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Circularly Polarized Square Patch Antenna with Trimmed Corners Using Textile Material

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ABSTRACT: In this paper a circularly polarized wearable antenna at 2.4 GHz has been proposed for navigation, military communication, body centric communication and medical emergency. Body centric communication is an important application in the field of wireless communication and since antenna can be implemented on textile material, hence it can be widely used for military communication also. The paper presents the design of the wearable antenna made by the use of jeans substrate textile material with thickness 1mm, dielectric constant 1.7 and loss tangent 0.02. To feed the antenna inset feeding with a quarter wave transformer has been used. The proposed antenna offers approx -20 dB reflection loss, approx 3.5 dB axial ratio and 29% antenna efficiency.

KEYWORDS: Square Patch, Circular Polarization, Textile Material

I.INTRODUCTION

The micro strip patch antenna (MPA) consists of a conducting patch of any planar or non planar geometry on one side of a dielectric substrate with a ground plane on the other side [1]. Radiation characteristic is an important characteristic of a patch antenna. The proposed antenna is suitable to wear so it is termed as wearable antenna [2], [3]. It used jeans substrate textile material. The direct communication is performed by this antenna. The requirement of this antenna is because of its small size, low cost and free from installation. Textile material forms interesting substrate because fabric antenna can be easily integrated into clothes [4], [5], [6]. The substrate of the designed antennas was made from jeans textile material while the radiating element and ground plane are made from copper tape. Use of this textile material for the development of flexible wearable antenna [7], [8] has been swift due to the miniaturization of wireless devices and it has a very low dielectric constant which improves the impedance bandwidth of antenna and decease the surface wave losses. The proposed antenna material has some important features that are dielectric constant (relative permittivity) 1.7, loss tangent less than 0.025 and thickness 1mm. The dielectric properties depend on the frequency, temperature, and surface roughness and also on the moisture content, purity and homogeneity of material.

The micro strip antennas are good candidates for body bone application. Wearable antennas are of planar structure, flexible conductive material in patch and ground plane and flexible dielectric materials. The wearable antenna is thus the bond that integrates cloth into the communication system, making electronic device less obstructive. To achieve good results, wearable antennas have to be thin, lightweight, low maintenance, robust, inexpensive and easily integrated in radio frequency circuit. The applications of this antenna are navigation, military, body centric communication, medical emergency.

II. ANTENNA DESIGN

The structure of the proposed antenna on the jeans material is shown below. A square patch of size 46.6 X 46.6 mm^2 is used to design this antenna. A quarter wave transformer of length 31.275 mm and width 2.6 mm is used to feed the antenna. A transmission line of length 10mm and width 4.8mm is used at the edge of the quarter wave transformer where a port of 50 Ω impedance is implemented. Two opposite corners of the square patch are trimmed to achieve circular polarization. Truncation of 5mm in length and 5mm in width of square patch has been implemented at two opposite corners of the square patch. To implement the antenna jeans substrate textile material has been used whose parameters have been shown in Table1:

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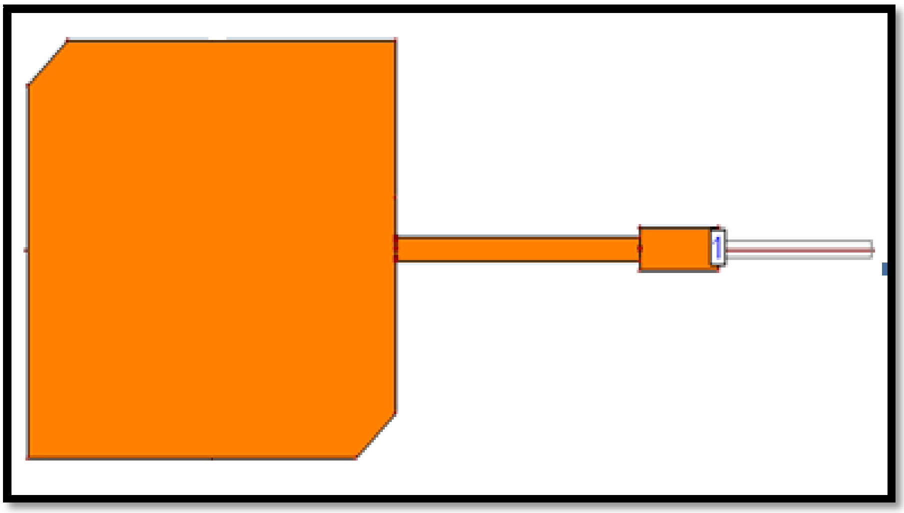

Fig.1: Design of the proposed antenna

In proposed antenna, inset feeding with quarter wave transformer has been used for proper impedance matching. The impedance of the quarter wave transformer is calculated by the formula i.e.

$$Z_0=\sqrt{Z_A Z_P}$$

Where,

Z_0= Impedance of quarter wave transformer
Z_A= Impedance of the antenna at edge
Z_P= Impedance of the transmission line at the port (50 Ω).

Table1: Material description of the proposed antenna.

Material	Values(in mm)
Dielectric Constant	1.7
Thickness	1
Loss tangent	0.02

III. RESULT AND DISCUSSION

The proposed antenna has been simulated on Zealand IE3D software. Fig. 2 shows return loss vs. frequency plot of the antenna. From this plot it is clear that return loss of the antenna at 2.4 GHz is -20 db approximately which shows a good result. After Simulation, parameters of proposed antenna are shown below:

Parameters	Result values
Return loss	-20 db (approx.)
Axial ratio	3 db (approx.)
Efficiency	29%

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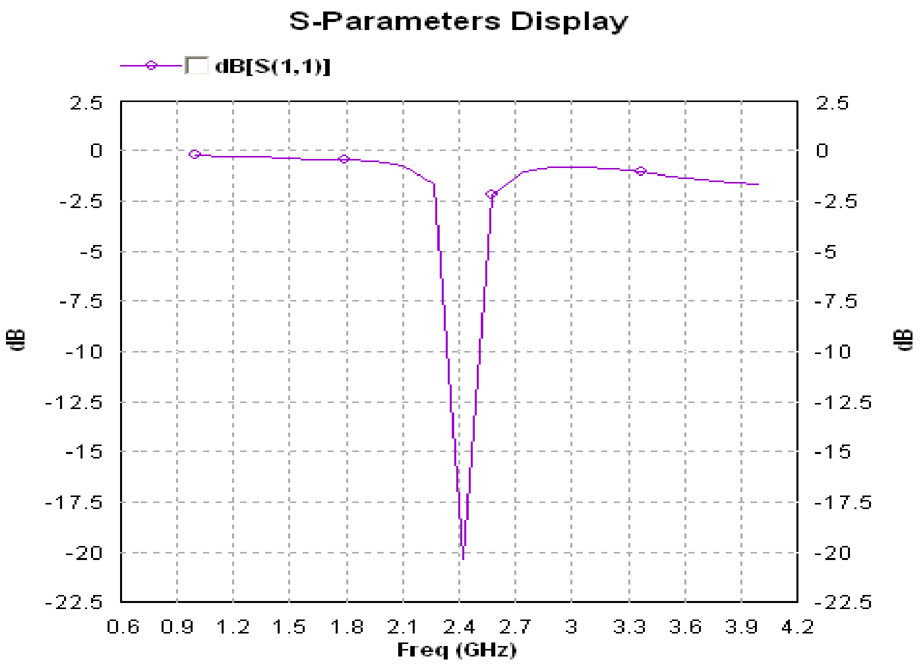

Fig.2: Return Loss vs frequency plot.

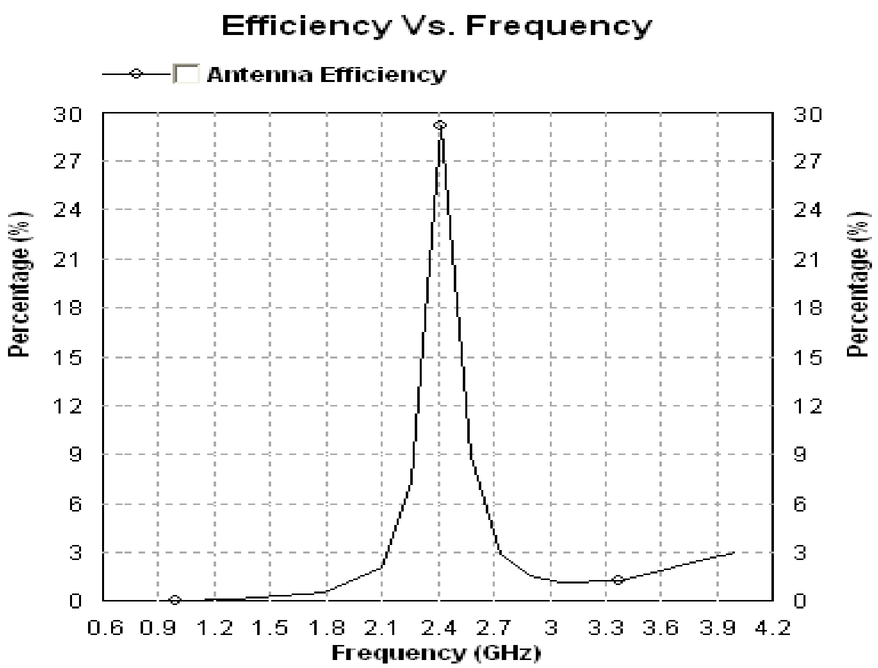

Fig.3: Antenna Efficiency Vs. frequency plot.

Fig. 4 shows axial ratio vs frequency plot and from the plot it can be shown that at 2.4 GHz axial ratio is approx 3.0 db which indicates that that antenna achieves circular polarization at 2.4 GHz.

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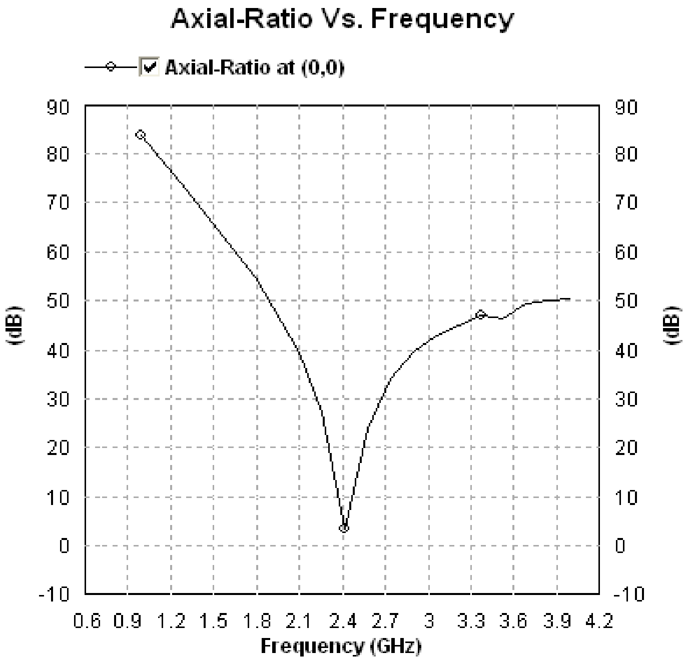

Fig. 5 shows elevation pattern gain display of the antenna at two different directions (φ = 0° and φ = 90°).

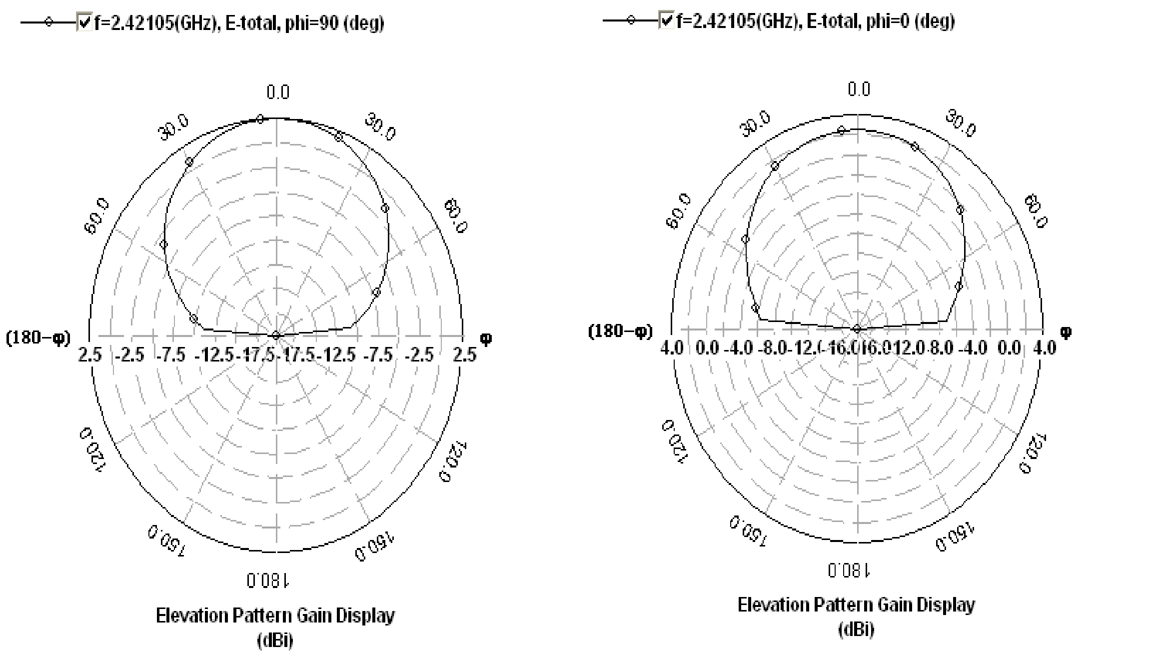

Fig.5: Elevation pattern gain display

IV.CONCLUSION

In this paper, the proposed antenna has been designed at jeans substrate textile material at 2.4 GHz. The used textile material has a very low dielectric constant 1.7. The low dielectric constant reduces the surface wave losses. Therefore,

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decrease the dielectric constant increase the impedance bandwidth of the antenna. Simulation results of the proposed antenna are in good agreement. This antenna can be used for navigation, military communication, body centric communication and medical emergency.

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