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A Frequency Reconfigurable Semi circular Ring Slot Micro Strip Antenna

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Abstract - The design of a switchable micro strip-fed semi circular ring slot micro strip antenna for multi band frequency operation is proposed in the paper. It consists of a three RF switches that are place along the radiating patch. A simple micro strip-fed miniaturized frequency reconfigurable antenna is proposed. A simple DC-biasing excitation circuit can be implemented for the antenna structure. Simulation and measurement results were taken. The return loss, VSWR, and radiation pattern were simulated and verified for acceptable performance.

Index Terms- SDR, RF switch, Frequency reconfigurable, Micro strip Antenna.

1. INTRODUCTION

The ability to simultaneously reconfigure and switch the radiation pattern, return loss, gain in real time to increase the spectrum efficiency is challenging the communication engineers to design smart antennas. One method to overcome the limitation is to design a wideband antenna to accommodate all the frequencies of interest. The communication systems has to be designed to suppress the Inter channel effects and wide band noise to design a acceptable Signal to Noise Ratio (SNR). Hence the need to design a frequency selective and real time digitally reconfigurable antenna is gaining attention of the modern communication systems designers. The RF switches can be used to alter the electrical length of the radiating patch to resonate at the desired frequency[1,2].PIN diodes are preferred over other alternatives RF MEMS for their fast switching speed and ruggedness.

In the literature the simple method to method to achieve frequency reconfigurablity is by incorporating PIN diodes along the slot of a narrow

T-shaped folding [3],L-shaped 4], and S-shaped [5] antennas. Here, the slot's perimeter length was changed by switching the RF PIN diodes, which in turn results in changing the resonant frequencies.——Besides the aforementioned technique (using PIN diodes to alter the slot's perimeter) that usually involved in using slot antenna types, the use of patch antenna type for achieving frequency reconfigurablity have also been reported [6],[7].

In view of the above mentioned techniques that are commonly used to perform frequency reconfigurablity, an innovative method of incorporating a meandered shaped tuning a half circular patch loaded within a circular slot is proposed. By simply switching the three PIN diodes incorporated along the tuning patch , the length of the tuning patch will be altered, that in turn will alter the current distribution path length of the resonant frequency resulting in four resonant frequencies at 2.42, 3.6 , 4.41and 5.42 GHz can be controlled. The following sections discuss the design and simulation and

experimental result analysis of the proposed antenna.

2. ANTENNA STRUCTURE DESIGN

2.1 Antenna Geometry

The following Fig.1 shows the antenna geometry of the proposed antenna. The Micro strip antenna was constructed using the FR-4 (Fire Retardant Grade)substrate with relative permittivity of Er= 4.4 and thickness of t=1.6mm and loss tangent =0.02.

It consists of three RF switches SW1,SW2,and SW3 placed along the patch to alter the electrical length/ Current distribution.

The fabricated antenna consists of switches modeled using the ideal characteristics. The ON switch is modeled using a radiating rectangular patch(PEC) of 0.5*0.5 mm^2.The patch is removed to mimic the OFF state of the switch.Fabrication of micro strip antenna with the switches in the state 000 (mode-1) and state 111(mode-4) are shown in the figure 3a-b,and 4a-b respectively. The antenna was fabricated on a size of 52*52 mm^2.

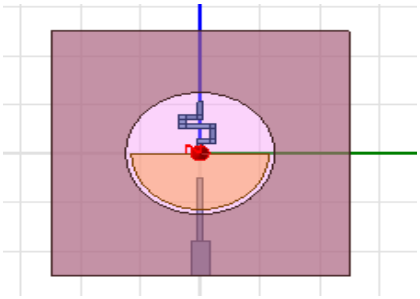

Fig1: The geometry of the proposed antenna structure(Top View)

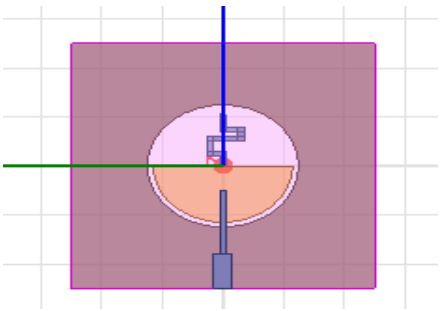

Fig2: The geometry of the proposed antenna structure(Bottom View)

Fig3a : Fabricated Antenna Top view (111 State)

Fig3b : Fabricated Antenna Bottom view (111 State)

Fig4a : Fabricated Antenna Top view (000 State)

Fig4b : Fabricated Antenna Bottom view (000 State)

2.2 RF Switch Modeling

The PIN diode is modeled using lumped parasitic elements R, L, and C. The values are used from the datasheet of the PIN diode SMP 1320.The parasitic values from the data sheet are[9].

L = 1.5 nH , R_S=0.9 Ω , R_O=1.5 KΩ, Co= 0.23 pF.

Fig4: The electrical equivalent circuit of RF PIN diode(ON state)

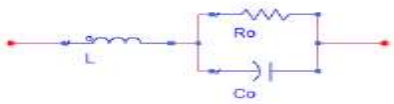

Fig4: The electrical equivalent circuit of RF PIN diode(OFF state)

3.. EXPERIMENTAL SETUP, SIMULATION, AND MEASUREMENT

The antenna was simulated using the HFSS tool and return loss, VSWR, and radiation pattern were measured for acceptable performance.

The antenna is fed through a coaxial probe with an SMA of 50 ohm impedance.. The measurement set up for testing the performance of designed antenna is shown in Fig. 5. The proposed Micro strip antenna geometry is designed & simulated using HFSS software to obtain various parameters like return loss, voltage standing wave ratio (VSWR), bandwidth, gain–and radiation pattern. The designed antenna is tested using VNA ZVK(10 MHz-10 GHz) tool.

Fig5: Measurement setup of the antenna using VNA

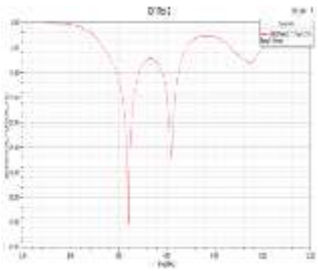

Fig6a: Return Loss when switches are in **000** state

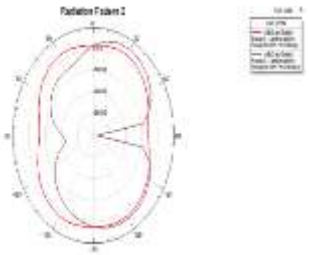

Fig6b: Radiation pattern when all switches in 000 state OFF

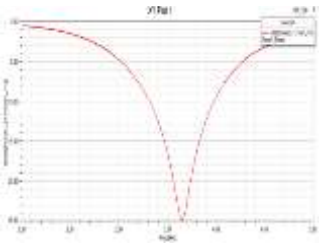

Fig7a: Return Loss when switches are in 100 state.

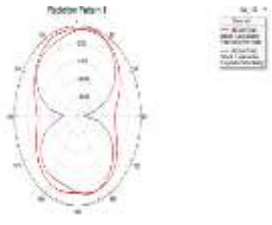

Fig6b: Radiation pattern when switches are in 100 state

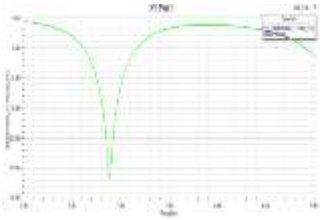

Fig8a: Return Loss when switches are in 110 state.

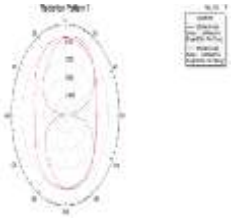

Fig8b: Radiation pattern when switches are in 110 state

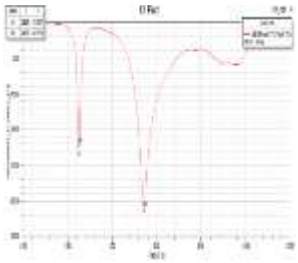

Fig8a: Return Loss when switches are in 111 state.

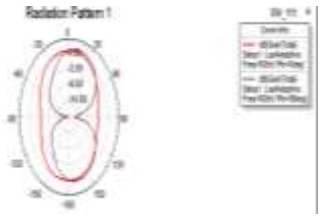

Fig8b: Radiation pattern when switches are in 111 state

TABLE 1 : Result Analysis

	Mode-1	**Mode-2**	**Mode-3**	**Mode-4**
Switch State	000	100	110	111
Resonant Frequency/ies (in GHz)	4.41 , 6.19	3.6	2.8	2.42 5.42

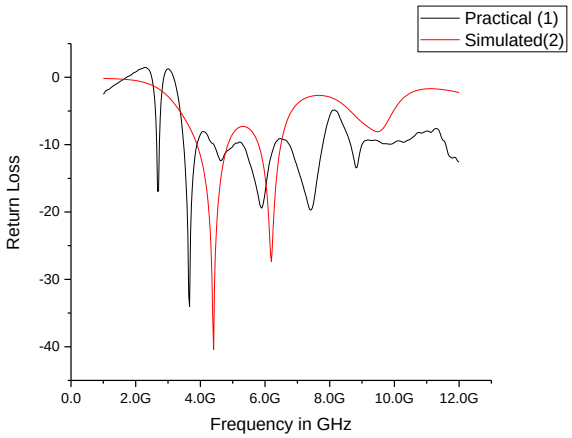

Fig 9a: Comparison of return loss in Switch State 000

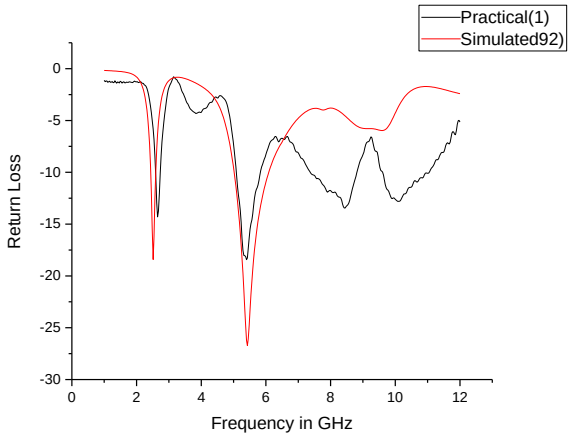

Fig 9b: Comparison of return loss in Switch State 111

Finally, the simulation results were compared with the measured results for result analysis. There were some variations attributed to the parasitic elements in the PIN diode modeling and the fabrication pitch tolerance variations.

4.. CONCLUSION

A study of frequency reconfigurable antenna with semicircular slot was designed and studied in this paper. The slots were switched using RF switch PIN diode using the lumped modeling of parasitic elements. The return loss , radiation pattern, VSWR , was tabulated. The antenna operates in four modes with dual and single band resonance. Practical and simulated data was tabulated and compared for acceptable performance. The antenna finds application in the cognitive radio applications and Ad-hoc wireless networks to achieve spectrum efficiency.

Acknowledgment

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