COMPACT MICROSTRIP SLOT ANTENNA FOR BROADBAND OPERATION

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ABSTRACT: *An arrow-shaped microstrip antenna with a pair of narrow slots embedded near the non-radiating edges gives wide impedance bandwidth. The experimental and simulated (IE3D) results show that antenna bandwidth is ~3.5 times that of a conventional patch with the added advantage of reduced antenna size. The radiation characteristics are found to* *be uniform throughout the operating band.* Microwave Opt Technol Lett 37: 248–250, 2003; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.10884

Key words: *broadband; compact; microstrip antenna; bandwidth enhancement*

1. INTRODUCTION

The major drawback of a microstrip antenna in its basic form is its narrow impedance bandwidth. Several techniques have been proposed in the literature for widening bandwidth, including stacking of patches [1] and the use of a thick substrate [2]. However, these techniques increase the antenna volume substantially or produce poor radiation characteristics. Embedding different types of slots on patch antennas is another method for achieving bandwidth enhancement.

An arrow-shaped microstrip antenna, which provides greater area reduction and has similar radiation characteristics as a conventional rectangular patch antenna, has been reported in [3]. The patches show improved gain performance and are more compact than a drum-shaped antenna [4]. In this paper, a broadband design of this antenna with slots embedded close to the non-radiating edges of an arrow shaped patch antenna is proposed. The broadband operation is achieved by the co-existence of two adjacent resonant frequencies of the TM_{10} and $TM_{\delta 0}$ modes ($1 < \delta < 2$) [5]. The proposed antenna merits attention due to its greater size reduction, as compared to other wideband slot-loaded patches [6, 7]. Experimental and simulated (IE3D) results of this broadband antenna are presented.

2. ANTENNA DESIGN

The configuration of a dual-frequency arrow-shaped patch antenna is shown in Figure 1. L denotes its length, W the width, W_{cd} the height of the intruding triangle, and W_{cp} the height of the protruding triangle. The structure is etched on a substrate with thickness h and relative permittivity ε_r. A pair of narrow slots of width w_s are embedded in the patch parallel to the nonradiating edges at a distance s from the edges. By choosing suitable values for W_{cd} and W_{cp} two frequencies of the same polarization but different frequency ratio can be obtained. For our particular design, these two operating frequencies merge, which significantly enhances its bandwidth. The antenna is excited by electromagnetic coupling using a 50-Ω microstrip feedline of length Lp.

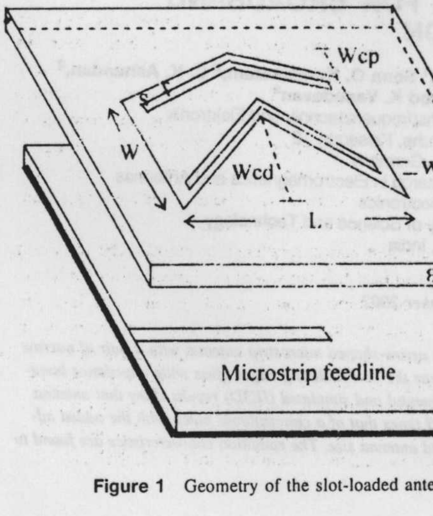

Figure 1 Geometry of the slot-loaded antenna

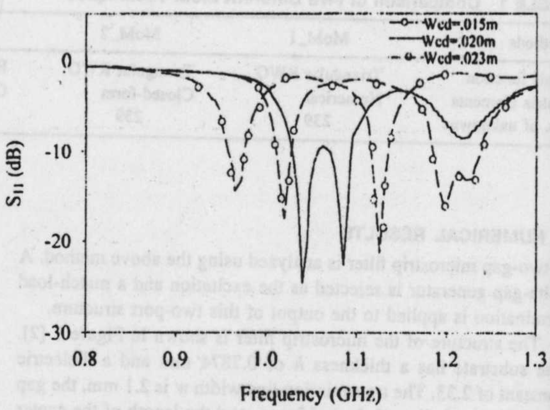

Figure 2 Variation of return loss with frequency for different W_{cd}: L = 0.06 m; W = 0.03 m; W_{cp} = 0.01 m

The proposed antenna configuration is simulated using IE3D software and experimentally investigated. A typical design has dimensions $L = 0.06$ m, $W = 0.03$ m, $W_{cp} = 0.01$ m, and $W_{cd} = 0.02$ m fabricated on a substrate of thickness $h = 0.0016$ m and dielectric constant $\varepsilon_r = 4.28$. Slots of width $w_s = 0.002$ m are placed at a distance $s = 0.003$ m from the non-radiating edges. A good impedance matching of the two operating frequencies can be obtained by using a 50-Ω microstrip feedline etched on the substrate of same thickness and permittivity and kept below the antenna to provide electromagnetic coupling.

3. RESULTS

By varying the height Wcd of the intruding triangle of the arrow-shaped antenna, the frequency ratio between the two resonant frequencies can be varied. The simulated frequency response of the arrow-shaped patches with different W_{cd} is shown in Figure 2. For an optimum value of W_{cd}, these two frequencies merge to produce large bandwidth. Results show that for $W_{cd} = 0.02$ m, the antenna offers a 2:1 VSWR bandwidth of 62 MHz (~6%).

The optimum antenna is fabricated and the radiation characteristics are studied. Figure 3 shows radiation patterns at start, stop, and centre frequencies of the operating band. It is found that the antenna offers similar radiation patterns and identical polarisation in the entire band. Also, a good cross-polar discrimination of better than 20 dB is obtained. For comparison, a rectangular patch antenna operating at the same frequency is constructed [8] and investigated. From our observations it is inferred that the arrow-shaped slot antenna obtains a bandwidth of 3.5 times that of the rectangular patch with an area reduction of ~75%. The above performance is obtained with a reduction in gain of ~2 dB.

4. CONCLUSION

The experimental and simulated (IE3D) results of a slot-loaded arrow-shaped microstrip patch antenna with broadband operation are presented. The proposed design has the same polarization plane and similar radiation characteristics throughout the operating band. The impedance bandwidth is enhanced to ~3.5 times that of a conventional rectangular microstrip antenna with a large reduction in patch area.

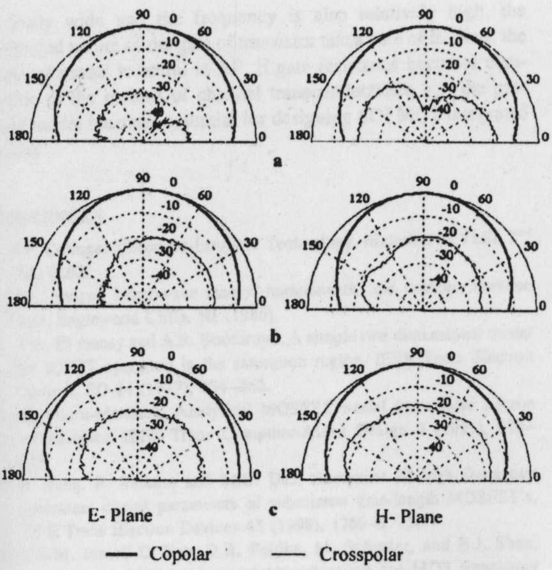

Figure 3 Radiation patterns for start, centre, and stop frequencies in the operating band: (a) 1 GHz; (b) 1.06 GHz; (c) 1.1 GHz

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