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A Novel Design of Coplanar Waveguide-Fed Rhomb Shape Antenna for UWB Applications

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1. Introduction

The emerging UWB radio is the technology of transmitting and receiving short, radar and remote sensing applications [1]. According to the regulations released by Federal Communications Commission (FCC) in 2002, the UWB systems have been collocated to the bandwidth from 3.1GHz to 10.6GHz [2]. Due to UWB communication system appealing features of wide bandwidth, compact size and easy to fabricate, it will be an attractive candidate in the future. Recent years, various novel UWB antennas have been proposed. Several techniques were published such as using various U type radiation patch [3-4], notches on the square patch [5-6] and circular monopole radiation patch [7-8]. To achieve the required bandwidth for UWB applications a pair of the symmetrical notches is placed at the two corners of the ground plane and we present a novel rhomb shape antenna with coplanar waveguide-fed, which has the advantage of the low cost, compact size, omni-directional radiation patterns and easy fabricate. Details of the antenna design and experimental results are presented and discussed.

2. Antenna Design

The configuration of the proposed antenna design is shown in Fig.1, which has compact dimensions of 29 x 17 x 0.8mm^3(W_{sub} x L_{sub} x H). A novel coplanar waveguide feed rhomb shape antenna printed on FR4 substrate with relative dielectric constant (e_r) of 4.4 is presented. The CPW-feed geometry has the signal line width W_f = 3.4mm and length L_f = 13.2mm. The CPW feed line connected to the 50 Ω standard miniature adapter (SMA). The basis of the antenna structure is selected to be a rhomb patch with dimensions of P_1 = 12.02mm, P_2 = 9.62mm and the flare angle of the antenna denoted by $\alpha = 90^\circ$. The distance between the end of the monopole and the terminal of the CPW-feed line denoted of L_α = 2.4mm. The feed gap distance G = 2.2mm is an important parameter in determining the impedance matching. The feed gap is the distance between radiation patch and top edge of the ground plane. The width W_g and length L_g of the symmetrical ground plane on the proposed antenna is of 6.5mm and 11mm, respectively. By cutting the symmetrical two notches of proper dimension W_1 x L_1 = 1mm x 5mm at upper corner of the ground plane, it is found that much broad bandwidth can be achieved for the proposed antenna. The phenomenon account because the two notches affect the electromagnetic coupling between the rhomb radiation patch and the ground plane to enhance the impedance matching bandwidth.

3. Experimental Results and Discussion

The proposed antenna is successfully measured is taken by an Agilent 8720ES vector network analyzer. The measured return losses for the optimal dimensions proposed antenna design and without notches antenna are shown in Fig. 2. As the notches width are changed from 0mm to 1mm, the 10-dB impedance bandwidth for the optimal proposed antenna is from 3.1GHz to 11.9GHz. Fig. 3 shows the measured antenna gain against frequency. The maximum peak antenna gain is measured to be 6.2dBi at 9.7GHz. That is adequately for UWB applications. The far-field radiation patterns were measured and calibrated in our anechoic chamber. Fig. 4 shows the

ISBN: 978-4-88552-223-9 C3055©IEICE

measured radiation patterns at 3.5, 7.5, and 10.6GHz in both X-Z plane and X-Y plane, respectively. The CPW feed line is located parallel to the z-axis, the X-Z plane radiation patterns of the proposed antenna has a null in z-direction. In the X-Y plane measurements are also presented, where it is noted that this antenna is the nearly omni-directional radiation characteristics even at higher frequency.

4. Conclusion

The proposed antenna exhibits a broad bandwidth is approximately 117.3%(3.1~11.9GHz) for 10dB impedance bandwidth and a good radiation performance by using the rhomb shape radiation patch and the notches in the ground leads to achieve broadband impedance match. The proposed antenna has a simple structure, thin profile, low cost and compact size therefore it will be an attractive candidate for the UWB applications. Further the band-reject characteristic will be investigated and implemented in the future work.

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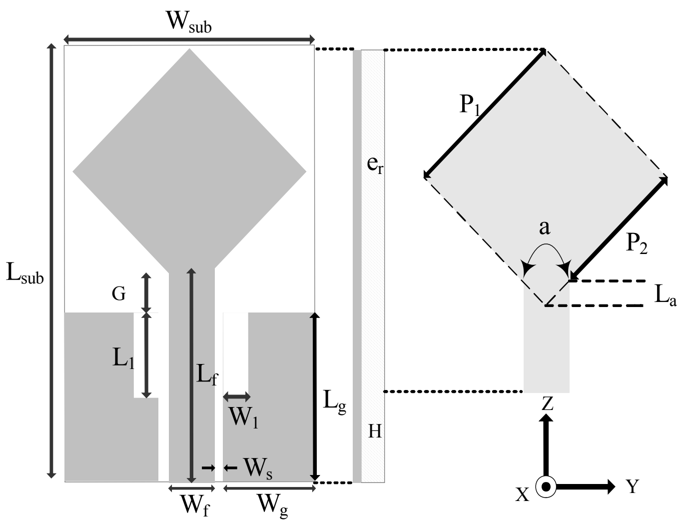


Figure 1: The geometry of the CPW-feed rhomb shape antenna.

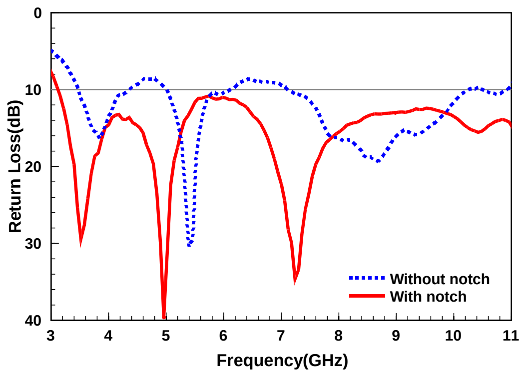


Figure 2: Comparision of measured return loss

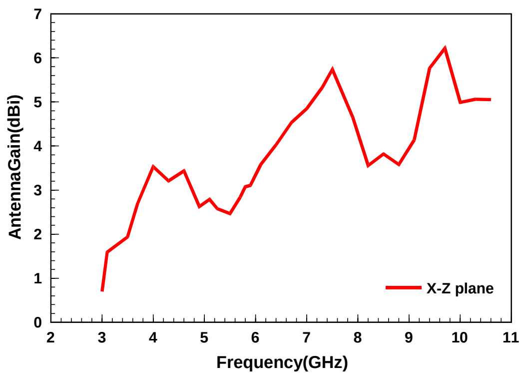
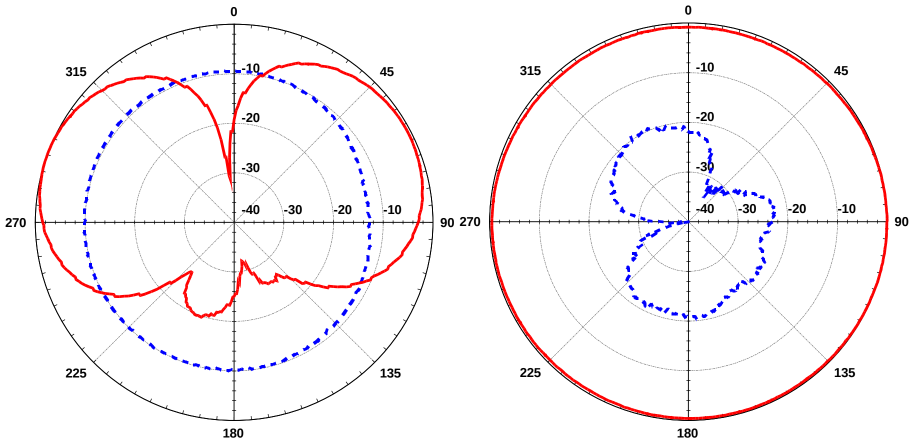
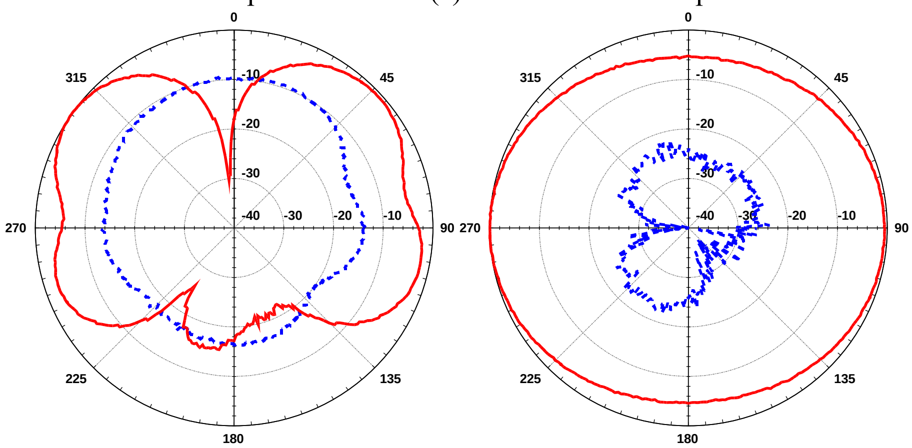


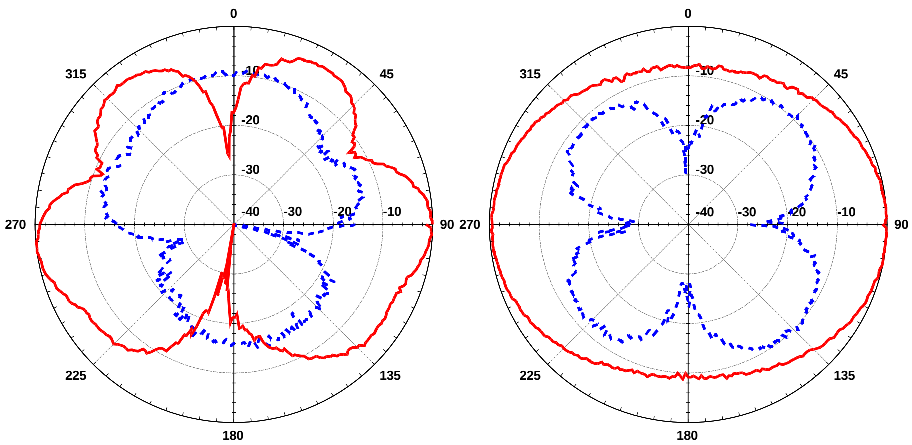
Figure 3: Measured gain of proposed antenna.



X-Z plane (a) X-Y plane



X-Z plane (b) X-Y plane



X-Z plane (c) X-Y plane

Figure 4: Measured far-field radiation patterns of Antenna in the X-Z plane and X-Y plane at (a) f = 3.5GHz, (b) f = 7.5GHz and (c) f = 10.6GHz, (Where co-pol presented by solid line, and cross-pol presented by dash line).