Low-Cost Design of Stacked Microstrip Array Antenna for DBS Application

Young-Bae Jung* and Seong-Ook Park

School of Engineering,

Information and Communications University, P.O.Box 77, Yusong, Taejon. 305-600 Korea

Tel : +82-42-866-6132, Fax : +82-42-866-6227 , E-mail : faith98@icu.ac.kr,

Abstract: This paper presents the circularly polarized stacked slot array antenna by using low cost foam-substrate. The feed line is embedded in the middle of triplate to prevent the unwanted and spurious radiation. The proposed stacked slot array antenna has a modified slot with supplementary section to improve the axial ratio and impedance bandwidth performances. The experimental and theoretical results of 8x8 array antenna are performed to receive DBS (Direct Broadcast from Satellite) signal.

Introduction

Many researches had studied a stacked broadband microstrip antenna with retaining high gain, low-cost, and small size for DBS application [1], [2]. The proposed antenna configurations are shown in Fig.1 and 2. As seen in the Fig. 2, a truncated square patch fed by a microstrip line was used as an original patch to obtain a circular polarization. The parasitic patch on the top of the original patch within corner-truncated slot is placed on the upper thin film layer, and it improves the axial-ratio performance. The height, separated by foam-substrate between driven and parasitic patch, can be changeable to optimum matching condition. The upper and the lower layer of proposed antenna are made of polyester based copper-clad laminate film. As a goal of the minimization of the VSWR as well as that of axial ratio, the single element of stacked antenna is simulated with optimal condition in the frequency range of 11.7~12.0GHz [3].

For the array design, the link-budget is calculated by the link condition of broadcasting satellites, Koreasat, Mukunghwa. Using the result of the calculation antenna budget, 8x8 array antenna are designed and fabricated to receive DBS-TV signal.

Simulation and Experimental Results

The simulation results of single element antenna are shown in Fig. 3. As seen in Fig 3 (a) and (b), the impedance bandwidth have 9.5% at -10dB. The 3dB axial-ratio bandwidth has 2.6% and 1.3% at the dual-resonance frequencies 11.45GHz and 12GHz, respectively. And 6dB axial-ratio bandwidth including two resonance frequencies has about 8.1% from 11.2GHz to 12.15GHz. In Fig. 3 (b), solid-line is the axial-ratio performance of general stripline fed slot antenna, and dot-line is that of the proposed element antenna. And the supplementary stub placed on the upper thin film is used for the role as impedance matching and covering stripline feed. The optimum dimension of that has 2.8*mm* × 2.3*mm*. The gain of proposed element antenna is 9.0dBi at 11.8GHz, which has suitable for array

0-7803-7070-8/01/$10.00 ©2001 IEEE

implementation.

Initial work on the array was directed toward the optimization of the basic radiating element of 2x2 sub-array with optimized parameters. In this design, 2×2 array is designed by using parallel feed-network, very simple design, and the feed-network is composed of power divider, so called T-junctions.

The 8x8 array antenna was built and tuned experimentally to receive DBS channel. The CAD design of the 8×8 array antenna, was fed by rectangular waveguide WR-75, is shown in Fig.4 (a). In Fig. 4. (b), the measured impedance bandwidths are about 11.16~12.3GHz ($|S_{11}|$<-10dB, 9.66%). As seen in Fig. 5 and 6, the axial-ratio bandwidth has 9.5% at the reference of 6dB which has the two resonance fequencies, 2.8% at 11.4GHz and 1.4% at 11.8GHz within 3dB. And, the measured maximum gain of the 8x8-array antenna has 25.3dBi at 11.8GHz including feed cable and connector loss and mismatch loss. Radiation patterns was measured at the frequency 11.7~12GHz. SLL has about -12dB~-14dB at the measured frequencies and this value is general performance in planar array. Radiation patterns at both 11.8 and 12GHz are shown in Fig. 7. As a result of receiving test for the fabricated 8×8 antenna with attaching the LNB, the C/N, valuation standard of quality-of-picture, is measured as about 12dB level.

Conclusions

Using the result of the calculation antenna budget, 8x8 array antenna for satellite-TV reception is designed and fabricated with low-cost foam-substrate and polyester based copper-clad laminate film. The proposed stacked slot array antenna has the parasitic patch with the corner truncated inverted slot to improve the axial-ratio bandwidth. The experimental and theoretical results of 8x8 array antenna are performed for the application of DBS.

From above mentioned antenna performances, it can be seen that the planar arrays can be replaced with the conventional parabola antennas, and the proposed array antenna can be useful for the application of broadband systems using circular polarization or dual-band communication systems.

References

[1] Ju-Sung Jun and Yun-Hun Lee, "A Study on the Fabrication for Microstrip Array Antenna for Koreasat Reception", *KEES*, Vol. 11, No. 4, pp. 544-552, Aug. 2000

[2] L. Bekraoui, "Low Cost Broadband Microstrip Antenna for Satellite-TV Reception", *Antennas and Propagation Society International Symposium*, 1999, AP-S Digest, Vol. 2, pp. 916-919 , 1999

[3] F. Croq, G. Kossiavas, and A. Papiernik, "Stacked resonators for bandwidth enhancement: a comparison of two feeding techniques", *Microwaves, Antennas and Propagation*, IEE Proceedings H , Vol. 140 Issue: 4, pp. 303-308, Aug. 1993

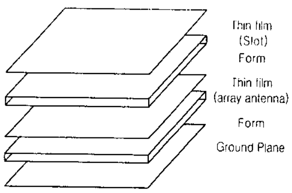


Fig. 1. Antenna structure

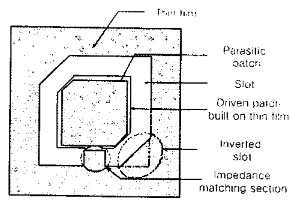
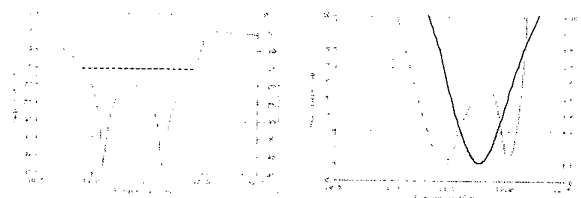


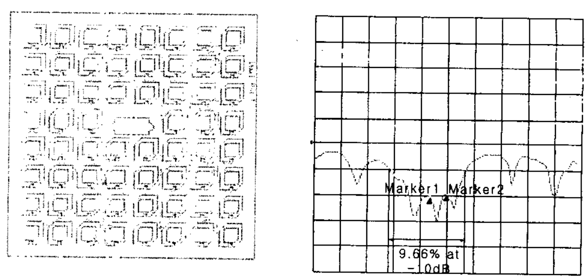
Fig. 2. Design of element antenna



(a) Return loss

(b) Axial-ratio

Fig. 3. Simulation result of element antenna



(a) CAD design of the 8?8 array

(b) Return loss

Fig. 4. Design of the 8?8 array

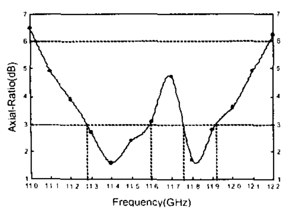


Fig. 5. Axial-ratio bandwidth of 8?8 array

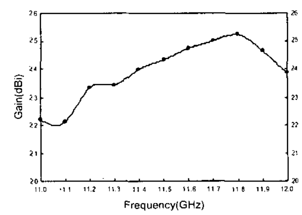


Fig. 6. Gain of 8?8 array

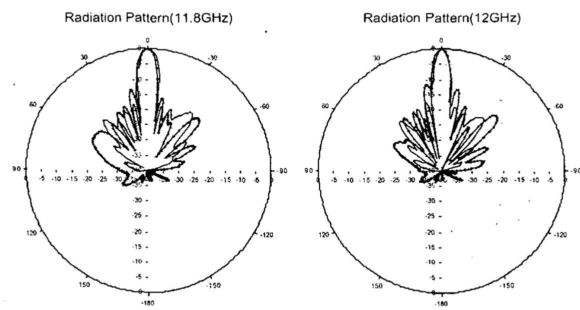


Fig. 7. Radiation patterns of 8?8 array