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EXPERIMENTAL STUDY ON APERTURE COUPLED TRIANGULAR MICROSTRIP ANTENNA

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ABSTRACT

Triangular microstrip patch antenna which is fed by a slot coupling have been investigated experimentally. The proposed antenna exhibits a 2:1 VSWR bandwidth of 24% at the center frequency of 6.5 GHz. The cross polar level is better than 22 dB in E-plane and 18 dB in H-plane. The average gain in the bandwidth is about 4.8 dB.

Introduction

Aperture coupled microstrip antennas has been the subject of current studies[1,2]. Some experimental results on triangular microstrip antennas has been reported by authors[3].

This paper deals with aperture coupled triangular microstrip antenna (ACTMA) (Fig. 1). The feed consists of an open ended microstrip line that is located on dielectric substrate below the ground plane. An equilateral triangular microstrip patch of length L_1 = 19.5 mm is formed on the separate dielectric substrate above the ground plane and the two structures are electromagnetically coupled through an electrical small aperture (13.5 x 0.8 mm). An open circuited length (L_f) of the microstrip line extending beyond the aperture provides an additional use for impedance matching and bandwidth enhancement. Furthermore the spacing of the patch to the ground plane t_{o1} provides an additional degree of freedom to be used for bandwidth enhancement. The effect of various design parameters such as stub length (l_f) slot length (L_s), patch length (L_1) and spacer height (t_{o1}) studied in detail to obtain the optimum bandwidth. The experimental optimized parameters of the proposed ACTMA are shown in Fig. 1.

Experimental Results

The bandwidth of the ACTMA is optimized by bringing the optimum size loop of the impedance locus inside the VSWR = 2 circle using various combinations of design parameters. The stub together with the patch length can be used to control the input impedance over a wide range of values. As shown in Fig. 2, by increasing the stub length, the input impedance at a fixed frequency follows roughly a constant resistance circle, with the reactance increasing according to the reactance of the open circuited stub. Keeping the aperture size fixed, a wide range of resistance and reactance values may be achieved by adjusting the patch size and stub length, as shown in Fig. 3. Further experiments were carried out with the structure for increasing the bandwidth by changing the spacer height t_{o1} (Fig. 4). A bandwidth of about 1550 MHz is obtained with experimentally optimized dimensions L_1 = 19.5 mm, t_{o1} = 4 mm, L_s = 13.5 mm, W_s = 8 mm, W_f = 2.32 mm, L_f = 3 mm and l_f = 60 mm. This is about 24% bandwidth at the center frequency of 6.5 GHz. The experimental VSWR variation with frequency is shown in Fig. 5. The radiation patterns ACTMA is measured in both the E and H-plane at various frequencies within the impedance bandwidth of 24%, as shown in Fig. 6 and 7. The 3 dB beam width varies from 75° to 85° in E-plane and 60° to 80° in H-plane. The fluctuations observed in H-plane patterns with frequency, may be because of the interference between the slot and patch radiations. The cross polar level is better than 22 dB in the E-plane and 18 dB in H-plane in the frequency range 5.92 GHz to 7.52 GHz. The measured gain of the proposed ACTMA is between 4.5 dB to 5 dB within the impedance bandwidth of 1550 MHz. All experimental results obtained for this aperture coupled triangular microstrip antenna are in good agreement with those recently reported[4] for aperture coupled rectangular microstrip antenna.

References

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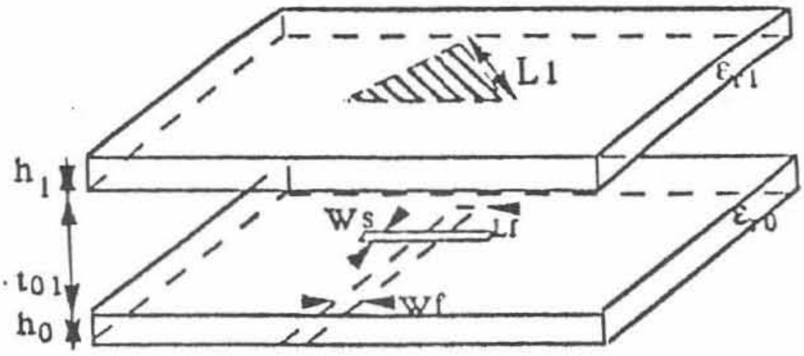
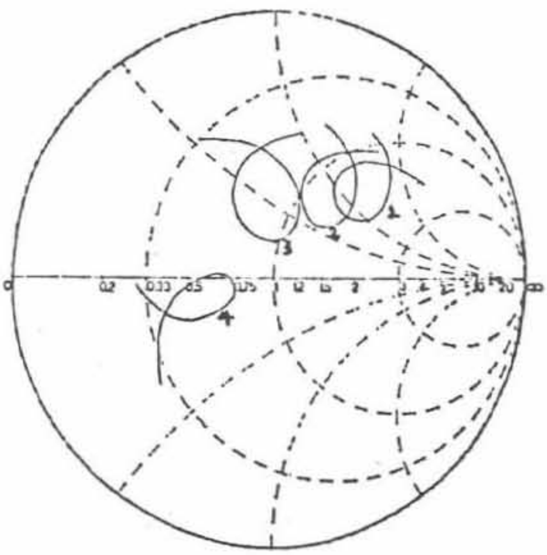


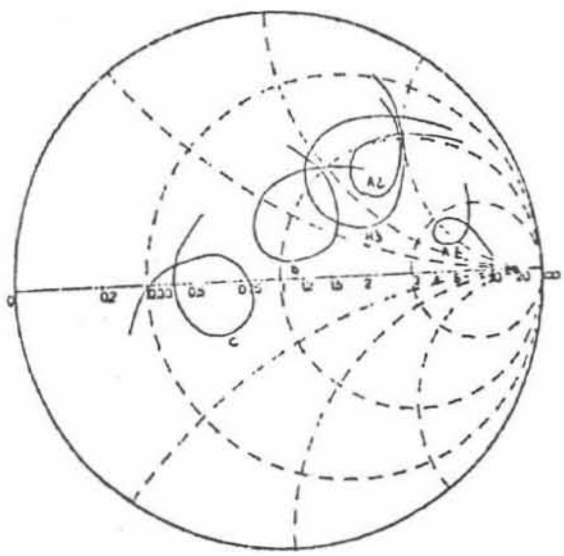
(W_f=2.32 mm, W_s=0.8 mm, L_f=3 mm, L_s=13.5 mm, Er_0=Er_1=2.2)
h_0 = h_1 = 0.8 mm, L_1 = 19.5 mm, to_1 = 5 mm

Fig. 1 Aperture Coupled Triangular Microstrip Antenna



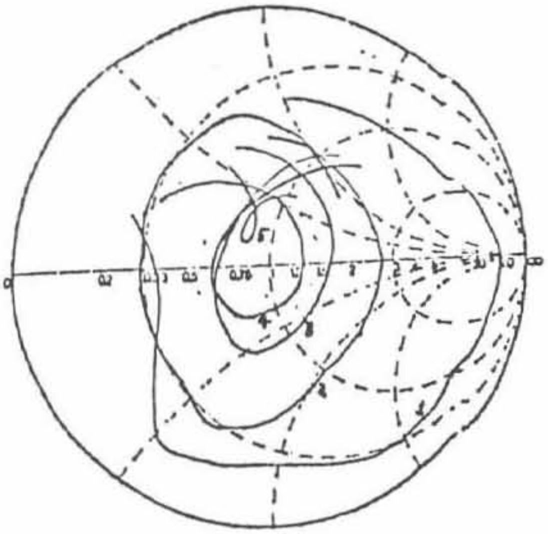
(L_1=20 mm, L_s=13.5, to_1=4mm)
L_f=9 mm(1), 7 mm(2), 5 mm(3), 3 mm(4)

Fig. 2 Variation of Stub Length Lf



(A) to_1=4 mm, L_f=10 mm, L_s=13.5 mm
L_1=21 mm(1), 25 mm(2), 30 mm(3)
(B) to_1=4 mm, L_s=13.5 mm, L_1=21 mm, L_f=5 mm
(C) to_1=4 mm, L_s=13.5 mm, L_1=21 mm, L_f=3 mm

Fig. 3 Variation of Patch Length and Stub Length



L_f=3 mm, L_s=13.5 mm, L_1=19.5 mm
t_1=0.8mm(1), 2.8mm(2), 3.8mm(3), 4.0mm(4), 5.8 mm(5)

Fig. 4 Variation of Spacer Height

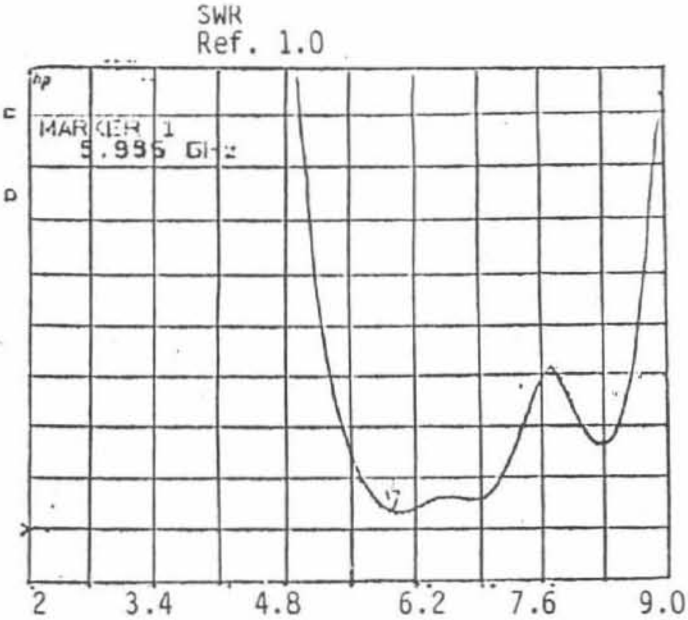


Fig. 5 VSWR Variation with Frequency

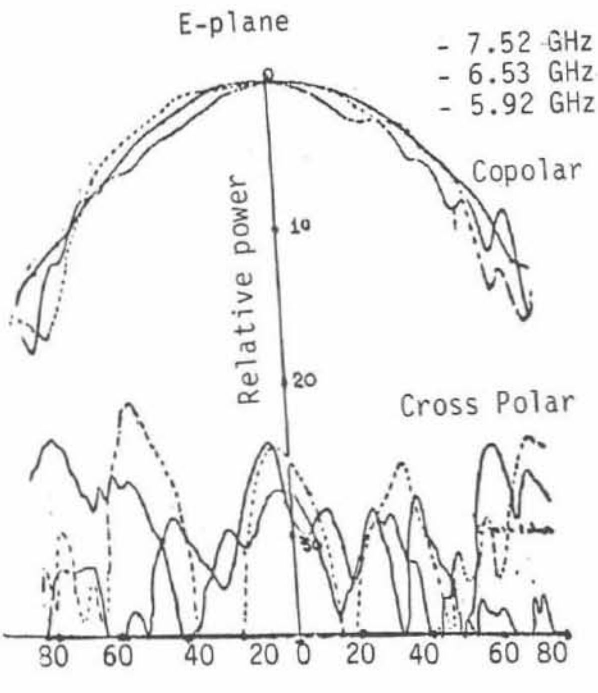


Fig. 6 E-plane Radiation Pattern

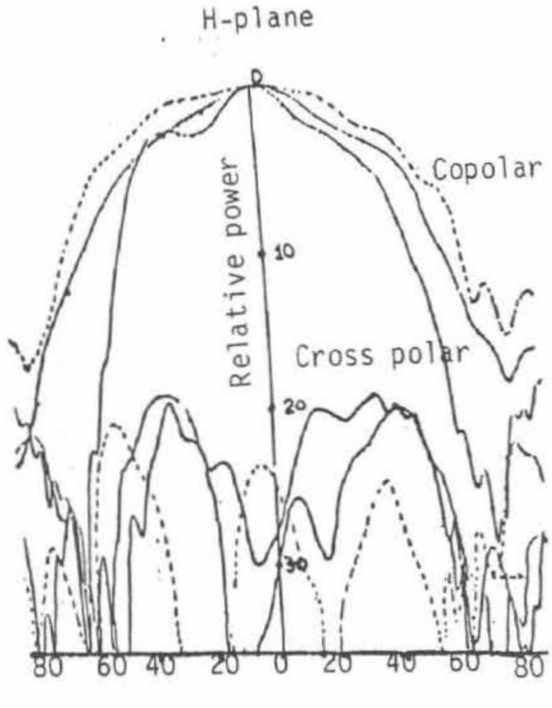


Fig. 7 H-plane Radiation Pattern