# Design, Fabrication and Performance Analysis of Microstrip Patch Antennas for Wireless Applications

**Miss. Sontakke Monika Dagadu[1] Mrs. N. V. Bhosale[2]**
[2]Guide
[1,2]Department of Electronics & Telecommunication Engineering
[1,2]TPCT's college of Engineering, Osmanabad, India

*Abstract*— Wireless communications has been developed widely and rapidly in the modern world especially during the last two decades. The future development of the personal communication devices will aim to provide image, speech and data communications at any time, and anywhere around the world. This indicates that the future communication terminal antennas must meet the requirements of multi-band or wideband operations to sufficiently cover the possible operating bands. However, the difficulty of antenna design increases when the number of operating frequency bands increases within a single antenna. The aim is to study and design various rectangular microstrip patch antennas for wireless communication systems and study the effect of various antenna parameters like patch length (L), patch width (W), substrate relative dielectric constant, substrate thickness etc. Here CPW feed and microstrip line feed methods have been used to excite the patch antenna.

***Keywords:*** Fabrication, Microstrip Patch Antennas, Wireless Applications

## I. INTRODUCTION

The last few years, the development of WLAN represented one of the principal interests in the information and communication field. To the study and design various rectangular microstrip patch antennas for wireless communication systems and study the effect of various antenna parameters like patch length (L), patch width (W), substrate relative dielectric constant, substrate thickness etc.Here CPW feed and microstrip line feed methods have been used to excite the patch antenna. A MPA consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 3.1.The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate.

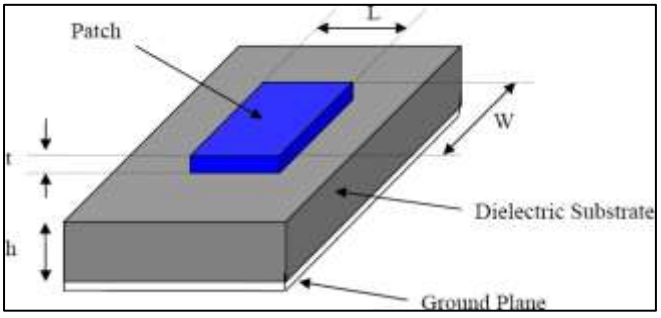


Fig. 1: Structure of microstrip patch antenna

## II. OBJECTIVE:

The project's objectives can be summarized as:

- To study the microstrip patch antenna: properties, design and performance.
- To design and analysis of traditional microstrip patch antenna at 2.4GHz.
- To enhanced bandwidth and remove harmonics of traditional patch antenna using Defected Ground Structure (DGS) techniques.
- To design and analysis of Proposed electromagnetically coupled microstrip antenna at 2.4GHz.
- To compare performance between traditional microstrip and proposed electromagnetically coupled DGS microstrip patch antenna.
- To implement the microstrip antenna with electromagnetically coupled DGS techniques with harmonic reduction for WLAN Applications.

### *A. Advantages and Disadvantages of Microstrip Patch Antenna*

Microstrip patch Antennae are increasing in popularity for use in wireless applications due to their lowprofile structure. Therefore they are extremely compatible for embedded antennae in handheld wireless devices such as cellular phones, pagers etc. The telemetry and communication Antennae on missiles need to be thin and conformal and are often Microstrip patch antennae. Another area where they have been used successfully is in Satellite communication.
The principle advantages are given below:

- Light weight and low volume.
- Low profile planar configuration that can be easily made conformal to host surface.
- Low fabrication cost, hence can be manufactured in large quantities.
- Supports both, linear as well as circular polarization.
- Can be easily integrated with microwave integrated circuits (MICs).
- Capable of dual and triple frequency operations.
- Mechanically robust when mounted on rigid surfaces. Microstrip patch Antennae suffer from a number of disadvantages as compared to conventional Antennae.

Some of the disadvantages are given below:

- Narrow bandwidth
- Low efficiency
- Low Gain
- Extraneous radiation from feeds and junctions
- Poor end fire radiator except tapered slot Antennae
- Low power handling capacity
- Surface wave excitation

 

## III. LITERATURE REVIEW

The concept of Microstrip radiators was first proposed by Deschamps in 1953.A patent was issued in France in 1955 in the names of Gutton and Baissinor. However 20 years passed before practical antenna ware fabricated. Development during 1970's was accelerated by the availability of good substrate with low loss tangent and attractive thermal and mechanical properties, improved photolithographic techniques, and better theoretical models. The first practical antenna was developed by Howell [1] and Munson [2]. Since then extensive research and development on microstrip antennas aimed at exploiting their advantages.

### *A. Dual-Frequency Patch Antennas*

A dual frequency patch antenna provide a large-bandwidth planar antennas, in applications in which large bandwidth is really needed. Here single antenna operated at two separate transmit- receive bands. When the two operating frequencies are far apart, a dual-frequency patch structure can be conceived to avoid the use of separate antennas. This paper discusses about various antenna. Orthogonal mode dual-frequency patch antennas, Multi-patch dual frequency antennas and reactively loaded dual-frequency patch antennas.

### *B. CPW-fed Slot Patch Antenna for 5.2/5.8GHz WLAN Application*

This paper represent CPW-fed patch antenna with slots. The antenna consists of patch structure with two rectangular slots on it. The physical size of the proposed antenna is 30mm x 24mm. The impedance bandwidth of the proposed antenna is 4.1GHz ranging from 4.8GHz to 8.9GHz and has a fractional bandwidth of 60%. The proposed CPW-fed slot patch antenna produces a 30% higher bandwidth compared to the conventional CPW fed patch antenna. The antenna is resonating at 5.5GHz and gives monopolar radiation pattern at this frequency. This antenna can be used in 5.2GHz/5.8GHz WLAN application.

### *C. Microstrip Patch Antenna with Skew-f Shaped DGS for Dual Band Operation*

The goal of this paper is to use DGS in microstrip antennas for dual band operation at microwave frequencies. The soft nature of the DGS facilitates improvement in the performance of microstrip antennas. A design study on microstrip patch antenna with specific DGS slot has been presented. A SMPA has been designed for broadband behaviour, and then skew-F shaped DGS has been integrated with a detailed study of possible DGS slots in a small area for dual band operation.

## IV. PROBLEM FORMULATION

- A new efficient and accurate method of analysis of the circular microstrip patch antenna on spherical surfaces, that permit analysis of the arrays of such elements, is presented.
- Viewing space as a spherical waveguide, the circular microstrip antenna performance analysis is viewed as a spherical waveguide junction discontinuity problem and solved.
- Enforcing all the boundary conditions, the far zone broadside radiated field expression is derived.
- Numerical computation of this field provides the patch resonant frequency. The role of creeping waves in the substrate region is stated.

## V. METHODS OF ANALYSIS

The most popular models for the analysis of Microstrip patch antennas are the transmission line model, cavity model, and full wave model (which include primarily integral equations/Moment Method) [35]. The transmission line model is the simplest of all and it gives good physical insight but it is less accurate. The cavity model is more accurate and gives good physical insight but is complex in nature.

### *A. Transmission line model*

This model represents the microstrip antenna by two slots of width W and height h, separated by a transmission line of length L. The microstrip is essentially non-homogeneous line of two dielectrics, typically the substrate and air.

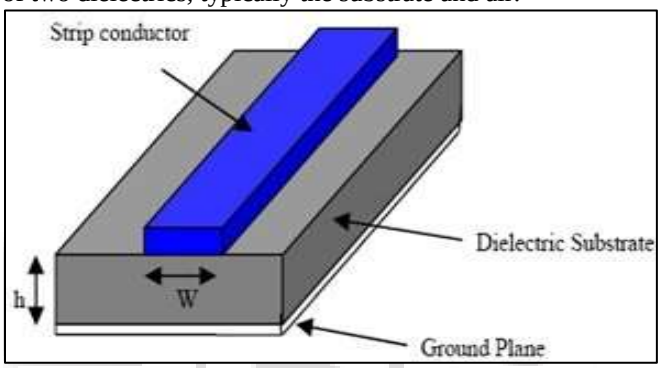


Fig. 1: Microstrip line

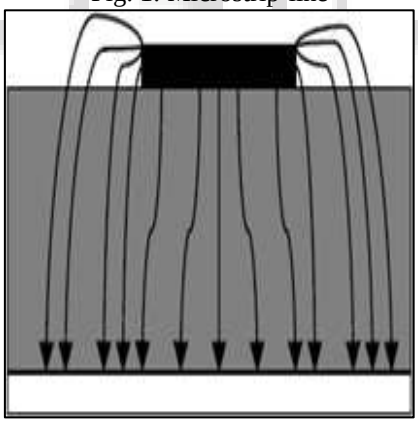

Fig. 2: Electric field lines

Hence, as seen from Figure 3.8, most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this transmission line cannot support pure transverse electric-magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate. Instead, the dominant mode of propagation would be the quasi- TEM mode. Hence, an effective dielectric constant ( $\varepsilon_{reff}$ ) must be obtained in order to account for the fringing and the wave propagation in the line. The value of $\varepsilon_{reff}$ is slightly less than $\varepsilon_r$ because the fringing fields around the periphery of the patch are not confined in

 

### *B. Applications of Microstrip Patch Antenna*

The Microstrip patch antennas are well known for their performance and their robust design, fabrication and their extent usage. The advantages of this Microstrip patch antenna are to overcome their de-merits such as easy to design, light weight etc., the applications are in the various fields such as in the medical applications, satellites and of course even in the military systems just like in the rockets, aircrafts missiles etc. the usage of the Microstrip antennas are spreading widely in all the fields and areas and now they are booming in the commercial aspects due to their low cost of the substrate material and the fabrication. It is also expected that due to the increasing usage of the patch antennas in the wide range this could take over the usage of the conventional antennas for the maximum applications.Some of the applications for the Microstrip Patch Antenna are as follows:

- Radio altimeters
- Remote sensing and environmental instrumentation
- Feed element in complex antennas
- Satellite navigation receivers
- Mobile radio
- Integrated antennas
- Satellite communication and direct broadcast services (DBS)
- Doppler and other radars

## VI. CONCLUSION

This chapter sums up all the work presented in this thesis, and then obtain a conclusion that would help in the development of this work and finally preset the future work.Firstly a CPW-fed 'U' shaped dual band microstrip patch antenna has been designed. The obtained -10 dB impedance bandwidth for 'U'-shaped dual band antenna is 37.66% and 20.30% at the bands of 2.23 GHz and 5.27 GHz respectively, sufficiently covering the bandwidth requirement of WLAN system and WiMAX system in the 2.4/5.2/5.8 GHz standard and in 2.5/5.5 GHz standard respectively. CPW feeding has been used because of its many advantages such as wide bandwidth, simple single metallic layer and easy integration with MMIC devices.Further by modifying this antenna, a CPW-fed 'E-G' shaped triple band microstrip patch antenna has been designed which covers 2.4/5.8 GHz WLAN standard and 3.5/5.5 GHz WiMAX standard. The obtained -10 dB impedance bandwidth for CPW-fed 'E-G' shaped triple band antenna is 25.45%, 13.05% and 20.03% at the bands of 2.20 GHz,3.37 GHz and 5.84 GHz respectively.A Microstrip-fed triple band monopole antenna using defected ground structure has been designed which covers 2.4/5.2/5.8 GHz WLAN standard and 2.5/3.5/5.5 GHz WiMAX standard. The obtained -10 dB impedance bandwidth for this antenna is 14.16%, 16.66% and 15.20% at the bands of 2.4 GHz, 3.48 GHz and 5.46 GHz respectively/Monopole-like radiation pattern observed which fulfills the condition of radiation pattern for a better WLAN and WiMAX system.

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