International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-1, 2019
ISSN: 2581-3404 (Online)

Microstrip Patch Reconfigurable Antenna with Defected Ground Structure: A Review

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ABSTRACT

A reconfigurable antenna is an antenna capable of modifying dynamically its frequency and radiation properties in a controlled and reversible manner. In order to provide a dynamical response, reconfigurable antennas integrate an inner mechanism (such as RF switches, varactors, mechanical actuators or tunable materials) that enable the intentional redistribution of the RF currents over the antenna surface and produce reversible modifications over its properties. Reconfigurable antennas differ from smart antennas because the reconfiguration mechanism lies inside the antenna rather than in an external beam forming network. The reconfiguration capability of reconfigurable antennas is used to maximize the antenna performance in a changing scenario or to satisfy changing operating requirements. Reconfigurable antennas, with the ability to radiate more than one pattern at different frequencies and polarizations, are necessary in modern telecommunication systems. The requirements for increased functionality (e.g., direction finding, beam steering, radar, control, and command) within a confined volume place a greater burden on today's transmitting and receiving systems. In this paper various reconfigurable components that can be used in an antenna to modify its structure and components are discussed.

Keywords: Antenna, Reconfigurabilty, Defected Ground Structure, Microstrip, patch.

INTRODUCTION

1) Reconfigurable Antennas:

As the modern communication technologies are developed in recent years, the need of multifunctional antennas has attracted much attention. These multifunctional antennas called as reconfigurable antennas which can alter their antenna parameter as per service requirement or field of operation. Reconfigurable antenna is a new concept antenna, which is gaining popularity due to its beauty of performing the operation of multiple antennas. They can dynamically alter their radiation characteristics such as frequency, polarization, radiation pattern etc. on changing its electrical or physical configuration.

In this manner, one antenna can be a potential replacement for several numbers of antennas, resulting in considerable saving in weight, cost and size. The reconfigurabilty can be obtained by adding RF MEMS technology, semiconductor compound, ferrite, ferroelectric, silicon-based semiconductor, and varicap diode. Furthermore, as the size of these devices become smaller and smaller, the need for compact and miniaturized antennas with desirable radiation characteristics is on the rise. The key characteristic of future generation wireless communication systems is the ability of antenna reconfiguration.

The operation of reconfigurable antennas is based on the appropriate biasing of the reconfiguration networks. The biasing of these networks should be

incorporated with the antenna by ensuring a minimal negative effect on the antenna radiation characteristics. The activation of the biasing process is based on supplying the appropriate voltage/current to the integrated switching elements used to reconfigure the antenna's mode of operation. The correct activation of the switching elements is essential to ensure a smooth and fast functioning of the system controlled by the incorporated reconfigurable antenna. In general, reconfigurable antennas can rely on switching elements such as p-i-n diodes, varactors, or photo conductive switches, as well as on the usage of mechanical tuning tools such as actuators or stepper motors. Reconfigurable antennas have received lots of attention in modern wireless communication systems for their multifunction. This type of antenna provides wideband tuning range achievable without deteriorating the antenna return loss, gain, and radiation pattern. The advantage of using a reconfigurable antenna is to operate in multiband where the total antenna volume can be reused and therefore the overall size can be reduced.

2) Defected Ground Structure:

In recent years many new techniques have been developed in field of antennas. One such technique is DGS (Defected Ground Structure). In this technique, the ground metal of Microstrip line is modified for further better results. As the name suggests "Defect" has been placed in the ground plane. The defect can have many shapes of dumbbell, double-dumbbell or a slot of any shape. Different shapes of Defected Ground Structure are shown in fig. a.

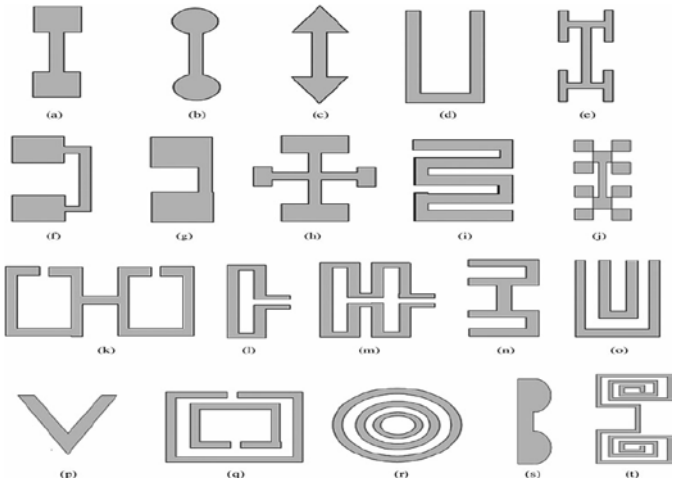

Fig 1: a Different shapes of Defected Ground Structure.

LITERATURE SURVEY-

[1] In this paper "A Reconfigurable Microstrip Antenna with Defected Ground Structure for Radio Applications" Mr. Harshal Nigam et.all [1] has designed a circular patch antenna with defected ground structure having elliptical patch which is used for radio applications. On depending the switching of diodes the antenna applications can be switched between C-band and X-band as shown in fig.1 (a) and (b). FR-4 substrate is used with optimized dimensions for best results. On closely observing the dimensions of the antenna the bandwidth has been improved.

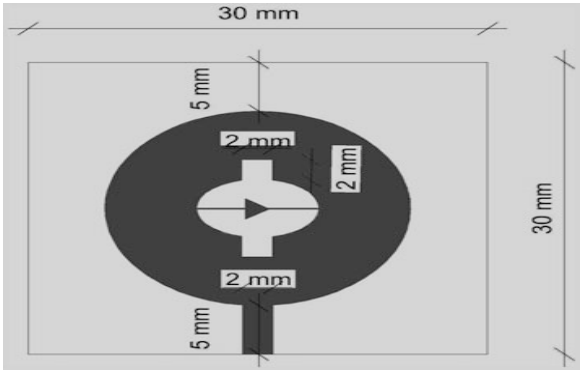

Fig 1 (a): Front view of elliptical patch with Diode in horizontal plane (D1)

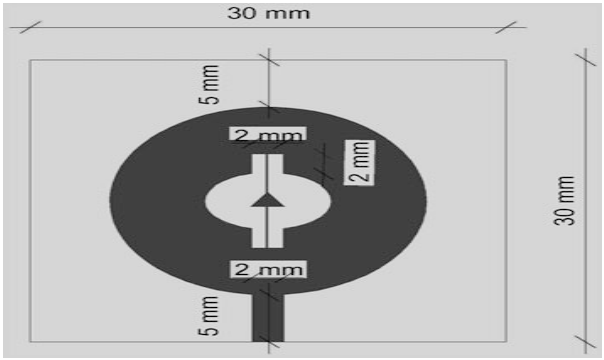

Fig 1(b) : Front view of elliptical patch with Diode in vertical plane (D2)

[2] In this paper "Design and study of Frequency Reconfigurable Antenna for Wireless Applications" Mr. Venkateswara Rao et.all [2] has designed a frequency reconfigurable antenna for Wi-Fi, Wi-MAX and C-band applications In this paper the patch dimensions is 18mm x 14.5mm having a radiating feed line. FR-4 substrate with thickness 1.6mm and permittivity 4.4 is used. A staircase slot is made at the centre of patch and its position is optimized to get the desired frequency as shown in fig.2 (a), (b) and (c).

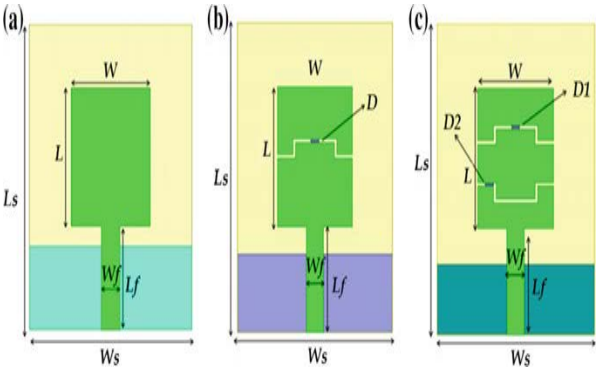

Fig 2: Geometry of **a** dual band antenna, **b** dual and **c** triple frequency reconfigurable antenna

[3] In this paper "Octagonal shaped Frequency Reconfigurable Antenna for Wi-Fi and Wi-MAX applications" Mr. B.T.P.Madhav et.all [3] designed an octagonal patch antenna comprising of four switchable states at 0.1-1.1, 2.2-3.4, 4.8-5.2, 7.4-7.8 GHz. Defected Ground Structure is used having three PIN diodes in it as shown in fig.3(a) and (b).

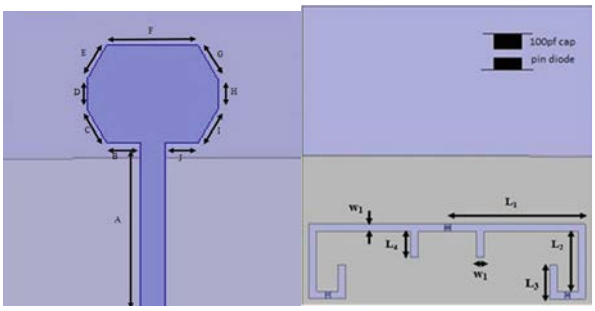

Fig 3(a): Octagonal patch antenna
Fig 3(b): DGS with PIN diodes

[4] In this paper "Patch rotation based Frequency Reconfigurable antenna for wireless applications" Ms. Perla Devi et.all [4] designed an antenna having three patches of rectangular, circular and square patch and are placed on Rogers RT Duroid substrate. The desired frequency can be achieved by rotating the patches by 120 degrees. This antenna can also be used for PCS (Personal Communication System), Wi-Fi and Wi-MAX applications. When rectangular patch is connected with the feed, the return loss is -35.09dB and resonant frequency is 3.45 GHz; when circular patch is connected with the feed, the return loss is -31.69 dB and resonant frequency is 2.45 GHz; when square patch is connected with the feed, the return loss is -26.55dB and resonant frequency is 1.9 GHz as shown in fig.4 (a), (b) and (c).

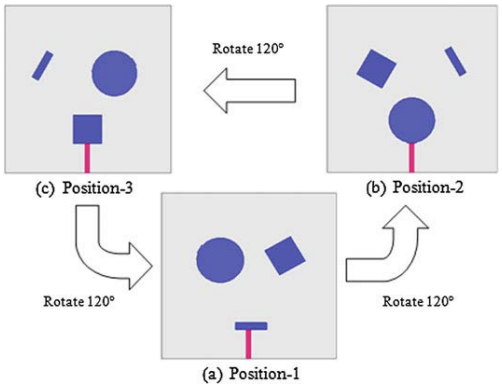

Fig 4: Antenna reconfigurabilty process

[5] In this paper "Design of very simple Frequency and Polarization Reconfigurable Antenna with finite ground structure" Mr. Jie Liu et.all [5] has used PIN diodes for switching to obtain the frequency and polarization reconfigurable antenna. This antenna shows four states namely: 2.02-2.56 GHz; 2.32-2.95 GHz; 1.92-2.70 GHz and 1.88-2.67 GHz. The first two states show linear polarization and the last two states show left-hand and right-hand circular polarizations respectively as shown in fig. 5 (a) and (b).

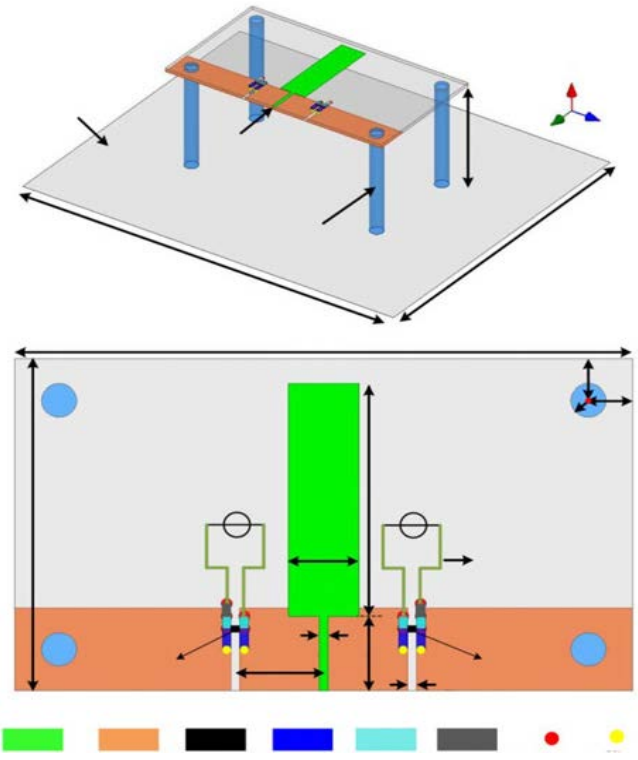

Fig 5: Proposed antenna structure

[6] In this paper "A Frequency and Pattern Reconfigurable two-element array antenna" Mr. Nailah Mastura Zainarry et.all [6] designed an antenna using varactor diodes and is based on stub-loaded configuration. By using this designed antenna the relative frequency tuning range is extended by 10% from 2.15 GHz to 2.38 GHz with significant increase in scanning angle from -23 degree to +23 degree as shown in fig. 6.

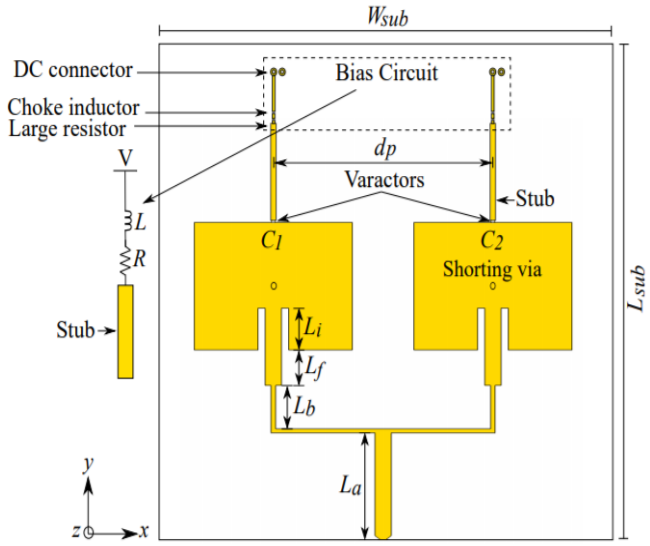

Fig 6: Proposed antenna structure

[7] In this paper "Design of Reconfigurable Tri-Band Antenna on chip" Mr. Rahul Pandey et.all [7] designed an antenna radiating at 2.4 GHz (ISM band), 5.2 GHz and 7.5 GHz. The proposed antenna used one square and four rectangular slots connected with PIN diodes for switching to achieve the desired frequency as shown in fig. 7.

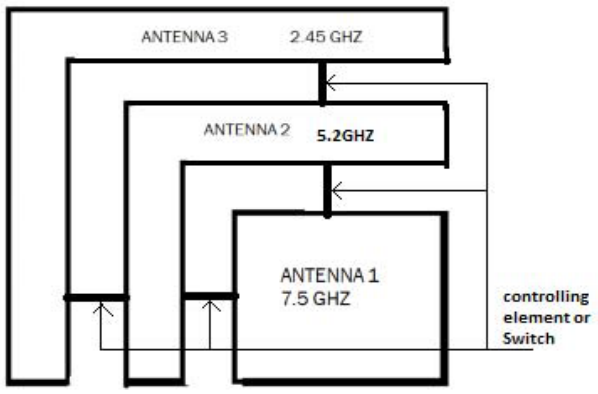

Fig 7: Reconfigurable patch antenna with switches

[8] In this paper "Rectangular ring Reconfigurable Antenna for Wireless Communication" Mr. Ashish

Kumar Sharma et.all [8] designed an antenna which shows frequency and pattern reconfiguration. The proposed antenna uses PIN diode to the left and right hand side of the feed line as shown in fig. 8, operating at frequency 2.7, 2.8 and 3.6 GHz and can be used for Wi-MAX and WLAN applications.

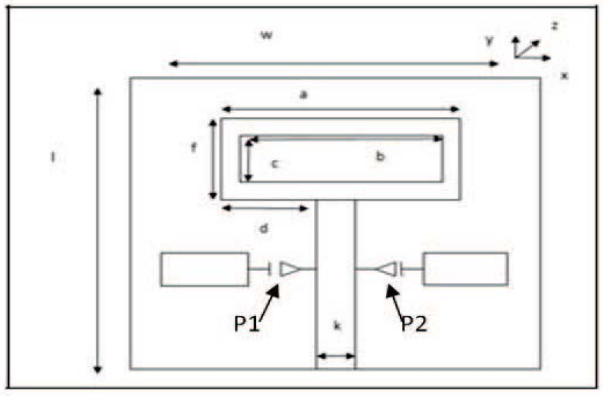

Fig 8: Proposed antenna structure

[9] In this paper "Frequency Reconfigurable Antenna using Pixel Ground" Mr. Ajay Yadav et.all [9] designed an antenna operating at UWB band. It operates at multiple frequencies ranging from 5.2/5.4/5.6/6.6/7.0/7.8/8.2/9.4 GHz bands for WLAN and X-band as shown in fig. 9(a) and (b). FR-4 substrate having thickness 1.6mm.

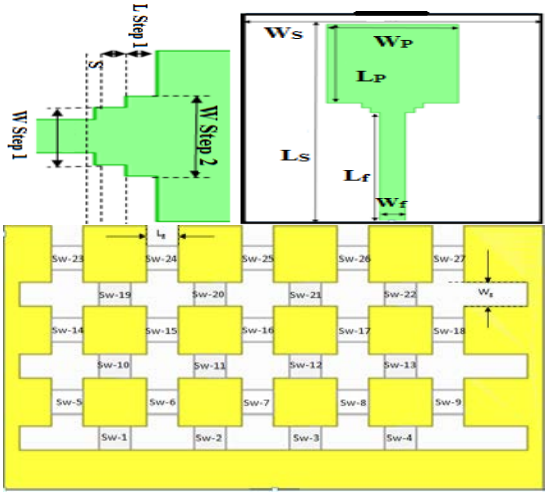

Fig 9(a): Front view of proposed antenna
Fig 9(b): Back view of proposed antenna

[10] In this paper "Design of a dual band Frequency Reconfigurable Patch Antenna for GSM and Wi-Fi applications" Mr. Saad Shoukat et.all [10] designed an antenna having a rectangular patch surrounded by two metallic rings as shown in fig. 10. It operates at 1.8 and 2.4 GHz and is used for Wi-Fi and GSM applications.

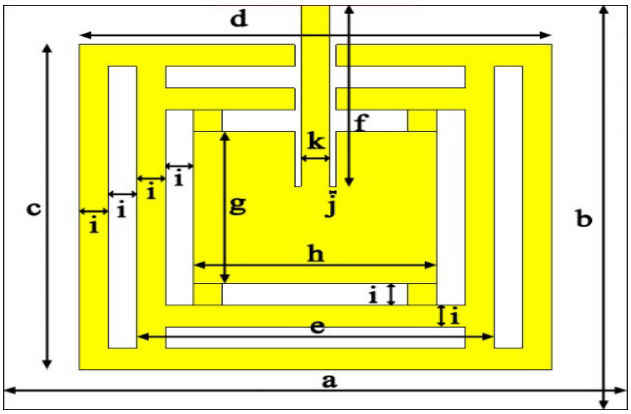

Fig 10: Proposed antenna structure

[11] In this paper "Reconfigurable antenna for Wireless Communication Bands" Mr. P. Chakrapani et.all [11] designed a reconfigurable antenna operating at three frequency bands of WLAN, Wi-MAX and LTE Communication band. This antenna works by controlling the switching mechanism of two PIN diodes as shown in fig.11.

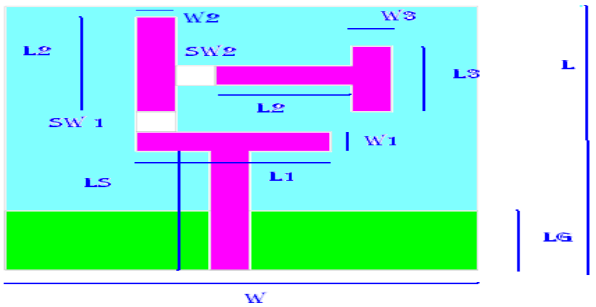

Fig 11: Proposed Antenna Structure

[12] In this paper "Design of Compact Frequency Reconfigurable Antenna with Defected Ground Structure for UWB applications" Mr. Esmail Nasrabadi et.all [12] designed an antenna having four modes of operating frequency covering a

frequency band of 3-22 GHz. Three PIN diodes are used as a switch in ground plane and switching of these changes the mode of antenna as shown in fig.12.

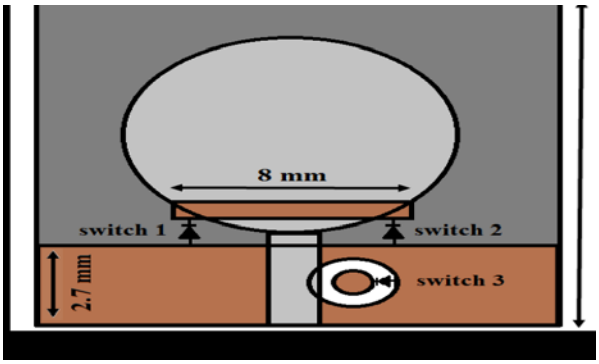

Fig 12: Proposed Antenna Structure

[13] In this paper "A Single-Element Frequency and Radiation pattern Reconfigurable Antenna" Mr. Imran Shoaib et.all [13] designed an antenna having two PIN diodes as switch which are used to alter the surface current distribution and radiating edges on antenna. When the switches are in OFF state, the return loss is -10dB with bandwidth from 5.401 to 6.045 GHz having broadside radiation pattern. When the switches are in ON state, dual frequency band operation is there of 2.110-2.875 GHz and 5.665-5.968 GHz as shown in fig.13.

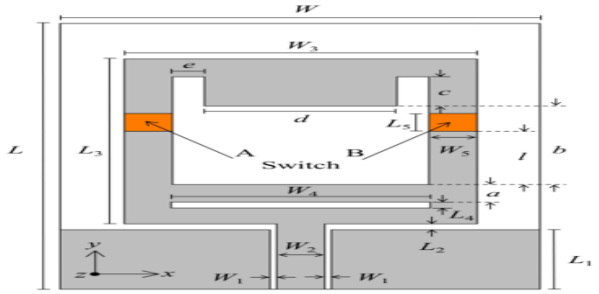

Fig 13: Proposed Antenna Structure

[14] In this paper "Novel Frequency Reconfigurable Microstrip Patch Antenna based on a square slot for Wireless devices" Mr. Ghanshyam Singh et.all. [14] designed an antenna having rectangular patch with square slots and two PIN diodes. The antenna has centre frequency of 10 GHz. By switching the diodes in ON/OFF states, frequency reconfiguration can be achieved. This antenna is designed on FR-4 substrate having permittivity of 4.54 and thickness 1.6mm as shown in fig.14.

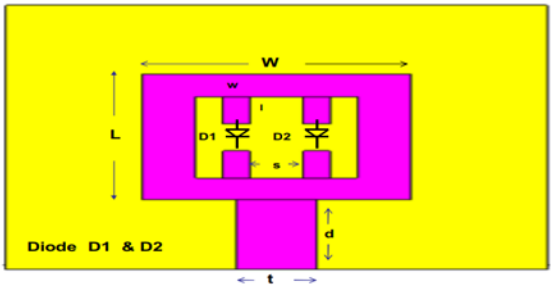

Fig 14: Proposed Antenna Structure

CONCLUSION-

A survey paper of various frequency reconfigurable antennas used for wireless applications is studied. Reconfigurable antennas have their applications in numerous areas such as Space Communication, Digital Video Broadcasting, Satellite Communication and Cognitive Radio Systems. They possess the properties to change their characteristics and/or radiation properties in real time. These antennas can change their radiation properties either by polarization (Linear or Circular), by using Patch Antennas or by using Electromagnetic Bandgap materials. In Reconfigurable Antennas reconfiguration mechanism can be varied by three methods: 1. mechanically rotating the Antenna, 2. by using different material properties, or 3. by using switches. The proposed antenna finds application on different wireless communication standards.

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