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The Four-Element MIMO Antenna Design with Low Mutual Coupling at 28 GHz for 5G Networks

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Abstract*: in this contribution, a MIMO micro strip patch antenna with four radiating elements is designed3 at 28 GHz. The designed antenna has a very low isolation loss between radiating antenna elements. The MIMO antenna is simulated using the CST Microwave simulator. The measurement results are also shown in this paper. Both simulation and measurement results are studied to analyze the performance of the antenna. The MIMO patch antenna features such as, return loss, VSWR, gain, beam-width and radiation pattern are analyzed at a center frequency of 28 GHz. The isolation loss between the MIMO antenna elements is investigated experimentally with inter-element spacing of 3 mm. The envelope correlation coefficients among the elements, the mean effective gains, the efficiencies are also discussed. The designed antenna is planner, compact and thin so it is applicable for 5G handset.

Keywords: MIMO; SNR;5G;UE.

I. INTRODUCTION

In MIMO technology more antennas are used at transmitter and receiver to introduce the spatial multiplexing and diversity technique to reducing the fading of signals caused by multipath environments. These deep fading events have a profound impact on the performance of the wireless communication system. This fading process which causes the received power to vary is an important and key aspect of a wireless communication system in multipath propagation environment so one of the solutions to overcome the adverse impact of fading is MIMO Antenna to reduce the bit error rate and increase the reliability of the signal [1]. MIMO Antennas are very important to achieve high data rate and transmission reliability [13]. This paper concentrate on the miniaturization of MIMO antenna with improved isolation.

II. ANTENNA CONCEPT AND DESIGN

The dimensions of the Microstrip Patch Antenna are varied according to resonant frequency (*fr*) and the dielectric constant (*εr*) by following equation (James et al., 1989) [2]

$$f_r = \frac{c}{2L_{eff}\sqrt{\varepsilon_{eff}}}$$

Duroid Roger(RT-5880) substrate (lossy) with the thickness of 0.8mm, ε_r = 2.2 and tanδ = 0.0009 is chosen for this MIMO antenna fabrication.The dimensions of ground plate are optimized as $W_g \times L_g$=13.5×*13.16* mm^2. The size of each radiating patch element is chosen as $W_p \times L_p$ =3.90×*3.40* mm^2 with inset feed of $X_1 \times X_2$=*0.65*×*0.55*mm^2 to impedance matching of 50 Ω.

The edge to edge separation is kept as 3 mm along x-axis and 5 mm along y axis to achieve low mutual coupling between the radiating elements of MIMO antenna. Fig.1 shows the geometry of a single element of MIMO antenna. The dimensions of the antenna have been given in Table 1. Fig.2 illustrates the geometry of the MIMO antenna.

Table.1. Parameters Value for Four-Element MIMO Antenna

S. No.	Parameters	Variables	Dimensions(mm)
1.	Patch and Inset slots	W_p L_p X_1 X_2 X_3	3.90 3.40 0.65 0.55 0.75
2.	Roger RT5880 Substrate	Ws Ls h	13.5 13.16 0.8
3.	Ground	Wg Lg	13.5 13.16
4	Feed -Line	W_f L_f	1.24 2.5
5.	Inter-element spacing	P S	3.0 5.5

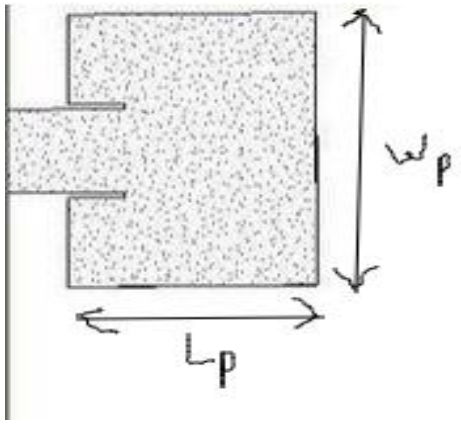

Fig.1.The Geometry of Single Element Antenna

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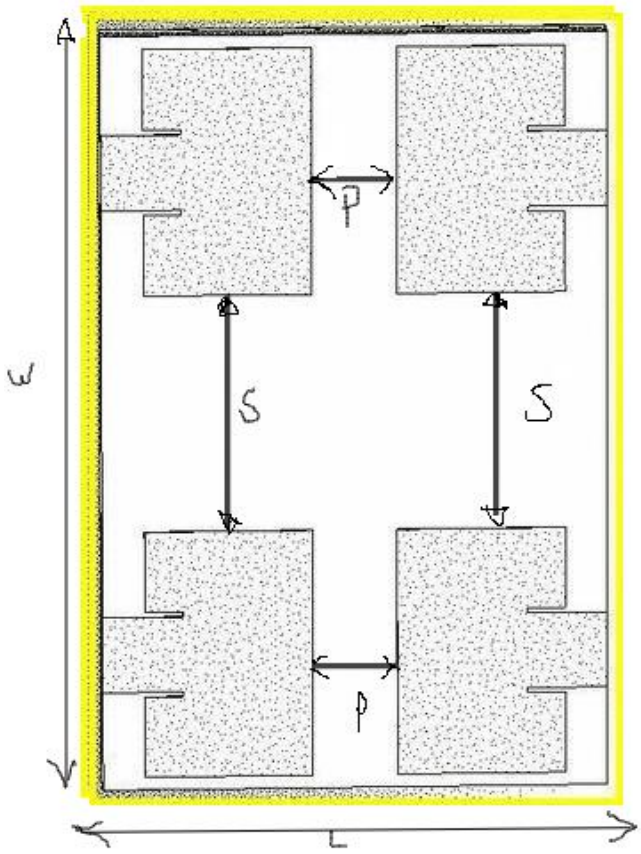

Fig.2. The geometry of the Four-element MIMO antenna

Fig.3.The fabricated Four-Element MIMO antenna

III. RESULTS

The simulated S-parameters (S11) plot at port 1 of MIMO antenna has shown in figure 4. From Fig.4 it can be seen that the impedance bandwidth of 1 GHz was achieved covering the frequency band 27.5 GHz - 28.5 GHz and there is a resonance at 28 GHz with the minimum value of return loss of -18 dB. The measured return loss plot is shown in figure 5. Fig.6 illustrates the comparison between simulated and the measured S-parameters for the MIMO antenna. A resonant frequency shift is observed that can be caused by soldering the connector pin to the feeding line.The Simulated isolation loss plots for the 4 element MIMO antenna are shown in figure 8.A port to port isolation as illustrate in Fig.8 are below -20 dB. The gain is noted to 6.34 dB of MIMO antenna in the 3D radiation plot as shown in figure 11.

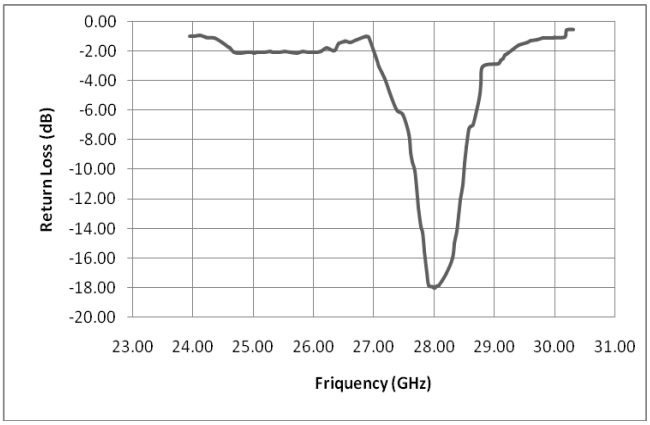

Fig 4. The S-11 Parameter of the MIMO Antenna at Port 1

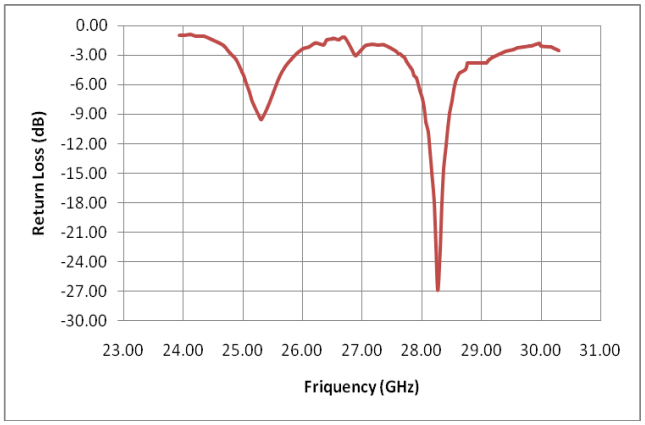

Fig.5. Measured S11 plot of the MIMO antenna at port 1

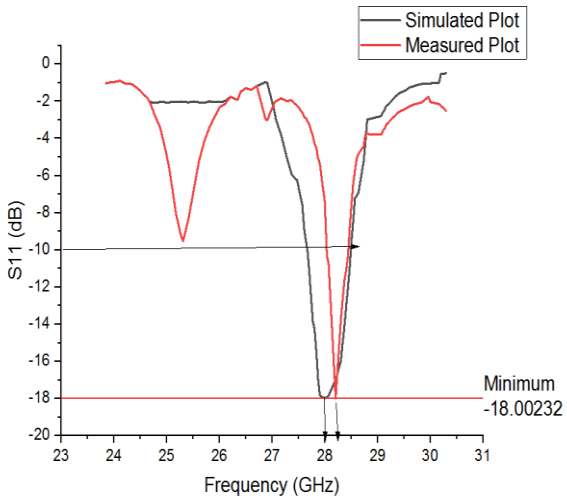

Fig.6. Simulated and Measured S11 Plots for the Patch at 28 GHz.

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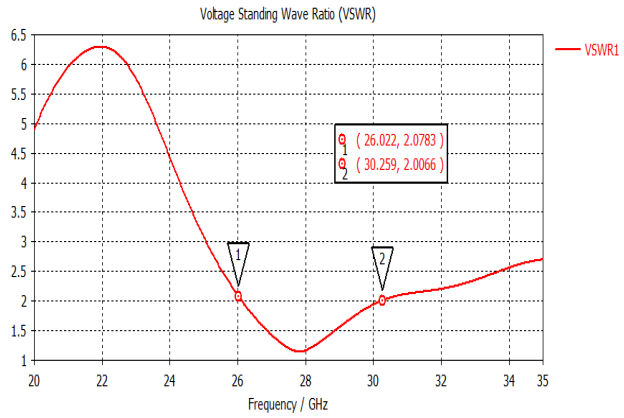

Fig.7.The VSWR Plot of the MIMO antenna at port 1

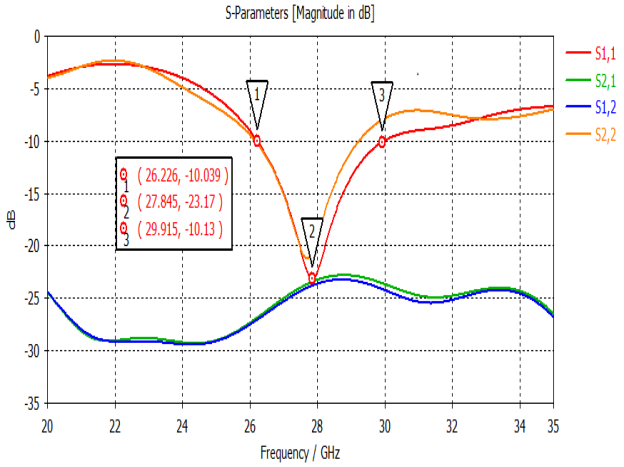

Fig.8. Simulated Isolation Loss Plot of the four-element MIMO antenna

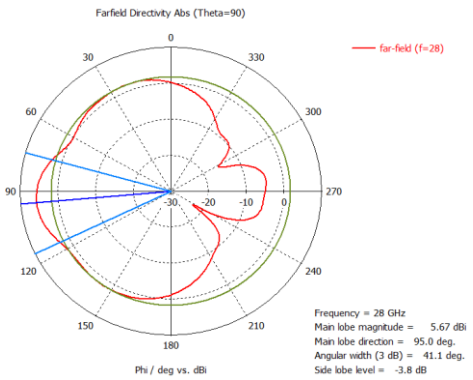

Fig.9. the Simulated Polar Plot At Port 1

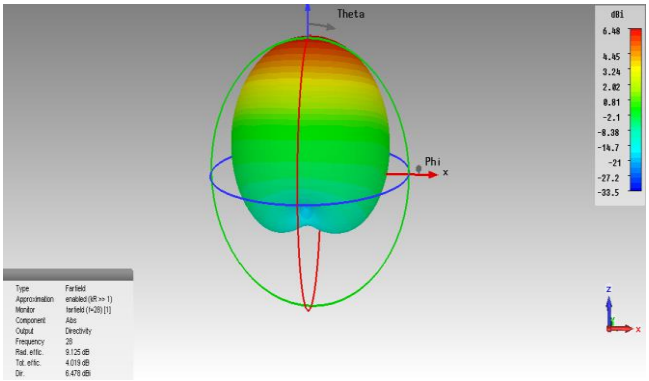

Fig.10. 3D Radiation Plot of a Single Element of The Mimo Antenna

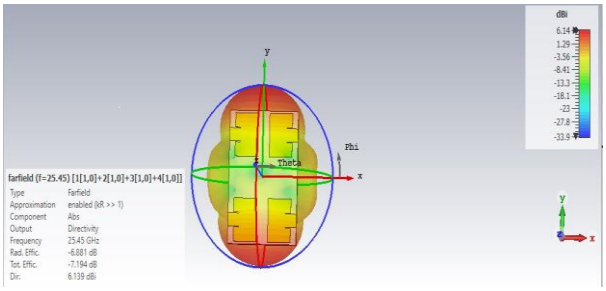

Fig.11. Simulated 3D radiation plot of MIMO Antenna

IV. CONCLUSION

A planner four-element MIMO microstrip patch antenna is fabricated for 5G networks. The BW is achieved to 3 GHz from 26.25 GHz to 29.25 GHz. The gain of the MIMO antenna is shown as 6.34 dB. The beam-width of the MIMO antenna is noted as 41.1 degree. High isolation between radiating elements is being preserved in this paper.

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