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A Monopole Antenna with Two Symmetric Strips for UWB Applications

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ABSTRACT

In this paper, a monopole antenna with two symmetric L strips is proposed. Closed rings on either side have been introduced to enhance the bandwidth of the proposed antenna. The antenna geometry is fed with a microstrip line. The proposed geometry is designed on easily available FR4_epoxy dielectric material and the dimensions of the dielectric substrate used are of 50 mm x 50 mm x 1 mm. Antenna geometry's performance is investigated in the frequency range between 2 GHz to 7 GHz. To validate the design, proposed geometry was fabricated and tested. Antenna impedance bandwidth of 86.3% was obtained in the operating band of 2.5GHz to 6.3GHz. Measured results fairly agree with the simulated data.

General Terms

Monopole microstrip antennas, Planar UWB antennas.

Keywords

Monopole antenna, Microstrip antenna, and Ultra-wideband operation

1. INTRODUCTION

Wireless technology has witnessed the development ever since its inception [1]. Over the last decades there have been different standards of this technology that evolved out of the demands [2]. Presently, in strategic as well as public domain the wireless devices and systems need to cater to different frequencies, should be small in size, broadband and should be of low cost. There have been numerous design changes of antenna with thousands of published documents relating to its design, analysis and optimization. Over the period new design concepts have been introduced. Recently, wireless local area network (WLAN) (working at 2.4/5.2/5.8 GHz) and worldwide interoperability for microwave access (WiMAX) (working at 2.5/3.5/5.5 GHz) allowed for convenient portable/mobile wireless access to various digital communication systems have been becoming very attractive [3, 4]. The demand of wideband antennas with simple structure and superior radiation performance for WLAN/Wi MAX applications have been increasingly appealing [5-8].

In recent works [9–12], with wide-band property, monopole antennas have drawn much attention in multi-band antenna designs. To get a multi-band characteristic, [9] has used a dual L-shaped elements, which gets good performance in impedance bandwidth. However, due to the dual L mutual impacts, these radiation patterns are affected. Other antennas radiation patterns are also affected to some extent, as mentioned in [9-13], because of their asymmetrical constructions. In other works reported in [10, 14], have good performance both in impedance bandwidth and radiation pattern performance, but at their high frequency bands, the undesired frequency bands between 3.5GHz and 5.2GHz are ignored, and this will undoubtedly lead to some signal interference with the near frequency bands [15].

In this paper, a monopole antenna fed with microstrip line suitable for UWB operation has been proposed. Although, the proposed geometry is an extension of work presented in [15], here we have made an effort to convert narrow multiband antenna into a UWB antenna with fractional impedance bandwidth of 86.3%. The proposed geometry is designed on easily available FR4_epoxy dielectric material with thickness of 1mm and permittivity of 4.4. Antenna geometry's performance is investigated in the frequency range between 2 GHz to 7 GHz.

Antenna geometry is presented in Section 2. Section 3 presents geometry optimization procedure. Experimental results and discussions are covered in Section 4. Finally, the work is concluded in Section 5.

2. ANTENNA DESIGN

The geometry of rectangular monopole microstrip antenna with closed ends is shown in Figure 1. It consists of two symmetrically folded arms closed at the end and having L-shaped strips. The closed folded arms are added to enhance bandwidth & gain of Wi-MAX band. The geometry was fed with the microstrip line which is placed on the same side as the feeding strip line at the feed end for proper impedance matching and ground plane is placed on the other side of the substrate. The proposed geometry has been designed and optimized on easily available FR4_epoxy substrate with dielectric constant of 4.4 and thickness of 1 mm.

3. GEOMETRY OPTIMIZATION

In this section parametric study is carried out for optimizing the proposed antenna geometry. Parameters chosen for optimization are length of ground plane, width of symmetric arms, and width of base hand (feeding hand). Effect of all these parameters on antenna performance are investigated thoroughly and presented in the following sub-sections.

3.1 Variation of Length of Ground Plane (GL)

In this study length of ground plane is varied from 22mm to 24mm in steps of 1 mm by keeping all other parameters constant. The simulated results of reflection coefficient (S_{11}) of antenna are shown in Figure 2. From the study of simulated reflection coefficient characteristics the antenna performance is optimum at G_L=24mm.

3.2 Variation of Length of Outer Arm (HL)

In this study length of outer arm is varied from 12.5mm to 16.5mm in steps of 1 mm by keeping all other parameters remains constant. The simulated results of reflection coefficient (S_{11}) of this study are shown in Figure 3. From the Figure 3, it may be noted that geometry performs well for HL=14.5mm.

3.3 Variation of Feed Arm Width (W)

In another study, the width of microstrip feed line has been varied to observe its effect on antenna performance. The feed arm width (W) is varied from 2mm to 2.4mm in steps of 0.1 mm by keeping all other parameters constant. The results (S_{11}) are presented in Figure 4. From Figure 4, it may be noted that the optimum results can be obtained for W=2.2mm.

4. EXPERIMENTAL VALIDATION OF THE GEOMETRY AND DISCUSSIONS

The proposed geometry shown in Figure 1 with its optimized dimensions is fabricated on FR4_epoxy substrate having dielectric constant of 4.4 and thickness of 1 mm. The photograph of fabricated prototype is shown in Figure 5. Reflection coefficient characteristics of measured results are compared with simulated values in Figure 6. From Figure it may be noted that measured results fairly match with simulated data. Radiation patterns at all three frequencies are plotted in Figure 7. From these plots it may be noted that the radiation characteristics are stable across the frequencies of operations.

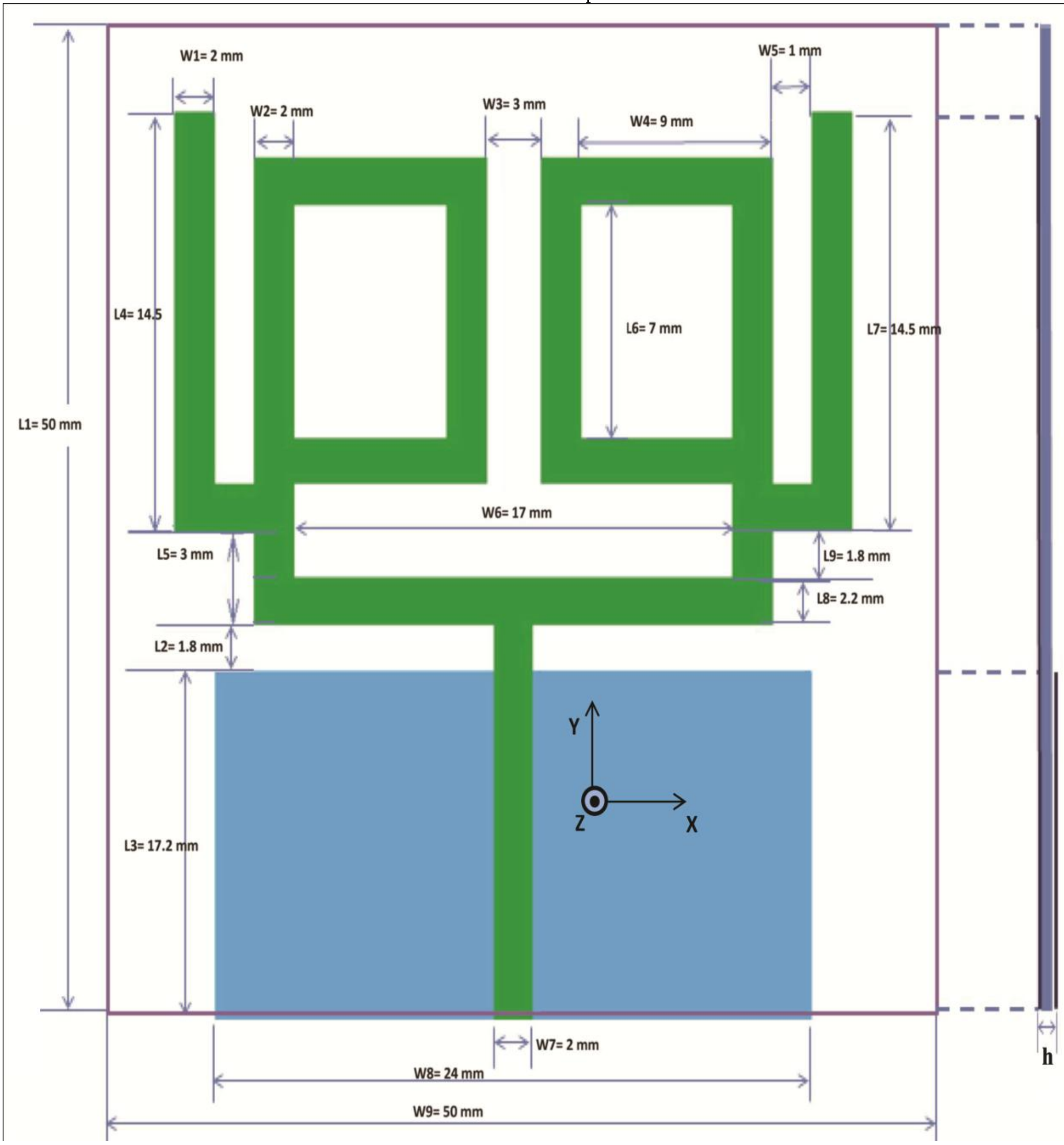


Figure 1: Geometry of the proposed antenna.

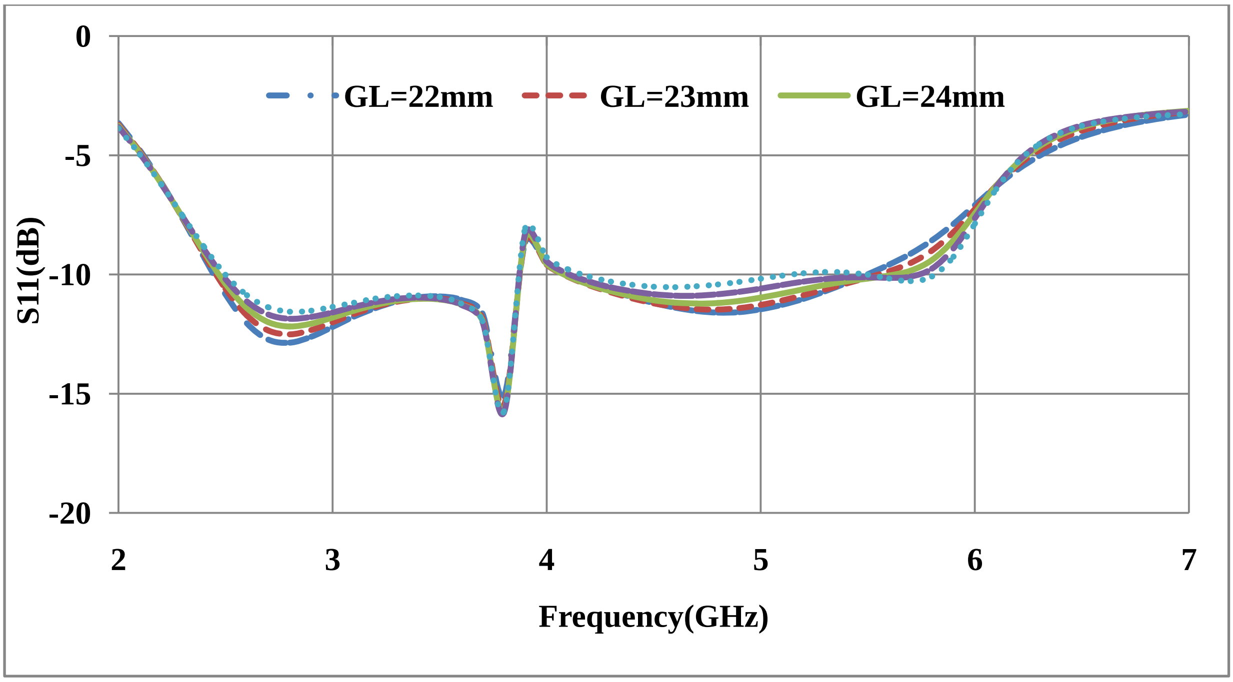


Figure 2: Effect of Ground Length (GL) variation on reflection coefficient characteristics.

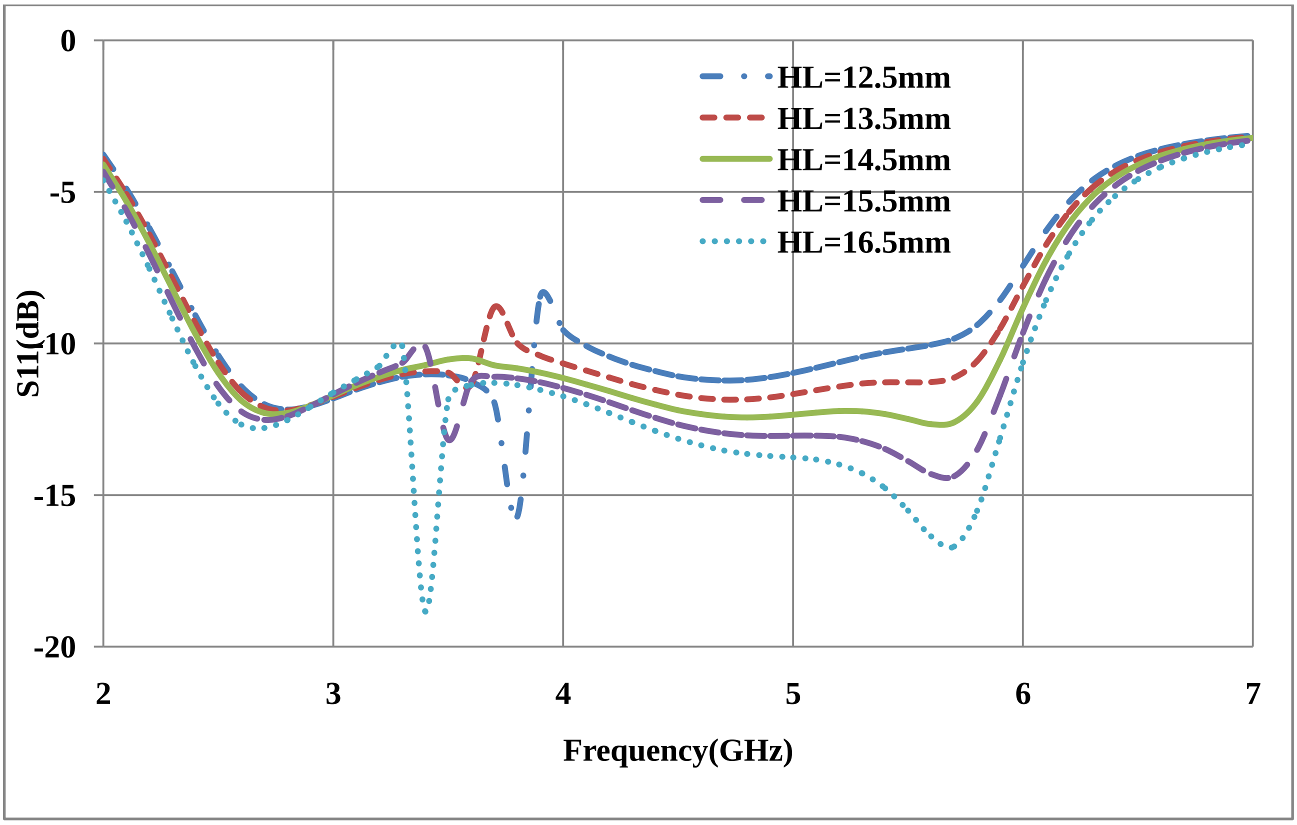


Figure 3: Effect of Hand Length (HL) variation on reflection coefficient characteristics.

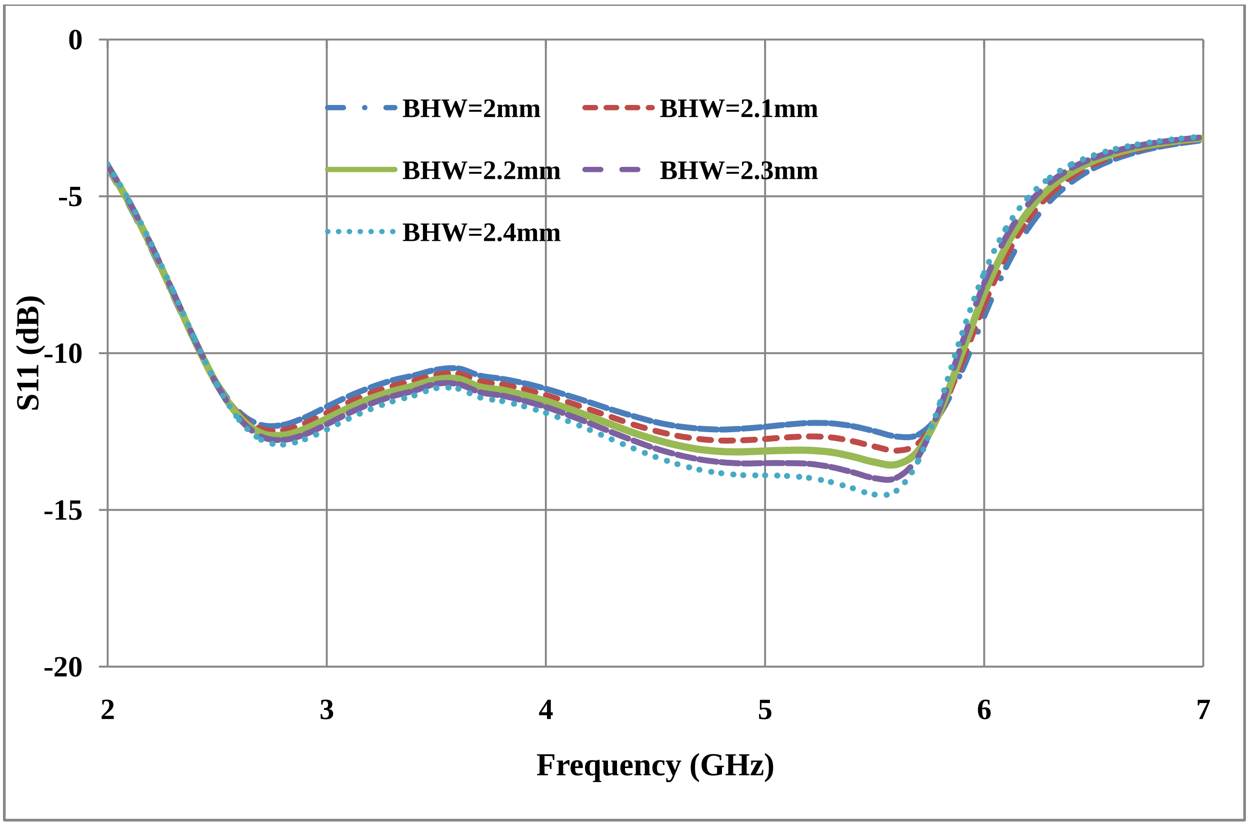
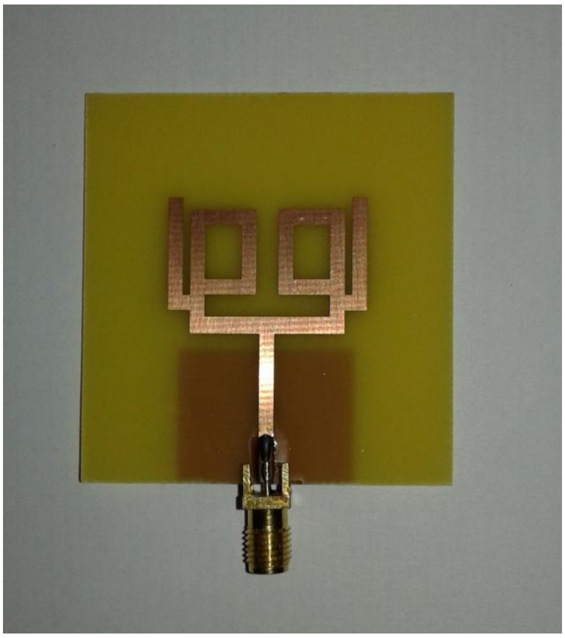
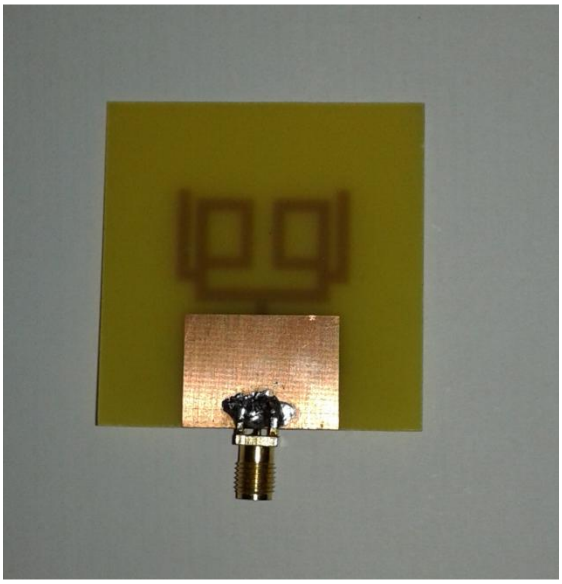


Figure 4: Effect of Base Hand Width (BHW) variation on reflection coefficient characteristics.



(a)



(b)

Figure 5: Photograph of fabricated prototype (a) Front side (b) Back side.

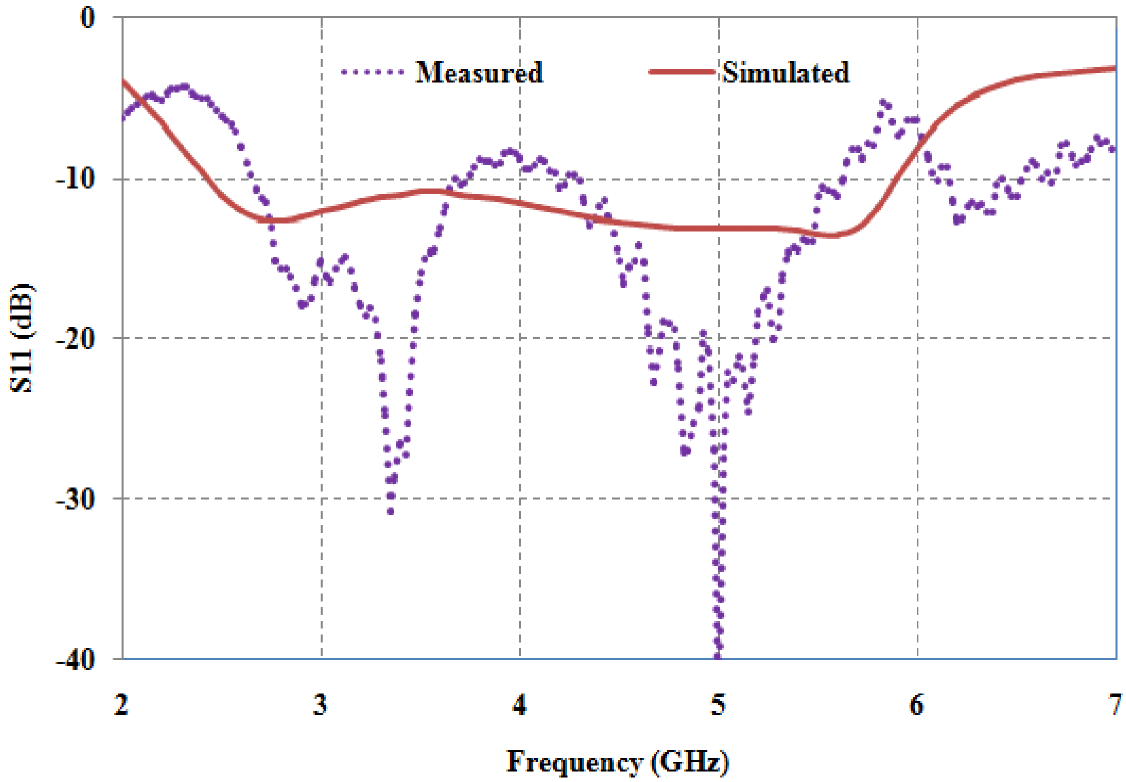
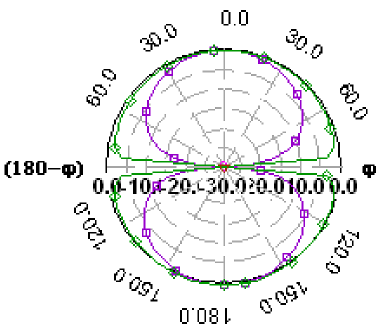
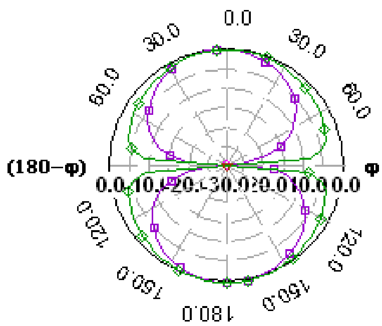


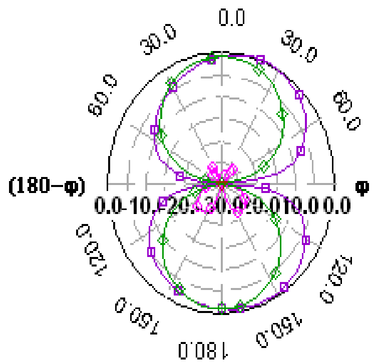
Figure 6: Reflection coefficient characteristics comparisons of fabricated antenna.



(a) 2.4GHz



(b) 4.1GHz



(c) 5.9GHz

Figure 7: E and H plane radiation patterns at different frequencies in operating band.

5. CONCLUSIONS

In this paper, a monopole antenna with two symmetric strips for UWB applications is proposed. The proposed geometry is fed with a microstrip line which is on the same side of the patch. The proposed geometry is designed on easily available FR4_epoxy dielectric material and closed rings on either side have been introduced to enhance the bandwidth of the proposed antenna. The proposed geometry was fabricated and tested for its validation and found 86.3% impedance bandwidth. Therefore the proposed geometry proves to be a good candidate for WLAN and Wi-Max, and UWB applications. In further study it is planned to measure the gain, radiation patterns, and model the antenna.

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