Reconfigurable Microstrip Antenna with Frequency and Polarization Diversities

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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 (ε_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

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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

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

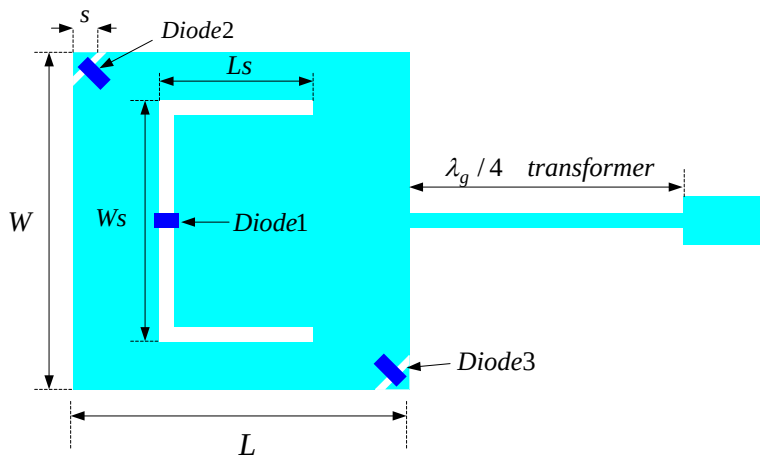
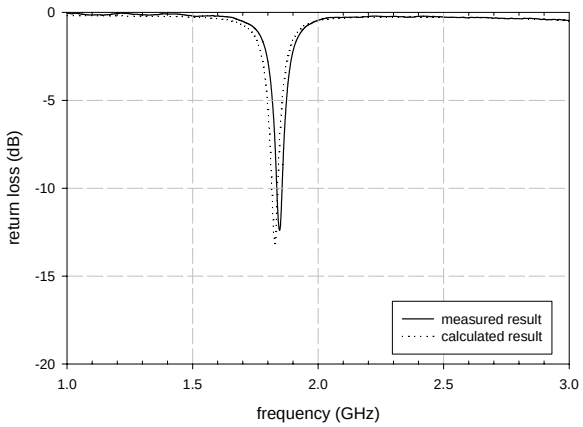
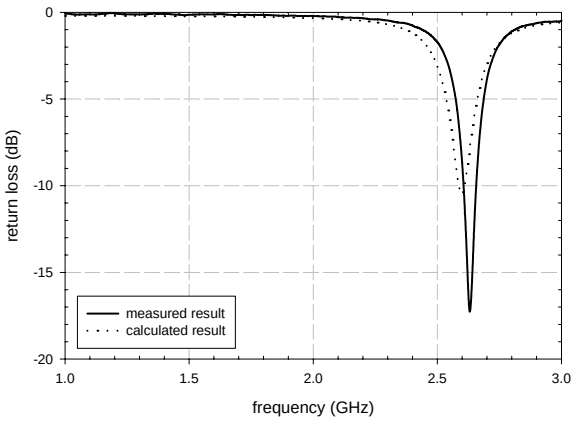


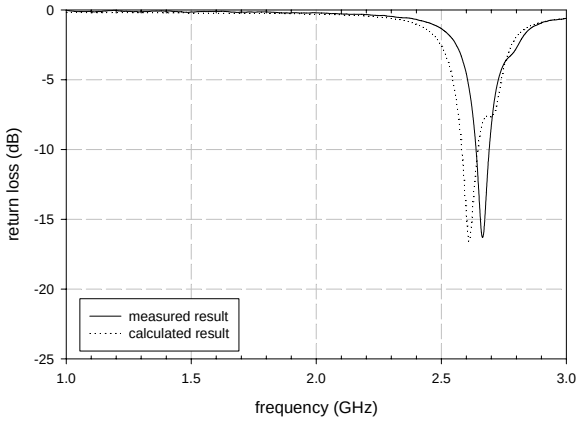
Fig. 1. Geometry of proposed antenna.



(a)



(b)



(c)

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

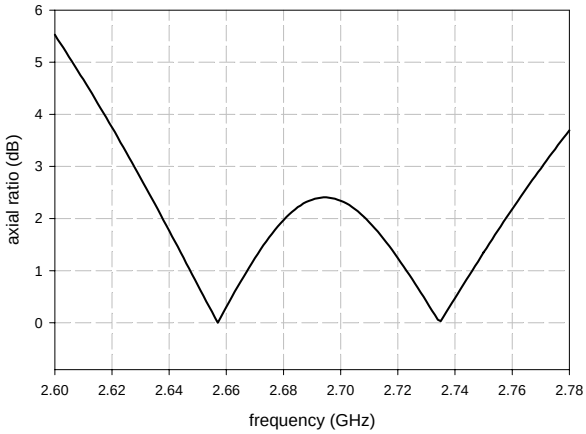
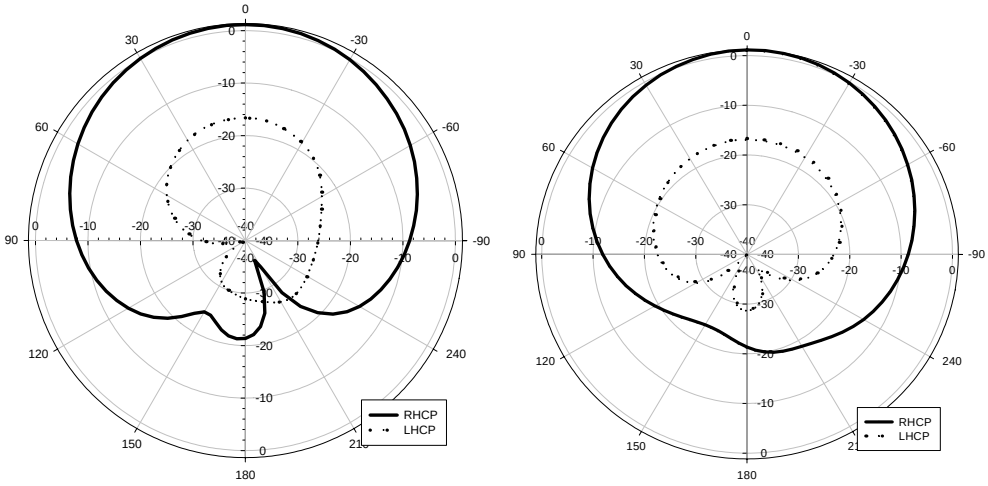


Fig. 3. Calculated axial ratio characteristic at DMB band.



(a) (b)

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

Table I. Summary of results

	PCS (Rx)		DMB (gap filler)		DMB (satellite)	
Service	**1840-1870 MHz**		**2630-2655 MHz**		**2630-2655 MHz**	
Diode State	**D1**	**OFF**	**D1**	**ON**	**D1**	**ON**
	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**
(<-10 dB)	**30 MHz**	**30 MHz**	**20 MHz**	**50 MHz**	**70 MHz**	**60 MHz**
Polarization	**LP**		**LP**		**RHCP**	
CP Bandwidth (<3 dB)					**2630-2770 (130MHz)**	