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DESIGN OF FREQUENCYRECONFIGURABLE SWASTIK PATCH ANTENNA FOR 5G &SATELITE COMMUNICATION

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Abstract: The key components in modern-day wireless links applications such as cognitive radio, Reconfigurable antennas play a vital role. Rapid growth in the 5G and satellite communication has received much interests based on the requirements like compact size of communication devices. An adjustable frequency microstrip patch antenna in the shape of a Swastik is described in this paper.The proposed design Rogers-4003 substrate ($\in r = 3.38$, tan $\delta = 0.0027$) dimensions of 30*30*1.6 has a Swastik shaped patch to cover the frequency of 19 GHz to 25 GHz. The antenna has a property that causes its frequency to change, which causes its characteristics to change depending on the state of diodes positioned above and below the design's centre. According to the simulated findings, the resonating band's return loss is less than -10dB, and the VSWR is between 1-2.

Keywords — Microstrip patchAntenna, Swastik patch, microwaves, reconfigurable, PIN Diode.

I.INTRODUCTION

From the fast few years, Demand for miniaturised antennas has raised interests of research work on compact microstrip designs among the microwave and wireless communications.As a result of the development of this new UWB technology, interest in creating wideband antennas has grown. These antennas offer fast data speeds due to the short length of UWB pulses and are ideal for short-range applications due to their low emission levels [1].PIN diodes are utilised in this article to achieve frequency reconfigurability. PIN diodes have the advantages of great power handling capacity, extremely low driving voltage, and inexpensive cost. Here, the type of switch and the antenna's topology determine the switch's location and control/biasing tactics. The antenna resonance properties were impacted by the DC wires placed close to the radiating elements [2].In order to support high mobility required devices like telecom devices, short & light weight antennas are preferred. For this, Microstrip antennas are one of the most suitable applications [3].The main benefit of the different-shaped microstrip patch antennas is that they make it possible to design patches in a variety of shapes for a broad range of frequencies, including square, rectangle, ring, disc, triangle, elliptic, and pentagonal. [4]. The radiating element of the proposed antenna consists of Swastika symbol slot operating at k and Ka bands [4]. the slots created in the ground plane enables the antenna resonates at eleven resonating frequencies by placing six diodes in the slots. The switching configurations of the diodes enables the reconfigurability [5]. Reconfigurable antennas address a large number of complex systems requirements by varying the parameters of the antenna like geometry and electrical behaviour The multiple number of patches can be connected by using the diodes as switching elements also results in the frequency reconfigurability [6]. In the same way frequency reconfigurability can be achieved by using smart materials like fluids and liquid crystals. By creating the substate milled channels and introducing smart materials into it also results in reconfigurability. By using Various state combinations of those smart materials results in the frequency shifting [7].

II.LITERATURE SURVEY

Due to continuous increase in demand of customers for access to large number of standards/applications with in single portable device; the field of mobile communication has advanced a lotstill requires extensive research to get its conclusion. This advancement in mobile communication has resulted in getting access to several applications [8-10]. Due to the sudden rise in demand of 5G communication increased the demand. In the 5G sub bandwidth frequency range of 24-52 GHz. In order to make resonant antennas fit inside a specific volume inside a phone, extensive research has been conducted over the past 20 years [10-12].

III.DESIGN& DIMENSIONS

A. Design

The design of proposed reconfigurable antenna is presented. Fig. 1(a), presents the front view of proposed antenna. Fig. 1(b), presents the side view of the proposed antenna. Fig. 1(c), presents the 3D view of the proposed reconfigurable antenna. The dimensions of the proposed design such as the length & width of the patch and calculated with the help of antenna toolkit by ground plane, width of the ground plane, length of the patch and width of the patch are calculated using the online emtalk microstrip patch calculator by giving the specifications such as dielectric constant, substrate height and resonating frequency. The antenna is proposed on Rogers R0 4003 substrate with a thickness of 1.6mm, with permittivity of 3.38 and loss tangent of 0.0027. The proposed design is fed with coaxial feeding at the center of the design. The proposed design consists of slots at the above and below the center of the patch with a PIN diode are placed in those slots. To achieve frequency reconfigurability, PIN diodes are utilised.The size of the slot is 2.5*4mm. the microstrip patch is of 20*24 mm^2. the dimensions of ground plane are30*30 mm^2. The dimensions of the design are depicted in Table I.

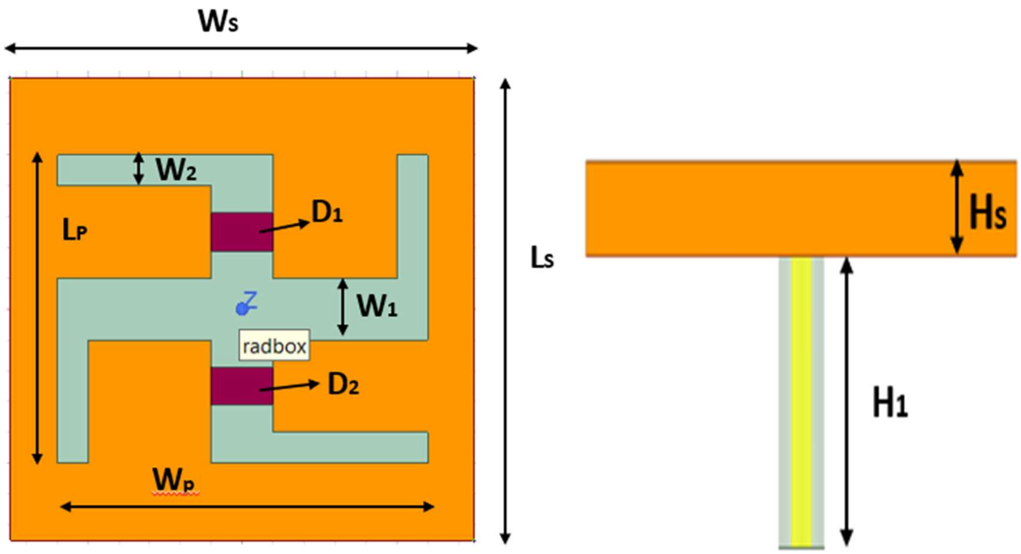

Fig. 1(a). Front view of proposed antenna (b). side view of proposed antenna

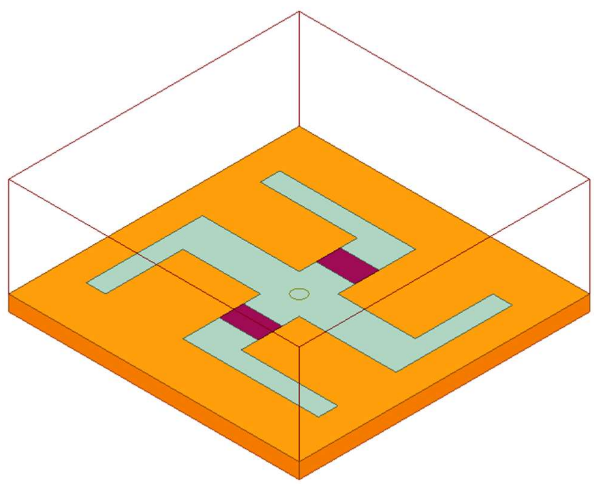

Fig.1 (c). 3D view of proposed antenna

The dimensions of the model are specified as follows:

TABLE I Dimensions of the Proposed Design

Parameter	Length in mm
Ls	30
Ws	30
Hs	1.6
Lp	20
Wp	24
W1	4
W2	2
H1	5

B. Modellingof PIN Diode

When the diode is switched OFF, the antenna resonates from 21.53-25.21 GHz PIN diodes are used as switching elements. When the switches are ON state, the antenna is resonating at 19.97-21.41GHZ & 23.76-25.17 GHz. Without changing the dimension of the antenna, the antenna resonates at different frequency with the help of PIN diodes. The equivalent circuit of PIN diode in forward biased and reversed biased is shown in Fig. 2a and Fig. 2b respectively. The equivalent circuit for forward biased PIN diode consists of series inductance L=0.4nH and series resistance of R=3Ω and the reverse bias equivalent circuit consists of shunt Capacitance C= 0.03pf and shunt resistance R = 3kΩ. We use ANSYS Ansoft Electronics DesktopStudent 2022 R2 software to simulate our design.

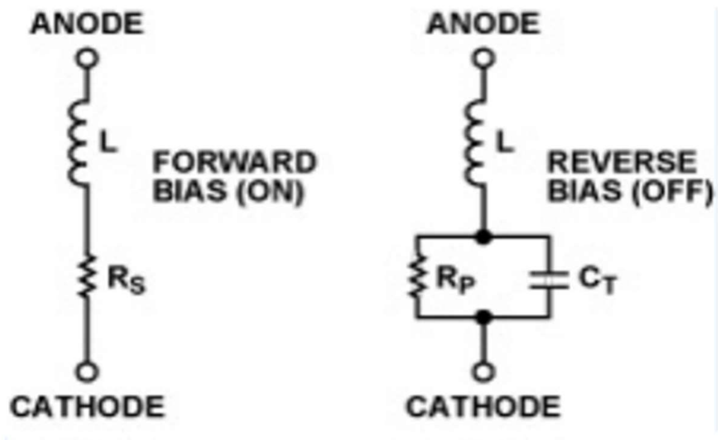

Fig2: PIN diode under (a) forward (b) reversed biased condition

IV.SIMULATED RESULTS

In this section simulated results of the proposed design like VSWR, return loss (S11) and radiation pattern are depicted below. The proposed model has operated in two states. State 00 and State 11. Fig. 3, shows the S_{11} of proposed reconfigurable antenna. The simulated return loss for all the frequency bands is less than -10dB. Fig. 4 depicts the simulated VSWR value of proposed value. The simulated VSWR for all the frequency bands lies between 1 to 2. Return loss (S_{11}) and VSWR value for different frequency bands were summarized in Table II. Fig.5 and Fig. 6 shows the simulated radiation pattern of proposed antenna with different switching states

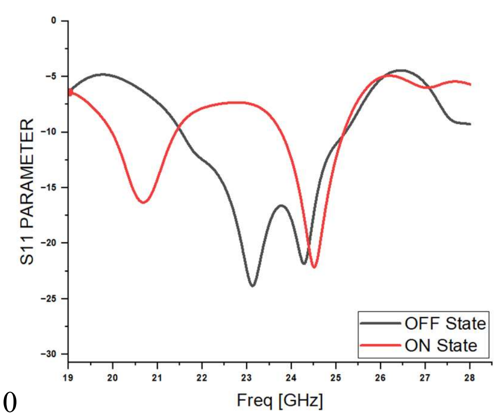

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Fig. 3. Simulated S11 value of proposed antenna

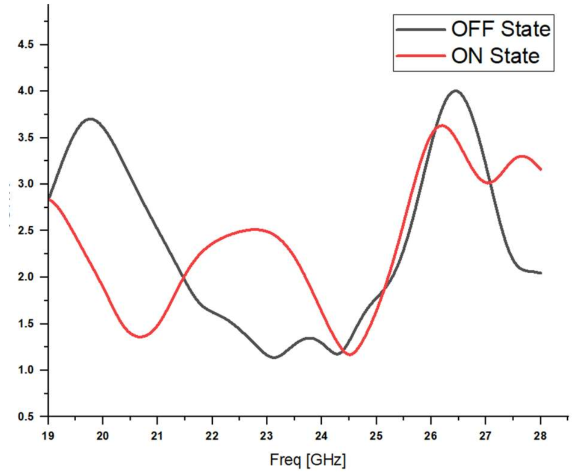

Fig. 4. Simulated VSWR value of proposed antenna

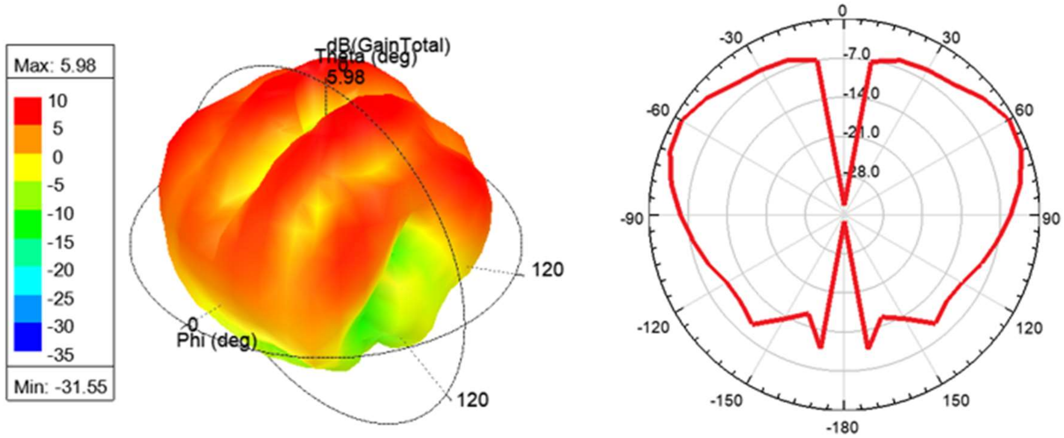

Fig. 5. Simulated 3DGain and Directivity of proposed antenna for OFF state.

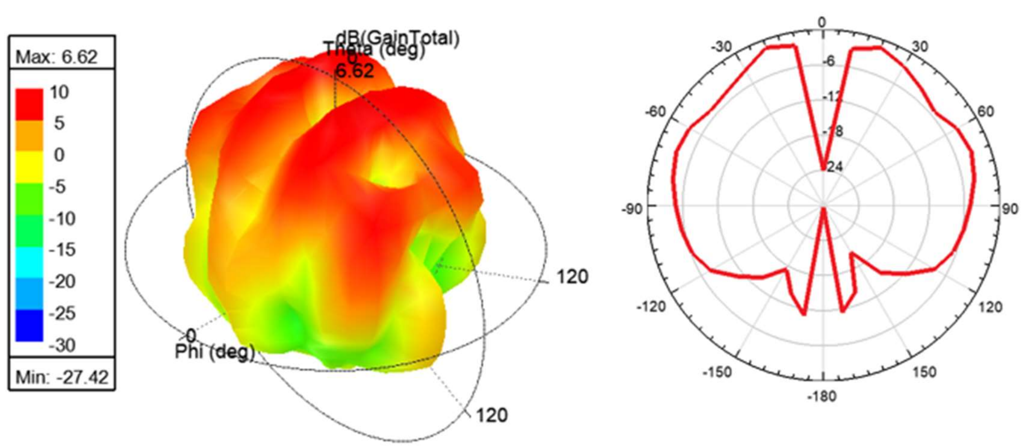

Fig. 6. Simulated 3DGain and Directivity of proposed antenna for ON state.

TABLE II. S11 AND VSWR VALUE FOR PROPOSED ANTENNA

STATE		Resonating Frequency Range (GHz)	VSWR	Return loss(dB)	Resonating Frequency (GHz)	Bandwidth (GHz)	Peak Realized Gain(dB)	Band of Operation
D1	D2							
0	0	21.53-25.21	1.13	-23.81	23.14	3.81	5.98	Radar, Satellite communications (k-band)
1	1	19.97-21.41& 23.76-25.17	1.36, 1.17	-16.31, -22.15	20.68, 24.51	1.56, 1.51	6.62	5G sub band (k-band)

V.CONCLUSION

In this paper a frequency reconfigurable Swastik shaped microstrip patch antenna for satellite and 5G mobile communion is presented. The suggested antenna is compatible with a variety of wireless protocols, including radar and satellite communication, etc. Two PIN diodes are used to switch frequency between different standards. The antenna radiates at four different frequency bands for two switching conditions. The proposed design can be fabricated due to its planar structure, very small in size with a width of 30mm*30mm. The antenna resonates at the optimum value of VSWR and return loss.

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