

Polarization Controllable Circular Slot Antenna

Shinya SASAKI Eisuke NISHIYAMA Masayoshi AIKAWA

Faculty of Science and Engineering, Saga University, 1, Honjo-machi, saga-shi 840-8502, Japan

E-mail: shinya@ceng.ec.saga-u.ac.jp

1 Introduction

In this paper, a novel polarization controllable circular slot antenna is proposed, and the realizability is theoretically proved by the use of simulation results [1][2]. The orthogonal transmission and reception function of conventional antennas is generally fixed, because there is no switching function in the antennas. If polarization switching or applied polarization angle control are possible, the design flexibility of the radio system will be much more expanded. In order to realize the orthogonal polarization controllable antenna, four switching diodes are mounted on a slot antenna. The characteristics of this functional antenna are discussed by using simulation results. The Ansoft HFSS is used to simulate the antenna. The realizability of the antenna is successfully verified.

2 Configuration of polarization controllable slot antenna

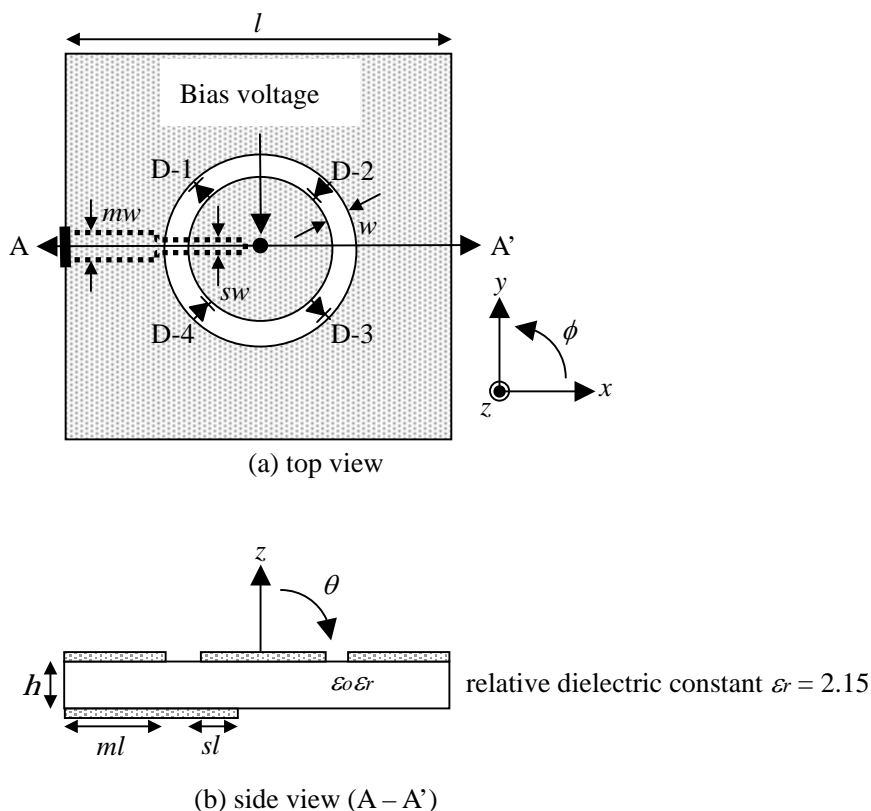


Fig. 1: Polarization controllable circular slot antenna

The structure of the proposed circular slot antenna, which is capable to control the orthogonal polarization, is shown in Figure 1. The antenna is a circular slot on a dielectric substrate (relative dielectric constant ϵ_r of 2.15, thickness h of 0.8mm), and four switching diodes are mounted on the slot. The length of side of the substrate is $l = 40\text{mm}$, and width of the circular slot is $w = 1.5\text{mm}$. The circular slot antenna is excited by a feeding microstrip line on the reverse side. The length of $\lambda/4$ transformer and the stub are $ml = 9\text{mm}$ and $sl = 6\text{mm}$, and the width of $\lambda/4$ transformer and the stub are $mw = 1\text{mm}$ and $sw = 0.3\text{mm}$, respectively. The resonant frequency of the antenna is 6.5GHz, where the slot length is one wave-length (λ_g) of 42mm.

3 Basic behavior of the antenna

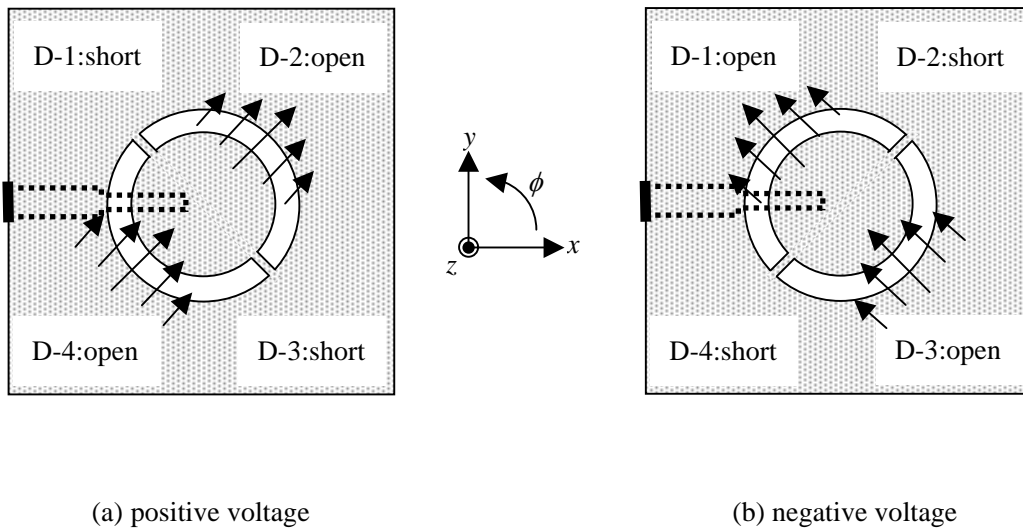


Fig. 2: Basic behavior of polarization controllable circular slot antenna

The basic behavior of the antenna is shown in Figure 2. When a positive voltage is applied to the center of the circular conductor, the diodes D-1 and D-3 are conductive, while the diodes D-2 and D-4 are open due to the opposite bias. In the state, the slot is excited as shown in Figure 2 (a), and the main polarization axis angle ϕ of the antenna is tilted to +45 deg.. When the polarity of the bias voltage applied to the diodes is reversed, the condition of the diodes is changed as shown in Figure 2 (b), and the main polarization axis is tilted to -45 deg..

4 Characteristics

In the simulations, the shorted diodes D-1 and D-3 can be approximately replaced with conductor lines.

Figure 3 shows the frequency characteristics of the return loss at the microstrip feeding point. The minimum value of -35dB is obtained at 6.8GHz and the relative bandwidth of less than -15dB is 10%. This bandwidth is almost equal to the conventional slot antenna.

Figure 4 is the frequency characteristics of the main polarization axis angle. The polarization tilt angle ϕ is almost +45 deg. in the frequency range of the return loss of less than -10dB. Also, by inverting the polarity of the bias voltage, this axis can be tilted to $\phi = -45$ deg.. Consequently, it is possible to control the orthogonal polarization by the applied bias polarity.

Figure 5 shows the radiation patterns of the proposed circular slot antenna. Excellent radiation patterns almost similar to that of a conventional slot antenna are obtained. Although the cross-polarization component is a little larger than that of the conventional antenna, it is less than -13dB in a bore sight direction.

5 Conclusion

In this paper, in order to realize an orthogonal polarization controllable antenna, the circular slot antenna on which four switching diodes are mounted is proposed. The functional performance of this antenna is simulated by the Ansoft HFSS.

The antenna can have the main polarization angle of $\phi = +45$ deg., when a pair of diodes is conductive with a positive voltage. When the polarity of the bias voltage is reversed, the condition of the diodes is reversed, and the main polarization axis can be controlled to the tilted angle ϕ of -45 deg.. Hence, the polarization controllable slot antenna has been successfully proved.

It is scheduled to carry out the experiment of this antenna soon.

Reference

- [1] E.Nishiyama, K.Takenaka and M.Aikawa, "Polarization Controlled Microstrip Antenna," *Electrons and Communications in Japan.*, Part 1, Vol. 86, No. 11, 2003
- [2] K.Kodama, E.Nishiyama and M.Aikawa, "Slot Array Antenna using Both-Sided MIC Technology," Proc. of 2004 *IEEE AP-S Int. Symp.*

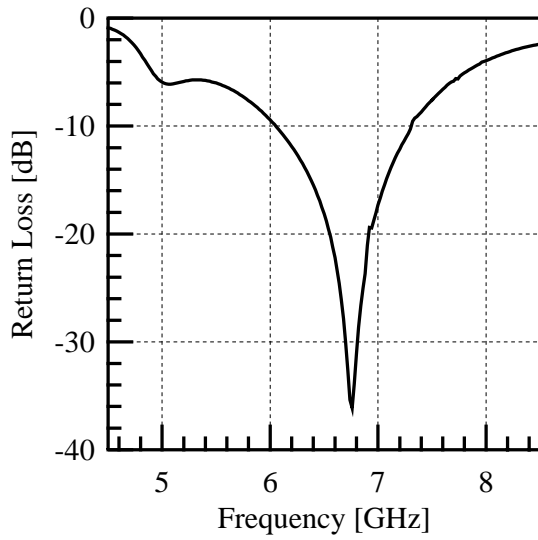


Fig. 3: Frequency characteristic of return loss

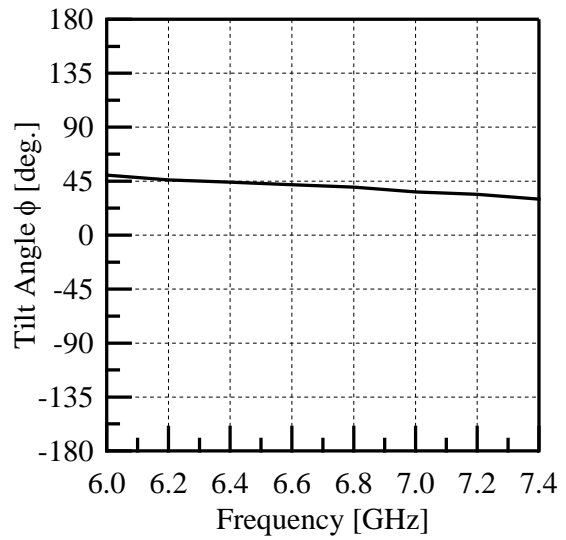
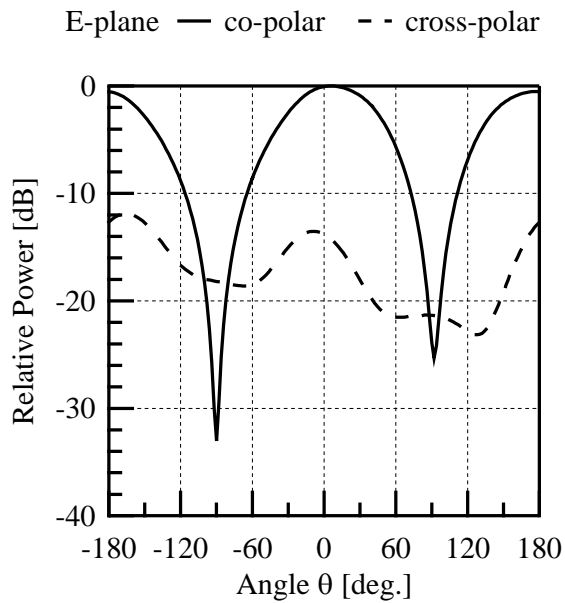
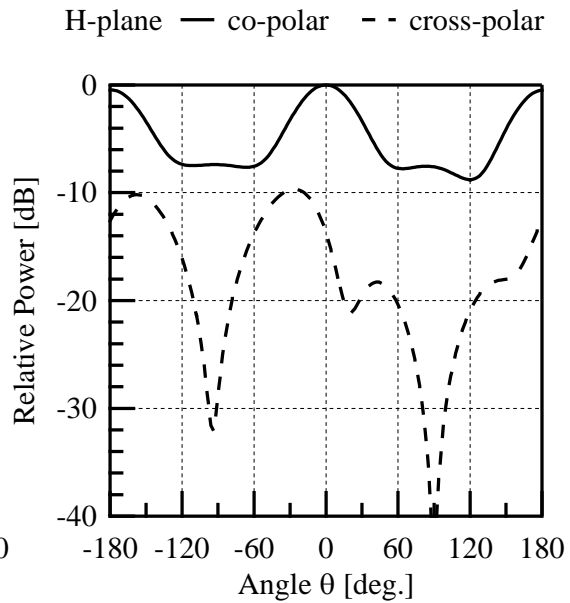


Fig. 4: Frequency characteristic of polarization tilt angle



(a) $\phi = +45\text{deg.}$



(b) $\phi = -45\text{deg.}$

Fig. 5: Radiation patterns (Frequency = 6.8GHz)