# Reconfigurable Microstrip Antenna with Frequency and Polarization Diversities

\*Kyungho Chung, Yongsik Nam, Taeyeoul Yun and Jaehoon Choi\*\*
Department of Electrical and Computer Engineering, Hanyang University
17 Haengdang-dong Sungdong-gu, Seoul, 133-791, Korea
\*\*
<u>choijh@hanyang.ac.kr</u> (corresponding author)

# **I. Introduction**

Reconfigurable antennas have recently received much attention in wireless and satellite communication systems due to their selectivity for operating frequency and polarization diversities. A microstrip reconfigurable antenna is an attractive candidate to provide reconfigurability because of low profile, light weight, conformability and easy fabrication properties [1].

Several researches for polarization diversity of microstrip antenna have been recently studied. In [2], the antenna was presented whose polarization can be switched between linear polarization (LP) and circular polarization (CP). In [3]-[4], other microstrip antennas having polarization diversity capability were introduced.

In this paper, we propose a novel reconfigurable microstrip antenna with frequency and polarization diversities. The frequency diversity characteristic of this antenna is realized by using a PIN-diode on a U-slot of a microstrip patch. The polarization diversity is also obtained with two PIN-diodes on the truncating corners of a square patch. The proposed antenna is designed to operate at 1850 MHz of personal communication systems (PCS) or at 2640 MHz of digital multimedia broadcasting (DMB) systems. The design has been successfully implemented and the experimental results are presented.

### **II.** Antenna Design and Results

The geometry of the proposed reconfigurable microstrip antenna with a U-slot and truncated corners is illustrated in Fig. 1. A single feed square patch having a side dimension of L = 24.2 mm is fabricated on a substrate of thickness 1.6 mm and relative permittivity ( $\varepsilon_r$ ) of 4.4. U-slot with parameters of Ls=9.9 mm, Ws=19 mm is inserted into the patch. In order to obtain CP characteristic, corner truncation approach is used [5]. This corner-truncated square patch has two small parasitic conductors of triangular shape with a side length of s=1.45 mm. To obtain the diversity characteristic of the proposed antenna, three PIN diodes are used. A PIN diode 1 is inserted into the center of the U-slot and PIN diodes 2, 3 are placed at the gaps between the patch and the triangular conductors. Frequency and polarization diversities of the antenna are controlled by switching diodes on and off.

When all diodes are off, this antenna basically operates at resonant frequency of 1850 MHz. If all diodes are turned on, the current can flow directly through all the diodes. As a result, this antenna

resonates at a higher frequency of 2640 MHz and exhibits LP characteristic. In the case of the proposed antenna with diode 1 on and diode 2, 3 off, RHCP can be excited at around 2640 MHz.

The proposed antenna is designed with HFSS [6]. Fig. 2 shows measured and calculated return losses in PCS and DMB bands. The measured data agree well with the calculated ones and satisfy the -10 dB return loss requirement for two service bands. Frequency and polarization diversities characteristics by switching diodes on and off are well presented in Fig. 2 (a), (b) and Fig. 2 (b), (c), respectively. Calculated 3-dB axial ratio (AR) CP bandwidth in broadside direction is shown in Fig. 3. It is observed that the CP bandwidth (< 3 dB) is 140 MHz. The calculated radiation patterns in two orthogonal planes at 2640 MHz are illustrated in Fig. 4, and good RHCP radiation pattern is observed. The measured and calculated impedance bandwidth and CP bandwidth are summarized in Table I.

# **III.** Conclusion

A novel reconfigurable microstrip antenna with frequency and polarization diversities has been designed and fabricated. The frequency diversity characteristic of this antenna is realized by placing a PIN-diode in the middle of a U-slot of a microstrip patch. The polarization diversity is also obtained with two PIN-diodes on the truncating corners of a square patch. The designed antenna satisfies return loss requirement (<-10 dB) at PCS (Rx), DMB service bands and also shows a good axial ratio characteristic at DMB service band. The proposed antenna is suitable for PCS/DMB applications.

#### Acknowledgement

This work was supported by grant No. (**R01-2004-000-10461-0**) from the Basic Research Program of the Korea Science & Engineering Foundation.

### Reference

[1] S. Xiao, B. Z. Wang, and X. S. Yang, "A novel frequency reconfigurable patch antenna", *Microwave Opt. and Technol. Lett.*, 36, pp. 295-297, Feb. 2003.

[2] M. K. Fries, M. Grani, and R. Vahldieck, "A reconfigurable slot antenna with switchable polarization", *IEEE Microwave Wireless Compon. Lett.*, vol. 13, no. 11, pp. 490-492, Nov. 2003.

[3] Fan Yang and Yahya Rahmat-Samii, "A reconfigurable patch antenna using switchable slots for circular polarization diversity", *IEEE Microwave Wireless Compon. Lett.*, vol. 12, no. 3, pp.96-98, Mar. 2002.

[4] N. Jin, F. Yang, and Y. Rahmat-Samii, "A novel reconfigurable patch antenna with both frequency and polarization diversities for wireless communications," *IEEE Antennas and Propagation Int. Symp.*, pp. 1796-1799, Jun. 2004.

[5] W. S. Chen, C. K. Wu, and K. L. Wong, "Novel compact circularly polarized square microstrip antenna," *IEEE Trans. Antennas Propagat.*, vol. 49, pp. 340-342, Mar. 2001.

[6] Ansoft high-frequency structure simulator (HFSS), Ansoft Corporation.



Fig. 1. Geometry of proposed antenna.



Fig. 2. Measured and calculated return loss characteristic. (a) PCS (b) DMB (LP) and (c) DMB (CP).



Fig. 3. Calculated axial ratio characteristic at DMB band.



Fig. 4. Calculated RHCP and LHCP radiation pattern at 2640 MHz. (a) E-plane (b) H-plane.

	PCS (Rx)		DMB (gap filler)		DMB (satellite)	
Service	1840-1870 MHz		2630-2655 MHz		2630-2655 MHz	
	D1	OFF	D1	ON	D1	ON
Diode State	D2	OFF	D2	ON	D2	OFF
	D3	OFF	D3	ON	D3	OFF
Impedance	Calculation	Measurement	Calculation	Measurement	Calculation	Measurement
Bandwidth	1815-1845	1840-1870	2590-2610	2610-2660	2580-2650	2630-2690
(< <b>-10 dB</b> )	30 MHz	30 MHz	20 MHz	50 MHz	70 MHz	60 MHz
Polarization	LP		LP		RHCP	
CP Bandwidth (<3 dB)					2630-2770 (130MHz)	

Table I. Summary of results