A Novel Frequency Reconfigurable Antenna for Wireless Application

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***Abstract*—**In this paper we have presented a novel design of miniaturized microstrip antenna used for wireless applications. The antenna is based on reconfigurability property, consisting of two switch which is used to change the surface current distribution and hence the frequency of operation. Antenna in ON state have dual band at 3.5GHz and 5.8GHz, while antenna in OFF state have a single band at 5.8GHz. Both simulated and measured result are in close agreement. It is switchable either at 3.5 or 5.8 or both the bands depending on the different switch conditions.Here lumped port excitation is being used.

Keywords*—Frequency reconfigurable, Microstrip antenna, Reconfigurable antenna, Strip line, Subsrate.*

I. INTRODUCTION

The reconfigurable antenna has the advantage to offer additional performance gains for various wireless system. This type of antenna is very useful in fading environment where there is a loss of communication due to reflection of signal from various structures like buildings, hills etc. This type of antenna rejects multipath phenomenon and reduce delay spread and thus considerably increasing the capacity of the system. Therefore frequency reconfigurable antenna will be a good option for such situations [1]-[5].

A simple reconfigurable microstrip antenna is presented in this paper. Microstrip is an antenna which is most adaptable antenna that could be used as a single element in miniature devices in addition to large phased arrays [6]. Here a new novel frequency and reconfigurable antenna is optimized for 3.5GHz (WiMax) and 5.8GHz (Wi-Fi) WLAN applications. Antenna configuration consist of two switch when both the switch are ON dual band operation is seen and when switch is OFF only single band operation exists. NO external matching circuit is used matching properties are totally determined by the placement of switch.

II. METHODOLOGY

The antenna designing is concluded by using Ana soft HFSS V-13.Microstrip rectangular patch antenna is premeditated and lumped port excitation is being used. Both the rectangular slots B1 and B2 are etched in the patch to realize multiband resonance of frequencies. Switches are used to obtain tune-ability or for reconfiguration. The antenna is projected on “Fiber- glass Reinforced epoxy” FR-4 material.

III. ANTENNA GEOMETRY

The geometry, dimension (unit mm) of antenna is shown in Fig1(a) and 1(b). The antenna is premediated on FR4 substrate with a dielectric constant of 4.4 (ε_r=4.4) and height of 1.6mm for a resonant frequency of 5GHz.

The patch length and width is calculated from the formula [7]

$$L = \frac{\nu_0}{2 f_r \sqrt{\varepsilon_{reff}}} - 2\Delta L \qquad (1)$$

$$W = \frac{\nu_0}{2 f_r} \sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (2)$$

Where L is length,$\nu_0$is frequency in free space,$f_r$is resonant frequency,ε_r permittivity,$\varepsilon_{reff}$is effective permittivity and W is width of microstrip patch. On calculation length and width comes to be 14.545mm and 19.2574mm.

The strip line or feed line width and length is calculated by the formula [8]

$$\frac{W}{h} = \frac{8\exp(A)}{\exp(2A)^{-2}} \qquad (3)$$

Where W is the width of strip line, h is the height of the substrate and A is given by

$$A = \frac{Z_c}{60}\{\frac{\varepsilon_r + 1}{2}\}^{0.5} + \frac{\varepsilon_r - 1}{\varepsilon_r + 1}\{0.23 + \frac{0.11}{\varepsilon_r}\} \quad (3.1)$$

$$\frac{\lambda_g}{4} \quad \text{where } \lambda_g = \frac{c}{f_r \sqrt{\varepsilon_{reff}}} \qquad (4)$$

$\lambda_g$is the guided wavelength which is nothing but the length of strip line,c is the velocity of light in air. On calculation the length and width of strip line comes to be 3.23 mm and 8.42 mm respectively. The position of the feed line is calculated by the formula [7]

$$R = R_{in}\cos^2(\tfrac{\pi}{L}.y_0) \qquad (5)$$

R is the desired impedance ,R_{in} is the input impedance and y_0 is the position of feed line.

On calculation the position of feed lines comes to be 7.812 mm. Alternatively position of feed line is calculated by thumb rule which says that position of microstrip line is one third of total length of patch(length +width).

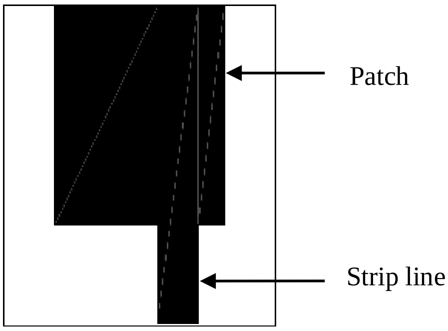

Fig 1(a). Basic Design

For dual band of operation two slot B1 and B are introduced in the patch. Also, to get exact resonance position of feed line is adjusted by some trial and error techniques. Two switch is introduced in order to get single band when it is in OFF state

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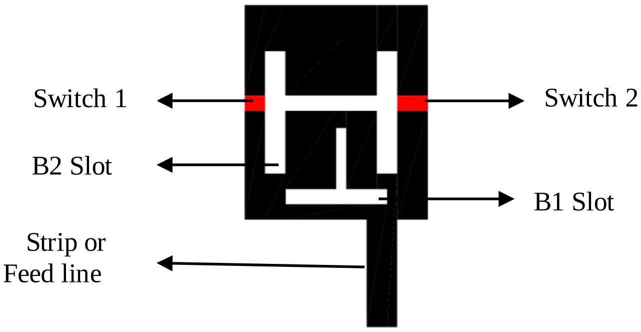

Fig 1(b).Layout of reconfigurable microstrip antenna

Fig 2 (a), shows the effect of rectangular slot B1.It shows that on increasing the width of this slot does not affect the lower frequency but there is a frequency shifting at higher band and also there is a change in return loss. Also this slot is very helpful in suppressing the lower frequency band when the switch is in OFF state .Fig 2(b) shows that variation of length in rectangular slot B2 both the frequency band changes. On increasing the length above 13.2 mm no frequency band is received.

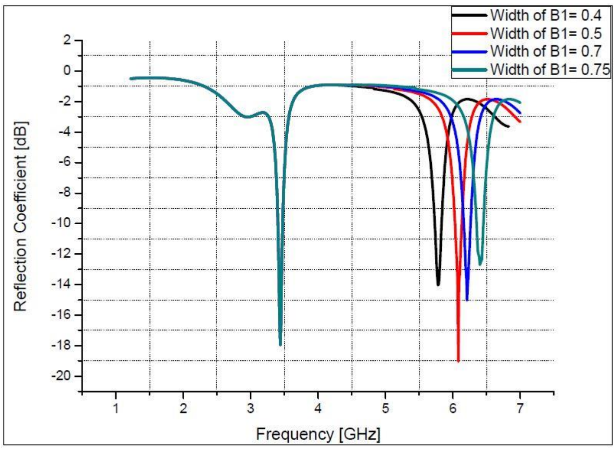

Fig 2(a). Simulated S-parameter for microstrip reconfigurable antenna with different dimensions of the rectangular slot B1.

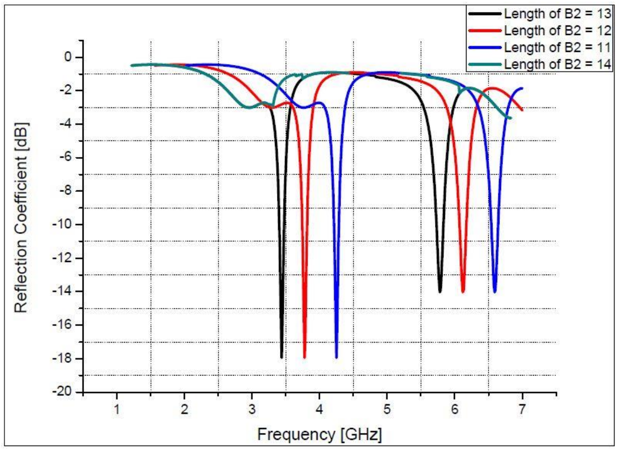

Fig2 (b). Simulated S-parameter for microstrip reconfigurable antenna with different dimensions of the rectangular slot B2.

IV. RESULTS AND DISCUSSIONS

To prove the simulations, a prototype of the proposed antenna was fabricated and their parameters are measured through N5230C PNA-L microwave network analyzer .Fig 3 shows the fabricated antenna prototype with and without switch.

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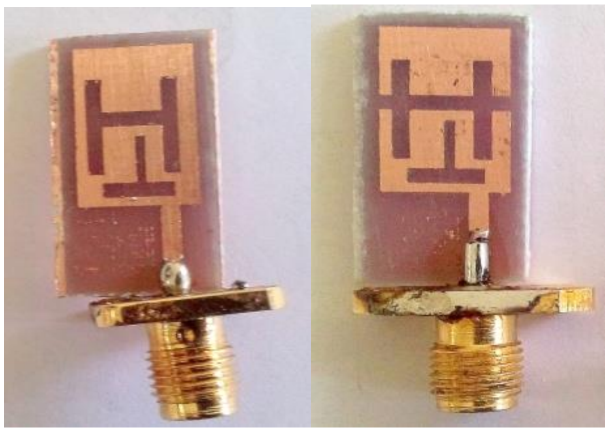

Fig 3. Fabricated Antenna, with and without Switch

A. Frequency Reconfiguration

The simulated and measured reflection Coefficient of the above antenna is shown in Fig 4(a), 4(b)and 4(c). The measured and simulated results are in good agreement. Both the switch play a vital role in the operation of antenna .When both the switch are in ON state, dual band of operation is achieved at 3.48 GHz and 5.89 GHz with -10 dB return loss Bandwidth from 3.42GHz to 3.54GHz and 5.8 GHz to 5.9 GHz. When the switch is in the OFF state only single band of operation exists at 5.87 GHz with -10 dB return loss bandwidth from 5.86 GHz to 5.99GHz.

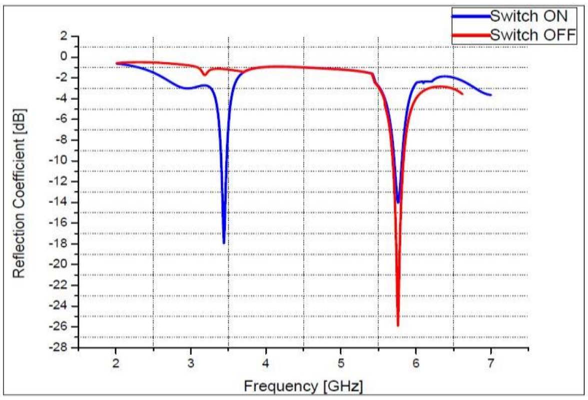

Fig 4(a)Simulated Reflection Coefficient of the reconfigurable microstip antenna

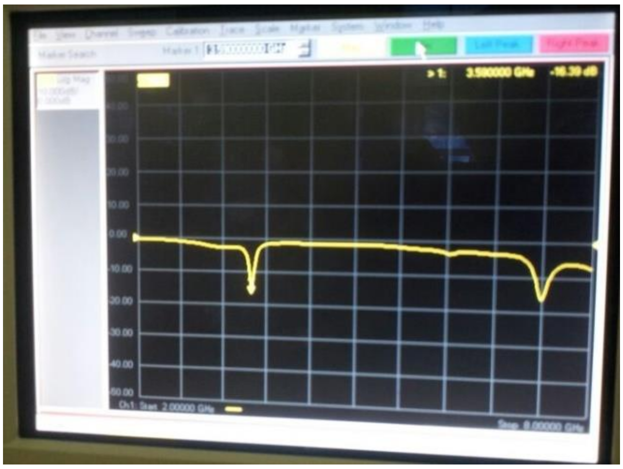

Fig 4(b). Measured Result with Switch ON Condition

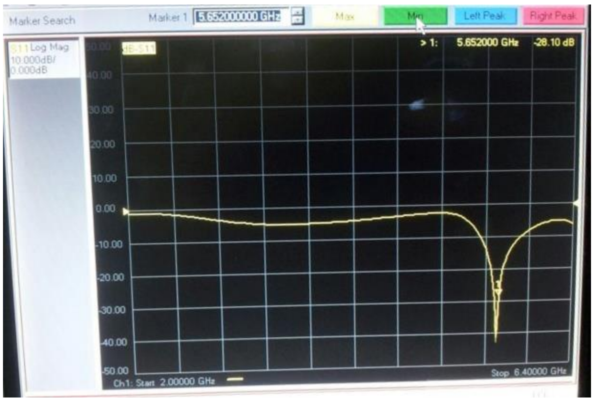

Fig 4(c).Measured Result with Switch OFF condition

B. Radiation Pattern

The radiation pattern is mainly determined by the surface Current distribution .The switch position changes the structure of antenna thereby changing its surface current distribution and ultimately the frequency and radiation pattern. Radiation pattern of antenna with switch ON and OFF is shown in Fig 5 and the surface surface current distribution on antenna is shown in Fig 6.

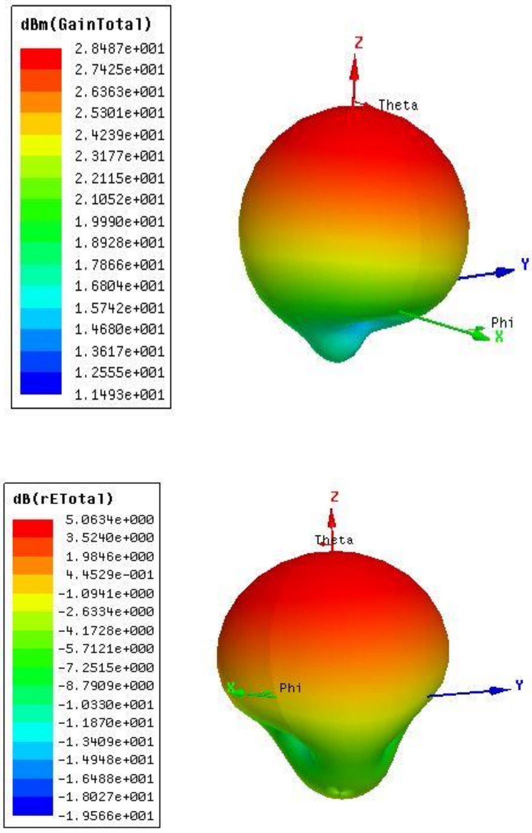

Fig 5. Radiation Pattern of reconfigurable antenna with switch ON and OFF.

V. CONCLUSION

In this paper a single element novel multiband frequency reconfigurable antenna was presented. The parametric study of the antenna is also presented. The two slot B1and B2 affect the frequency and reflection coefficient of this antenna drastically. The above designed antenna provides two very useful frequency band one for WiMax (3.5 GHz) and another for Wi-Fi (5.8GHz) with two switch. Future work will involve implementation of varactor diode or pin diode switches and attain hybrid reconfigurability (i.e. initially attain alteration in the resonant frequency bands and after adjusting each of the bands.

VI. REFERENCES

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