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COMPACT CIRCULARLY POLARIZED MICROSTRIP ANTENNA WITH WIDE BEAMWIDTH FOR COMPASS SATELLITE SERVICE

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Abstract—A compact circularly polarized (CP) microstrip antenna with inserted nine cross slots is proposed to reduce the size and widen the beamwidth. The antenna is operated at 1.268 GHz, and built by using a substrate with a coaxial probe feed. The impedance bandwidth (VSWR < 2) is 1.5% and the 3 dB axial ratio bandwidth is 0.52%. The measure gain is 4.5 dBi and beamwidth is about 110°. The measured results for the compact CP antenna with embedded cross slots size shows that the resonate frequency is significantly lowered from 1.951 GHz to 1.268 GHz, corresponding to a 35% antenna size reduction compared with the one without any slot.

1. INTRODUCTION

There are huge demands for the miniaturization of the mobile communications equipment. Microstrip circularly polarized antennas are attractive in satellite communication systems owing to their good features such as low profile, light weight and easy to fabricate. However, conventional microstrip circularly polarized antenna do not have sufficient beamwidth to provide enough coverage for the China Compass satellite communication system. One popular approach to widen the beamwidth is to reduce the overall size of the patch. A number of single-fed circularly polarized microstrip antennas are described. The major advantage of single-feed circularly polarized microstrip is their simple structure. There are a number of approaches to reduce the size of patch antennas, such as using high dielectric substrate [1], embedding cross slots of unequal [2] or equal lengths [3].

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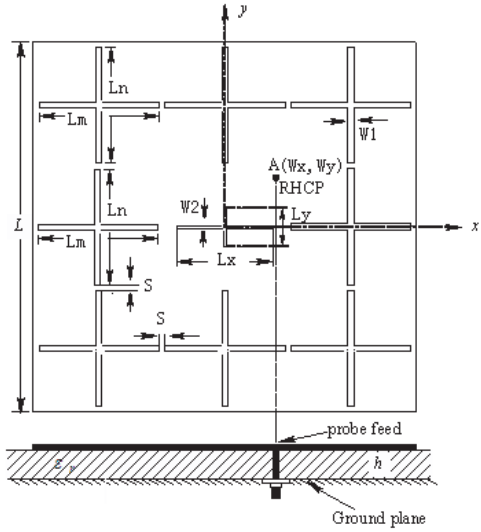
Using T-shaped slits [4] or a bent slot [5] has also been suggested. The above methods can achieve small CP antenna, but can't generate radiation patterns with wide enough beamwidth.

In this paper, a special technique which inserting nine cross slots on the middle patch is proposed to reduce the size of a patch antenna. By changing the length of slots, the antenna can operate effectively with circular polarization. The proposed technique can broaden beamwidth for the China Compass satellite communications.

2. ANTENNA DESIGN

The configuration of the proposed antenna is shown in Fig. 1. A square patch with the length L is printed on a dielectric substrate, whose thickness is 2 mm, relative permittivity is 2.65. Eight thin crossing slots with length $(L_m * L_n)$ and width (W_1) are cut on the square patch. In the center of the square patch one asymmetry crossing slot with length $(L_x * L_y)$ and width (W_2) is etched to tune the axial ratio The antenna is fed by a coaxial probe located at point A (W_x, W_y) to obtain right handed circular polarization (RHCP). The length of the ground plane is L_g.



Parameter	L	L_m	L_n	L_x	L_y	W_1	W_2	W_x	W_y	S	L_g
Unit (mm)	60	18	18	12	4	1.5	0.5	6	6	2	100

Figure 1. The configuration details of the proposed antenna.

3. RESULTS AND DISCUSSION

The proposed antenna was first simulated and optimized using the electromagnetic software Ansoft HFSS and then a prototype of the

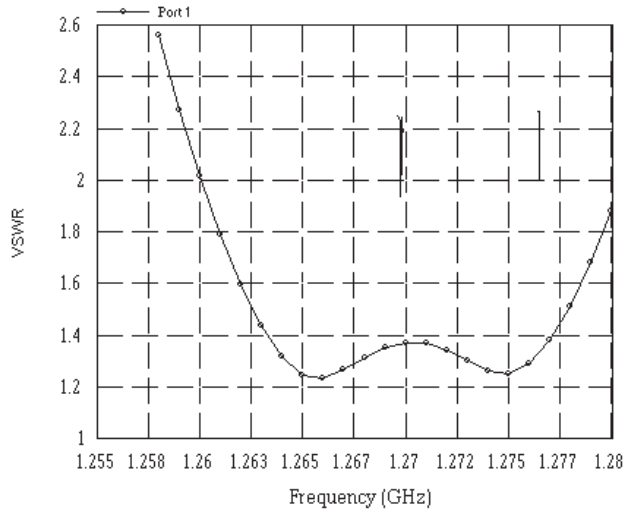
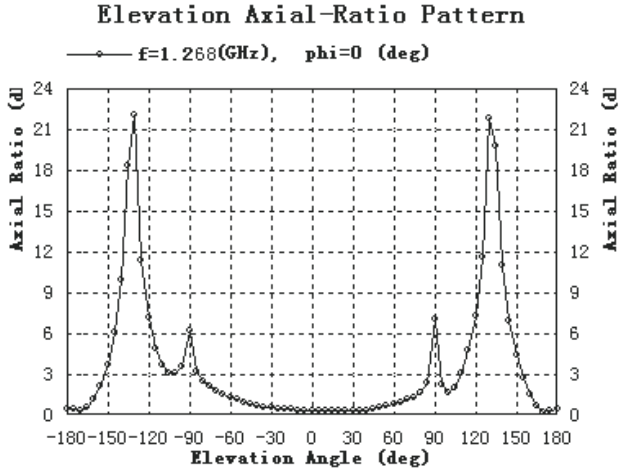
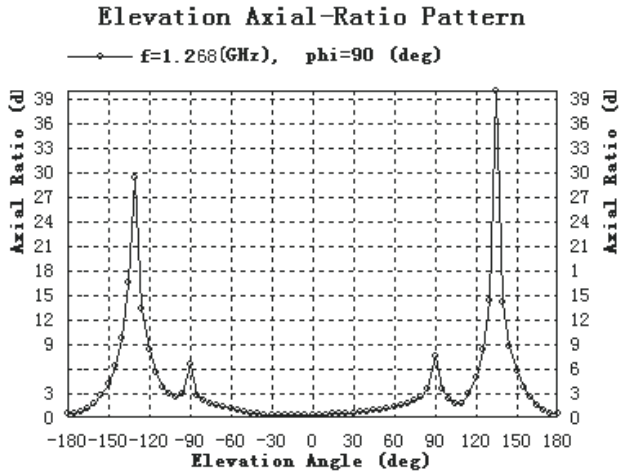


Figure 2. (a) The simulated VSWR, (b) the measured VSWR.



(a)

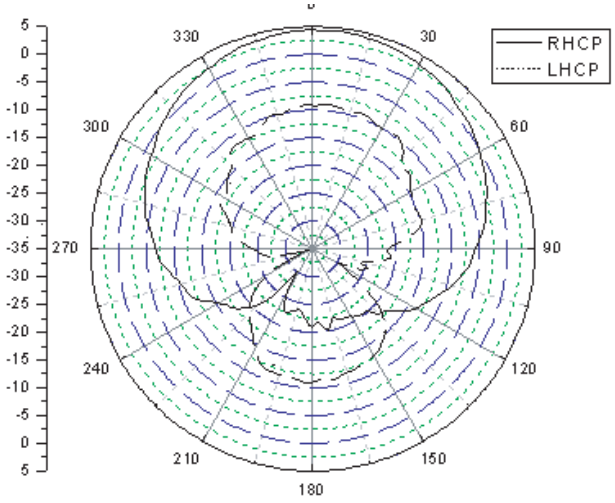


(b)

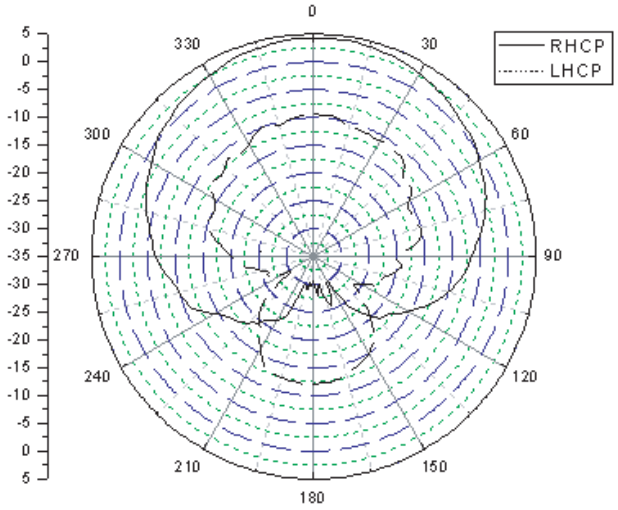
Figure 3. (a) The simulated AR at $\phi = 0^\circ$ plane, (b) the simulated AR at $\phi = 90^\circ$ plane.

antenna was fabricated. The proposed CP antenna is tuned at 1.268 GHz. Simulated and measured VSWR are shown in Fig. 2. The simulated axial ratio at $\phi = 0^\circ$ and $\phi = 90^\circ$ in elevation plane are also shown in Fig. 3. It is observed that the minimum VSWR of the antenna is 1.24, the best axial ratio is 0.4 dB and AR is less than 3 dB in $\pm 80^\circ$ coverage. The measured radiation patterns are given in Fig. 4. It can

be seen that the maximum gain of the antenna is about 4.5 dBi and the co-polarization is around 15 dB higher than the cross-polarization. The beamwidth is around 110° for both cases at $\phi = 0°$ and $\phi = 90°$ planes. The front back ratio is about −30 dB.



(a)



(b)

Figure 4. (a) The measured pattern at $\phi = 0°$ plane, (b) the measured pattern at $\phi = 90°$ plane.

The results indicate the eight cross slots on the top patch can greatly lengthen the current path of the TM_{10} mode and TM_{01} mode, which effectively lowers the resonant frequency of the antenna and provide the miniaturization for the antenna. By changing the length of the cross slot in the middle patch, it is easy to optimize the axial ratio.

4. CONCLUSION

A small probe-fed circularly polarized patch antenna with slots has been designed. The proposed antenna exhibits impedance bandwidth of 1.5% for VSWR < 2, 3 dB axial ratio bandwidth of 0.52%, and gain of 4.5 dBi. Wide beamwidth of around 110° has been achieved. The size reduction of the circularly polarized patch antenna can reach 35% comparing with the conventional patch antenna.

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