Design and Analysis of Array Microstrip Patch Antenna with Frequency Reconfiguration

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Abstract

In this paper, arraymicro strip patch antenna with frequency reconfiguration is designed which produce different radiation pattern without changing the antenna dimensions and used to achieve a greater efficiency. Frequency reconfiguration is achieved by electrical reconfiguration technique which uses the varactor diode that was placed in the via hole to switch between various frequencies,because, varactor diode acts as a tunable device in RF circuits. The operating frequency of the antenna is 2.5 GHZ. So, the antenna size is reduced and achieved the gain of 4.8 db. The 3x1 array size represents the antenna elements and the feed point. Simulation is done by using the HFSS software (High Frequency Simulation Software). Because of compact size it can be used in receiver station of the IRNSS(Indian Regional Navigational Satellite) satellite system

Keywords: *micro strip patch, varactordiode, size, Meta material*

I. INTRODUCTION

Microstrip patch antenna consists of a very thin metallic strip placed on above the ground plane with a dielectric material in-between the ground plane and metallic strip [1].They are very compact size antennas having low radiation. The patch antennas are popular for low profile applications at frequencies above 100MHZ.usually, the micro strip patch is chosen to be square, circular or rectangular in shape for the easy of analysis and fabrication. The radiation pattern of micro strip patch antenna is board. It has low radiation power and narrow frequency bandwidth. Array of patch antenna is used to achieve a greater directivity [5].

Reconfigurable antennas are capable of modifying dynamically its frequency and radiation properties in a controlled and reversible manner. Frequency reconfigurable antennas can adjust dynamically their frequency of operation. They are useful in situations where the multiple antennas are required that can be replaced by a single reconfigurable antenna. In other words it can be defined as changing the mode of operation such as TE_{10}toTE_{01}. It takes millimeter waves and reconfigures that to the UWB application. Reconfigurable antennas can be designed by integrating PIN/Varactor diodes and RF MEMS devices into the structure of the antenna. By electrically controlling these components, the radiation patterns of the antennas can be modified.

II. PROPOSED ANTENNA DESIGN

In this paper array micro strip patch is designed to produce various radiation pattern for different frequencies that can be achieved by electrical reconfiguration technique. It uses the varactor diode for switching between different frequency ranges. Frequency reconfiguration is defined as changing the mode of operation. When modes are changed its far field and near field also changed to produce various radiation pattern. Frequency reconfiguration is achieved by electrical reconfiguration technique it uses the varactor diode. In this antenna design it uses the via hole for placing the varactor diode. Via hole is nothing but punching hole in patch design. During simulation process the via hole use the varactor diode characteristics to switch the between various frequencies in the antenna. By using this via hole technique the losses are reduced. After the fabrication process, varactor diode is placed in that hole. Three via holes are used in this design where the one via hole is placed inside the patch antenna it act as a switching element the remaining two via holes used as reflector. So, it can also be act as a yagi uda antenna.

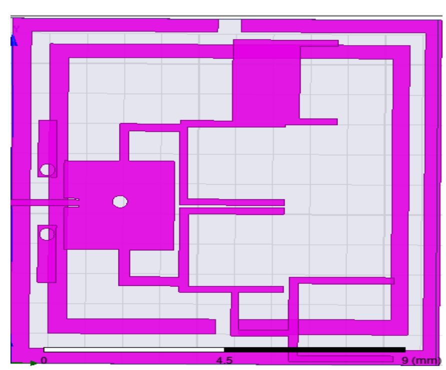


Fig:2.1Array Micro Strip Patch Antenna Design with Frequency Reconfiguration

In this design ring shape ground and meta material substrate is additionally used for narrow band and wide band application above the ground. Meta material substrate is also used for this design it produce a narrow band and prevents unwanted radiation. This antenna operates at 2.5GHZ and size is reduced to 0.0472 inches. Because of compact size this antenna is used for variety of application. Microstrip patch antenna uses the FR4 substrate. Array of microstrip patch improve the gain and directivity.

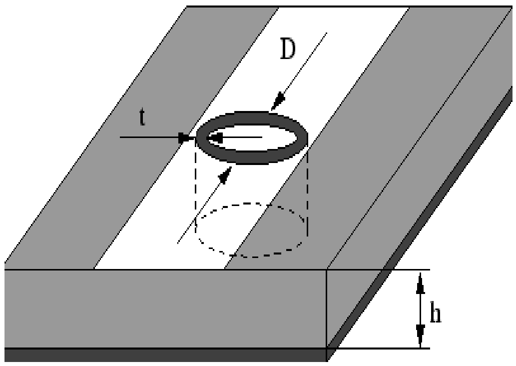


Fig: 2.2 Via Hole in Patch Antenna

The capacitance of the diode is inversely proportional to the square root of the voltage applied to the diode.

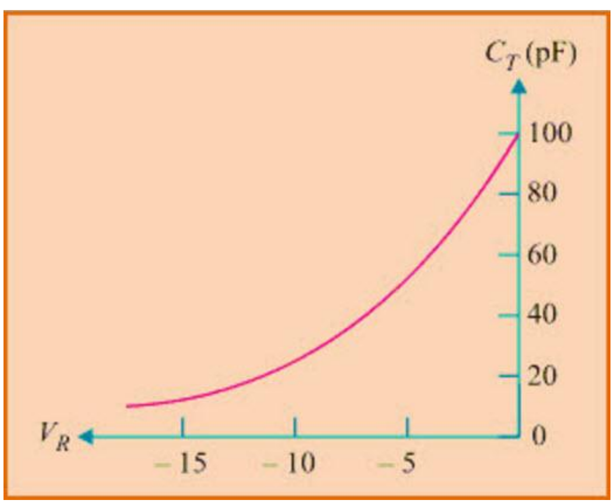


Fig: 2.3 Characteristics of Varactor Diode

A. Design Parameters

Frequency (f) = 2.5 GHZ

Wavelength (λ) = c/f

= 0.12 = 120mm

Width (w) =λ/2[$\sqrt{2}/(\varepsilon_r$ +1)]

= 0.0365 = 36.5mm

ε_{reff} =ε_r + 1 /2

= 2.7 = 2700mm

Guide wavelength (λ_g) = λ/ $\sqrt{\varepsilon_{ref}}$

=0.073 =73mm

Thickness of the patch antenna is 1.6mm and via hole thickness is same as the patch antenna thickness. And the diameter of the via hole is 0.9mm.

B. Gain and Directivity

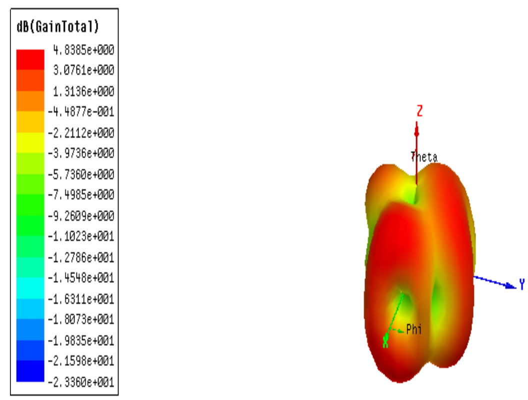


Fig: 2.4 Gain

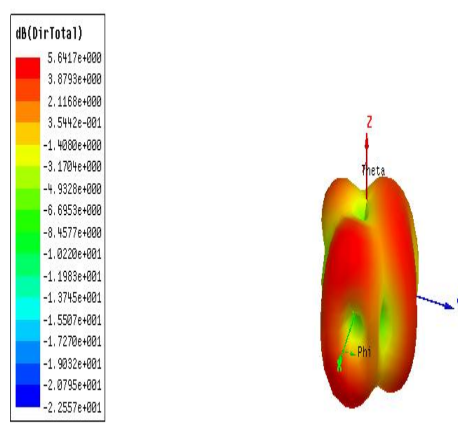


Fig: 2.5 Directivity

This figure shows the gain and directivity of proposed system. This antenna designed at 2.5 GHZ. Hence, it achieve the greater gain of 4.7db and directivity of 5.6db compared to the existing system and the efficiency of the proposed system is 83%.

C. Return Loss and Vswr

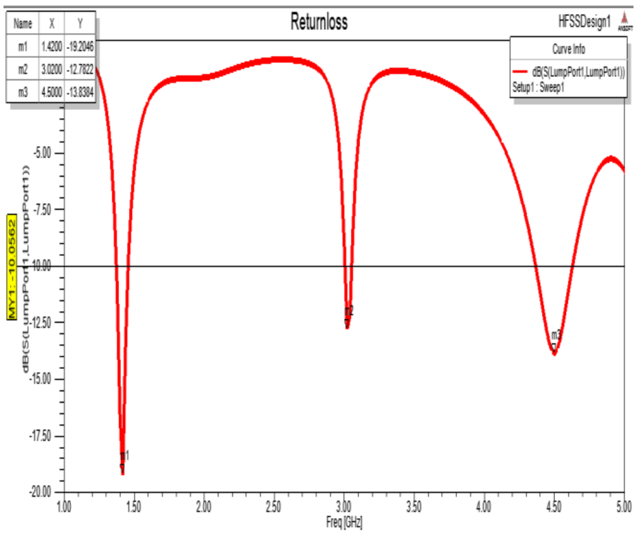


Fig: 2.6 Return Loss

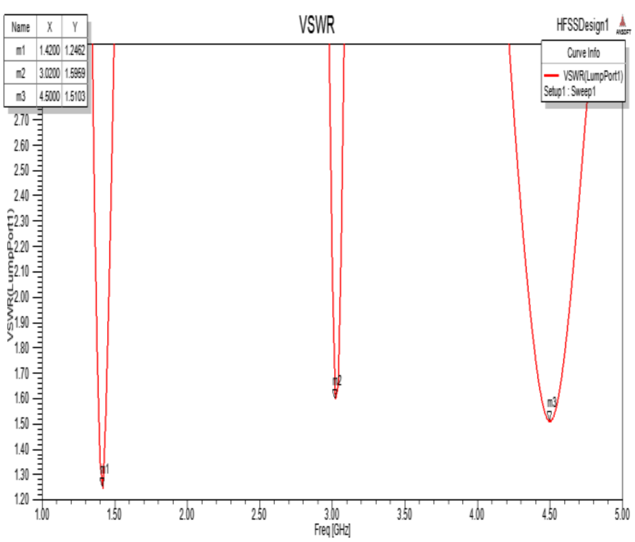


Fig: 2.7 VSWR

This Figure shows the return loss and VSWR of a proposed system. Three frequencies ranges are marked in this figure as a sample. The marked points show this antenna is used for various applications. Where m1, m2 are used for ISM band and m3 is used for UWB frequency application. If the VSWR=1.0, then the input impedance and the output impedance are perfectly matched. Hence, there is no reflected power through the transmission line of the antenna. It will be used to achieve the better radiation pattern and improve the gain and directivity.

D. Radiation Patterns

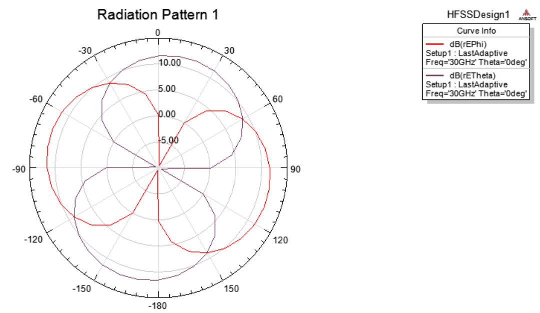


Fig: 2.8 Radiation Pattern 1

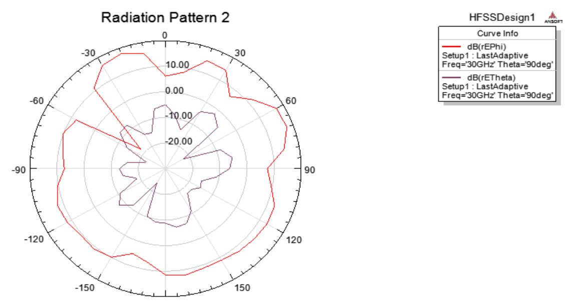


Fig: 2.9 Radiation Pattern 2

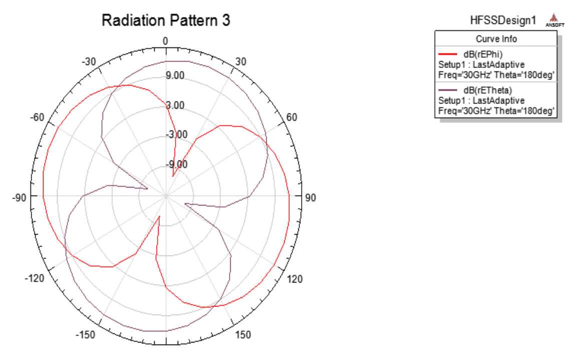
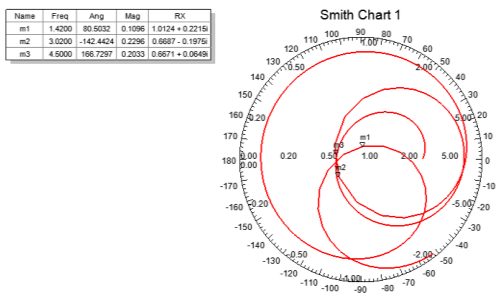


Fig: 2.10 Radiation Pattern 3

This figures show the radiation patterns of proposed system for different θ and ϕ values. By varying the capacitance value in the varactor diode the current distribution also varies.so, the near field and far field region varied and produce different radiation pattern for the proposed system From this frequency reconfiguration is achieved.

E. Smith Chart



Name	Freq	Ang	Mag	RX
m1	1.4200	80.5032	0.1096	1.0124 + 0.2215i
m2	3.0200	-142.4424	0.2296	0.6687 - 0.1975i
m3	4.5000	166.7297	0.2033	0.6671 + 0.0649i

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Fig: 2.11 Smith Chart

From the smith chart the resistance and reactance values are calculated for the proposed system. By this the output impedance (Zout) is calculated and input impedance (Zin) is 50Ω

III. CONCLUSION

This Paper proposes an array micro strip patch antenna with frequency reconfiguration. Designed antenna produce a different radiation pattern for different frequency. It uses the varactor diode for frequency reconfiguration. Via hole technique are used to reduce the losses. This antenna produces improved performance interms of gain and directivity compared to existing system and also achieves the better efficiency. Because of, compact size it can be used for many wireless application. In future, it will meet the requirements of compact size antenna in IRNSS satellite system.

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