Circularly Polarized Microstrip Patch Antenna

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Abstract

Microstrip patch antennas have been widely used in a various useful applications, due to their low weight and low profile, conformability, easy and cheap realization. The antenna is designed for some improvement in the performance of directivity, gain, return loss and size of circuit area. The compact antenna is expected to improve the cost of production due to the size reduction in the overall circuit area especially in a mass production.
The paper presents the steps of designing the circular patch micro strip antenna. Microwave Office simulator is used to compute the gain, power, radiation pattern, and S-parameters of the antenna with the help of IE THREE-D software for patch antenna design. Changing the parameters like substance's thickness, material, tangent loss and dielectric constant affect the gain performance of the antenna.

Keywords: Circular patch micro strip antenna, gain, radiation pattern, S-Parameter.

1. Introduction

Micro strip antennas are started in early 1970's when conformal antennas were required for missiles. These antennas are attractive due to their light weight,

conformability and low cost.These antennas can be integrated with printed strip-line feed networks and active devices. A major contributing factor for recent advances of micro strip antennas is the revolution in electronic circuit miniaturization. As conventional antennas are bulky and costly, micro strip antennas based on photolithographic technology have low cost and small size.This is a relatively new area of antenna engineering.

The aim of the thesis is to design and fabricate a circularly polarizedMicro strip Patch Antenna with the help of IE 3D simulator and study the effect of antenna dimensions Length (L),and substrate parameters relative Dielectric constant (εr), substrate thickness (t) on the Radiation parameters of Bandwidth and Beam-width.

2. Microstrip Patch Antenna
2.1 Introduction
Micro strip Patch antenna 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 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. The patch is selected to be very thin such that $t \ll \lambda o$ (where t is the patch thickness). The height h of the dielectric substrate is usually $0.003 \, \lambda o \leq h \leq 0.05 \, \lambda o$. The dielectric constant of the substrate (εr) is typically in the range $2.2 \leq \varepsilon r \leq 1$.
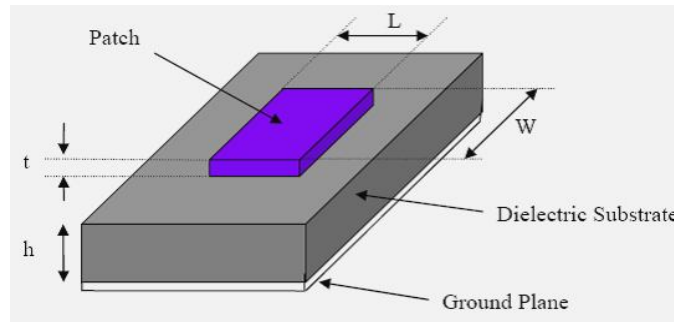
Fig. 1: Structure of a Micro strip Patch Antenna.

2.2 Circularly Polarized Micro strip Antennas
Generally antenna radiates an elliptical polarization, which is defined by three parameters: axial ratio, tilt angle and sense of rotation. A perfect circular polarization results for the unity axial ratio with zero tilt angle. A single patch antenna can be made to radiate in circular polarization if two orthogonal patch modes are simultaneously excited with equal amplitude and90^0 out of phase with sign determining the sense of rotation.

Two types of excitations for circularly polarized micro strip antennas: (a) dual-fed patch and (b) singly fed patch.The first type is dual fed patch, which uses an external power divider network. The other is singly fed patch for which an external power divider is not required.

3. Micro Strip Patch Antenna Design
3.1 Design of Micro strip Patch Antenna for Circular Polarization using IE3D Simulator
The essential parameters for the design of a Micro strip Patch Antenna are:

- Dielectric constant (ε_r) = 2.55
- Frequency (f_r) = 3.0 GHz
- Height (h) = 1/16 Inch = 1.59 mm
- Velocity of light (c) = 3×10^8 m/s
- Practical width (W) , W = 30 mm
- Loss Tangent (tan δ) = 0.001
- Practical Length (L) L = 30 mm

3.2 Simulation in IE3D
Steps for the simulation of Microstrip Patch Antenna in IE3D simulator:

- StartZeland Program Manager
- Double click on mgrid.
- Click on File–Open New File.
- Make Grid Size 0.025 mm.
- Define Substrate Parameters
- Click on Entity–Rectangle
- Click on Entity–Probe Feed to Patch
- Give Location of first Feed Point
- Give Location to Second Feed Point.
- Go to Adv Edit – Rectanglization
- Click on Process – Simulate
- Enter Frequencies
- Press OK.
- Simulation Starts and after simulation we get the results.

3.3 Results of Simulation
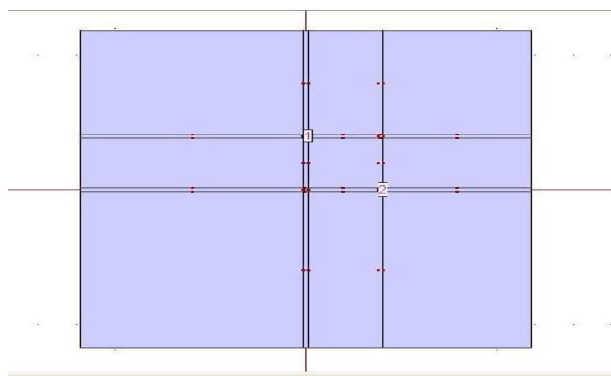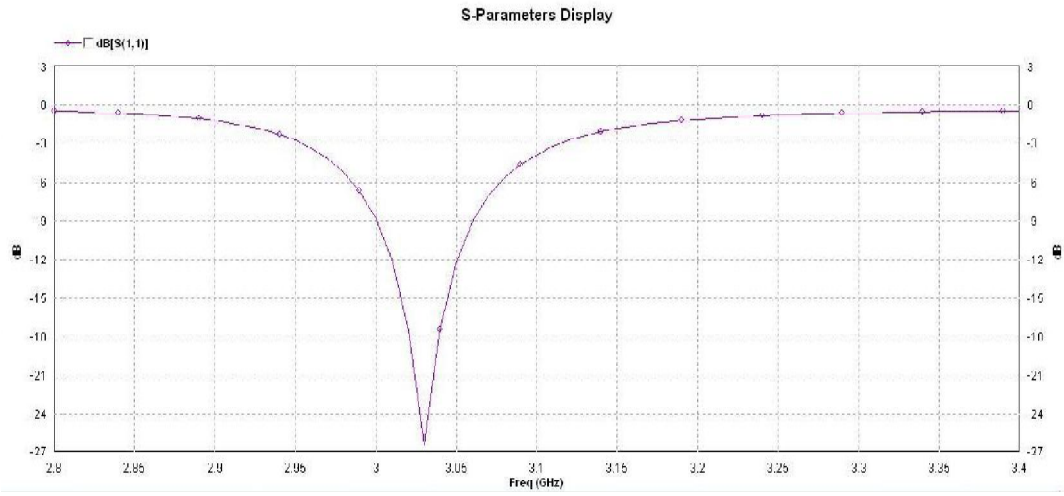

Fig. 2: Patch Designed in IE3D Software.

Asim Kumar et al

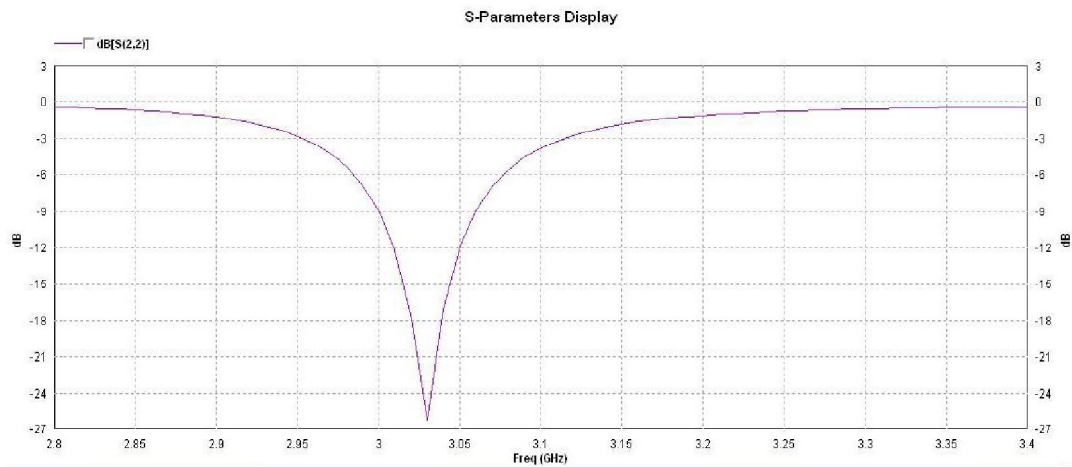**Fig. 3**: S-Parameter Display for S(1,1).

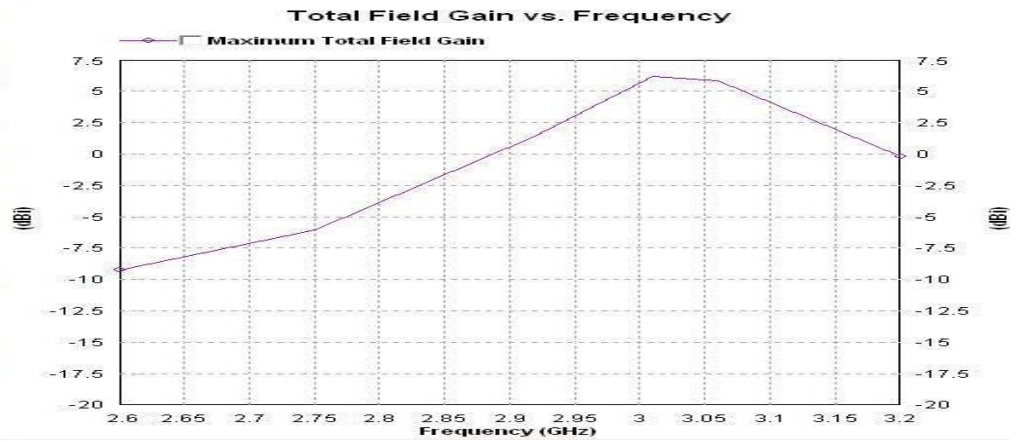**Fig. 4**: S-Parameter Display for S(2,2).
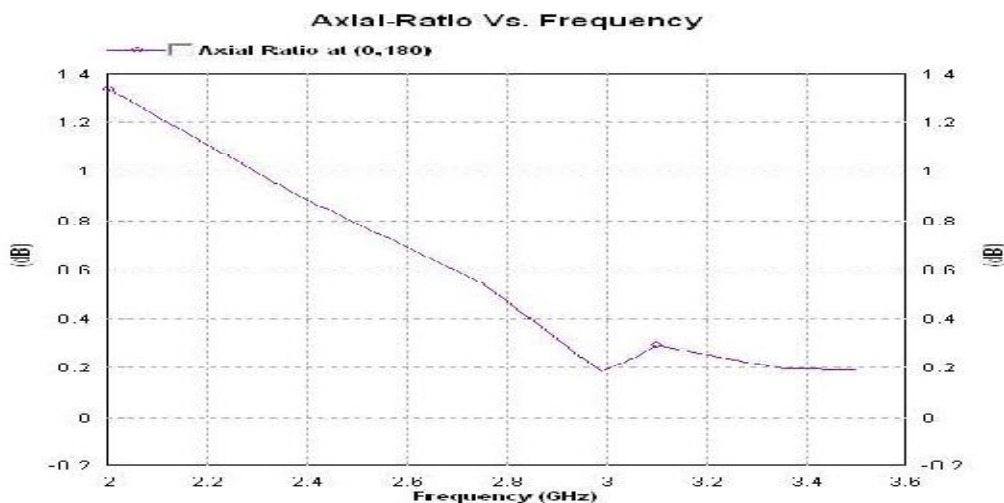

Fig. 5: Gain vs Frequency.

Fig. 6: Axial Ratio vs. Frequency Plot.

4. Conclusion

The design of rectangular patch Micro strip antenna for circular polarization has been completed using IE3D software. The simulation gave results good enough to satisfy our requirements to fabricate it on hardware which can be used wherever needed. The paper has been limited mostly to theoretical studies and simulations due to lack of fabrication facilities.Detailed experimental studies can be taken up at a later stage to fabricate the antenna.

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