Polarization Reconfigurable Patch Antenna through Modification of Feeding Network

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Abstract – **This paper proposes an antenna with ability to reconfigure the polarization between linear polarization, right-hand circular polarization and left-hand circular polarization through the modification of the feeding network. The antenna consists of circular patch on the upper side of the substrate, and the coplanar waveguide transmission line is placed on the ground plane at the underside of the substrate. For reconfigurability purpose, eight switches are applied and positioned at the feeding network. The performance of the proposed antenna is presented and discussed. The proposed antenna is operated within WLAN frequency band (2.4-2.48 GHz).**

Index Terms — **Polarization reconfigurable, feeding network, patch antennas, CPW.**

I. INTRODUCTION

Reconfigurable antennas have recently gained great attention from all researchers around the globe, due to the ability to cope and meet with the changing of the system parameters and demands. For instance, the properties of the reconfigurable antennas, like operating frequency, radiation pattern and polarization can be altered using numerous techniques. This special benefit makes the reconfigurable antennas becoming the desired feature and play important role in modern wireless communication system.

Reconfigurable antennas with polarization diversity has the ability to realize the frequency reuse and to alleviate the harmful effects due to multipath fading, hence provide additional functionality and enhance the system capability. Polarization diversity antennas can also improve the capacity when being used in the multiple-input-multiple-output (MIMO systems). The polarization reconfigurable antenna might take place between dual orthogonal linear polarization (LP), between left-hand circular polarization (LHCP) and right-hand circular polarization (RHCP), or between LP and circular polarizations (CP). A number of polarization reconfigurable antennas that achieved through tunable feeding network have been reported in the literature [1-4].

In this paper, the solution here proposed is based on the modification of coplanar waveguide (CPW) feeding line. Similar principle has been proposed previously in [5], however, it only capable to excite simultaneously LHCP and RHCP uses dual ports and no reconfigurability feature introduced in the design. The simulation process is carried out using CST Microwave Studio software.

II. ANTENNA STRUCTURE AND CONFIGURATION

The schematic of the proposed antenna is illustrated in Figure 1. The antenna consists of a circular patch antenna with radius r on the top and a finite ground plane on the bottom of Taconic RF-35 substrate (L X W mm), with a dielectric constant of 3.52 and a thickness of 1.52 mm. The port is connected to the CPW that located on the ground plane surface. The circular patch antenna is coupled with two tapered impedance transformer that positioned on the x-axis and y-axis, and then later is optimized to obtain good impedance matching.

To obtain the reconfigurability feature, eight switches (currently represented by copper strips for proof of concept) are embedded in the CPW feed line. The presence of copper strips indicates the switch is ON meanwhile at OFF state during the absence. Phase shifter line is introduced at the both feed lines, initially set approximately a quarter wavelength and later been optimized using parameter sweep technique. To achieve circular polarization, the patch is coupled with feed line that one of it is making shorter to another, thus providing the 90º phase difference between two orthogonal modes. In contrast, the LP is excited when the length of the both feed lines is equal. The switching configuration with the respected polarization is tabulated in Table I.

The dimensions of the structure are as follows (unit in mm): L = 90, W = 90, r = 15, $Lf1$ = 40.75, $Lf2$ = 24.5, $Lf3$ = 11, $Lf4$ = 13.25, $Lf5$ = 11.65, $Lp1$ = 9.73, $Lp2$ = 13.75, Lm = 6, Wc = 2.8, Wf = 0.5, Wm = 4.4.

III. SIMULATED RESULT AND DISCUSSION

Fig. 2 shows the simulated reflection coefficient for all cases. The simulated -10 dB bandwidth of S_{11} are 33 MHz (2.467-2.500 GHz), 58 MHz (2.420-2.478 GHz), 109 MHz (2.386-2.495 GHz) and 153 MHz (2.342-2.495 GHz), for antenna A1, A2, A3 and A4, respectively. Good impedance matching is achieved for all configurations.

Fig. 3 presents the simulated result of axial ratio for antenna A3 and A4. The simulated BW_{CP} as referred to 3-dB axial ratio bandwidth is 23 MHz (2.443-2.466 GHz) for antenna A3. In addition, for antenna A4, the BW_{CP} is 26 MHz (2.445-2.471 GHz). The axial ratio for LP is high for any frequencies.

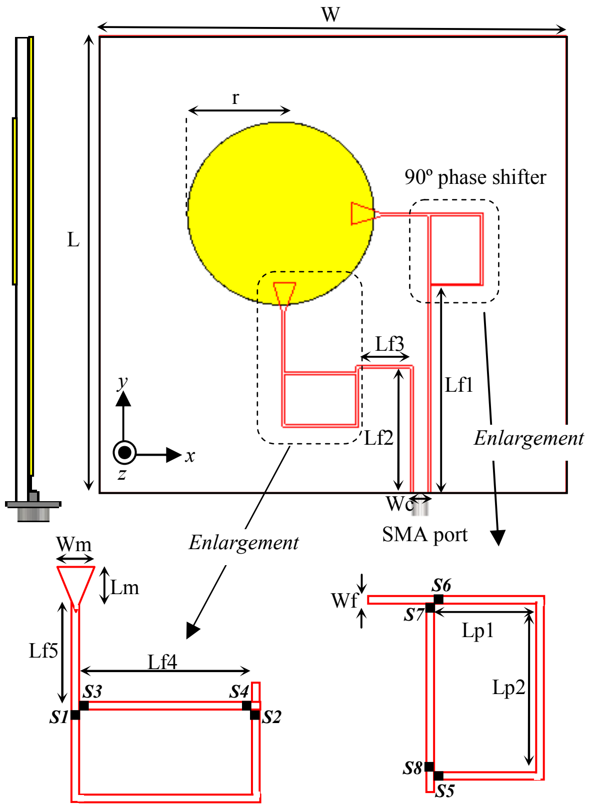

Fig. 1: Geometry of the proposed antenna. (Yellow colour indicates the metallization on the top layer, white colour for substrate and red line indicate the feedline on the ground plane).

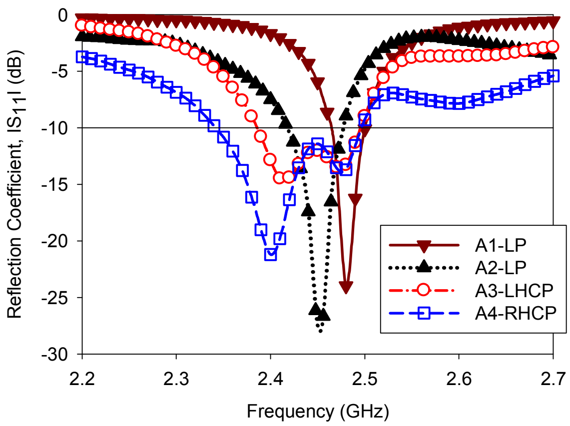

Fig. 2: Simulated reflection coefficient (dB) for all switch configurations

TABLE I
SWITCHING CONFIGURATION OF THE PROPOSED ANTENNA

Ant.	State of the switch								Polar.
	S1	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*	*S8*	
A1	O	O	X	X	O	O	X	X	LP
A2	X	X	O	O	X	X	O	O	LP
A3	X	X	O	O	O	O	X	X	LHCP
A4	O	O	X	X	X	X	O	O	RHCP

O: On state, X: Off state

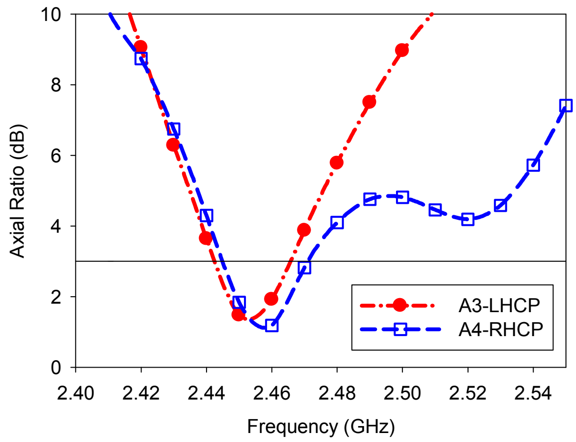

Fig. 3: Simulated axial ratio (dB) for CPs

IV. CONCLUSION

The polarization reconfigurable patch antenna through modification of feeding network is presented. By controlling the state of the eight switches (ON or OFF) interconnected in the feed line (currently utilizing the copper strips), triple polarization modes can be excited, either LP, RHCP and LHCP that operated in WLAN frequency band. The simulation results of reflection coefficient and axial ratio are presented. The fabrication of ideal diode and implementation of the RF PIN diode is underway.

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