A Simple Broadband Patch Antenna

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***Abstract*-The design and development of a simple broadband patch antenna for X-band application is introduced. The antenna consist of 2 layers substrate, which can be manufactured easily. The measured bandwidth is more than 20% for voltage standing wave ratios<2. The measured radiation patterns of the 1×8 element linear subarray are presented and discussed in detail. It can be used as a conformal antenna.**

I. INTRODUCTION

A great deal of research has been devoted in the last years to improve microstrip antenna bandwidth to meet the radar antenna demands[1-4]. However, most antenna use aperture-coupled microstrip patch arrays, which is a multilayer structure, need the support of the foam[5-6]. For these antenna, the manufacturing is complex and the cost is expensive.

In the present article, the broadband patch antenna element consists of dual-stacked patches, this results in a low profile. The antenna is easy to manufacture, and can be used as a conformal antenna. The simulations were performed using Ansys HFSS electromagnetic software. Experimental results are presented for a 4×8 elements array in X-band.

II. ANTENNA DESIGN

The radiation element geometry is shown in Fig.1. Arlon Diclad880 with a relative dielectric constant of 2.2 has been selected as the material for the microstrip antenna substrate. The excited patch, which fed by T-shaped microstrip lines, is placed on the top side of the lower substrate, and the ground is placed on the bottom side. The T-shaped microstrip line is on the same layer of the excited patch. Coaxial connector to the microstrip line adopts vertical transition form in this antenna. The parasitic patch is placed on the top side of the upper substrate, so that increase the antenna bandwidth. Thickness of both the substrates is 1.524mm, which leads to a low profile as well as low weight and low cost.

The designed antenna works from 9 to 11GHz, and the simulated bandwidth of the antenna is more than 20% for voltage standing wave ratios(VSWR)<2, as shown in Fig.2. Its simulated radiation patterns are shown in Fig.3, which indicates good pattern performance. As the radiation patterns of horizontal polarization (HP) and vertical polarization (VP) are similar, only horizontal polarization radiation patterns are given in Fig.3.

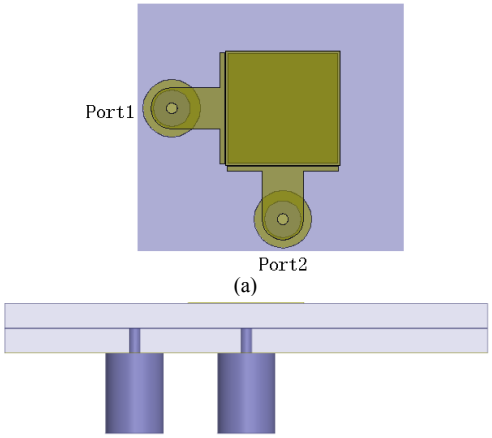


Figure 1. Geometry of the propose antenna. (a) Top view and (b) Cross-sectional view.

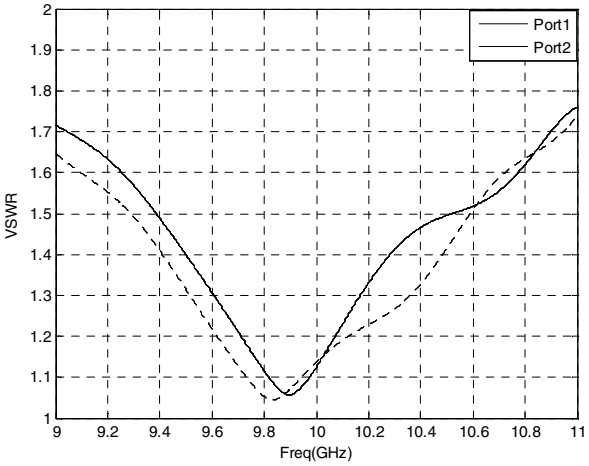
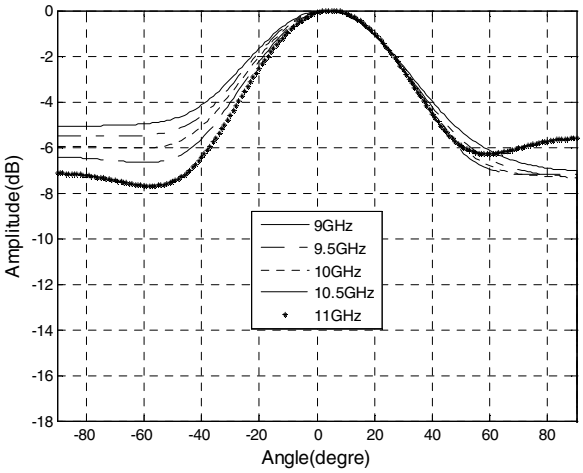
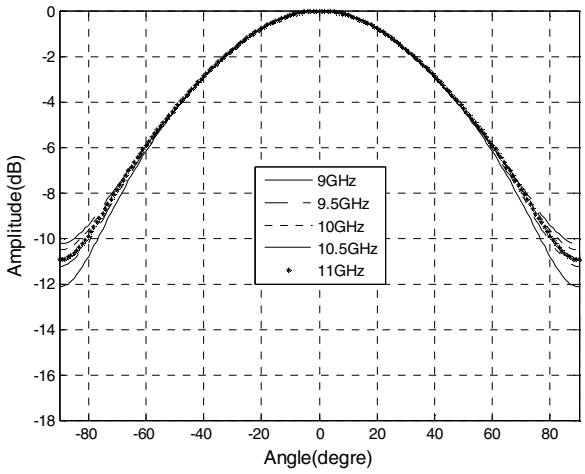


Figure 2. Simulated VSWR of the propose antenna.

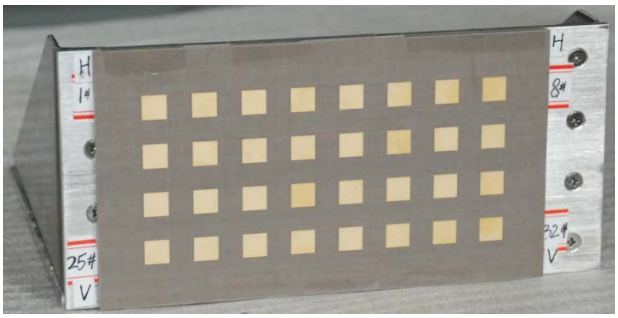


(a)

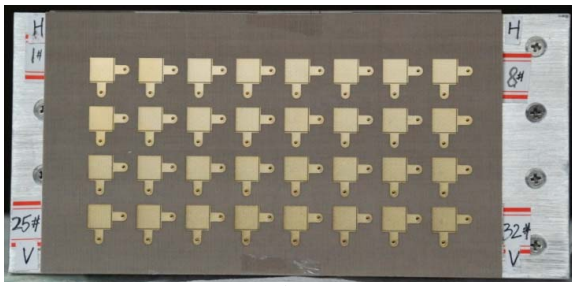


(b)

Figure 3. Simulated horizontal polarization radiation patterns of the propose antenna. (a) Elevation cuts and (b) Azimth cuts at 9, 9.5, 10.0, 10.5 and 11 GHz.



(a)



(b)

Figure. 4. Photograph of the 4×8 element array. (a) parasitic patch layer and (b) excited patch layer.

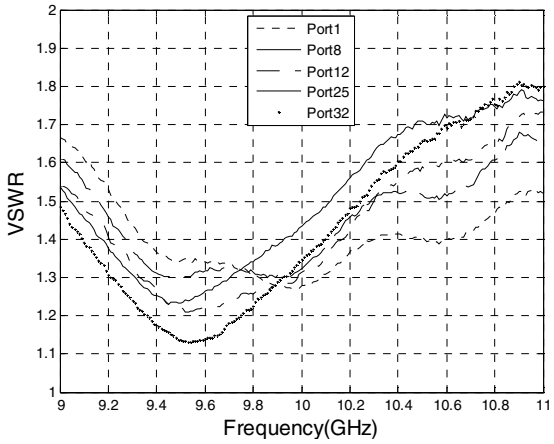
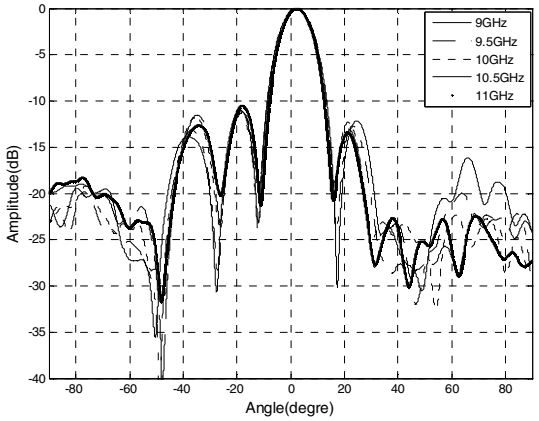
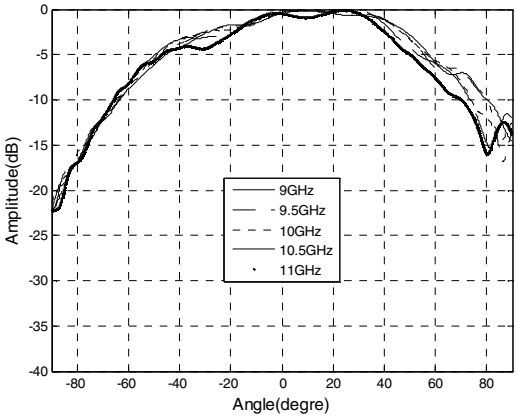


Figure. 5. Measured VSWR of the propose antenna



(a)



(b)

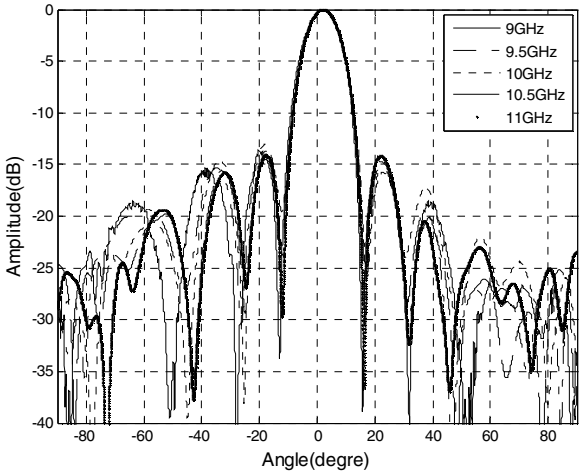
Figure. 6. Measured radiation patterns for H-pol. (a) Elevation cuts and (b) Azimth cuts at 9, 9.5, 10.0, 10.5 and 11 GHz.

III. MEASURMENTS RESULTS

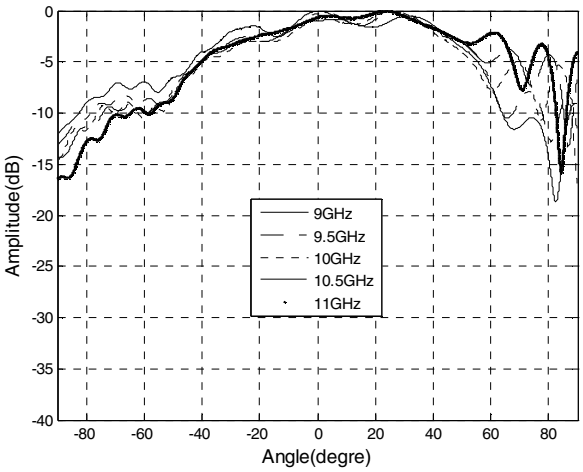
A 4×8 element array arranged as foresaid configuration is designed, manufactured and measured. The photograph of the 4×8 element array is presented in Fig.4. Two layers of the substrate have to be fixed together using RO4400 series prepreg flake, under high temperature. The measured results suggest that the prepreg flake layer does not degrade the RF performance of the antenna.

Fig.5 shows the measured VSWR curves of the array elements, VSWR is less than 2 from 9 GHz to 11 GHz for both polarizations. In order to see clearly, only typical curves are given in Fig.5. The radiation patterns of the array were measured in an anechoic chamber. For the 4×8 element array, 8 elements in azimuth plane and 4 elements in elevation. As a result, attentions are placed on the azimuth plane. Two additional 1:8 microstrip divider networks are used for constructing the 1×8 element linear subarray. For HP of the 1×8 element linear subarray, the uniformly radiation pattern measured at 9, 9.5, 10, 10.5 and11 GHz for the 0°-tilt case in azimuth plane (all linear arrays are excited equally) is given in Fig.6, where it shows a near-in sidelobe peak at -11.5dB level. For VP of the 1×8 element linear subarray, the radiation pattern in azimuth plane is given in Fig.7, where it shows a

near-in sidelobe peak at -13dB level. This is because in the azimuth plane, vertical polarization feed network is symmetric.



(a)



(b)

Figure. 7. Measured radiation patterns for V-pol. (a) Elevation cuts and (b) Azimth cuts at 9, 9.5, 10.0, 10.5 and 11 GHz.

IV. CONCLUSION

A simple broadband patch antenna, consisting of 2 layers substrate, has been developed to improve microstrip antenna bandwidth. A T-shaped feeding structure is used to excite the patch antenna, and a parasitic patch is employed on the top side of the upper substrate. The measured bandwidth is more than 20% for voltage standing wave ratios<2, the radiation patterns indicate good performance. The thickness of total antenna is about $\lambda/10$, which means low profile as well as low weight and low cost. Consequently, It can be used as a conformal antenna.

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