A Printed Microstrip Patch Antenna Design for Ultra Wideband Applications

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Abstract: ***In this paper a printed microstrip patch antenna for ultra wideband application (UWB) is proposed. The proposed antenna consists of a beveled rectangular patch and partial ground plane, which is etched onto Rogers TMM6 (tm) substrate, with an overall dimension of 31mm × 32mm × 1.27mm. Simulated results indicate that the antenna achieved an UWB impedance bandwidth (S_{11}<-10dB) ranges from 3.0GHz to11.58GHz. The proposed antenna exhibits a good voltage standing wave ratio (VSWR) performance and its E- and H-plane radiation patterns are stable over the UWB frequency range. The simulation was done using Ansoft High Frequency Structure Simulator (HFSS) software.***

Keywords: Printed antenna, ultra wideband (UWB), HFSS

1. Introduction

Application of ultra wideband (UWB) technology on wireless communication system has increased considerably in last seven years. Because the UWB technology has great potential in the development of various modern wireless communication systems, the Federal Communication Commission (FCC) authorized the unlicensed use of the ultra wideband (3.1GHz-10.6GHz) frequency spectrum for indoor and hand-held wireless communication since early 2002 [1]. The merits of printed antenna such as light weight, small size and low profile make them an attractive candidate for UWB antenna development [2]. Many researchers around the world have designed filters and antenna to meet the applications in UWB communication systems [3-4]. A conventional microstrip antenna exhibits the inherent drawback of narrow impedance bandwidth. Numerous techniques have been investigated and reported to enhance the printed impedance bandwidth. This includes the feed gap optimization [5], bevels [6] and ground plane shaping [7].

In this paper, a printed microstrip patch antenna for UWB application is proposed. The -10dB return loss bandwidth of the antenna covers 3.0GHz to11.58GHz which satisfies the UWB system requirement. The outline of this paper is as follows. Section 2 describes the design of the proposed antenna. Simulation results are presented in Section 3 and the conclusions are summarized in Section 4.

2. Antenna Design

Fig.1. illustrates the geometry and configuration of the proposed antenna, which is etched on the Rogers TMM6(tm) substrate with a thickness of 1.27mm and dielectric constant of 6. Excitation is made through a 50Ω microstrip feeding line. The proposed antenna is composed of a partial rectangular ground and a planar rectangular radiation patch. The gap between the ground and the radiation patch is 0.2mm. The initial length (L) and width (W) of the patch has been determined from the following expressions [8].

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (1) \qquad L = L_{eff} - 2\Delta L \quad (2)$$

where,

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \quad (3)$$

$$\Delta L = h \times 0.412 \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad (4)$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2} \quad (5)$$

$$f_r = \frac{c}{\lambda} \quad (6)$$

To obtain a good impedance matching over a broad bandwidth, the radiation patch is beveled [9].The optimized parameters are summarized in Table1.

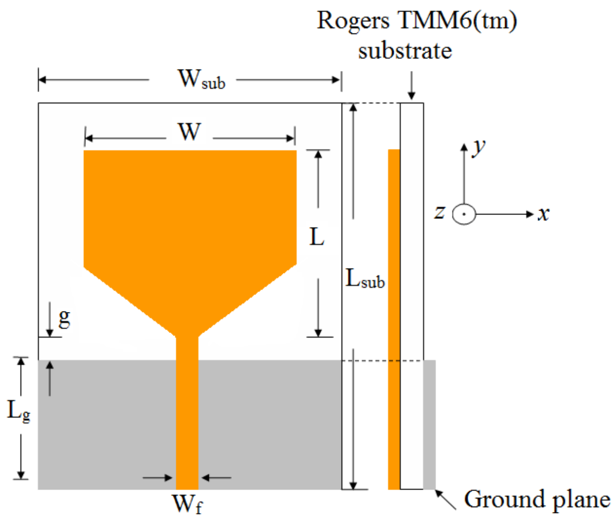

Figure 1: The geometry of the proposed antenna.

Table 1: The optimized parameters of the proposed antenna

Variable	*Dimension(mm)*
W_{sub}	31mm
L_{sub}	32mm
W	14mm
L	18mm
L_g	13.8mm
W_f	1.9mm
g	0.2mm

3. Simulation Result and Discussion

A printed microstrip patch antenna was simulated using Ansoft High Frequency Structure Simulator (HFSS) software. The simulated return loss (S_{11}) of the proposed antenna is shown in **Fig.2**. It was found that the -10dB return loss bandwidth of the antenna was approximately 8.58GHz (3.0GHz-11.58GHz) and the antenna shows stable behavior over the band. The simulated return loss shows that the antenna is capable of supporting multiple resonance modes, which are distributed across the spectrum. There are three resonance modes formed by the antenna. Their values are 3.5GHz, 7.2GHz and 10.5GHz respectively. Therefore, the overlapping of these resonance modes leads to the UWB characteristics. It was discovered that the VSWR of the optimized parameters of the proposed design is less than 2, this can be seen in **Fig.3**. According to **Fig.4,** The radiation patterns show omnidirectional characteristics at H-plane for 3.5GHz, 4.5GHz and 6GHz but changes in shape for 7.2GHz. It has been observed that a typical monopole like pattern in E-plane from 3.5GHz to 7.2GHz.

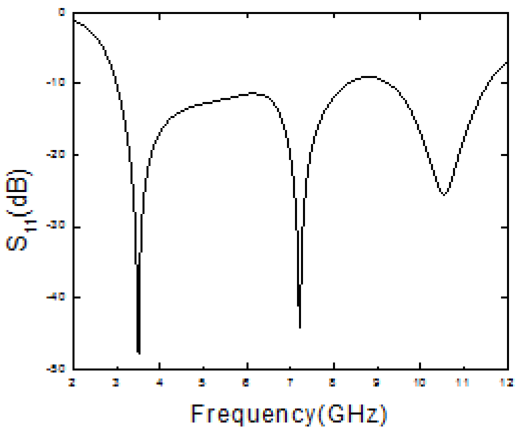

Figure 2: The simulated return loss of the proposed antenna

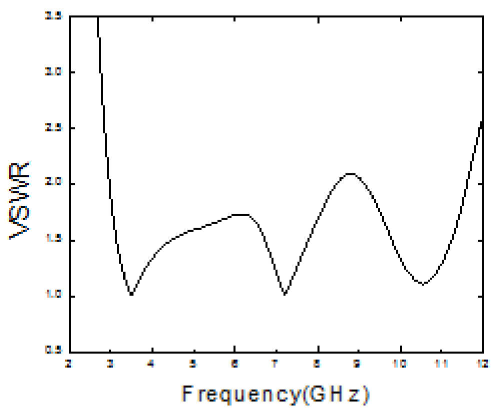

Figure 3: The VSWR of the proposed antenna

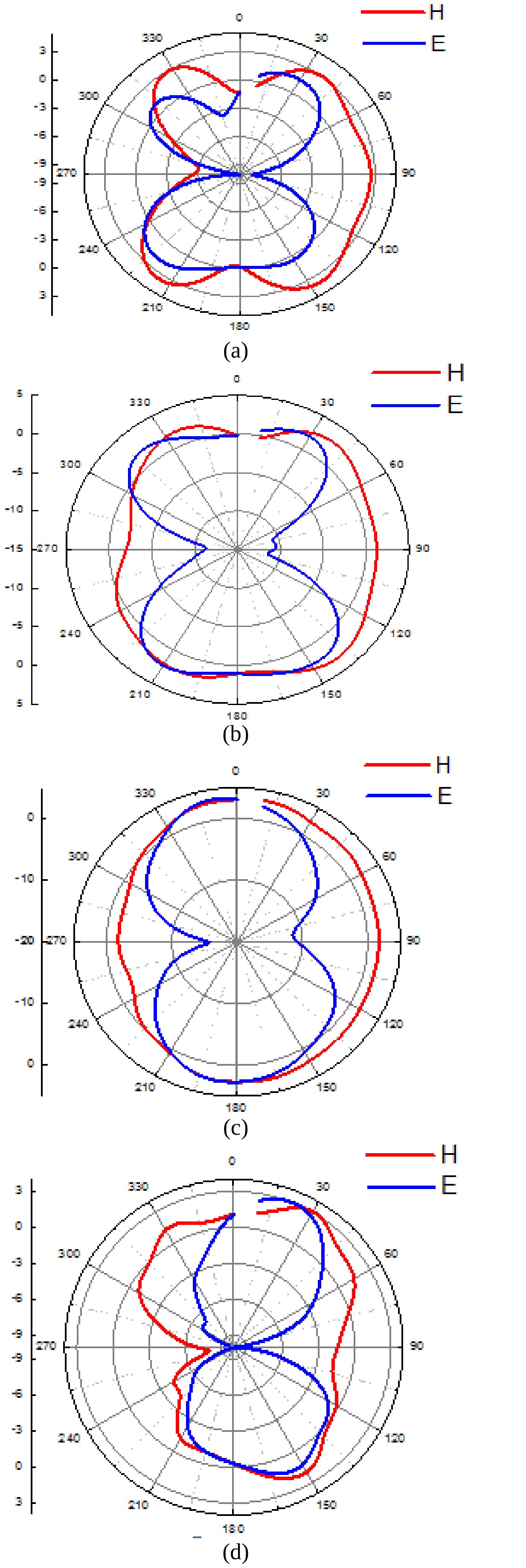

Figure 4: The simulated radiation patterns at E-plane and H-plane of the proposed antenna at (a) 3.5GHz, (b) 4.5GHz (c) 6GHz and (d) 7.2GHz

4. Conclusion

A printed microstrip patch antenna for ultra wideband application was proposed. The operating bandwidth (S_{11}<-10dB) achieved was 3.0GHz to11.58GHz.The proposed antenna is capable of supporting multiple resonance modes, at 3.5GHz, 7.2GHz and 10.5GHz which are distributed across the spectrum. The antenna exhibited a stable radiation patterns. Due to its very wide bandwidth, the antenna can be considered as a potential candidate for UWB applications.

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Zuhura Juma Ali received her B.Sc degree in Electronics and Communication Engineering from Yildiz Technical University Istanbul, Turkey and M. Sc degree in Electronics Engineering from Tianjin University of Technology and Education, China in 2006 and 2014 respectively. She is currently an instructor at Karume Institute of Science and Technology Zanzibar, Tanzania. She is now undergoing research in the field of microwave and wireless technology at Tianjin University of Technology and Education. P. R China.