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ANTENNA DESIGN FOR VEHICULAR OVERTAKING

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Abstract—In VANET, vehicles are equipped with antenna which can transmit and receive data between each other. The existing system for vehicular communication is achieved by radar which involves the application of any type of directional antennas. The proposed antenna focuses the radio frequency (RF) energy in one or two directions thereby increasing the strength of the signal and distance covered in that direction. The design of rectangular patch antenna has been investigated keeping in view the vital parameters such as frequency of operation, dielectric constant and bandwidth. In this work, the simulation tools Advanced Design System (ADS) 2011.01 and CST microwave studio are used to study the performance and gain of the rectangular micro strip patch antenna. The design and simulation of patch antenna is widely used today, and our prominence in this work is on design of a 5.9 GHz rectangular micro strip patch antenna.

Keywords- VANET,Directional antennas,Gain.

I.INTRODUCTION

In the last couple of years communication between vehicles has attracted the interest of many researchers around the world.Vehicle to vehicle communication (V2V), often referred to as vehicular ad hoc networks (VANETs), enables many new services for vehicles and creates numerous opportunities for safety improvements. Communication between vehicles can be used to realize driver support and active safety services like collision warning. However, besides enabling new services VANETs pose many challenges on technology, protocols, and security which increase the need for research in this field.

In this work the idea to use directional antennas for vehicular communication. Patch antennas play a very significant role in today's world of wireless communication systems. Integrating several antenna arrays into the car body or the windows can be feasible for new car models but using directional antennas which is coming for rather low prices can therefore increase the potential performance of vehicle to vehicle communication.

Microstrip patch antennas radiate primarily because of the fringing fields between the Patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation. Microstrip patch antennas are increasing popularity for use in wireless applications due to their low-profile structure. Therefore they are extremely compatible for embedded antennas in hand held wireless devices such as cellular phones, pagers etc.

The structure of the Micro strip patch antenna consists of a thin square patch on one side of a dielectric substrate and the other side having a plane to the ground. In its most fundamental form, a Micro strip antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on other side. The patch is generally made of conducting material such as copper or gold. The basic antenna element is a strip conductor of length L and width W, on a dielectric substrate. The thickness of the patch being h with a height and thickness t is supported by a ground plane. The rectangular patch antenna is designed so that it can operate at the resonance frequency.

II: LITERATURE REVIEW

The use of microstrip structures to radiate electromagnetic waves was contemplated in the 1950's. The earliest form of antennas was developed by Deschamps [1]. Later it was formally introduced by Munson as planar antennas on missiles. By early 1970's, the importance of microstrip radiators was realized when researchers noted that almost half of the power in a microstrip radiator escapes as radiation. Thus, a microstrip radiating patch with considerable radiation loss was defined as microstrip antennas. Later, it was proved that this radiation mechanism was arising from the discontinuities at each end of the microstrip transmission line. At the time of its inception microstrip antennas were associated with many disadvantages, such as low efficiency, lower power, high Q, poor polarization purity, poor scan capability, and very narrow bandwidth. With the evolution of design technology, microstrip antennas have achieved higher bandwidth, mechanical robustness and versatility with respect to resonant frequency, improved polarization pattern and wider impedance bandwidth. Since printed circuit technology is currently widely used to provide smaller and low profile antennas for personal and mobile communication devices, this research study will embark on designing a microstrip antenna for specified bandwidth purposes. The broadband microstrip patch antennas are finding increasing applications in satellite communications, GPS, Wimax [1], WLAN and commercial usages especially as base station antennas, antennas for access point. But before these antennas can be designed to meet our desired requirements, the basic theory associated with the technology needs to be understood.

III. DESIGN OF THE ANTENNA ELEMENT

The three essential parameters for the design of a rectangular Microstrip Patch Antenna:

● **Frequency of operation (fo) :** The resonant frequency of the antenna must be selected appropriately.The resonant frequency selected for my design is 5.9 GHz.

● **Dielectric constant of the substrate (εr) :** The dielectric material selected for our design is FR4 which has a dielectric constant of 4.3.

● **Height of the dielectric substrate (h) : T**he height of the dielectric substrate is selected as 1.6mm.

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Hence, the essential parameters for the design are:

- Frequency of operation (fo) = 5.9 GHz
- Dielectric constant (εr) = 4.3
- Substrate thickness (h) = 1.6 mm

Step 1: Calculation of the Width (W):

The width of the Micro strip patch antenna is given as:

$$w = \frac{c}{2\,fo\,\frac{\sqrt{\varepsilon_R + 1}}{\sqrt{2}}}$$

Substituting c = 3.00e+008 m/s, εr = 4.3 and fo = 5.9 GHz, we get:

W=15.16

Step 2: Calculation of Effective dielectric constant (εeff):

The effective dielectric constant is given as:

$$\varepsilon_{eff} = \frac{\varepsilon_R + 1}{2} + \frac{\varepsilon_R - 1}{2}\left[\frac{1}{\sqrt{1 + 12\left(\frac{h}{w}\right)}}\right]$$

Substituting εr = 4.3, W =15.6 mm and h= 1.6 mm we get:

Eeff=3.5

Step 3: Calculation of the Effective length (Leff):

The effective length is given as :

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

Substituting εreff =3.5 , c = 3.00e+008 m/s and fo = 5.9 GHz we get:

Leff = 13.12 mm

Step 4: Calculation of the length extension (ΔL):

The extension length is given as :

$$\frac{\Delta L}{h} = 0.412 \frac{\left(\varepsilon_{eff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{eff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}$$

Substituting εreff = 3.5, W = 15.6 mm and h = 1.6 mm we get:

ΔL= 0.81mm

Step 5: Calculation of actual length of patch (L):

The actual length is obtained by:

$$L = L_{eff} - 2\Delta L$$

Substituting Leff = 13.12 mm and ΔL= 0.81 mm we get:

L= 12.3 **mm**

IV.SIMULATION RESULTS

The rectangular patch is by far the most widely used configuration.A basic form of rectangular patch is shown in the Fig.1.

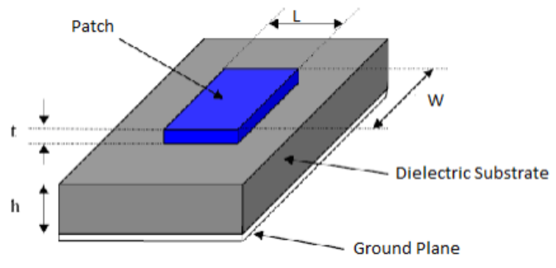

Figure 1: Rectangular Microstrip Patch antenna.

The parameters required for the patch in simulation tool are the following:

- Dielectric constant = 4.3.
- Frequency (fr) = 5.9 GHz.
- Height (h) = 1.8 mm.
- Velocity of light (c) = 3×108 ms-1.
- Practical width W = 42.1 mm.
- Loss Tangent (tan δ) = 0.001.
- Practical Length (L) L = 12.3 mm.

The dimensions of the antenna are mentioned in Table 1.

Parameters	Size (mm)
W	15.6
L	12.3
εr	4.3
h	1.6
Leff	13.12

Table 1. Dimensions of antenna

4.1.Simulation using ADS : The choice of dielectric material will play an important role in the design of micro strip antenna. For this design, the substrate FR4 with dielectric constant εr=4.3 and thickness (h) = 1.6 mm is chosen.Given the specifications,the patch was designed in ADS 2011.01. After design, the patch was simulated in ADS 2011.01 to get the directivity along with the 3D visuals of the far field radiation and the 3D view of the designed antenna patch.The rectangular patch was energized using inset feed.Fig. 2 shows the design of the rectangular patch in ADS environment.

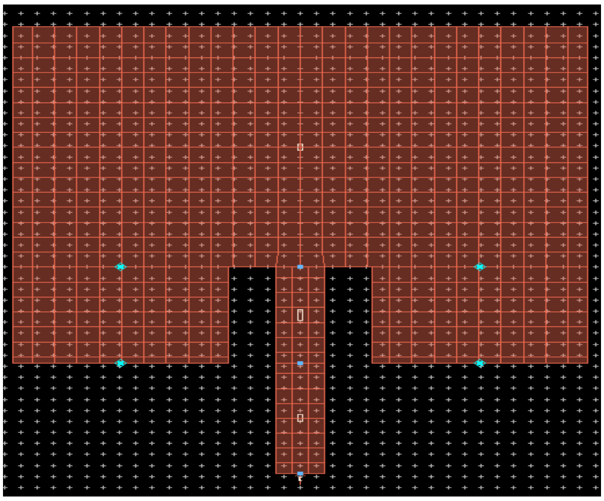

Figure 2. Layout of Rectangular patch designed in ADS.

The 3D view of the rectangular patch is shown in Fig.3.

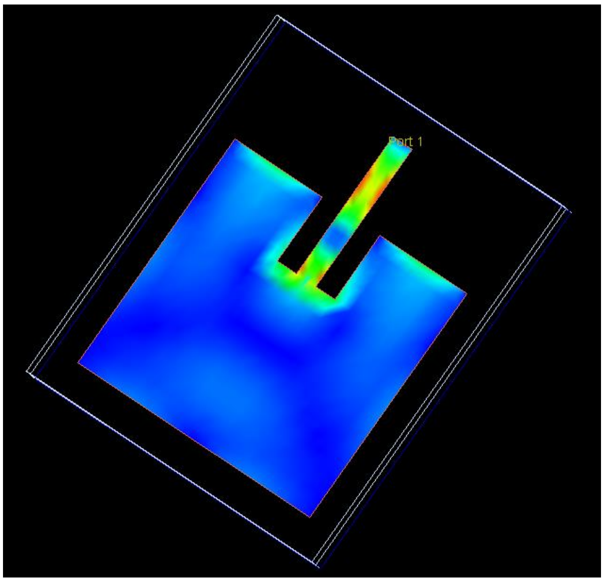

Figure.3 3D view of rectangular patch.

Fig. 4 and Fig. 5 show the shows the simulation results of the rectangular patch in ADS 2011.01. Fig. 4 shows the behavior of the S(1,1) parameter or the input reflection coefficient over a range of frequencies. It is clear from the figure that the patch resonates at 5.9 GHz and has minimum loss at the resonant frequency i.e. -4 dB.

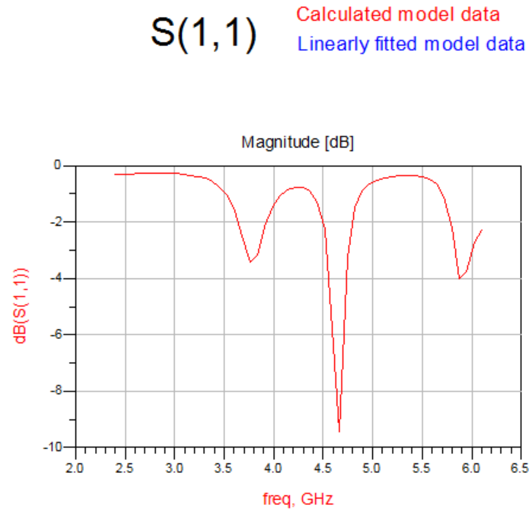

Figure:4 Return Loss.

Fig.5 shows the same input reflection coefficient (S1,1) result in the Smith chart.

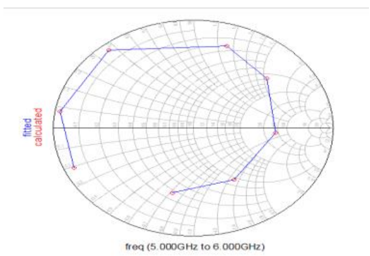

Figure:5 S(1,1)-parameter shown in Smith chart.

Similarly ADS Momentum simulates the three dimensional view of the directivity and the far field radiation pattern, of the rectangular patch microstrip antenna as shown in Fig.6.

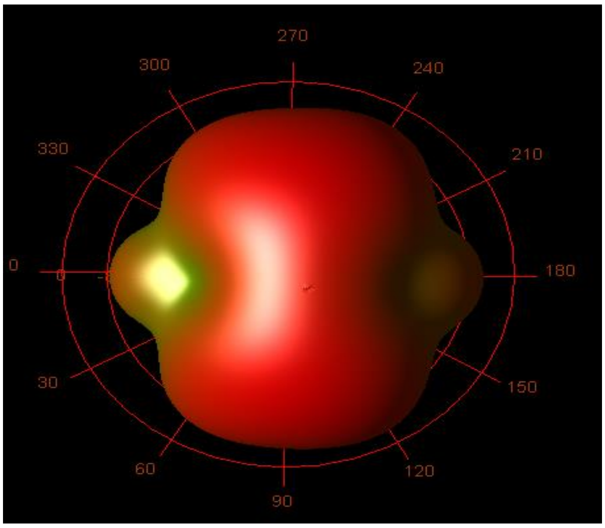

Figure:6 3D graph of the far field radiation.

Hence, from the simulation results of rectangular patch antenna using ADS it can be inferred that the return loss is less which implies that the gain is relatively high.

4.1.1.Simulation using CST : The designed antenna was also simulated using CST microwave studio.The return loss is observed to be at -2.8 dB at 5.9 GHz.Fig.7 shows the E-plane radiation pattern of the designed antenna.

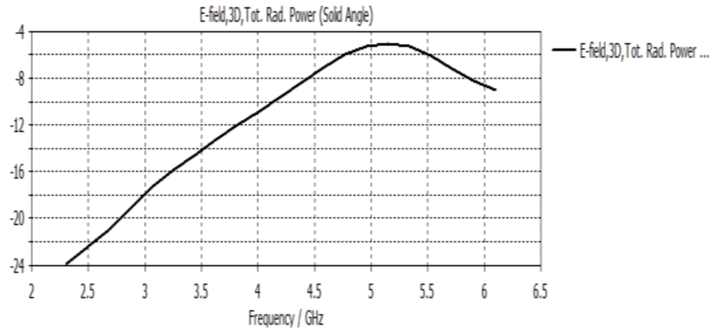

Figure:7 E-field Total Radiated Power.

Antenna gain is the main factor for the measure of efficiency.Antenna gain depends on the mechanical size, the effective aperture area, the frequency band and the antenna configuration.Fig.8,Fig.9 shows the gain and bandwidth potential of the designed antenna.

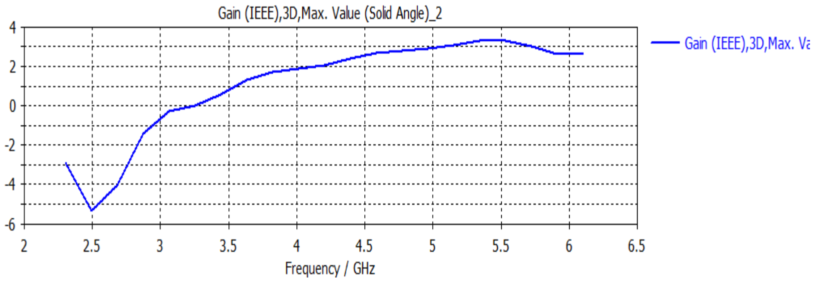

Figure:8 Gain of Rectangular patch antenna.

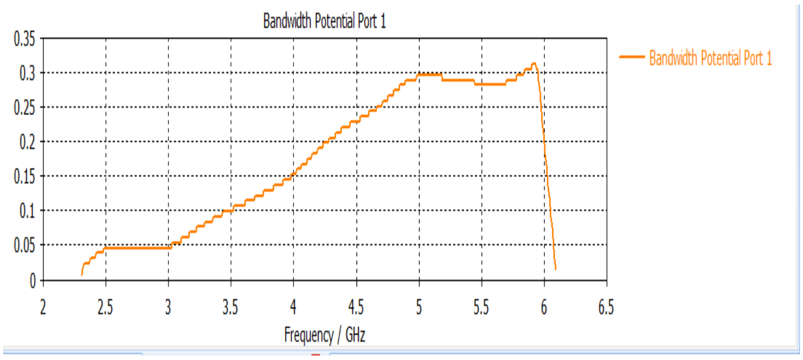

Figure:9 Bandwidth Potential of Rectangular Patch antenna.

Fig.10 shows the directivity of the rectangular patch antenna.

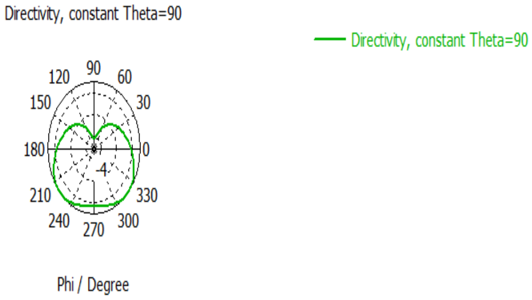

Figure :10 a)DIRECTIVITY: FOR THETA=90 DEG.

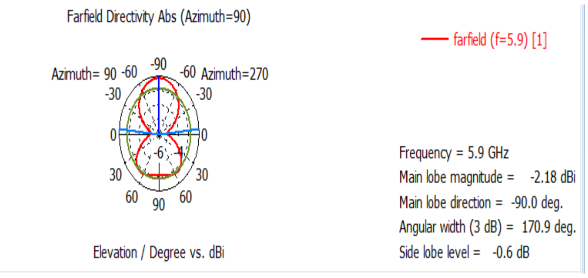

Figure:10 b)FAR FIELD DIRECTIVITY FREQ:5.9GHZ

V.CONCLUSION

The present state of work includes the design procedure of Microstrip rectangular patch antenna using ADS and CST at resonant frequency of 2.4GHz.The Radiation patterns (3D) and the other important parameters like gain, efficiency and return loss have been studied.The narrow beam gets rid off interference that permits reception-inside building where signals are too weak to be picked up by standard antenna. It delivers 10 times less radiations to user's head without any shielding device. It makes battery to last longer. The overall working of antennas was understood and the radiation patterns and gain v/s frequency plots were studied and their implications were understood.

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