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A NOVEL MIMO ANTENNA FOR 5G COMMUNICATIONS

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ABSTRACT

From the past few years there has been remarkable progress in the field of wireless communication sector. Moreover usage of 2G,3G,4G frequency bands getting overcrowded due to increasing number of users. So, it is necessary to reduce the problems faced by telecommunication sector. So, to approach the requirements of future generation the analysis of 5G communication antennas are under research because 5G provides high data rates and high capacity frequency channels.5G is much concerned with fast speeds in signal and data transmission as well as higher spectral efficiencies. The MIMO system is employed to achieve fast transmission rate and better communication quality. Our goal is to develop MIMO system that performs in the 30–40 GHz frequency range with a 34.167 GHz resonant frequency.

Keywords: 5G, MIMO, ECC.

INTRODUCTION

At present in telecommunication sector allocation of frequency bands to multiple users at a same time is becoming very difficult due existing frequency bands getting overcrowded. At the same time there is remarkable progress in video technologies like High Definition(HD) and Quadruple High Definition (QHD). These resolutions require high data rates. 2G,3G,4G technologies facing many difficulties to provide these high data rates. So, to cope with these problems 5G is necessary and it is need of the day.5G provides ever increasing internet traffic, and demands for high data rates. In light of this, 5G technology is more suited for users that desire fast data rates[1]. Although 5G promises bandwidth speeds of 20Gbps with latency of less than 1 millisecond, 4G technology offers bandwidth speeds of 100Mbps with latency ranging from 68 to 90 milliseconds. So, we are moving to 5G technology to cope with problems of wireless communications. MIMO technology is widely applied in the field of wireless communication because it provides a stable communication quality and high transmit rates[2].Generally data transfer capacity of 5G mm wave channels are drastically more than current 4G LTE(Long Term Evolution)[3]. We are aimed to design MIMO antenna rather than single antenna because single antenna provides less gain and less channel capacity but Whereas MIMO antenna provides higher gains and high transmit rates.

Literature Survey

In order to create MIMO antenna suited for 5G communications, we have reviewed many research articles. There are several different 5G designs, which are seen in [4]–[10]. The bulk of the proposed devices only utilise one antenna, which delivers less gain and less bandwidth and provide poor channel capacity.using array antennas in place of single antenna also have low bandwidth to accommodate multiple users at a same tim and provide less frequency channels available to several users at same time. The gain of array of antennas is higher than that of single element antennas, yet it is not enough for 5G Communications.

So we have implemented MIMO system for 5G communications. As MIMO systems provides high gain, high bandwidth and provides better data transfer capacity of a channel.

Antenna Design

The design consists of patch, substrate along with partial ground. The patch is made up of copper annealed with dimensions of 10*10*0.035 mm is printed on Rogers RT5880(lossy) as a substrate material havingdimensions of 14*16*0.508 mm. Finally ground is made up of copper annealed with dimensions of 14*14*0.035 mm. The front view and back view of proposed antenna is illustrated in Fig.1(a) and Fig.1(b).

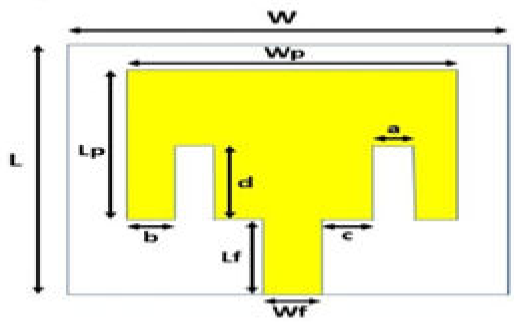

Fig.1(a):-Front View

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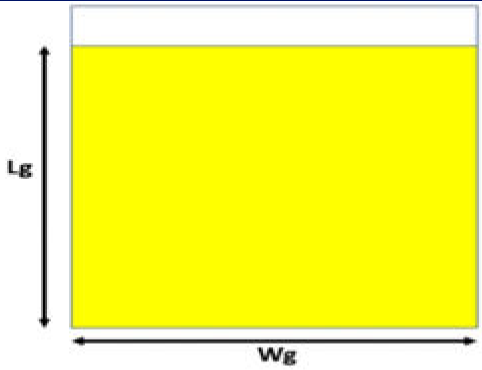

Fig.1(b):-Back View

We developed a two element MIMO antenna after creating a single element antenna. The rogers material's total measurements are 30*16*0.508mm. The photos below show the recommended two-element MIMO antenna's geometry. Figures 2(a) and 2(b) show the proposed two-element MIMO's front and back views, respectively.

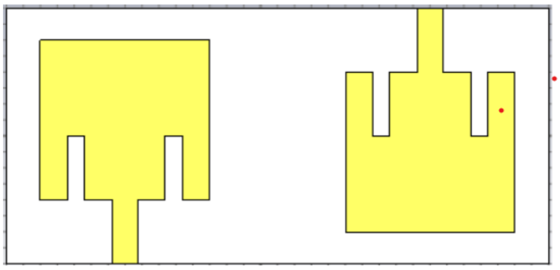

Fig.2(a):- Front View

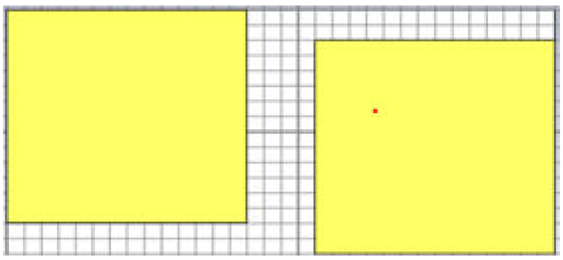

Fig.2(b):-Back View

Design Methodology

To design two element mimo antenna, first we need to design single element antenna. Following figure represents design procedure of an antenna in CST.

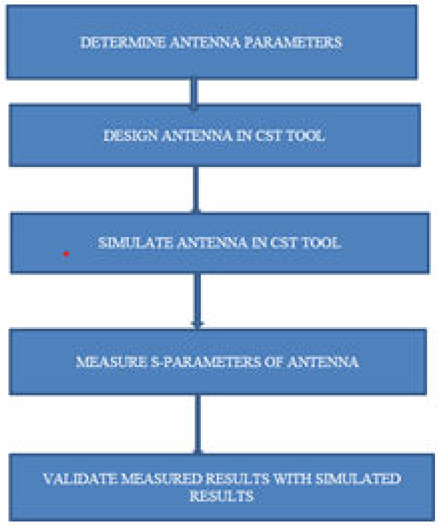

Fig 3:-Design Procedure of MIMO System

Simulated Results

Two element MIMO antenna is designed in Computer Simulation Technology studio suite. CST studio suite is a software tool that is used to simulate antennas and provides various parameters as output. Following parameters are recorded.

Single Antenna Results

After completing the design of single element antenna, we need to simulate that antenna to note down results. These are some of the antenna's different parameters.

A. Reflection Coefficient

It determine how much amount of power reflected back from antenna due to standing wave. Fig.4(a) represents the s- parameter plot of a single element. The antenna is plainly seen to be resonating at

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34.09 GHz in the accompanying picture, which is the ideal bandwidth as suggested by the FCC.

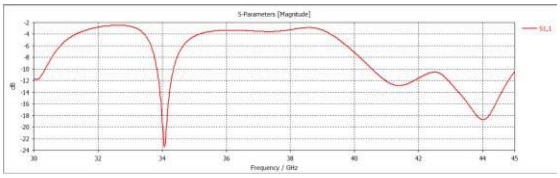

Fig.4(a):-S-parameter

B. Realized Gain and Directivity

The realized gain of the proposed antenna is found to be 6.6 dBi, whereas the directivity is 7.0 dBi, at the resonance frequency. The 3D graph of realized gain and the directivity shown in Fig. 4(b) and Fig.4(c) respectively.

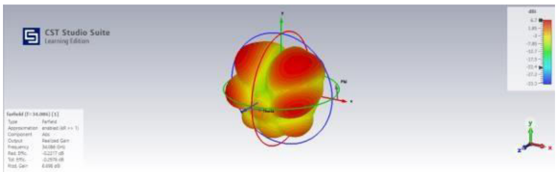

Fig.4(b):-Realized Gain

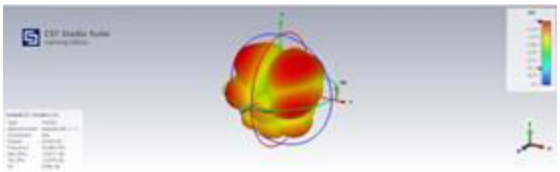

Fig.4(c):-Directivity

MIMO Antenna Results

After recording the results of single element antenna, we can implement single element to two element MIMO antenna. Below figures represents the various parameters of MIMO, resulting after performing simulation.

A. S-Parameters

All the elements of MIMO are resonating at 34.16 GHz, and the curve for each SXY is below 20 dB showing that isolation is less than 15 DB.

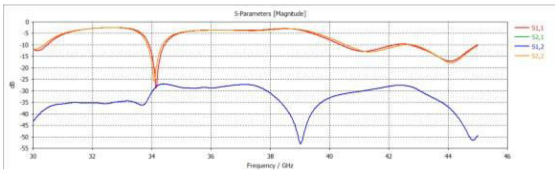

Fig.5(a):-S-Parameters

B. Envelope correlation coefficient

It identifies the variations between the radiation patterns of two antennas. If one antenna is polarised in the horizontal direction, and the other is automatically vertical direction, then assume that there is no correlation between the two antennas.

Generally ECC is calculated between a pair of elements. It is evaluated using S-parameter method.Fig.5(b) represents the ECC of MIMO antenna.

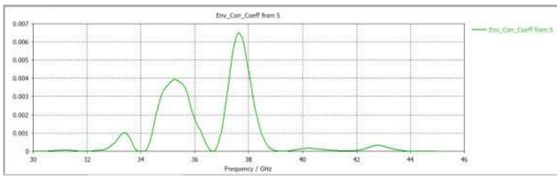

Fig.5(b):-ECC

C. Diversity Gain

Diversity gain quantifies how much a diversity system may reduce transmission power without compromising performance or how much the signal-to-interference ratio can be improved. Diversity gain is frequently expressed in decibels, however it can alternatively be expressed as a power ratio.

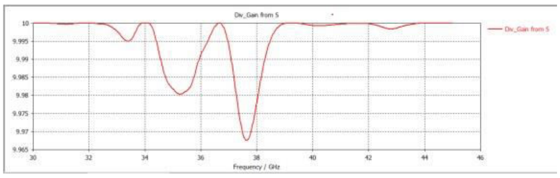

Fig.5(c):-Diversity Gain

D. Far Fields

Far-field refers to a field that is away from the antenna. As the radiation effect is strong here, it is also known as a radiation field. Many antenna factors, including antenna directivity and radiation pattern, are only taken into account in this area.

E. Field Patterns

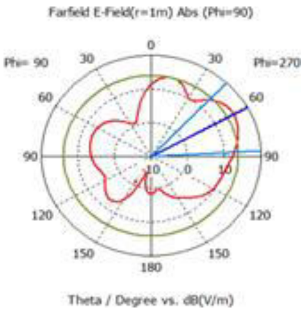

Fig 6(a):- E-Field for Antenna1

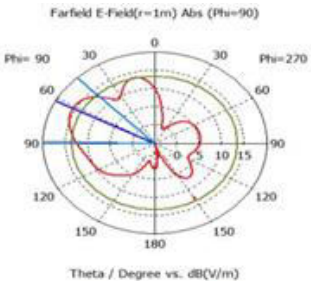

Fig 6(b):- E-field for Antenna2

H-Field Patterns

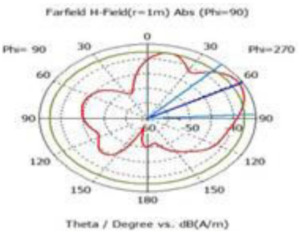

Fig 6(c):- H-field for Antenna1

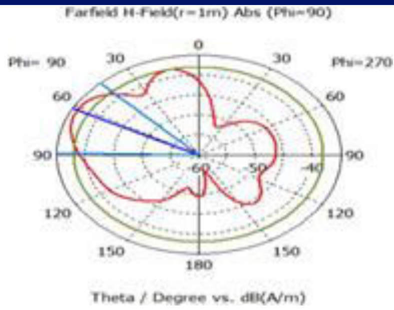

Fig 6(d):- H-field for Antenna2

Conclusion

The two-element 5G MIMO is designed, with a resonant frequency of 34.167 GHz.The suggested antenna has a small shape and a respectable 1.372 GHz bandwidth. The achieved gain and directivity of a single element antenna are 6.6 dbi and 7.0 dbi, respectively. The MIMO design has demonstrated a strong agreement with the MIMO performance criteria, making it an excellent option for upcoming 5G applications.

Future Scope

The antenna that we have designed is operating at 34.167GHZ. So, our proposed design can be used in 5G mm wave applications, because the range of 5G mm wave is between 24GHZ to 40GHZ. Some of the 5G mm wave applications are radio astronomy, remote sensing, automotive radars, military applications, imaging, security screening, telecommunications etc. So our designed antenna is suitable for these applications.

We now use a two element antenna. Future applications might include Four element MIMO antennas and Eight element MIMO.

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