Circularly Polarized Patch Antenna for PCS and WLAN

Ashwini Sawant1 Prof. M. M. Wankhade2 Prof. S. B. Takale3
1P.G. Student 2,3Assistant Professor
1,2,3Department of Electronics & Telecommunication Engineering
1,2,3SCOE, Pune, Maharashtra, India

Abstract— Due to development in wireless devices, it poses a new challenge for the design of an antenna in wireless communication. Patch antennas are well suited for various wireless application systems due to their low weight, low profile, versatility, conformability, low cost and low sensitivity to manufacturing tolerances. This paper present design, simulation of a rectangular micro strip antenna for WLAN and PCS. The aim of the work is to design compact, circularly polarized, dual band patch antenna for wireless devices.

Key words: Circular Polarization, Dual Band, HFSS, Wireless Communication, WLAN, PCS, Ansoft HFSS

I. INTRODUCTION

Communication between humans was first by sound through voice. With the desire for slightly more distance communication came, devices such as drums, then, visual methods such as signal flags and smoke signals were used. These optical communication devices, of course, utilized the light portion of the electromagnetic spectrum. One of human kind’s greatest natural resources is the electromagnetic spectrum and the antenna has been instrumental in harnessing this resource.

Developments in LAN, Wireless LANs are being setup in home and offices it becomes more affordable. A wireless LAN is a flexible data communication network used as an alternative for a wired LAN [2]. Primarily they are used in industrial sectors where employees are on the move, in temporary locations or where cabling may hinder the installation of wired LAN. The increasing popularity of indoor wireless LAN capable of high-speed transfer rate is prompt the development of efficient broadband antenna. The broadband antennas are required to be low-profile, directive, compact with high transmission efficiency and designed to be discrete. Due to these requirements coupled with the ease of manufacture and repeatability makes the micro strip patch antennas very well suited for broadband wireless applications.

Rapid development in wireless communication system increases the demand of compact micro strip antenna with high gain and wide operating frequency. Micro strip antenna is more popular because it has advantages like low profile, conformal, light weight, low manufacturing cost and simple realization process, so it is also used in cellular phone, pagers, etc [1]. But it suffered from narrow bandwidth and polarization; therefore various techniques are used to improve the bandwidth of antenna [2] and to get circular polarization [9]. These includes decrease substrate permittivity, cutting slot on patch, increase patch height, use of various impedance matching techniques, feeding techniques and use of multiple resonators. In this paper we design a patch antenna for circular polarization and dual band [6] with compact size. It is having co-axial feeding, design on glass epoxy substrate to give wide bandwidth and maximum gain as well as radiating efficiency [3]. The proposed patch antenna is designed and simulated on ANSOFT HFSS software. This antenna is suitable for PCS (Personal Communication System) and WLAN (Wireless Local Area Network) system.

II. BACKGROUND

All radios, whether transmitting or receiving, require some sort of antenna. The antenna accepts power from the transmitter and launches it into space as electromagnetic or radio wave. At the receiving end of the circuit, a similar antenna collects energy from the passing electromagnetic wave and converts it into an alternating electric current or signal that the receiver can detect. According to their applications and technology available, antennas generally fall in one of two categories:

− Omni directional Antennas
− Directional Antennas

A micro strip antenna consists of conducting patch on a ground plane separated by dielectric substrate. This concept was undeveloped until the revolution in electronic circuit miniaturization and large-scale integration in 1970. The early work of Munson on micro strip antennas for use as a low profile 2 flush mounted antennas on rockets and missiles showed that this was a practical concept for use in many antenna system problems. Various mathematical models were developed for this antenna and its applications were extended to many other fields. The micro strip antennas are the present day antenna designer’s choice. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch can take any shape but rectangular and circular configurations are the most commonly used configuration. Other configurations are complex to analyze and require heavy numerical computations. A micro strip antenna is characterized by its Length, Width, Input impedance, and Gain and radiation patterns. The length of the antenna is nearly half wavelength in the dielectric [8]; it is a very critical parameter, which governs the resonant frequency of the antenna. There are no hard and fast rules to find the width of the patch.

Dual-frequency operation [12] is an important subject in micro strip antenna design. These dual-frequency micro strip antennas include the use of multilayer stacked patches, a rectangular patch with a pair of narrow slots placed close to the patch’s radiating edges, a square patch with a rectangular notch, a rectangular patch loaded with shorting pins and slots, a rectangular patch fed by an inclined coupling slot.

Fig. 1: Structure of Patch antenna [8]
The major advantage of single-feed, circularly polarized microstrip antennas is their simple structure, which does not require an external polarizer. They can, therefore, be realized more compactly by using less board space than do dual-feed, circularly polarized microstrip antennas. Many designs of single-feed, circularly polarized microstrip antennas with square or circular patches [12] are there. Various CP designs with a compact patch size at a fixed operating frequency have been reported. The compact CP techniques used include embedding a cross-slot of unequal arm lengths, embedding a Y-shaped slot of unequal arm lengths, inserting slits or spur lines at the patch boundary, truncating patch corners or tips, introducing small peripheral cuts at the boundary of a circular patch, adding a tuning or a bent tuning stub, among others. For feeding these compact CP designs, a probe feed or an edge-fed microstrip-line feed can be used. A compact CP design using a 50Ω inset microstrip-line feed is also used. In this case, the main problem to be solved arises from the perturbation effects caused by the inset microstrip line on the excited patch surface currents, which makes it difficult for the excitation of two orthogonal near-degenerate resonant modes for CP radiation. Several possible designs for solving this problem have been reported and details of the designs applied to a corner-truncated square and diagonal feeding signal to microstrip antenna.

To enhance the bandwidth of an antenna numbers of techniques are available:
1) Slotted patch
2) Multiple Resonator
3) Low dielectric constant
4) Increase in substrate thickness.

III. ANTENNA DESIGN

Analysis of an antenna can be done by basically three type of model analysis [8].
1) Transmission-line model.
2) Cavity Model analysis.
3) Full wave analysis.

In transmission-line model rectangular microstrip antenna can be represented as an array of two radiating narrow apertures (slots), each of width w and height h, separated by a distance L, while in cavity model microstrip antenna by two slots, separated by a low-impedance Zc transmission line of length L.

For proposed antenna analyzed by transmission-line model [8], W and L are width and length of patch respectively, h is height of substrate, ϵr is dielectric constant, fr is a resonant frequency, ϵreff is effective dielectric constant. When L/h >> 1 fringing is reduced. W/h>> 1 and ϵr >>1 the electric field lines concentrate mostly in the substrate.

\[ \frac{W}{h} > 1 \]

\[ \epsilon_{reff} = \frac{\epsilon_{r} + 1}{2} + \frac{\epsilon_{r} - 1}{2} \left( 1 + 12 * \frac{h}{W} \right)^{-0.5} \quad \cdots (1) \]

\[ \frac{\Delta L}{h} = 0.412 * \left[ \frac{(\epsilon_{reff} + 0.3) \cdot \frac{W}{h} + 0.264}{\epsilon_{reff} - 0.258} \right] \quad \cdots (2) \]

\[ \text{Leff} = \frac{1}{2 \cdot \epsilon_{r} \cdot \sqrt{\mu_{r} \cdot \epsilon_{reff}}} - 2 \Delta L \quad \cdots (3) \]

\[ W = \frac{1}{2 \cdot \epsilon_{r} \cdot \sqrt{\mu_{r} \cdot \epsilon_{reff}}} \quad \cdots (4) \]

\[ L = \text{Leff} - 2 \Delta L \quad \cdots (5) \]

Fig. 2 shows that geometry of proposed antenna, patch has length L=33.2mm and width W=25.5mm, ground plane has length L1=50mm and width W1=50mm, slot or perturbation area has length L2=9mm and width W2=9mm. F is a feeding point on a patch.

**Fig. 2: Proposed Antenna.**

The software used to model and simulate microstrip patch antenna is HFSS. HFSS is a high performance full-wave electromagnetic field simulator for arbitrary 3D volumetric passive device modeling that takes advantages of the familiar Microsoft windows graphical interface [10]. It integrates simulation, visualizations, solid modeling and automation an easy to learn environment where solution of 3D problems are quickly and accurately obtained. Ansoft HFSS, [11] employs the Finite element method, adaptive meshing and brilliant graphics for performance. Ansoft HFSS used to calculate parameters such as S-parameters, resonant frequency, fields, etc.

IV. RESULT AND DISCUSSION

An antenna is simulated in a HFSS. Fig. 3 shows the structure of antenna in 3D model. It consists of patch having slot above to substrate and ground is below to substrate. It was assigned with air box boundary and virtual radiation to create far field radiation pattern and assigned with excitation.

**Fig. 3: Design of patch antenna (1) in a HFSS**

Fig. 3 shows that the simple patch antenna feed at diagonal simulated in HFSS. Fig.4 shows return loss of an antenna. From these two figure we conclude that if patch not having slot on it, it is well resonate at only one frequency. When we calculate bandwidth it is also less as compare to next one.
Here in this case we are getting circular polarization but not well dual frequencies. To achieve circular polarization antenna feed diagonally such that axial ratio should be near about 1. When axial ratio is more or infinity then polarization type is getting linear polarization.

In next case addition of slot with changing the dimension of slot like l=0, 0.5, 1, 1.5, 9mm. As slot dimension is increases bandwidth increases simultaneously, it also affect on the resonant frequencies.

For slotted antenna design VSWR value is also near about ideal i.e. 1.

Addition of slot also affect on bandwidth of an antenna. Fig. 8 shows the output parameter axial ratio graph which shows that it is having less value.

Circular polarization is an important parameter of an antenna. The main achievement of a design is compact, multiband, circular polarized with large bandwidth antenna.

So here we conclude that to enhance bandwidth slot on patch is required which also reduces size of patch. When patch is feed along the axis it is not giving proper result. To achieve circular polarization patch feed with single source diagonally. Size also reduces by addition of slot on patch.

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**REFERENCES**


