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DGS BASED FREQUENCY RECONFIGURABLE MICROSTRIP PATCH ANTENNA FOR COGNITIVE RADIO AND WI-MAX APPLICATIONS

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ABSTRACT

In this paper, Defective ground based frequency reconfigurable micro strip patch antenna for cognitive radio and Wi-max applications is proposed. The different antenna parameters like Return loss (S_{11}), VSWR, Radiation pattern, Gain and Directivity are improved when compared with the antenna with DGS to the antenna without DGS structure. Simulated frequency of an antenna range lies in the range of 3.2-3.67 GHz. The simulation results of an antenna carried by using computer simulated technology (CST) microwave studio software. Resonating frequency range of the antenna is well suitable for Wi-max and cognitive radio applications.

KEYWORDS: Frequency Reconfigurable, Micro Strip Patch Antenna, Wi-Max, DGS, Cognitive Radio

INTRODUCTION

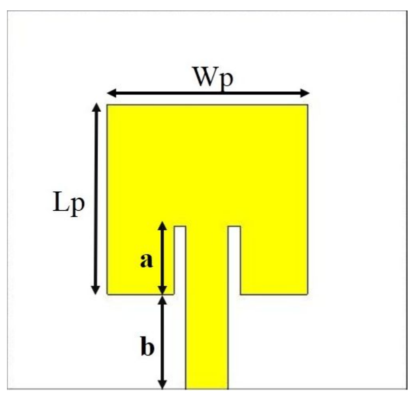
Now a days, Reconfigurable antennas are involved in lot of attention, specifically in future wireless communication system. For Future cognitive radio communication systems, frequency reconfigurable antennas can improve the radio environment by improving its functionalities like fading channel or the existence of interfering signal. Combined of several functions in single reconfigurable antenna will improve the performance of the cognitive radio communication system. Frequency reconfigurable micro strip patch antennas are used for cognitive radio systems because of in cognitive radio communication system, the secondary users can occupy the slot which is free without interfering of primary users. In order to fulfill Wi-MAX requirements we are using micro strip patch antennas because of multi-functional performance of the antenna in a single antenna. Micro strip patch antennas are chosen because of their features. The Major advantages which makes the micro strip patch antenna most popular are low weight, low cost, performance, ease of installation, low profile and conformal. Micro strip patch antennas are very easy to fabricate and can be integrated with other micro strip components. Frequency reconfigurable antennas are widely used in so many applications in these days because of low weight, less cost and easy to fabricate by using printed circuit technology. Microstrip patch antennas are having some disadvantages over on its advantages those are low gain, low impedance match and extra radiation occurring from feeds and junctions [1]. Reconfigurable patch antenna design and analysis discussed in [2-4]. Defected ground plane structure is defined as the antenna which is having slots or gaps in the ground plane of the antenna in the cascaded form. Polarization reconfigurable antenna with loop slots on the ground plane explained in [5]. Simple polarization Reconfigurable antenna with T-shaped feed discussed in [6]. Multiband Reconfigurable extended U-slot antenna with switchable polarization discussed in [7]. Reconfiguration micro strip patch antennas with different methods for different applications are showed in

[8-12]. Antenna which is having reflector at the ground plane discussed in [13]. Micro strip patch slot antenna suitable for radio applications are explained in [14].

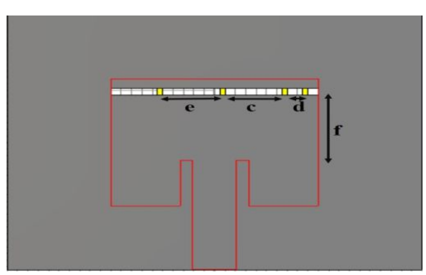
In this design, reconfigurable antenna with patch on the front view of an antenna and slot which is place at the ground plane which is under patch is proposed. The location of the slots and inset feed are adjusted to get better return loss. The Dimensions of the substrate are $40\times39mm^2$, which is very small in size. There are different kinds of software's are available in these days to simulate and analyze the results of an antenna. The simulations of results are carried via computer simulation technology (CST) microwave software tool here.

DESIGN AND OUTLINE

The design and Configuration of the proposed antenna is described here. Figure 1 describes the structure of the suggested antenna. Antenna which is designed by using substrate name called FR-4 substrate having thickness of $1.6mm$with permittivity of 4.3, and Loss tangent is about 0.0018. We preferredFR-4 substrate because of its good availability, cost is cheap and everyone can process it. The patch size is $19.5\times20mm^2$. The length of the feed line is given by a= $7mm$ which is having width of $1.2mm$. Feed point length is b= $9.75mm$ with a width of $4.2mm$. The slot which is presented at the ground plane with a distance of g=5.5 mm. The length of the total slot is given by $20mm$ which are having width of $1mm$. Totally, there are four small slots present in the main slot; the first slot is positioned at $0.5mm$ away to right on x-axis with width of $0.5mm$ and length of $1mm$. Second slot is positioned at a distance of c= $5.5mm$ away right to the First slot with width of $0.5mm$ and length of 1mm. Third switch is placed at d= $1.5mm$ away to the second slot with same width and length as second slot. Finally, last slot i.e. fourth slot is placed at a distance e= $5.5mm$ away left to the first slot. There are four types of feeding methods are available. But, we are using micro strip line feeding method.



a. **Front View**



b. **Back View**

Figure 1: Proposed Structure of Antenna

The Function of antenna is done by changing the position or gap of the different slots positioned on the main slot which is placed on the ground plane. Different Resonating frequencies are takes place at different places of the slots in the main slot of the Ground plane as shown in the following Table 2.

Table 1: Switching Configuration

Frequency	Slot 1	Slot 2	Slot 3	Slot 4
F1	ON	OFF	OFF	OFF
F2	ON	ON	OFF	OFF
F3	ON	ON	ON	OFF
F4	ON	ON	ON	ON
F5	OFF	ON	OFF	OFF
F6	OFF	ON	ON	OFF
F7	OFF	OFF	ON	OFF
F8	OFF	OFF	ON	ON
F9	OFF	OFF	OFF	ON
With Total slot	OFF	OFF	OFF	OFF
Without Total Slot	OFF	OFF	OFF	OFF

RESULTS AND DISCUSSIONS

Reconfigurable patch antenna which is useful for Cognitive Radio and Wi-MAX applications are designed with CST microwave studio software and calculated the results like return loss, voltage standing wave ratio, radiation pattern, gain and directivity etc. The simulation results of an Antenna with defected Ground structure and Without Defected Ground structure are described in this results and discussion. Figure 2 shows the simulated results of the return loss vs. frequency.

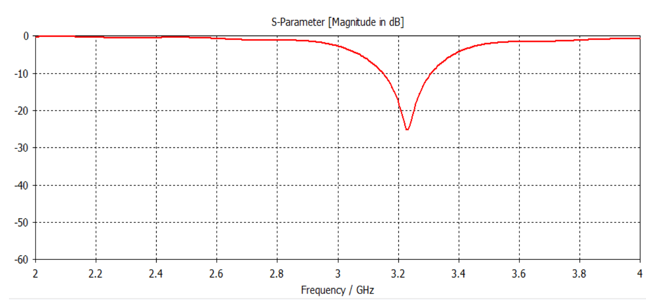


Figure 2: Return Loss of an Antenna without DGS Structure

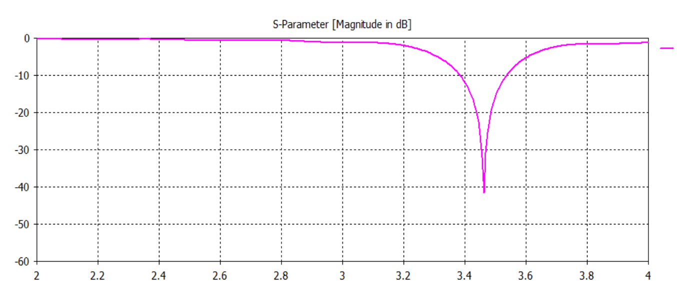


Figure 3: Return Loss of an Antenna with DGS Structure

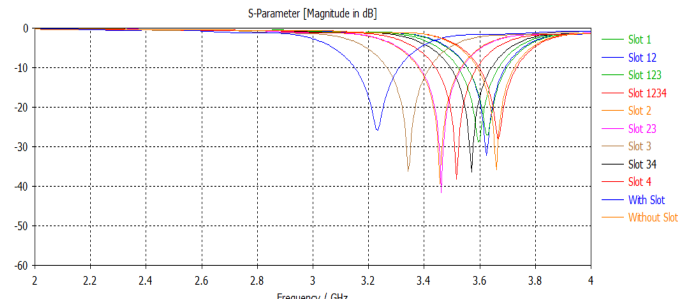


Figure 2: Simulated Return Loss over Different Frequency

From the above figure we can observe that simulated Return loss are Less than -10 dB at all resonating frequency ranges. Which covers Wi-MAX application middle range frequency range from 3.2 to 3.6 GHz. The antenna which radiating at minimum of frequency is 3.23 GHz frequency with return loss of -25.73 dB, and maximum radiating frequency is 3.66 GHz with return loss of -35.81 db. Antenna which is radiating at the frequency point 3.43 is giving the more return loss than all other radiating frequencies.

Return loss of an antenna is given by

$$RL = 10\log\left(\frac{Pr}{Pi}\right)$$

Where, Pin= input power

Pr= Radiating power

The below figure 3 shows the voltage standing wave ration over frequency. Basically, the range of VSWR from 1 to 2. In proposed antenna VSWR range is varying from 1.01 to 1.10 according to the radiating frequency.

Voltage standing wave ratio and return loss are related by using the relation:

$$\text{VSWR}=\frac{1+\sqrt{\left(\frac{Pr}{Pi}\right)}}{1-\sqrt{\left(\frac{Pr}{Pin}\right)}}$$

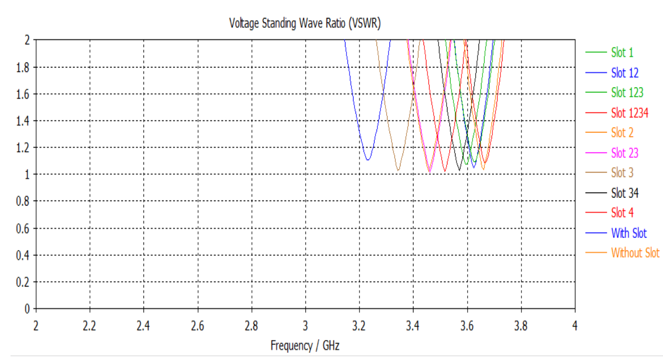


Figure 3: VSWR vs. Frequency

The following Table 2 shows the simulation results of the Return loss and VSWR over radiating frequency.

Table: 2 Return Loss vs. VSWR vs. Frequency

Configuration	Frequency	Return Loss	VSWR
F1	3.59	-28.82	1.07
F2	3.62	-32.11	1.05
F3	3.63	-27.03	1.09
F4	3.66	-28.37	1.07
F5	3.45	-39.33	1.02
F6	3.46	-41.65	1.01
F7	3.34	-36.15	1.03
F8	3.57	-36.42	1.03
F9	3.51	-38.24	1.02
with slot	3.23	-25.73	1.10
without slot	3.66	-35.81	1.03

In this design the antenna is more radiating at 3.46 GHz which having Return loss of -41.65 dB and VSWR is around 1.01. When the return loss is decreasing VSWR is increasing, we can observe from the above table.

The below figures from 4 to 12 represents the far field radiation pattern of an antenna at different frequencies.

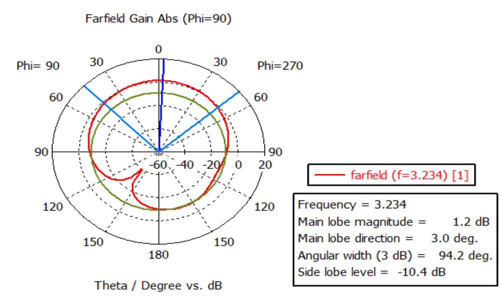


Figure 4: Radiation Pattern of an Antenna at F=3.23 GHz

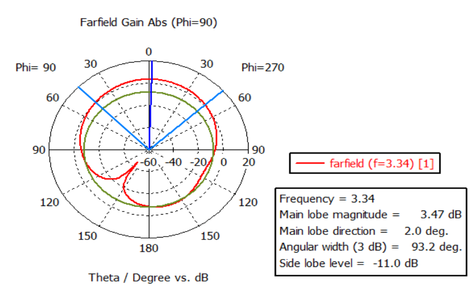


Figure 5: Radiation Pattern of an Antenna at F=3.34 GHz

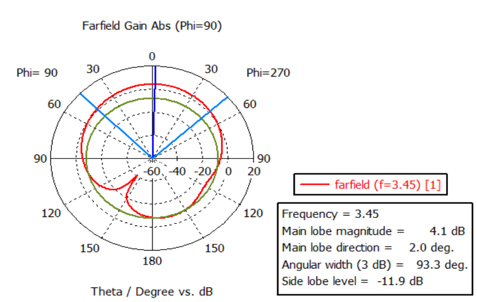


Figure: 6 Radiation Pattern of an Antenna at F=3.45 GHz

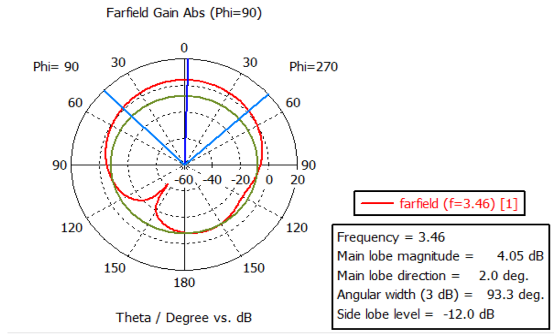


Figure 7: Radiation Pattern of an Antenna at F= 3.46 GHz

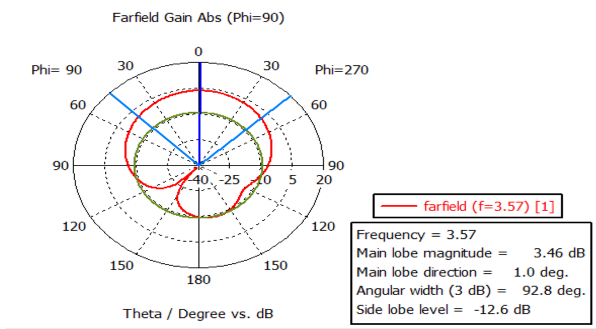


Figure 8: Radiation Pattern of an Antenna at F=3.57 GHz

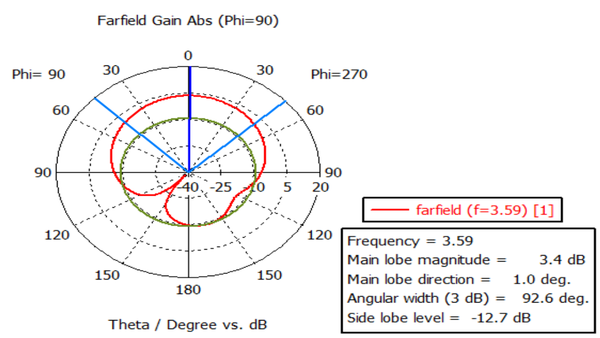


Figure 9: Radiation Pattern of an Antenna at F=3.59 GHz

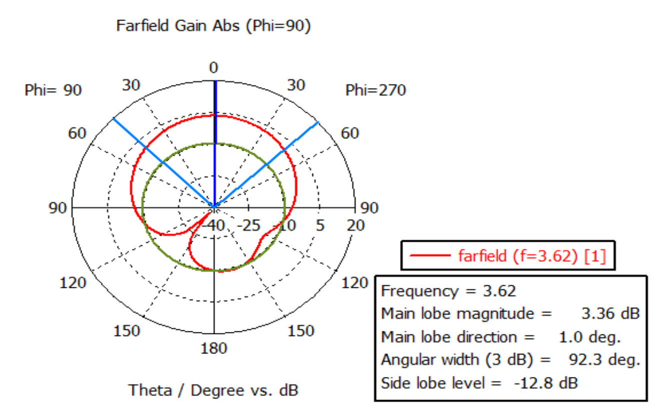


Figure 10: Radiation Pattern of an Antenna at F=3.62 GHz

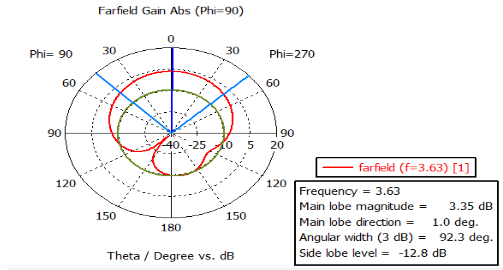


Figure 11: Radiation Pattern of an Antenna at F=3.63 GHz

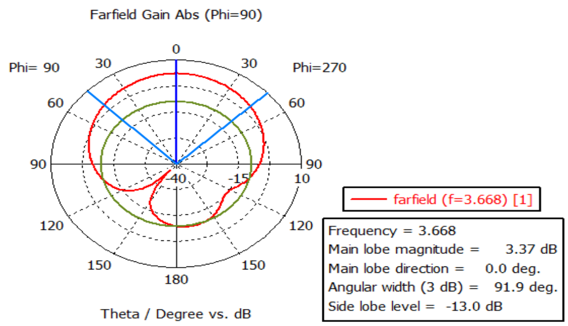


Figure 12: Radiation Pattern of an Antenna at F=3.66 GHz

Figures 13, 14, 15 and 16 represents the 2D radiation pattern of an antenna at the frequencies f= 3.23 and 3.46 GHz. From this 2D representation of antenna we can observe the gain and directivity of an antenna.

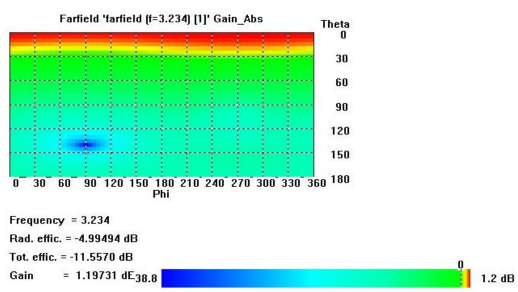


Figure 13: Gain of an Antenna at F= 3.23 GHz

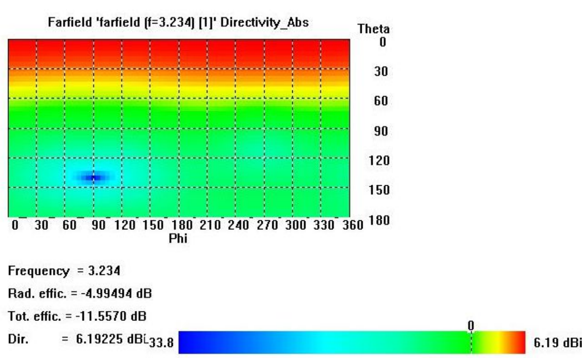


Figure 14: Directivity of an Antenna at F=3.23 GHz

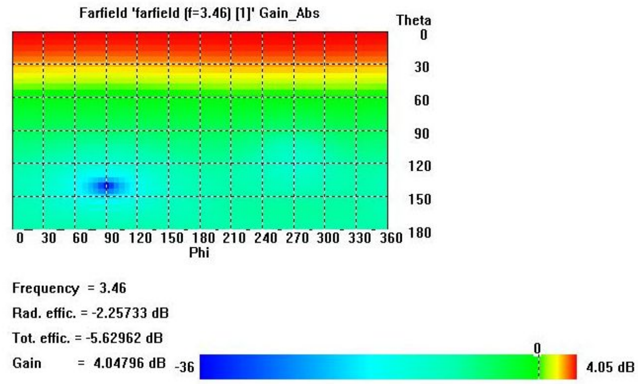


Figure 15: Gain of an Antenna at F=3.46 GHz

By observing figures we can observe that, antenna is achieving more gain=4.04 dB and directivity= 6.30dBi at radiating frequency f=3.46 GHz.

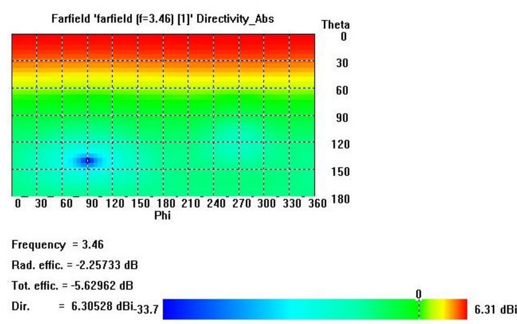


Figure 16: Directivity of an Antenna at F= 3.46 GHz

CONCLUSIONS

Defective ground structure based Frequency reconfigurable micro strip patch antenna was designed. Return loss of an antenna with DGS is very lee than compared with return loss of an antenna without DGS. The VSWR value which is obtained by antenna with DGS based having the value of 1.01 dB i.e. equal to unity. The antenna with defective ground structure based is useful for wireless and Cognitive Radio Applications.

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