Broadband Microstrip Patch Antenna with Rhombic Slot

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Abstract

This paper presents the rhombic slot antenna that has a broadband characteristic 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 rhombic slot antenna has a rectangular patch with supplementary section to improve the impedance bandwidth performances. The experimental result of 2×1 array antenna is performed to validate the simulation. A bandwidth of 40% can be achieved. The electrical characteristics of the proposed antenna make it attractive for use in satellite communications.

1. Introduction

Recently, as the use of the satellite communication was increased, the antenna has demanded that it was light weight, broadband, and so on. Though this demand can be solved by using the microstrip patch antenna, the microstrip patch antenna has a narrow bandwidth inherently. This characteristic has limited to use a broadband antenna in spite of its advantages-thin profile, light weight, low cost, compact and conformable in structure, and easy to fabricate and to be integrated with solid-state devices [1]. To achieve the broadband bandwidth, the proposed antenna are using the proximity-coupled feeding structure, the rhombic slot that has the modified U-slot, and the foam substrate which results into low cost [2][3].

2. Antenna Configuration

The figure of the proposed antenna with rhombic slot is shown in Fig. 1. In Fig. 1. (a), the patch has length L = 12 mm, slot S_1 = 8.5 mm, S_2 = 3.8 mm, and S_3 = 1.5 mm, and the aperture size is W = 19 mm. In Fig. 1. (b), the substrate (foam) has relative permittivity ε_r = 1 and h_1 = 2 mm, and h_2 = 0.5 mm. Since a stripline feeding structure is approximately designed about 109Ω in order to use the array elements, the waveguide-to-stripline transition is used to impedance matching for the feeding structure.

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3. Simulation and Experiment Results

We designed this antenna using by commercial program based on the MoM method [4], and the fabricated antenna is measured with Agilent 8510C Network Analyzer and nearfield measurement system. The single element of proposed rhombic slot antenna was simulated with various parameters that consist of the width and length of slot, stub at each corner, offset of the feedline, the thickness of foam. By adjusting many parameters, it was optimized to achieve the maximum impedance bandwidth with 41.7 % at −10dB (9.1~13.9 GHz). The simulated S_{11} value of the single element is shown in Fig. 2.

Since this antenna was initially designed to use both X band and Ku band, the broadband matching of the input impedance was very difficult with stripline to cover these frequency bands. Thus, we built with the 2×1 array antenna by using the waveguide-to-stripline feeding structure which is well suited to the array feedline. The overall structure of 2×1 array antenna is shown in Fig. 3, stripline is fed by the rectangular waveguide WR-75. The simulated and measured results of the 2×1 array antenna are shown in Fig. 4, in term of S_{11}. In the simulation, The resonant frequency occurs at 11.55GHz and the impedance bandwidth has about 40.7% at −10dB(9.2~13.9 GHz). In the measurement, the resonant frequency occurs at 11.23GHz and the impedance bandwidth has about 41.7% at −10dB(8.89~13.57 GHz). The radiation patterns at both φ=0, 90 (in degrees) with 10.6 GHz are shown in Fig. 5.

4. Conclusion

The proposed rhombic slot antenna has a broadband characteristic that was verified with simulation and measurement. According to Fig. 4, this broadband antenna can be used for the satellite communication by obtaining the proper gain with increasing the array element. By adjusting parameters, the resonant frequency and the bandwidth can be controlled to the proper purpose for satellite communication. The proposed array antenna can be useful for the application of broadband satellite communication systems with the linear polarization.

References

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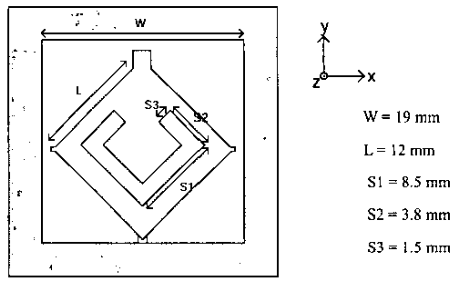
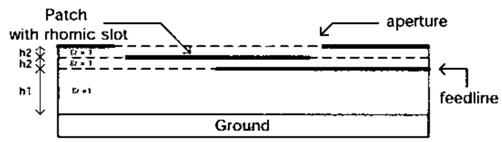
[4] Ensemble, Ansoft cop.



(a) Top view



(b) Side view

Figure 1. Antenna Structures

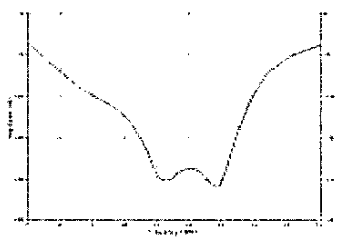


Figure 2. Return Loss of single element

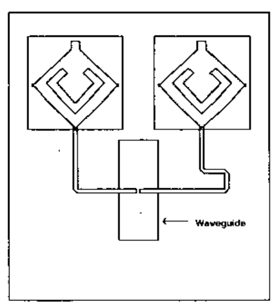
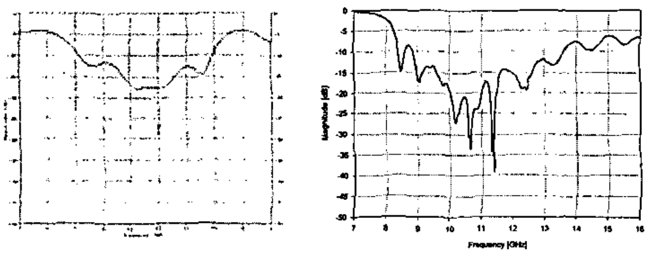
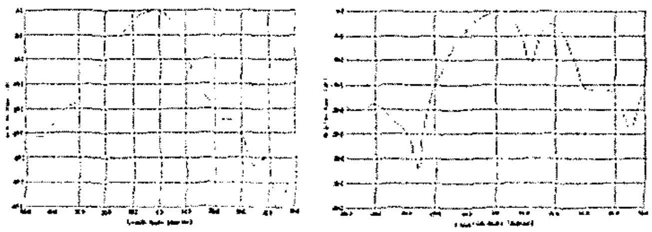


Figure 3. 2×1 array antenna structures



(a) Simulation (b) Measurement

Figure 4. Return Loss of 2 X 1 array antenna



(a) $\varphi = 0^{\circ}$ (x-z plane) (b) $\varphi = 90^{\circ}$ (y-z plane)

Figure 5. Measured radiation pattern at 12.06GHz