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A Novel Frequency Reconfigurable Antenna Using GaAs FET switches for RLANs, PCS, WiMax, and Satellite communication Applications

Shagufta Parveen Asif Akhtar* Amit Kumar

***Abstract*— A compact frequency reconfigurable antenna which could be easily switched between a narrowband state and a dual-band state is presented in this paper. The narrow band covers (5.3-6.1 GHz) where (5.470 – 5.850 GHz) is used for short Range devices (RLANs), and the dual-band Covers (1.89-4.1 GHz) which can be use for PCS (1.85-1.99 GHz) and WiMAX (3.4-3.69GHz) and it also cover (18.02-20.6GHz) which can be used for Fixed Sattelite services .The reconfigurability is achieved by using two GaAs field effect transistor switches to change the length of the current flow path. The switch can be directly driven by digital signal, and no bias network is needed. The antenna is fabricated on FR4 epoxy substrate. The proposed antenna is well suited to be integrated within the wireless handheld devices**

***Index Terms*— Compact antenna, frequency reconfigurable antenna, GaAs field effect transistor (FET) switches, Octagonal ring shape Patch**

I.INTRODUCTION

WITH the rapid development of wireless communication technologies, reconfigurable antennas have attracted much attention in the recent years. There are various reconfigurable antennas, such as frequency reconfigurable antenna [1], pattern reconfigurable antenna [2], and polarization reconfigurable antenna [3]. For frequency reconfigurable antenna, the preference performance is that the reflection coefficient, radiation patterns and gain unchanged as antenna reconfiguration. In general, operating states of the reconfigurable antenna can be realized by employing PIN-diode, microelectromechanical systems (MEMS) switches, varactor diodes or GaAs field effect transistor (FET) as tunable components.

Many reconfigurable antennas are designed based on PIN diodes because of low cost and easy assembly, .However; the high power loss of the PIN-diodes limits their applications. In recent years, due to the developments of the MEMS technology, reconfigurable antennas design using MEMS switches have attracted much attention. Compared to PIN-diodes, MEMS switches have lower power loss, higher Isolation and linearity. But the MEMS switches control voltage is relatively high, which will increase the complexity of the communication systems. Moreover, the reliability of the MEMS switches also need to be further improved. In addition, varactor diodes are also commonly utilized for obtaining continuous frequency reconfigurablility. Whereas integrating GaAs FET in the reconfigurable monopole antenna achieved remarkable reconfigurable capability. The aforementioned switching techniques improveon the design of the reconfigurable antennas. However, each design needs direct-current (dc) biasing circuits to bias the switch components, which will inevitably increase complexity of the antenna structure and affect the electromagnetic (EM) performances of the antennas.

Generally, GaAs FET switches have low insertion loss and good switching speed. Especially, some kind of GaAs FET switches can be driven without dc bias. In this paper , a compact frequency reconfigurable antenna integrated with two GaAs FET switchs is proposed. The structure of the antenna is easy assembling with GaAs FET switches. The bias network and blocking capacity are not required in the antenna. The switch can be driven directly by digital signal (such as 3.3 V CMOS level). By changing the state of the GaAs FET switch, the operating bands of the antenna are altered between narrowband state and dual-band state. The proposed antenna is simple, compact and easy to fabricate.

A microstrip patch antenna consists of conducting patch on a ground plane separated by dielectric substrate. copper or gold. The shape of the patch could be square, rectangular, circular, elliptical, semicircular, hexagonal, triangular or other common shape. Length, width, input impedance, gain and radiation patterns are main parameters to characterize a microstrip antenna. For proper matched input impedance there are four types of feeding techniques like Microstrip line feed, Coaxial feed, Aperture coupled feed, Proximity coupled feed. In this design we are using Microstrip line feed technique Conducting patch is made of conducting material such as

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2. THEORY AND DESIGN APPROCH

The proposed antenna is examined and designed by simulation software program Ansoft HFSSv.13, based on three dimensional (3D) full-wave finite element method. The

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Shagufta Parveen Asif Akhtar, persuing M.Tech in RF & Microwave Engineering from Swami Vivekanand Subharti University,Meerut (India).

proposed antenna design is simulated on rectangular substrate.and the switching method is used GaAs FET switch.

The geometry of Octagonal ring MPA is designed on 30mm X 30mm FR4 epoxy substrate with a dielectric constant and tangent loss of 4.4 and 0.025 and thickness of 1.6mm where an Antenna consist of a microstrip feedline, one strip line, aoctagonal ring, two switchs . The impedance of a feed line is 50Ω.The bottom side metallization area partial ground plane with size of 30mm X 9mm . The switch control signal, such as 3.3 V COMS level, can be directly fed to driving lines to activate/deactivate the switch. The switches are placed at two place on the strip line right and left side of feeding line. By altering the state of GaAs FET switch, the operating mode can be changed .When the switch is oFF the length of strip gets shorter and it gives Narrow band, the frequency band ranges from 5.3-6.1GHz with the center frequency 5.7GHz. when the switch ON the length of the strip gets longer and it gives dual frequency band one frequency band ranges from (1.89-4.06GHz) with the center frequency 3.32GHz and the other frequency band ranges from 18.02-20.6GHZ with the center frequency 19.56GHz.

I. STRUCTURE OF ANTENNA

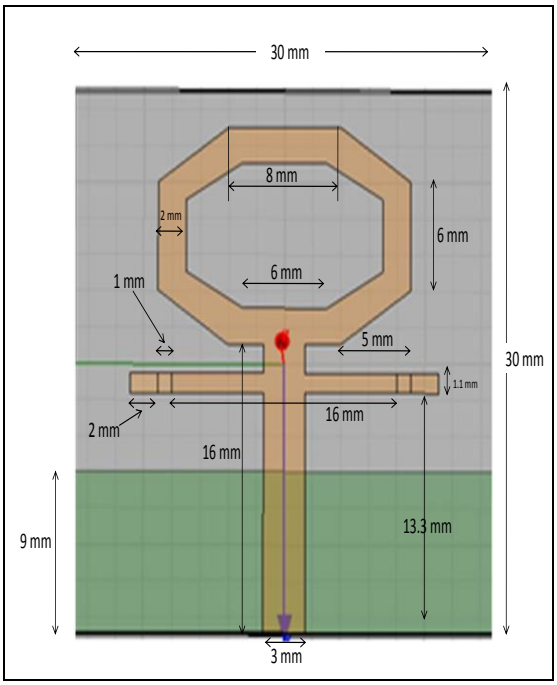

Fig 1: Geometry of Proposed antenna

IV. MODE OF OPERATION

Mode 1: Narrow band, when both the switches are OFF:

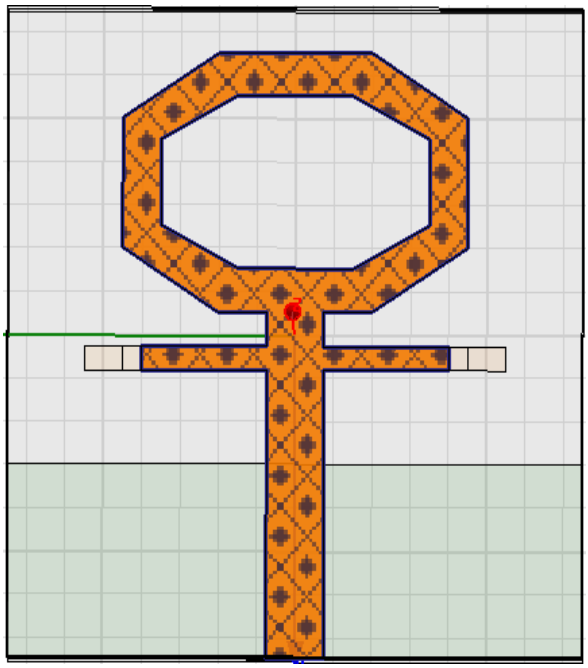

Fig2: Geometry of Antenna in Narrow band mode

Mode 2: Dual band, when both the switches are ON:

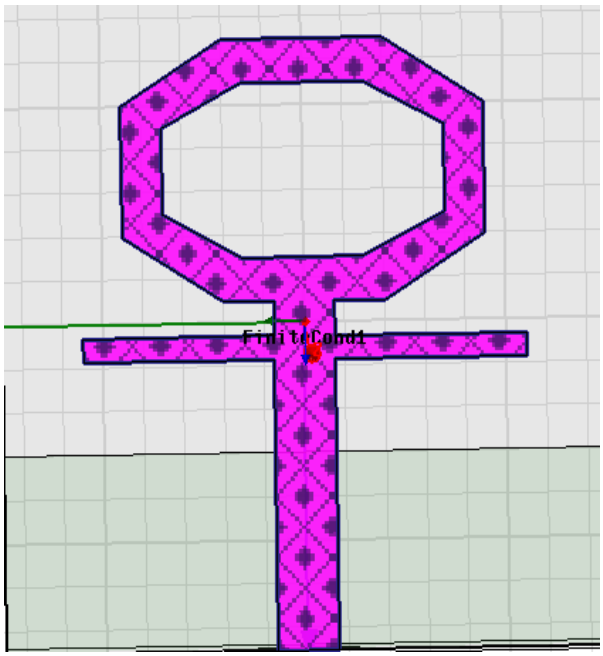

Fig3: Geometry of Antenna in dual band mode

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V. ANTENNA SIMULATION AND RESULT

1) RETURN LOSS

When the load is mismatched, the whole power will not delivered to the load and is a return of power is called loss, and this loss that is returned is called the return loss. Larger return loss indicates higher power being radiated by the antenna which eventually increases the gain. In this Figure 4, it show that the Narrow band microstrip patch antenna resonating at 5.7GHz having a maximum return loss of -41.4db and impedance bandwidth at -10 db are 840MHz. whereas Fig5, shows two frequency bands , first frequency band with center frequency 3.32 GHz having maximum return loss of -28.31db and bandwidth 2.17GHz and the second frequency band with center frequency 19.5GHz having maximum return loss of -27.56dbwith band width 2.58GHz

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SIMULATED S11 PARAMETER OF ANTENNA

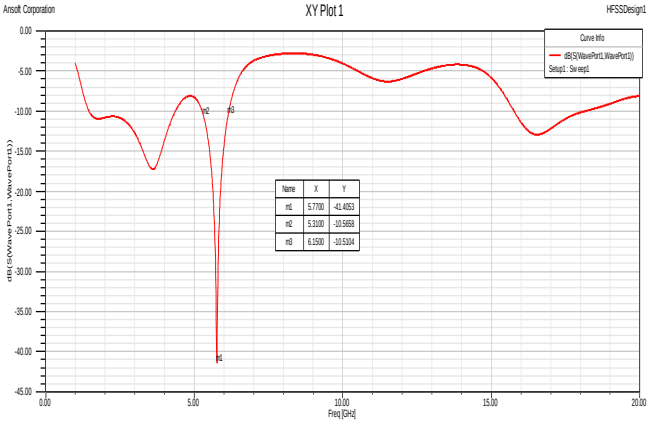

Fig4: Return Loss in Narrowband mode

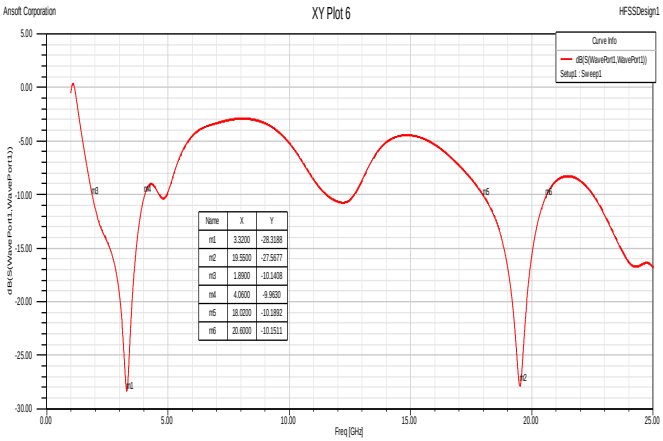

Fig5: Return Loss in Dual band mode

2) VOLTAGE SIGNAL WAVE RATIO

VSWR is a measure of how well matched Antenna is to cable impedance. A perfectly matched antenna whould have a VSWR of ratio 1:1. This indicates howmuch power is reflected back or transferred into a cable. high VSWR implies that the port is not properly matched , for good matching VSWR should be always less than 2.

SIMULATED VSWR OF ANTENNA:

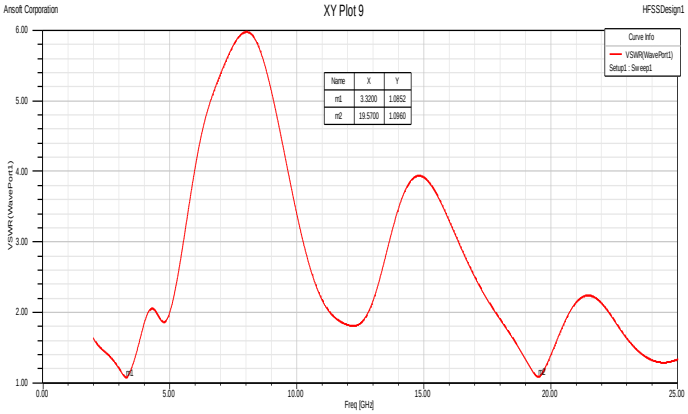

Fig 6: VSWR for Narrow band

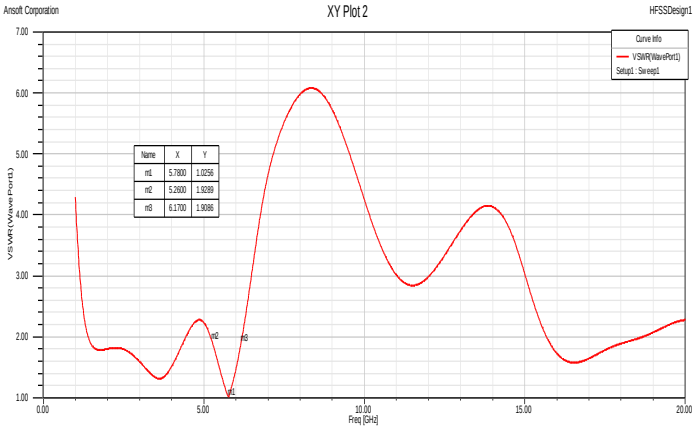

Fig 7: VSWR for Dual band

3) RADIATION PATTERN

The radiation pattern of microstrip Patch Antenna is the power radiated or received by the antenna. It is the function

of angular position and radial distribution from the antenna. The radiation pattern for the proposed microstrip patch antenna is show below.

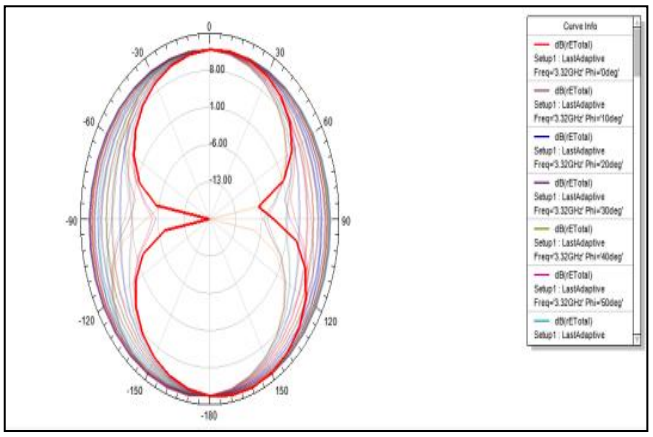

Fig8: Radiation pattern at resonant frequency 3.32GHz

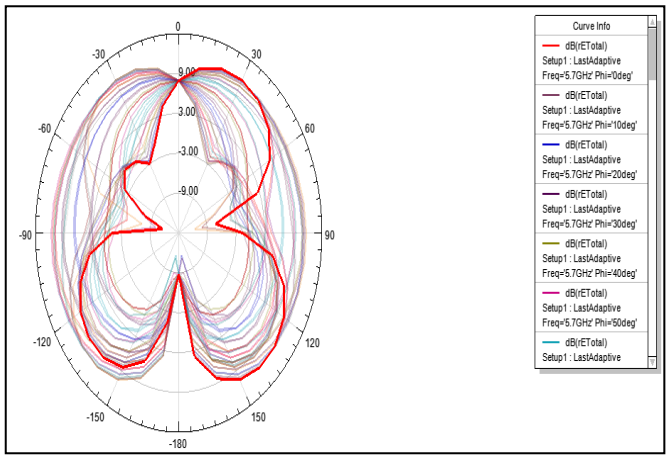

Fig9: Radiation pattern at resonant frequency 5.7GHz

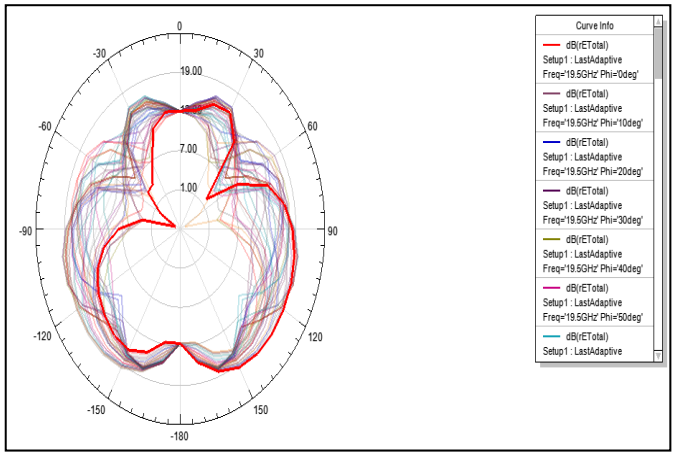

Fig10: Radiation pattern at resonant frequency 19.5GHz

4) 3D POLAR RADIATION PATTERN OF ANTENNA

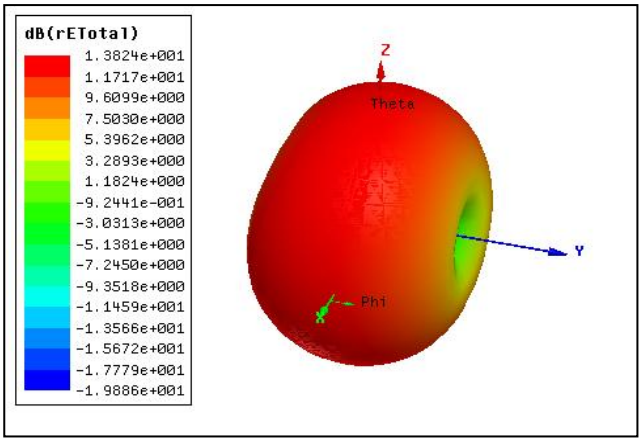

Fig11: 3D Polar Radiation Pattern at resonant Freq 3.32GHz

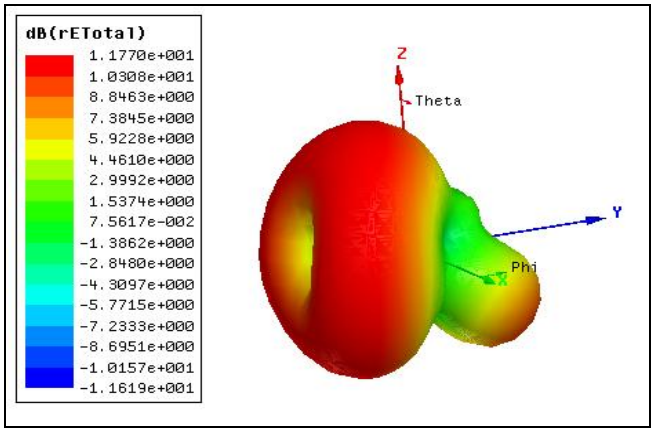

Fig12: 3D Polar Radiation Pattern at resonant Freq 5.7GHz

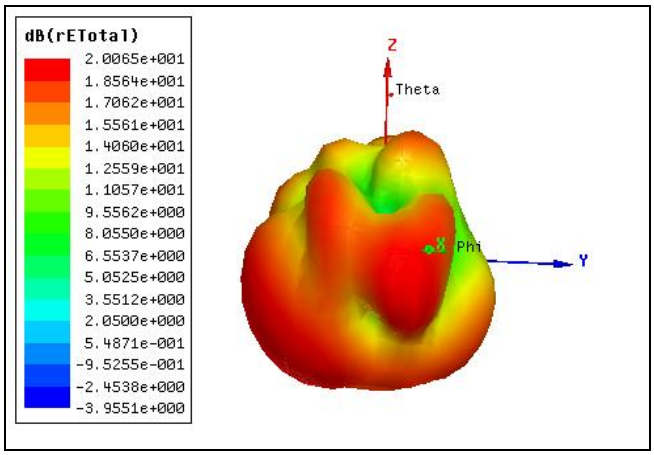

Fig13: 3D Polar Radiation Pattern at resonant Freq 19.5GHz

VI. CONCLUSION

A novel frequency reconfigurable microstrip patch antenna with two GaAs FET switches on both side of feedline of strip line of antenna has been designed.The switch can be directly driven by digital signal. The bias network and blocking capacities are not needed. By making switches OFF or ON the resonant frequency of antenna can be switched from 3.32 GHz to 5.7GHz and 19.5GHz. The proposed antenna is easy to design and fabricate. The proposed Antenna can be used for the RLANs,PCS, WiMAX and Sattelite Communication purposes. Further research on frequency band and return loss can be done by altering the size of octagonal ring or by changing the height of ground plan or by changing the shape of a ring.

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Shagufta Parveen Asif Akhtar has done Diploma in Industrial Electronics in 2003 from Maharashtra State Board of Technical Education and received the B.E degree in Electronics Engineering from Mumbai University in 2007 and persuing M.Tech in RF & Microwave Engineering from Swami Vivekanand Subharti University,Meerut (India). Her area of interest is reconfigurable antennas, Fractal antennas.

Amit Kunar, working as Assitant professor in Subharti Institute of Technology & Engineering, Swami Vivekanand Subharti University Meerut (India), having 8 years of teaching experience, his area of interest is MEMS technology and Microstrip Antenna.