Analysis and Design of DGS by Inserting of a Active Element PIN Diode in Slot Patch

Rahul Kumar Verma, R L Yadava

Abstract*: In this work, a rectangle is formed one side of substrate material i.e. FR-4/glass epoxy, PIN diode and slot integrated on ground patch ,on the basis of reflection coefficient S11, a re-configurability characteristics is found. Using the PIN diode the electrical length of slot can be changed when the PIN diode is in ON / OFF position has more than one resonant frequency. Patch antenna is compatible with characteristics use as dual band antenna under ON condition of PIN diode in wireless communication, these frequencies are 6.45 Ghz and 9.7 GHz. OFF conditions 6.46GHz and 9.8GHz.all the parameters remains same during the current distribution. A reconfigurable property of patch antenna is found.

Index Terms*: DGS, Electrical length, PIN Diode, reconfigurable, slot.

I. INTRODUCTION

Wireless communications development has improved the demand for low-profile antennas with excellent radiation features to be constructed into the new generation of electronics devices. For this purpose, any size of patch antennas is normally used as they can be mounted directly on the circuit board. Many type wireless applications i.e. Laptop, Radar, Mobile and aircraft etc. This is mounted on any type of surface and with proper feed line. But their radiation power is affected by the materials used for fabrication, compact sizes [3].This is very popular above the 10^6 Hz range. The term reconfigurability means significant and desired function for wireless communication, sensing, and imaging in modern, agile, radio frequency (RF) devices. Antenna reconfiguration is accomplished by intentionally altering its features of frequency, polarization, or radiation. There are methods that redistribute the antenna currents and thus alter the electromagnetic fields of the effective aperture of the antenna are achieving this change.Jun Hu et al[2] quad-polarization reconfigurable array antenna with a wide operating bandwidth and simple switching circuits. The geometrical structure and layout of the suggested patch antenna array, which can be reconfigured. The wideband antenna component was created using a structured dual layer that includes an embedded waveguide cavity powered substratum and four patches of parasite radiation. A Polarization in a circular patch antenna with a C-shaped slot was created by Ka Ming Mak et al[1].The antenna's radiation pattern may be switched either in linear or circular mode. Microstrip patch antenna's fundamental structure is provided through the rectangular patch and runs to produce multiband features through several slotted iterations. Integrated microwave planar circuit with ground plane slots are referred to as defected ground structure. A fundamental idea behind the defective ground surface technology and numerous mathematical approaches are discussed to analyze the defected ground structure in microstrip patch.Park et al. first suggested defected ground structure (DGS) and used the word "DGS" to describe in the shape of a dumbbell. Different microwave circuits such as filters [4], amplifiers, rat race couplers , branch line couplers and Wilkinson energy dividers [5-6] were suggested to be realized in many forms. In the earlier stages of DGS implementation to design microstrip filters, different defective ground surface were investigated, and these applications caused antenna engineers to develop planar antenna with stopband functionality by incorporating DGS into their ground plane. DGS was used to improve the standard planar antenna's multiple parameters. Using DGS, multiband can also be accomplished. In this respect, several proceedings have been reported[7]. For wireless apps, dual broadband antenna with rectangular slot was analyzed[8]. In this paper, we have planned to design and optimize the reconfigurable patch antennas using PIN diode to improve the dual frequency and the impedance matching. This maximizes the power transfer and minimizes signal reflection from the load. The design parameter includes the length of the patch, width of the patch, slot length, slot width, PIN position, position of the feed. The proposed methodology will be implemented in the working platform of HFSS and the results will be analyzed with the recent state of art methods.

II.METHODOLOGY AND STRUCTURE DESIGN

DGS was integrated with a planar transmission line on the ground plane, i.e. a microstrip line, a coplanar wave guide and a coplanar wave guide supported by the conductor. The deformity on the ground plane disturbs the current distribution on the ground plane ; this interference changes the features of a transmission line (or any structure) by including parameters (slot resistance, slot capacitor).Microstrip patch antenna's fundamental structure is provided through the rectangular patch and runs to produce multiband features through several slotted iterations. By taking the FR4/glass epoxy material, the original size of the patch is taken at 5.5 GHz and the material height is 1.6 mm, loss tangent 0.02 and dielectric constants 4.4. The fundamental equations for length and width are provided below. The calculated size is 12.45 mm and 16 mm.

$$w = \frac{c}{2f_0}\sqrt{\frac{2}{\varepsilon_r+1}} \quad (1)$$

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$$\varepsilon_{reff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left(1+\frac{12h}{w}\right)^{-\frac{1}{2}} \quad (2)$$

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}} \quad (3)$$

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{w}{h}+0.8\right)} \quad (4)$$

$$L = L_{eff} - 2\Delta L \quad (5)$$

This patch antenna is made DGS (Defected Ground Structure) by cutting the rectangular slot and one of the slot is reconfigured by the PIN diode designed through HFSS. The diode works like as a switch in ON and OFF states. The dimension of the substrate is 28.1mm and 32 mm.

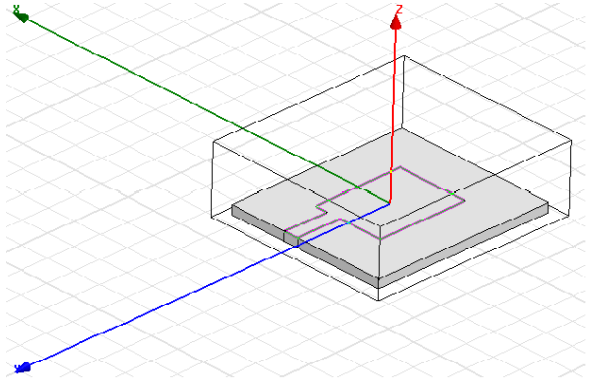

Fig1 Patch antenna front view

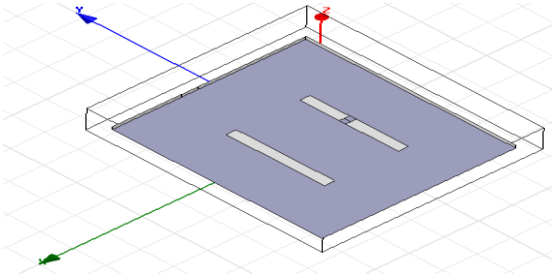

Fig.2. Slot on ground plain

III.RESULT AND DISCUSSION

The fig. 3 shows the s_{11} Vs frequency curve for the designed reconfigurable microstrip antenna. The curve is the combined curve for the both states (ON and OFF) of the PIN diode. The Red curve shows the curve for the ON state and black curve for the OFF state.

Fig.3 S_{11} Vs Frequency Curve

VSWR curve

Fig 4 shows the VSWR Vs Frequency curve for the ON states of the PIN diode.

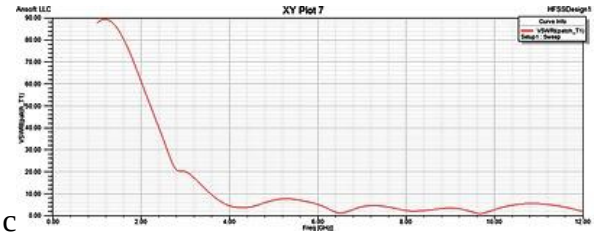

Fig. 4 VSWR Vs Frequency curve

This curve shows that given antenna in the on states shows the good matching under the different frequency of the UWB frequency.

Gain Vs Frequency Curve

Fig 5 show the 3 dimension gain pattern of the antenna in ON state.

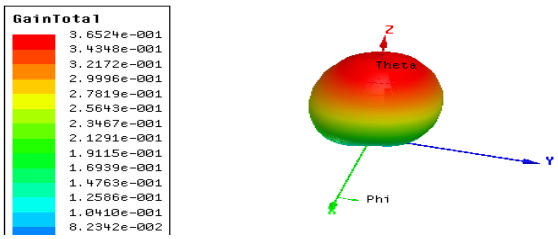

Fig. 5 3 D Gain Vs Frequency curve

IV CONCLUSION

It may be concluded that embedded of PIN diode in slot as DGS affects as significantly dual resonance frequency characteristics in fig 3.

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