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

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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 – 5.850G Hz) is used for short Range devices (RLANs), and the dual-band Covers (1.89-4.1 GHz) which can be used 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.

KEYWORDS: 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, micro electromechanical systems (MEMS) switches, varactor diodes or GaAs field effect transistor (FET) as tenable 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 micro strip patch antenna consists of conducting patch on a ground plane separated by dielectric substrate. Conducting patch is made of conducting material such as copper or gold. The shape of the patch could be square, rectangular, circular, elliptical, semicircular, hexagonal, triangular or

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other common shape. Length, width, input impedance; gain and radiation patterns are main parameters to characterize a micro strip antenna. For proper matched input impedance there are four types of feeding techniques like Micro strip line feed, Coaxial feed, Aperture coupled feed, Proximity coupled feed. In this design we are using Micro strip line feed technique.

II. THEORY AND DESIGN APPROACH

The proposed antenna is examined and designed by simulation software program Ansoft HFSSv.13, based on three dimensional (3D) full-wave finite element methods. The proposed antenna design is simulated on rectangular substrate. 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 micro strip feed line, one strip line, octagonal ring, two switches . 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 places 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 centre 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 centre frequency 3.32GHz and the other frequency band ranges from 18.02-20.6GHZ with the centre frequency 19.56GHz.

III. STRUCTURE OF ANTENNA

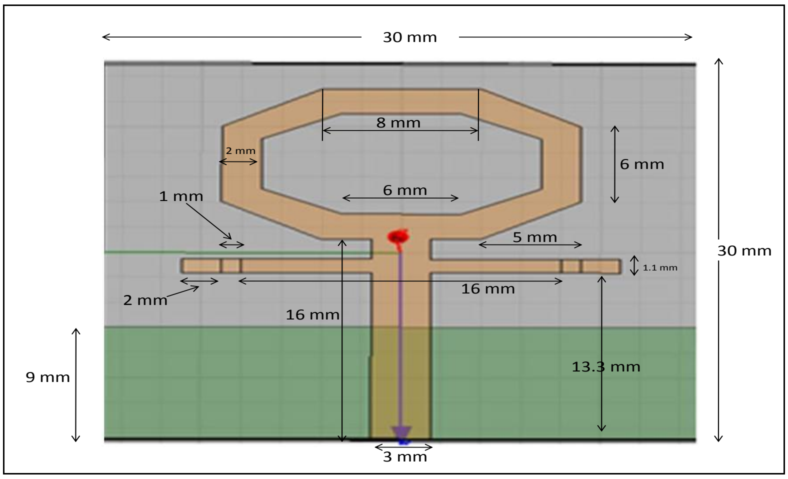

Figure 1: Geometry of Proposed antenna.

IV. MODE OF OPERATION

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

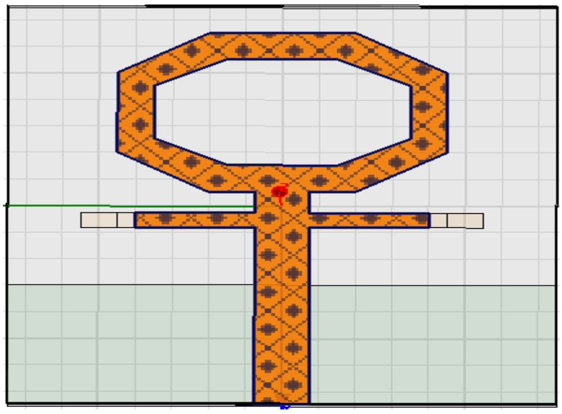

Figure 2: Geometry of Antenna in Narrow band mode.

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

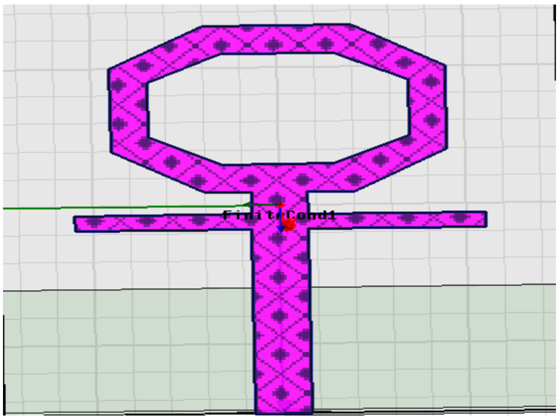

Figure 3: Geometry of Antenna in dual band mode.

V. ANTENNA SIMULATION AND RESULT

5.1. Return Loss:

When the load is mismatched with load, the whole power will not delivered to the load and is a return of the power, that 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 micro strip patch antenna resonating at 5.7GHz having a maximum return loss of -41.4db and impedance bandwidth at -10 db are 840MHz. whereas Figure 5, shows two frequency bands , first frequency band with centre frequency 3.32 GHz having maximum return loss of -28.31db and bandwidth 2.17GHz and the second frequency band with centre frequency 19.5GHz having maximum return loss of -27.56dbwith band width 2.58GHz.

5.1.1. Simulated S11 parameter of Antenna;

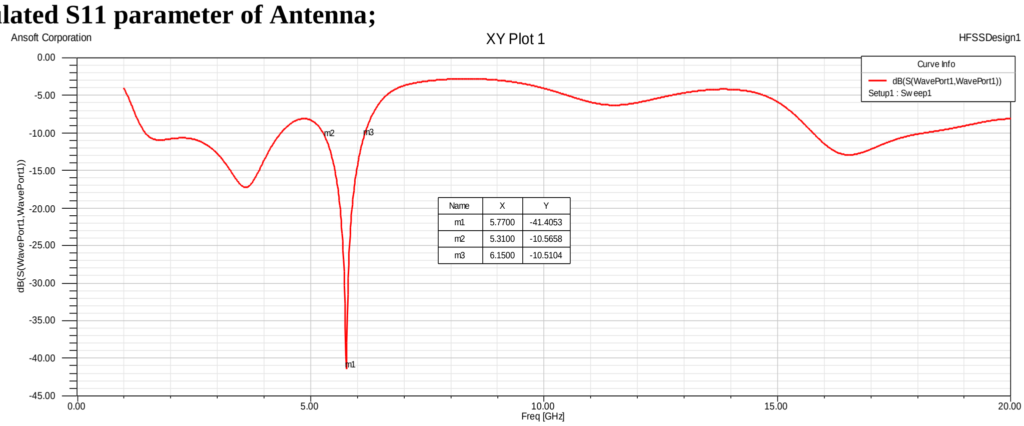

Figure 4: Narrow band mode**.**

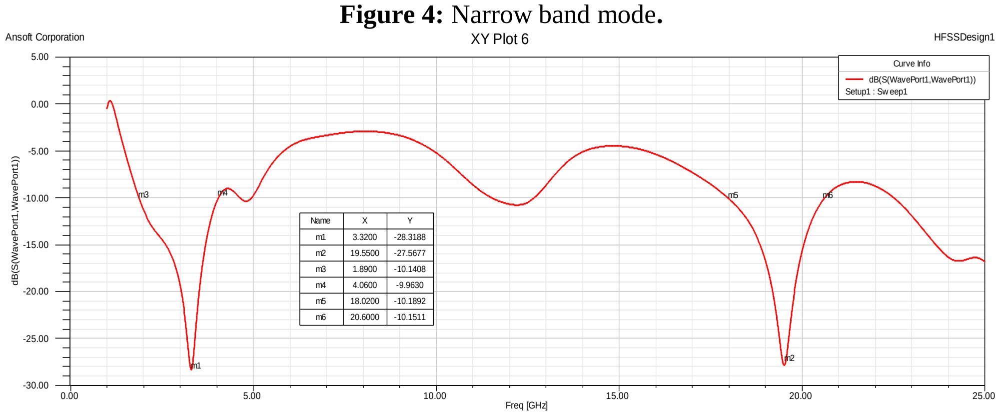

Figure 5: Dual band mode.

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5.2. Voltage Signal Wave Ratio:

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

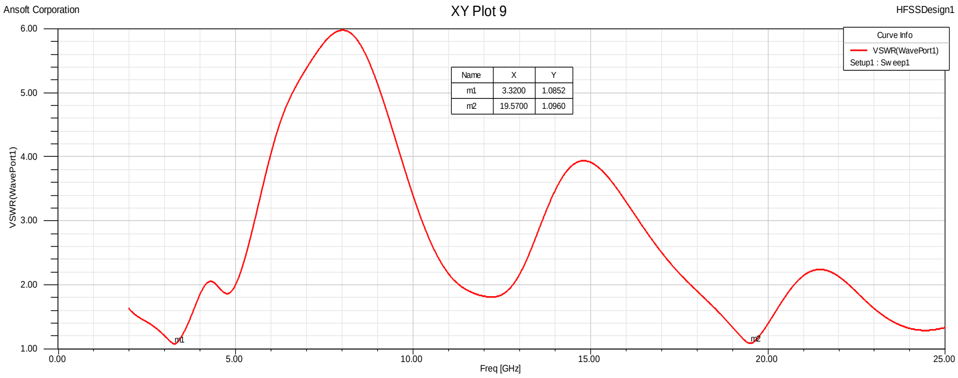

Figure 6: VSWR for Narrow band.

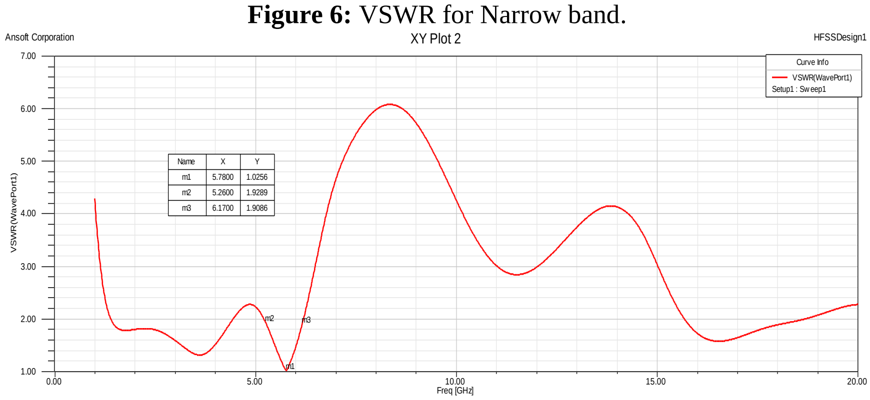

Figure 7: VSWR for Dual band.

5.3. Radiation pattern:

The radiation pattern of micro strip 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.

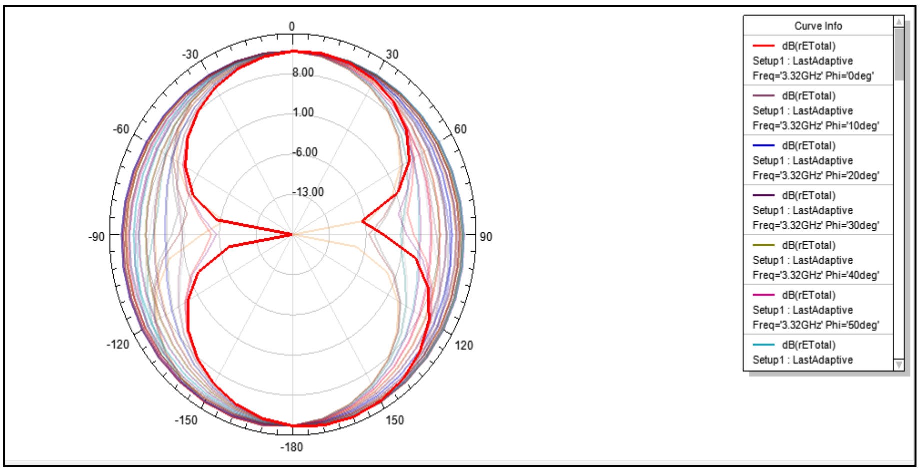

Figure 8: Radiation pattern at resonant frequency 3.32GHz.

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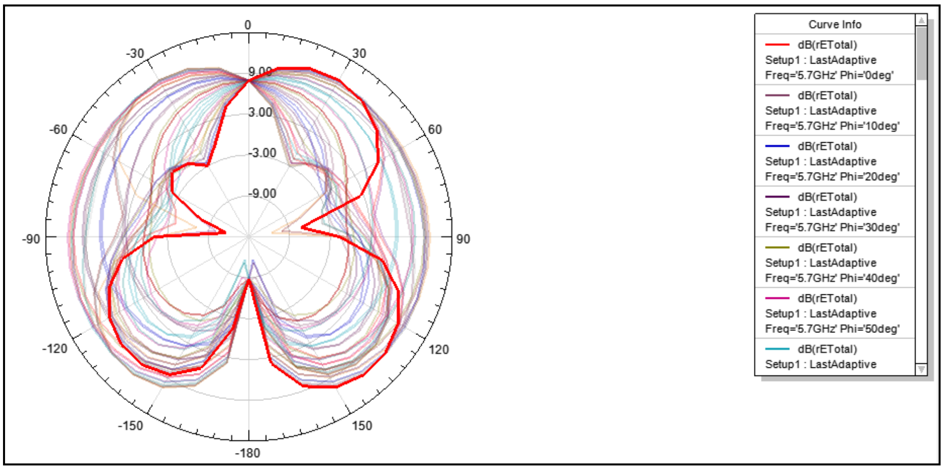

Figure 9: Radiation pattern at resonant frequency 5.7GHz.

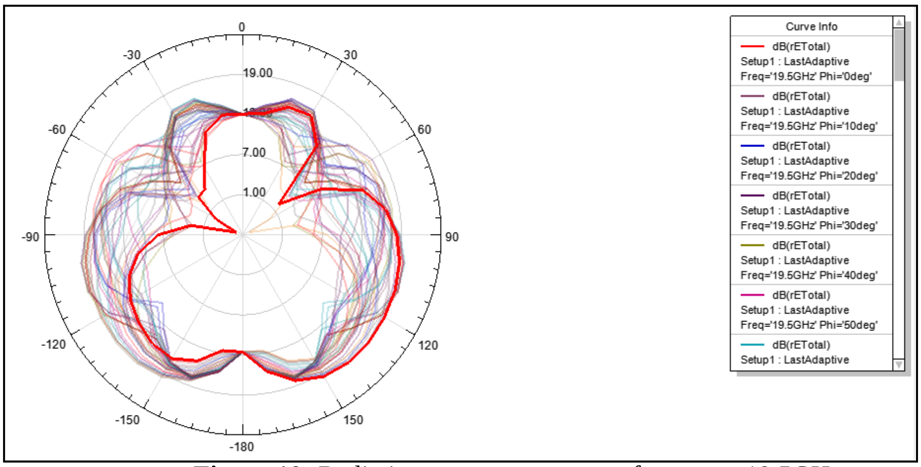

Figure 10: Radiation pattern at resonant frequency 19.5GHz.

5.4.3D Polar Radiation Pattern of Antenna:

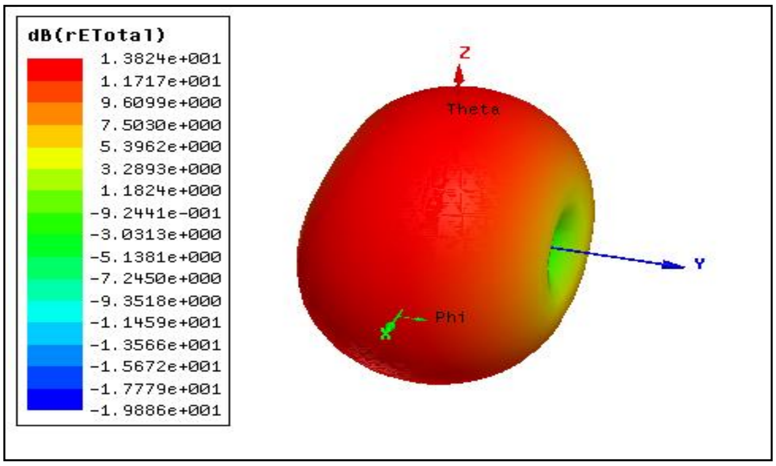

Figure 11: 3D Polar Radiation Pattern at resonant Freq 3.32GHz.

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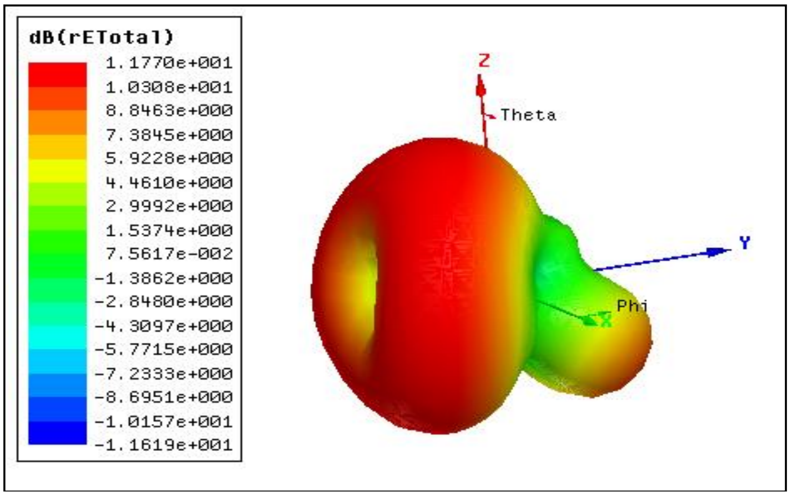

Figure 12: 3D Polar Radiation Pattern at resonant Freq 5.7GHz.

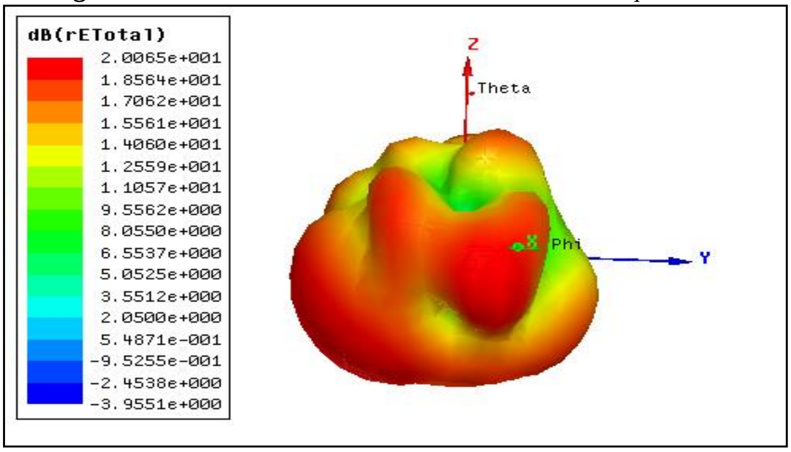

Figure 13: 3D Polar Radiation Pattern at resonant Freq 19.5GHz.

V. CONCLUSION

A novel frequency reconfigurable micro strip patch antenna with two GaAs FET switches on both side of feed line 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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