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A Multiband MIMO Microstrip Patch Antenna for Wireless Applications

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Abstract- This letter presents the design of a compact size modified rectangular shaped microstrip line feed with DGS patch antenna is proposed here. DGS structure is used for improving the performance of microstrip patch antenna. The proposed compact size microstrip antenna consist of a microstrip feed line on one side of the substrate with defective ground structure with rectangular slot, other side of ground plane. The parameters of proposed antenna like returns loss, VSWR, radiation pattern, gain are simulated and analyzed using   CST Microwave studio suit 2015. The antenna system resonates at 9.256GHz for VSWR=1 and their 2x1 MIMO implementation for wireless applications. The antenna system operates four frequency ranges such as 7.14-7.42GHz, 7.6-8.2GHz, 8.2-8.6GHz, 9.8-10.2GHz frequencies for VSWR≤2. A study was performed to implement this antenna in 2x1 MIMO arrangements on the same circuit space with orthogonal polarization. The proposed antenna have Better mutual coupling and better envelope correlation coefficient are achieved.
Keywords—Multiple Input Multiple Outputs (MIMO);, Defective Ground structure(DGS), VSWR.

I. INTRODUCTION

Recently, demand on wireless communication has been rapidly increasing resulting in deployment of modern wireless communication systems such as Wi-Fi, WiMAX, and 3G/4G. Along with these applications, modern antennas are required to have small size and light weight. Antenna [1] is a transducer which transmits or receives electromagnetic waves. Microstrip antennas have several advantages over conventional microwave antenna and therefore are used in a variety of practical applications. Microstrip antenna was first introduced in the 1950s. However, this concept had to wait for about 20 years to be realized after the development of the printed circuit board (PCB) technology in the 1970s. microstrip antennas are the most common types of antennas with wide range of applications due to their apparent advantages of light weight, low profile, low cost, planar configuration, easy of conformal, superior portability, suitable for array with the ease of fabrication and integration with microwave monolithic integrate circuits (MMICs).

Multiple transmit and multiple receive antennas has emerged as one of the most significant technical breakthroughs in next generation wireless communications. MIMO is the use of multiple antennas at both the transmitter and receiver to improve communication performance. MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without requiring additional bandwidth or transmit power, higher spectral efficiency and reduced fading. Because of these properties, MIMO is an important part of modern wireless communication standards such as IEEE 802.11n (Wifi), IEEE 802.16e (WiMAX), 3GPP Long Term Evolution (LTE), 3GPP HSPA+, 4G and 5G systems to come. In today's environment, technology demands antennas which can operate on different wireless bands and should have different features like low cost, minimal weight, low profile and are capable of maintaining high performance over a large spectrum of frequencies. In this paper microstrip patch antenna array are used, because of its attractive features of low profile, light weight, small size, low cost, easy fabrication [1].   Two modified rectangular shaped radiating patch element are arranged perpendicularly to each other on one side of the substrate, other side on which some rectangular defective ground structure[5-8] and their 2x1 MIMO implementation proposed which can be operated frequency range 7.14-7.42GHz, 7.6-8.2GHz, 8.2-8.6GHz, 9.8-10.2GHz frequencies for VSWR≤2, ECC less than 0.01; Mutual coupling is less than -10 dB. The antenna design is simulated using the CST microwave suit 2015. In section 2, the proposed antenna geometry is presented and in Section 3 the results are presented. The final conclusion of the paper is given in Section 4.

II. ANTENNA DESIGN

The proposed antennas are designed on FR4 substrate with thickness (hs) of 1.6mm having relative permittivity (εr) of 4.4. The patch has the dimensions of 19.5 × 20 mm with height (hp) of 0.1 mm. The ground has the dimensions of 20 mm × 19 mm with

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height (hg) of 0.1 mm. Antenna is excited with microstrip feed having characteristics impedance of 50 Ω. The feed has dimension of 16mm × 4 mm with height (hf) of 0.1 mm. In order to improve the Bandwidth and Return loss, ground is defected with square-Shape slot. The dimension of slot along Y-axis is 3.5×5.5×11.3 mm and the dimension of slot along X-axis is 6.5×5.5×5mm. Also this slot made on ground helps in the reduction of overall weight and size of proposed antenna. The Proposed antenna resonates at frequency (fr) of 9.32GHz. The designed front view and back view single geometry of proposed patch antenna shown in fig.1, and fig.2 respectively
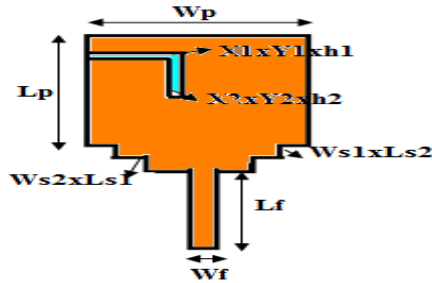

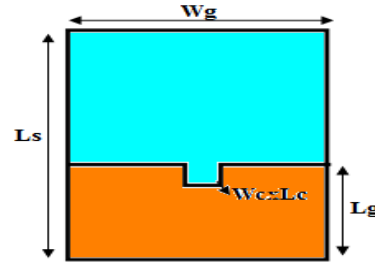Fig.1Geometryof proposed patch anteena front view   Fig.2 Geometry of proposed patch anteena back view

Table 1 shows some common design parameters or specifications for proposed antennas

Table 1 Common design specifications of antennas

Sl.No	Parameters	Dimensions are in mm/values
1	Ground (Lg×Wg×Wg1xWg2×hg)	20×19×1×1×0.1
2	Substrate (Ls×Ws×hs)	38×40×1.6
3	Patch (Lp×Wp×hp)	19.5×20 × 0.1
4	Feed (Lf×Wf×hf)	16×4 ×0.1
5	Permittivity of substrate material FR4	4.4
6	Step 1(Ws1×Ls1)	1.5×1.5
7	Step 2(Ws2×Ls2)	1×1
8	Slot on patch(X1×Y1×h1×t1, X2×Y2×h2×2)	6.5×5.5×5×0.4,3.5× 5.5×11.3×0.2
9	Slot on ground plane(Wc×Lc)	3.8×2.7

The simulation results of the return loss of the proposed antennas are shown in fig. 3 from the figure we can conclude that the proposed patch antenna system resonates at 9.256GHz for VSWR=1. The proposed modified rectangular shaped patch antenna is much suitable for MIMO system. The VSWR of proposed antenna is less than 2 over entire operating frequency range. The VSWR plot of the proposed antenna is shown in fig.4
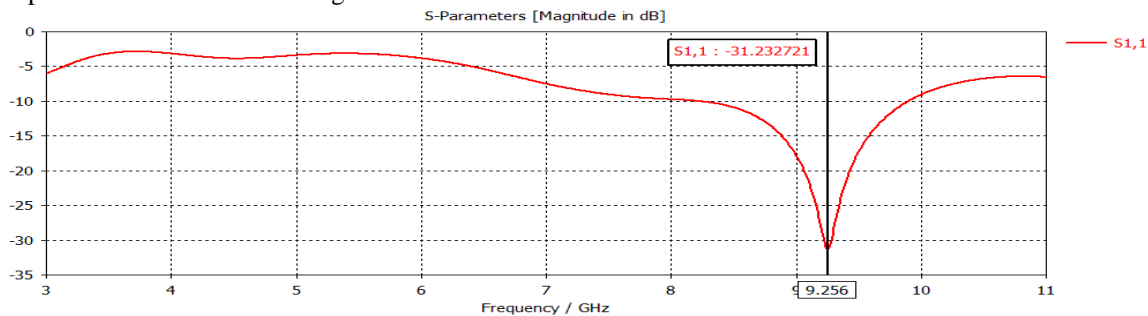

Fig. 3 Scattering parameters of proposed patch antenna

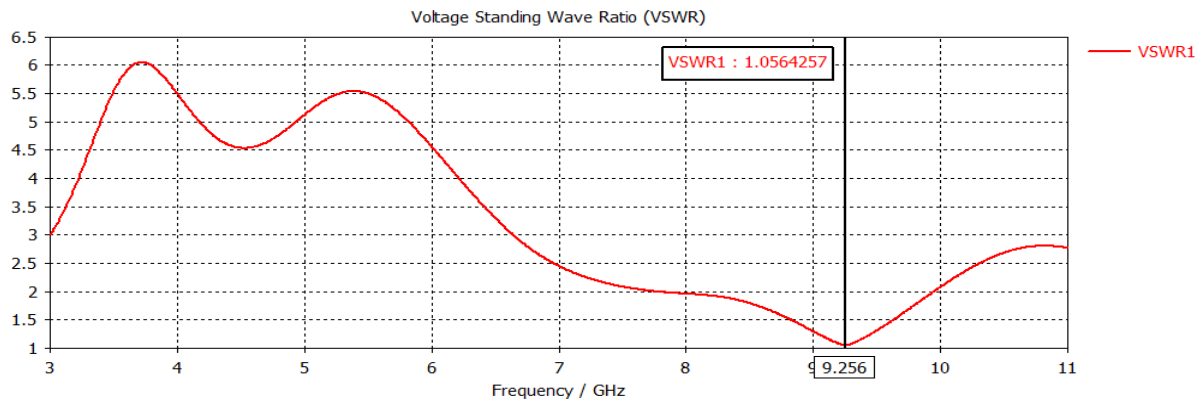# International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Fig .4 VSWR of proposed patch antenna

In MIMO system the major issue faced by the designer is mutual coupling, which occurs due to the electromagnetic interactions between the antennas in the array, this problem mainly arises due to the small space between antennas. The mutual coupling can be reduced by using diversity techniques which is mentioned in [8] Here a two 2x1 MIMO antenna is designed by using proposed modified rectangular shaped patch antenna with element are arranged perpendicularly to each other same substrate with dimension 80mm×40mm×1.6mm. Front view of MIMO antenna shown Fig. 5 and Ground plane of MIMO antenna is shown in fig.6.
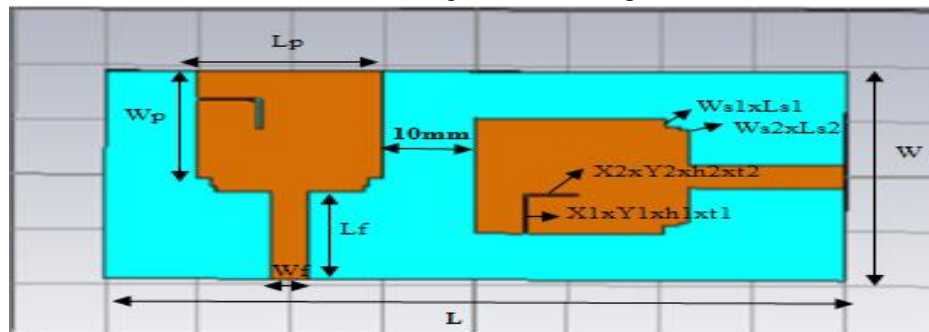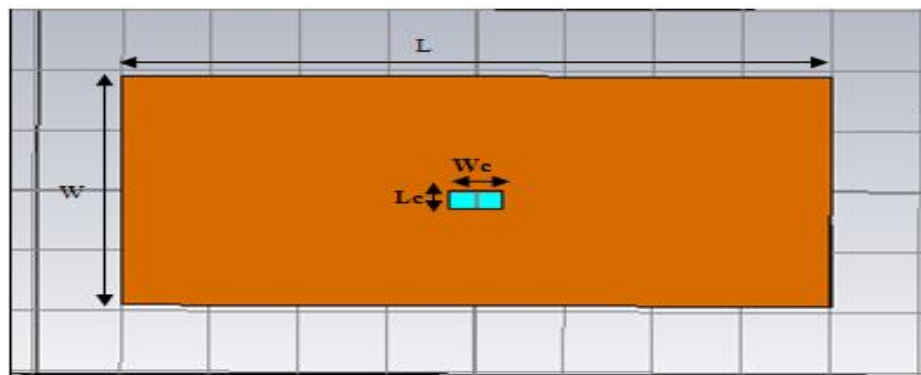

Fig.5 Front view of MIMO antenna

Fig. 6 Ground plane of MIMO antenna

III. RESULTS AND DISCUSSION

The proposed modified rectangular shaped patch microstrip patch antenna is designed using a CST Microwave studio suit 2015 which works on principle of FIT (Finite Integration Technique). The simulation results of the return loss of the proposed MIMO antennas are shown in Fig. 7 from the figure we can conclude that the proposed antenna operate in multiband frequency range 7.14-7.42GHz, 7.6-8.2GHz, 8.2-8.6GHz, 9.8-10.2GHz frequencies for VSWR$\leq$2 The VSWR of the proposed antenna is presented in the Fig.8. The radiation patterns of the MIMO antenna are shown in Fig.9, Fig.10, Fig.11, Fig.12, Fig.13, Fig.14 for the frequencies 7.89 GHz, 8.4 GHz and 10Ghz of both antenna respectively. The VSWR value is observed less than 2 as shown in fig.8. ECC less

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than 0.01 shown in fig.11 the mutual coupling of proposed antenna is less than -10 dB shown in figure.
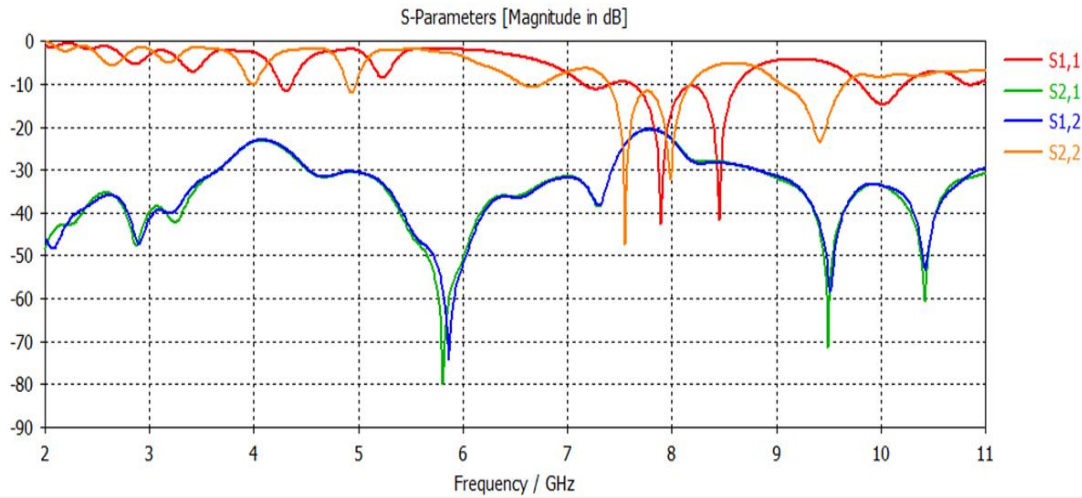

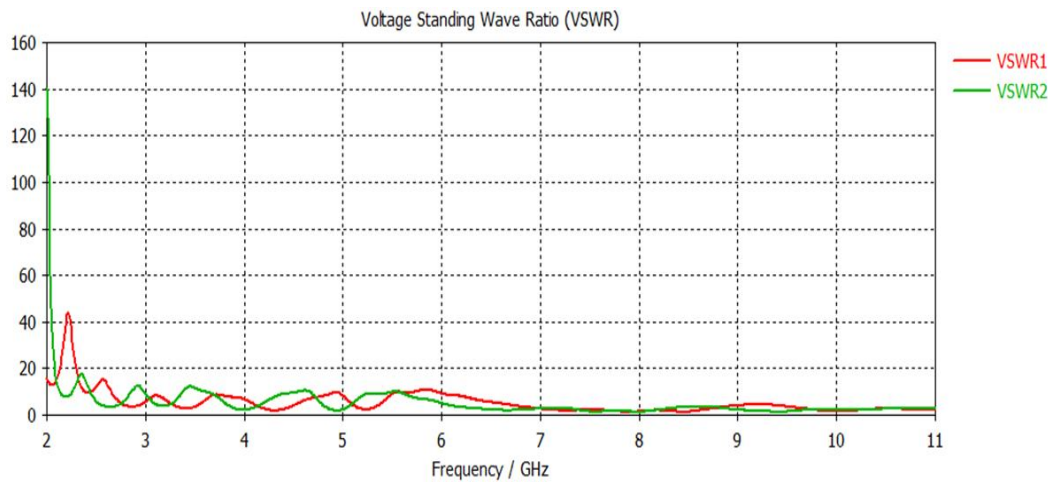Fig. 7 Scattering parameters of proposed MIMO antenna

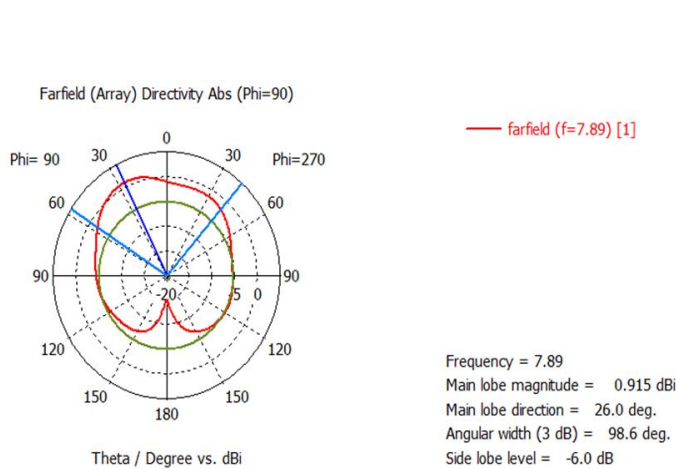Fig.8 Frequency versus VSWR of proposed MIMO antenna

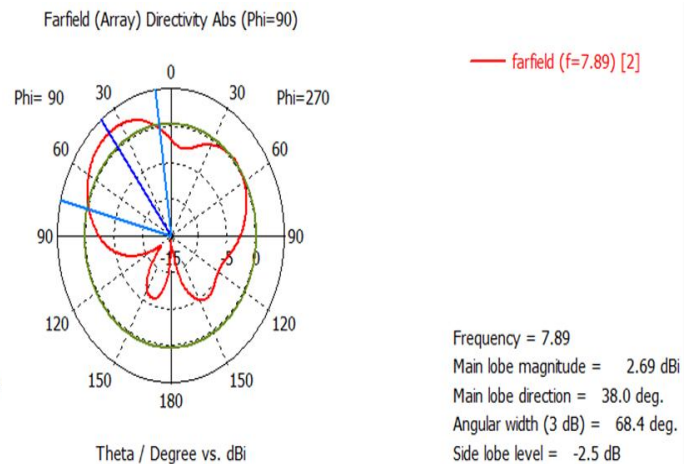Fig .9 radiation pattern of mimo antenna 7.89 GHz(1)   Fig .10 radiation pattern of mimo antenna 7.89 GHz(2)

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Fig .11 radiation pattern of mimo antenna 8.4 GHz(1)

Fig .12 radiation pattern of mimo antenna 8.4 GHz(2)
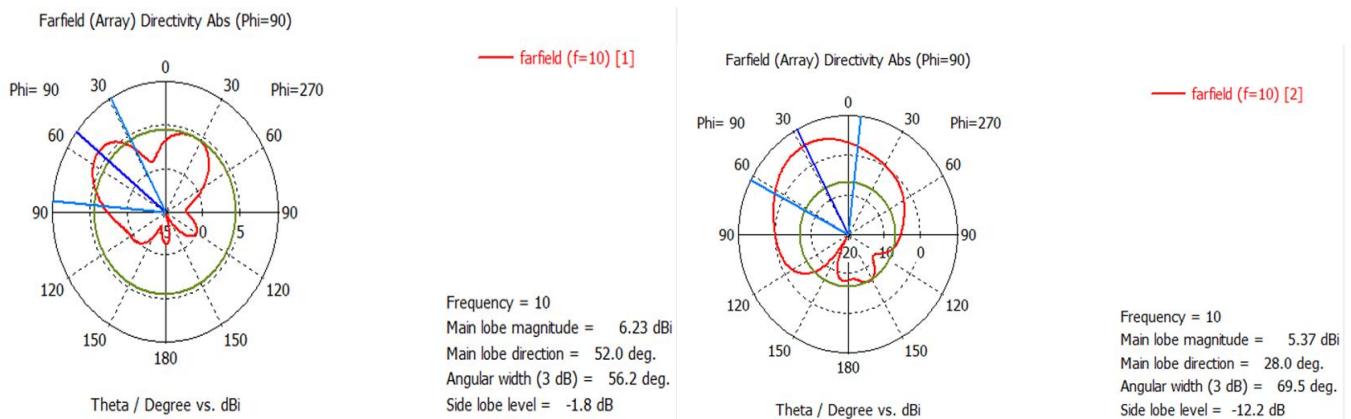

Fig .13 radiation pattern of mimo antenna 10GHz(1)

Fig .14 radiation pattern of mimo antenna 10GHz(2)

The envelope correlation coefficient (ECC) is decisive parameter as it indicates the diversity performance. Computed ECC of the proposed MIMO antenna shown in fig.15. Generally a value of ECC below 0.1 is good enough to maintain channel capacity. The proposed two elements MIMO antenna provides very low correlation coefficients less than 0.005 in the overall frequency range.

Fig. 15 Computed ECC of proposed MIMO antenna

IV. CONCLUSION

In this paper presents the design of a compact size modified rectangular shaped microstrip line feed with DGS patch antenna and their 2x1 MIMO implementation for wireless applications. The proposed antenna operate frequencies range 7.14-7.42GHz, 7.6-8.2GHz, 8.2-8.6GHz, 9.8-10.2GHz frequencies for VSWR≤2 study was performed to implement this antenna in 2x1 MIMO

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arrangements on the same circuit space. VSWR should less than 2, ECC less than 0.005; Mutual coupling should be less than -10 dB. The proposed Antenna have Better mutual coupling and better envelope correlation coefficient are achieved.

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BIOGRAPHY

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