Volume: 6 Issue: V Month of publication: May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5053

# Rectangular Ring Frequency Reconfigurable Micro Strip Antenna - RRFRMSA for Frequency Hopping Wireless Networks and SDR

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***Abstract: A frequency reconfigurable micro strip antenna using a feed line for frequency agile applications is demonstrated in this paper. This antenna consists of two rectangular strips separated by rectangular slots Four RF switches (PIN Diodes) are placed in the rectangular ring slot to bridge the gap and to switch the frequency between WLAN bands resonating at 5.2 GHz and 5.8 GHz. PIN diodes are used to switch the frequency among WLAN bands. When compared to traditional micro strip antenna, the proposed antenna provides a size reduction of 8% at 5.2 GHz, and 60% at 5.8 GHz. The simulated return loss, and radiation patterns are presented and compared with the experimental data. This antenna can be used for modern wireless networks to improve spectrum efficiency.***
***Keywords: frequency reconfigurable, micro strip antenna, RF switches, WLAN.***

## I. INTRODUCTION

The need to use spectrum efficiently is driving modern antenna design. The recent design techniques constrain the use of antenna in high efficient spectrum scarce environments. The frequency diversity antennas are gaining attention to minimize the adverse effects caused by multipath signal propagation, increase the channel capacity by frequency reuse, minimize the disturbance of interfering signals, thereby increasing the quality of service (QOS) of the signal provider. They offer more functionalities than conventional antennas [1]. The parameters of the antenna that can be reconfigured are frequency, radiation pattern, polarization or combinations of them. In this paper a frequency hopping antenna with a simple feed structure is demonstrated for WLAN applications.

The research on simple –feed frequency and polarization reconfigurable micro strip patch antenna is reported earlier [2-3]. The concept is demonstrated by software simulation results using ideal switches. Although, the conceptual view of circuit including lumped elements is demonstrated, the real behavior of PIN diode switch and its associated bias circuit was not considered in the simulation. This paper demonstrates the frequency reconfigurable ring slot micro strip patch antenna incorporating the practical RF PIN diode parameters for accurate modeling of antenna characteristics. The concept is also validated by simulation and experimental results. The antenna operates in dual frequency bands in the WLAN range.

### *A. Software Defined Radio*

The Federal Communication Commission (FCC) allocated some part of radio frequency spectrum intended for telephones which are mobile during the year 1969. In year of 1987, SDR design has started with the development of a programmable modem which was funded by Air Force Rome Labs (AFRT). This was the step which paved way for the development of the structural design of the integrated communication, identification structure design (ICNIA) as well navigation. ICNIA was designed by the merging of multiple radios having single box with the compilation of numerous single purpose radios. The software can define the frequency band as well bandwidth of radio channel, user application, and modulation method, coding method, resource management protocols and mobility management protocols of transceiver. On the basis of defined features, SDR is defined as “Software radio is an emerging technology, thought to build flexible radio systems, multiservice, multi-standard, multiband, reconfigurable and reprogrammable by software [4-5].

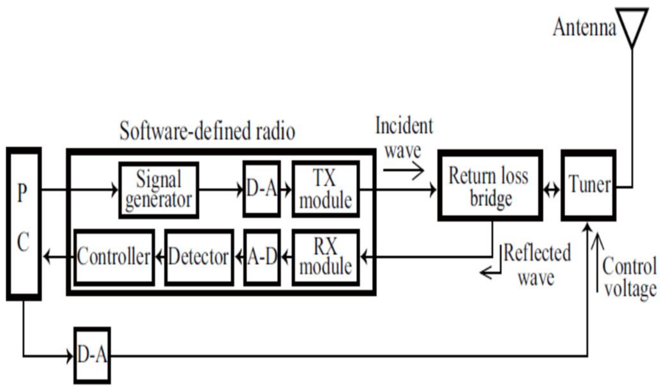


Fig-1**:** Generic block diagram of transceiver

## II. DESIGN OF ANTENNA STRUCTURE

The following Fig.2 shows the geometry of proposed frequency reconfigurable antenna with detailed dimensions. A square patch of side *a* is printed on substrate with relative permittivity of $e_r$ = 2.2) with thickness of t = 0.8 mm. A quarter wave transformer of impedance 50 Ohm feed line is connected to the radiating patch for impedance matching. A rectangular ring slot is etched out in the patch with 1mm spacing.

The operating frequency is determined by patch side length *L*, and effective permittivity of the substrate $e_{eff}$ and is given by[6].

$$f = c/2*L(e_{eff})^{1/2} \qquad \text{--------(1)}$$

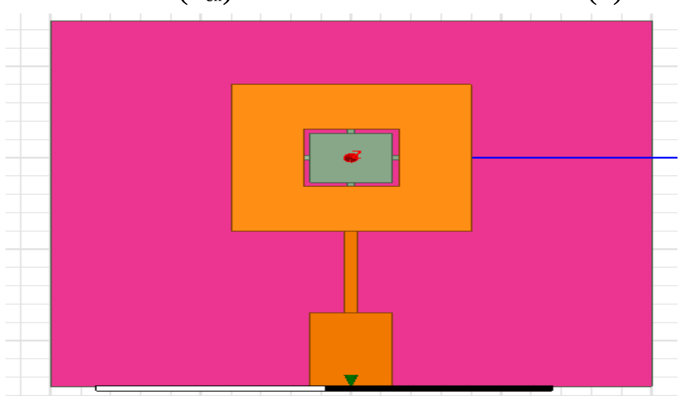

Fig 2: Geometry structure of the proposed RR- FRMSA with all Switches.

Four RF switches SW1, SW2, SW3 and SW4 are placed in the ring slot to vary the effective electrical length of the antenna. The switches are modeled using the PIN diodes by Skyworks. SMP1322.

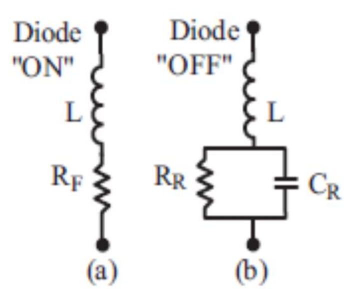


Fig 3 : Equivalent cicuit for the RF Switches when ON and OFF.

It consists of Ls=0.45nH, $R_F$=0.7Ω, $R_R$=1.5KΩ, and $C_R$=0.02pF.These parameters are used in the simulation using lumped passive elements for accurate modelling of the PIN diodes[7].

Table I: Dimensions of the proposed antenna

| Parameter | Size in mm |
|---|---|
| $L_{p1}$ | 16 mm |
| $W_{p1}$ | 16 mm |
| $L_{p2}$ | 6.38 mm |
| $W_{p2}$ | 6.38 mm |
| h | 0.8 mm |

## III. RESULTS AND CONCLUSION

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. 4. 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.

Fig 4: Measurement set up of the Micro strip antenna

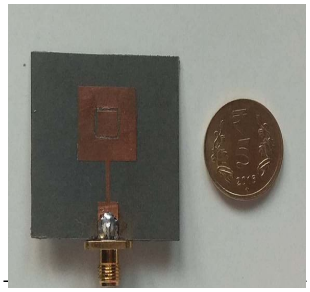

Fig 4a: Antenna Mode-1 Top view

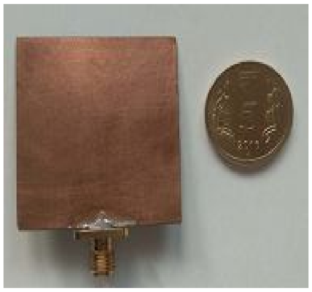

Fig 4b: Antenna Mode-1 Bottom view

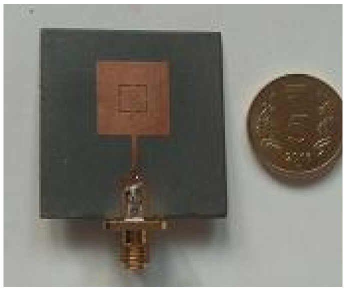

Fig 5a: Antenna Mode-2 Top view

Fig 5b: Antenna Mode-2 Bottom view

*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887*
*Volume 6 Issue V, May 2018- Available at www.ijraset.com*

The return loss plots were plotted using the simulation data and practical measured data from VNA. The comparison of the simulation and practical return loss for the both the modes were drawn using Origin(R) Plotting software.

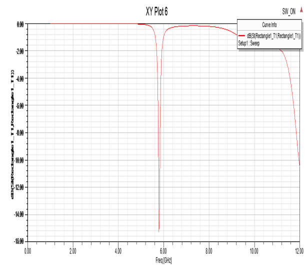

Fig6a:Return Loss results of the antenna when ON.

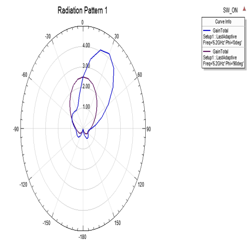

Fig6b:Radiation pattern of the antenna when ON

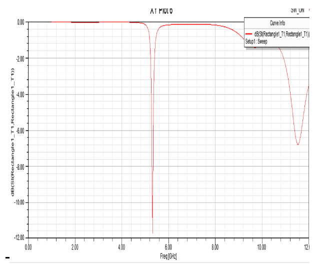

Fig7a:Return Loss results of the antenna when OFF.

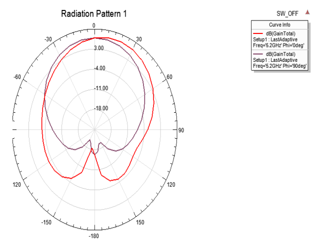

Fig7b: Radiation pattern of the antenna when OFF.

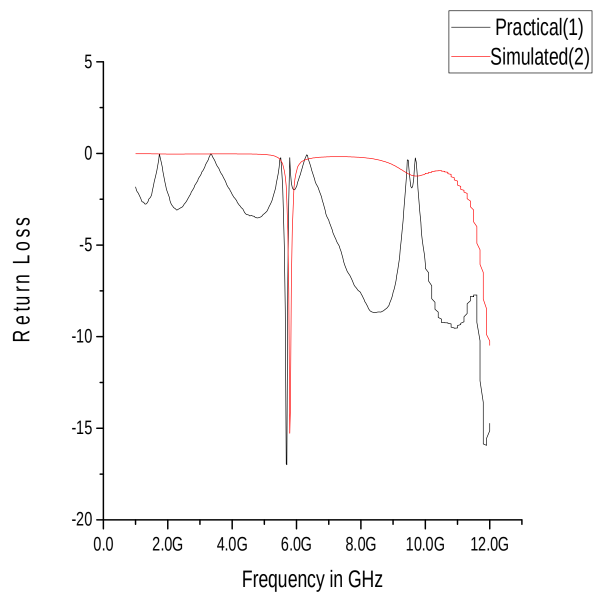


Fig 8: Comparison results of the multiband antenna when ON.

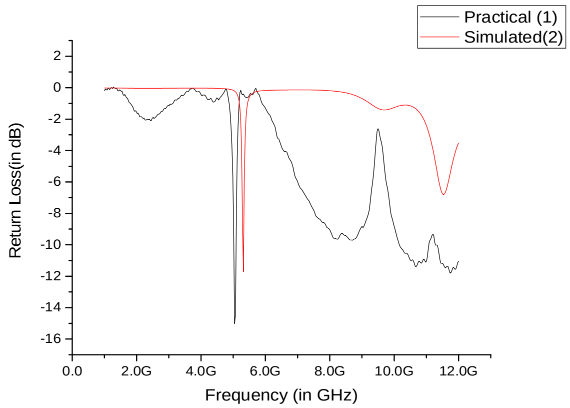


Fig 9: Comparison results of the multiband antenna when OFF.

TABLE II: Result Analysis

| PARAMETER | MODE-I | MODE-II |
|---|---|---|
| Resonant frequency | 5.24 GHz | 5.73 GHz |
| Switch states | ON | OFF |

The variations in the return loss were attributed to the parasitic inductance and capacitance of the PIN diode switch. In this study, we proposed a communication system that achieves high communication efficiency by integrating the tunable antenna and the SDR. The antenna resonates in two WLAN 5.2 GHz and 5.8 GHz with slight variations due to parasitic elements of the PIN diode. The return loss VSWR, and radiation pattern were measured and plotted. In future works the antenna can be designed for polarization reconfigurablity and multiband tuning using the same structure.

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