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Abstract. The proposed MIMO antenna system consists of four components operating at a dual-band (28/38 GHz) frequency through an antenna system with an angle of 90 deg to each other. A simulated impedance bandwidth (S11< -10dB) is obtained by the proposed antenna at frequency 28.81 GHz & 38.098 GHz is -15.83dB and -11.87dB, respectively, allocated to the 5G applications by the Federal Communications Commission. By using MIMO antenna system, capability and transmission speeds can improve in a communication system. The design of such antennas is important in visualizing the desired output/result with the aid of simulation and helps to achieve the necessary antenna outcomes for future work. The simulation effects help us to test certain parameters for the better performance specifications of the built device, such as return constraint, antenna isolation & bandwidth. RT/Duroid 5880 is a low loss/cost substrate and is used in designs. For both operating frequencies, the band width of this MIMO is more than 1GHz, which is desirable for future work.

Keywords: Frequency resonant; 5G; Wireless communication; MIMO.

1 Introduction

Mobile communication technologies and features have evolved rapidly over the last few years & it is growing for the next generation in line with the demands of people's mobile communication or data transmission, which has become one of the most relevant and creative approaches of interest to the area.(1) With great results & wide appications, due to their large sequential bandwidth, all researchers are interested in the region. Subsequently, however we are indented & need more attention to millimeter wave and sub-millimeter wave bands. There are many types/features of antennas in the world that can be used for applications with 5G mm waves, such as the micro strip antenna and its series. The decrease in radiation quality however occurs due to the substantial loss of metallic and surface waves at mm-wave frequencies.

The main patch material is conducting copper & shape of patch is rectangular. The substratum is one of the components of electromagnetic wave channeling. The substrate (ROGGER:5880) characteristics have a significant influence on the efficiency of the antenna. The substrate thickness affects the antenna bandwidth. The ground plane of the antenna was used as the ground. We use simple equations which can used

to find the length and Patch factor measurements for designing the micro strip antenna & are as follows, (2)

$$W = c/(2fo\sqrt{\epsilon r + 1/2})$$

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + \frac{10h}{W}\right]^{-1/2}$$

$$L = \frac{c}{2f_0\sqrt{\epsilon_{eff}}}\left[0.824h\left\{\frac{\left(\epsilon_{eff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\epsilon_{eff} - 0.258\right)\left(\frac{w}{h} + 0.8\right)}\right\}\right]$$

Here :-
C value is $3x10^8$ m/s
Frequency f_0(GHz)
Relative permittivity ϵ_r
Effective permittivity ϵ_{eff}
H is thickness of substrate(mm)
W is width of patch antenna(mm)
L is length of Patch antenna(mm)

Although it is recommended that the ground plane has a size greater than the substrate thickness, In order to obtain the equation as follows for the plane ground scale,

$$L_g = L + 12h$$

$$w_g = w + 12h$$

Table1. Antenna Design Specifications

S. No	Parameter	Quality Status
1	Frequency	28GHz to 38GHz
2	VSWR	≤ 2
3	S-parameter	< -10db
4	Band Width	≥ 500MHz

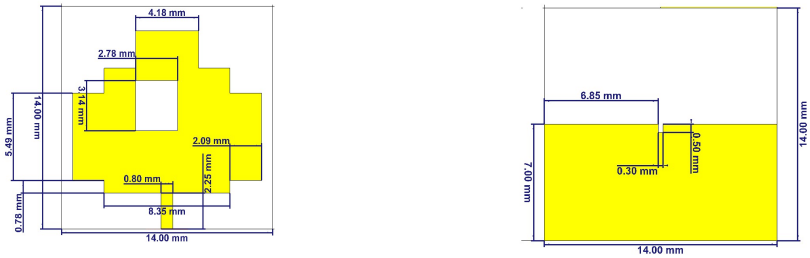
In the last few years, wireless communication technology has been a field of massive change and cutting edge creation. Starting from the first-generation networking systems to the 4G LTE systems of nowadays, a rapid growth and need to migrate voice data, live video streaming, text, GPS data, & many more for transmitting and receiving devices.(3)

The technology used for millimeter waves contains all The creative features that will make users more demanding in the near future. HereIn order to meet many requirements of modern technology, a new patch antenna concept is proposed.(3-4) In

particular, micro-strip patch antennas are very compatible with a number of surfaces, circuits and machines. However, a significant shortcoming of such antennas is their restricted bandwidth. With various techniques used, such as inset feeding[5] or etching various geometric shapes on the ground plane, called defected ground plane structure(DGS).(6)

2 ANTENNA ARRAY GEOMETRY AND DESIGN

For the design of MIMO antenna, first the single antenna is built with patch & cut slots, which form a 2x2 MIMO antenna & these antennas are stacked together. There will also be a contrast between the performance characteristics of the two antennas, such as their efficiency. (7)



(a)Front View of single Antenna (b) Back View of single Antenna

Fig:- 1 shows the patch antenna front(a) & rear(b) view which is initially designed

This antenna is made of three filial (branches) opposite the feed line and a rectangle is chopped off. The proposed antenna is developed for the band of 28-38 GHz. The dimension of patch antenna is as below,

Table(1) details of parameters of cut & patch slot of antenna with dimensions in mm

Parameter	Value in(mm)	Parameter	Value in (mm)
Patch length (L)	14	W (Patch Width)	14
Feed line Width (W_f)	0.80	Feed line length (L_f)	2.25
Substrate height (h)	0.254	Relative permittivity (ε_r)	2.20
Patch cut length (L_P)	3.14	Patch cut Width (W_P)	2.78
Material Height	0.034		

RESULT OF SINGLE ANTENNA

The substratum circuit is manufactured using ROGERS RT5880 substrate 0.254 mm thickness with tangent loss 0.0009 and relative permittivity 2.2, the cooper thickness is 0.034 mm. The design board with substrate is chosen to have a size of (28x28)

mm^2. The dimensions used to design for the proposed antenna are given above in the Table1.

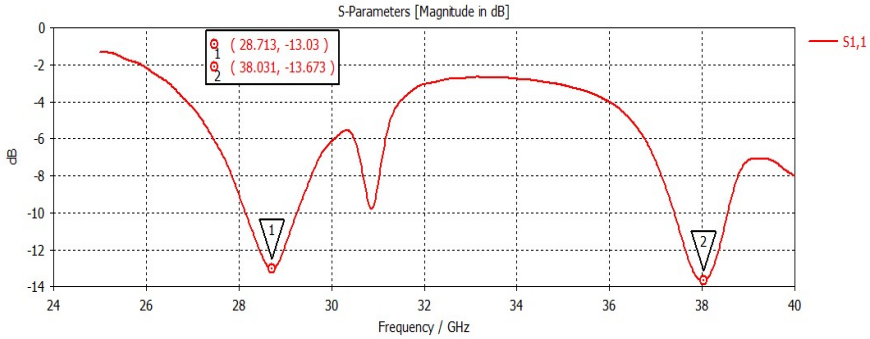
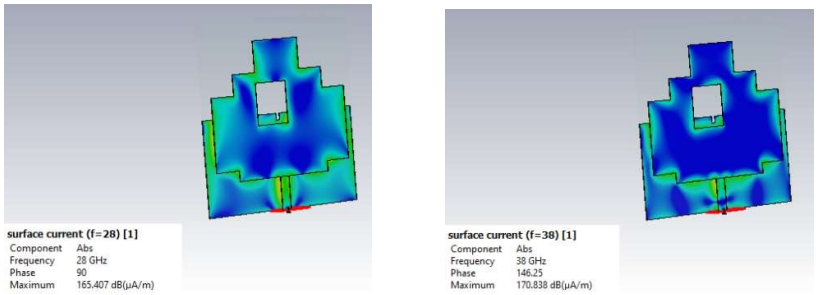


Fig:- 2 shows the S-parameter of single patch antenna



3(a) Surface Current at 28GHz 3(b) Surface Current at 38GHz

Fig:-3 shows the Surface Current for Mobile communication frequency at 28/38GHz

The patch antennas are chosen for mobile unit antennas for MIMO systems. But the main downside is low band-width. This can be achieved by reducing the thickness of the substrate or by lowering the permittivity value. We also suggested that the antenna should be a 3-layer patch antenna. By reducing ground-plane areas, we can achieve higher band-width. For smaller ground areas, the capacitance between the patch region and the ground plane is lowered and by this the band-width increased. The planed four segment 2x2MIMO antenna is shown in Fig. 4 and fig.2 & Fig.3 shows the graph for S-parameter & surface current at 28Ghz & 38GHz respectively.(8-9)

SIMULATED RESULTS

With considering several parameters & changing the dimensions of cut & patch to achieve acceptable reflection coefficient|S11|, gain and total efficiency required for each frequency. All concept simulations are rendered using Computer Simulation Technology (CST) Microwave Studio as a commercial software program.(3)

Fig 4 shows the 2x2 MIMO antennas with different cut of edges on patch & ground in copper conductor. For results, the feed line also have important role for obtaining the desired frequency. 2x2 MIMO patch antenna is shown below,

4(a)Design of Patch Antenna 4(b) Back view of patch antenna

Fig:- 4 Shows the final design of 2x2 MIMO antenna with patch at front & back side on ground

Figure 4 displays the configuration & shape of the 2x2 MIMO patch antenna, sequentially the effect is obtained when the length of different slots is adjustable for different cuts in lengths. Therefore, among all, the best outcome of the frequency drop, this is lowest at the target frequency. In addition, the reflection coefficient, which is -15.83 and -11.87 respectively for the 28GHz & 38GHz frequencies, also shows a strong result. Technically, for good efficiency reflection coefficient must be less than -10dB, especially in terms of frequency drop & we achieved it for both frequencies with good bandwidth of more than 1 GHz bandwidth. As shown below,

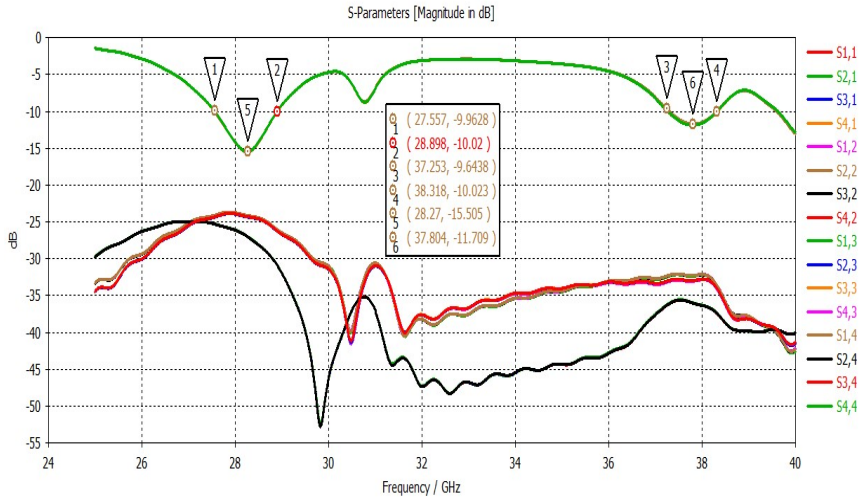


Fig:-5 Shows the S-Parameter of 2x2 MIMO antenna for resonant frequency

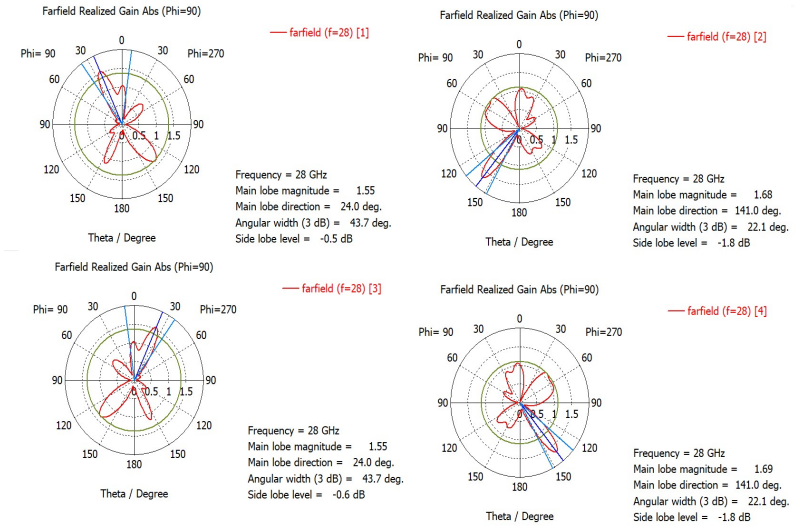


Fig:- 6 Shows the far-field of 2x2 MIMO antenna at 28GHz frequency

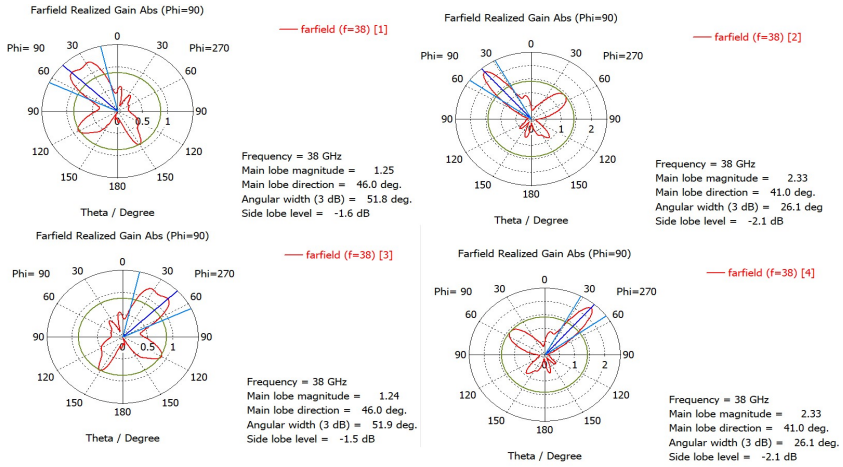


Fig:- 7 Shows the farfield of 2x2 MIMO antenna at 38GHz frequency

Conclusion

For 5G applications, four element MIMO antennas are proposed to fulfill the requirements of the reflection coefficient by designing them with a 90˚ angle to each

other and to achieve a relatively high isolation with a relatively nearby small antenna, which is suitable for wireless communications today. Proposed antenna designed with a compact size using substrate Rogers RT5880 to operate for 28-38 GHz. The findings show that the suggested antenna has good efficiency in terms of radiation pattern characteristics, reflection coefficient and bandwidth. The final result has a bandwidth of 1.45 GHz at 28 GHz & 1.7 GHz at 38 GHz, so the results obtained suggest its promising potential for 5G applications. The design is attractive for 5G mobile terminal MIMO antenna designs.

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