# DESIGN AND ANALYSIS OF MICROSTRIP PATCH ANTENNA FOR 5G APPLICATIONS USING PIN DIODES

**Mr.J.Navarajan[1], Mr.L.Ashokkumar2, S.Swethapriyaa[3], Ann Maria fredy[4], Tejaswini G[5]**

[1] Asst.Professor(Grade – I), Panimalar Engineering College, [2] Asst.Professor(Grade – I), Panimalar Institute of Technology, [3]U.G students, Panimalar Institute of TechnologyChennai, TamilNadu

**ABSTRACT:**
The creation of reconfigurable antenna for advancements in wireless technology is discussed in this study. This study suggests a small, flexible multiband patch antenna for WLAN (2.4 GHz) and Wi-max (5. 8 GHz) applications. The design flow-profile, frequency-reconfigurable, multiband patch antenna is the subject of the proposed system. To provide dual band operation, or to choose different frequency bands, this system comprises of a rectangular patch with a U-shaped slot and three RF PIN diodes positioned at various locations on the ground plane. The size of the gadgets and the rising complexity of wireless technology are its key drawbacks. The suggested technique makes it simple to use a single antenna to serve a variety of frequency bands. High Frequency Structure Simulator Software is used to do the analysis. further achieved stable radiation patterns. PIN Diodes, multiband, frequency, and patch are index terms.

## INTRODUCTION:

For better interoperability and flexibility, all systems in the technological world are moving towards wireless technology. Wireless technology's quick development has resulted in serious spectrum congestion. Due to their selectivity for operating frequency and crucial aspect of effectively exploiting the spectrum, frequency reconfigurable antennas have gained great attention. Antennas that serve numerous functions choose a variety of frequency bands, tune resonances, alter polarisation, and alter radiation patterns, leading to their advancements requiring contemporary technologies. By adjusting the PIN diode states, these antennas may change between a number of frequencies. PIN diodes are used in the L- or U-shaped slots of repositionable antennas. Traditional antennas require an external variable power and phase distribution network to feed them, which makes them expensive and complex. A reconfigurable antenna that resonates at different frequencies at different times by employing switches can solve the problems mentioned above. Both the price and size of the system are decreased. Micro electro mechanical systems (RF-MEMS), RFPIN diodes, varactor diodes, photoconductive elements, physical change of the antenna radiating structure, and redistribution of currents utilising ferrites and liquid crystals are some of the components used to create reconfigurable antennas. Because they are small in size, inexpensive, have minimal insertion loss, provide appropriate isolation, are extremely reliable, and have a high switching speed, RF PIN diodes are used as switches in our suggested system. In this study, a rectangular patch with a U-shaped slot and three RF PIN diodes positioned differently on the ground plane are used.By changing the locations and the lengths of the slots, the antenna can achieve dual-band modes. The bandwidth and low operating frequency ratio in OFF and ON states of the PIN diodes. In the next section, we will discuss about design of Multiband antenna, experimental results and conclusion followed by references.

## DESIGN OF MULTIBAND PATCH ANTENNA:

A proposed rectangular patch antenna developed on a FR4 substrate with a relative permittivity of εr=4.34 and a substrate height of h=1.6 millimeters (mm). The high frequency structure simulator software (version 13.0) is used to design this antenna. HFSS is a commercial finite element solver for electromagnetic structures. It is one of many commercial tools used to design antennas and complex RF electronic circuit components such as filters, transmission lines and housings. HFSS provides accurate and efficient computational options for electromagnetic analysis and design. It is based on the Finite Element Method (FEM). The board has a ground plane on one side and a stepped feedline on the other. It uses a short-ended U-shaped slot and an open-ended L-shaped slot for dual-band operation (2.4 and 5.8 GHz). By inserting two PIN diodes (D1 and D2) into the slots, the antenna can switch between two single-band modes and two dual-band modes. Another L-shaped slot with a PIN diode is introduced symmetrically to minimize cross-polarization. Stepped leads are used for impedance matching. The three parameters essential to patch antenna design are: Operating frequency (f0): The resonant frequency of the antenna should be chosen appropriately. For multiband operation, the selected frequency range is 2 to 7 GHz. Therefore, the designed antenna should work in this high frequency range. The resonant frequencies chosen for my design are between 2 GHz and 7 GHz. Substrate dielectric constant (εr): The FR4 dielectric chosen for the design has a dielectric constant of 4.34. A low dielectric constant substrate was selected. This is because the antenna bandwidth increases. Dielectric Substrate Height (h): For a microstrip patch antenna to be used in multiband applications, it is essential that the antenna be low bulk. In this case, 1.6 mm is chosen as the height of the dielectric substrate.

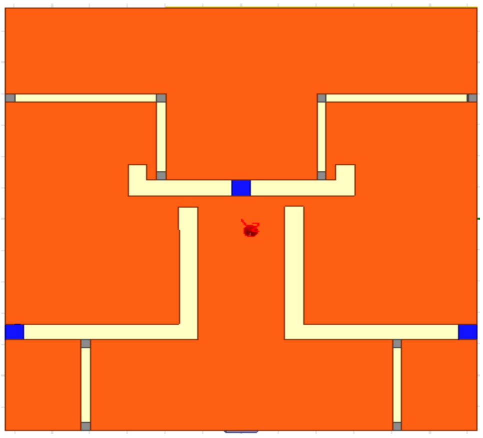


**FIGURE 1. Proposed Antenna**

The proposed antenna is shown in the figure indicates the radiator fed with microstrip feed line. The radiator consists of a groove with a radiating edge flow. These slots with the feed reduce the return loss to a greater extent. The proposed antenna is designed by cutting one slot to obtain a slot antenna. The antenna efficiency can be increased by increasing the current intensity in terms of cutting the antenna slots. The basic structure of the antenna consists of a base plate, a substrate, a chip and a feed line.

## EXPERIMENTAL RESULTS:

The antenna is fabricated on a Roger substrate with a dielectric constant of 1.6 mm thick. Input reflection coefficients are measured with an Agilent N5230A vector network analyzer and radiation patterns are measured with an Agilent E8257D microwave swept source and a Lab-Volt 8092 antenna training and measurement system.

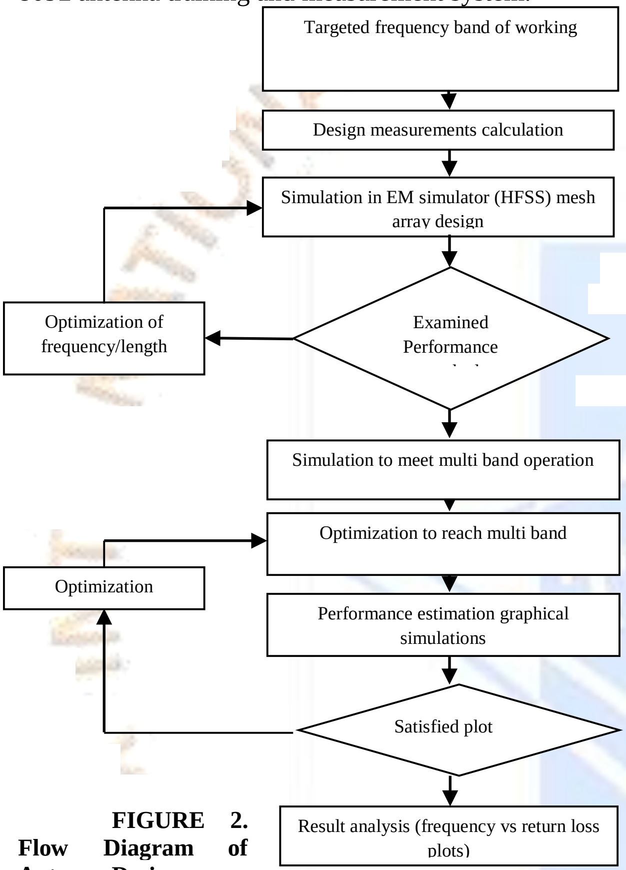
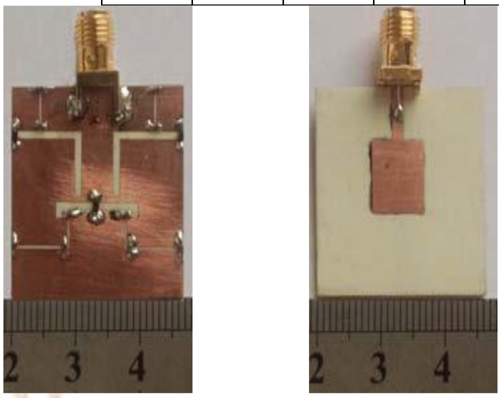



**FIGURE 2. Flow Diagram of Antenna Design**

Simulated and measured input reflection coefficient. It can be seen that the proposed antenna he achieves four switchable states. 2.4 and 5.6 GHz in two single-band modes. 2.3/4.5 and 4.5/5.8 GHz in two dual-band modes. The -10 dB bandwidths simulated for states 1, 2, 3, and 4 are 2.29-2.39/4.40-4.52, 4.29-4.57/5.71-5.94, 2.3-2.4, and 5.62-5.98 GHz. It can meet the bandwidth requirements of LTE (2.3-2.39GHz), AMT fixed line services (4.4-4.5GHz) and WiFi (5.725-5.825). In the four states, the measured resonant frequencies are 2.39/4.59, 4.32/5.64, 2.42, and 5.66 GHz, with relative bandwidths of 6.6% (2.28–2.44 GHz)/2.7% (4.38–4.5GHz), 7.6 % (4.16 GHz). -4.48GHz)/4.6% (5.5-5.76GHz), 2.5% (2.32-2.38GHz), 6.7% (5.49-5.86GHz).

**Table1 specifications of proposed Antenna**

| S.No. | Diode D1 | Diode D2 | Diode D3 | Frequency (GHz) |
|---|---|---|---|---|
| 1. | OFF | OFF | OFF | 7.25 |
| 2. | OFF | OFF | ON | 4.88 |
| 3. | OFF | ON | OFF | 6.53 |
| 4. | ON | OFF | OFF | 7.64 |
| 5. | ON | ON | ON | 5.80 |




**(a) (b)**

**FIGURE 3. Photography of antenna (a) Front view (b) Back view**

Based on the state of the PIN diodes the operating frequency are varied as follows.

Radiation patterns are also measured. Antennas have similar radiation patterns under different conditions at the same frequency. Figure 8 shows the normalized radiation patterns for State 1 and State 2. The results for the measured antenna are consistent with the simulated antenna. This antenna was found to have an omnidirectional H-plane radiation pattern and a bi-directional E-plane radiation pattern. The measured and simulated results of the antenna mainly depend on the parasitic effect of this PIN diode, the accuracy of the dielectric constant and the manufacturing error. The peak gains measured in states 1, 2, 3 and 4 are 0.7/2.5, 1.8/2.8, 0.3 and 2.5 dBi respectively. The measured results are reduced by -0.5/0.2, 1.3/1.3, 0.1 and 1.4 dB when compared to the simulated results. The simulated efficiencies for states 1, 2, 3, and 4 are approximately 59%/67%, 85%/75%, 57%, and 78%. Therefore, it provides good antenna efficiency for LTE (2.3 GHz), AMT fixed line (4.5 GHz) and WLAN (5.8 GHz) applications. The efficiencies measured in the four states are approximately 67%/64%, 74%/62%, 53% and 75% respectively.

## WEBPAGE OUTPUT:

The low efficiency of F1 is due to the small size of the antenna and the parasitic effects of the diode. Finally, Table shows the main specifications of the proposed and reported frequency-tunable U-shaped or L-shaped slot antennas. For a switchable single band, the proposed antenna has a larger frequency ratio between bands and fewer switches compared to similarly sized antennas. Moreover, the size of the proposed antenna is smaller than that of 1.56. 1. For single-band and dual-band reconfigurable antennas, the designed antenna has a smaller size and a higher inter-band frequency ratio by etching open slots on the substrate.

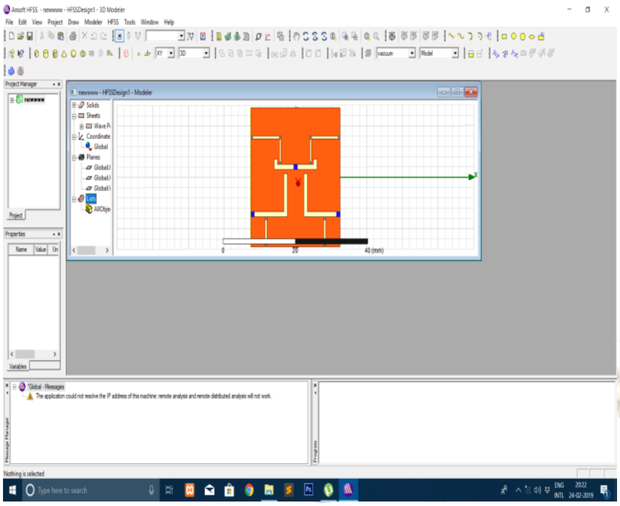


**FIGURE 4. Web page output**

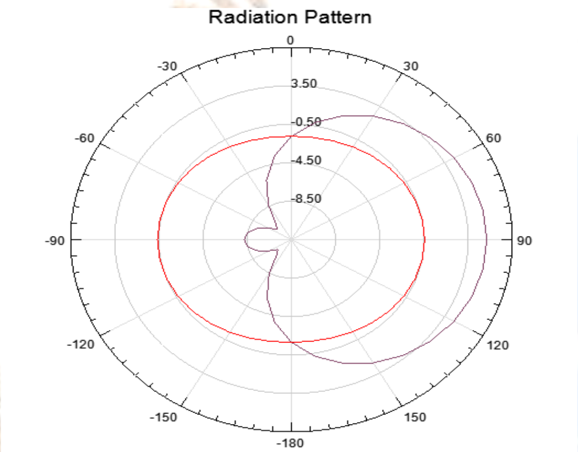



**FIGURE 5. Radiation pattern of D1-OFF, D2-OFF & D3-ON**

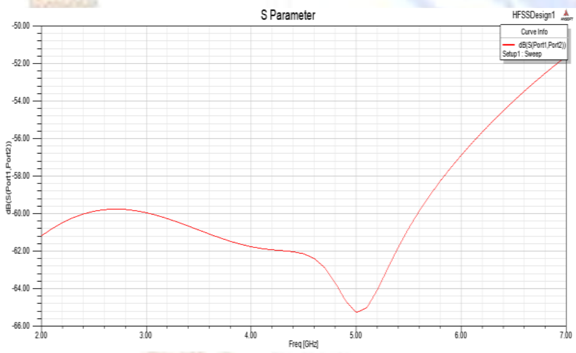



**FIGURE 6. Return loss of D1-OFF, D2-OFF & D3-ON**

## CONCLUSION:

Antennas are designed for wireless applications. A short-ended U-shaped patch and two open-ended L-shaped patches are etched into the ground plane for dual-band operation. By placing three of her PIN diodes with switches in slots, the antenna can achieve four switchable states. Two single band modes and two dual band modes. And the frequency ratio is 2.54. 1 has been reached. Conventional reconfigurable patch antennas typically have half-wave dimensions, reducing the antenna size by 30.4%. It has potential for 4G wireless networks and is being implemented in various multi-frequency systems.

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