A Compact MIMO Microsrip Patch Antenna Designat 28 GHz for 5G Smart Phones

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***Abstract*—in this paper, a rectangular MIMO microstrip patch antenna with 4 radiation elements using inset microstrip line feeding are designed for 5G mobile handsets. In designing the antennas, MIMO technique is introduced to increase the SNR and to reduce the bit error rate and losses due to the multipath fading effect, hence increasing the capacity of channel. MIMO antenna is simulated using CST Microwave software and operated at 27-28.95 GHz. The results of the designed MIMO microstrip antenna are analyzed with an impedance bandwidth of 1.95 GHz and the return loss of -18.71 dB at 28 GHz. The gain of 6.14 dBi is noted in the 3D radiation pattern at 28 GHz. The antenna is capable to fix in 5G mobile phones.**

Keywords—MIMO;SNR;5G,UE.

I. INTRODUCTION

With the rising demand of high data rates, low latency, low bit error rate, increase in spectral efficiency, mobile phone manufacturers are thinking to manufacture such equipment as demanded by mobile phone users. In Release 9 of 3GPP specification up to four antennas were defined in User Equipment and further in release 10 specifications up to 10 antennas were possible in the UE. Beam forming was also introduced in Release 10. 5G, services were evolved in 3GPP release 14 to release 17 which will operate in the millimetre wave band (30GHz to 300 GHz) with more antennas at the user equipment to eliminate the effects of small-scale fading and to enhance both communication reliability as well as the capacity of communication (by transmitting different data in different antennas)[5]. In our work, we design a compact four-element MIMO antenna at 28 GHz to utilize the practicable 5G handset space as the 5G mobile handset is approximately similar to the dimensions of 6 to7 cm.

II. ANTENNA DESIGN

The MIMO Antenna design is accomplished in two main stages: arising from single element antenna design and four-elements MIMO antenna design. Each antenna configuration is a planar design in this article, a conformal MIMO antenna operation at 28 GHz frequency Bands are introduced for mobile smart-phones. The MIMO antenna is fabricated on an inexpensive Rogers 5880 substrate (lossy) with h = 0.8mm and εr = 2.2 and loss tangent tanδ = 0.0009 with dimensions of $W \times L$ = 5.5×*5.16* mm$^{2.}$ The radiating patch dimensions are chosen as $W_p \times L_p$ 3.96×*3.44*mm^2 with an inset feed of $g \times p$ = 0.*65*×*0.55*mm^2 with an impedance matching of 50 ohm.

The introduced antenna offer acceptable results with respectable matched impedance bandwidths and decent radiation patterns. Finally, the design of four-port MIMO Antenna achieve essential isolation superior to 27 dB without using any added constructions. The MIMO antennas can be simply appropriate for the higher and lower boundaries of modern handheld devices due to its squeezed size. The focal principle for multiport design is mutual coupling, which mostly rises due to the smaller distance between the two antennas, by expanding the distance between the two antenna elements; the mutual coupling can be diminished. The parting between the two edges of the patch antennas is about λ to evade the grating lobes. The width and length of the inset feed have an expressive influence on the resonant frequencies and return loss levels, so the great satisfactory results should be achieved and established by optimization and numerous parametric cases. The complete structure of the single element antenna has shown in Figure 1 and the concluding optimized parameters are listed in Table 1.

Table.1. Antenna Parameters

Parameters	Values (mm)
W	5.5
L	5.16
W_p	3.96
L_p	3.44
W_s	1.24
L_s	1.25
g	0.65
p	0.55
d	0.70
h	0.8

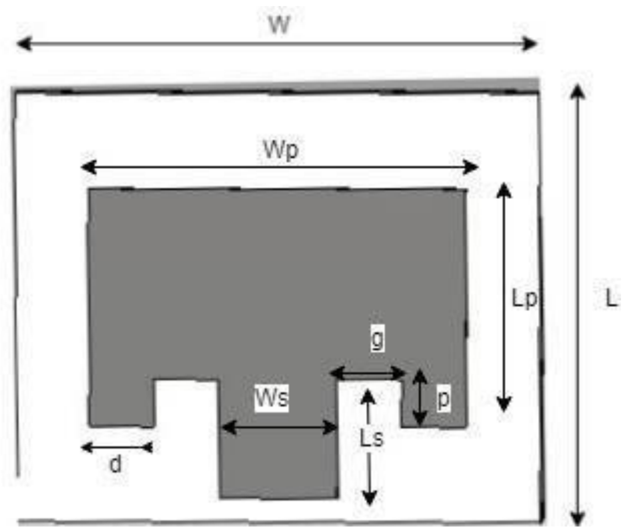

Fig.1. Top view of a single element of the designed MIMO antenna

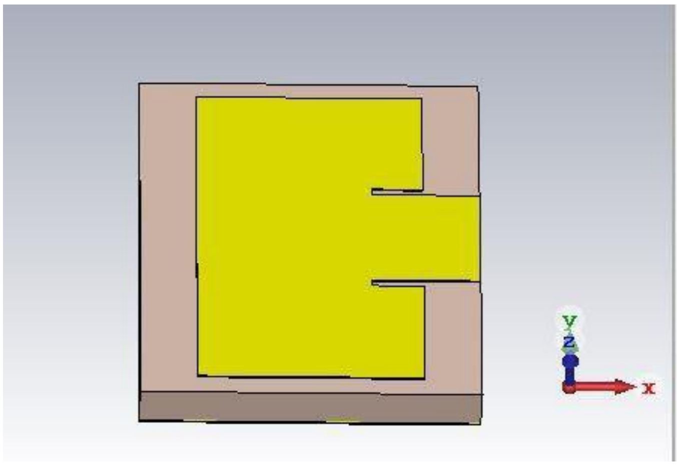

Fig.2. Side view of a single element of the designed MIMO antenna

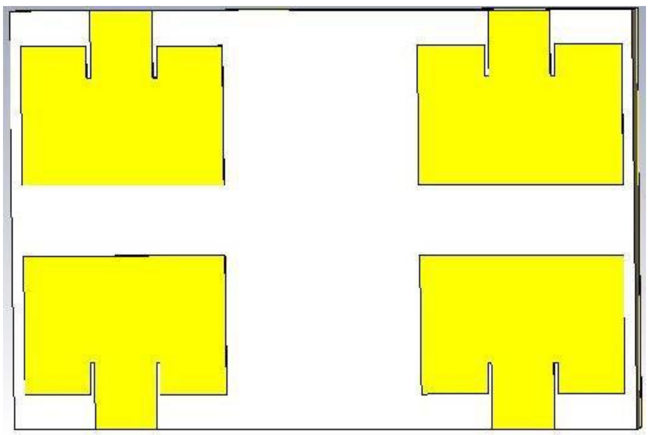

Fig.3. Top view of four-element MIMO antenna

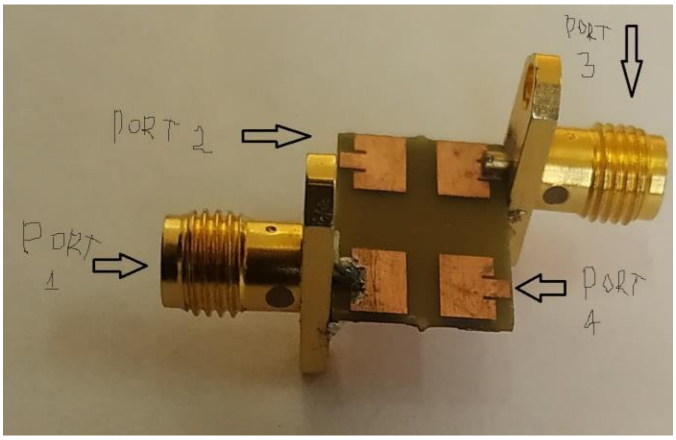

Fig.4. Prototype of four element MIMO antenna

III. SIMULATION AND RESULTS

The simulation process of designed MIMO antenna is carried out by CST software. Figure 5 shows the simulated return loss parameters for the four element of MIMO antenna. These simulated results have the impedance bandwidth of 1.95 GHz ranging from 27 GHz to 28.95 GHz and reaching the return loss of -18.71 dB at 28.06 GHz. The figure 6 shows the measurement return loss plot at port 1 of MIMO antenna. Simulated Isolation Loss Plot of four elements of the MIMO antenna is shown in figure 7. Finally, the designs of four-ports MIMO Antenna achieve essential isolation superior to 27 dB without using any added constructions.

The gain reaches to 6.14 dBi for four element of MIMO antenna as shown in figure 9 of 3D radiation plot. The antenna meets the required 5G antenna requirements.

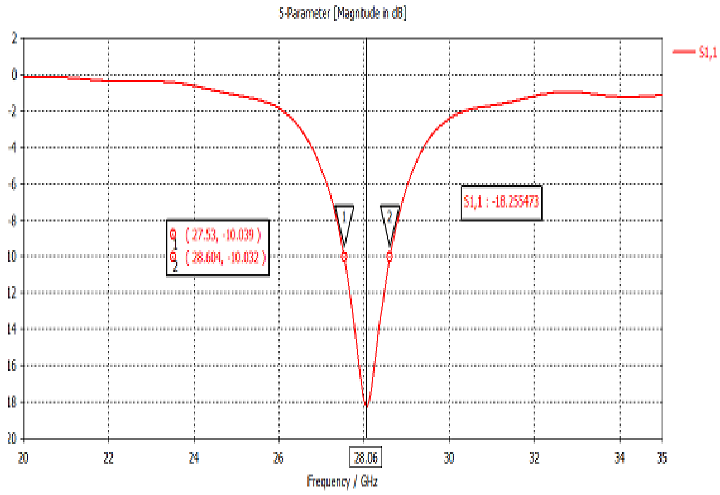

Fig. 5. Simulated Return Loss Plot of MIMO antenna

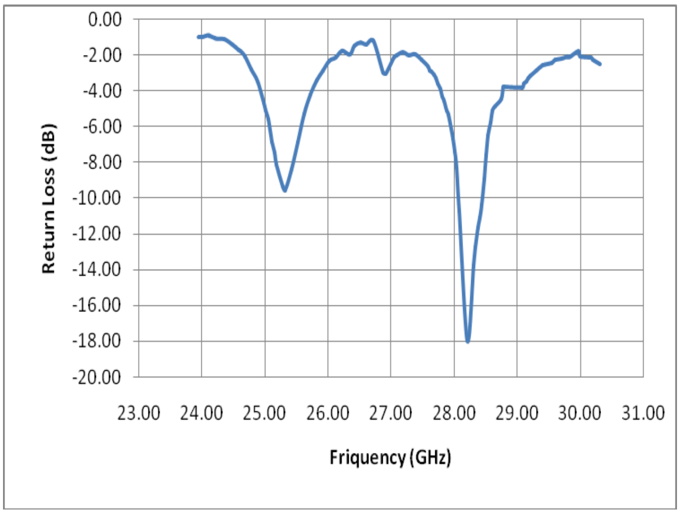

Fig. 6. Measured Return Loss (S11) Plot at port-1of MIMO antenna

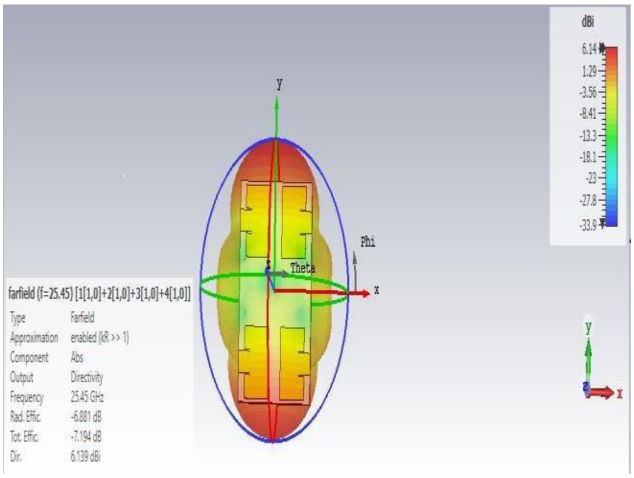

Fig.9. the 3D far-field radiation plot of MIMO antenna

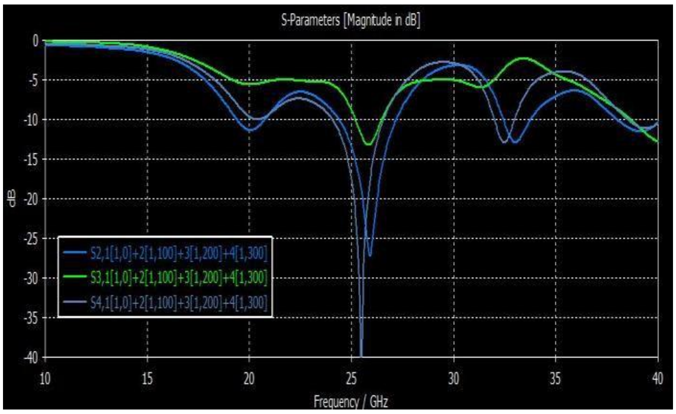

Fig. 7. Simulated Isolation Loss Plot for four elements of MIMO antenna

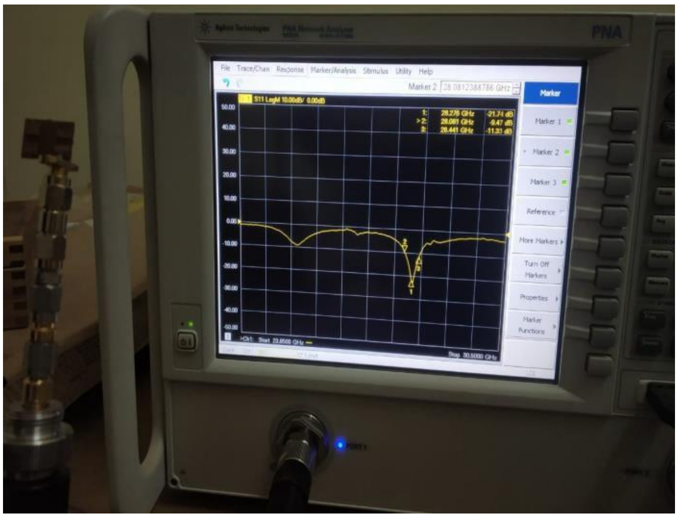

Fig.10 Measurement on Vector Network Analyzer

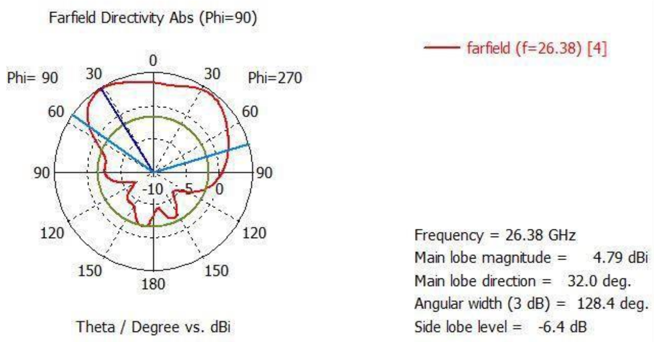

Fig.8. Simulated polar plot

IV. CONCLUTION

A conformal inset-fed four-element MIMO microstrip patch antenna operated at 28 GHz was introduced for 5G user equipment.The−10dB BW was realized to 1.95 Ghz from 27 GHz to 28.95 GHz. The gain of antenna was shown as 6.14 dB in the simulated Far-field pattern .The mutual coupling between the antenna element port 3 and port-1was calculated to -27dB. The antenna is thin and compact also. The -3 dB beam width of antenna was realized as 128.14 degrees such that there will be a low likelihood of interference between systems operating in the band.

V. REFERENCES

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