Broadband Reconfigurable Stacked Microstrip Patch Antenna at X-band

Ankita Katyal[1], Ananjan Basu[2]
1. Bharti School of Telecommunications Technology and Management, Indian Institute of Technology, Delhi, India
2. Centre for Applied Research in Electronics (C.A.R.E.), Indian Institute of Technology, Delhi, India

Abstract **–A broadband stacked microstrip patch antenna has been designed and fabricated that operates in X-band frequency region, having 3 GHz bandwidth and almost unidirectional radiation pattern. Gain of the antenna is in the range of 3-7 dB at different frequencies. Frequency reconfigurability has been introduced in the antenna using pin diode to shift the entire 3 GHz band by 300 MHz.**

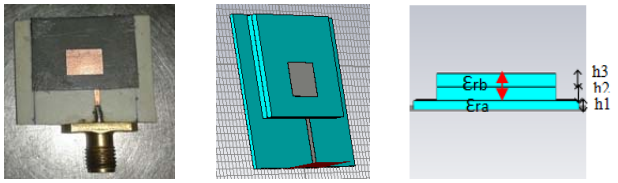
Index terms- **Broadband, Frequency reconfigurablility, Microstrip, Stacked.**

I. INTRODUCTION

Microstrip antennas have advantages of planar profile, cheapness, and easy integration with printed circuits but suffer with limited bandwidth. To overcome this several structures have been investigated in literature among which stacked configuration with large and uniform ground plane has been chosen which helps in achieving unidirectional radiation pattern. Stacked structures reported in literature are either broad band ([3],[4]) or have less BW with unidirectional radiation pattern ([5]).In [6] the antenna is broadband but has probe feed which may not have the ease of integration with all printed circuits. Here the focus is to design stacked microstrip patch antenna having microstrip feed line (printed on thin substrate to avoid surface waves) with wide bandwidth and unidirectional radiation pattern. Thus it can find applications in target scanning for radar detection and other wireless communications.

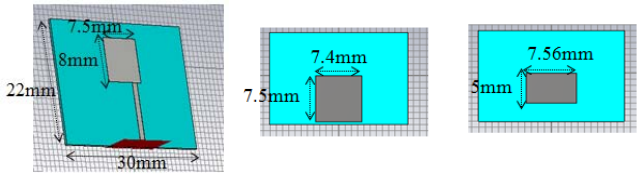
II. ANTENNA DESIGN

The proposed broadband stacked microstrip patch antenna, shown in "Fig.1", operates in the X-band frequency region. Stacking is done over a limited surface area of the lower patch antenna. The lower patch is designed at centre frequency of 10 GHz, at thin substrate of $\in ra$=3.66, h_1=0.508mm and large ground plane using transmission line analysis and some optimization. Feeding is done using shifted 50 ohm microstrip feed line printed over the thin lower substrate to reject spurious waves, as shown in "Fig.2".Feed is connected to the patch without λ/4 transformer to avoid single resonance. Impedance matching is done by shifting the feed to a point that provides the best matching condition (2.5mm from centre). The second and third layer consists of a thicker substrate with $\in rb$= 2.2 and h_2, h_3=0.762mm. Middle patch is designed such that its major section comes above the feed to couple maximum energy; similarly the third patch is designed to maximize the coupling. The main features of proposed antenna are that it is sufficiently broadband, occupies very small area and has a unidirectional radiation pattern. The overall bandwidth is 3 GHz and it has a surface area of 22mmX30mm. The different layers of antenna are joined via silicon paste for measurements to avoid any air gap and can be screwed at later stage.



a) Fabricated antenna b) 3-D view(Simulated c) Side view(Simulated)

Fig. 1 Proposed Antenna Structure



a) Lower layer b) Middle layer c) Upper layer

Fig. 2 Layer by layer view (Simulated)

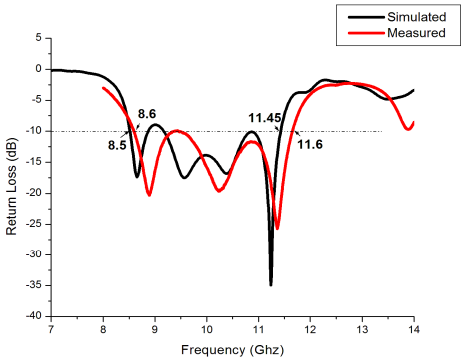
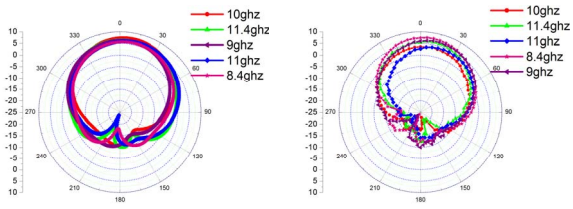


Fig .3 Return loss of proposed antenna



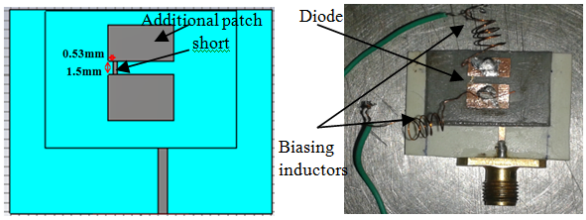
a) Simulated b) Measured

Fig.4 H-plane radiation pattern at different frequencies

Simulated and measured results agree well with each other. The obtained gain values range from 3-7dB at different frequencies.

III. FREQUENCY RECONFIGURABLE ANTENNA DESIGN

A slight variation in the above described antenna structure is being implemented to make it reconfigurable. An additional patch has been introduced in the upper layer which does not affect the antenna performance. But when these two patches in the upper layer are connected to each other via a short, it results in the shift of 200 MHz of the overall frequency band of 3 GHz in simulation while a shift of 300 MHz in measured results when shorted via a pin diode in ON state.



a) Simulated Design b)Fabricated Antenna

Fig. 5 Reconfigurable stacked microstrip antenna

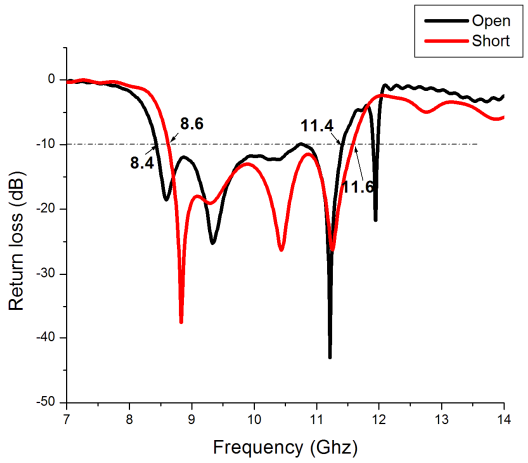


Fig.6 Return loss for open and short condition (Simulated)

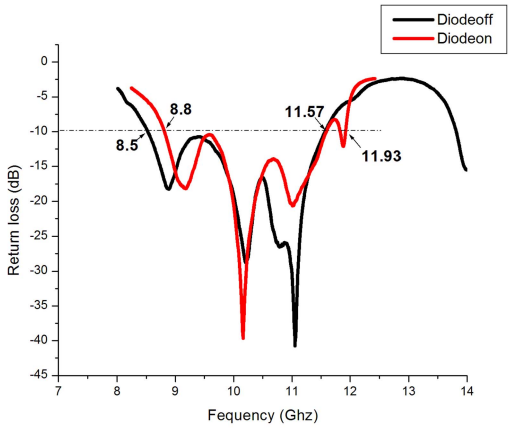
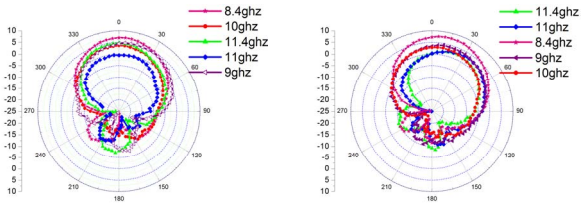


Fig.7 Return loss for diode on and off (Measured)



a) Diode on b) Diode off

Fig. 8 H-plane radiation patterns for diode on and off states

The above described reconfigurable stacked microstrip antenna helps in utilizing the remaining frequencies in the X-band that were left in the original design.The shift in the frequency band is not very large but it shows the scope of the design to shift the entire bandwidth. The radiation patterns show very less variation in on and off states of diode and are almost unidirectional at all frequencies.

IV. CONCLUSION AND FUTURE SCOPE

A broadband reconfigurable stacked microstrip antenna has been designed and fabricated which operates in X-band frequency region. It has unidirectional radiation pattern which makes it useful for target scanning in radar applications and other wireless applications. Introducing the frequency reconfigurability in the design helps in covering otherwise left frequencies in the X-band. The shift in the frequency band can be increased to a considerable amount by further altering the antenna structure and antenna can be made to cover frequencies outside X-band region too. Now shifting of frequency band from C to X band is under process.

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