U-Shaped Planer UWB Antenna with Unsymmetrical Feed

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Abstract

A simple planer rectangular UWB is designed and the frequency band is further enhanced by changing the fed position. The effect of U-shaped slot on the patch is studied for unsymmetrical fed antenna. The antenna offers more than 114% bandwidth when printed on a substrate of dielectric constant 4.4.

Keywords : Antennas UWB Unsymmetrical fed

1. Introduction

With the development of wireless technology, many systems now can operate in more than one frequency band, satellite navigation systems, wireless LANs, ultrawideband (UWB) systems and some combinations of them are examples. Their capability of operating in multiple, diverse frequency bands eventually depend on their antennas performance. To fulfill this requirement, multiple antennas are implemented in many devices, and each one covers a specific operating band or several bands. However, these antennas together occupy much space, which is at a premium in most devices, and also increase the system complexity. Such installations of multiple antennas prevent future system upgrades that require the use of currently unsupported bands. Therefore, a single antenna that has an impedance bandwidth that is wide enough to cover the operating frequency bands of multiple wireless communication systems is more desirable. Such an antenna should have stable radiation-pattern characteristics over the entire frequency range.

Commercial UWB systems require small low-cost antennas with omnidirectional radiation patterns and large bandwidth [1]. It is a well known fact that planar monopole antennas present really appealing physical features, such as simple structure, small size and low cost. Due to all these interesting characteristics, planar monopoles are extremely attractive to be used in emerging UWB applications, and growing research activity is being focused on them.

In UWB communication systems, one of key issues is the design of a compact antenna while providing wideband characteristic over the whole operating band. Consequently, number of planar monopoles with different geometries have been experimentally characterized [2], [3] and automatic design methods have been developed to achieve the optimum planar shape [4], [5]. Moreover, other strategies to improve the impedance bandwidth have been investigated [6].

This paper focuses on a rectangular monopole antenna for UWB applications, which combines the rectangular-patch approach with U-shaped slot, and the ground plane with partial ground conducting plane that achieves a fractional bandwidth of more than 114%.

2. Antenna Design

The rectangular monopole antenna fed by a microstrip line is shown in Fig. 1, which is printed on a FR4 substrate of thickness 1.6 mm, permittivity 4.4, and loss tangent 0.0018. The width. W_f of the microstrip feedline is fixed at 2.5 mm. The basic antenna structure consists of a rectangular patch, a feedline, and a ground plane. The rectangular patch has a width of W_p and length of L_p placed on 40×40 mm^2 FR4 substrate. The patch is connected to a feed line of width W_f and length L_f, as shown in Fig. 1. On the other side of the substrate, a conducting ground plane of

width $_{Wsub}$ and length L_{gnd} is placed. The proposed antenna is connected to a 50Ω SMA connector for signal transmission.

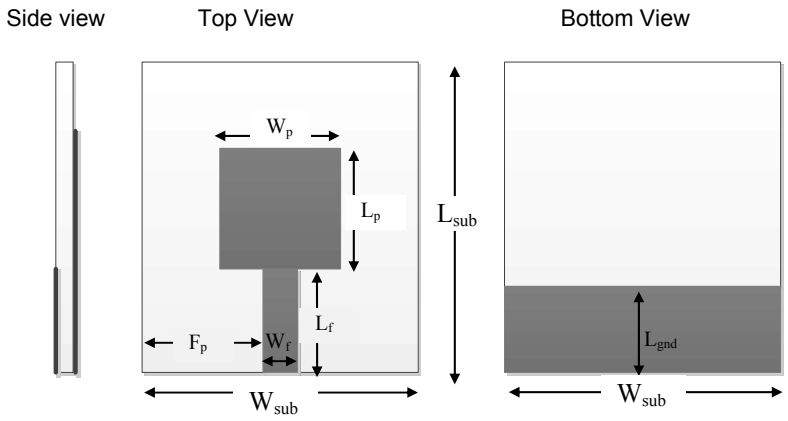

Figure 1: Geometry of proposed antenna with u-shaped slot and conductor-backed plane.

The antenna is initially simulated without U-shaped slot and partial ground (L_{gnd}=L_{sub}) for a narrowband antenna that operate at 5.5GHz. Parametric simulation is done by varying the ground plane L_{gnd} to obtain wideband. The bandwidth of the antenna is further widen by shifting the feedline position by varying F_p. As a result of unsymmetrical feedline and rectangular patch gives ultra wide band response. The U-shaped slot is introduced on the rectangular patch without sacrificing bandwidth of the antenna as shown in Fig. 2.

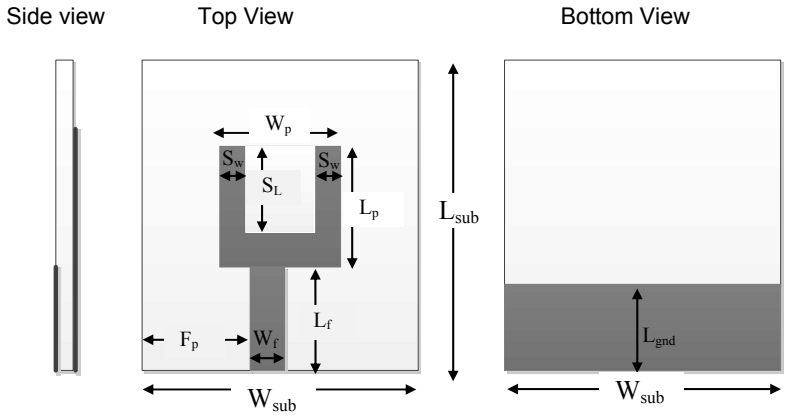

Figure 2. Geometry of proposed antenna with u-shaped slot and conductor-backed plane.

The optimal dimensions of the designed antenna are as follows: W_{sub}= 40 mm L_{sub}= 40 mm W_p= 16.6 mm, L_p = 12.4 mm, L_f = 13.6 mm, L_{gnd} = 12.5 mm, F_p = 18.7 mm (for symmetrical fed) , F_p = 15.7 mm (for unsymmetrical fed), S_L = 9.9 mm, S_W = 2.5 mm and W_f =2.5 mm.

3. Results and Discussions

In this Section, the planar monopole antenna with various design parameters were constructed, and the numerical and experimental results of the input impedance and radiation characteristics are presented and discussed. The parameters of this proposed antenna are studied by changing one parameter at a time and fixing the others. The simulated results are obtained using the Ansoft simulation software high frequency structure simulator (HFSS) [7].

Figs. 1 and 2 show the structure of the various antennas used for simulation studies. Return loss characteristics for rectangular patch antennas are compared in Fig. 3. As shown in Fig. 3, the rectangular patch with symmetrical feedline antenna results frequency band from 3.85 GHz to 7.15 GHz and it can be the fundamental and next higher resonant radiation band at 4.5 and 5.9 GHz, respectively. However, changing position of the feedline results unsymmetrical feeding, additional third, fourth and fifth resonances are excited respectively, and hence the bandwidth is increased for this unsymmetrical feedline antenna. The resonant frequencies are occurred at 4.02, 6.30, 7.66, 9.58 and 11.45 GHz. The frequency band of the unsymmetrical feedline antenna is 3.2GHz to 12.2 GHz. When the unsymmetrical feedline with rectangular patch is modified to U-shaped slot as shown in Fig. 2, there are fundamental, first and second resonance at 4.39, 9.3 and 11.4 GHz, respectively. However, the bandwidth of both the antennas with unsymmetrical feedline is remain almost same.

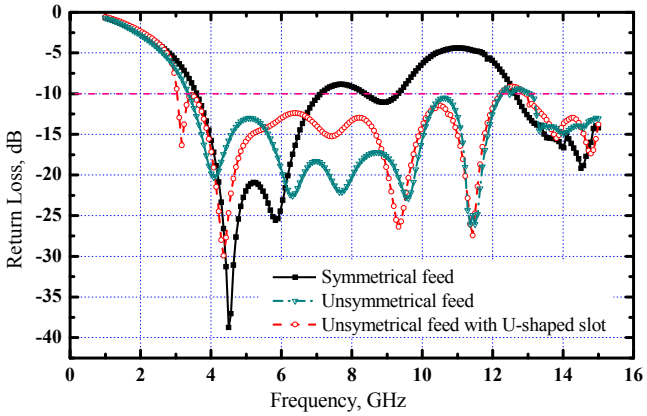

Figure 3. Simulated return loss characteristics for antennas shown in Figs. 1 and 2.

The simulated surface current distribution of the U-shaped slot unsymmetrical feedline patch antenna is shown in Fig. 4. The experimental and simulated u-shaped antenna is shown in Fig. 5. The fabricated antenna shows ultra wideband behaviour. However, experimental gives better results than simulation and the higher frequency limit go beyond simulation results. This is due to fabrication mismatch from the simulation dimension.

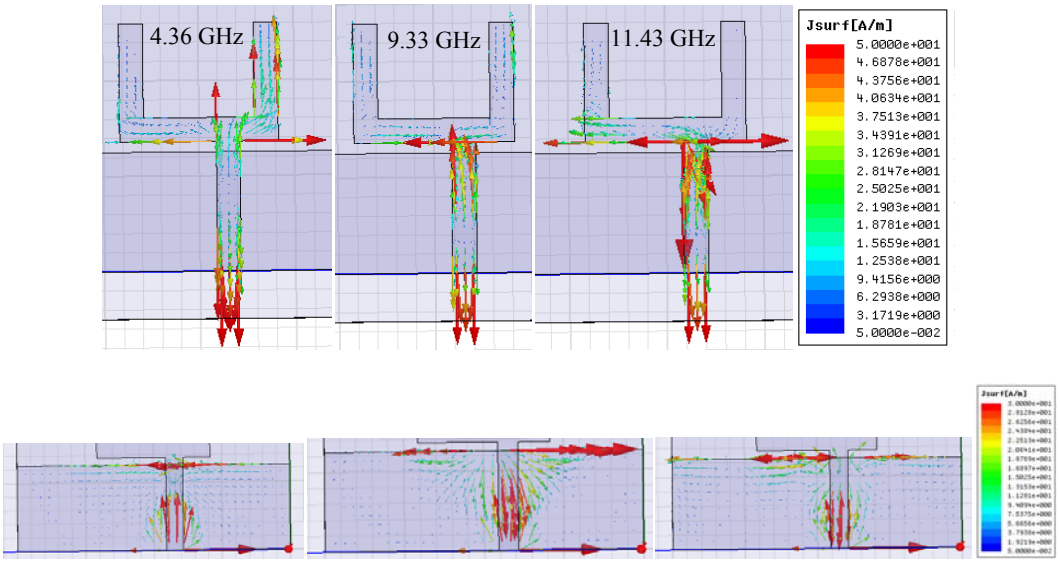

Figure 4: Simulated surface current distributions on radiating U-shaped patch and ground plane for the proposed antenna at 4.36 GHz, 9.33 GHz and 11.43 GHz.

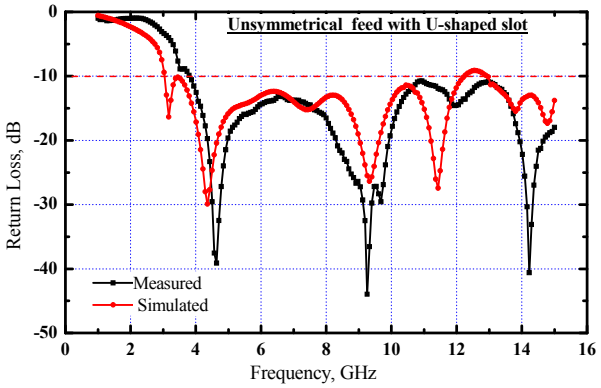

Figure 5. Experimental and simulated return loss characteristics for antenna shown in Fig. 2.

3. Conclusions

In In this paper, a U-shaped printed monopole antenna (PMA) has been proposed for UWB applications. The fabricated antenna satisfies the 10-dB return loss requirement from 3.8 to more than 15 GHz. By cutting rectangular patch to U-shaped slot creates additional resonance and hence enhance the bandwidth of the antenna. The overall dimension of the antenna is 40×40×1.6 mm^3. The empty space on surface can be utilized for other purpose. The proposed antenna has a simple configuration and is easy to fabricate. Experimental results show that the proposed antenna could be a good candidate for UWB application.

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