Wideband ± 45^0 Polarization Reconfigurable Aperture-Fed Patch Antenna

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***Abstract*—This paper introduces a wideband aperture-fed patch antenna with ± 45^0 reconfigurable polarizations. A new method is proposed to achieve the switchable ± 45^0 polarizations by designing a reconfigurable feeding aperture for a square radiating patch. To realize this, we introduce four PIN diodes as RF switches connected between a cross feeding aperture such that the orthogonal directions of the rectangular aperture can be controllable. As the result, ± 45^0 polarizations can be reconfigured since the polarization is determined by the direction of the feeding aperture. In order to widen the bandwidth of a single patch antenna, we introduce a parasitic patch above the main radiating patch to bring an additional resonance. The bandwidth of the double-patch structure can reach 21% which is much wider than that of a single patch. In addition, the antenna has a stable gain across the operating bandwidth with the peak gain of 9.6 dBi. Good broadside radiation patterns are obtained with the 3-dB beamwidth of 56 degree. The antenna is suitable for applications requiring wideband and polarization reconfigurable characteristics.**

***Index Terms*—reconfigurable antennas, wideband, aperture-fed patch antenna.**

I. Introduction

Reconfigurable antennas become more and more popular along with the rapid development of modern wireless communication system. Antennas with reconfigurable features have many noticeable merits as avoiding multipath interference, enhancing the channel capacity and being capable of polarization coding [1] – [2].

Polarization reconfigurable antennas are able to radiate waves with different polarizations but maintain the same radiation pattern. Many efforts have been made to realize polarization reconfigurable antennas as in [3] – [10]. However, they face the same challenge of narrow bandwidth. For example, patch antennas are commonly modified to form a reconfigurable radiator to realize the switchable polarizations as in [3] – [9]. But the maximum bandwidth is less than 5%. In addition, antenna with the reconfigurable feeding network can also realize the controllable polarization as in [10]. The bandwidth of 6% is still very narrow.

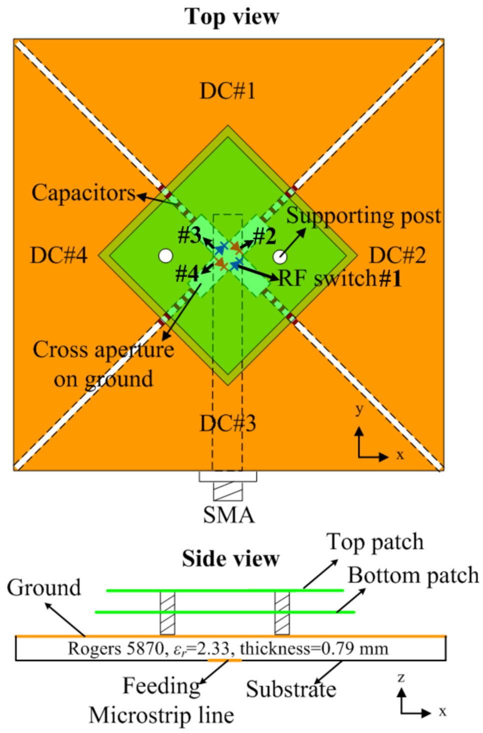

Fig. 1. Antenna configuration

In this paper, we proposed a new idea to realize the ± 45^0 polarization reconfigurable antenna by modifying the traditional aperture-fed patch antenna. We introduce four PIN diodes on a cross aperture to switch the direction of the feeding rectangular aperture for the square patch, such that $\pm 45^0$ polarization can be reconfigured. We add a parasitic patch above the main radiator to bring an additional resonance. As the result, the bandwidth can be enhanced to 21%. Good broadside radiation pattern and stable gain are also obtained.

II. Antenna Design and Performance

A. Antenna Configuration

The proposed antenna structure is shown in Fig. 1. It consists of two radiating patches and an aperture feeding. Both patch radiators are made of copper plates and have the square-shape. The bottom patch acts as the main radiator with the side length of 51 mm and the top patch works as the parasitic one with the side length of 48 mm. The distance between the two patches and the distance between the bottom patch and the feeding substrate are the same 4 mm. Two supporting posts fix the two patches with the feeding substrate together. The aperture feeding structure is printed on the Rogers 5870 substrate with the relative permittivity of 2.33 and thickness of 0.79 mm. The bottom feeding transmission line has the characteristic impedance of 50 ohm with the width of 2.3 mm. A cross feeding aperture is etched on the ground plane with the length of 23 mm and the width of 2 mm. The side length of the square ground is 140 mm. Four PIN diodes are located in the aperture as seen in the figure. In addition, the ground is separated into four parts and biased with different DC voltages as DC#1, DC#2, DC#3 and DC#4. Some capacitors as DC blocks are connected between each part below the patch radiator. The slit width is 1 mm as same as the length of the DC block capacitor.

B. Operating Principle and Performance

In order to realize the reconfigurable function, we introduce four PIN diodes as RF switches connected between the cross-aperture. By controlling the ON/OFF states of the diodes, the shape of the feeding rectangular aperture can be switched orthogonally as seen in Fig. 2. As the result, the radiating polarizations can be switched between $+45^0$ and -45^0 since the polarization is determined by the direction of the rectangular feeding aperture. From Fig.2 we can see the currents on the patch flow orthogonally to the rectangular aperture. To switch the polarizations, if we apply the DC voltages to the four parts of the ground with DC#1 = 1.5 V, DC#2 = 0 V, DC#3 = 0 V and DC#4 = 1.5 V, $+45^0$ polarization is realized as diode#2 and diode#4 are turned on. On the contrary, -45^0 polarization will be generated if we turn on diode#1 and diode#3 as seen in Table I.

Figure 3 shows the reflection coefficient and the realized gain of the proposed antenna. Wide impedance bandwidth of 21% from 2.25 to 2.75 GHz has been obtained. Antenna gain is stable across the bandwidth with the peak value of 9.6 dBi. In addition, good broadside radiation patterns at 2.45 GHz are observed in Fig. 4 with the 3-dB beamwidth of 56 degree. Because the antenna structure is strictly symmetrical for both$\pm 45^0$ polarizations, all results for two modes are identical.

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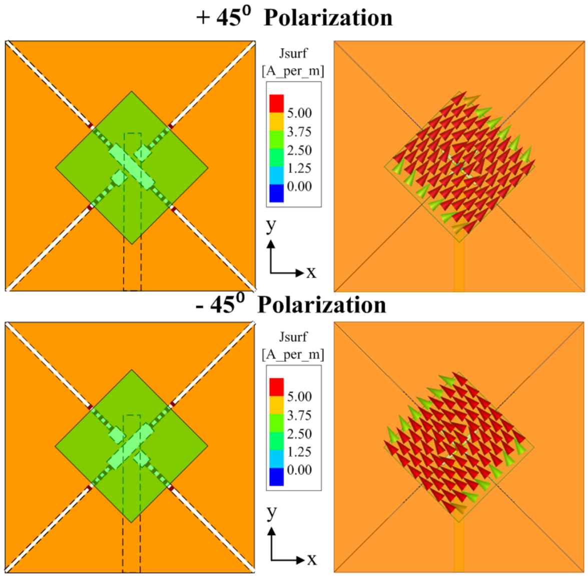

Fig. 2. Current distributions of the radiating patch in the two states of the $\pm 45^0$ linear polarizations.

TABLE I
POLARIZATIONS BY DIFFERENT BIASING VOLTAGES

DC#1	DC#2	DC#3	DC#4	Polarization
1.5 V	0 V	0 V	1.5 V	$+45^0$
0 V	0 V	1.5 V	1.5 V	-45^0

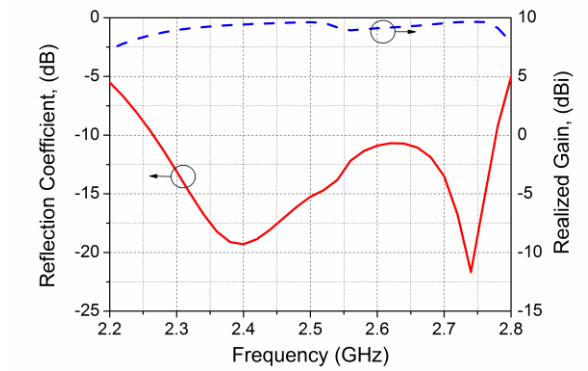

Fig. 3. Simulated reflection coefficient and realized gain for both modes.

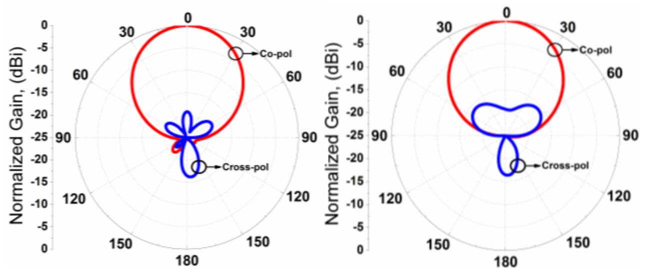

Fig. 4. Simulated radiation patterns at $\varphi = 0^0$ (left) and $\varphi = 90^0$ planes (right).

III. References

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