

Design of A Multiband Pattern Reconfigurable Antenna

D.Rama Krishna,T.Bhaskar,V.M.Pandharipande

Abstract— This Paper presents the design and simulation of a Multiband pattern Reconfigurable Antenna. Switches are being inserted into the antenna geometry, depending upon the switches that are kept on, the antenna works as a Triple/Double/Single Band Pattern Reconfigurable Antenna. The proposed antenna also works as a Wideband Antenna. The Antenna resonates at multiple frequencies in the frequency range from 5 GHz to 12 GHz. One configuration of the antenna was fabricated and return loss characteristics are measured.

Index Terms— Triple Band Antenna, Dual Band Antenna, Single Band Antenna, Wide Band Antenna

1 INTRODUCTION

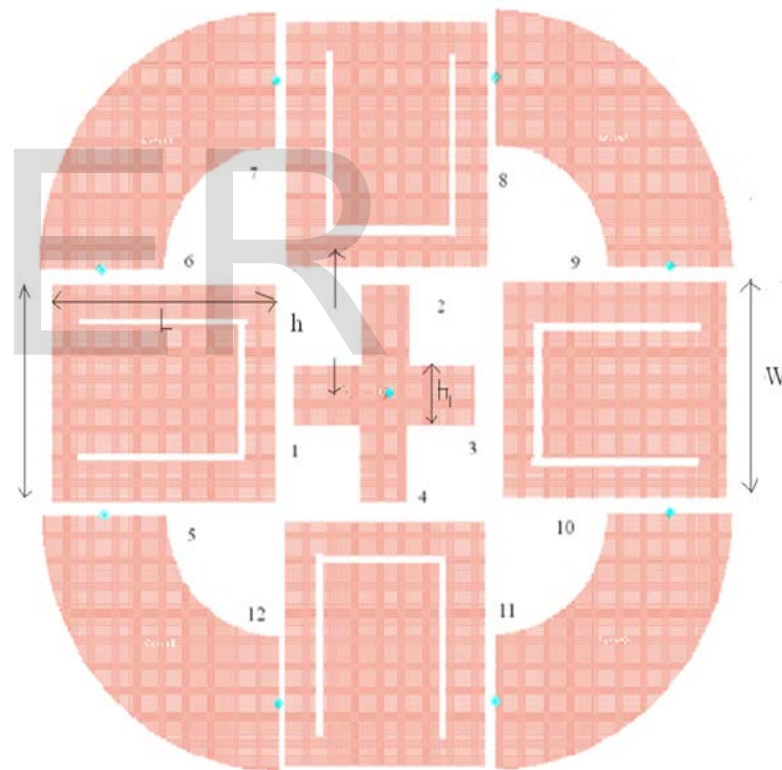
More antennas in a communication system will increase the capacity and diversity of the system. If it is required to either transmit or receive multiple signals at a time then the one has to choose among the following among a . Multiple antennas, b. Multi band antenna , c. Reconfigurable antenna. While multiple antennas provide serious isolation problem, multi band antenna shows degraded performance with respect to SNR when compared to reconfigurable antenna[1]. In this paper design of a multi band pattern reconfigurable antenna has been presented, the proposed antenna simulated using ADS EM solver, RT Duroid of a thickness 1.6 mm and relative permittivity of 2.2 was taken as the substrate for the simulation purpose. Total 12 switches are inserted into the antenna geometry, 9 states (state defined as the antenna configuration when certain switches are kept On and other switches are kept Off) of the antenna were useful. The proposed antenna works as a Triple/Dual/Single Band Pattern Reconfigurable Antenna, it also works as a Wideband Antenna. One configuration of the proposed antenna was fabricated on the FR4 substrate with relative permittivity 4.4, thickness of the substrate was taken as 1.6 mm, return loss characteristics of the fabricated antenna were measured.

2 ANTENNA DESIGN

A Microstrip patch of size 8X9 that resonates at 11 GHz has been chosen. The Patch was loaded with a U shaped slot of total length 18.3 mm . Four patches were placed in four directions, arc shaped bends were taken so that they can be connected to desired patch, the arc shaped bends are placed close to the slot loaded patch so that the coupling effects should come into effect, the arc radius and width were chosen from trial and error method, a common feed is given at the center of the antenna with a coaxial probe.

- D.Rama Krishna is currently working as a Assistant Professor at Dept.of ECE,Osmania University INDIA. E-mail:dasariramakrishna@yahoo.com.
- T.Bhaskar is currently working as a Lecurer at IIIT,RGUKT,Hyderabad,INDIA. E-mail: eichersuna@gmail.com.
- V.M.Pandharipande is Currently Serving as a Vice Chancellor of Dr.Babasaheb Ambedkar Marthwada University, Aurangabad INDIA. E-mail: vijaympande@yahoo.com.

The Antenna shows multiple bands due to the slot loaded patch, parasitic patch loading (the bends), coupling between



the slot loaded patch and the bends.

Fig. 1. Antenna Top side view
($W= 8\text{ mm}$, $L=9\text{mm}$, $h=5\text{ mm}$ and $h_1= 1.9\text{ mm}$.)
(1,2,3,4,5,6,7,8,9,10,11,12 are the switch numbers)

The Geometry of the Antenna: we have patch dimensions as $L=9\text{ mm}$ and $W=8\text{ mm}$ and for the slots we have a slot width of 0.3 mm and slot longer arm of 6.8 mm and shorter arm of 5.3 mm , the gap between the bend loads and the patch is 0.5 mm and the other parameters are explained in figure, and the bends are of 5 mm width and radius of 7 mm .

3 SIMULATION AND TEST RESULTS

The proposed structure has been simulated in different configurations (based on different switching combinations), out of which the following are some of the useful configurations

- Antenna 1: Switch 1,2,3,4,5,6,9,10 are ON
- Antenna 2: switch 1,2,3,4,7,8,11,12 are ON
- Antenna 3: switch 1,2,3,4,7,8, are ON
- Antenna 4: switch 1,2,3,4, are ON
- Antenna 5: switch 1,3 are ON

In the simulation and while testing the antenna when Switches are in on states metallic strip length of 1.0 mm and width of 1.0 mm are used when the Switches are in off-states, metallic strips were removed from the geometry leaving the gap of 1.0mm. Based on the obtained simulated results the useful configurations of the antenna have been discussed which include, configurations in which antenna works as Triple/Dual/Single band antenna.

3.1 Triple band Pattern Reconfigurable Antenna

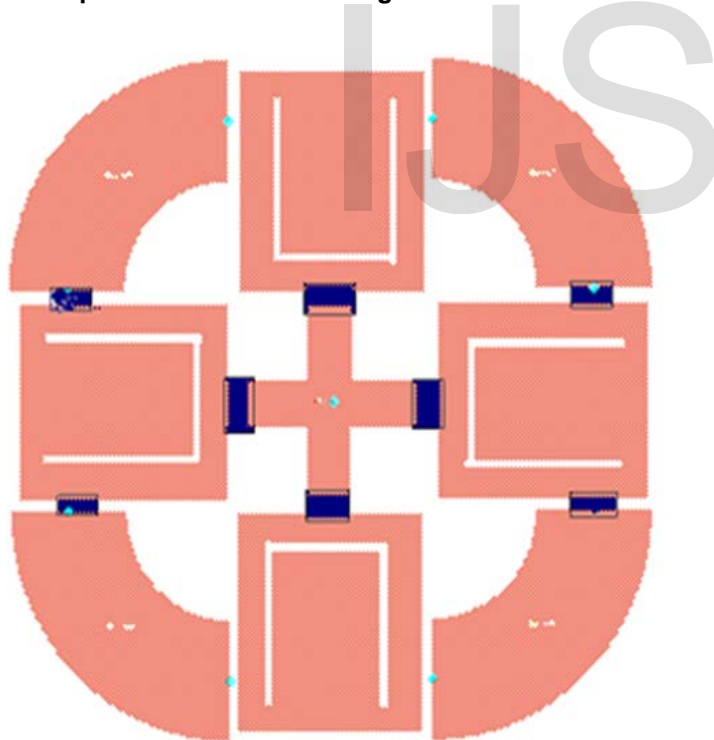


Fig 2. Antenna 1 structure.

The return loss characteristics of Antenna 1 (fig 3), Antenna 2 (fig 4), are very similar, both have three resonances. The 3D Radiation Pattern of the Antenna 1 (fig 6) and Antenna 2 (fig 7), both are different and one can be obtained from the other by

rotating 90 degrees. This shows that proposed antenna works as a triple band pattern reconfigurable antenna.

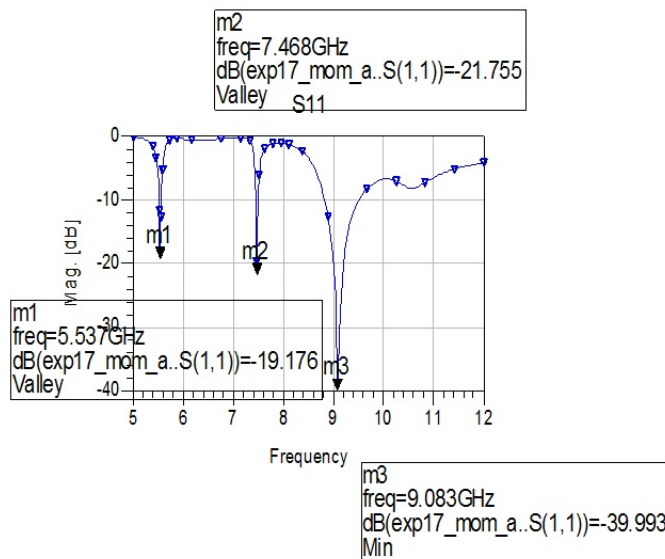


Fig 3. Antenna 1 return loss characteristics

Antenna 1 was fabricated on the FR4 substrate with $\epsilon_r = 4.4$, height of the substrate is 1.6 mm. The measured return loss for Antenna 1 (fig 8) are shown in fig 9. The antenna retained its triple band performance, the resonance frequencies are shifted by a factor of 0.73, this is due to increase in the effective dielectric constant by a factor of 1.9 as the resonant frequency is inversely proportional to the square root of the effective dielectric constant. Even though the antenna was fabricated on different substrate, the antenna retained its performance. This shows the versatility of the design.

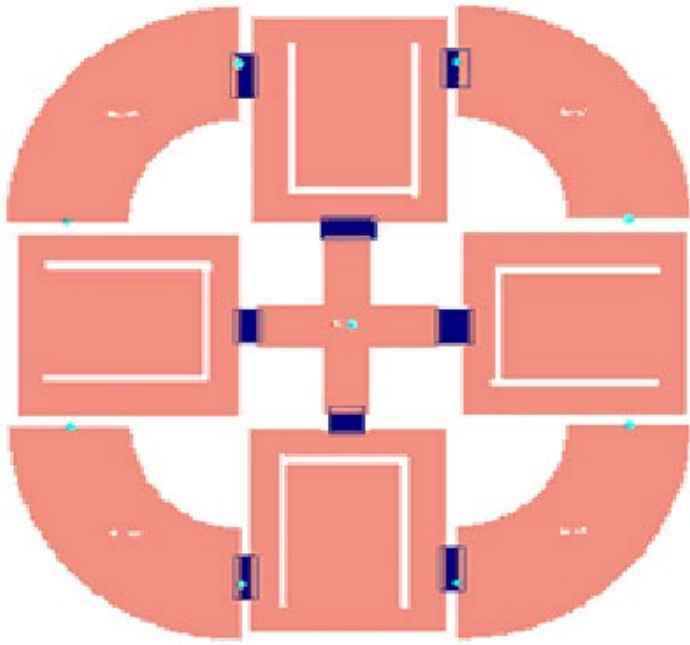


Fig 4. Structure of Antenna 2 .

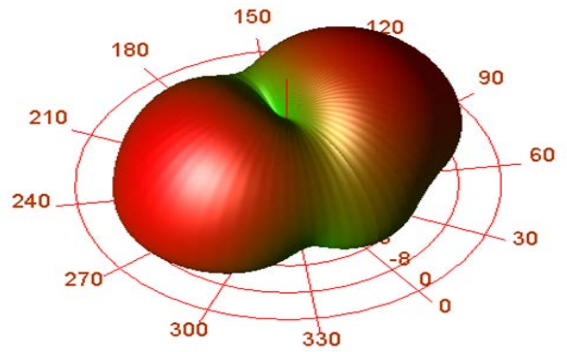


Fig 6. Radiation pattern of Antenna 1 (3D).

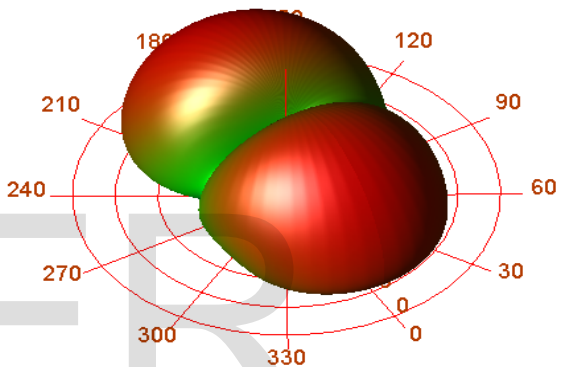


Fig 7 Radiation pattern of Antenna 2 (3D).

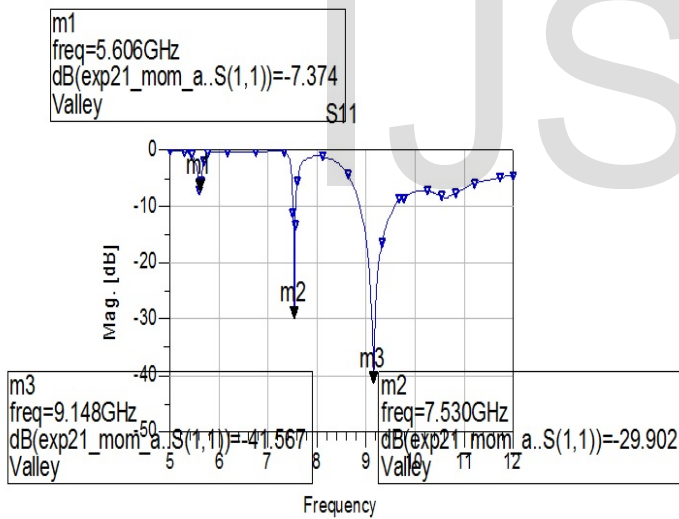


Fig 5. Return loss of Antenna 2.

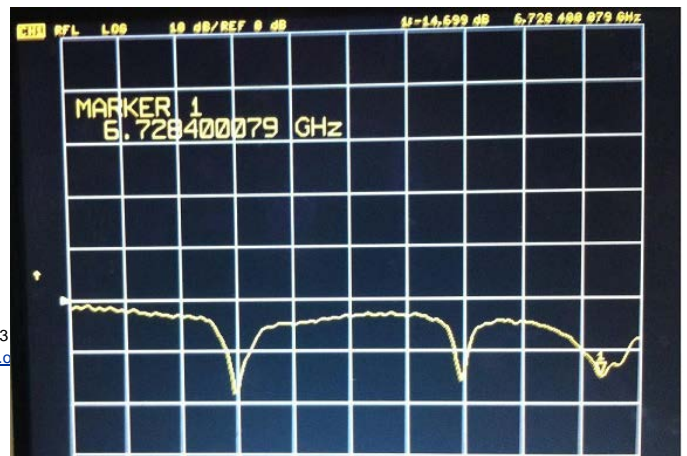




Fig 8 Photograph of the fabricated Antenna(Antenna1).

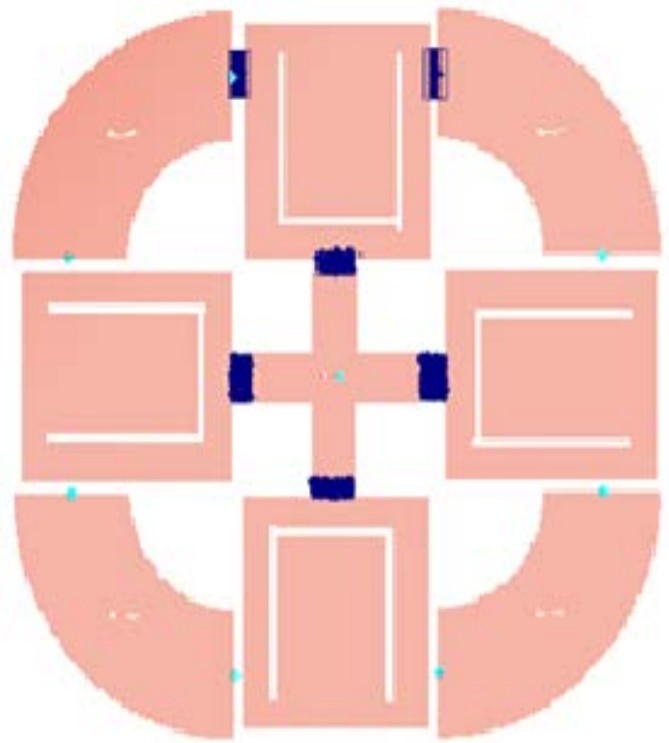


Fig 10 Structure of Antenna 3.

Fig 9 Measured Return loss For Antenna 1.

3.2 Dual band Antenna

Antenna 3 (fig 10) resonates at two frequencies (fig 11), the 7.4 GHz resonant frequency got suppressed because of the removal of two parasitic bend loads, which leads to low coupling between the bends and the slot loaded path when compared to Antenna 1/Antenna 2. Three more Antenna configurations of the Antenna3 can be formed by connecting two bends at a time to each of the patches (config1-1,2,3,4,9,10 switches are kept On, config2- 1,2,3,4,11,12 switches are kept On, config3- 1,2,3,4,5,6 switches are kept On), all the configurations have similar S11 characteristics, but their radiation patterns are different, the proposed antenna works as a dual band pattern reconfigurable antenna.

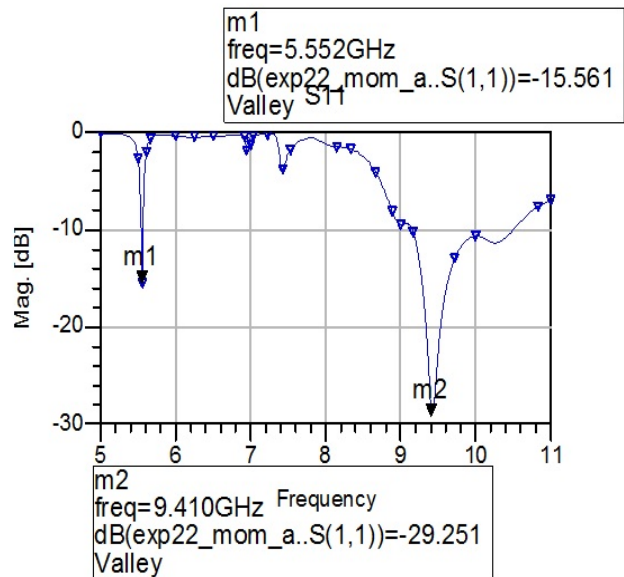


Fig 11 Return loss characteristics of Antenna 3.

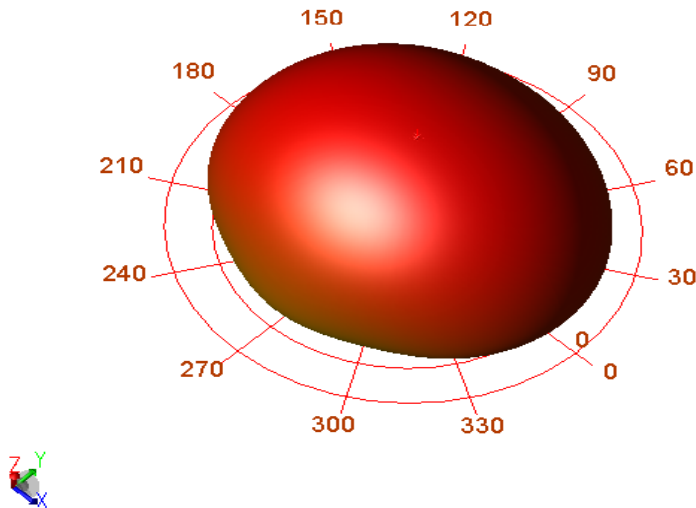


Fig 12 Antenna 3 Radiation pattern (3D).

3.3 Wide band antenna

Antenna 4 (fig 13) works as a wide band antenna. It offers a bandwidth of almost 1GHz (taken S11 below -10 dB, (ref fig 14)). All the parasitic bends were disconnected, which leads to poor coupling among the slot loaded patch and the bends, this leads to suppression of 7.4 GHz, there is no 5.6 GHz resonant frequency due to the fact that the resonance causing bends were removed, in this way by properly controlling the bend loads we can get the Multiband performance for a microstrip antenna.

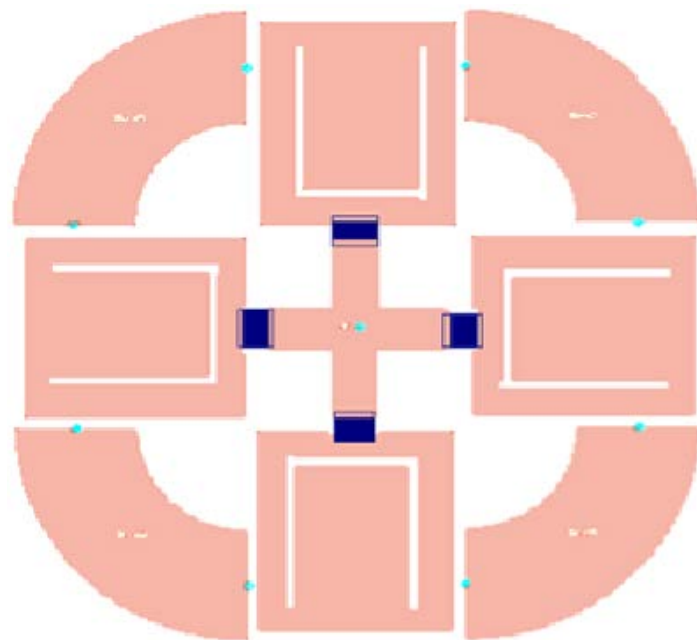


Fig 13. Structure of Antenna 4.

3.4 Single Band Pattern Reconfigurable Antenna

Antenna 5 (fig 16), where only two slot loaded patches are switched On, the antenna oscillates at 11.33 GHz (fig 17), compared to Antenna 4 , in Antenna 5 the impedance match is the best at 11.33 GHz, as expected Antenna 5 radiation pattern (fig 18) has two lobes. One more configuration of the Antenna can be obtained by switching On two slot loaded Patches in vertical direction (switches 2,4 are kept), from the symmetric shape of the antenna, one can say that the other configuration of the Antenna 5 also have S11 characteristics similar to Antenna 5, at the same time we will get the different radiation pattern, the proposed Antenna works as a Single Band Pattern Reconfigurable Antenna.

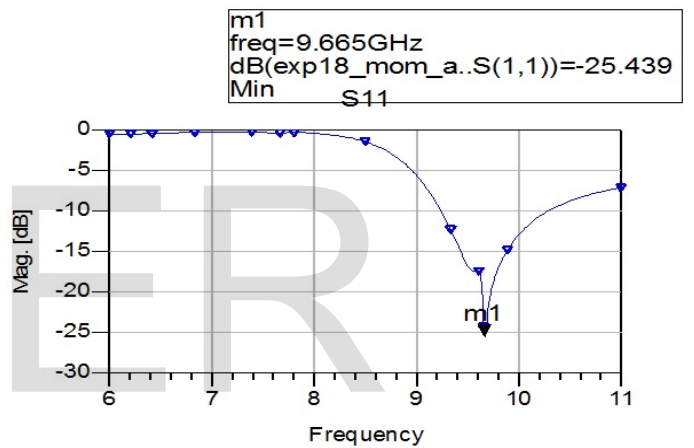


Fig 14 Return loss characteristics for Antenna 4.

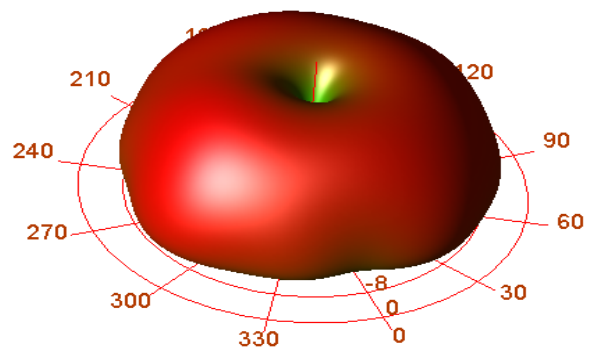


Fig 15 3D Radiation pattern of Antenna 4.

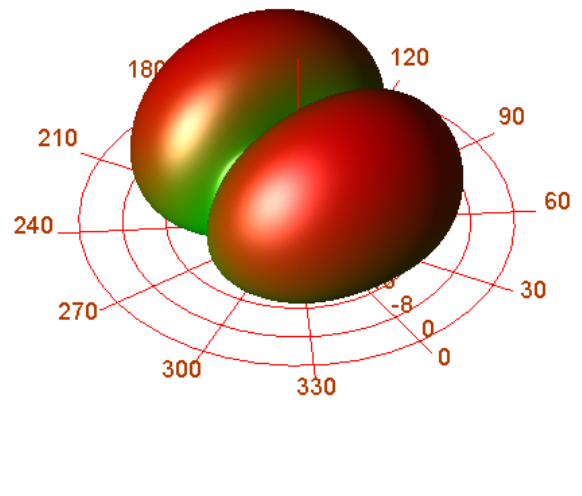
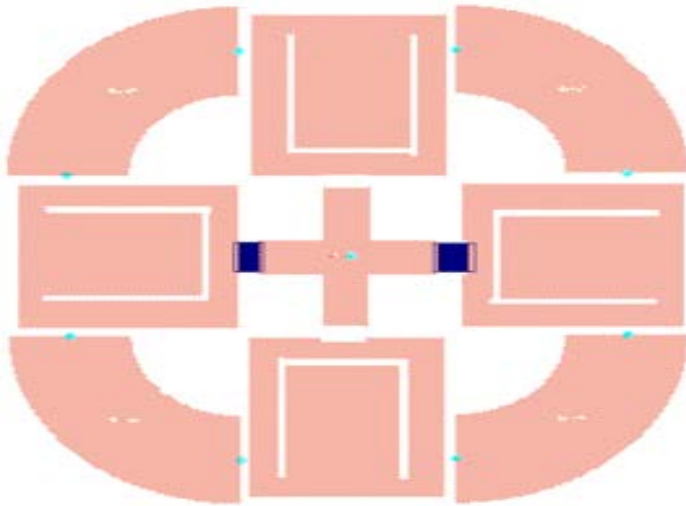


Fig 18 3D Radiation pattern for Antenna 5.

Fig 16 Structure of Antenna 5.

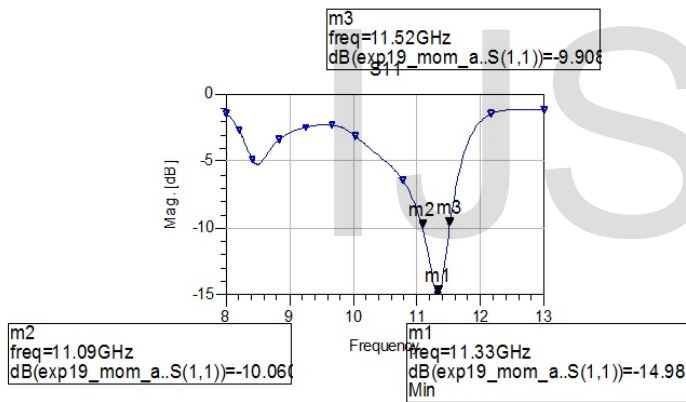


Fig Return loss 17 characteristics for Antenna 5.

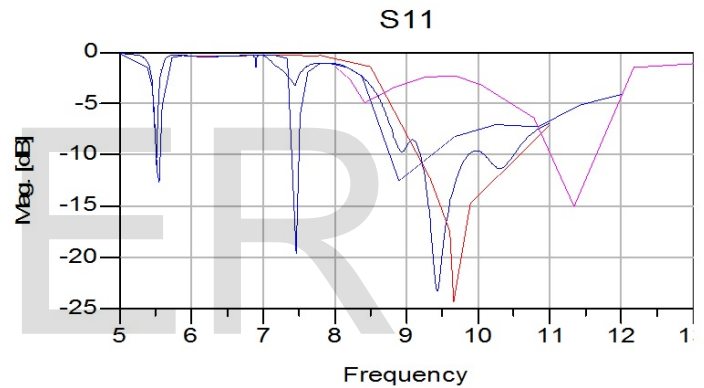


Fig 19 Return loss of all the five Antennas taken on a single graph.

4 CONCLUSIONS

A Multi Band Pattern Reconfigurable Antenna, which oscillates at multiple frequencies in the range from 5 GHz to 12 GHz has been designed. Simulation and measured results show that the proposed design can be used to design Multi Band Reconfigurable Antennas, with proper slot loading and proper parasitic patch loading, by making use of coupling among the Microstrip patch, Multiple bands can be obtained. Moreover the proposed Antenna has a wide tunable range. Improvements in the design can be done by inserting true switches into the Antenna geometry, controlling the switches with a control circuit will make the switching between different states of the Antenna easier.

Acknowledgment

The authors wish to gratefully acknowledge Centre For Excel-

lence in Microwave Engineering (CEME) of Osmania University, Hyderabad, India.

REFERENCE

[1] Frequency-Reconfigurable Antennas for Multi radio Wireless Platforms-Songnan Yang, Chunna Zhang, Helen K. Pan, Aly E. Fathy, and Vijay K. Nair.

IJSER