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Reconfigurable Inverted U Slot Antenna with Switching Mechanism for Wireless Applications

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Abstract: *Frequency reconfigurable antennas are mostly used for many wireless applications. The proposed antenna uses a PIN diode to switch between 2.45 to 3.93 GHz. The ultra-wideband is obtained by a partial rectangular ground plane with an inverted U slot and the narrowband is obtained by adding a parasitic element electrically connected to the ground by positive bias of PIN diode. Frequency Reconfigurable antennas can adjust dynamically its frequency of operation as per the requirement. For better designing of antenna and to get better accurate results, we usually change the physical dimensions of the antenna. It is lengthy and time taking process if we consider this method. Comparison and selection in designing of antennas will be difficult if we keep on changing the dimensions. So, we prefer Reconfigurability.*

Keywords: Frequency Reconfigurable, Inverted U Slot, PIN diode, Microstrip antenna, LAN

I. INTRODUCTION

Reconfigurability is a property where the frequency response will have an impact on radiation characteristics without changing the dimensions of the antenna. Using reconfigurability we can develop a compact frequency and pattern.

Reconfigurable antenna is also designed with different shapes of antenna with metamaterial-based antenna. This antenna measures at different polarization states like right hand linear polarization, left hand linear polarization, right hand circular polarization and left-hand circular polarization. This antenna is resonated at 5.2GHz frequency range.[1]

MIMO antenna structure is arranged in array form like 1*2 or 2*2 array etc. i.e., two rectangular patch antennas are placed in 1*2 array or four rectangular patch antennas are equally placed in 2*2 array structure. The size of the substrate is 120*60 mm and thickness are 1.6mm and the material of substrate is FR4 substrate. Reconfigurability is achieved by using PIN diodes or Varactor diodes etc. This MIMO type of reconfigurable antenna operates at L band frequency range.[2] Circular metal ring monopole Reconfigurable antenna is designed by using two PIN diodes. We can control the polarization states by switching states of PIN diode. If two PIN diodes are used, then the diode conditions are 4 states. One diode is ON, another diode is OFF. OFF-ON, ON-ON, OFF-OFF. Monopole antenna operates at C band Applications.[3]A Reconfigurable multiband antenna is fabricated by using inkjet printing method. A reconfigurable inkjet printer antenna is fabricated on paper substrate for flexibility and bendability purpose. The size of the substrate is 30*40mm and thickness is 0.44mm. It is used for mobile and wireless applications. This type of Flexible antenna is resonated at 1 to 4GHz frequency range.[4]

A reconfigurable antenna with low RADAR cross section is designed, in this design PIN diodes are used to improve the gain and increase the bandwidth. The gain can be increased nearly 3dB.One of the promising reconfigurable antennas is phase grating method, it is radiated in multi directions and then resonate at 4GHz frequency range.[5] Reconfigurable dipole antenna is designed by using flasher origami. It is one of the foldable papers, this can be folded into a cube, and it is resonating from 0.77GHz to 1. 23GHz.Origami is twistable paper to generate different structures and these methods can be applicable to different reconfigurable electronic materials [6] One of the most polarization technique in reconfigurable antenna is circular polarization, in this CP substrate material is liquid dielectric material. There are two types of CP's one is Left hand circular polarization and another one is Right hand circular polarization. This type of antenna is used for RFID applications and operating at 2.4GHz. we can also use this type of substrate material in liquid type of antennas.[7] In dual polarization frequency reconfigurable consists of +45 degree and -45 degree polarized reconfigurable of frequency dipole antennas. The shape of the structure is the U shape structure and it is mostly used for better impedance matching purposes. It is resonating at 3 to 5GHz frequency. The switching configuration is PIN diode and obtainable gain is 6.86dbi. [8] Another type of reconfigurable antenna is slot antenna using liquid metal. In this antenna the use of substrate material is PDMS (polydimethylsiloxane) with lower band of frequency, it is fabricated on PCB.[9] Different type of reconfigurable antenna is mm wave Vivaldi antenna, and then it is fabricated on graphene based variable resistor. The value of the resistor is 20Ω to 200 Ω. By tuning

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the resistor values, we can show the changes in radiation pattern of Vivaldi antenna. The operating frequency is 30GHz.[10] By tuning the bias of the PIN diode in frequency reconfigurable T shaped slot antenna and Ring slot antenna, it can be switched from one frequency to another frequency, and it is applicable for satellite applications.[11]

Dual polarization reconfigurable antenna array resonating from S band to C band of frequencies in wide range of bandwidth. This type of antenna array consists of 8 PIN diode switches and 2x2 array for c band and s band applications.[12]

II. EXISTING METHODOLOGY

The configuration of the antenna is composed of a simple monopole circular patch fed by a feed line, connected to a 50 ΩSMA connector, placed on the opposite side of a partial ground plane where a rectangular slot has been inserted. The optimized size of the compact antenna proposed is 31×38×1. 6mm3.The drawbacks of existing system are low gain, low bandwidth, and less frequency regulation.

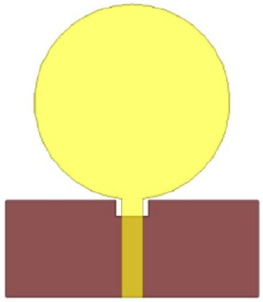

Figure1(a):Ground without Slot

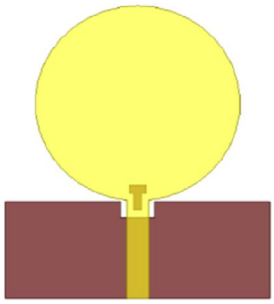

Figure1(b):Ground with Slot

Types of antenna reconfigurations are

- Frequency reconfiguration.
- Radiation pattern reconfiguration.
- Polarization reconfiguration.
- Compound reconfiguration

III. PROPOSED METHODOLOGY

The rectangular slot is replaced with the inverted U shape slot so that return loss decreases and more frequency regulation happens. Two-pin diodes are placed on either side of the Inverted U shape so that it acts as a short circuit when in forward bias and acts as an open circuit in reverse bias(on and off).The components are Micro Strip Antenna,Slot,PIN Diode.

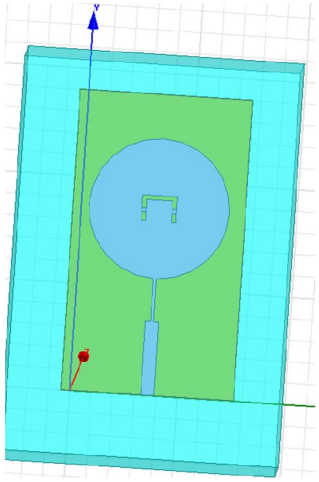

Figure 2: Design of Inverted U slot antenna

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3.1 Microstrip Antenna

The micro-strip antenna is the widely used antenna and it also defined as printed antenna. It comprises of a metallic patch, a ground plane and a substrate. The patch is kept above the ground plane and substrate is placed in between ground plane and patch. Moreover, these antennas can be easily mounted on the surface of satellites, aircrafts, space crafts, missiles and on handheld devices. Micro strip antenna contains 3 sections, 1. Ground 2. patch, 3. Substrate.

3.2 Slot

Slots are inserted at bottom layers; therefore, the gain will increase. Different shapes of slots can insert for broadband applications. The size and frequency of slot can vary different radiation patterns.

Advantages

Mass Production is Easier, They're Simpler, Can Transmit High Power Levels, Lower Wind Load, They're Omni-Directional, Size Matters.

3.3 PIN Diode

PIN diodes are mostly used as the switching components in different wireless applications Resistance of PIN diode is proportional to DC bias current and it can be used as a Switching mechanism. Diode is ON when the diode is forward biased. When the diode is reverse biased, it is turned OFF.

Frequency reconfigurable antennas can be adjusted their operation of frequency, Frequency reconfiguration is generally obtained by physical or electrical variations to the antenna dimensions using RF switches or pin diodes. Here we find gain, directivity, return to loss, VSWR and Radiation patterns of following using pin diodes

- Frequency reconfigurability (on, off): In this reconfigurability one diode is 5kΩ and another diode is 50kΩ
- Frequency reconfigurability (on, on): In this reconfigurability one diode is 5kΩ and another diode is 5kΩ
- Frequency reconfigurability (off, off): In this reconfigurability one diode is 50kΩ and another diode is 50kΩ
- Frequency reconfigurability (off, on): In this reconfigurability one diode is 50kΩ and another diode is 5kΩ

IV. RESULTS

4.1 Frequency Reconfigurability (on, off)

4.1.1 Return Loss

Return loss is the superlative and suitable technique to compute the input and output of the signal sources; when the load impedance is perfectly match with the source impedance, therefore the “Return Loss” is less otherwise the Return loss is high. The S parameter has shown in above slide which is Frequency Reconfigurability (on, off). The simulated S parameter of first frequency (2.43 GHz) is -19.88 dB, and second frequency (4.20 GHz) is -18.14dB, and third frequency (5.8GHz) is -20.77 db.

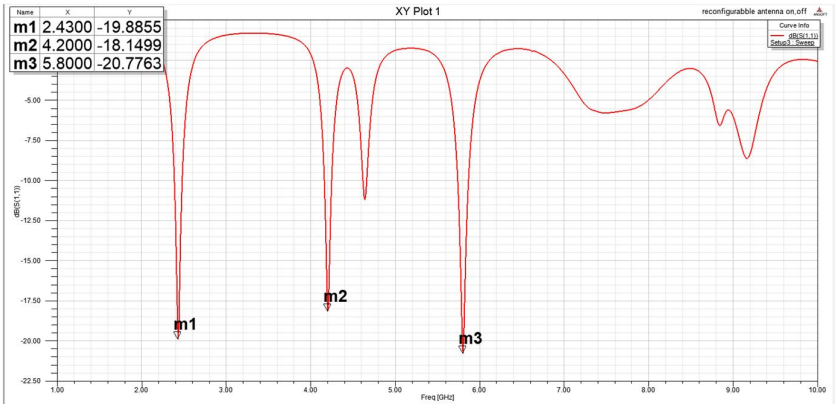

Figure 3: S Parameter

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4.1.2 VSWR

Voltage Standing Wave Ratio is to display a large power transfer from source to antenna to antenna to implement robustly. This occurs only when the impedance is terminated to the source impedance. From below figure VSWR values are 1.9,2.1 and 1.59 respectively.

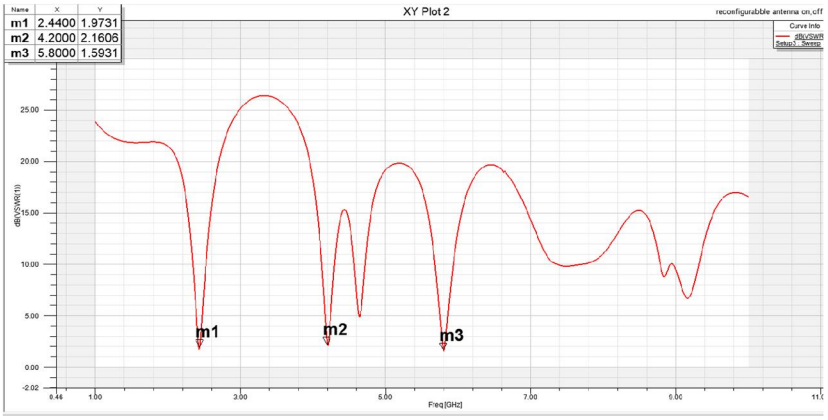

Figure 4: VSWR

4.1.3 Gain

By verifying these 3D polar plots, we can observe how much amount of gain is radiated in particular directions.

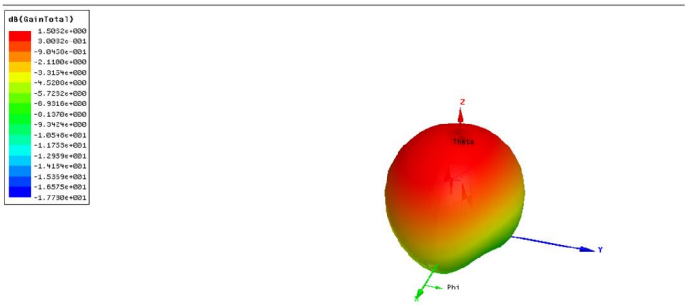

Figure 5:Gain

4.1.4 Radiation Pattern

The Radiation pattern is the best typical value of the antenna. It is defined as a pictorial representation of the radiation possessions as a purpose of space coordinates. Generally, the radiation pattern is stimulated in the far field set up.

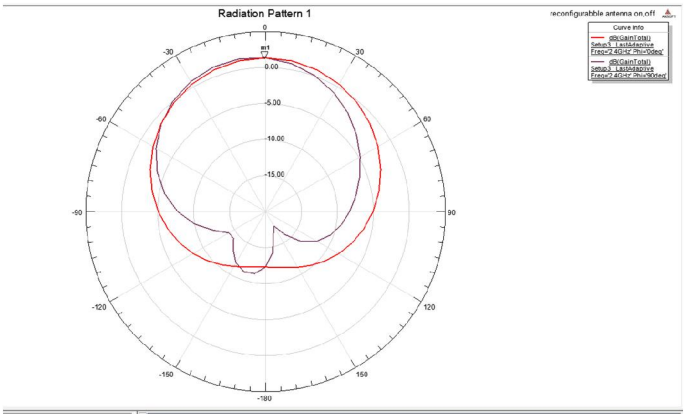

Figure 6:Radiation Pattern

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4.1.5 Directivity

The Directivity of an antenna describes the relative radiation power density in a specific distance and direction, radiation power thickness. This defines the ratio between power radiated to the isotropic power.

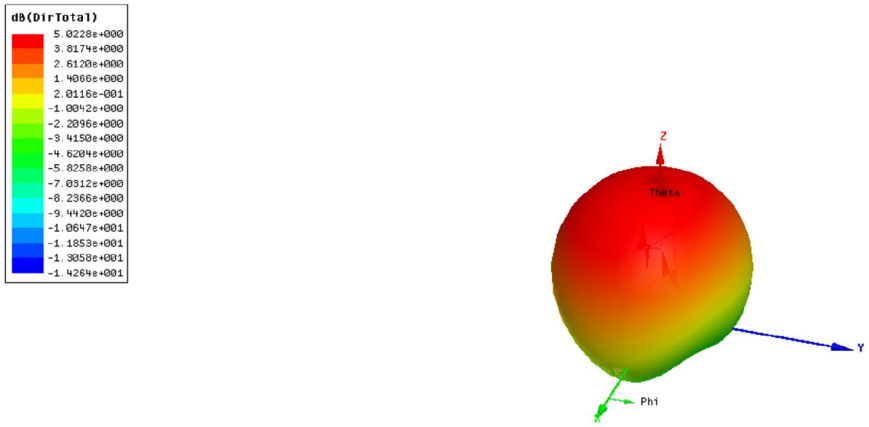

Figure 7: Directivity

4.2 Frequency reconfigurability (on, on)

4.2.1 Return Loss

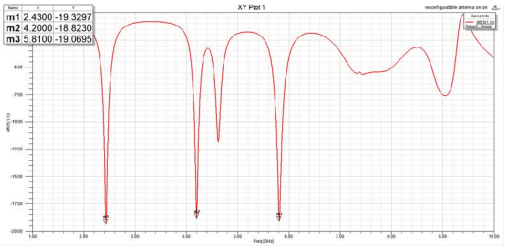

Figure 8: S parameter

4.2.2 VSWR

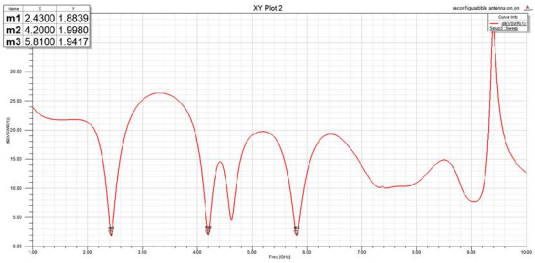

Figure 9: VSWR

4.2.3 Gain

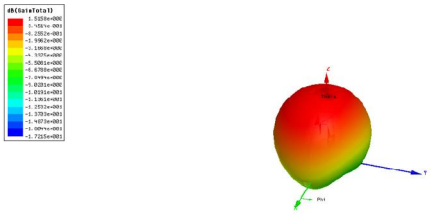

Figure 10: Gain

4.2.4 Radiation Pattern

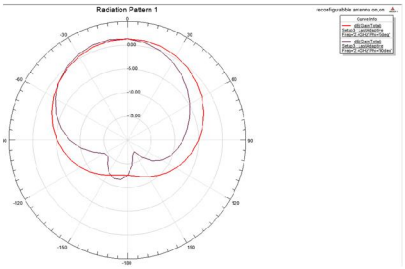

Figure 11: Radiation Pattern

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4.2.5 Directivity

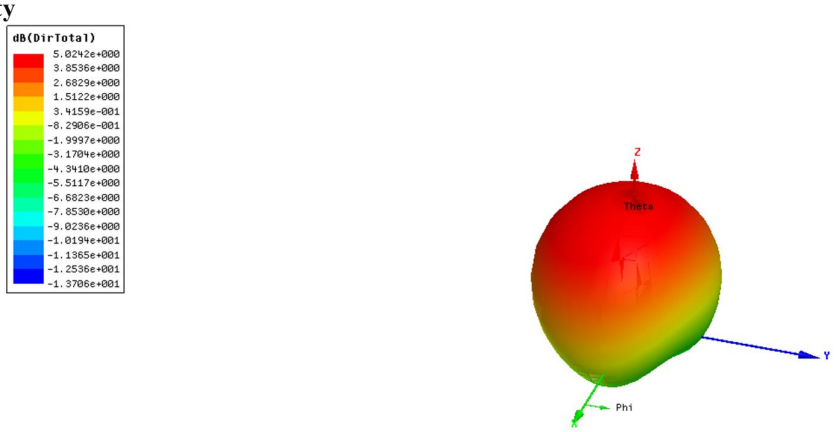

Figure 12: Directivity

V. CONCLUSION

A compact frequency reconfigurable antenna has been designed with inverted U slot antenna. This structure, intended for wireless cognitive applications in the S and C bands, works in the narrowband mode from 2.4 GHz when the RF switch is activated and in the ultra-wideband mode from when the switch is deactivated. The antenna designed on a dielectric substrate FR4 of thickness 1.6mm with a permittivity of 4.4. Results calculated and which allows this antenna to be a candidate choice for wireless cognitive applications

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