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Design of Microstrip Antenna for Coupling Reduction

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ABSTRACT: The basic conceptions and transmission characteristics of defect ground structures are introduced and the equivalent circuit models of defect ground structures units are also presented. Defect ground structure is an intentionally designed defect on a ground plane, which creates additional effective inductance and capacitance. In this technique can be used to design microstrip lines with desired characteristics, while significantly reducing the footprint of the microstrip structures. Defect ground structures are widely used in microwave circuits and antenna design because they produce the band-rejection characteristics similar to electromagnetic band gap structure but with a more compact size. A compact H-shaped defect ground structure is applied to reduce the mutual coupling between array elements and eliminate the distance between the antenna arrays in MIMO applications. In order to reduce the number of antenna in cellular communication defective ground structure is used. The proposed defect ground structure is inserted between the adjacent E-plane coupled elements in the array to suppress the pronounced surface waves. A two-element array is measured and the results show that a reduction in mutual coupling of 11dB is obtained between elements at the resonant frequency of the array. Two elements array with and without the defect ground structures are measured. The configuration has been designed, simulated and validated experimentally.

KEYWORDS: Array, Microstrip feed, Mutual Coupling, Defected Ground Structures, Reflection coefficient, Transmission coefficient, Gain.

I. INTRODUCTION

Antenna plays a vital role in any wireless communication system. Antennas are the backbone and almost everything in the wireless communication system without which the word could have not reached at this age of technology. In multi user is a set of multiple- input multiple- output (MIMO) technologies for wireless communication, in which a set of users or wireless terminals, each with one or more antennas, communicate with each other. In contrast, single user MIMO consider a single multi-antenna transmitter communicating with a single multi-antenna receiver. In long term evolution is a standard for high speed wireless communication for mobile phones and data terminals, based on the global system for mobile communication (GSM)/ enhanced data rates for GSM evolution (EDGE) and universal mobile telecommunication system (UMTS)/ high-speed packet access (HSPA) . It increases the capacity and speeds using a different radio interfere together with core network improvement and size is reduced. To reduce the distance between two antenna in MIMO applications. In order to reduce the number of antenna the defect ground structure is used. In long term evolution, wireless fidelity (Wi-Fi), worldwide interoperability for microwave access (WiMAX) and (HSPA+) needs the user high data rate and increasing the capacity speed and to compact size.

Interference is a major problem in any wireless communication system. In conventional electronic interference cancellation techniques are bandwidth limited and they are unable to cancel in-band interference. In MIMO application long term evolution needs the user high data rate and size is reduced. Hence we will develop a microstrip patch antenna array with suitable structure that effectively eliminates the electromagnetic interactions.

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The goal of this project is to design and simulate a microstrip patch antenna array is to reduce the electromagnetic interaction by using a method of DGS structure. The design antenna should be capable of operating from 1GHz to 4GHz while maintaining the radiation pattern and gain characteristics throughout the operating band

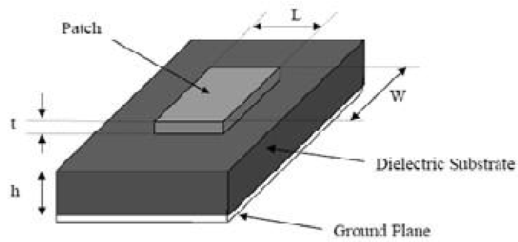

Fig 2.1: Microstrip patch antenna

II. MICROSTRIP ANTENNA

In its basic form, a Microstrip Patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Fig 2.1

Manufactures for mobile communication base station often fabricate these antennas directly in sheet metal and mount them on dielectric posts or foam in a variety of ways to eliminate the cost of substrates and etching. This also eliminates the problem of radiation from surface wave excited in a thick dielectric substrate used to increase bandwidth.

III. DESIGN EQUATIONS

$$W = \frac{C}{2f_0\sqrt{\left(\frac{\varepsilon_r + 1}{2}\right)}}$$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}}$$

$$L_{reff} = \frac{C}{2f_o\sqrt{\varepsilon_{reff}}}$$

$$\Delta L = 0.412h\,\frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)}$$

$$L = L_{eff} - 2\Delta L$$

$$L_g = 6h + L$$

$$W_g = 6h + W$$

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IV.DESIGN OF MICROSTRIP PATCH ANTENNA

SINGLE MICROSTRIP PATCH ANTENNA

It consists of any planar or non-planar geometry on one side of a dielectric substrate with a ground plane on the other side as shown in Fig 4.1. Radiation characteristics have been calculated for a large number of patch antennas. Rectangular and circular patch antennas are widely used.As shown in Fig 4.1.a, to analyze the performance of single microstrip patch antenna, a substrate material with height 1.6mm and dielectric constant 4.3 is chosen. The resonant frequency is about 2.4GHz The design achieves a return loss between 2.4 GHz for isolation greater than 10dB.The proposed antenna is found to have omni-directional radiation pattern in H-Plane at lower resonantfrequencies and the pattern is distorted at higher frequencies.

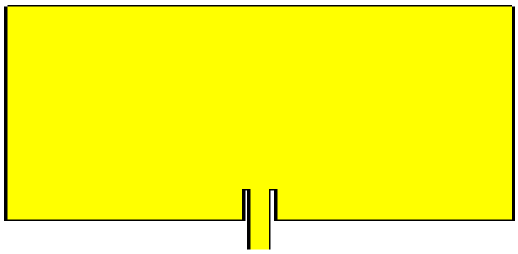

Fig 4.1 Design of single microstrip patch antenna

As shown in Fig 4.1b, in a single microstrip patch antenna the gain is about 5.21dB and the resonant frequency is 2.4GHz

DUAL MICROSTRIP PATCH ANTENNA

In array antenna application poses a strong challenge in the antenna community. In antenna arrays, multiple antenna elements designed to operate at the same frequency share a common substrate as shown in Fig 4.2. A serious problem of coupling between antenna elements occurs, which may significantly interfere with neighbouring antenna unit cells resulting in reduced antenna gain, operational bandwidth and radiation efficiency. Therefore, it is necessary to suggest a suitable method to overcome this coupling effect and to improve the performance of the antenna array. Two microstrip patch antenna with edge to edge spacing of 7mm.

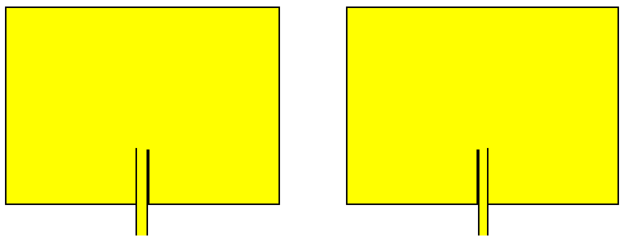

Fig 4.2 Design of dual microstrip patch antenna

SIMULATION RESULTS:

In a dual microstrip patch antenna return loss and the mutual coupling between the two antennas which have same substrate and ground plane. As shown in Fig 4.2a into analyse the performance of the dual microstrip patch antenna, a substrate material with height 1.6mm and dielectric constant 4.3 is chosen. The resonant frequency is about 2.4 GHz. The design achieves a mutual coupling between 2.4 GHz for isolation greater than 10dB.

The proposed antenna is found to have omni-directional radiation pattern in H-Plane at lower resonant frequencies and the pattern is distorted at higher frequencies. The pattern in E-Plane is bidirectional at lower frequencies

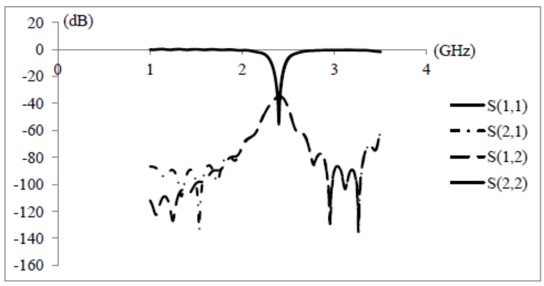

Fig4.2a Return and coupling loss characteristics of dual microstrip patch antenna

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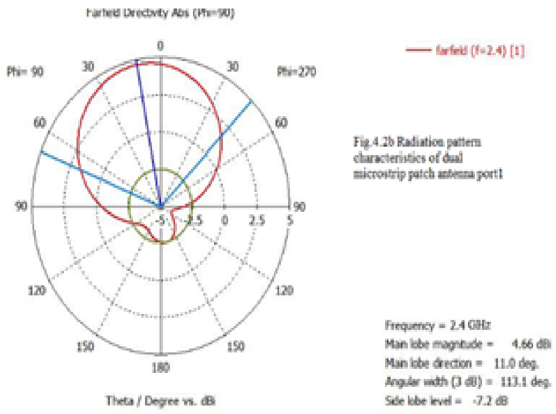

Fig.4.2b Radiation pattern characteristics of dual microstrip patch antenna port1

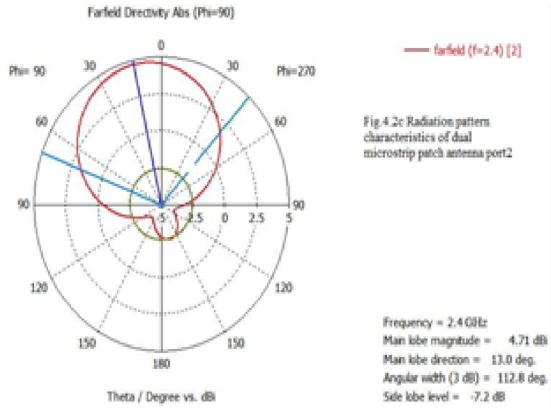

Fig.4.2c Radiation pattern characteristics of dual microstrip patch antenna port2

As shown in Fig 4.2b and Fig 4.2c, the far-field characteristics of the dual microstrip patch antenna without DGS structure the gain is about 4.7dB.

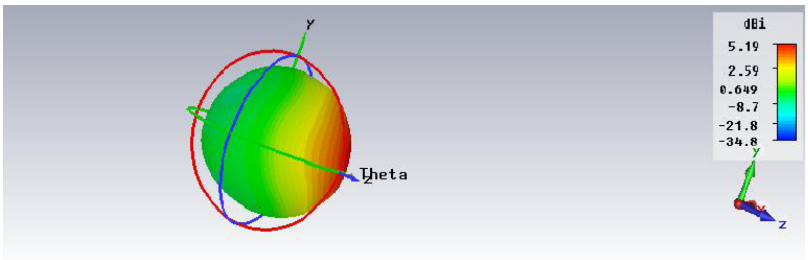

Fig 4.2e 3D radiation pattern without DGS at port 1

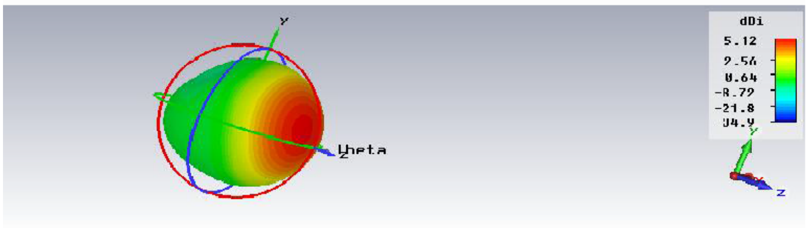

Fig 4.2f 3D radiation pattern without DGS at port 2

As shown in Fig 4.2e and Fig 4.2f simulated electric field on the patch and respective 3D radiation pattern for first few higher order resonant modes in a rectangular patch without defect ground structure.

V. DEFECTED GROUND STRUCTURE

Itis a carved cross section shape which situates on the ground plane. It is acknowledged by carving surrenders in the rear metallic ground plane under a microstrip line. An essential and generally utilized DGS cell is made out of two wide surrendered regions and a limited interfacing space, for example, H-shape thin at focus. The name for this strategy just implies that an 'imperfection' has been set in the ground plane, which is ordinarily viewed as an estimation of an interminable, splendidly leading current sinks. It enables the creator to put a score (Zero in the exchange work) anyplace. IT is a scratched occasional or non-intermittent fell arrangement imperfection in ground of planar transmission line (for example microstrip, coplanar and conductor sponsored coplanar waveguide) which bothers the shield current appropriation in the ground plane reason for the imperfection in the ground. This unsettling influence

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will change attributes of a transmission line, for example, line capacitance and inductance. In a word, any deformity scratched in the ground plane of the microstrip can offer ascent to expanding compelling capacitance and inductance. It can be comparable by three sorts of equal circuits: LC and RLC equal circuits, π formed equal circuit and semi static identical circuit.

DESIGN OF DUAL MICROSTRIP PATCH ANTENNA WITH DEFECTED GROUND STRUCTURE (DGS)

The DGS is etched in the ground plane of a grounded microstrip substrate. The substrate has a dielectric constant and a thickness of h. A 50 V microstrip transmission line is used to scale the characteristics of the DGS. The performances of the H-shaped DGS and the conventional square head dumbbell shaped DGS are compared using the CST microwave studio. Two structures are designed with the same rejection band frequency of 2.4 GHz.

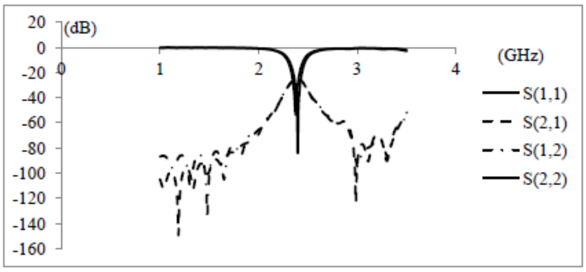

Fig.5.10 Return and coupling loss characteristics of dual microstrip patch antenna with DGS structure

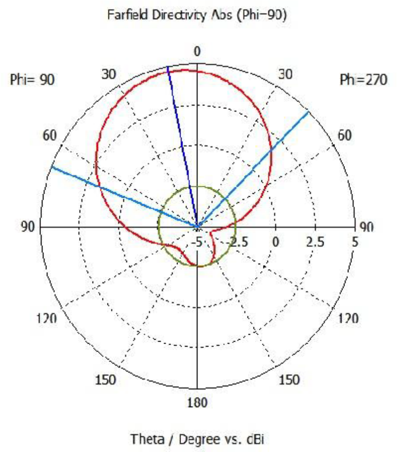

Fig.5.11 Radiation pattern characteristics of dual microstrip patch antenna with DGS structure port1

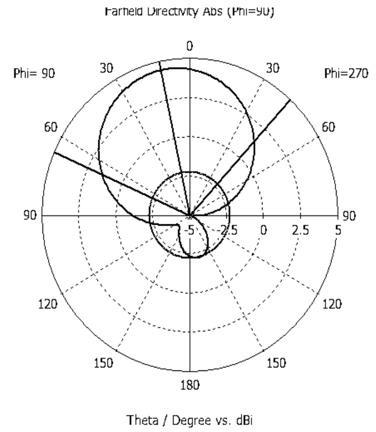

Fig.5.12 Radiation pattern characteristics of dual microstrip patch antenna with DGS structure port2

As shown in Fig 4.5, the optimized dimension for the H-shaped DGS are gap=0.7mm, length=4mm, width=1mm, edge to edge spacing=7mm.

VI. SIMULATION RESULTS

In a dual microstrip patch antenna return loss and the mutual coupling between the two antennas which has same substrate and ground plane with DGS structure.

As shown in Fig 5.10, to analyse the performance of the dual microstrip patch antenna, a substrate material with height 1.6mm and dielectric constant 4.3 is chosen. The resonant frequency is about 2.4 GHz. The design achieves to reduce a mutual coupling between 2.4 GHz for isolation greater than 10dB.

The proposed antenna is found to have omni-directional radiation pattern in H-Plane at lower resonant frequencies and the pattern is distorted at higher frequencies. The pattern in E-Plane is bidirectional at lower frequencies.As shown in Fig 5.11 and Fig 5.12, the far-field characteristics of the dual microstrip patch antenna with DGS structure the gain is about nearly 4.75dB.

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As shown in Fig 5.15 and Fig 5.16 simulated electric field on the patch and respective 3D radiation pattern for first few higher order resonant modes in a rectangular patch with H-shaped defect ground structure.

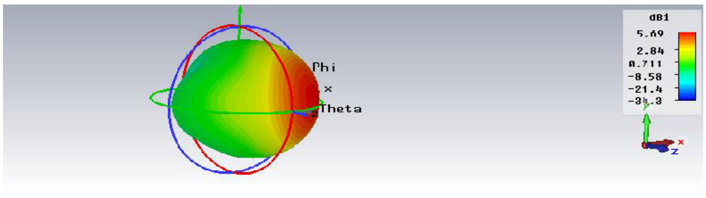

Fig 5.15 3D radiation pattern of H-shaped DGS at port 1

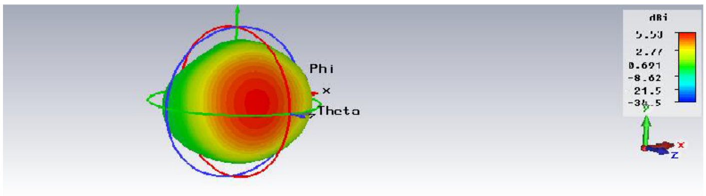

Fig 5.16 3D radiation pattern of H-shaped DGS at port 2

COMPARSION OF RETURN LOSS

As shown in Fig.5.17, in a return loss characteristics of dual microstrip patch antenna with and without DGS structures is compared to reduce the electromagnetic interaction.

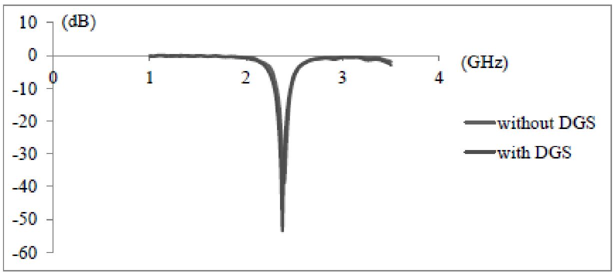

Fig 5.17 comparison of with and without DGS structure

VII. CONCLUSION

In this project, a new configuration using DGS structure has been proposed to enhance the isolation between two antenna elements in microstrip patch antenna arrays. The properties of DGS structure are verified using band-gap analysis. The design achieved to reduce coupling loss is 5dB at the operating frequency. The proposed antenna is simulated using CST-MWS studio commercial software. The simulated results have confirmed to reduce the electromagnetic interactions in dual microstrip patch antenna. These features make them attractive for future communication systems.

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