International Journal of Engineering & Technology, 7 (2.12) (2018) 222-224

SPC

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper

Realization of trophy shaped flexible wearable antenna based on foam substrate

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Abstract

The endeavor of this paper is to analyze a light weighted flexible antenna for modern communication system. There are three different patch designs with operating frequency 4GHz. These proposed antennas are compact in size, shows high directivity and large bandwidth. Ex-pandable polystyrene foam is used as a substrate because such antenna are bendable, wearable, cheap, require less attention and having good features like low dielectric constant, low loss tangent and better efficiency. The antenna parameters like reflection coefficient, gain, band-width, radiation pattern are analyzed. The reflection coefficient of anticipated antenna provides a good concurrence between simu-lated and measured result. Foam based design is simulated by using CST studio.

Keywords: *Expandable Polystyrene Foam; Copper Foil Tape; CST; Reflection; Coefficient.*

1. Introduction

In last year's, the demand of flexible antenna has been increased tremendously. A major factor in area of demanding of such antenna is the advancement in computer architecture and numerical compu-tation [1-4]. Microstrip patch antenna offers wide applications in satellite communication, telecommunication, navigation system etc. [5-9]. The choice of substrate gives antenna performance in terms of impedance bandwidth, gain, radiation pattern. For flexible and wearable applications there are many dielectric material like paper, expandable polystyrene foam (EPS), leather etc. available in market. These materials are light in weight, low cost profile, less relative permittivity. The proposed antenna design is used foam as a sub-strate whose relative permittivity $\varepsilon_r = 1$ that is approximately equal to air dielectric constant. Due to this losses and attenuation are very less than other substrate antenna [10-12]. It enhances the bandwidth of antenna.

In proposed antenna foam is used as a substrate material sand-wiched between two layers of copper tape of width 0.038. First layer is ground and other layer is patch shape. Here height h of sub-strate is 2mm, dielectric constant is 1 and operating frequency is 4 GHz. In this paper simulation is done by using CST software studio and gives the results in terms of reflection coefficient, gain, band-width and efficiency [13-15].

2. Design of antenna

Fig.1 illustrates Trophy shape antenna consist three layers in which first layer is known as ground, made by copper tape of 0.03mm thickness, second layer is of substrate. In this paper foam of 2mm height is using as a substrate. Patch design is made by using copper tape on substrate. Probe connection is provided in microstrip feed line. This method is very easy to fabricate and commonly used for power feeding. This antenna is fully ground by using copper con-ducting material. The specifications are shown below in table 1.

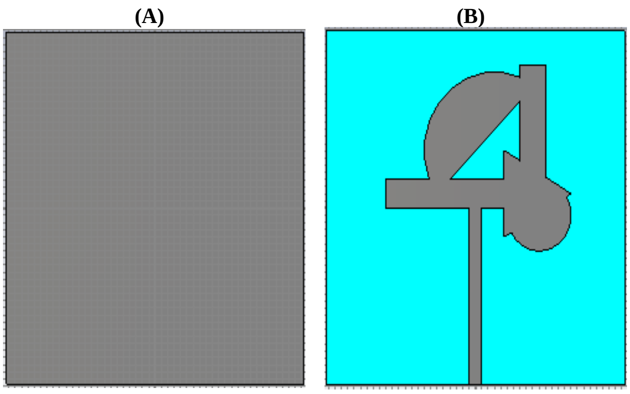

Fig. 1: Proposed Antenna Geometry (A) Back Side (B) Front Side.

Table 1.1: Design Specifications of Proposed Antenna

S. No.	Antenna Parameter	Values
1.	Relative permittivity (ε_r)	1
2.	Substrate height	2 mm
3.	Loss tangent	0.025
4.	Ground dimension	46mm×49mm
5.	Substrate dimension	46mm×49mm
6.	Microstrip feed line dimension	22mm×2mm
7.	Operating frequency	4 GHz

3. Simulated results

Simulation of anticipated antenna is done by CST software. Fig. 2 shows the reflection coefficient plot of anticipated antenna3. The presented antenna provides the wideband of 47.20% (9.84GHz –

15.92GHz) at resonance frequency 10.10GHz and 15.35 GHz. Simulated results of polar plot of proposed antenna are publicized in Fig.3. Fig.4 shows 3D pattern of presented antenna at 10.1GHz and 15.35GHz. This presented antenna has good directivity 7.765dBi at 10.1 GHz and 8.524 dBi at 15.35 GHz.

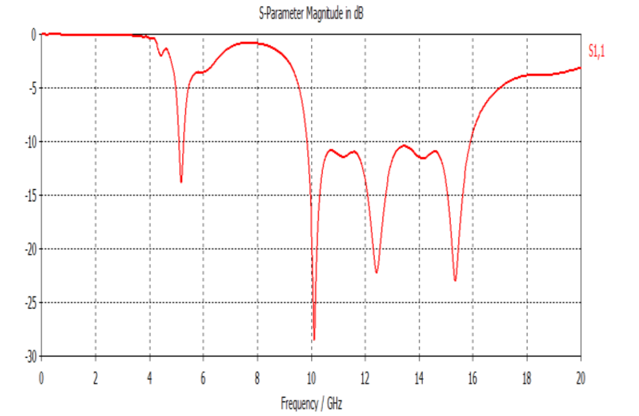

Fig. 2: Simulation Return Loss vs. Frequency Plot of Proposed Antenna3.

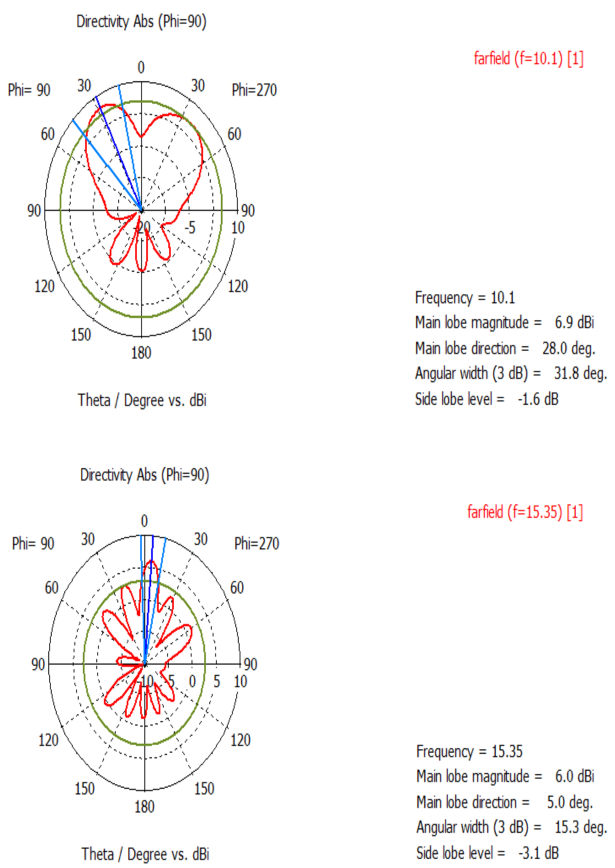

Fig. 3: Polar Plot of Antenna at 10.1 GHz And 15.35GHZ.

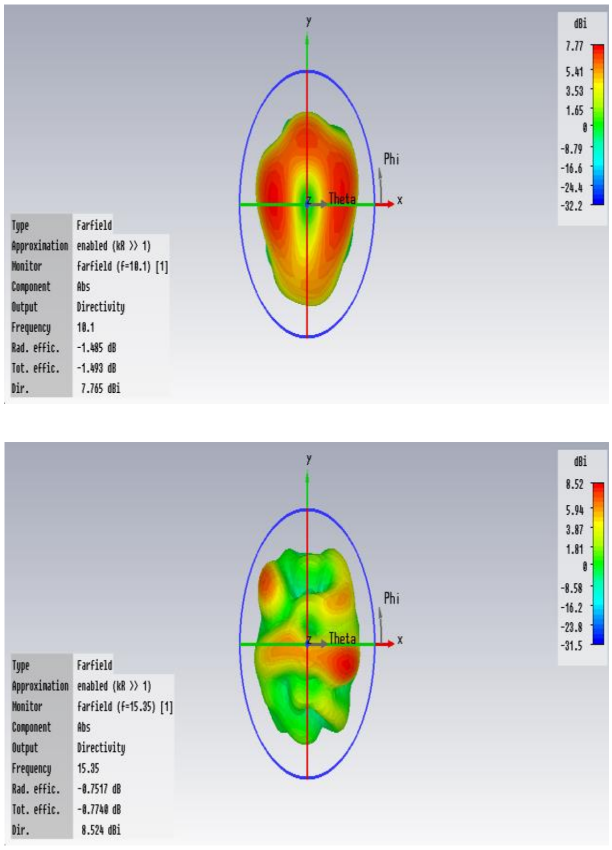

Fig.4: 3D Pattern of Presented Antenna at 10.1 GHz and 15.35 GHz.

4. Evaluation steps of proposed antenna

This section presents different steps of proposed antenna and comparative simulated return loss which is shown in Fig.5 and Fig.6. The reflection coefficient & bandwidth of anticipated antenna 3 are better than antenna1 and antenna2. The comparative study of presented antennas gives the larger bandwidth with high directivity which is need of directional antenna.

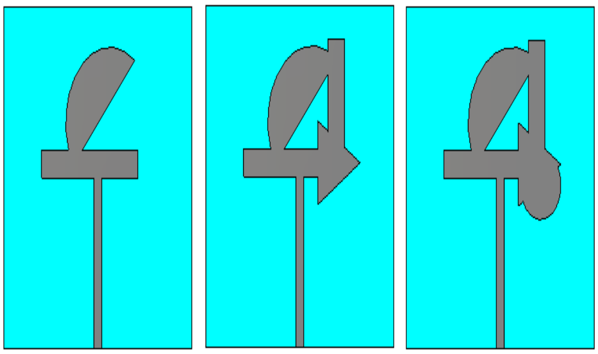

Fig. 5: Geometry of the Proposed Antennas (A) Antenna1 (B) Antenna2 (C) Antenna3.

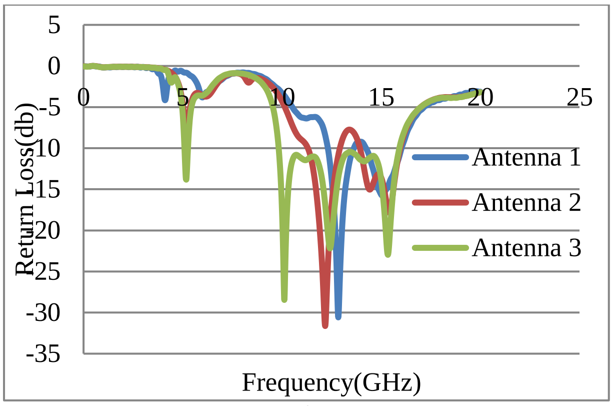

Fig. 6: Return Loss vs. Frequency of Antenna1, Antenna2 and Antenna3.

5. Fabricated antenna and experimental results

The hardware of designed antenna is shown in fig.7. This hardware describes foam as a substrate and copper as conductive patch. The fabricated antenna is tested in Microwave lab at IIT Kanpur. The simulated and measured results are shown in fig. 1.8. There is a small variation in simulated and measured return loss curve due to uncertainties in dielectric constant, soldering effects and quality of probe.

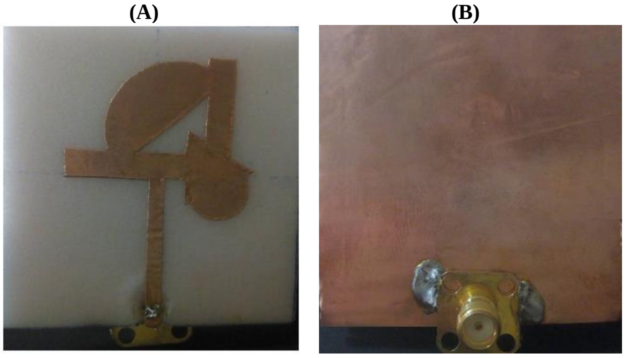

Fig. 7: Hardware of Anticipated Antenna 3 (A) Front Side (B) Back Side.

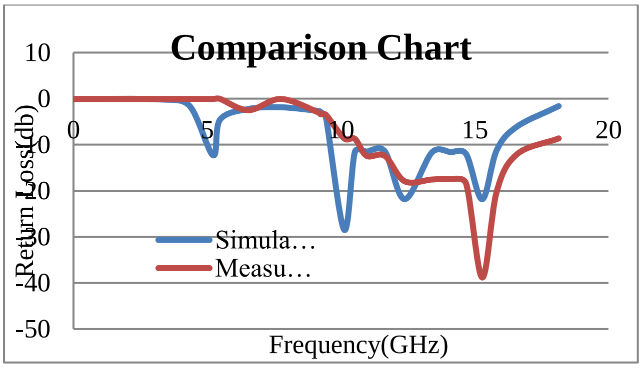

Fig. 8: Similarity of Simulated and Measured Return Loss Plot of Proposed Antenna3.

6. Conclusion

The designed foam based flexible antenna can be used for modern communication systems. There are wide applications in body worn system, satellite communication and wireless communication. A designed antenna is small in size and provides good results according to our requirements. It gives high directivity, wide bandwidth. The main purpose of using foam as a substrate is its dielectric constant value which is approximately equal to 1 so that minimum losses occur. Designed antenna covers bandwidth 40.81% (10.96GHz – 16.58GHz) and gives high directivity of 8.524 dBi.

Acknowledgement

The authors would like to thank Dr. Kumar Vaibhav Srivastav, IIT Kanpur, UP, India to provide the facility for the antenna measurements at IIT Kanpur Microwave Lab.

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