Design of Broad Beam Circular-Polarized Microstrip Antenna

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Abstract- In this paper, broad beam circular-polarized microstrip antennas are studied. Using a corner-truncated structure with conducting post[1], a patch antenna with a height of 0.1λ only is designed and exhibits a 3dB gain beam width of over 160° , but the axial ratio is poor. Then a stacked squared-ring microstrip antenna is designed using hybrid perturbation method in order to increase 3dB AR beam width. Simulation results for operating at 2.06 GHz are presented and discussed.

I. INTRODUCTION

Microstrip antenna has been widely used in mobile terminals and satellite communication systems for its lightweight, low profile, low cost and easy to conform. However, the above application systems require that the antenna can provide uniform response over approximately the entire upper hemisphere and high gain at low-angle [2]. But the 3dB gain beam width of conventional microstrip antenna is only $70^{\circ}\sim110^{\circ}$ and gain at low-angle is about -7dB~-3dB. Some methods are presented to solve the problem, such as using high permittivity substrate, employing a pyramidal configuration or operating at higher order modes. But these methods only meet the requirement in some degree.

In this paper, a microstrip antenna example operating at 2.06GHz is presented. The designed patch antenna has a height of 0.1λ only and exhibits a 3dB gain beam width of more than 160° [3]. To increase the 3dB gain beam width, some techniques are employed [4]. The patch presented is enclosed partially by some conducting posts to increase the 3dB gain beam width to more than 130° . Corner-truncated method is adopted to realize circular-polarization (CP) and the 3dB Axial Ratio(AR) beam width can reach about 80° . According to the cavity theory, size of the corner can be determined. To improve circular-polarization characteristic further, a stacked squared-ring microstrip antenna designed using hybrid perturbation[5] method is adopted to increase 3dB AR beam width. Simulation results for operating at 2.06 GHz are presented and discussed.

II. ANTENNA CONFIGURATION

Antenna A in Fig.1 shows the geometry of the normal square-patch antenna which is mounted on a plane. The patch is printed on a square Arlon AD255a(tm) substrate of thickness 40mil, relative permittivity 2.55 and size 100mm×100mm, and is probe fed at a point which is 14.3mm from the patch center. The side length L of the patch is 55.6mm. Moreover, an air layer with a thickness of 1.5mm is embedded between the ground and substrate layer.

To study the effects of the conducting posts and the truncated corner, two other prototypes in Fig.1 are implemented and investigated. The first one, denoted by antenna B, consists of truncated corner but no posts exist. The side length L of the patch is 55.6mm and the length ΔL of the truncated corner is 7.0mm. The second one, antenna C, is constructed by adding posts to antenna B. The distance between two adjacent posts is 10mm and the height of the posts is 14.5 mm . Antenna parameters, such as the VSWR , gain beam width, 3dB axial-ratio beam width are simulated.

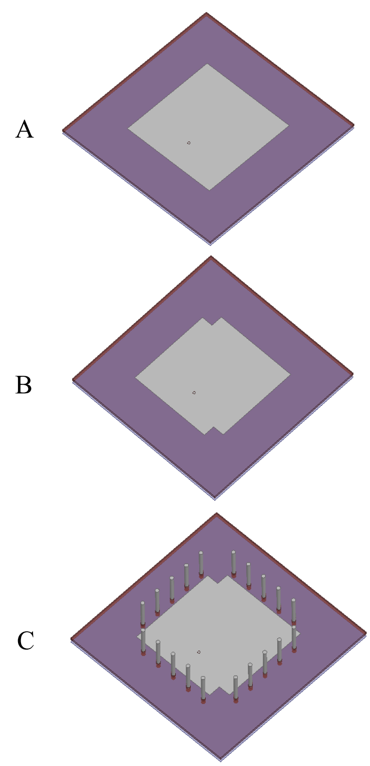


Figure 1. Configuration of proposed antennas(A:normal patch antenna; B:corner-truncated CP patch antenna; C: final broad beam circularly-polarized patch antenna)

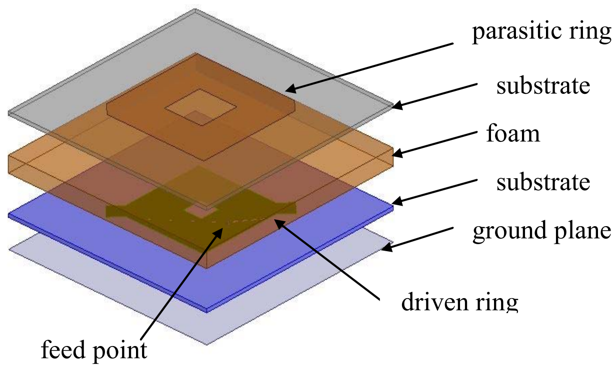


Figure 2. Configuration of hybrid perturbation CP antenna

We know, a CP patch antenna can be achieved by truncating its diagonal corners (a negative perturbation) as shown in Fig.1. However, the 3dB AR beam width is not satisfied for some communication systems. Fig.2 shows a unique hybrid perturbation stacked squared-ring microstrip antenna to obtain good polarization characteristic, where both positive and negative perturbation are used. The substrate[6], in the case, adopts Arlon 255a(tm),which has a dielectric constant of 2.55, thickness of 40mil. A foam layer is embedded between the two substrate. To decrease antenna's size for a given frequency, the regular patches are perforated at the center to form ring antennas. Only the driven ring is probe fed at a point which is 11.3mm from the center.

III. DISCUSSIONS & RESULTS

Fig .3 shows the return loss of antenna C. It is shown that antenna C can provide a impedance bandwidth(VSWR<2) of over 170MHz. The radiation pattern is presented in Fig 4, and

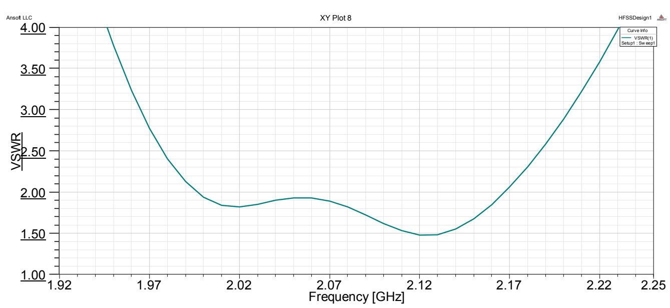
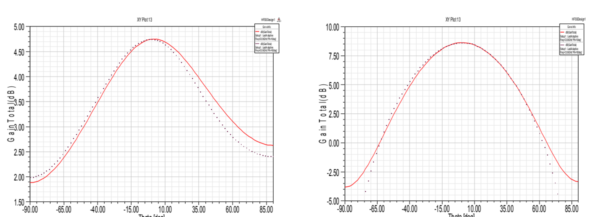


Figure 3. VSWR of antenna C



antenna C antenna A

Figure 4. gain beam width of antenna A and antenna C at 2.06GHz in both E and H plane

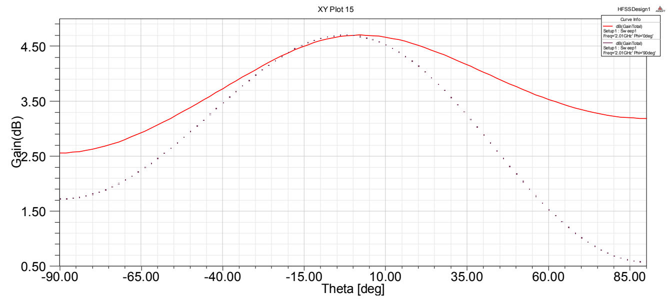


Figure 5. gain beam width of antenna C at 2.01GHz in both E and H plane

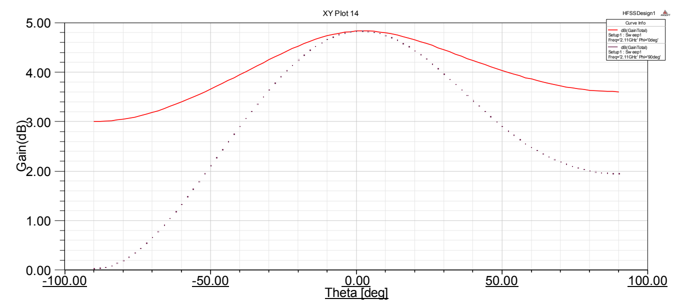


Figure 6. gain beam width of antenna C at 2.11GHz in both E and H plane

antenna C's 3dB gain beam width is over 160° in both E plane and H plane, contrarily, antenna A can only provide a gain beam width of about 80° . To understand antenna C's radiation characteristic at different frequency, we choose 2.01GHz and 2.11GHz as investigation points. Fig.5 and Fig.6 illustrate the radiation pattern respectively. Obviously, the 3dB gain beam width are both over 130° .

The circular-polarization technique we adopt in antenna C can provide a 3dB AR beam width of about -40° ~40° in both E plane and H plane as is shown in Fig.7. In order to obtain a better circular-polarization characteristic, hybrid perturbation method is adopted. The 3dB AR beam width presented in Fig.8 is about 140° ,which is improved greatly compared to antenna C.

IV. CONCLUSION

A corner-truncated patch antenna with conducting posts has been concisely studied for operating at 2.06GHz. Employing

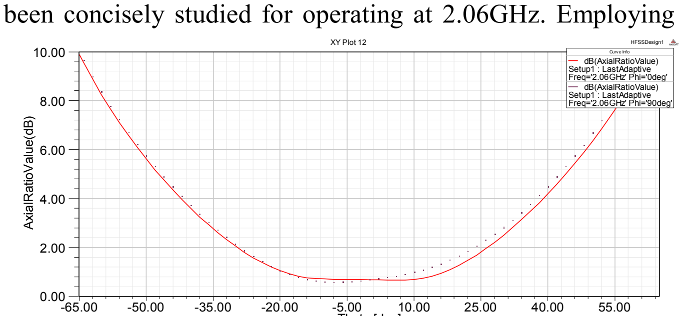


Figure 7. 3dB AR beam width of antenna C

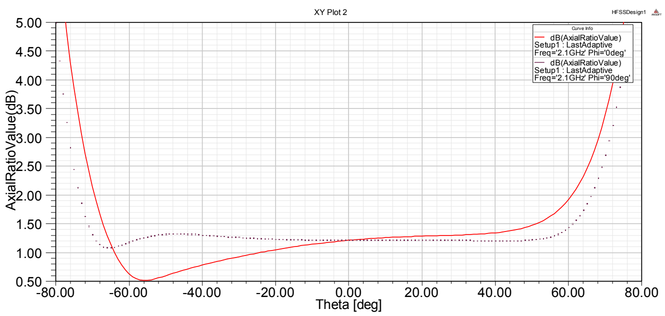


Figure 8. 3dB AR beam width of hybrid perturbation antenna

this technique, the antenna can achieve a wide 3dB gain beam width of up to 160° and the 3dB AR beam width is about 80° . To obtain a better circular-polarization, hybrid perturbation method is adopted. The 3dB AR beam width can reach about 140° ,which is improved greatly compared to the former.

ACKNOWLEDGMENT

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