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Reconfigurable Antenna for Mobile Communication

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Abstract

A low profile and compact reconfigurable antenna for mobile communication is presented in this article. The antenna is capable of covering GSM 1800(1710- 1880 MHz), GSM 1900(1850-1990 MHz), UMTS (1920-2170 MHz), and LTE frequency bands in the range of 1.7-2.4 GHz when considered to a return loss of 10dB. The antenna is composed of a patch with microstrip feeding meandered monopole antenna with an extended metallic branch for re-configurability. The extended metallic branch is connected and disconnected by using the p-i-n diode switch which changes the path for current flow thereby achieving re-configurability. When the p-i-n diode is 'ON', the metallic branch is activated and the current start flowing through it and pattern is shifted to the left side and return loss is less. When the p-i-n diode is in 'OFF' state, the metallic branch is disconnected and the pattern is shifted to the right side and return loss is slightly more than ON state. The substrate used for this antenna is FR-4 having the relative permittivity of 4.4, loss tangent of 0.02 and a volume of 60 x 100 x 1.6 mm3. The antenna inhabits an area of 22 x 13.5 mm2. The simulation and measurement results confirm a good performance of the antenna.

Keywords: Reconfigurable Antenna, reliable data transfer, mobile communication

1. Introduction:

A mobile phone is one of the most important necessities of human life which makes the communication simpler as well as human life. A need for high speed data transmission resulted in evolution of communication standards such as Long Term Evolution (LTE) that presently used for 4G technologies. A person having 4G mobile handset that can see LTE on the top of his mobile screen. In India Reliance Jio that work on LTE band is taken digital revolution. Also wireless LAN and Worldwide interoperability for Microwave Access (WiMAX) which in turn induced the need of having such wireless communication devices that can support a high data rate transmission and reception. The most basic and important part of any wireless communication device is its antenna system. To support a highly reliable data transfer, the antenna must be capable of providing a organized communication link. Reconfigurable antennas have the capability of providing organized and uninterrupted multimedia voice, audio and video data communication services without the need of having extra channel bandwidth. That's why it is necessary to develop a reconfigurable antenna for small wireless terminals which can provide re-configurability of the radiation pattern. Several designs of reconfigurable antennas have been presented in literature of which only few are for mobile handsets. Some of the reconfigurable antenna designs for mobile handsets have been presented in reference papers. In this paper, a pattern reconfigurable printed antenna for mobile handsets is presented**. The antenna is composed of a patch with microstrip feeding meandered monopole antenna with an extended metallic branch for re-configurability. The extended metallic branch is connected and disconnected by using the p-i-n diode switch which changes the path for current flow thereby achieving re-configurability. When the p-i-n diode is 'ON', the metallic branch is activated and the current start flowing through it and pattern is shifted to the left side and return loss is less. When the p-i-n diode is in 'OFF' state, the metallic branch is disconnected and the pattern is shifted to the right side and return loss is slightly more than ON state.** The following section will present the design of the reconfigurable antenna followed by simulation results.

2. Antenna Design

The geometrical structure of the antenna and the radiating element including dimensions, is shown in Fig. 1. The antenna is based on a 100mm × 60mm FR4-epoxy substrate with a dielectric constant of 4.4, loss tangent 0.02 and a

thickness of 1.6 mm. The patch, which is T shaped is fed using a 2.5mm wide microstrip line. The width of feed is choose according to best impedance matching. Antenna is printed on non grounded part of substrate. Area of antenna is very less that is 22 x 13.5. Reconfigurability is achieve by using a extended metallic strip which connect or disconnect by PIN diode. Low capacitance (0.017pF) in the 'OFF' state and low resistance of 4.7Ω in 'ON' state as well as minimum insertion loss of the switch makes it much suitable to be implemented in mobile handsets.

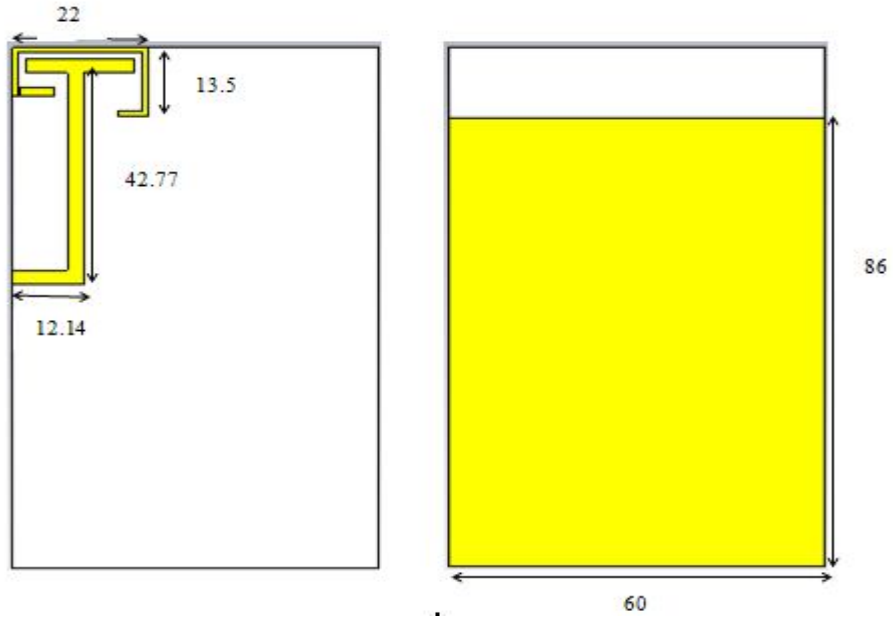


Figure 1 - Simulated Design Of reconfigurable Antenna for Mobile Communication when diode is OFF (Top & Bottom View)

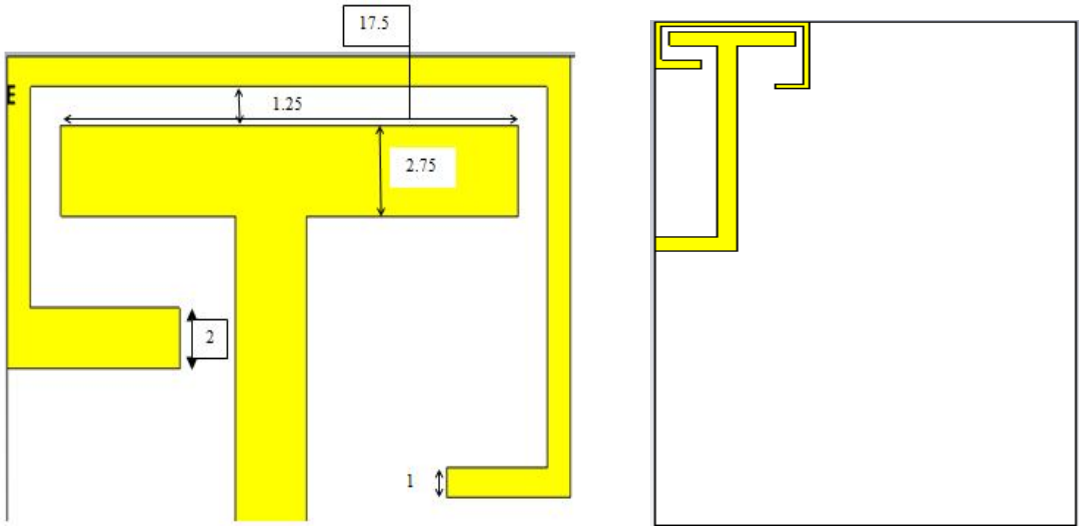


Figure 2 - Simulated Design Of reconfigurable Antenna for Mobile Communication when diode is ON (Top View) with dimensions

3. Working and Results of Antenna

As we can see in below table 1 when diode PD1 is OFF then it radiate on two frequencies is 2.04 and 2.38 GHz and return loss is -18.06 and -15.43 respectively as shown in figure 3.

In second case when PD1 is ON it radiates on two frequencies. First is 1.89 GHz and second frequency is 2.35 GHz and return loss are -32.75 and -33.40 dB respectively As shown in figure 4.

TABLE 1: OPERATING FREQUENCY, AND RETURN LOSS OF THE ANTENNA FOR EACH SWITCHING CONDITION

Case	I	II
PD1	OFF	ON
Frequency(GHz)	2.04/2.38	1.89/2.35
Return loss(dB)	-18.06/-15.43	-32.75/-33.40

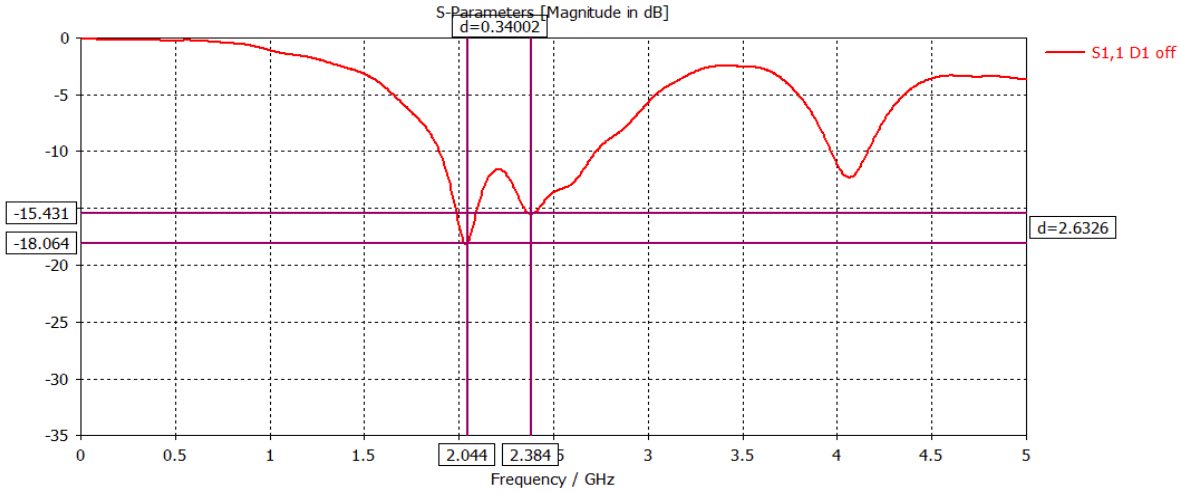


Figure 3 - Return Loss Of Reconfigurable Antenna When PD1 OFF

The Return loss curve for case-I is shown figure 3. The above figure clearly shows that the return loss curve is lower than -10 dB for very small operable band in the 1.85–2.75 GHz range is obtained. The Return loss curve for case-II is shown figure 4. The above figure clearly shows that the return loss curve is lower than -10 dB for very small operable band in the 1.8–2.7 GHz range is obtained.

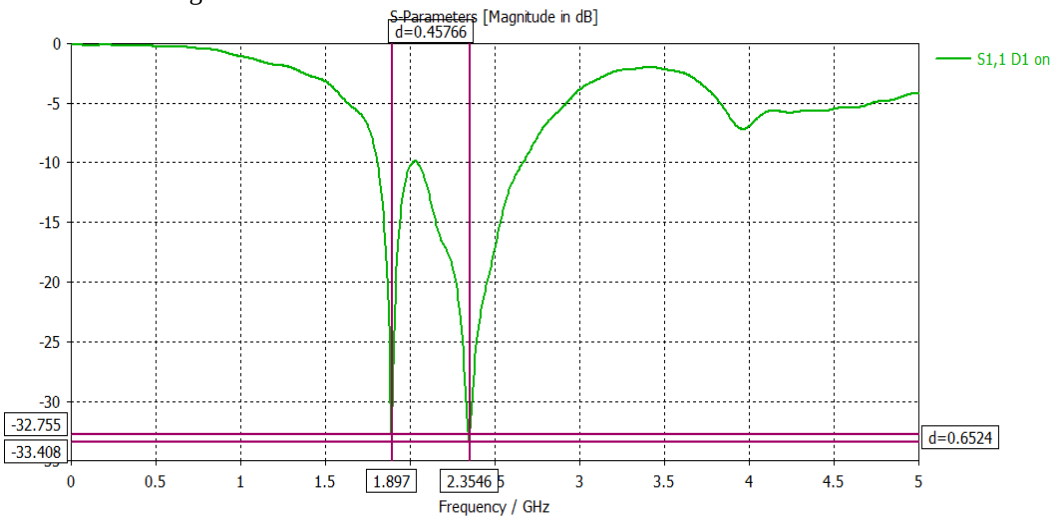


Figure 4 - Return Loss Of Reconfigurable Antenna When PD1 ONF

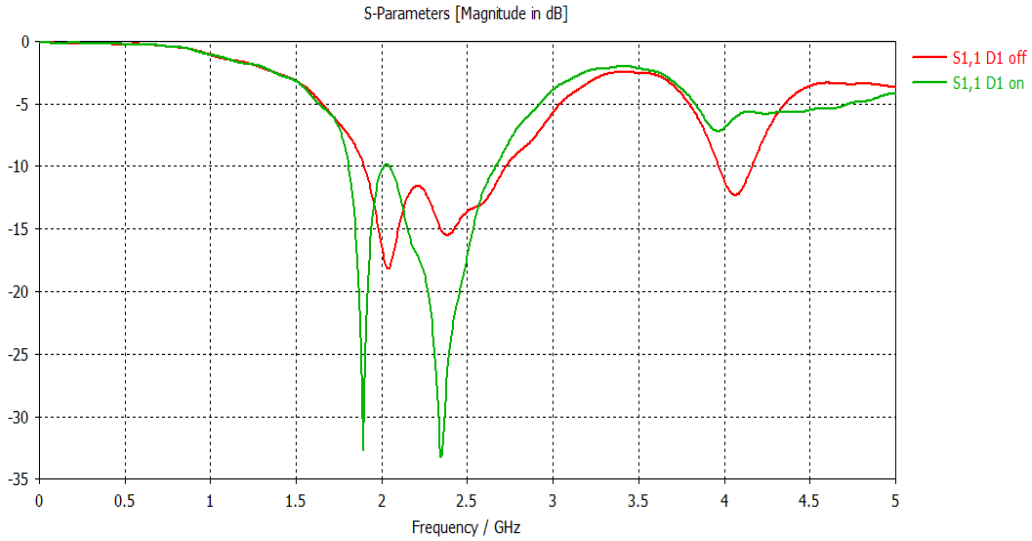


Figure 5 - Return Loss In ON And OFF condition of PD1

We can clearly see the variation of frequencies in above return loss pattern. The antenna is capable of covering GSM 1800 (1710-1880 MHz), GSM 1900 (1850-1990 MHz), UMTS (1920-2170 MHz and several LTE bands in the range of 1.7 GHz to 2.4 GHz. As shown in figure 5.
The Voltage Standing Wave Ratio (VSWR) Curve for the case I and case II of the proposed antenna is shown in figure 6 given below. For this antenna its value is less than or equals to 2 in range of 1.7 to 2.4GHz in each case.

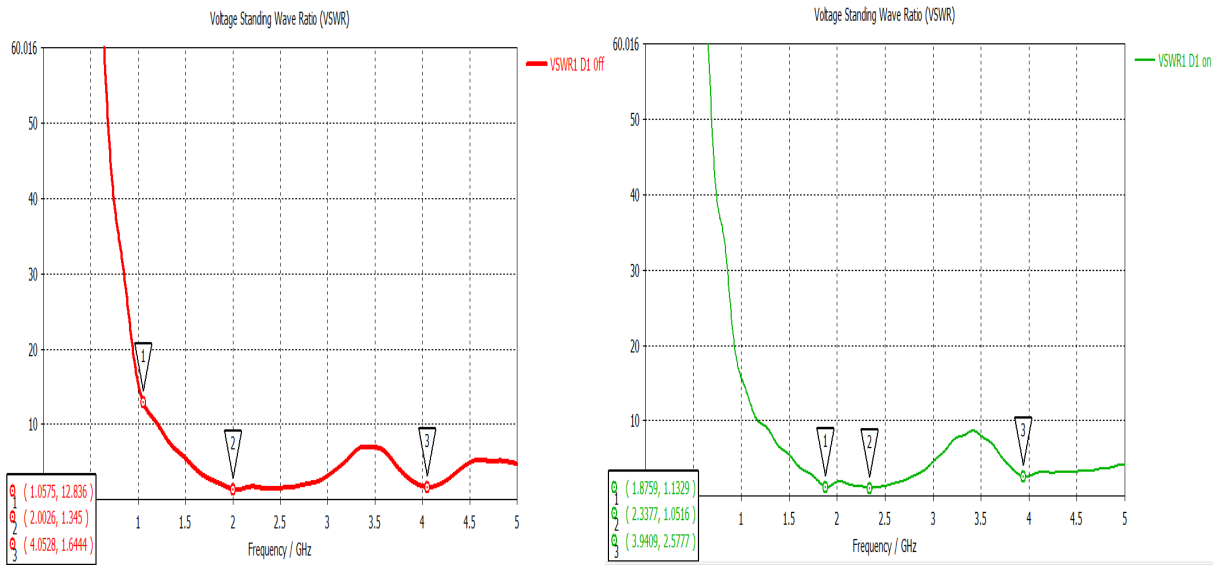
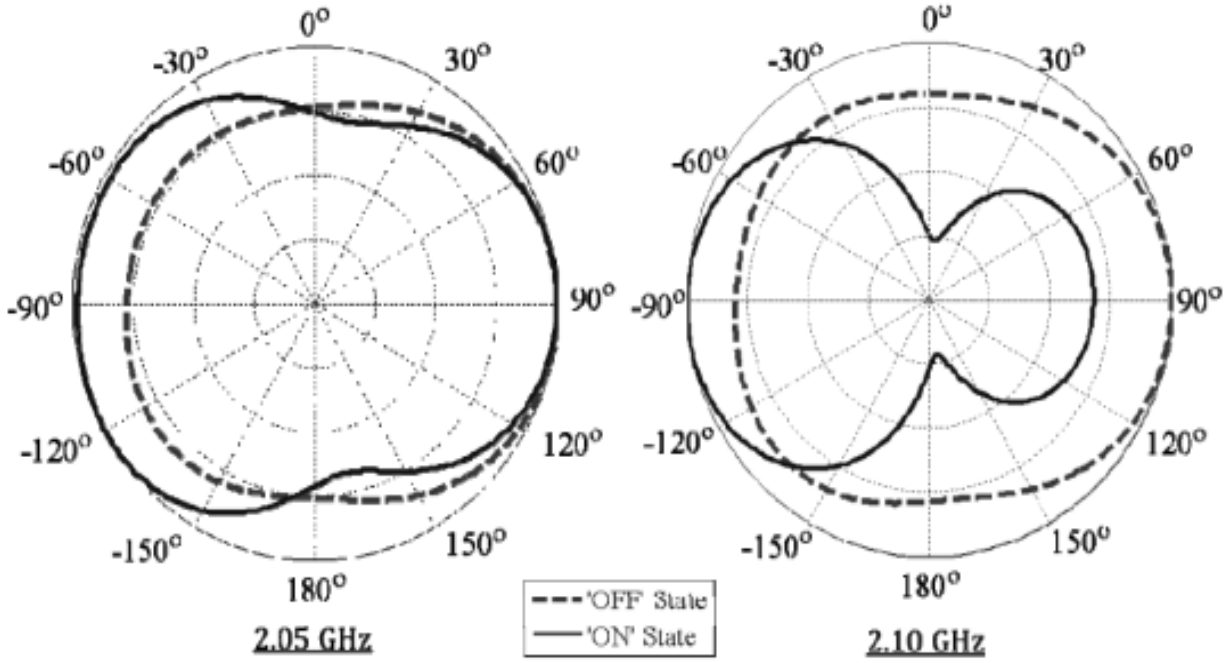


Figure 6 - VSWR curve for case-I and case II of the proposed design

4. Radiation Pattern

The radiation pattern depicting far field Gain at two different frequencies viz. 2.05, 2.10, 2.5 GHz and 5.0 GHz are shown in figure 7. The radiation pattern is a measure of field strength transmitted or received by an antenna. Reconfigurability developed at frequency 2.05 and 2.10GHz as shown in figure below. The antenna shows slightly bidirectional radiation pattern at the frequency of 2.5 GHz where as it reaches to omni-directional pattern (nearly) at 5 GHz.



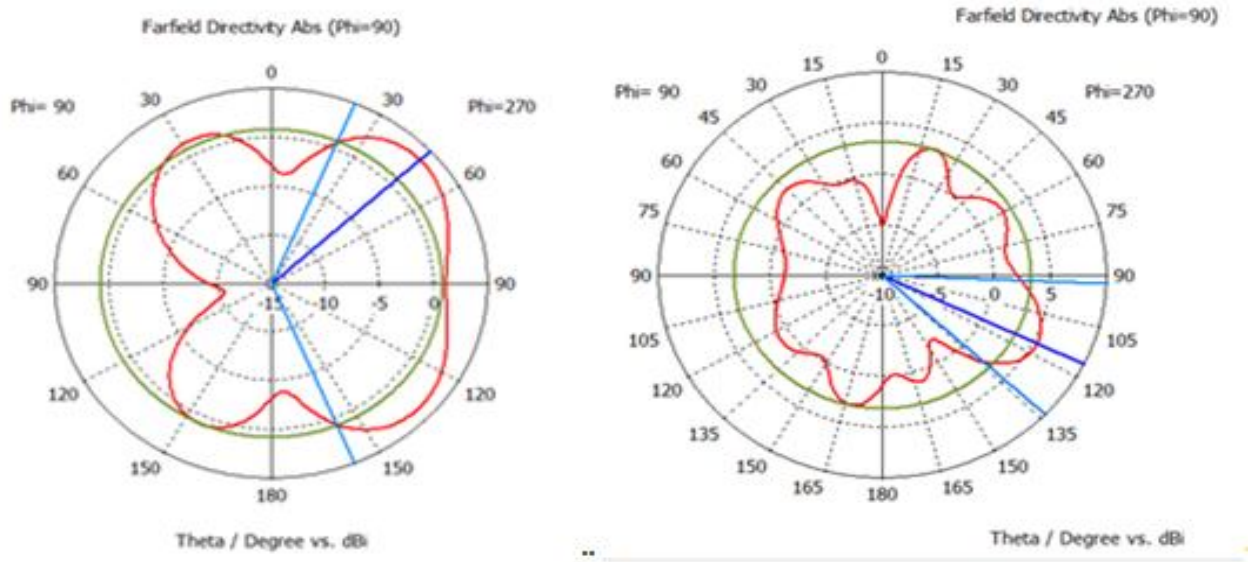


Figure 7 - Radiation patterns of the reconfigurable antenna for mobile communication at different frequencies

5. Conclusion

In this article, a double band reconfigurable antenna employing a pin diode has been presented. By using the characteristics of equivalent circuit of the pin diode, the resonance of monopole antenna can be reconfigurable by switching the diode either in "on" or "off" state. The proposed antenna **is capable of covering GSM 1800(1710- 1880 MHz), GSM 1900(1850-1990 MHz), UMTS (1920-2170 MHz), and LTE frequency bands in the range of 1.7-2.4 GHz o**perates for mobile communication applications. An antenna prototype is fabricated and measured. The s-parameters results show a good agreement between the simulation and measurement. Based on this design, an approach is proposed. The trend of both simulation and measurement results are agreed. This type of reconfigurable technique can be used for compact size mobile communication system for different communication purposes.

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