Design and Analysis of Microstrip Antenna for 5G Application

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***Abstract*—As the technology changing everyday we need more bandwidth antennas for communication purpose. 5G is one of the major solution for it. For the same we have designed 3.45Ghz antenna. We created antenna using FR4 material which is double sided copper coated pcb. It has dielectric constant of 4.4 along with 1.6 mm as height of substrate. Initially we designed antenna simulation in Advanced Design System (ADS). We plotted its graphs for gain, directivity, frequency plot, radiation pattern, Electric field plane and Magnetic field. Using ADS software we also made the equivalent circuit diagram of antenna that is being designed. Simulated the results for the antenna and calculated the S-parameters.**

Keywords- Antenna Design, Microstrip Antenna, 3.45Ghz antenna

I. INTRODUCTION

To communicate from one point to another point we need antenna which will serve as transmitter and receiver. As per the revolution of the communication technology in recent development we found that we can implement the 5G antenna. Currently we are using 4G in India with mobile antenna bandwidth operating at around 800-900 Mhz. To implement the for 5G we need to design antenna in such way that it will be supporting the required application. As the population is increasing continuously and requirement of quality network is also increasing. Still the 5G is trying to solve the problem by providing the solution to the problem discussed above. For the same we had come up here with basic antenna of 3.45 Ghz and implemented it using the ADS software first. After successfully implementing the design work we went ont to making the hardware. We designed and In this paper we implemented the antenna we printed the pattern onto the pcb material. After printing it we connected it with connector and connected it to the machine to generate the output. The advantages that a microstrip patch antenna is that it is light weight, easy to implement, low profile antenna, low cost and very versatile.

Having great advantages it has some of the drawback that has narrow bandwidth , low efficiency and low power. The design we are making is made in such a way that it will perform great and tried to get maximum output from it. Also tried to make parameters as required to start the fabricating the antenna.

The main impact in the microstrip patch antenna is by the pattern that is being printed on the surface of the fr4 material substrate. Any changes in the pattern causes change in the output of the antenna and lead to the failure of the antenna as we will not be able to get the desired output of our antenna. The one of the main point here is that we have to take the ground plane as whole size. Also we have to make sure that we have not to make design antenna pattern on ground plane side. We have to take the ground plane as it is.

II. ANTENNA DESIGN

First step for designing the antenna we need to select the frequency that is 3.45Ghz. After selecting the frequency we have to calculate the length and width of the patch. For calculating it we have to use the following formula.

- Calculation of the Width (W)

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

- Calculation of the Effective Dielectric Constant

- Calculation of the Effective length

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}}$$

- Calculation of the length extension ΔL

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

- Calculation of actual length of the patch

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

- Calculation of Ground Plane

Wg = W + 6h

Lg = L + 6h

The antenna that is designed was initially made on the ADS software. Substrate that we used here was basically FR4 of dielectric constant 4.4. with the height of 1.6mm and side view of the dielectric is shown in Fig 1 as below.

Fig.1. Side view of the microstrip antenna

The pattern that is designed for our antenna is as follows in which we calculated first length and width of the antenna using the formulas. After that we calculated the length and width of the feed. The pattern is shown in Fig.2. as follow.

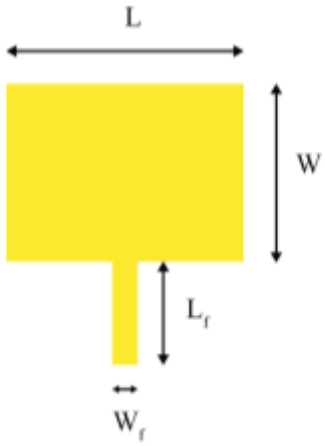


Fig.2. Top view of the microstrip antenna

While designing for the ground plane was also done by using

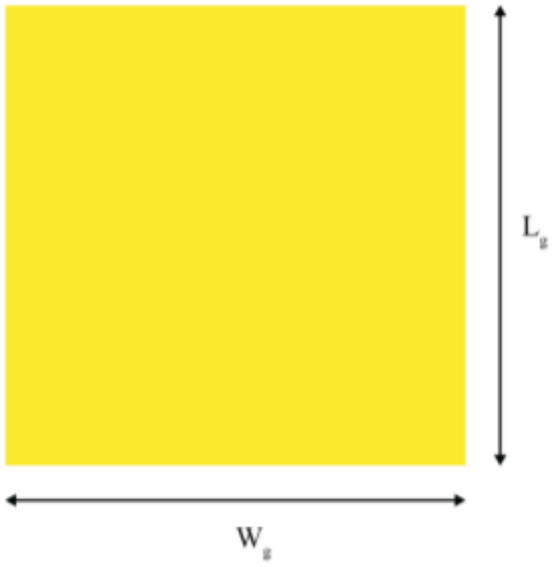


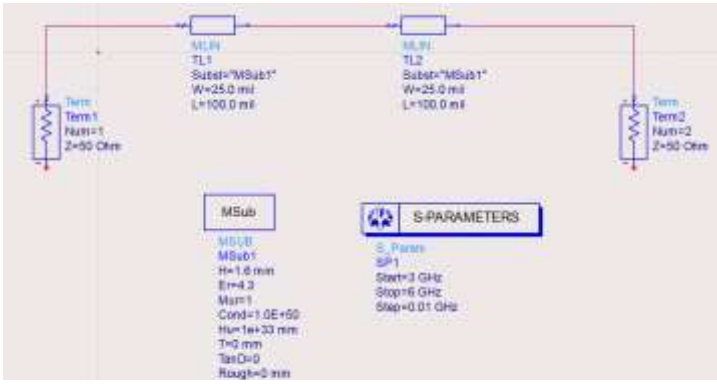
Fig.3. Ground view of the microstrip antenna

To make antenna work at frequency of 3.45Ghz we have done so many calculations and find the values by doing trial and error method. The values for different sides, patch and ground plane can be seen in the Table.1.

TABLE.1 ANTENNA DESIGN PARAMETERS

Sr. No.	Parameter	Dimension(mm)
1.	L	26.21
2.	W	20.20
3.	L_f	12
4.	W_f	3.11
5.	L_g	50
6.	W_g	50

The equivalent circuit of the antenna represent antenna in the from of the RLC components and it can be designed using the same in the project if someone want to make it from the passive component. For implementing it we also need the S parameters. In ADS software after simulating the pattern the antenna is designed automatically and that is shown below in Fig.4.



III. SIMULATION RESULTS

Simulations are performed from 3Ghz to 6Ghz by taking one step as 0.1 Ghz as step in ADS software. We got the output of the simulation result. Considering resonance frequency for our antenna as 3.45Ghz we get the return loss as -8.661dB. As shown in Fig.5.

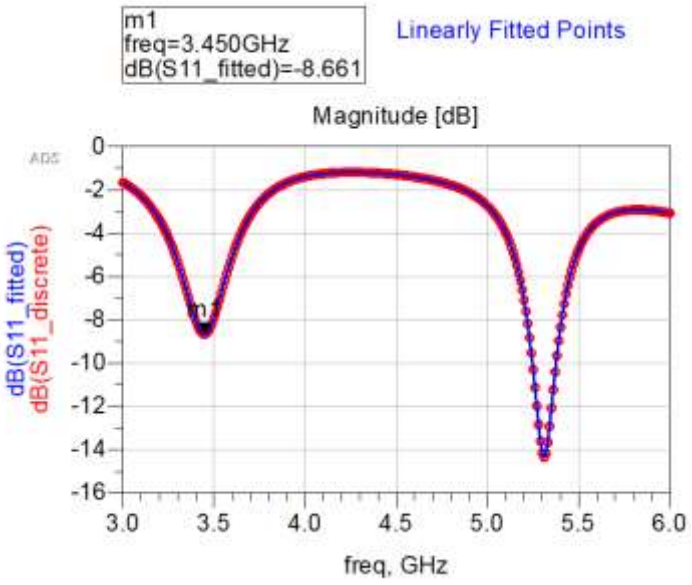


Fig.5. Return loss vs Frequency

While Fig.6. shows the far field radiation pattern and near field radiation pattern of the designed antenna. As it is clearly seen that both the patterns look similar in terms of the structure.

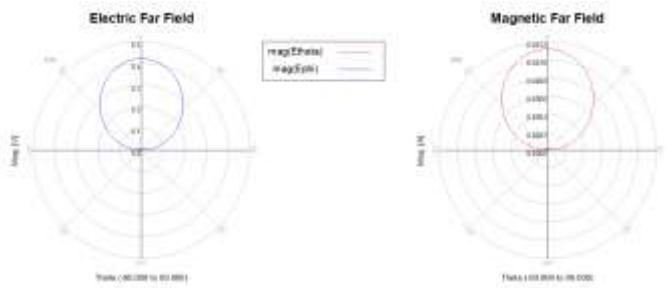


Fig.6. Electric far field and Magnetic far field

Whereas the output obtained for linear polarization and circular polarization is different in terms of the pattern. It is clearly seen from the following figure Fig.7.

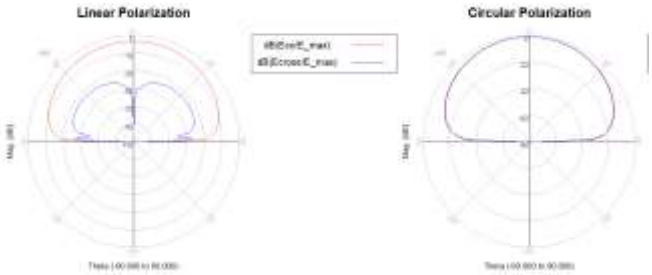


Fig.7. Linear polarization and Circular polarization

Simulated directional wave pattern of the antenna is shown in Fig.8. which is simulated in ADS software. It also gives the animated output for the antenna in the pattern format with green color.

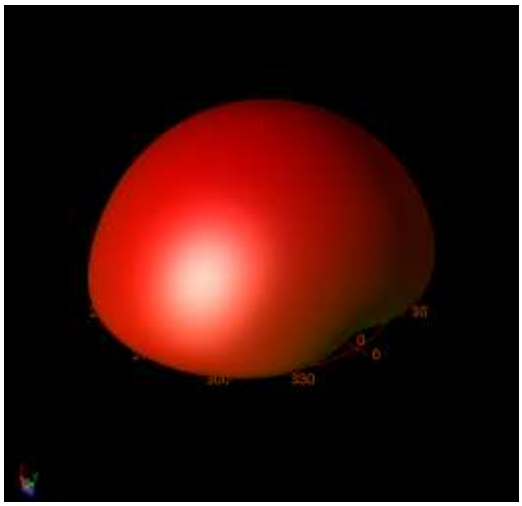


Fig.8. Radiation pattern for the antenna.

Finally the original implemented hardware can be seen in the following image. The hardware is built and tested in the lab. Following figure shows the hardware.

The designed antenna has gain of 1dBi and the radiation efficiency is 28.75%.
Table.2 represents summary of the parameters obtained after simulation.

TABLE.2 SIMULATION RESULTS SUMMARY

Sr. No.	Antenna Parameter	Values
1.	Return Loss	-8.661dB
2.	Gain	1dBi
3.	Directivity	6.4dBi
4.	Radiation Efficiency	28.75%

IV. CONCLUSIONS AND FUTURE WORKS

In the project proposed microstrip patch antenna for 5G communication. The designed antenna is simple in terms of design and easy to implement. The antenna resonates at 3.45Ghz frequency and its gain is seen to be of 1dB with return loss as -8.661dB. The return loss value is found to be good and gain value is found to be okay to work also it shows good radiation. Antenna works successfully and gives the output. The work done can be useful for future 5G communication. The antenna design structure was very simple 50mm×50mm×1.6mm and can be easily designed.

Currently antenna is working at resonance frequency of 3.45Ghz. But still the antenna can be improved as per the requirement of the application. The antenna can be improved by choosing more quality substrate. Also the improvement can be done by reducing the dimension so that antenna will resonate with higher frequency and will take lesser space and consume lesser power. By reducing the dimensions we can have improvement in radiation, efficiency, directivity and more effective.

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