A Frequency Reconfigurable Planar Inverted-F Antenna for Wireless Applications

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Abstract-A compact frequency reconfigurable Planar Inverted-F Antenna (PIFA) is presented in this paper. This antenna is suitable for wireless applications. It allows three frequency reconfigurable modes via two switches, which cover five communication bands. The three modes are ISM-LTE, GSM-PCS, and DCS, respectively. The overall area of this antenna is 17×23mm^2. The simulation results of this antenna show good performances in each modes.

I. INTRODUCTION

Nowadays, a growing number of wireless communications equipments appear in people's lives. The widely use in many field makes the miniaturization and multi-band become the mainstream trend of antenna design [1], but it is a huge challenge to design antennas to meet the requirements with a single antenna. As an effective solution, reconfigurable technology is gradually considered by scholars in the whole world. The reconfigurable antenna can work under different electromagnetic environments by changing some parameters of the antenna. At present, reconfigurable technology can be classified into the following three forms. The first form is frequency reconfigurable technology, which can make the antenna work in different frequency. The second form is pattern reconfigurable technology, it means the radiation pattern changes while the frequency band remains the same. The last form is polarization reconfigurable technology [2], which means the polarization could be transformed from right hand (RHCP) to left hand (LHCP) circular. Many methods have been used to realize reconfigurable antenna. PIN switches have been reported in some papers [3] . A reconfigurable method can be used in antenna design by switching different feeding locations [4]. Multi-band antenna can be designed with varactor diodes [5]. Ideal model switches for reconfigurable antennas are in [6].

In this paper, the frequency reconfigurable is considered. Five bands including GSM(0.893 GHz -0.931 GHz)、DCS(1.73 GHz -1.88 GHz)、PCS(1.86 GHz -1.98 GHz)、ISM(2.41 GHz -2.48 GHz) and LTE(2.5 GHz -2.67 GHz) can be generated by using the antenna proposed in the paper. These bands can be shifted by changing the two ideal model switches.

II. ANTENNA DESIGN

A. PIFA Antenna

Planar Inverted-F Antenna (PIFA) is a kind of commonly planar antennas, it is widely used in wireless communication equipment because of its advantages, such as small volume, easy processing and omni-directional radiation [7].

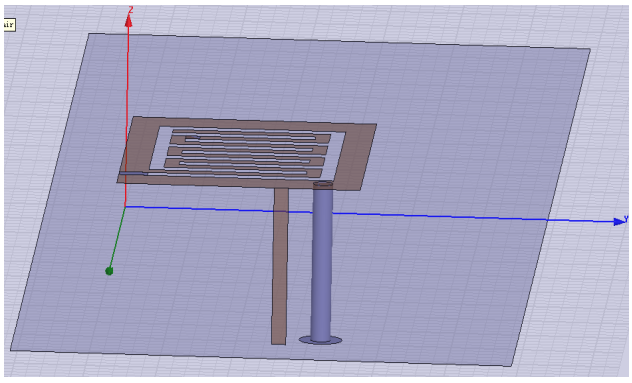
The traditional Inverted-F antenna [7] consists of the radiation patch located above a ground plane, a short circuit and a feeding. For rectangular patch planar Inverted-F antenna, the approximate resonant frequency can be written as

$$f_c = \frac{c}{4\times(a+b)} \tag{1}$$

Where c is the speed of light in a vacuum, a is the length of the rectangular patch, b is the width of rectangular patch. Equation (1) shows that the resonance frequency depends on the radiation piece. The size of the ground plate will affect the performance of low frequency. Usually, the length of the ground plate is 80~120 mm for the band of GSM.

B. Reconfigurable Antenna Structure

Antenna structure is shown in Figure. 1, the antenna applied the meander structure embedded in the patch of the traditional PIFA [8]. The PIFA is shorted to the ground by a 1 mm wide metal strip and fed by a 50 Ω coaxial cable. The ground dimension is $120\times35\,mm^2$ .The distance from the ground to the patch is 10 mm. The switch 1 and switch 2 are two ideal model switches. The dimension of the patch is $17\times23\,mm^2$. Compared with the size of other applications on the frequency of GSM, the antenna in this paper is smaller. The dimensions of the patch are listed in Table 1.



(a) 3D view

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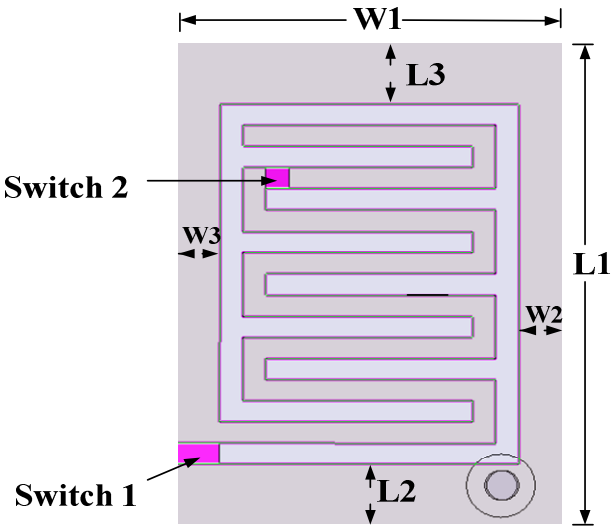


(b) Top view

Figure 1. Structure of the PIFA antenna. (a) 3D view (b) Top view

Table 1. Dimensions of the PIFA antenna.

Parameter name	Parameter value(mm)
L1	23
L2	3
L3	3
W1	17
W2	2
W3	2

III. RESULT AND DISSCUSSION

The three switch conditions corresponding to the frequency are presented in Table 2.The design of slots prompts the antenna to generate five bands. The reflection coefficients (S_{11} <-6 dB) [9] of the PIFA antenna through the switches under the condition of different states are presented in figure 2.

Table 2. Desired Matching for the different Switch Configurations.

Mode	Switch configuration	Frequency band
1	off-on	ISM(2.41-2.48GHz)、LTE(2.5-2.67GHz)
2	off-off	GSM(0.893-0.931GHz)、PCS(1.86-1.98GHz)
3	on-on	DCS(1.73-1.88GHz)

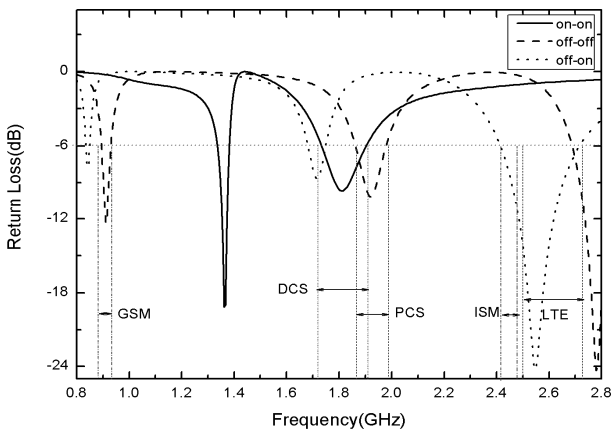
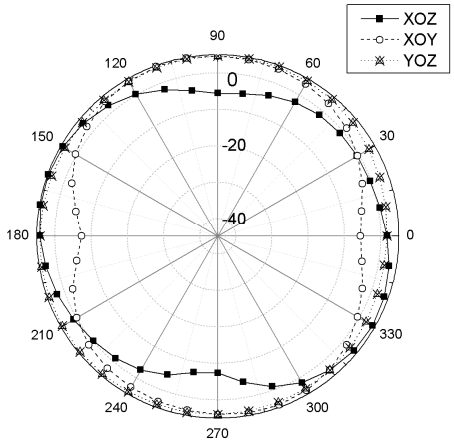
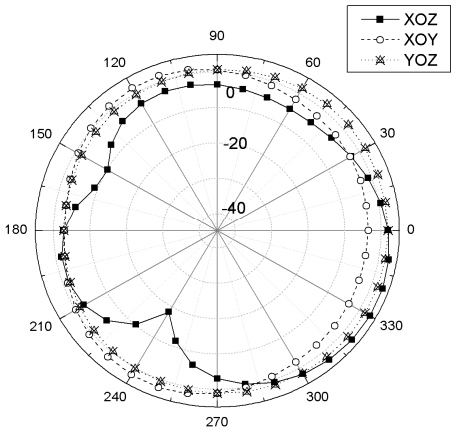


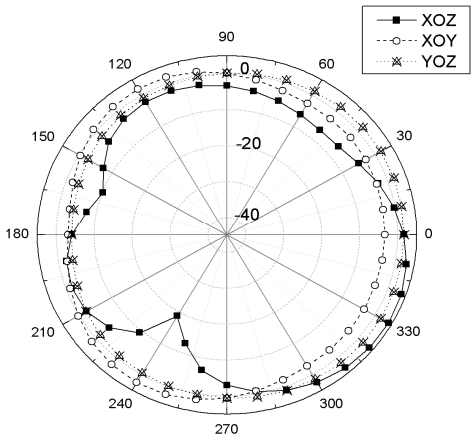
Figure 2. Simulated return loss for three different switch configurations.



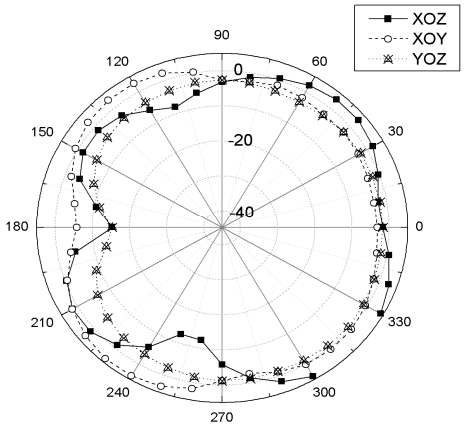
(a)GSM 0.9GHz



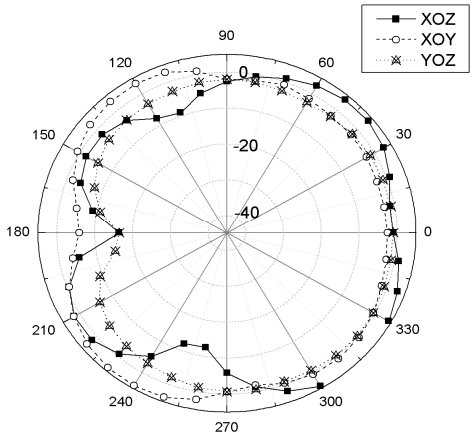
(b) DCS 1.7GHz



(c) PCS 1.8GHz



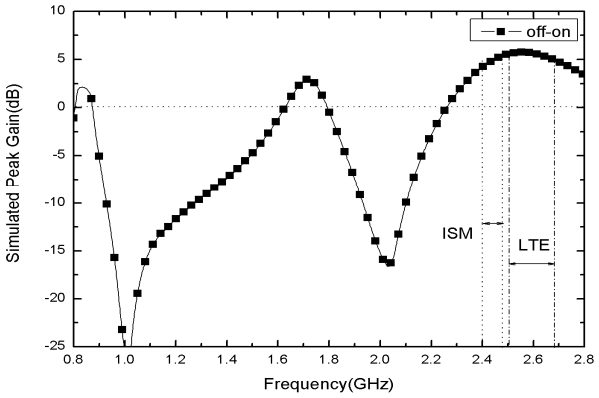
(d) ISM 2.4GHz



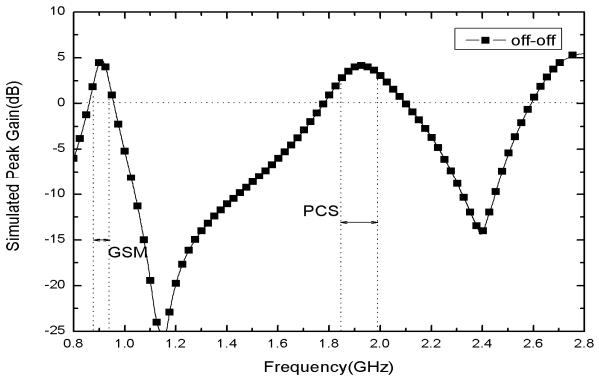
(e) LTE 2.5GHz

Figure 3. Radiation pattern for five bands (a) GSM (b) DCS (c) PCS (d) ISM (e) LTE

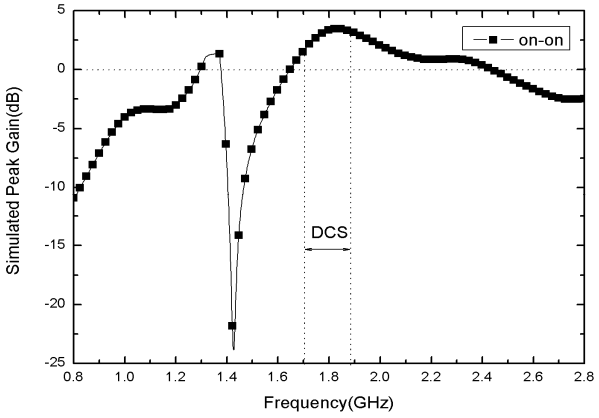
The radiation patterns for the five bands are shown in figure. 3 (a)-(e).



(a) Simulated peak gain for ISM\LTE.



(b) Simulated peak gain for GSM\PCS.



(c) Simulated peak gain for DCS

Figure 4. Peak Gain for three reconfigurations. (a) off-on (b) off-off (c) on-on

The Figure.4(a)-(c) shows the peak gains for the GSM、DCS、PCS、ISM and LTE are 4.76dBi, 3.4dBi, 4.14dBi, 5.1dBi and 5.46dBi.

IV. CONCLUSION

A compact frequency reconfigurable PIFA Antenna with three communication frequency reconfigurable modes is presented. The modes covering GSM、DCS、PCS、ISM and LTE can be controlled by two ideal switches. The simulation results that the return loss and radiation properties show that the antenna is in good performance in the five bands.

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