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Research paper

Study and Analysis of Millimetre Wave Antenna for 5G

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Abstract

Due to the demand of more capacity and users, 5G (next generation) of wireless will be able to handle thousands times more traffic than today it works and it will be 10X faster than today 4G LTE. There has been a great research around the world in advancing future generation 5G wireless networks. Till now 5G standards are not available for us. Some researchers have been started that will provide these standards. The 5G system will require compact but efficient antenna. The main goal of 5G is to obtain better coverage at lower cost. The technology used in 5G to attain this goal will be obtained millimeter waves. Our smart phones and other electronic devices in our homes use specific frequency on radio frequency spectrum typically those under 6 GHz but these frequencies are started to get more crowded. Carriers can only squeeze so many bits of data on same amount of radio frequency spectrum. As more devices come online we are going to see lower service and more dropped connection. The solution is to adapt some new real estate like millimeter waves. In this paper, we present the future antenna for 5G, methodology and variety of simulation results at 6.5 GHz by using HFSS software. A microstrip patch antenna is designed by using FR4-epoxy for advantages of low cost, high flexibility, harmless to human body.

Keywords: *6.5 GHz, millimeter wave, 5G, microstrip patch antenna, HFSS*

1. Introduction

The introduction of digital standard was 2G,which allowed sms(short message service) to be sent in 1992 with speed of 14kpbs – 64 kbps. With development of 2.5G(internet on move) in 1997 and 2.75G (high speed data) in 1999 increased speed of 144 kbps. After 10 years 3G was introduced as first broad band solution and integrated video, data and voice with speed of 144kbps – 2Mbps. With further development of 3.5G and 3.75G, speed increased from 2Mbps to 10Mbps. The current generation of network 4G was mainly introduced for faster speed. LTE is first phase of 4G with speed of 10 Mbps – 100Mbps. 5G is on pace improved many aspects of current generation mobile network. Some of these major factors include speed, latency, bandwidth, energy consumption. This requires many new technologies. Among them the most important is millimeter wave. All electronic devices used frequency spectrum from 3KHz to 6GHz. This was not issue in past when devices were limited. However with the introduction of internet of things new smart devices require constant fast connections. These frequency bands are becoming increasingly congested. This rate of growth of connected devices is only set to exponentially increase in coming years. If all these devices would remain on currently established frequency spectrum no device will be able to get proper amount bandwidth to operate as designed which results in drop connections. Millimeter wave opens frequency spectrum from 6GHz to 300GHz and allow much more bandwidth. But we cannot immediately use all the frequency spectrum. For average consumer it will be cm waves. There will be some licensed and shared spectrum. Licensed spectrum ranges from 24GHz to 40GHz initially. And shared spectrum will be from60GHz to 70GHz for mission critical services. Mission critical services will include smart city infrastructure, self travelling cars, health care and more. These services require constant high speed and low latency connection. Therefore a shared spectrum is keen in showing that devices are always connected. Millimeter wave will provide more bandwidth, low latency range between 1ms to 10Ms and high speed communication. The main aim of this research is to design microstrip patch antenna for 5G based on antenna parameter like gain, directivity, radiation pattern, return loss, impedance plot etc for simulation. This research introduces millimeter wave technique at 6..5GHz by using HFSS software.

2. Literature Review

In this paper “design and simulation of directional antenna for millimeter wave mobile communication”,they have designed microstrip patch antenna for millimeter wave mobile communication at 2.8 GHz frequency by using the basic micro strip transmission line methodology and line calculation analyze from HFSS software. In that design input reflection coefficient or the S11 parameter for antenna element was -42dB at resonant frequency 2.8GHz , peak gain 8.2119dB, the bandwidth of 0.0565GHz was achieved in simulation of S11 parameter and directivity 8.4dB was obtained by electric field pattern by HFSS software.

3. Proposed Work

In this plan, microstrip patch antenna for millimeter wave mobile communication operating at 6.5GHz is designed by using microstrip transmission line methodology and by HFSS software.Milimeter wave antenna will help us to increase more bandwidth. Microstrip patch antenna is microstrip patch on dielectric material and supported by ground plane. It is used most widely used antenna as it is easily fabricated. It is easily installed, low size and low cost.The proposed antenna consists of rectangular radiating patch on one side of dielectric substrate with ground plane on other side.The electric field lines remain partially in lower dielectric substrate and partially in air due to absence of the ground plate and dielectric substrate.Themicrostrip antenna design consist of following parameters:

Frequency of operation (fo) : 6.5GHz

Substrate : FR4 epoxy

Dielectric constant(εr):(@1GHz) =4.25-4.55

Operating frequency, $f_o = C/2L\sqrt{\varepsilon_{reff}}$

Input impedance ∞ 1/w

$W = C/2f_0 \sqrt{(\varepsilon_{reff}+1)/2}$

$\varepsilon_{reff} = (\varepsilon r+1)/2 + (\varepsilon r-1)/2[1+12(h/W))-1/2$

For microstrip patch antenna:

Coordinates for substrate (0,0,0) for FR4

X=30 Y=40 Z=1.6

Coordinates for Boundary (-20,-25,-25)

X=80 Y=90 Z=50

Coordinates for Rectangle (9.5,0,2.5)

X=10

Z= -4.5

4. Simulation Result

The output results of designed microstrip antenna when simulated on radiation pattern, impedance, gain vs. frequency, return loss, VSWR, Directivity on HFSS are

4.1. The Return Loss

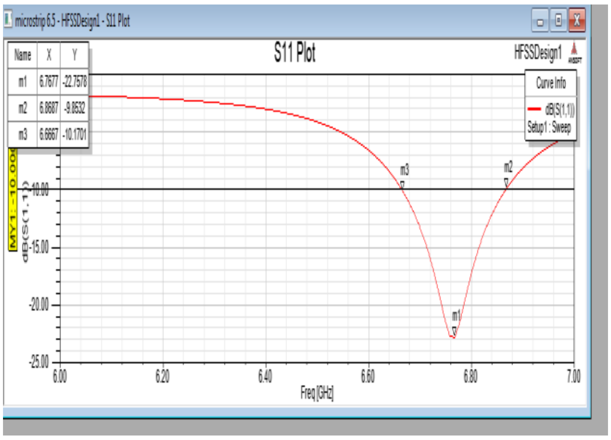

Fig 1: The Return Loss Plot

4.2. Radiation Pattern

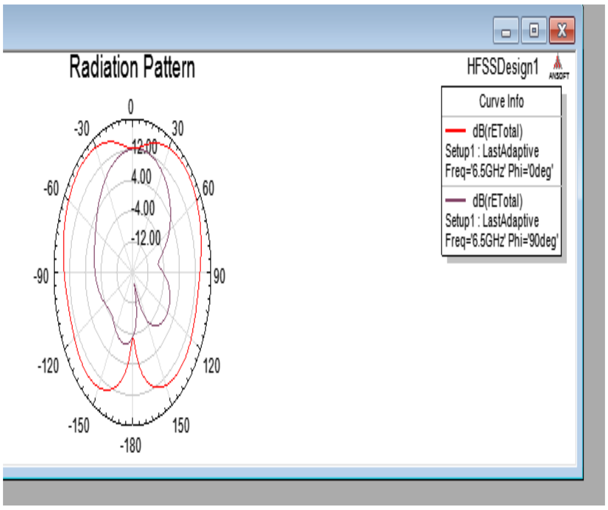

Fig 2: The Radiation Pattern Plot

4.3. Gain

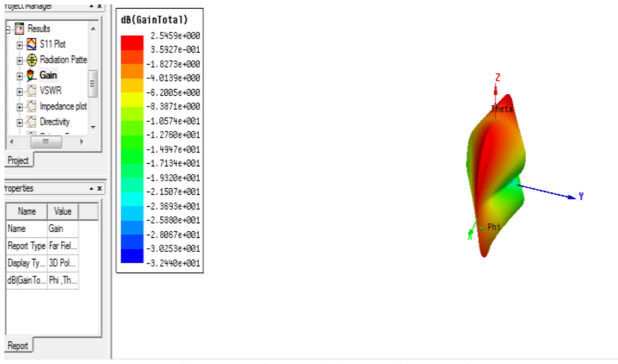

Fig 3: The Gain obtained during the simulation

4.4. VSWR

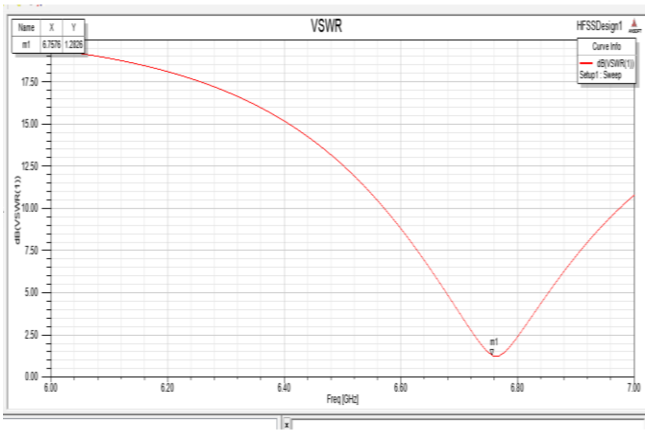

Fig 4: The VSWR Plot

4.5. Impedance Plot

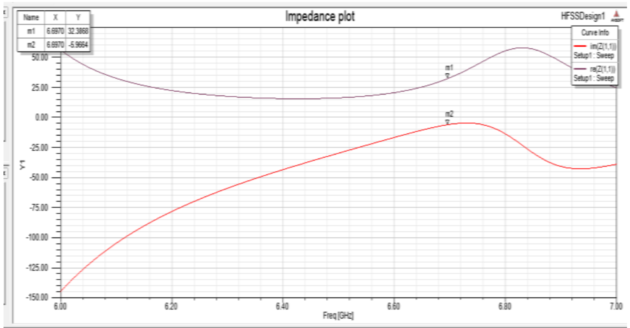

Fig 5: The Impedance Plot

4.6. Directivity

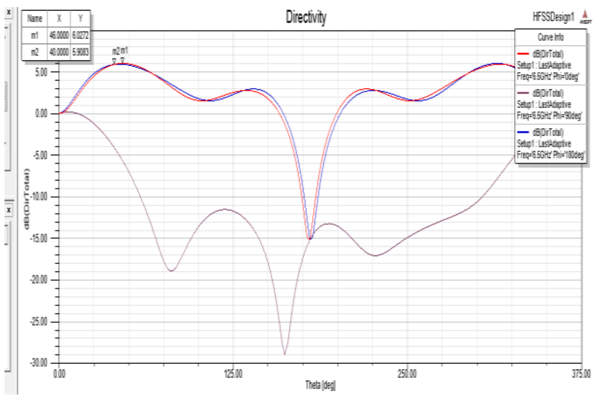

Fig 6: The Directivity Plot

4.7. Gain VS Frequency.

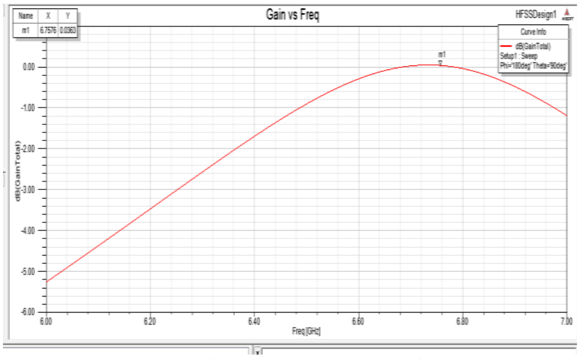

Fig 7: The Gain vs. Frequency Plot

In this design bandwidth obtained 200 MHz at 6.5 GHz, return loss is -23 dB, directivity obtained is 5.87db , resonance frequency 6.76 GHz , highest radiation intensity 2.63 db.

5. Conclusion

In this paper, microstrip patch antenna is designed for 5G and simulated using HFSS software. The results gives better performance for different antenna parameters that are compared to reported design, the proposed design is working well and has achieved the desired results. This approach can be used to design directional antenna for millimeter wave mobile communication at frequency 6.5GHz.

Table 1: Performance Parameter.

SERIAL NO	**PARAMETER**	**Reported design F_o=2.8 GHz**	**Proposed design F_o=6.5 GHz**	**REMARK**
1.	Return loss	-42db	-23db	Return loss is improved.
2.	Bandwidth	0.0565 GHz	0.2GHz	Bandwidth is high. High bandwidth means higher connection speed.
3.	Gain	8.2119db	0.25db	Gain decreased in present work.
4.	Directivity	8.48db	5.87db	Proposed design is more directional as compared to reported design.

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