Reconfigurable Antenna of Frequency and Polarization Diversity for PCS and DMB

Jong-Hyuk Lim and Tae-Yeoul Yun
Department of Electrical and Computer Engineering, Hanyang University
17 Haengdang-dong Seoungdong-gu, Seoul, 133-791, Korea
Email: taeyeoul@hanyang.ac.kr

I. Introduction

In recent years a reconfigurable patch antenna becomes important issue in wireless and satellite communication systems, because it can operate frequency and polarization diversity using PIN-diodes switching [1-5]. The frequency and polarization diversity with single patch and single feed produces a simple structure, small size, and low cost for wireless systems. The polarization diversity is especially to avoid the detrimental fading loss caused by multi-path effect [1]. The reconfigurable antennas are also utilized to realize frequency reuse for doubling the system capability in satellite communication systems [2].

In this paper a new polarization and frequency diversified patch antenna is proposed, using three PIN-diode connections on slot and spur lines. Diodes direct the antenna to work for personal communication systems (PCS) at 1750 MHz or digital multimedia broadcasting (DMB) systems at 2630 MHz. The basic antenna shape consists of a square patch with a spur line, a parasitic patch, and switching PIN diodes. From experimental results, the proposed antenna is verified to show the polarization and frequency diversity and an excellent axial-ratio in circular polarization (CP) performance. Following sections detail the antenna design and theory in section II, simulation and measurement results of all three structures in section III, and finally discussion in section IV.

II. Antenna structure and Theory

A new reconfigurable antenna structure is presented in Fig. 1. A microstrip-fed rectangular patch is printed on a substrate of thickness 1.6 mm and permittivity (ε_r) 4.4. Dimensions of the proposed antenna are mentioned in Table 1. As shown in Fig. 1, it has the square patch with three PIN-diodes on the spur line and wide slot. The antenna can be converted into three configurations by switching diodes on and off. When the diode 1 (D_1) and diode 2 (D_2) turn off, the antenna has the spur line of '*L*' shape in the main patch with the isolated parasitic patch. Then it is well known as the polarization diversity (LP ⇔ CP) antenna controlled by the diode 3 (D_3) [3]. When D_3 turns off, the spur line introduces the patch to be right-hand circular polarization (RHCP). Because it has two near-

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degenerate orthogonal resonant modes, TM_{10} and TM_{01}, equal amplitudes and 90° phase difference of fields produce. When D_3 turns on with D_1 and D_2 off, the antenna shows the square patch with the parasitic slot line of '*I*' shape. It works as the linear polarization (LP) antenna due to similar characteristics of the basic patch antenna of TM_{10} mode. Therefore switching D_3 with D_1 and D_2 off can change the polarization during operating at the same frequency over the DMB band. When all diodes turn on, the antenna has a larger rectangular shape with the wide parasitic slot line and '*I*' shape slot. It operates at the lower frequency over PCS band with the linear polarization (LP).

III. Simulation and Measurement Results

Performance of the proposed antenna is simulated to confirm frequency and polarization diversity. Diode-on state is just considered as ideally conducting in the simulation for the simplicity. HFSS (High Frequency Structure Simulator) of Ansoft is used to simulate and optimize the antenna. Results of the input return loss in Fig. 2 show that the realized antenna performs excellent frequency diversity on PCS and DMB bands. Also the measured data are very well agreed with the simulation. Fig. 3 shows a wide 3-dB axial-ratio bandwidth, 100 MHz and CP performance. Radiation patterns for each antenna are simulated with excellent results, as shown in Fig. 4. All measured and simulated data are summarized in Table 2.

IV. Conclusion

In this paper, a novel reconfigurable antenna having three kinds of operation has been presented with single structure and single feed, controlled by switching diodes. The simulation and measurement agreed very well each other. Frequency and polarization diversity was verified, and wide axial-ratio was also obtained in the circular polarization performance. The proposed reconfigurable patch antenna should be useful for PCS and DMB applications.

Acknowledgement

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Reference

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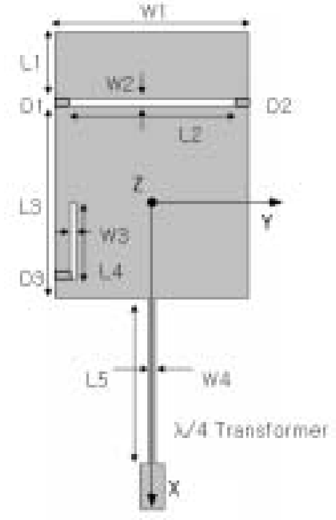
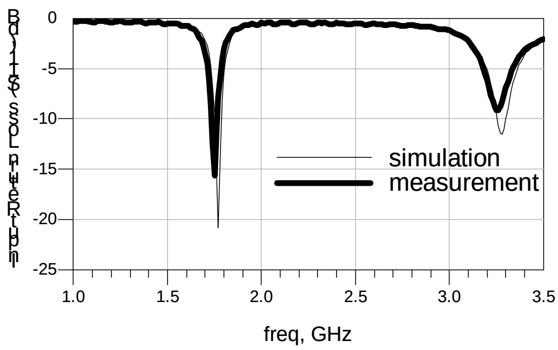


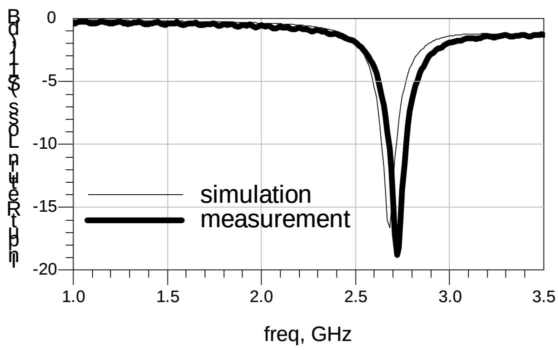
Table 1. Dimensions of the proposed antenna. (unit : mm)

W1	25	**L1**	8.6	**L5**	21.5
W2	1	**L2**	21.6	**D1**	1.7x1
W3	0.7	**L3**	25	**D2**	1.7x1
W4	0.8	**L4**	10	**D3**	2x1

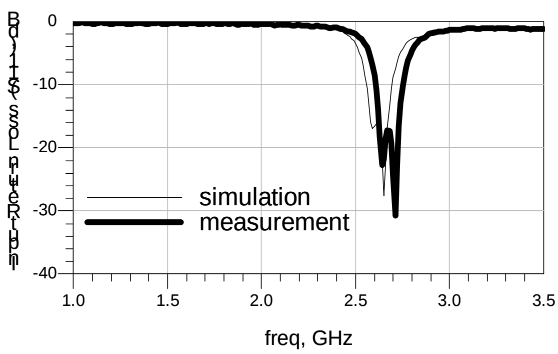
Fig. 1 Geometry of the proposed reconfigurable antenna



(a)



(b)



(c)

Fig. 2 Input return loss (a) PCS LP (1750~1780 MHz), (b) DMB LP (2630~2655 MHz), and (c) DMB (RHCP) (2630~2655 MHz)

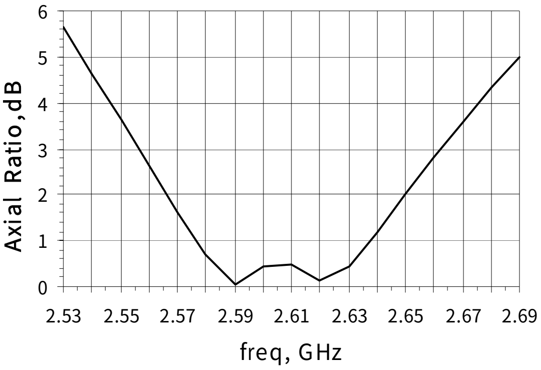
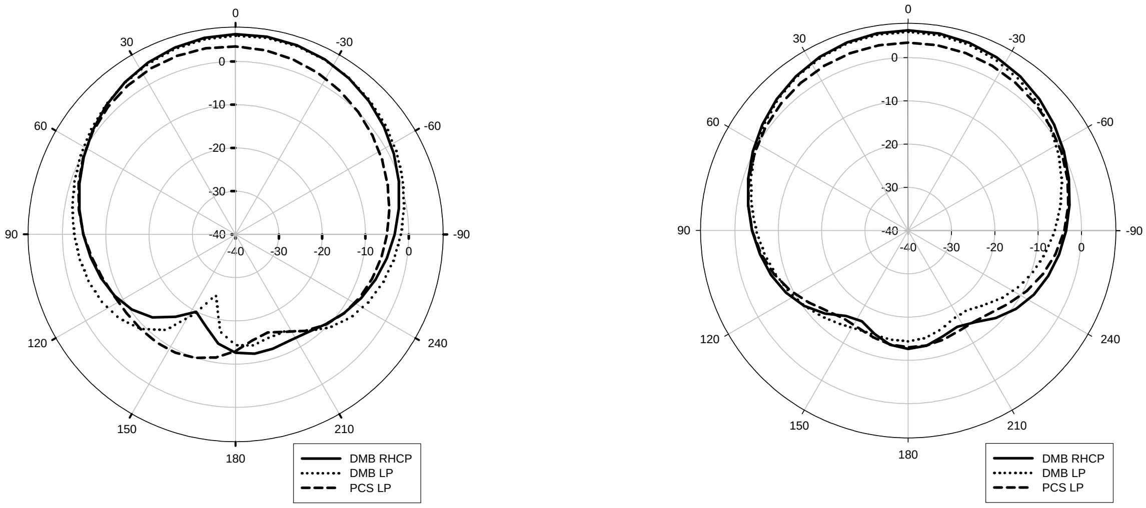


Fig. 3 Simulation of Axial Ratio



(a) **(b)**

Fig. 4 Radiation patterns (a) x-z plane (b) y-z plane

Table 2. Summary of results

	PCS		**DMB (gap filler)**		**DMB (satellite)**	
Service	**1750-1780 MHz**		**2630-2655 MHz**		**2630-2655 MHz**	
Diode State	**D1**	**ON**	**D1**	**OFF**	**D1**	**OFF**
	D2	**ON**	**D2**	**OFF**	**D2**	**OFF**
	D3	**ON**	**D3**	**ON**	**D3**	**OFF**
Bandwidth	**Simulation**	**Measurement**	**Simulation**	**Measurement**	**Simulation**	**Measurement**
	1750-1780	**1735-1765**	**2630-2710**	**2670-2770**	**2560-2700**	**2605-2750**
	30 MHz	**30 MHz**	**80 MHz**	**100 MHz**	**140 MHz**	**145 MHz**
Polarization	**LP**		**LP**		**RHCP**	
					3-dB Axial Ratio : 2560-2660 (100MHz)	