implantable devices, Patch antenna.

I. INTRODUCTION

A transducer which is used to transfer information in the form of electromagnetic waves is termed as antenna. The electromagnetism has found greater application in the medical field since the introduction of the main X-ray analysis. The rise in the field of electromagnetic waves offers more analysis and disease treatment [1]. The microwave, EM waves find extensive application for cancer treatment, cell imaging, and wound identification. The wireless communication in conjunction with this, the development of wireless communication also helps to improve the comfort of affected people by, for example, reducing the invasiveness of electromagnetic (EM) medical devices [2]. The invention of pacemakers and the pills that the affected people with the sensing skills could swallow, took medical field to a different level. Inside the human body, implantable antennas have two kinds of biomedical applications. They are treatment with biotelemetry and biomedicine.

Biotelemetry can create a remote connection between the human body and the environment outside. Biomedical treatment involves the treatment of various diseases and allows supervision of the treated peoples 'physical health.These applications reduce the patient's time of hospita lization[3-5]. Wireless Body Area Network (WBAN) is the f ramework for human body observation that uses implantable gad-gets within the human body. This framework allows th e patient to be observed by home human services.

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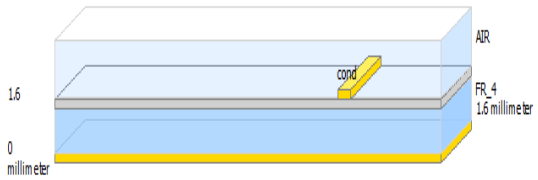
The main consideration with the implantable antennas is the design that should be compatible with the conditions of the human body, the presence of natural tissues that can sometimes alter the radiating element's performance. The implants in human body need to communicate with the external device which necessitates the use of antennas in the implants. The design of a specific radiator is the key component of an implantable gadget that works in a few meters wide WBAN. In other words, it requires implantable antennas with reduced area occupancy with increased diagnostic capacity. The rising demands in the communication call for the radiating element with different radiating structures, polarization, and different mechanisms for input feeding and directional variations. Patch antenna is the most well-known sort of Microstrip transmitting element[6]. The speckle antennas can be obtained by etching the vital structures over the metal trace. Patch structures may not include dielectric as a substrate instead the metal can be used as ground plane to increase the bandwidth. This paper provides detailed information on implantable antennas analysis and design.

II. LANDSCAPE H SHAPED SLOT OVER PATCH ANTENNA

A. Ground Plane

Plane which is almost flat, large enough to conduct and reflect the wave from other antenna element is ground plane. The conducting region can be made as a Ground plane only when the diameter is quarter of the wavelength .For the antenna elements which deals with high frequencies the ground plane can be metallic strips.



Presented design is made to have the infinite ground plane which consists of infinitely flat and thin conducting surface. Single conducting surface is used in the patch. The Landscape H shaped slot over Patch is intruded on to the substrate is evident in the figure. Preferably copper foil is used as the ground plane with thickness of 35 micron.

B. Substrate

FR4 Compatible Substrate is considered with the relative permittivity value of 4.6 and substrate is calculated to

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have 1.6mm thickness.The design considerations of the patch are well satisfied with the choice of FR4 substrate which suits the required frequency of operation. The Landscape H shaped Slot over Patch dimensions are calculated as per the below mentioned formula.

$$Width = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}}; \quad \varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right]$$

$$Length = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}\right)$$

C. Antenna Design

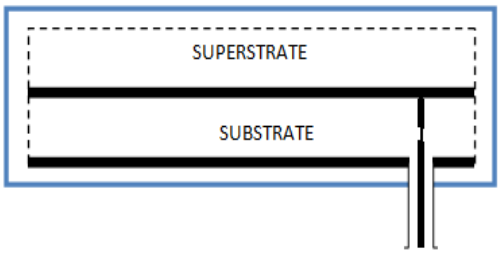
The H shaped slot and interventional slot is etched over the Rectangular patch antenna with the aspect ratio of about 0.985. The slot antenna works as a radiator based on the Babinet principle. The 4 slots created are used to enhance the operating parameters of the radiating element in terms of frequency and bandwidth coverage, gain, Directivity. The width of the slot plays a vital role in determining the frequency of operation and thus the slot width for the presented radiating element is 2 mm.

TABLE I DESIGN SPECIFICATIONS

Symbol	Quantity	Dimensions
L	Proposed patch Length	18.8mm
W	Width of the patch	24.67mm
h	Substrate Height	1.6 mm
εr	Permittivity relative to vacuum	4.4
H	Thickness of ground plane	35 Micron
w	Width of slot	2 mm

III. BIOCOMPATIBILITY OF ANTENNA

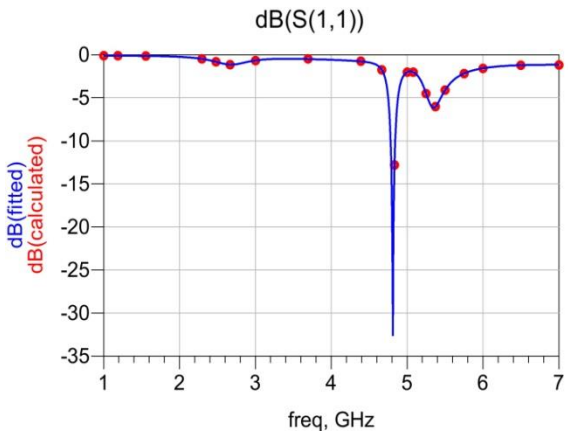
Major consideration with antennas infixed in body is its simultaneousness with the human tissues without creating any impairment[7,8]. Issue with the tissues is that they are usually conductive in nature so at times there is a chance for short circuit between the tissue and antenna. Thus the concentration should be highly on the simultaneousness and respond to lively act on short circuits to enhance the infix antennas life time[9-14]. Thus the Superstrate concept of separating the radiating element and tissue is preferred. The most broadly utilized approach for saving the biocompatibility of the antenna apparatus, while in the meantime isolating the metal radiator from human tissue, is to cover the structure with a Superstrate dielectric layer. And the second deal is to use the compatible antenna material for fabrication. The antenna is designed with the compatible material.



IV. RESULTS AND DISCUSSIONS

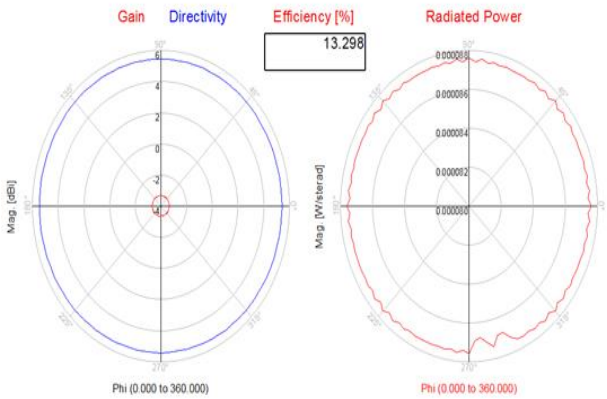
The presented antenna is designed using the advanced system Design software (2011.05) to operate over the frequency range of 2-5 GHz. Designed frequency of antenna is 4.8 GHz.

A. Return Loss



Simulated Graph for the designed element shows Return loss value of -33 Db for 4.8 GHz Frequency. Return loss is calculated to determine efficiency and to find the loss of power. The loss of power should be less to increase the efficiency.

B. Gain



Gain is the measure of the radiating elements operating efficiency and its antenna's directivity. Directivity is the claim for denoting the direction in which the radiation focuses mainly. Efficiency of a radiating element allows the calculation of the power that is radiated out from the provided input. The gain obtained is -3

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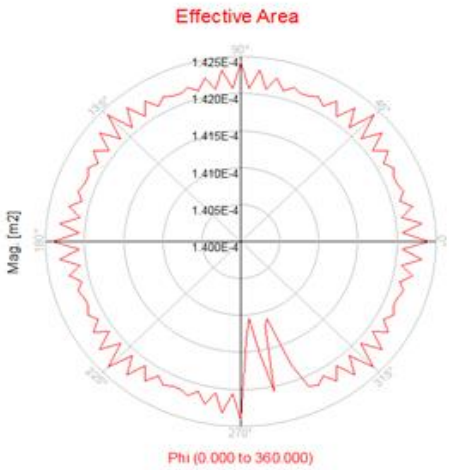
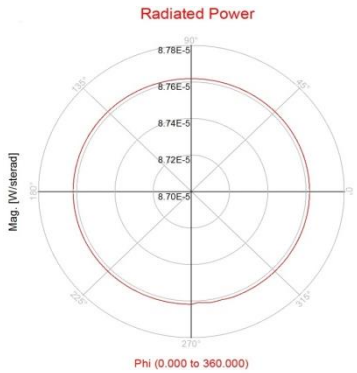
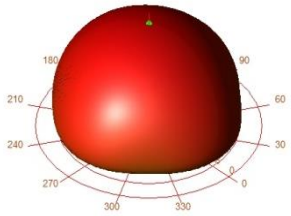
DB and the directivity value of the antenna is 6 DB.



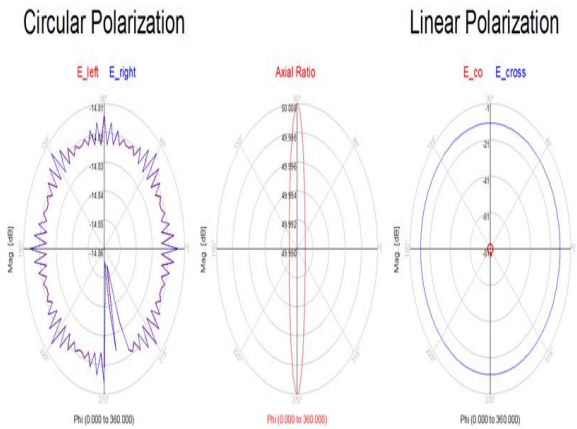
C. Radiation Pattern



The EM waves are transmitted equally in all the angles and simulation results of radiating element shows the Omni - directional radiation pattern. The coverage of the radiating element is similar to a sphere as shown in the figure.



D. Polarization of Antenna



V. CONCLUSION

Simulation results indicate that the presented Patch offers better VSWR and Return loss with improved gain, Efficiency of 13.298. Future scope of presented patch is that with the addition of reconfigurable elements and the variation of structures can be done to increase the bandwidth. Introduction of slots with various dimensions with patch can further enhance the performance of radiating element.

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