Circular Polarization Microstrip Patch Antenna Using Coaxial Feed To Operate In L5-Band Application

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Abstract : **In wireless system communication antenna plays very important role. Therefore, it is very crucial that antenna used should be of minimum weight, minimum profile, minimum cost, minor in dimension and conformity. Hence it is proved that a miniature sized antennas such as microstrip antenna is best for effective communication. This paper, proposes an efficient wide band circular polarization microstrip antenna is designed and simulated at operation frequency 1.17 GHz. The antenna used is dual-fed circular polarized microstrip antenna whereas technique used is Coaxial feeding for easier implementation. The Fr4 was chosen as a substrate material for the designed patch antenna with a dielectric constant of 4.4, and a height of 3.2 mm. The software used for simulation of antenna and to find out the results is HFSS (high frequency structured simulator). We keep changing the design of antenna as our motive was to achieve miniature antenna with better results than conventional antenna's, simulation results shows that the designed antenna characteristic is suitable for satellite and wireless applications etc.**

IndexTerms - RHCP Circular Polarization , Dual Coaxial Probe Feeding, Circular Microstrip Patch Antenna, L5-band, HFSS.

1) INTRODUCTION

In Zoology, Antenna term is referred as a Feeler which means a part of insect organ used for touch. In Radio astronomy, it refers a metallic device which transmits or receives radio waves. As per The IEEE Standard (IEEE Std 145–1983) Antenna is "a means for radiating or receiving radio waves". Generally Speaking, any metallic body can act as antenna as all kind of metals has a n number of free electrons which on oscillation generates electromagnetic waves[1].

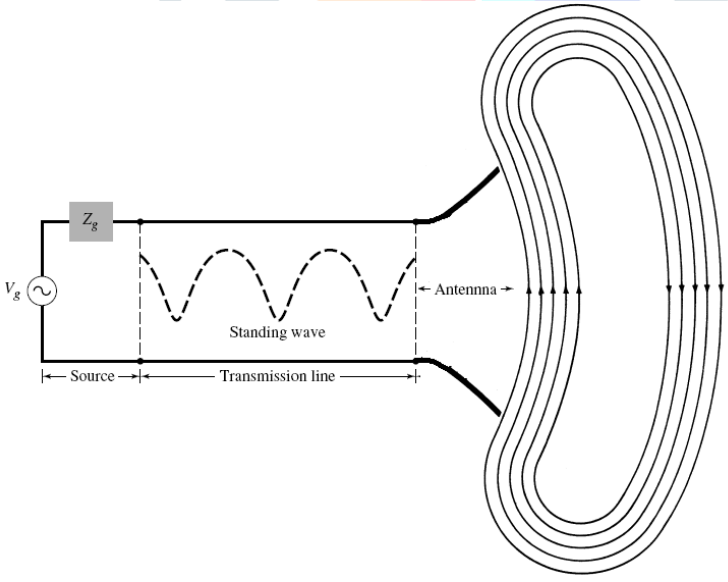

Figure 1:Antenna wave propagation with Transmission line system

In other words, the antenna is the transitional structure between free-space and a guiding device, Antenna is a transducer which acts as an impedance matching device between intrinsic impedance of free-space which is of 120Π with that of characteristic impedance 50 ohm of source cable or waveguide.

As per Maximum Power Transfer Theorem, if the Impedance of transmission line (cable) is matched with input impedance of antenna then maximum power will be delivered from source to antenna or can be received from the antenna. If there is mismatch in impedance of source and antenna then a standing wave pattern is appeared on the transmission line. This reflected wave is in out of phase with that of incident wave

which results in energy loss in the signal, as shown in Figure1. In such case antenna will act as storage element and not a radiating element.

There are several methods by which we can nullify above effect. One simple method is to use infinite length transmission line. In 1953, Deschamps first proposed the concept of printed Microstrip patch antenna. It was designed in 1970s by Munson & Howell. Because of the Micropatch Antenna's lowprofile structure they are very compatible in embedded Antena's which are used in wireless devices like mobile phones,pages etc, plus they are also used in Satellite Communication due to its light weight.

2) CIRCULAR PATCH ANTENNA

One of popular form of a patch antenna is the circular patch antenna, which has unique polarization properties due to its symmetry, and tends to have good beam width and return loss bandwidth when compared to a rectangle patch antenna. Circular patch antennas do not have the benefit of being circular polarized via one feed, the feed placement on the circumference of the patch will generate linear polarization, regardless of where it is placed; thus, requiring that a minimum of a second feed be added to create other polarizations. As circular patch antenna is designed for L5 band having resonant frequency 1.17645 GHz.

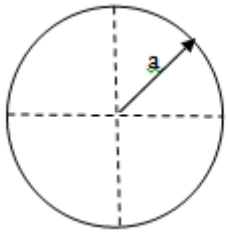

Figure 2.Circle with radius 'a'

$$f_o = \frac{8.791}{\left[\left(a + \frac{h}{\sqrt{\varepsilon_r}}\right)\sqrt{\varepsilon_e}\right]} GHz \quad (1)$$

Where a is radius of patch antenna which is in cm
f_o = resonating frequency of circular patch antenna
h is height of substrate which is in cm
consider $\varepsilon_e \leq \varepsilon_r$
Where ε_e is a effective dielectric constant and ε_r is a dielectric constant.

So, Design Equation for radius of circular path become

$$a \cong \frac{8.791}{\left(f_o\sqrt{\varepsilon_e} - \frac{h}{\sqrt{\varepsilon_r}}\right)} \quad (2)$$

3) SIMULATION OF CIRCULAR MICROSTRIP ANTENNA FOR L5 BAND

As per mathematical analysis of circular microstrip antenna for L5, we got all dimensions for designing and simulation in HFSS software. For L5 band dimensions are as below:

Table 1: Dimensions for patch antenna and ground plane

Sr. No.	Parameter	Dimension
1	Radius of Circular Patch (r)	34.86 mm
2	Dielectric Constant of FR4 Substrate	4.4
3	Height of Substrate	3.2mm
4	Dimension of Substrate (Ws × Ls)	120 mm × 120 mm
5	Dimension of Ground Plane (Wg × Lg)	120 mm × 120 mm

By following all simulation steps of HFSS software and using calculated dimensions, circular microstrip antenna look like shown in fig. 3

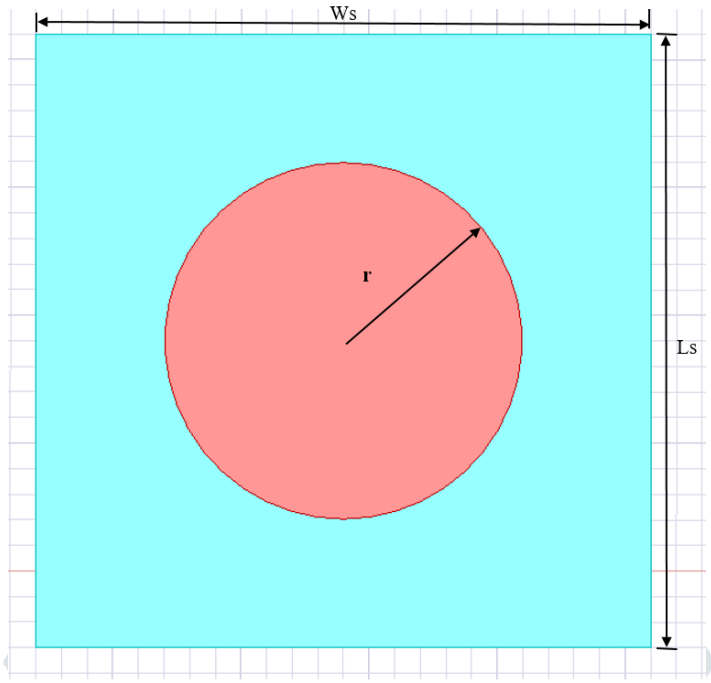

Figure 3. The configuration of the Dual-band antenna

4) RESULT FOR L5 BAND ANTENNA

The Microstrip patch antenna was designed and simulated using HFSS simulator. The performance of the antenna has been studied by comparing the Return loss, VSWR, Z parameter, Gain, azimuthal and elevation patterns.

Above structure is simulated in HFSS software and simulated results are described in next section.

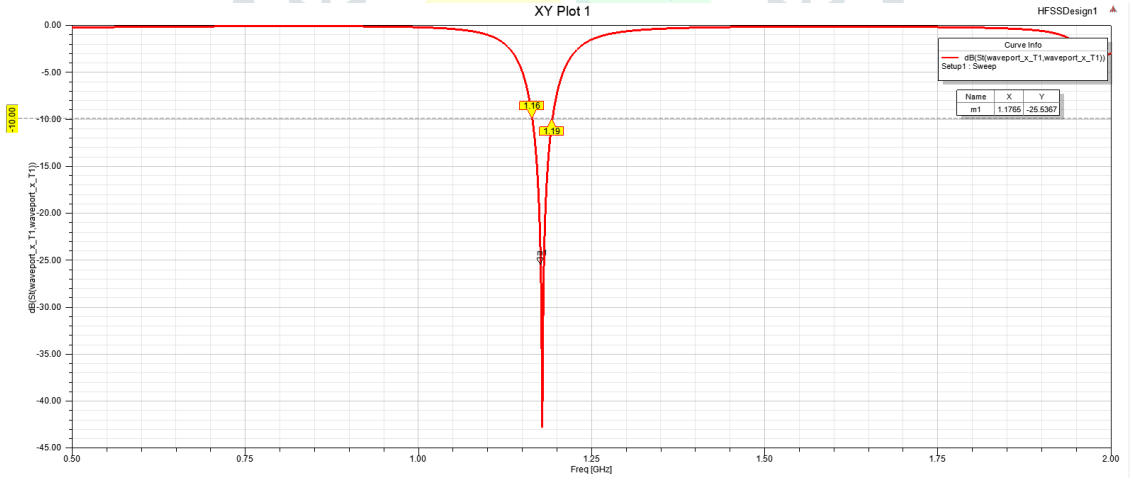

Figure 4. Return Loss (S11 in dB) Vs Frequency (GHz)

The return loss of the circular patch antenna can be seen in Figure 4 produced by HFSS software when the resonant frequency is equal to 1.17645 GHz. The coaxial feed used to design the circular patch antenna. The center frequency is always taken as 1, as the return loss is minimum at 1 Center Frequency. We have to consider minimum return loss as bandwidth has to be calculated from Return loss. The bandwidth of the antenna for this feed point location using HFSS software at fast EM optimization is seen to be 30 MHz and a center frequency of 1.17645 GHz is obtained which is the desired frequency of operation. It was observed from many trials of simulations that as the feed point location is moved away from the edge of the patch, the center frequency starts to decrease.

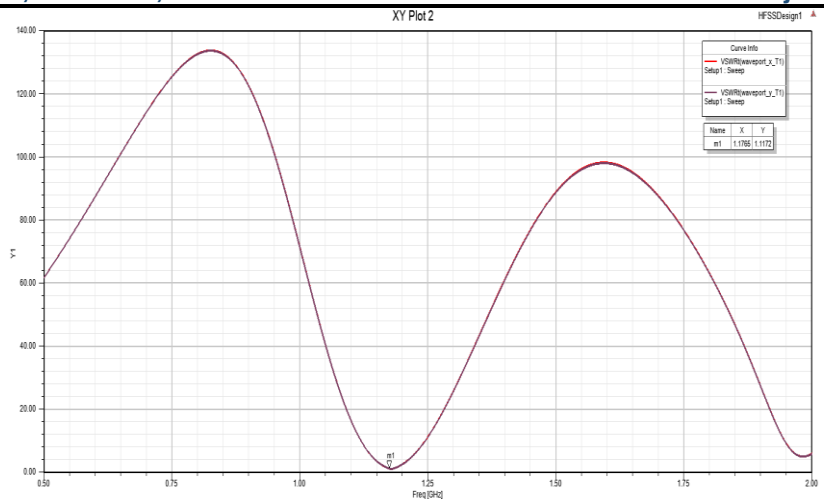

Figure 5. VSWR of proposed patch antenna at L5 band

The simulation results for Voltage standing wave ratio (VSWR) of Microstrip antenna for the frequency 1.17645GHz are shown in the. The value of VSWR can be seen to be within 1 to 2 in the operating range. In case of Microstrip patch antenna the value of VSWR is always less than 2. At Fr= 1.17645 GHz the value of VSWR is 1.172. This indicates very minimum standing waves are formed and hence antenna is acting like a good transmitter.

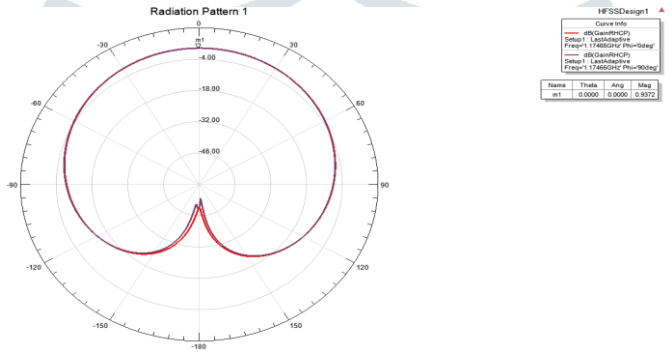

Figure6:Radiation Pattern (2D) RHCP of the Antenna at L5 band

Fig. 6 show radiation pattern of L5 band antenna. At 00 antenna gain is 0.9327dB. As we go 3dB below main lobe, it will give us Half Power Beam Width (HPBW)

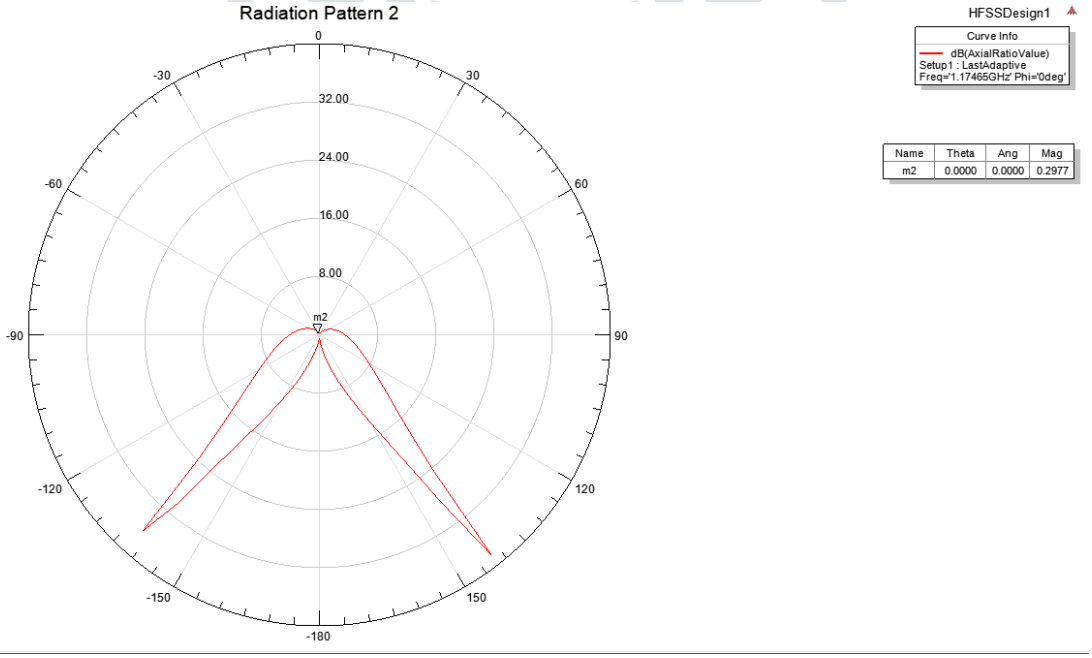

Fig. 7. Axial Ratio of the Antenna at L5 band

The axial ratio gives the ratio of electric field along the x and y directions. In order to obtain circular polarization, the axial ratio should be 3dB or less than that 3dB. we can get 0.2977dB axial ratio which shown in figure 7. this shows antenna is acting as circular polarization.

5) CONCLUSION

Table 2: Circular microstip patch antnna using HFSS software

Sr. No.	Parameters	Values
1	Return loss S11	-25.5367 dB
2	VSWR	1.1172
3	Bandwidth	30MHz
4	Gain	0.9372 dB
5	Axial Ratio	0.2977 dB
6	HPBW (degree)	98.6788^0

The proposed antenna is a single band microstrip patch antenna whose resonant frequencies are 1.17645 GHz. Also the return loss and VSWR are appreciable. The maximum gain is also good and the bandwidth covers good fraction of L5 band. The simple coaxial feeding technique has been used for antenna design which makes this antenna as a good receiver in many communication applications. After the complete examination it is observed that the features and many parameters of antenna proposed are significantly improved plus it has obtained dual band for L5 and s band frequency. Bandwidth is also acceptable for both bands. So we can say that clearly this antenna is perfect for L5-Band applications such as radar communication, military communication.

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