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· Letter ·

Dual -Polarized Slot -Coupled Microstrip Antenna with Very High Isolation

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Abstract A wideband dual-polarized slot-coupled stacked microstrip antenna with very high isolation and low cross-polarization is presented. To improve isolation between two polarization ports, the stacked patches are excited by an open-ended and a T-shaped microstrip lines both *via* two H-shaped slots placed in a "T" configuration. The measured isolation is better than 40.5 dB over the bandwidth from 8.8 to 9.8 GHz with cross-polarization level less than - 28.5 dB. The measured *VSWR* ≤ 2 bandwidths reach 20.7% and 19.1% at the vertical and horizontal polarization ports, respectively. This antenna is suitable to be used as array elements in spaceborne synthetic aperture radars (SAR) and active phased array radars.

Key words microstrip antenna, dual-polarization, isolation, cross-polarization.

1 Introduction

Dual linearly polarized antennas are increasingly required in communications and radar systems whose essential demands are high isolation and low cross-polarization[1-3]. A classical approach to enhance polarization purity is reported in Ref.[4], where a dual-polarized slot-coupled stacked patch antenna with two offset orthogonal slots is described. Two open-ended microstrip lines are placed on the same layer, resulting in isolation of about 18dB. Another dual-polarized stacked patch antenna with cross-slot, achieving isolation better than 20 dB, is reported in Ref.[5], but it requires a complex multilayer structure. A dual-polarized microstrip ring antenna with three coupling slots is introduced in Ref.[6], resulting in isolation of 30 dB with cross-polarization level of - 25 dB. In Refs. [7] and [8], two H-shaped slots and two L-shaped microstrip lines are used to realize dual-polarized operation of a stacked patch antenna, whose isolation is increased to 36 dB with - 22 dB cross-polarization. In this letter, by using both an open-ended and a T-shaped microstrip lines to excite stacked patches through double H-shaped slots, very high isolation is achieved. This is confirmed in the experiments. The design procedure and experimental results are presented.

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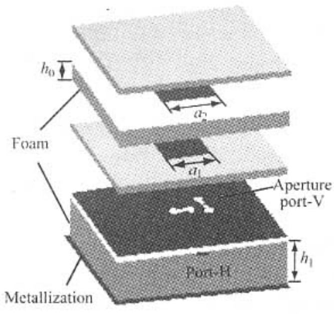
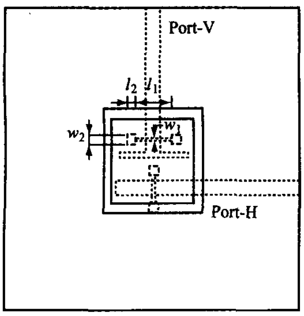
2 Antenna Design

Fig.1(a) is a decomposed view of a dual-polarized slot-coupled microstrip patch antenna. The proposed antenna consists of three dielectric substrates and two foam layers. The upper square patch of side length a_2 is printed on the back of the first substrate, and the lower square patch of side length a_1 is on the second substrate, separated from the upper one by a foam layer of thickness h_0. The microstrip feed lines are printed on the back of the third substrate while a ground plane is on its front with two H-shaped slots placed in a "T" configuration. One slot is fed from an open-ended microstrip line and the other from a T-shaped microstrip line so as to enhance isolation between two input ports and suppress cross-polarization. Besides, in order to improve the front-to-back ratio, another ground plane is placed below the feed circuit and a second foam layer of thickness h_1 inserted to separate them. All substrates have permittivity ε_r = 2.94 and a thickness $h = 1.524$ mm. The H-shaped slot is defined by parameters l_1, w_1, l_2, and w_2 as shown in Fig. 1(b).

Computer simulation is carried out using Ansoft HFSS, a commercial 3-D electromagnetic simulator based on the finite element method. The design parameters are optimized to improve the slot coupling and return loss. A test antenna is then designed and fabricated. The patch parameters are $a_1 = 7.7$ mm, $a_2 = 9.5$ mm, and $h_0 = 2.8$ mm; the slot parameters for port-V are $l_1 = 2.5$ mm, $l_2 = 0.75$ mm, $w_1 = 0.3$ mm, $w_2 = 1$ mm; the slot parameters for port-H are $l_1 = 3.5$ mm, $l_2 = 0.75$ mm, $w_1 = 0.3$ mm, $w_2 = 1$ mm.



(a) 3-D view



(b) Top view

Fig.1 Configuration of the dual-polarized slot coupled antenna

3 Experimental Results

The test antenna's return loss and isolation measured by 8720ES network analyzer are plotted in Fig 2. The measured frequency bandwidths defined by *VSWR* ≤2 are 20.7% covering 8.2 to 10.1 GHz at port-V, and 19.1% covering 8.5 to 10.3 GHz at port-H, respectively. Through out the frequency region from 8.2 to 10.3 GHz, the measured isolation is higher than 38.5 dB; and in the operating bandwidth 8.8 - 9.8 GHz, the measured isolation is better than 40.5 dB.

Fig.3 shows the measured and simulated E-plane and H-plane radiation patterns for port-V excitation only. Cross-polarization levels in both E-plane and H-plane are about - 30 dB in the main beam region at 9.3 GHz. For all patterns observed (including the patterns for port-H), the measured patterns are stable in the operating frequency band and the cross-polarization levels are less than - 28.5 dB.

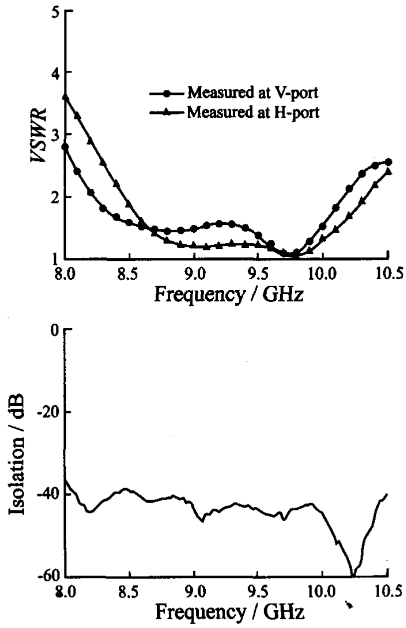
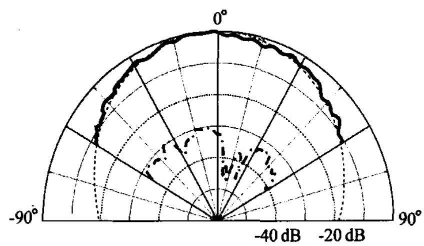
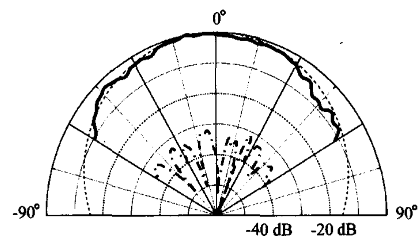


Fig.2 Measured *VSWR* and isolation



(a) E-plane



(b) H-plane

······ Simulated co-pol;
——Measured co-pol;
—·—Measured cross-pol

Fig.3 Radiation patterns at 9.3 GHz for port-V

4 Conclusions

A stacked dual-polarized microstrip patch antenna excited by both an open-ended and a T-shaped microstrip lines through two H-shaped slots has been studied, which achieves wide bandwidths (20.7% at port-

V and 19.1% at port-H), very high isolation (better than 40.5 dB), lower level of cross-polarization (less than −28.5 dB), and stable radiation patterns. This antenna is suitable to be used as array elements in spaceborne synthetic aperture radar (SAR) and active phased array radar applications.

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