

On the Performance of Rectangular Microstrip Patch Antenna using Rogers RT/Duriod 5880

Gnanamurugan.S, Sivakumar.P, K. Ramash Kumar, S. Balakumar

Abstract: The widely researched area in communication systems is wireless technology. The study of communication systems is incomplete without understanding the operation of the antennas. In the recent years of development in communication systems the important needs are lightweight, compact and cost-effective antennas that are capable of maintaining high performance over a wide spectrum of frequencies. This technological trend has focused much effort into the design of a Micro strip patch antenna, because they will provide high frequency and less bandwidth. This paper presents a design and simulation of rectangular micro strip patch antenna at 2.5 GHz frequency range for wireless communication that provides a radiation pattern along a wide angle of beam. The designing process uses the Rogers RT/duriod 5880 material is used as the substrate and coaxial probe feed method is used to gives the excitation value of the antenna compare with FR4 Epoxy. This antenna has many practical applications like WLAN, WI-FI, etc. so the HFSS software is used to design and implement the antenna.

Keywords: Micro strip patch antenna, Radiation pattern, Ansoft HFSS (High Frequency Structural Simulator).

I. INTRODUCTION

The world of transmission starts with the basic need antennas. In recent years there is a need for more compact antennas due to the announcement devices sizes are decrease rapidly. The micro strip antenna is one of the small size antennas and is printed openly on the printed circuit board. Micro strip antenna is a narrow band and wide beam antenna element pattern in a metallic trace bounded in dielectric substrate. The Federal Communication Commission specified some rules for Ultra Wideband system communication; it has authorized the use of UWB communication in the frequency band of 2.5 GHz. Radar systems have been used for various applications such as monitoring and remote sensing. Radar remote sensing techniques have become interesting to researchers. Ultra Wideband radar system based on the transmission of short duration pulses. The principle of this radar is transmitting a short duration pulses and then detecting the reflected pulse response.

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The microstrip UWB antennas is one of the most commonly used antennas in radar applications. Geometric shape of a microstrip antenna comprises a radiating element on the dielectric substrate and on the other side a ground plane, as illustrated in Fig 1 The most common is rectangular element. The antenna characteristics like the radiation pattern, gain, directivity, VSWR, Return loss and polarization are found by using the Ansoft HFSS simulator tool.

II. ANTENNA STRUCTURE

Micro strip patch antenna consists of a radiating patch on one side of the dielectric substrate which has a ground plane on the other surface and the patch is from the top side. The micro strip patch antenna consists of three layers these are the bottom layer, which constitutes the ground plane, the middle layer which shows the substrate and as a final point the top layer which shows the patch. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The general structure of the micro strip patch antenna was shown in figure 1.

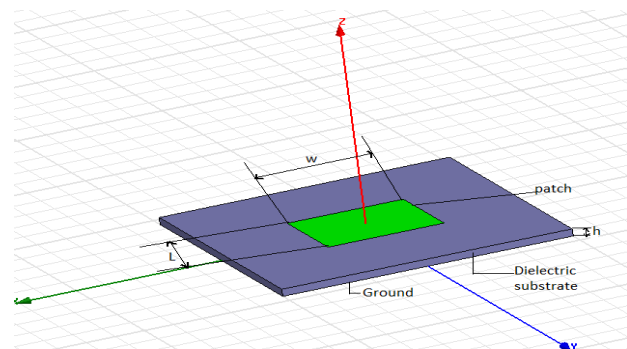


Fig. 1 Structure of Micro strip patch antenna

III. MICRO STRIP PATCH ANTENNA DESIGN AND CONSIDERATIONS

The Micro strip antenna was deliberate by using the Ansoft HFSS. It is one of the designing tools of antenna. The Ansoft HFSS is a simple and low cost tool which has the simple measures to design the antenna in a very efficient way. By using this software the antenna should be designed and simulated. By simulating this antenna we can get the frequency response, gain, directivity and radiation pattern.



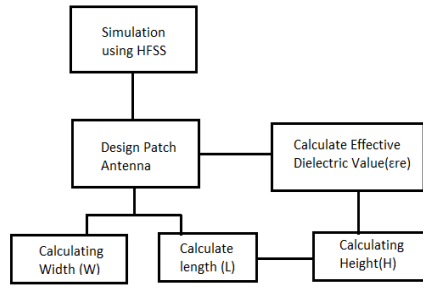


Fig. 2 Design flow of Micro strip patch antenna

The Micro strip antenna was designed by using the Ansoft HFSS. It is one of the designing tools of antenna. The Ansoft HFSS is an easy and low cost tool which has the simple procedures to design the antenna in a very well-organized way. By using this software the antenna should be designed and simulated. By simulating this antenna we can get the frequency response, gain, directivity and the radiation pattern. There are many analyzing methods are there in the antenna from these we use the transmission line analyzing method for the antenna design, which includes a lot mathematical calculations in the antenna design. The design flow of the micro strip antenna was shown in figure 2. Based upon these flow they should be designed.

a. Calculation for the Antenna Width (W)

The Width of micro strip patch antenna is given by eqn (1)

$$W = \frac{C}{2f_0 \sqrt{\frac{\epsilon_r + 1}{2}}} \tag{1}$$

Where, C is velocity of light, f_0 is a resonant frequency and ϵ_r is a relative die electric constant. Other widths are also chosen but for the higher widths the radiation efficiency is lower in manner and for the lower widths the radiation efficiency is larger in resulting values, in this equation we substituting $C=3*10^{11}$ mm/s, $\epsilon_r =2.2$ and $f_0= 2.8$ GHz frequency, finally by solving this equation we get the width value as 42mm for the 2.8GHz.

b. Calculating the Height of the Antenna

The height (H) of the antenna is given by eqn (2) and is written as

$$H = \frac{0.3C}{2\pi f_0 \sqrt{\epsilon_r}} \tag{2}$$

By substituting all the values and solving the equation we get the height of the antenna as 3.86mm for 2.8GHz or the standard height of the micro strip patch antenna 3.2mm is used for the simulation.

c. Calculating the Antenna Length (L)

Calculating the length of the micro strip antenna follows the several steps which should be have four steps these as follows as

1) Effective Die Electric Constant

Before calculating the length of the antenna we must calculate the several other computations, the first we would find the effective die electric constant of the substrate which

is much greater than the unity value. The effective die electric constant value is much closer than the die electric constant of the substrate. The effective die electric constant value is given in eqn (3)

$$\epsilon_{re} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + 12 \frac{h}{w} \right]^{-2} \tag{3}$$

By substituting all the values and solving the equation we get the effective die electric constant value as 2.03mm for 2.8GHz.

2) Extensive Length

The tangential fields of an antenna are in phase and combine they will produces the maximum radiation pattern along with its two sides of the antenna. The micro strip antenna are looks larger in size when compared to its actually size due to its fringing fields so the length of the antenna was extended by its two sides along a path distance of ΔL and it is given in eqn (4)

$$\Delta L = 0.412h \frac{(\epsilon_{re} + 0.3) \left(\frac{w}{h} + 0.264 \right)}{(\epsilon_{re} - 0.258) \left(\frac{w}{h} + 0.8 \right)} \tag{4}$$

By substituting all the values and solving the equation we get the extensive length of the antenna as 1.67mm for 2.8GHz.

3) Effective Length of the Antenna

The effective length of the of antenna is given eqn (5) and which helps to find the original length of the rectangular micro strip patch antenna and it is written as

$$L_{eff} = \frac{C}{2f_0 \sqrt{\epsilon_{re}}} \tag{5}$$

This should be calculated for the narrow bandwidth of the antenna structure and various parameters of the antenna.

By substituting all the values and solving the equation we get the effective length of the antenna as 43.97mm for 2.4GHz frequency range and 37.58mm for 2.8GHz.

d. Actual Length of the Antenna

The actual length of the antenna should be calculated by substituting the effective length and the extensive length of the antenna is given in eqn (6)

$$L = L_{eff} - 2\Delta L \tag{6}$$

By substituting all the values and solving the equation we get the length of the antenna as 39.89mm for 2.4GHz and 34.25mm for 2.8GHz.

IV. ROGER RT/DURIOD 5880(TM)

The Roger material has the die-electric constant value as 2.2 which will be mostly recommended material for the designing of the micro strip patch antenna [1].

By using this equipment the designing parameters values are get reduced and the size of the antenna was almost in small range and which will produce the maximum radiation



pattern along its transmission side of the structure. By using these materials the entire structure of the antenna gets minimized, cost of the designing procedure is getting compact and the same time we get output of the micro strip patch antenna in a good and accurate manner.

V. SOFTWARE TOOL

The software used for the simulation and model of the antenna is HFSS (High Frequency Structural Simulator). It is one of the antenna design tools and it is a high presentation full-wave electromagnetic field simulator for the 3D volumetric passive device. It has simple procedure for the designing of the micro strip patch antenna structure and also it is low cost, high performance and easily understandable software for everyone.

VI. SIMULATIONS AND RESULTS

The design and analysis of the rectangular MSA was designed at a frequency range of 2.5GHz. The rectangular antenna has a greatest advantage than other types because they have easily designed structure and have positive radiated edges on the mutually sides of the antenna. The three dimensional view of the simulated micro strip patch antenna was shown in figure3. The radiation pattern of the antenna is shown in figure 4 and figure 5 for 2.5 GHz. From the results will show the improved radiation pattern and the frequency response of the antenna.

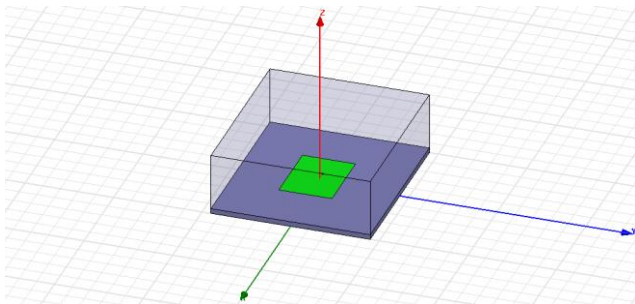


Fig. 3 Three dimensional view of antenna

i. Radiation Pattern

The radiation pattern of the patch antenna was plotted as shown in Figure-4 and 5. It has shown that the distribution of power radiation around the antenna as a function of direction represented by the π angle at 2.5GHz. The radiation pattern of an antenna has a typical radiation distribution to its surface and it gives a picture nature of the importance and direction of radiation, by which the antenna emits or receives the electromagnetic waves. The best way to represent radiation pattern is by the three dimensional chart. The radiation pattern is plotted to show the mental picture or provide a view of the radiation. Its magnitude depends on the patch antenna surface. Another way to represent it, is by the angular or polar coordinates. Figure-4 and 5 show the elevation pattern for designed antenna at $\phi=0$ and 90 deg.

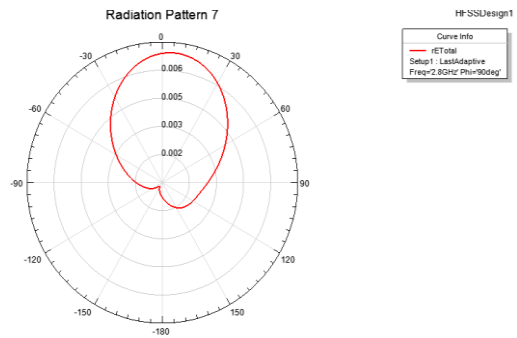


Fig. 4 Radiation pattern for $\phi=90$ deg. For (2.5GHz)

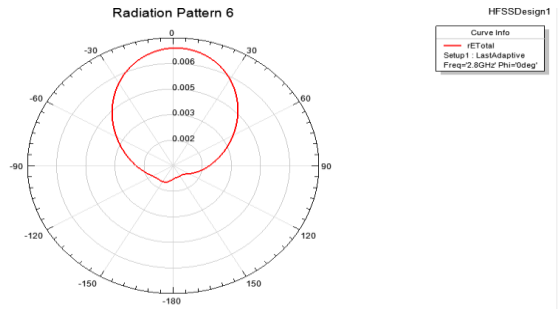


Fig. 5 Radiation pattern for $\phi=0$ deg. For (2.5GHz)

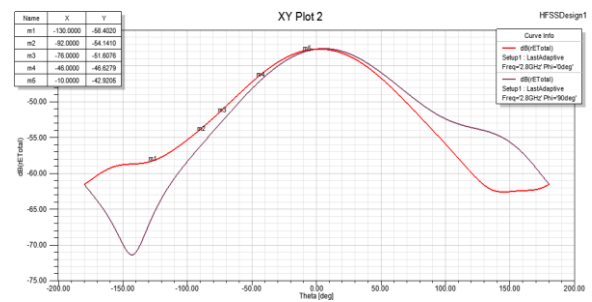


Fig. 6 Frequency response for (2.8GHz)

ii. Gain

The Frequency response of 2.5GHz show in the fig: 6 to develop frequency of long distance communication. The gain of an antenna is define as the ratio between the highest radiation intensity in a given direction to the highest radiation intensity from a reference antenna in the same direction, the achieved gain of the micro strip patch antenna is 9.8475 dB for 2.8GHz, where the figure 7 show the gain of the antenna.[7]

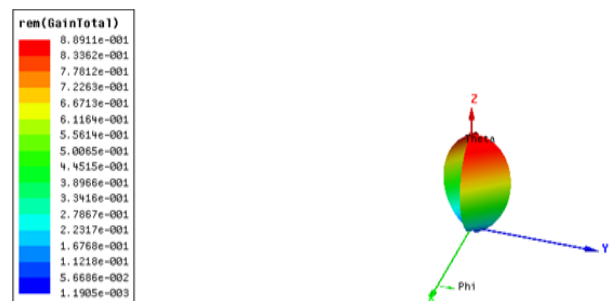


Fig. 7 Gain for (2.5GHz)



iii. Directivity

The directivity is a convenient way to measure the range of power conveyance in a specific direction. The figure 8 shows the directivity of the antenna it is defined as the ratio between the maximum radiation intensity to the average radiation intensity of the antenna, the achieved directivity of the micro strip patch antenna is 9.3172 dB for 2.8GHz.[7][8]

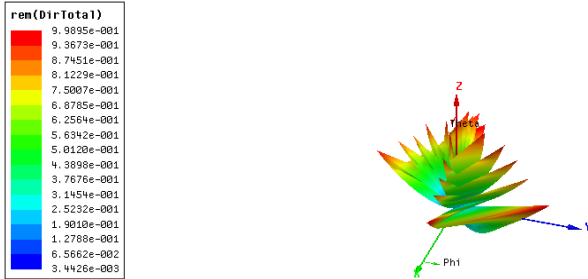


Fig. 8 Directivity for (2.5GHz)

iv. Realized Gain

The realized gain is the gain taking into the account the reflection losses at the input of the antenna in other words it is the ratio of power radiated to the power input to the antenna. The figure 9 and figure 10 shows the realized gain of the antenna is 7.3693 dB for 2.5GHz frequency range.[7]

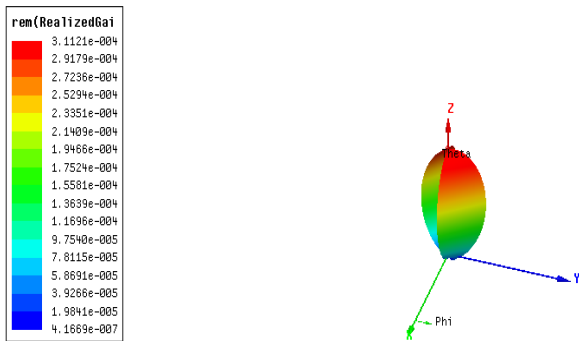


Fig. 9 Realized Gain for (2.5GHz)

v. Polarization

The divergence of a stimulating field is defined in terms of the direction of its electric field vector. If the electric field vector is always in one plane, then it is said to be linearly polarized.[8]

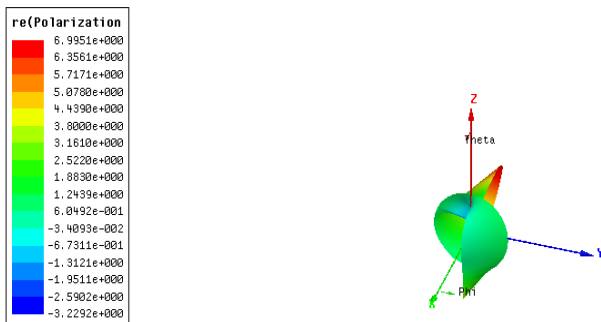


Fig. 10 Polarization for (2.5 GHz)

Table. 1 Micro strip patch antenna parameters for 2.5GHz Frequency range compare with Rogers RT/duriod 5880 and FR4 Epoxy

QUANTITY	Rogers RT/duriod 5880	FR4 Epoxy
Gain (dB)	9.8475	3.6475
Directivity(dB)	9.3172	3.6457
Peak gain(dB)	8.9800	4.3251
Peak directivity(dB)	9.9631	4.3622
Peak realized gain(dB)	3.1432	1.2356
VSWR	9.9998	3.6589
Radiation efficiency(dB)	1.6993	1.3691
Radiated power(dB)	1.7493	1.3254
Accepted power(dB)	1.0398	1.6537
Incident power(dB)	2.9706	1.3269
Realized gain(dB)	3.1121	2.0360
rE(dB)	7.4107	3.3213
Beam area	3.8172	1.2561

vi. VSWR

Another way to see how much may system is matched, VSWR can be used. VSWR is the ratio between the highest voltage and lowest voltage in the transmission line,[7] can be defined as follows: $VSWR = 1 + \rho / 1 - \rho$, where ρ is the magnitude of $|\Gamma|$. When the system is matched the reflection coefficient approaches 0, while VSWR approaches to 1.

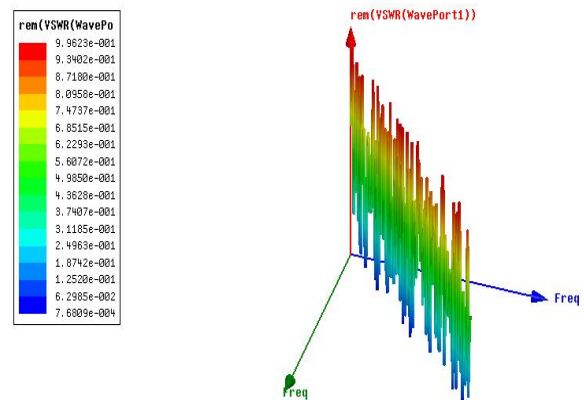


Fig.11 VSWR for (2.5GHz)

VII.CONCLUSION

The rectangular micro strip antenna was calculated and analyze with a frequency range of and 2.5GHz is imitation by using the Ansoft HFSS software.



The frequency response, radiation pattern are obtained, the designed antenna gain value is 8.8911 rem, directivity value is 9.9895rem and 3.1121rem for 2.5GHz, the polarization of the antenna is linearly polarized antenna for both the frequency ranges.

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