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CIRCULAR POLARIZATION DUAL FEED MICROSTRIP PATCH ANTENNA WITH 3dB HYBRID COUPLER FOR WLAN (2.4GHZ)

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ABSTRACT: *Microstrip patch antennas represent one family of compact antennas that offer a conformal nature and the capability of ready integration with communication system's printed circuitry. In this project, a 2.4 GHz circular polarization microstrip antenna is designed, constructed and measured. The selected microstrip antenna is a dual –fed circular polarized microstrip antenna. The antenna consists of square patch and 3 dB hybrid coupler. The dual – fed circular polarized microstrip antenna is etched on a FR4 with dielectric substrate of 4.6 with the height of 1.6 mm. Circular polarization is obtained when two orthogonal modes are equally excited with 90° phase difference between them. Circular polarization is important because regardless of the receiver orientation, it will always be receiving a component of the signal. This is due to the resulting wave having an angular variation.*

KEYWORD:*MICROSTRIP,CIRCULAR POLARIZATION*

I. INTRODUCTION

Microstrip antenna technology began its rapid development in the late 1970s. By the early 1980s basic microstrip antenna elements and arrays were fairly well established in terms of design and modelling. In the last decades printed antennas have been largely studied due to their advantages over other radiating systems, such as light weight, reduced size, low cost, conformability and possibility of integration with active devices. Therefore, this project is aimed to design a circularly polarized antenna at 2.4 GHz. The main advantage of using circular polarization is that regardless of receiver orientation, it will always receive a component of the signal. This is due to the resulting wave having an angular variation. This microstrip antenna consists of a radiating patch on the dielectric substrate. There are various shapes that can be used as the radiating patch. However, for this project, square patch with 3 dB hybrid will be designed. With dual feeding methods, two orthogonal modes are equally excited with 90° phase difference between them, thus the antenna will polarize circularly. The microstrip antenna is simulated using Advanced Design System, where electromagnetic analysis tools will be used. The design is fabricated and tested with spectrum analyzer. Both simulated and measured results will be compared.Wireless LAN can be used either to replace wired LAN or as an extension of the wired LAN infrastructure. There are in general two types of antennas for WLAN applications, fixed WLAN base stations or access points, and the other is for mobile communication terminals. For base station applications, impedance matching for WLAN bandwidth should be better than 1.5:1 VSWR or about 14 dB return loss, similar to the cellular system base station. Antenna that capable to excite circular polarization is very attractive because it can overcome the multipath fading problem, thus enhance the system performance, especially indoor WLAN operation. Currently, the most commonly used WLAN system is the IEEE 802.11b System. A key requirement of WLAN system is that it should be low profile, where it is almost invisible to the user. For this reason, the microstrip patch antennas are the antennas of choice for WLAN use due to

their small real estate area and the ability to be designed to blend into the surroundings. The objective is to design, simulate, and fabricate a circular polarization microstrip antenna at 2.4 GHz frequency using dual feed techniques.

II. DIRECTIONAL COUPLER

Generally branch-line couplers are 3dB, four ports directional couplers having a 90° phase difference between its two output ports named through and coupled arms. Branch-line couplers (also named as Quadrature Hybrid) are often made in microstrip line form. Power dividers and directional couplers, are passive devices used in the field of radio technology such as power division or power combining. A 3 dB, 90° hybrid coupler is a four-port device,

that is used either to equally split an input signal with a resultant 90° phase shift between output signals or to combine two signals while maintaining high isolation between them. The hybrid coupler, or 3 dB directional coupler, in which the two outputs are of equal amplitude, takes many forms. It is beginning when quadrature (90 degree) 3 dB coupler coupling with outputs 90 degrees out of phased. Now any matched 4-port with isolated arms and equal power division is called a hybrid or hybrid coupler. Today the characterizing feature is the phase difference of the outputs. If 90 degrees, it is a 90 degree hybrid. If 180 degrees, it is a 180 degree hybrid. This terminology defines the power difference in dB between the two output ports of a 3 dB hybrid. In an ideal hybrid circuit, the difference should be 0 dB.However, in a practical device the amplitude balance is frequency dependent and departs from the ideal 0 dB difference. All 90° Power Dividers/Combiners, also known as quadrature hybrids or simply quad hybrids, are reciprocal four port networks.

III. CIRCULARLY POLARIZED (CP) PATCH ANTENNA

A singly – fed circular polarization may be regarded as one of the simplest radiators for exciting circular polarization. The typical configurations of this antenna are shown in Figure 1. The generated mode in this case is usually excited in an electrically thin cavity region of the microstrip antenna. The operational principle of this antenna is based on the fact that the generated mode can be separated into two orthogonal modes by the effect of a perturbation segment such as slot or other truncated segment. Consequently, by setting the Perturbation segment to the edge of the patch, the generated mode is separated into two orthogonal modes 1 and 2.

The fundamental configurations of a dual – fed CP patch antenna are shown in Figure 1.

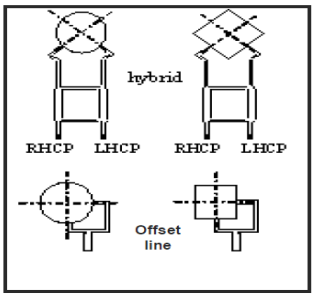


Figure 1 Dual – fed CP Patch Antenna

IV. DESIGN OF MICROSTRIP PATCH AND HYBRID COUPLER

We have chosen a substrate FR4 with the following specification, Height of the substrate = 1.6mm, Dielectric Constant=4.6,Frequency=2.4GHz

Microstrip patch design: The microstrip patch antenna consists of a patch and a 3 dB hybrid coupler. The square patch is chosen because it simplifies analysis and performance prediction. The circularly polarized antenna is designed to operate at 2.4 GHz with input impedance of 50Ω, using FR4 (ε_r = 4.6) and height (h) of 1.6mm.

Parameters of 3dB Hybrid Coupler in Schematic

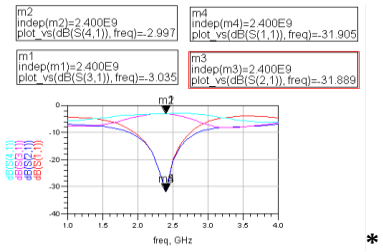
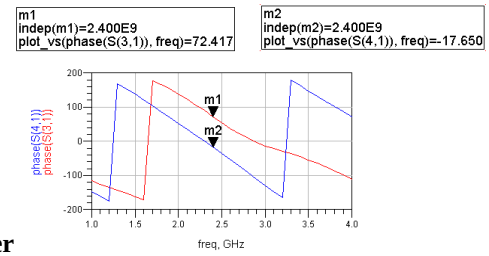


Figure 5 Parameters of 3dB Hybrid Coupler

The above Fig shows the graph of all the ports for the hybrid coupler at frequency 2.4GHz.



Phase Difference of Hybrid Coupler

Figure 6 Phase between port 1 and port 4 at 2.4GHz Hybrid Coupler

The Fig shows the phase difference between the two output ports which is about 90.067^0 and very close to 90^0at frequency 2.4GHz.

Layout of 3dB Hybrid Coupler

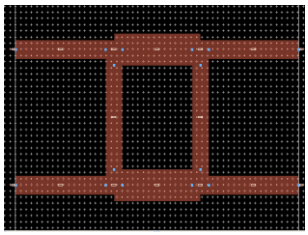
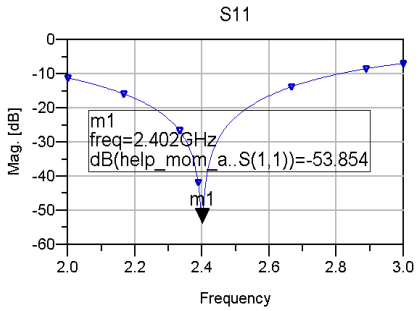


Figure 7 Layout of 3dB Hybrid Coupler



Return loss

Figure 8 Return loss of 2.4GHz Hybrid Coupler in Layout

In the above Fig, the return loss measured is **-53.854.**

Parameters of 3dB Hybrid Coupler in Layout

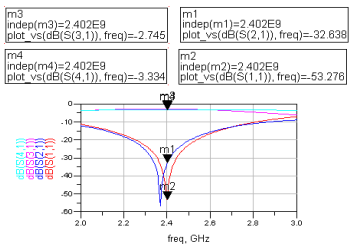


Figure 9 Parameters of 3dB Hybrid Coupler in Layout

The above Fig shows the graph of all the ports for the hybrid coupler at frequency 2.4GHz.

Phase Difference of 3dB Hybrid Coupler

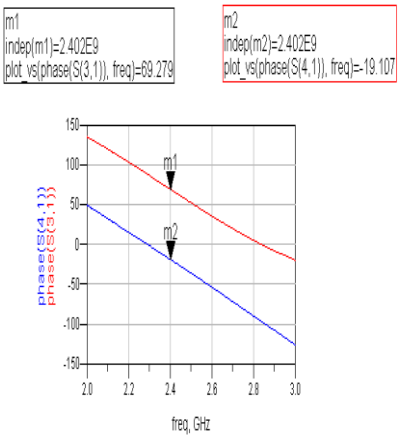


Figure 10 Phase between port 1 and port 4 at 2.4GHz Hybrid Coupler

The Fig shows the phase difference between the two output ports which is about 88.38^0 and very close to 90^0at frequency 2.4GHz.

Simulation of Patch Antenna

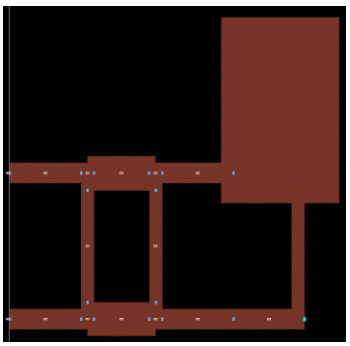


Figure 11 stimulation of patch antenna

Return loss of Patch Antenna

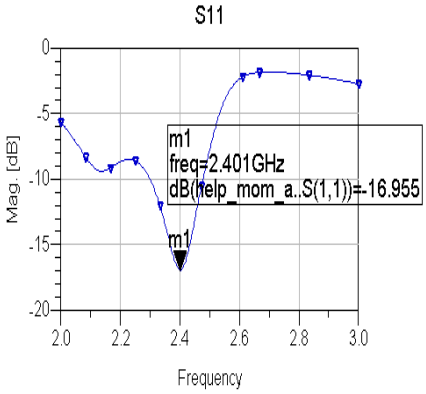


Figure 12 Return loss of Patch Antenna

In the above Fig, the return loss measured is **-16.955.**

3D Radiation Pattern of Patch Antenna

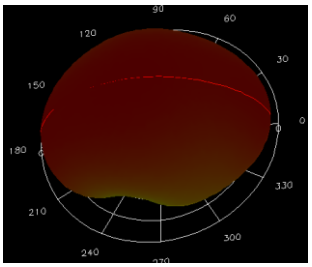


Figure 13 3D Radiation Pattern of Patch Antenna

2D Radiation Pattern of Patch Antenna

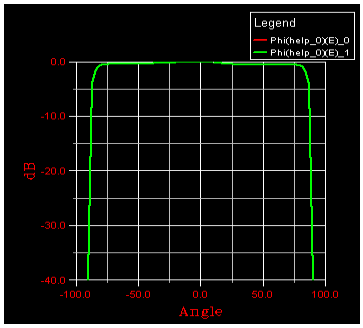


Figure 14 2D Radiation Pattern of Patch Antenna

In the above graph, the beam width measured is 170 deg

V I FABRICATED PATCH ANTENNA

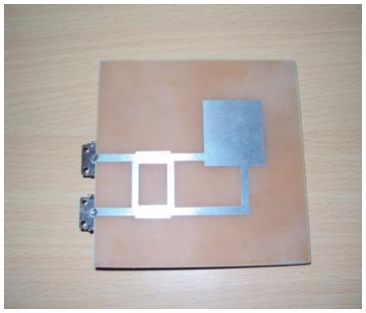


Figure 15 Fabricated Patch Antenna

RETURN LOSS AT 2.4GHz WITH SPECTRUM ANALYZER

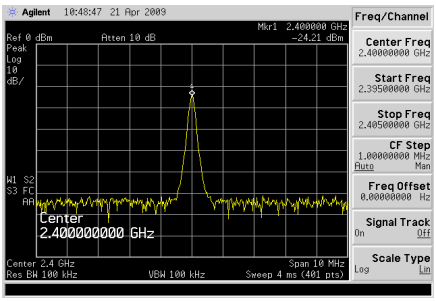


Figure 16 Return Loss

VII. CONCLUSION

There is various type of microstrip antenna that is able to excite a circular polarization. For this project, dual – fed circular polarization microstrip antenna is chosen. The microstrip antenna is design to operate at 2.4 GHz frequency. The dual –fed circular polarization microstrip antenna is successfully implemented and fabricated. The microstrip antenna resonates at 2.47 GHz and gives a good return loss, which is -23.25 dB. This is a good value because only 0.47 % power is reflected and 99.53 % power is transmitted. The VSWR of the microstrip antenna is 1.2:1, which shows that the level of mismatched for the microstrip antenna is not very high. High VSWR

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