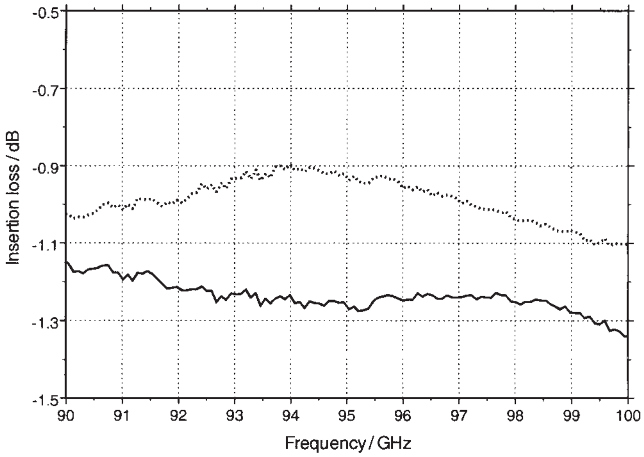

Figure 4 Insertion loss of different microstrip-line lengths ($l_1 = 4$ mm, $l_2 = 6$ mm): ●●● $l_1 = 4$ mm; __ $l_2 = 6$ mm

simulations. Therefore, microstrip lines similar to the one used in the transition, of different lengths, have been measured on-wafer in order to estimate the global losses. Figure 4 shows the results for 4- and 6-mm lines. As expected, the losses increase with the line length and the frequency. By taking a mean value of 0.2 dB/mm over the bandwidth, we estimate the global losses of the microstrip line to be about 4.2 dB. It means that the transition itself has about 1.2-dB losses that almost corresponds to simulated insertion losses. Furthermore, we have measured and simulated a back-to-back transition, so a single transition has about 0.6-dB losses. Moreover, the measured reflection coefficient shown in Figure 3 remains less than −10 dB between 90 and 100 GHz, exhibiting a good matching over 12% bandwidth.

CONCLUSION

We have made a millimeter-wave transition based on E-mode coupling between a standard waveguide and a microstrip patch antenna placed in it. The transition itself shows a 0.6-dB insertion loss although the relatively long microstrip line used for measuring the back-to-back transition has about 4-dB losses. Further efforts have to be conducted in order to find an appropriate substrate for enlarging the length of the microstrip line without a significant increase of dielectric losses. Nevertheless, this transition presents a simple modification of the waveguide, the substrate is held and kept on a metal block; it exhibits a solidity of transition. Due to these properties, it has demonstrated intrinsically good insertion losses that make it ideally suitable for mm-wave system applications.

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DUAL-POLARIZED CORNER-FED PATCH ANTENNA ARRAY WITH HIGH ISOLATION

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ABSTRACT: *A 16 × 1-element microstrip antenna array with dual-polarized stacked corner-fed square patches as its elements is presented. This linear array fed by the coplanar feed and the slot-coupled feed for dual polarization, respectively, together with the pair-wise anti-phase feeding technique, achieves measured port isolation better than 33 dB with the maximum reaching 43 dB in the bandwidth of 9.375–9.825 GHz. The measured bandwidths of VSWR ≤ 1.5 reach 15% and 13.5% for the two ports, respectively, and the measured gain is better than 16.7 dB in the operating bandwidth, which are suitable for synthetic aperture radar (SAR) application.* © 2005 Wiley Periodicals, Inc. Microwave Opt Technol Lett 47: 520–522, 2005; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.21217

Key words: *microstrip antenna array; dual-polarization; corner-fed; isolation*

1. INTRODUCTION

The space-borne synthetic aperture radar (SAR) systems require dual-polarized array antennas with high port-isolation, good radiation characteristics, and wide bandwidth. Microstrip antennas are the predominant candidates in this application because of their numerous advantages such as thin profile, light weight, and easy integration with the IMCC. In order to enhance the port isolation between the two polarizations, many studies on the dual-polarized microstrip antenna element and array have been reported. A dual-polarized corner-fed square microstrip element was introduced in [1, 2]. This element port isolation is nearly 10-dB higher than that of an edge-fed one and its 2 × 2-element array achieves about 36–38 dB. But for a linear microstrip array, it is difficult to obtain a high port isolation. A 6 × 1-element dual-polarized microstrip antenna array with port isolation of about 20 dB was presented in [3]. In the literature [4–7], several dual-polarized slot-coupled microstrip antenna arrays with different aperture or feed-line configurations have been reported. In [4], a dual-polarized 8 × 1-element array with the radiating element fed by two L-shaped microstrip lines via two offset rectangular slots was presented. This linear antenna array achieves an 18-dB port-isolation in the bandwidth of 5.225–5.375 GHz. In [5], another dual-polarized 4 × 1-element array with the two slots placed in a “T” configuration was reported for the IMT-2000 service base station, whose port isolation is better than 25 dB over the bandwidth of 1.82–2.22 GHz.

In this paper, a 16 × 1-element dual-polarized corner-fed microstrip antenna array is presented, whose measured port isolation is better than 33 dB in the operating bandwidth. Its vertical-polarization radiation is excited by the coplanar microstrip line feed and the horizontal-polarization radiation is excited by the slot-coupled feed so as to enhance the isolation between two polarizations. In addition, the pair-wise anti-phase feeding technique is used in both feed networks for better isolation. Details of the antenna design and experimental results are presented and discussed.

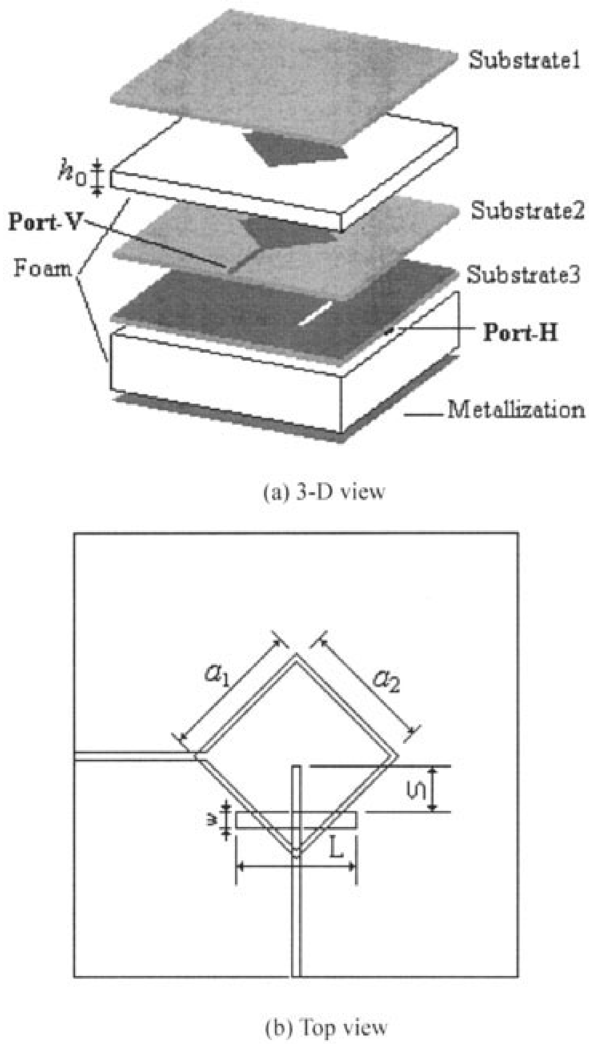

Figure 1 Configuration of the proposed single element

2. ANTENNA DESIGN

Figure 1 shows the explode view of a single dual-polarization corner-fed microstrip patch element. The proposed element adopts stacked patches where the upper square patch of side length a_1 is printed on the back of substrate 1 and the lower square patch of side length a_2 is on the front of substrate 2. A foam layer of thickness h_0 is used to separate both patches. One coplanar microstrip feed line on substrate 2 is used to excite the lower patch for vertical polarization and another microstrip feed line printed on the back of substrate 3 is used to excite that for the horizontal polarization via a rectangular slot cut in the ground plane on the front of substrate 3. The slot with length L and width w is placed at a distance s away from the center of the patch. In order to reduce the back radiation, a shielding metallization ground is placed a quarter-wavelength from the ground plane and supported by a form layer.

Figure 2 shows the top view of the 16 × 1-element antenna

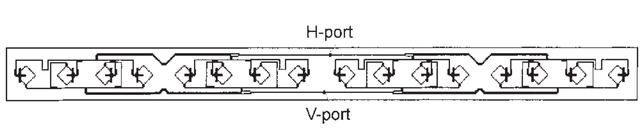

Figure 2 Top view of 16 × 1-element array

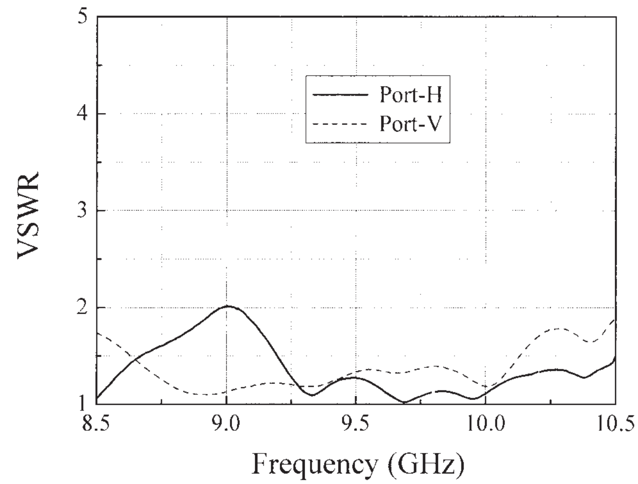

Figure 3 Measured VSWR for the proposed linear array

configuration. This linear array antenna consists of four identical 4 × 1-element subarrays, which can be considered as a base element. For the coplanar feed of a base element, each pair is fed 180° out of phase, and two pairs are mirrored with respect to the elevation plane. For that slot-coupled feed, one pair slots are far away from each other while the other pair is nearby, and both of them are mirrored in the elevation plane.

3. EXPERIMENTAL RESULTS

Based on the Ansoft Ensemble commercial simulation software, a dual-polarized corner-fed 16 × 1-element microstrip array is designed, fabricated, and measured. The element parameters are $a_1 = 9.7$ mm, $a_2 = 9$ mm, $h_0 = 2.3$ mm, $L = 8$ mm, $w = 1$ mm, and $s = 3.35$ mm. All the substrates are Rogers RT6002 with a relative permittivity of $\varepsilon_r = 2.94$ and a thickness of $h = 0.508$ mm.

Figure 3 plots the measured VSWR for the test microstrip linear array. The measured bandwidths defined by VSWR ≤ 1.5 are 13.5% (the center frequency is 9.6 GHz), covering frequencies from 9.2 to 10.5 GHz at port-H and 15.6% covering 8.6 to 10.1 GHz at port-V, respectively. In the operating bandwidth 9.375–9.825 GHz, the measured isolation between two ports is higher

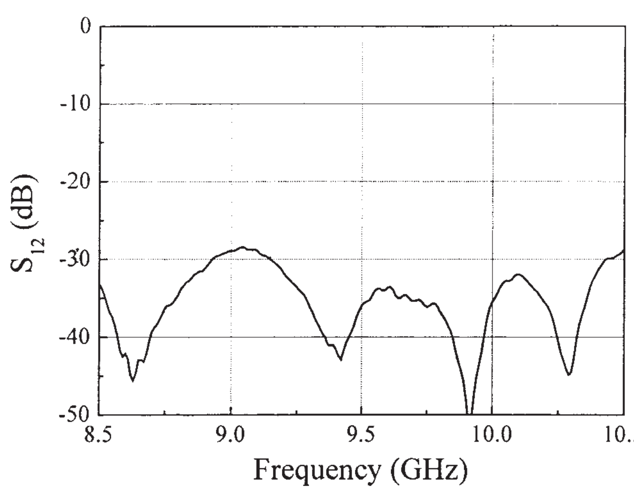

Figure 4 Measured isolation for the proposed linear array

than 33 dB with the maximum reaching 43 dB, as shown in Figure 4.

Figure 5 shows the measured radiation patterns for the proposed microstrip linear array at 9.6 GHz. During the measurement of port-V pattern, port-H is terminated at 50Ω and vice versa. The measured level of sidelobe is −12.6 dB for vertical polarization and −11.5 dB for horizontal polarization. The cross-polarization is lower than −20 dB in the mainlobe for both polarizations. Besides, it is also found that the main beam peak is slightly shifting from the direction of 0°, which is because the antenna position is not aligned exactly to be horizontal or vertical during the measurement.

The antenna gain is also measured compared with the standard gain horn. Figure 6 plots the measured gain from 9 to 10 GHz. In the entire operating bandwidth, the gain exhibits about 16.7∼17.3 dB for both polarizations.

4. CONCLUSION

A dual-polarized 16 × 1-element microstrip antenna array has been designed, fabricated and measured. The proposed antenna uses a corner-fed method together with the coplanar microstrip line feed and the slot-coupled feed both so as to enhance the port isolation. The measured isolation between two ports is better than 33 dB across the entire operating bandwidth and the maximum reaches 43 dB. The measured bandwidth of VSWR < 1.5 is better than 13.5% for both polarization ports and the gain is higher than 16.7 dB in the entire operating bandwidth. This linear array can be used as a subarray of SAR system by connecting it with the active transmitter/receiver (T/R) component.

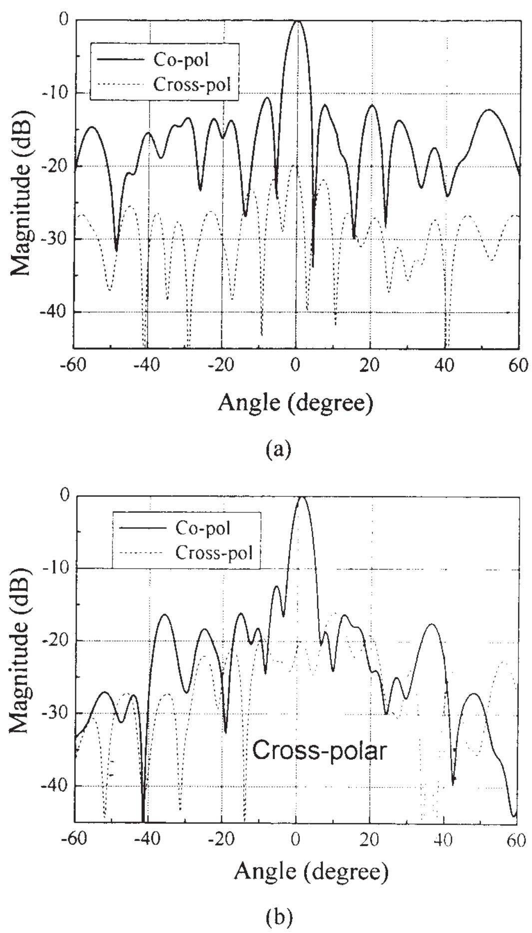

Figure 5 Measured radiation patterns at 9.6 GHz (a) Horizontal polarization (b) vertical polarization

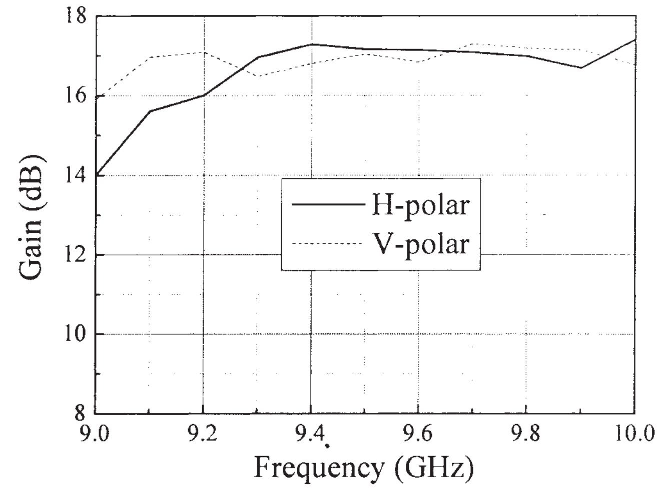

Figure 6 Measured gain for the proposed linear array

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