A Novel Circular Microstrip Patch Antenna With L-Strip Feed For WLAN Applications Using HFSS

Anil Kumar, Isha Puri.

***Abstract*---A work on the circular microstrip patch antenna with L-strip feed for WLAN applications is presented in the given paper. The proposed circular microstrip patch antenna is having cylindrical shapes for both ground as well as for the substrate of 8.5mm thickness and is working efficiently on newly introduced frequency of 5.9GHz for the WLAN applications. Ansoft HFSS is used for designing and simulation purpose. VSWR of value less then 2dB is obtained after running the simulation for VSWR at the resonating frequency of 5.9GHz. We can change the dimensions of the L-Strip feed and that of the patch for changing the resonating frequency as it depends upon the feed and the patch dimensions. Also the appreciative value is obtained for the bandwidth and gain of the antenna.**

Index Terms---Circular micro strip patch antenna, WLAN, Return loss, Bandwidth, VSWR.

I. INTRODUCTION

The twentieth century has seen the boom in the modern wireless communication system in which antenna is like the backbone for communication to take place. It is always desirable to have such antennas which have low profile, low cost, highly efficient and easy to install features. All these features are fulfilled by microstrip patch antennas and can easily fit to our demands. This is the reason that extensive work is going on to develop new methods and configurations to design highly efficient microstrip patch antennas. In the recent years several different types of microstrip patch antenna are designed and practically implemented in various communication systems. Recyangular [1] and circular [2] micro strip patch antennas are the widely studied microstrip antennas. There are mainly three types of models of analysis for micro strip patch antennas. These are the transmission line model [3], full wave model [4] and the cavity model [5]. in transmission line model micro strip antenna is represented as a two slots and a transmission line of low impedance is used to separate the two slots. Transmission line model is simple to design but is less accurate. Full wave model is which includes the integral equations is or the moments method is based on method of moments(MoM). The full wave models can be treated as single elements, stacked elements arbitrary shaped elements and are very versatile because of its accuracy. Out of these three models cavity model is the most precise one but its little difficult then the other two models to model. The substrate between the ground and the patch is treated as the cavity in the cavity model. The patch is kept circular in shape so we need to adjust only the radius of the patch to change the gain of the antenna whereas the dimension of the feed is changed for coupling energy more effectively from the feeding point up to radiating patch. It is seen that in case of circular micro strip patch antenna, more the distance is present between the radiating patch and the feeding point, more effectively the coupling of energy takes place. In this proposed work the circular micro strip patch antenna [7] is designed and is based on the cavity model. There is need of using L-strip micro strip feed to minimize the distance between the patch and the feeding point. Attractive and repulsive mechanisms are established to control the charge distribution on application of excitation in case of cavity model. The attractive mechanism is established between the opposite charges which are present on the bottom of the patch and on the surface of the ground whereas the repulsive mechanism is established between the same charges present at the bottom of the patch which pushes some of the charges along the edge and towards the top surface of the patch. Corresponding charge densities are established on the surfaces of ground and patch and thus resulting in radiations to take place.

II. DESIGN METHADLOGY

All the necessary theory regarding the basic concepts of the circular micro strip patch antenna is available in [6]. All the important formula regarding designing of the micro strip patch antenna is given in the flow chart below in a systematic manner. First of all we need to specify f_r, ε_r, h.

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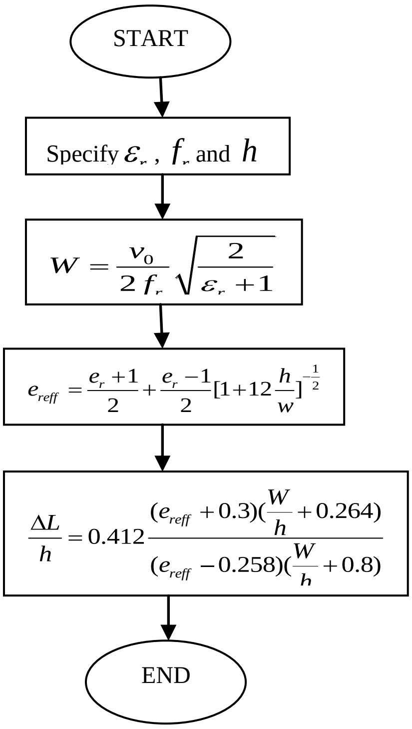
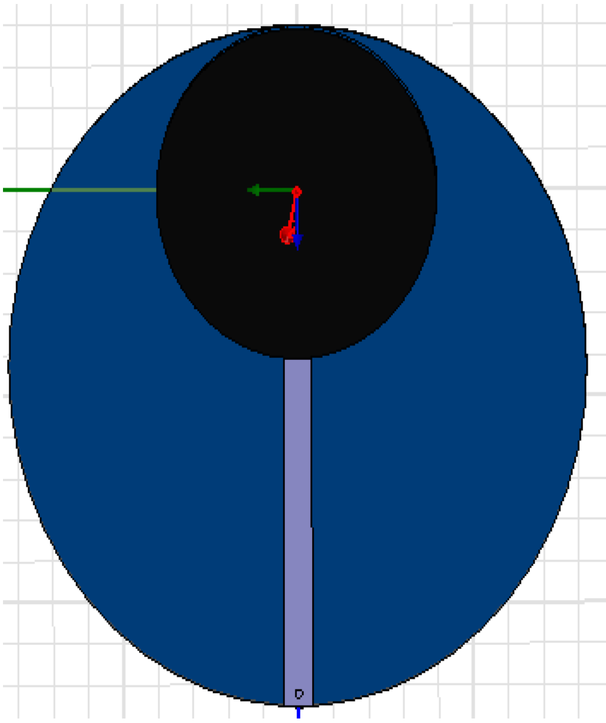


III. ANTENNA DESIGN AND GEOMETRY

A three layered structure of thickness 8mm is designed. First layer is of thickness S1=1.5mm, second layer S2=5mm and third layer S3=1.5mm. The L-strip feed [8] is used to reduce the spacing between the feed line and the patch. Underneath patch have the horizontal part of L-strip resulting in capacitance which helps to keep in check the inductance introduced due to the L-strip which is in ninety degree with horizontal L-strip. The top view of the designed antenna is shown in Figure.1



Fig

Figure1 Top View of Circular Microstrip Patch Antenna

First of all the ground of radius R=41.27mm is created over which the substrate one (S1) of radius R=41.27 and thickness S1 =1.5mm is drawn. The second layer of substrate consists of substrate two (S2) having a radius of 20mm and thickness of 5mm.The third and last layer of substrate which form the top most layer is of radius 20mm and is of thickness 1.5mm. The equivalent radius of the substrate and patch calculated from the formula of rectangular microstrip patch antenna (as given in the above flow chart) are considered to calculate the radius of the substrate and patch respectively. As it is important to provide the feeding pont as far as much from the radiating patch so the feeding point is provided at the extreme end of the feeed line at a distance of 61.0mm. The width of the feeding line is adjusted manually to provide the efficient coupling between the feeding point and the radiating patch. In this design the width of feeding line is 4mm. The impedence of the feed line is matched with 50 ohm standerd value of impedence for transmission line. The side view of the designed antenna is shown in Fig.2.

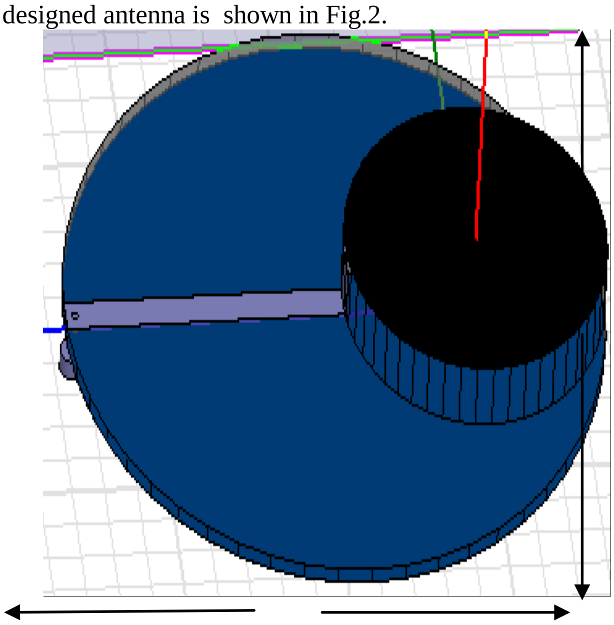


Figure 2:Side View of Circular Microstrip Patch Antenna

In the third figure the perfect E radiation formation is shown in the given circular microstrip patch antenna.

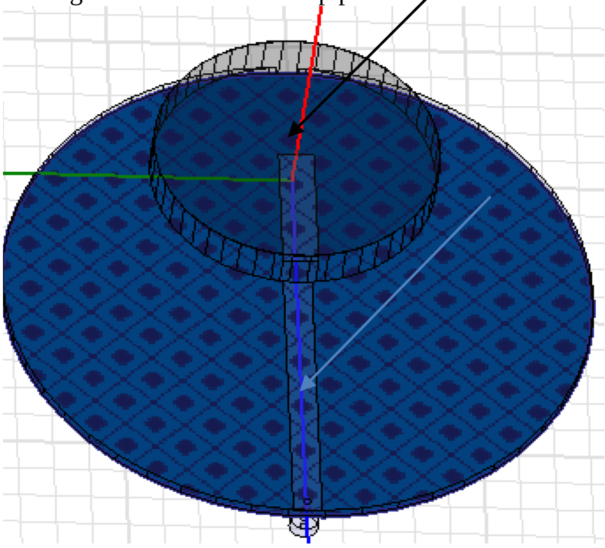


Figure 3 Prefect E Formation Inside the Circular Micro strip Patch Antenna

IV. FORMULA TO CALCULATE VSWR OF MICROSTRIP PATCH ANTENNA

As for good working of microstrip patch antenna the value of voltage standing wave ratio should be less than 2dB. VSWR value shows us that how efficiently our designed antenna is transmitting or receiving radio waves, that is, whether the matching of antenna with transmission line is properly done or not is given by VSWR. The VSWR and the reflection coefficient form a close relationship which is given by equation 1:

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|} \qquad (1)$$

Γ is called the Reflection Coefficient

In terms of -10dB impedance bandwidth , the formula for bandwidth calculation is given by the equation 2:

$$BW = f_h - f_l \qquad (2)$$

Percentage of the bandwidth is calculated by the given equation 3:

$$BW = \frac{f_h - f_l}{f_c} \times 100 \qquad (3)$$

Where f_h = uppermost frequency.

f_l = lowermost frequency.

f_c = frequency present at the centre between the uppermost frequency and the lowermost frequency.

V. SIMULATION AND RESULTS

Complete designing and simulations for the S11 parameter, VSWR, Gain and Radiation Pattern are carried out by use of Ansoft HFSS (high frequency structure simulator). The dimension for the radius of the ground as well for the substrate one are same that is 41.27mm and height of the substrate one is 1.5mm. The dimension of radius for the patch as well as for the substrate two and substrate three is same that is 20mm and combined height of the substrate two and substrate three is 6.5mm The simulation graphs are shown in Fig.4, Fig.5, Fig.6 and Fig.7.

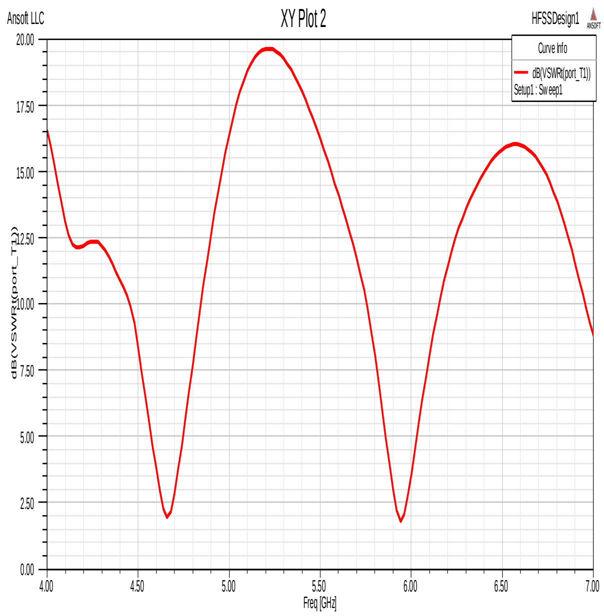


Figure 4 VSWR of Circular Microstrip Patch Antenna

In the above figure for VSWR the value of VSWR is less then 2dB that is for first operating frequency the the value of VSWR id 1.9dB and for second operating frequency the value is 1.5dB. As we know for microstrip patch antenna the value of VSWR should be les then 2dB which we have obtained in simulated results for the designed circular micro strip patch antenna.

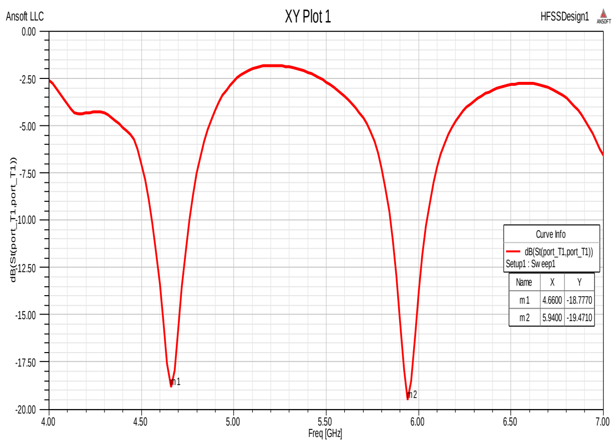


Figure 5 S11 Parameter of Circular Microstrip Patch Antenna

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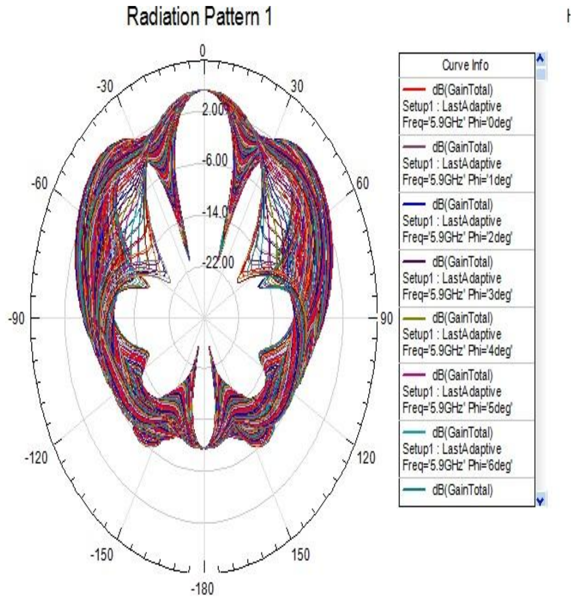

Figure 6 S11 Radiation Pattern of Circular Microstrip Patch Antenna

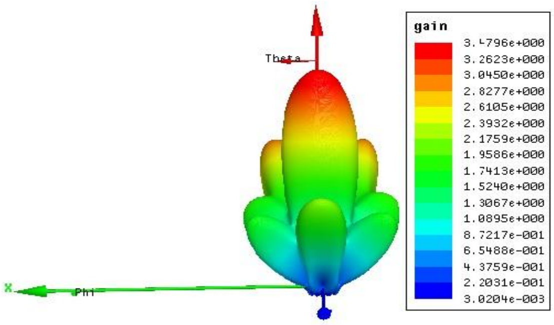

Figure 7 S11 Gain of Circular Microstrip Patch Antenna

VI. CONCLUSION

In this work circular micro strip patch antenna with cylindrical geometry of the substrate has been studied for newly introduced WLAN frequency of 5.9GHz. The resonating frequency is obtained at 5.9GHz showing that antenna is working at this frequency. Also optimum value of VSWR and bandwidth is obtained. In future we can increase the gain and bandwidth of the antenna by adapting proper slots inserting techniques.

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