

FREQUENCY RECONFIGURABLE MICROSTRIP ANTENNA USING METAL STRIPLINE (DIODES)

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ABSTRACT:

An effective design of compact, novel, single feed and frequency reconfigurable Microstrip Patch Antenna used for wireless and mobile communication is proposed and studied in this paper. By proposed system the frequency can be reconfigured and selection of the frequency is performed by using diodes or by using the metal strip lines. The proposed system is used with the operating frequency from 5GHz to 8GHz. The switching of the frequencies is due to the change in effective length and varying current density on the conducting patch by turning ON/OFF state of the diodes. Antenna is simulated with Computer Simulation Technology (CST). The Antenna is fabricated using the FR-4 substrate as it provides benefits such as multifunctional operation and symmetry of radiation pattern upon switching between different frequencies. The return loss of this proposed system is greater than 20dB between 5GHz to 8GHz. The Simulated and measured values give the better performance of the proposed system.

INTRODUCTION:

Microstrip Patch Antenna is widely used in wireless communications and telecommunication because of its low profile, light weight, and easy fabrication. Due to the advancement and rapid growth in wireless communications and the high demand for the integration of multiple wireless standards into a single platform, it is highly desirable that the operating frequency, radiation pattern, and polarization of antennas can be reconfigurable. Reconfigurable antennas modify their operating frequency, impedance, bandwidth, polarization, and radiation pattern, as per the operating requirements of the host systems. They can radiate multiple patterns at different frequencies and polarizations. Multiple factors need to be considered such as achieving good gain, stable radiation pattern

and good impedance matching throughout all the antenna's operation states. Frequency reconfiguration is achieved using RF MEMS switches, pin diodes and with the slots provided in the ground of the antenna. Compared to pin diodes the RF MEMS switches consumes less power and perform better but are still costly. Besides the reconfiguration of frequency, the proposed system has certain features such as reduced cost, size miniaturization and multipurpose functions, and ability to reject the interference from services coexisting in the spectrum. Slot antennas are one of the common types of antennas used in frequency tuning because varactors or switches could be used easily to change their resonant frequency. This paper adopts the circular shaped patch with the single feed, and the ground plane which has slots at which the biasing capacitors and the switches or pin diodes are placed. By modifying the conventional geometries of the antenna, it can be used in modern communication systems. Hence the different geometry of the antenna is proposed. A conventional patch antenna is modified in several steps with the ON/OFF state of switches and radiation performance in each stages of modifications are simulated using Computer Simulation Technology (CST) microwave studio simulation software.

DESIGN OF MULTIBAND PATCH ANTENNA:

Proposed circular patch antenna designed on FR4 substrate with relative permittivity of 4.3 and height of the substrate $h=1.6$ millimetre (mm). To design the antenna the Computer Simulation Technology (CST) is used. CST is used as commercial tool for designing of several other complex RF electronic circuits elements, including filters, transmission line, packaging and also antenna. It provides accurate, efficient computational solutions for electromagnetic analysis and design. On one side the ground with the slots bis provided and other side is a patch with circular shape is provided.

By inserting the switches or diodes in the slot, the antenna can switch the frequency. The frequency of operation with respect to the diodes positions ranges from 4-8GHz. Cutting of slots allows us to reconfigure the frequency of antenna based on the current flow throughout the antenna. Coaxial feed is provided with the impedance matching of 50ohm.

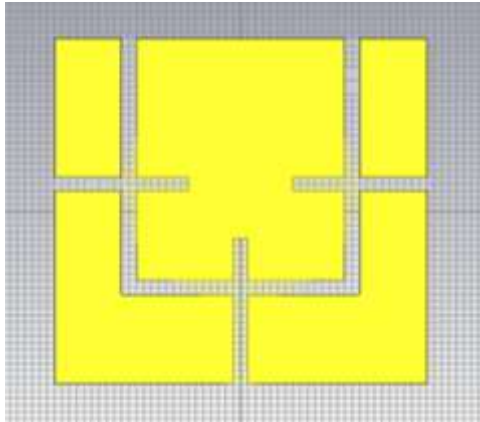


Fig. Ground of the Proposed Antenna

The square shaped ground plane is provided with the pin diodes or switches at slots for achieving reconfiguration of frequency. The length and width of the square shaped antenna's ground and substrate is 50mm. The circular patch has the radius about 16mm and the length of the feed is about 13mm, width of the feedline is 4mm. The center of the circular patch is (0,3).

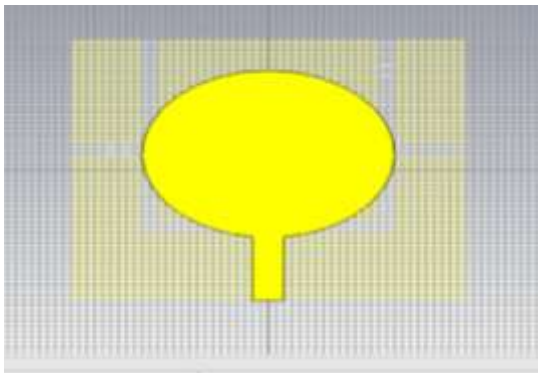


Fig. patch of the proposed antenna

In the ground plane, each slots has the spacing of about 2mm between which the diodes can be placed.

The diodes are placed in particular region for proper current distribution, so that we can reconfigure the frequency of the antenna.

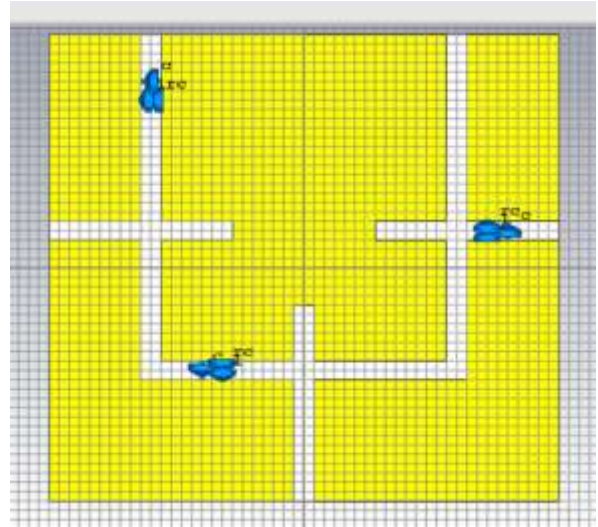


Fig. Ground with slots and diodes in the proposed antenna

The diode used in the proposed system is BAR-64-02. The equivalent circuit model of PIN diodes for ON/OFF states which consists of series parasitic inductance(L), and the intrinsic resistance (R_{ON}), when the PIN diode is ON, while a series L and an intrinsic capacitance (C) in parallel with a resistance (R_{OFF}), when a PIN diode is OFF. When PIN diode is in ON state, the values of inductance (L) and intrinsic resistance (R_{ON}) are 0.45nH and 1.5ohm respectively. When PIN diode is in OFF state, the values of the inductance is same, but the capacitance is in parallel with the intrinsic resistance, their values are 0.25pF and 2.5Kohm respectively. The biasing capacitance is also provided with the diode of value 47pF. Based on the equivalent circuit model the CST software is applied to further design, simulation, and optimization of antenna dimensions and performance.

EXPERIMENTAL RESULTS:

The proposed frequency reconfigurable microstrip antenna is based on the circular shaped patch and the slotted ground of the length and width 50mm. the coaxial feed to achieve antenna radiation. The slots have different lengths but has same spacing of 2mm. The first and second slot with horizontal cut from left and right towards center has the length about 18mm. The third slot which is a vertical cut from center to the bottom of the antenna has length about 21mm. The other slot is U-shaped which the left and right vertical slots having 37mm length and the horizontal slot having 32mm length. The 3 diodes are placed in the slots, and they are turned ON/OFF according to the frequency required.

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

S.NO	DIODE D1	DIODE D2	DIODE D3	FREQUENCY GHz
1	OFF	OFF	OFF	7.555
2	OFF	OFF	ON	5.98
3	OFF	ON	OFF	6.73
4	ON	OFF	OFF	7.545
5	ON	ON	ON	5.82

The Directivity values, when all the diodes D3, D2, D1 OFF given as 5.58dB, and diodes D3, D2, D1 are in ON state individually are 4.234dB, 5.959dB , 5.45dB respectively, and all diodes in ON state given as 4.618dB.

The Gain values, when all diodes D3, D2, D1 are OFF given as 2.22dB, and diodes D3, D2, D1 are in ON state individually are 0.123dB, 0.564dB, 2.250dB respectively, and all diodes in ON state given as 0.6285dB.

The return loss values, when all diodes D3, D2, D1 are OFF given as -29.01dB, and diodes D3,D2, D1

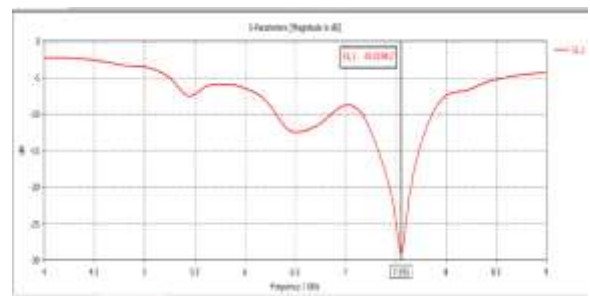
are in ON state individually are -33.4dB, -27.06dB, -29.20dB, and all diodes in ON state given as -20.31dB.

WEBPAGE OUTPUT:

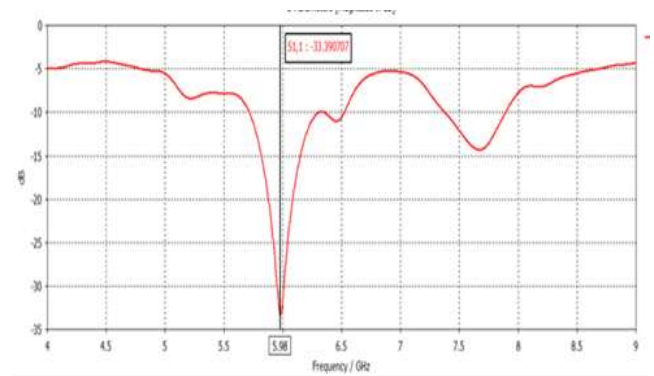


S-PARAMETERS AND WAVEFORM:

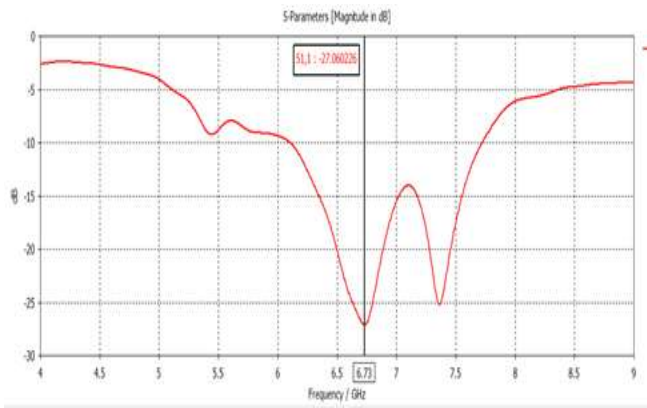
1) The operating frequency and s-parameter for all the diodes in OFF state, are plotted in waveform.



2) The operating frequency and s-parameter for the diode D3 in ON state and D1, D2 in OFF state, are plotted in waveform.

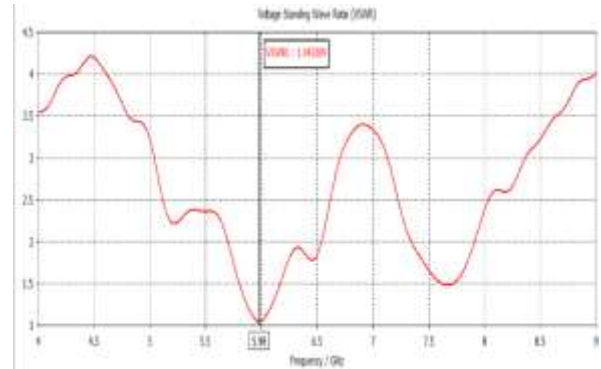


3) The operating frequency and s-parameter when diode D2 is in the ON state, and other diode D1, D3 is in OFF state, are plotted in a waveform.

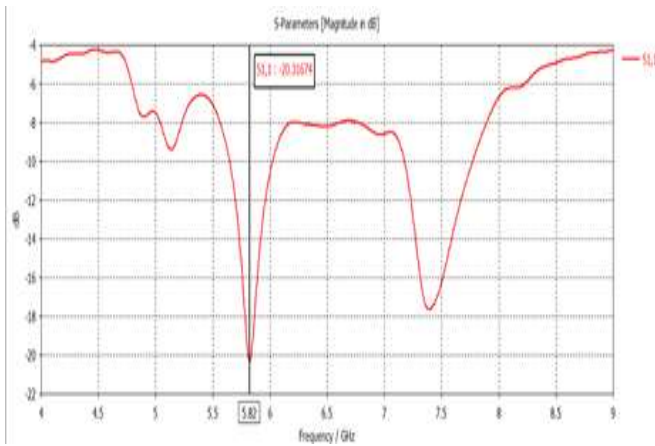


VSWR:

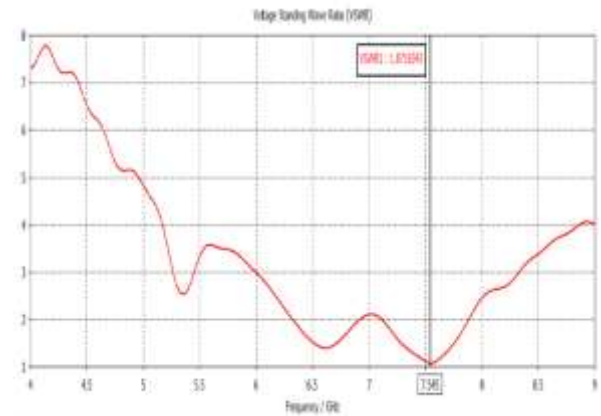
1) The VSWR waveform for diodes D1, D2 in OFF state and D3 in ON state shown as.



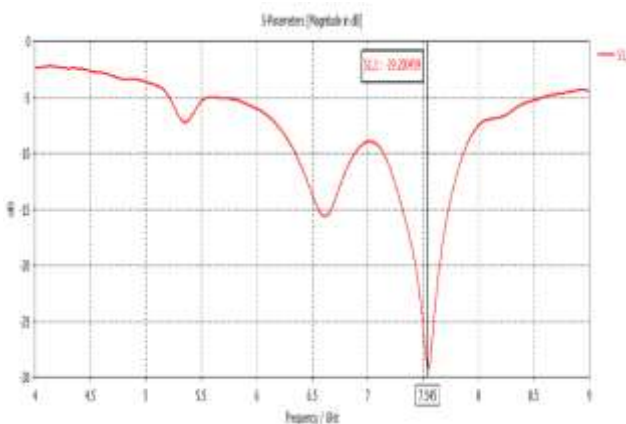
4) The operating frequency and s-parameter for all the diodes in ON state, are plotted in waveform.



2) The VSWR at D1 ON state, D2 OFF state, D3 OFF state.

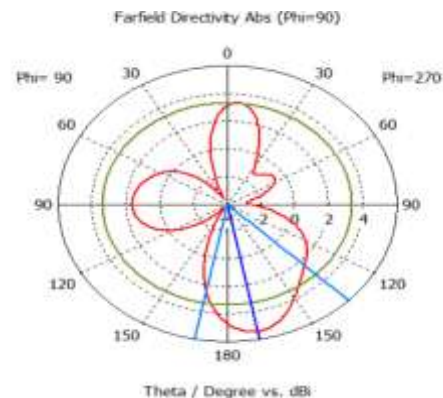


5) The operating frequency and s-parameter for diodes D1 in ON state, D2 and D3 is in OFF state, are plotted in waveform.

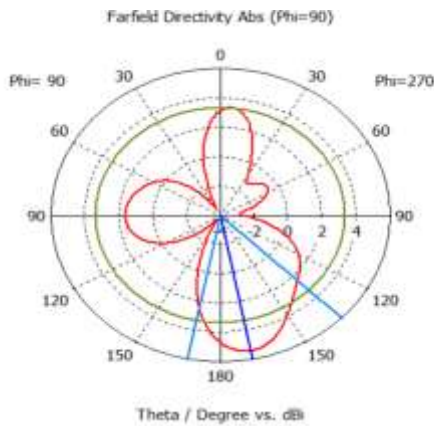


RADIATION PATTERN:

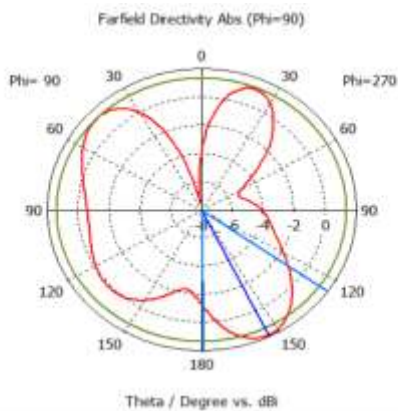
1) The Radiation pattern for all diodes at OFF condition shown as follows.



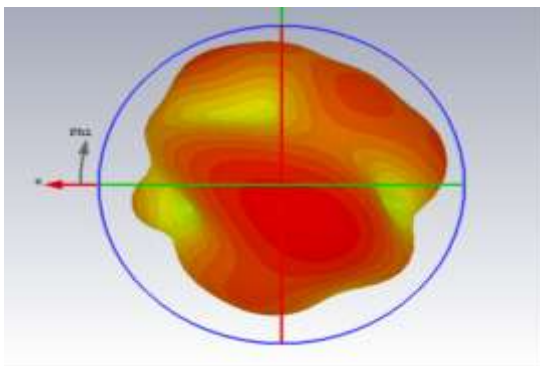
2) The Radiation pattern for diode D1 at ON state, diodes D2, D3 at OFF state.



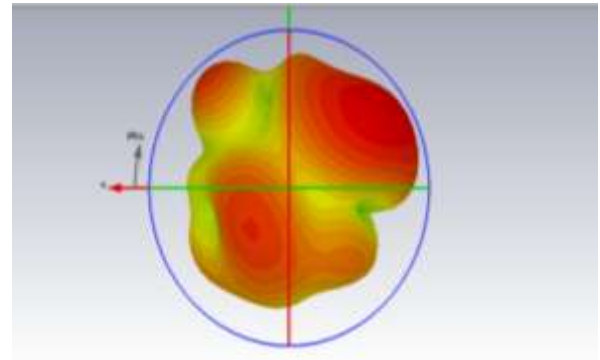
3) The Radiation pattern for diodes D1, D3 at OFF state, D2 at ON state.



4) The Radiation pattern in three dimensions for all diodes in OFF state at frequency 7.555GHz shown as.



5) The Radiation pattern in Three dimensions for diodes D1, D3 at OFF state and D2 at ON state with frequency 6.73GHz shown as follows.



CONCLUSION:

The Antenna design used for applications in the field of wireless communication and telecommunication for modern technology is designed. The proposed antenna is smaller in dimension and size than the conventional antenna. By placing the PIN diodes in the slot, the frequency can be reconfigured with better gain and efficiency. The return loss is greater than 20dB and the frequency is reconfigured between 4-8GHz and used in wideband WI-max, and also in mobile communications system and in other communication systems.

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