COMPACT CIRCULAR-SIDED MICROSTRIP ANTENNA FOR CIRCULAR POLARIZATION

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ABSTRACT: *Development of a new compact circular-sided microstrip antenna is presented. This antenna offers considerable area reduction compared to standard rectangular microstrip antenna designed for the same frequency. Typical antenna design and experimental results for circular polarization are also demonstrated. The antenna has a 3-dB axial ratio bandwidth of 1.5%.* © 2002 Wiley Periodicals, Inc. Microwave Opt Technol Lett 34: 176–177, 2002; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.10408

Key words: *compact; circular sided; microstrip antenna; circular polarization; axial ratio*

INTRODUCTION

Miniaturization of personal communication systems and microstrip array applications demand reduced-size microstrip antennas. Compact antennas with circular polarization are attractive in mobile communication systems to allow for more flexible orientation of the transmitter and the receiver antenna and to overcome the losses due to the misalignment between the antennas. A drum-shaped microstrip antenna [1, 2], which reduces the resonant frequency for a given patch area, has been reported in the literature. A compact drum-shaped microstrip antenna for circular polarized operation has also been discussed [3]. In the proposed design, the straight resonating edges of the patch are replaced by circular ones. The effective length is increased by this technique, so that the antenna resonates at a lower frequency, resulting in area reduction. The experimental results of such a compact circular-

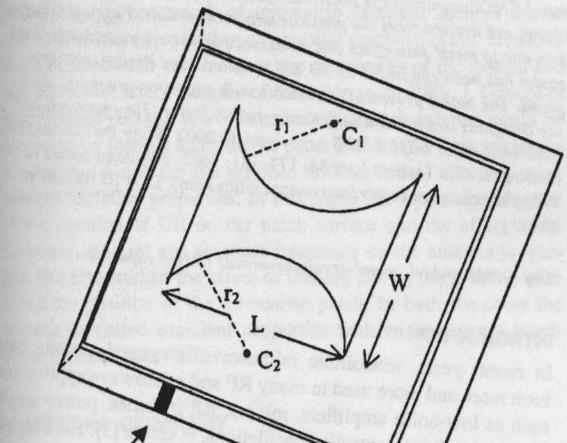


Figure 1 Geometry of the proposed microstrip antenna

TABLE 1 Variation of Resonant Frequencies and Area Reduction Compared to Standard Rectangular Patch with Length of the Patch

L, W, r_1, r_2 (cm)	h (cm), ε_r	Frequencies (GHz) $f1$	$f2$	Area Reduction (%)
8, 4, 6, 6		0.684	1.816	89.30
7, 4, 6, 6		1.997	2.300	79.78
6, 4, 6, 6	0.16, 4.28	1.080	2.213	69.24
5.6, 4, 6, 6		1.165	2.100	64.80
5, 4, 6, 6		1.341	2.063	55.51

TABLE 2. Variation of Resonant Frequencies with Length (Showing CP)

L, W, r_1, r_2 (cm)	h (cm), ε_r	Frequencies (GHz) $f1$	$f2$
2, 4.6, 2, 2	0.16, 4.28	1.648	3.25
3, 4.6, 2, 2		1.783	2.10
3.4, 4.6, 2, 2		1.885 (Circular Polarization)	
4, 4.6, 2, 2		1.18	2.447

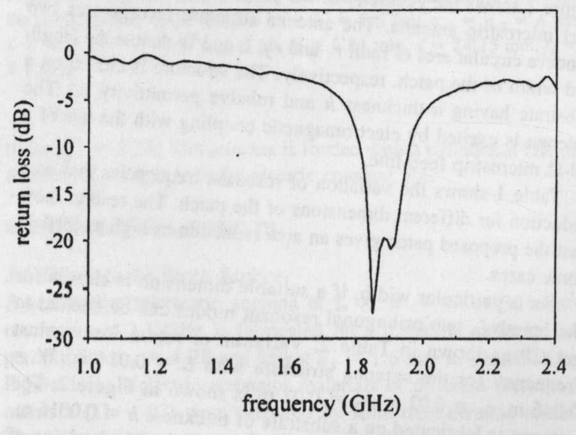


Figure 2 Measured return loss against frequency

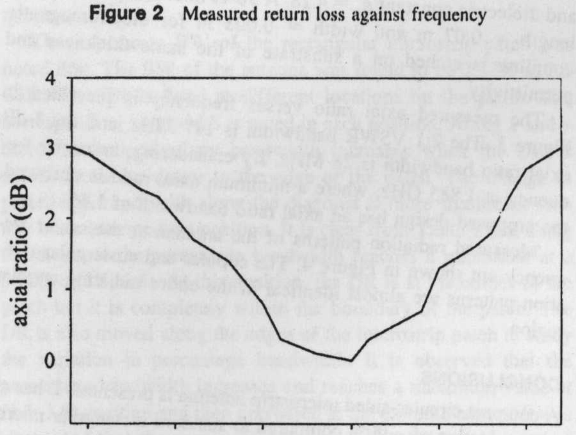
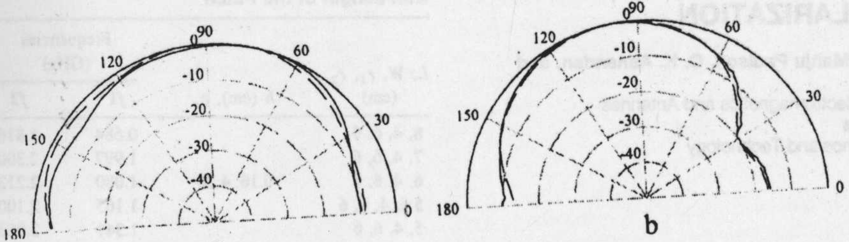


Figure 3 Measured axial ratio against frequency



a b

Figure 4 Radiation patterns for 1.885 GHz. (a) *E* plane, (b) *H* plane. Solid lines, copolar; dashed lines, cross polar sided microstrip antenna is presented here. A typical design to achieve circular polarization (CP) in this compact antenna is also given. This design is simpler and has more area reduction and larger axial ratio bandwidth compared to other similar designs. This antenna has a 3-dB axial ratio bandwidth of 1.5%.

ANTENNA DESIGN AND EXPERIMENTAL RESULTS

Figure 1 shows the geometry of the proposed circular-sided compact microstrip antenna. The antenna structure incorporates two concave circular arcs of radii r_1 and r_2. L and W denote the length and width of the patch, respectively. The structure is etched on a substrate having a thickness h and relative permittivity ε_r. The antenna is excited by electromagnetic coupling with the use of a 50-Ω microstrip feed line.

Table 1 shows the variation of resonant frequencies and area reduction for different dimensions of the patch. The results show that the proposed patch gives an area reduction as high as 90% in some cases.

For a particular width, if a suitable dimension is chosen for the length L, two orthogonal resonant modes can be excited to get CP as shown in Table 2. Variation of return loss against frequency for the antenna structure with L = 0.034 m, W = 0.046 m, r_1 = 0.02 m, r_2 = 0.02 m is shown in Figure 2. The antenna is fabricated on a substrate of thickness h = 0.0016 m, and dielectric constant ε_r = 4.28. A 50-Ω microstrip feed line of length = 0.07 m and width = 0.003 m for electromagnetic coupling is etched on a substrate of the same thickness and permittivity.

The measured axial ratio versus frequency is presented in Figure 3. The 2:1 VSWR bandwidth is 147 MHz, and the 3-dB axial ratio bandwidth is 28 MHz. By considering the center frequency at 1.885 GHz, where a minimum axial ratio is observed, the proposed design has an axial ratio bandwidth of 1.5%.

Measured radiation patterns of the antenna at the center frequency are shown in Figure 4. The copolar and cross-polar radiation patterns are almost identical in the entire radiating angular region.

CONCLUSIONS

A compact circular-sided microstrip antenna is presented. It has an area reduction of ~90% compared to standard rectangular microstrip antenna designed for the same frequency with a reduction in gain of 1.5 dB. A typical design of the antenna for CP is also demonstrated. It has a 3-dB axial ratio bandwidth of 1.5%.

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