A TWO-ELEMENT PATCH-LOADED PRINTED SLOT ANTENNA FOR BROADBAND CIRCULAR POLARIZATION RADIATION

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1. Introduction

Circularly polarized printed antennas have been widely applied in the designs of phased arrays, mobile antennas, satellite antennas, and receiving antennas for direct satellite broadcasting, due to their thin and compact structure. In such applications, many techniques have been developed to generate CP radiation. Sequentially rotating technique [1] is one of the promising techniques, especially in the microstrip array designs [2,3]. However, the related work using this technique to obtain CP radiation is mainly on printed patch antennas. In this paper, we present a very broadband printed slot antenna for circular polarization. The proposed design consists of two circularly polarized patch-loaded printed square slot elements [4] fed by using the sequentially rotating technique. For the purpose of restraining the backward radiation of the slots, a conducting reflecting plate is added and placed at a distance of a quarter wavelength away from the antenna's ground plane. These two square slots are arranged in orthogonal directions, and are fed with equal amplitudes, but 90-degree phase difference, provide by a simple microstripline network. With the proposed design, experimental results indicate that a very large CP bandwidth of 33% (determined by 3-dB axial ratio), with peak antenna gain 7.7 dBi and 10-dB return-loss impedance bandwidth 50%, can be achieved. Details of the antenna design and obtained CP performance are presented and discussed.

2. Experimental Results and Discussion

The proposed two-element broadband circularly polarized printed slot antenna is shown in Fig. 1. Two square slots are aligned in the x direction, and a simple T-shaped feed network with its two output microstriplines having a 90-degree phase shift is used to excite the two printed slots. In addition, the two output microstriplines, having a width w_p and a tuning stub length d_p, are arranged to excite the two square slots along different diagonals. The designed center frequency is selected to be at 2.4 GHz. The two square slots are of the same size and are separated with a spacing (S) of 88.8 mm, which is about 70% of the center operating wavelength, and are printed on a substrate of thickness (h_1) 1.6 mm and relative permittivity (ε_r) 4.4. A conducting reflecting plate is placed at a distance (h_2) of a quarter wavelength of the center frequency. Also, the square slots are all loaded with a rectangular patch of suitable dimensions ($a \times w$), which makes each square slot capable of circularly polarized radiation [4]. Fig. 2 shows the measured return loss against frequency for the proposed two-element printed slot antenna. The measured axial ratio versus frequency comparing with the single-element design is presented in Fig. 3. Results indicate that the proposed two-element design can have a 10 dB return-loss impedance bandwidth as large as 1211 MHz or about 50% referenced to the designed center frequency, and the 3dB axial-ratio CP bandwidth reaches 790 MHz or about 33%. The measured antenna gain for operating frequencies within the CP bandwidth is shown in Fig. 4. The gain variation is seen to be less than 2.8 dB, and the peak antenna gain is 7.7 dBi and the antenna gain at the center frequency is 7.2 dBi. Typical measured radiation patterns in two orthogonal planes are also plotted in Fig. 5. It is found that the directivity in x-z plane is increased as compared with the single-element design, which is due to the present arrangement of the proposed two-element design shown in Fig. 1. Measured results of the proposed two-element design and the single-element design are also presented in Table 1 for comparison.

3. Conclusions

By using a simple microstripline T-network with its two outputs having a 90-degree phase shift for the excitation of a two-element printed slot antenna, a very broadband circularly polarized printed slot antenna has been proposed and studied. The proposed design with a CP bandwidth of 33% has been implemented. More extensive studies are being conducted and will be given in the presentation.

Table 1: Comparison between the proposed two-element design and the single-element design; center designed frequency is at 2.4 GHz.

	Impedance bandwidth (10-dB return loss)	CP bandwidth (3-dB axial ratio)	Antenna gain (at 2.4 GHz)
Two-element design	1211 MHz or 50%	790 MHz or 33%	7.2 dBi
Single-element design	924 MHz or 39%	284 MHz or 12%	5.0 dBi

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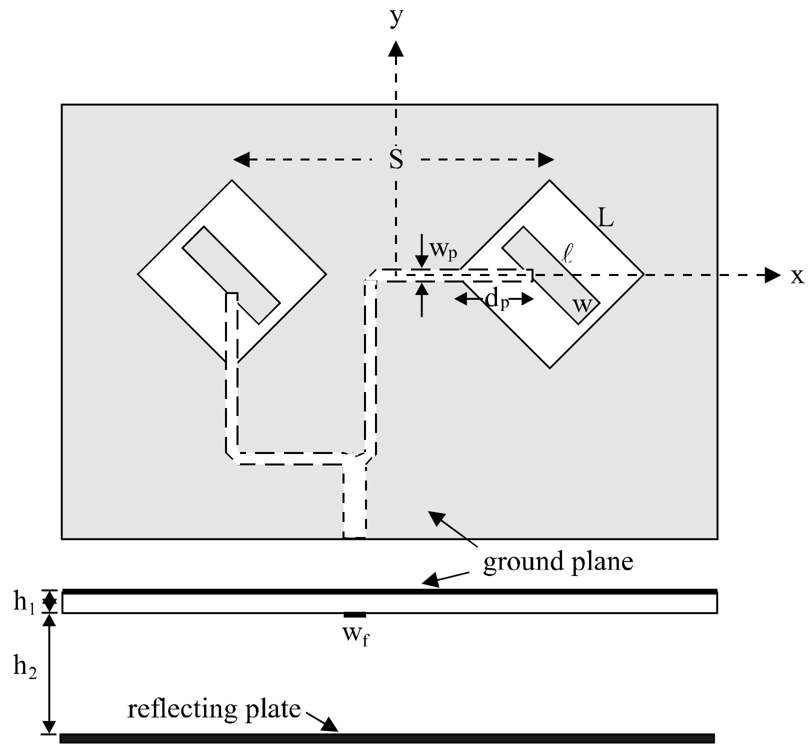


Figure 1 Geometry of the proposed two-element broadband circularly polarized patch-loaded printed slot antenna.

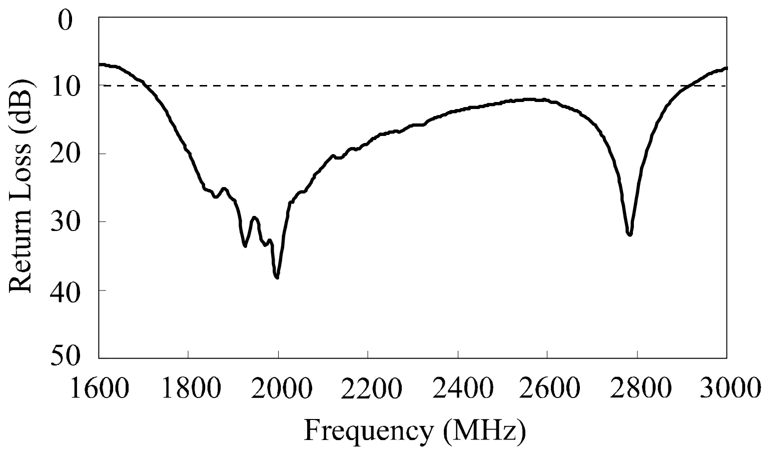
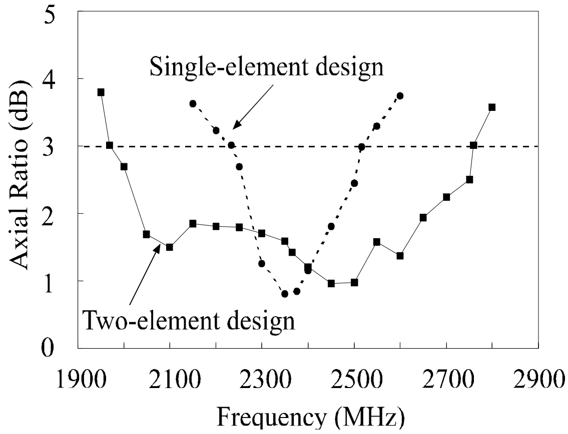


Figure 2 Measured return loss against frequency; ε_r = 4.4, h_1 = 1.6 mm, h_2 = 31.7 mm, L = 44.7 mm, a = 36.5 mm, w = 12.2 mm, d_p = 24.2 mm, w_p = 3.1 mm, w_f = 5.4 mm, S = 88.8 mm, ground-plane size = 130 mm × 195 mm.



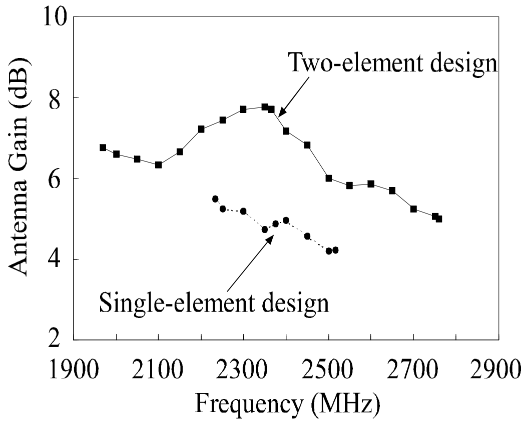


Figure 3 Measured axial ratio in broadside direction against frequency; antenna parameters are given in Fig. 2.

Figure 4 Measured antenna gain in broadside direction against frequency; antenna parameters are given in Fig. 2.

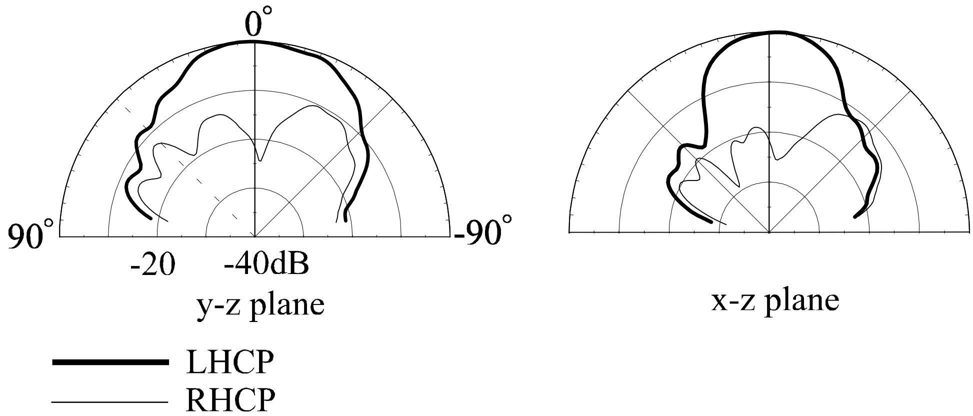


Figure 5 Measured radiation patterns in y-z and x-z planes at 2365 MHz; antenna parameters are given in Fig. 2.