Design And Simulation of Tunable Microstrip Patch Antenna For S Band Applications

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Abstract- *This paper presents an evaluation of frequency reconfigurable patch antennas for X-band, using PIN diode as a switch. A pin diode is incorporated in the slot etched on rectangular patch antenna. The frequency band selectivity can be achieved by controlling the state of switch inserted in the antenna. We are using IE3D simulation software for designing and analysis. We have discussed and analyzed the performance of unslotted Rectangular Microstrip patch antenna and slotted rectangular patch antenna with PIN diode in ON and OFF states.*

Keywords- Microstrip antenna, Patch antenna, Frequency tunable, MATLAB, HFSS.

I. INTRODUCTION

Micro strip patch antennas (also just called patch antennas) are among the most common antenna types in use today, particularly in the popular frequency range of 1 to 6 GHz. This type of antenna had its first intense development in the 1970s, as communication systems became common at frequencies where its size and performance were very useful. At the same time, its flat profile and reduced weight, compared to parabolic reflectors and other antenna options, made it attractive for airborne and spacecraft applications. More recently, those same properties, with additional size reduction using high dielectric constant materials, have made patch antennas common in handsets, GPS receivers and other massproduced wireless products. Antenna plays a major role in wireless communications. The type of antenna includes parabolic reflectors, patch antennas, slot antennas, folded dipole antennas etc. Amongthose, most useful antennas at microwave frequencies (f>1GHz) are micro strip antennas also called patch antennas with a metal patch on top of grounded dielectric substrate. The patch may be in variety of shapes but rectangular andcirculararе most common. In recent years there is a need for more compact antennas due to rapid decrease in size of personal communication devices. This paper presents design and simulation of a square micro strip patch antenna at 2.6 GHz for S- Band communications that provides a radiation pattern along a wide angle of beam and achieves a good gain. The tunable micro strip patch antenna was analyzed using Ansoft/Ansys HFSS. The proposed inset feed square patch antenna provide good Resonant Frequency, Return Loss, VSWR, Radiation Pattern and the antenna Gain.

II. LITERATURE SURVEY

Jia-Wei Dai, Hong-Li Peng, Yao-Ping Zhang, and Jun-Fa Mao proposed the paper on Novel tunable Microstrip patch antenna using Liquid crystal. This paper presents a novel tunable microstrip patch antenna using liquid crystala larger frequency tuning range, much wider impedance bandwidth, higher radiation efficiency and gain is achieved by adopting differentially driven, aperture-coupled, and stacked-patch structure. It is designed to operate at 28Ghz using an RT/Duroid 5880 substrate and K15 liquid crystal. It has antenna has a tuning range of 3.1%, an impedance bandwidth of 6.43%, a peak radiation efficiency of 70%, and a peak realized gain of 6.5 dBi,

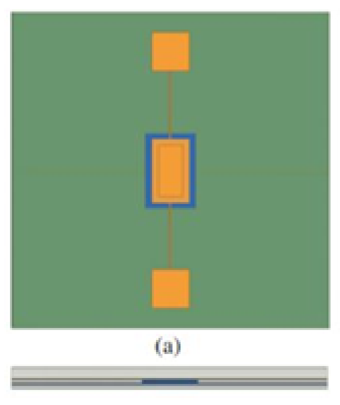

Fig 1: The novel tunable microstrip antenna using LC.

A novel tunable microstrip patch antenna using the liquid crystal is proposed for the first time in this paper. Because the differentially-driven, aperture-coupled, and stacked-patch structure is adopted, this novel antenna achieves a larger frequency tuning range, much wider impedance bandwidth, higher radiation efficiency and gain than the conventional design.

Sihem Missaoui, Sayed Missaoui, Mohsen Kaddour proposed the paper on Reconfigurable Microstrip Patch Antenna Based on Liquid Crystals for Microwave Applications.In this paper a novel design of a compact rectangular microstrip patch antenna using Liquid Crystals Substrates (LCs) for microwave applications is presented. A low bias voltage of 10V is applied to benefit from liquid crystal

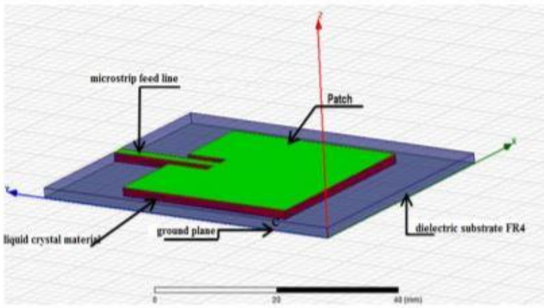

Fig 2: Design of microstrip patch antenna based on LC

anisotropy and to obtain frequency agility. It reduces the cost and overall volume of microwave system in wireless communication systems. It satisfies minimal return loss -52.47dB with a bandwidth of 60MHz for operating frequency of 2.53GHz. By applying a continuous voltage, the variation of the simulation resonance frequency (ΔFr) is 530MHz corresponding to frequency agility of 26.5%.

This paper presents the fundamentals of LC material and its applications for reconfigurable microstrip patch antenna. This structure are designed and simulated with HFSS simulator. The observation of the results confirms the potential frequency agility by varying the LC dielectric permittivity with applied DC voltage, improved the radiation characteristics and increased the peak gain of the device. Thus, this new structure based on LC can be used in microwave systems where the reduction of overall physical volume and cost is very important.

Rihana Parveen and Mohd Abdulla proposed the paper on Broadband Compact Antenna for S-Band and C-Band Application. In this paper a Compact Dual band antenna for S and C band applications using meta material and Orthogonal shorting pin techniques. Slotting has been done using meta material theory and impedance matching. Inverted U slot and Square slots designed in the patch and Meander slot is designed in the ground plan. It is carried out to design circular polarized antenna which is validated by axial ratio curve. Compactness achieved by shorting pins and loaded in to patch in orthogonal pattern.

Compact dual band antenna for S-C Band wireless communication is successfully investigated by one U-Slot, one Square slot with two orthogonal shortingpin, achieved - 10dB, Impedance bandwidth 41% from 2.1GHz to 3.2GHz for S-Band.-10dB, Impedance bandwidth 25% from 3.7 GHz to 4.8GHz for C-Band. Achieved compactness 48% at 2.55GHz, 20% at 4GHz. At 2.55GHz return losses is -25dB and at 4.4 GHz return loss is -32 dB. IE3DTM Simulator used for validation of proposed antenna. Meta material and orthogonal shorting pin techniques are used. Slotting has been done using impedance matching and meta material Invert U-Slot, Square Slot in the patch and Meander slot designed in the ground plan Circular polarization of antenna validated by axial-ratio (AR) curve. For achieving compactness and By loading a shorting pins to the patch in orthogonal pattern, the minimum point of lower frequency moves to higher frequency, and broad AR band is obtained consequently Compact dual band antenna for S-C Band is presented using The measured parameters satisfy required limits hence making the proposed antenna suitable for S-C Band applications, GSM, Satellite and radar application.

J. Salai Thillai Thilagam and Dr. P. K. Jawahar proposed the paper on Patch Antenna Design Analysis for Wireless Communication. In this paper a sixteen (hexadeci) faced microstrip patch antenna is designed and simulated using slit on the edge. The antenna is fed using probe feed model and is simulated using IE3D electromagnetic simulator. The simulated result achieve S-parameter, radiation pattern and voltage standing wave ratio (VSWR). The proposed design is suitable for operation in 900MHz wireless communication applications.

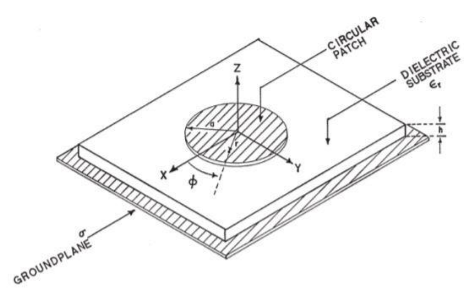

Fig 3: Geometry of a Circular Microstrip antenna

In this paper,they have analyzed a hexadeci faced microstrip antenna with slits on the edge. It is simulated in IE3D simulation result shows good agreement with theoretical values. The antennas proposed can be built and measured to compare the real results with those obtained from the simulations as a future work. Possible applications of this antenna include RFID, UHF applications.

software. Simulations havebeen carried out to investigate the antenna"sperformance and characteristics. The Alak Majumder proposed the paper on Rectangular Microstrip

Patch Antenna Using Coaxial Probe Feeding Technique to Operate in S-Band.This paper presents the design of a rectangular microstrip patch antenna to operate at a frequency range of 2GHz to 2.5GHz. It is based on Flame Retardant 4(FR-4) of thickness 1.6mm substrate with a dielectric constant of 4.4. VSWR, antenna input impedance , Return loss and current density are obtained after simulation.

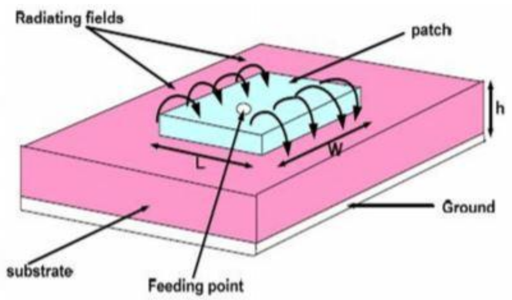

Fig 4: Rectangular Microstrip antenna

In this paper, we presented the design of a rectangular patch antenna covering the 2GHz−2.5 GHz frequency spectrum. It has been shown that this design of the rectangular patch antenna produces a bandwidth of approximately 2% with a stable radiation pattern within the frequency range. The design antenna exhibits a good impedance matching of approximately 50 Ohms at the center frequency. This antenna can be easily fabricated on substrate material due to its small size and thickness. The simple feeding technique used for the design of this antenna make this antenna a good choice in many communication systems.

Ghanshyam Singh and Mithilesh Kumarproposed the paper on Frequency Reconfigurable Microstrip circular patch antenna for wireless devices. In this paper a frequency reconfigurable circular antenna is designed and proposed for wireless devices. A circular patch antenna with circular slot using two PIN diodes is used to design an antenna of center frequency of 10GHz and simulated frequency reconfiguration is achieved in the range of 9.69-10.2Ghz and measured results shows the same effect in the range of 10.33-11.01Ghz as well. By switching the diodes on/off frequency reconfiguration is achieved. The antenna is designed on FR$ substrate of dielectric constant 4.54 and thickness of1.6mm, The structure was fabricated using microwave integrated circuit on same substsrate.

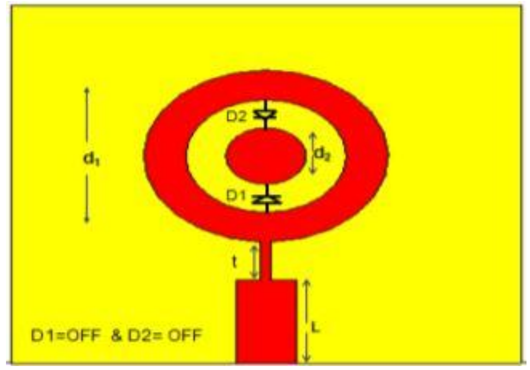

Fig 5: Reconfigurable design of circular patch antenna

In this paper, the design of a reconfigurable circular microstrip patch antenna has been described and their simulated results are compared with measured results. This reconfigurable patch antenna can be used for different resonance frequencies. By analyzing simulated and measured results, it showed that by using circular slot and diode switching the return loss shifts and hence the resonance frequency is also changed. This reconfigurable antenna can further be modified by using RFMEMS switches for fast switching purposes.

Akansha Tandon, Mr. Bimal Raj Dutta proposed the paper on Tunable Microstrip Patch Antenna with Switchable Polarization.In this paper, A novel reconfigurable microstrip patch antenna with frequency and polarization diversities has been designed. The frequency diversity characteristic of this antenna is realized by turning a PIN diode located offset to the center of the slot inserted into a microstrip patch on and off.

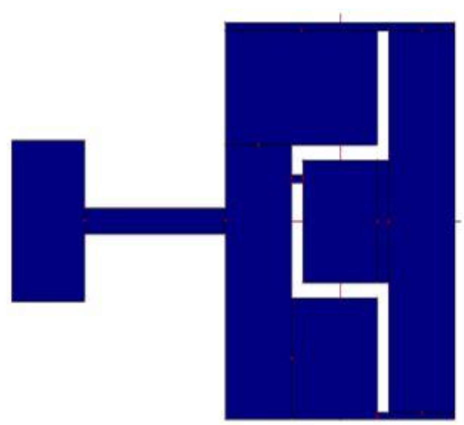

Fig 6: Frequency reconfiguration antenna with Pin diode

The polarization diversity is also obtained by switching two PIN diodes on the slot parallel to the feed line of the patch opposite to each other on and off. The designed antenna satisfies the 10 dB return loss requirement and also polarization diversity (LP, LHCP and RHCP).From the observed frequency properties was clear that antenna would operate in LHCP and RHCP as the gain is not equal. When the gain of LHCP properties is more than its RHCP properties means antenna is Left-Handed circular polarized (antenna III). Similarly if the gain of RHCP properties is more than LHCP properties means antenna is Right-handed circularly polarized (antenna IV). While when both the gains (LHCP gain and RHCP gain) are equal, the antenna linearly polarized (antenna I and antenna II).

Arpan Kumar proposed the paper on Microstrip Antennas for L-Band applications.The booming demand in wireless communication system applications have caused microstrip patch antennas to attract much interest due to their light weight, comfortable to planar and non-planar surfaces, simple and inexpensive to manufacture using modern printed circuit technology, mechanically robust when mounted on rigid surfaces, and when the particular patch shape and mode are selected, they are very versatile in terms of frequency, polarization, pattern and impedance. The main concern of this paper is to design (i) Microstrip Line-Fed rectangular Antenna. (ii) Probe-Fed Rectangular patch antenna (iii) Probe-Fed Circular Patch Antenna and study the effect of antenna dimensions Length (L), Width (W) and substrate parameters like relative Dielectric constant and substrate thickness (t) on Radiation parameters of Bandwidth. The Microstrip Line-Fed rectangular Antenna is designed using a 50Ω microstrip line. Conventionally, the Circular Patch is Probe-Fed rather than Line Fed because the input impedance along the circumference of the circular is much larger than 50Ω. This is why a Microstrip Line-Fed Circular Antenna is not designed. We will also fabricate the microstrip antenna and will compare the experimental results with the simulated ones.

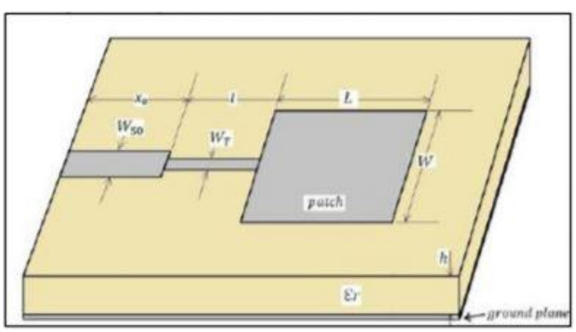

Fig 7: Microstrip patch antenna with Line feed

In their experiment they found that Probe-fed Rectangular patch antenna had a marginally better performance than that of the Probe-fed circular patch antenna. The best performance that is obtained practically is a return loss of 25.73dB and a VSWR ratio of 1.22:1 in the Probe-Fed Rectangular patch antenna. Proper Impedance matching is the key to obtaining lower return loss and higher gain. The voltage standing wave ratio is a measure of how well a load is impedance-matched to a source. The Antenna Gain also depends on the amount of conductor and dielectric losses in the Microstrip antenna.

Pasquale Dottorato presented the paper on Analysis and Design of the Rectangular Microstrip The analysis of rectangular microstrip patch antenna (RMPA) operating on the TM0n0 modes is presented. The characteristic parameters such as dielectric substrate, ground plane aspect ratio, input impedance as a function of the feed point position and the frequency effects have been theoretically investigated for these modes. The Finite Element Method and MATLAB model have been used for optimize and design RMPA operating at TM010 mode. The antenna has been carryout on the FR4 substrate and the characteristics has been measured with Vector Network Analyzer.

In this paper a Rectangular Microstrip Patch Antenna analysis has been presented. Firstly, the resonant frequency, size and feed location, the parasitic effects (such as fringing, dielectric, ground plane, etc.), far field pattern and fundamental parameter (such as width band, efficiency, quality factor, etc.) are modelled with the above equation and estimated with MATLAB Tool. Secondly the parameter such as: size, the effective resonant frequency, feed point location, etc., has been optimize and the numerical model investigated with FEM electromagnetic simulation technique. Finally the RMPA has designed on a standard FR-4 substrate and can be realized with conventional PCB techniques; after, the basic parameter has been measured and compared with the simulation data. The result to demonstrate that the RMPA model, as well as describing the behaviour of the antenna; it's also provides various real implications in the design itself.

Gourav Misra**,** Arun Agarwal and Kabita Agarwal proposed the paper on Design and Performance Evaluation of Microstrip Antenna for Ultra-Wideband Applications Using Microstrip Feed. In this paper they have designed an elementary Microstrip patch Antenna for ultra-wideband application. They have focused much effort on the basic concepts, characteristics and design of a Microstrip patch antenna. This paper explains the pattern of designs of the Microstrip patch antenna along with detailed study. Here in this technical review, the main goal is to design an elementary Microstrip antenna, which will work in the ultra-wide band range and also it should work in the desired operating frequency. An soft High Frequency Structured Simulations (HFSS) software is used for the elementary design of a rectangular patch Microstrip antenna and some of the basic calculations has been done by using MATLAB. This review paper also comprises of basic parameters, types of antenna, working, fundamental concepts and characteristics as well as feeding techniques and simulation, results of Microstrip patch antenna.

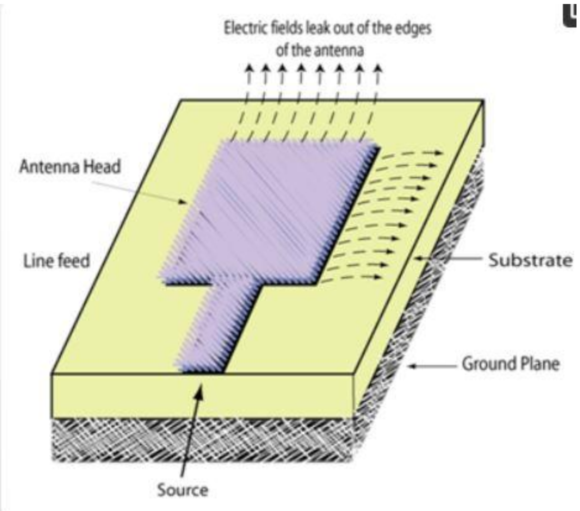

Fig 8: Radiation of Microstrip patch antenna

This paper presented the design and simulation of an elementary Rectangular patch Microstrip antenna with microstrip feed technique The main objective was to design an antenna for ultra-wide band range and the antenna should work in the target operating frequency that is 12 GHz, which was calculated using MATLAB. The length of the rectangular patch was increased and after that the design was simulated again by Ansoft HFSS and simulation result gave a large bandwidth which is in the ultra-wide band range to achieve target operating frequency (12 GHz) with the calculated value. The rectangular patch antenna was designed by changing the feed position, size of the substrate, and shape of the patch to get our objective or target output.

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