Group No.	31		
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Project Title	Design of a reconfigurable printed antenna		

The Proposed Application: An Introduction

Printed antennas are the antennas that can be printed on a dielectric substrate, e.g the microstrip antennas (MSA). An MSA in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. MSA's comes in various shapes, viz. rectangular, square, circular, triangular, etc. The advantages of MSA are its low weight, small volume and ease of fabrication using printed-circuit technology. With increasing requirements for personal and mobile communications, the demand for smaller and low-profile antennas has brought the MSA to the forefront. Radiation in an MSA is because of the fringing fields between the periphery of the patch and the ground plane. Fringing fields arises due to the finite length of the metallic patch. And that too, if we are giving the feed along the width, the fringing fields that contribute largely to the radiation are the ones along the width, since along length the current varies sinusoidally and the fringing fields cancels each other out. Copper is mainly used for designing the microstrip patch since it is a good conductor and also comes cheap as compared to others.

Our idea is to make this MSA tunable (vary frequency), according to the input given, so that they could be

used at multiple frequencies. This objective can be attained by using optically controlled PIN diodes, varactors, shorting posts, etc. PIN diodes operate at their respective frequencies, acting as a shorted circuit when a particular frequency is incident and as an open circuit otherwise. Varactors are diodes whose capacitance varies with the reverse bias voltage applied across it.

Description of the Functional Block Diagram and Hardware/Software Components

1. **Power Feed Methods**: The MSA can be excited directly either by a coaxial probe or by a microstrip line. It can also be excited indirectly using electromagnetic coupling or aperture coupling and a coplanar waveguide feed, in which case there is no direct metallic contact between the feed line and the patch. Feeding technique influences the input impedance and characteristics of the antenna, and is an important design parameter. We have used the coaxial probe feed in our design. The main advantage of this feed is that it can be placed at any desired location inside the patch to match with its input impedance. It's disadvantage is that it makes the whole model non-planar, because it protrudes out of the ground plane.

2. **Radiation**: The radiation is caused mainly by the fringing fields from the radiating patch, however, it could be altered by several other factors. As an example, if we are using microstrip line feed, then the fringing fields along that line could interfere with the overall radiation and hence alter the resonant frequency.

Hardware components:

Varactors: Varactors are diodes whose capacitance varies with the reverse voltage applied across it. So, when we connect the varactor between the edge of the radiating patch and the ground plane, upon varying the reverse bias voltage, the capacitance varies and so the resonant frequency of the overall patch also changes. The freqquency increases non-linearly with reverse bias voltage of the varactor.

$$C(v)=\frac{C(0)}{\sqrt{1-\frac{v}{a}}}$$

where C(v) is the capacitance of the varactor as a function of reverse bias voltage v, C(0) is capacitance at 0 bias voltage and ‘a’ is the built-in voltage of the diode.

Substrate: We are using the FR4 epoxy substrate with dielectric constant 4.4 and thickness 1.6 mm.

Discussions on the Design with Illustrations

We are designing a varactor loaded, coaxial fed rectangular microstrip antenna. T o begin with, we etch a rectangular microstrip patch on the FR4 substrate with length W=4cm and width L=3cm. For reasons of symmetry the probe feed and diode load were positioned at xp1 , = 10 mm and xp2 = -10 mm, respectively, along the x-axis. To position the diode a small hole was drilled through the substrate and the diode was soldered into place. The diode used to load the patch is BB639E7904 (silicon variable capacitance diode).

$f_0 = \frac{15}{\times\sqrt{\mathcal{E}l}}$, where Le is the effective length in cm, f_0 is resonant frequency in GHZ and $\mathcal{E}_l$ is the effective dielectric constant of the metallic patch.

Le = L + d, where $d = \frac{h(widthofsubstrate)}{\sqrt{\mathcal{E}l}}$

$$\mathcal{E}_l = (\mathcal{E}r+1)/2 + \frac{(\mathcal{E}r-1)}{2\sqrt{1+\frac{10h}{W}}}$$

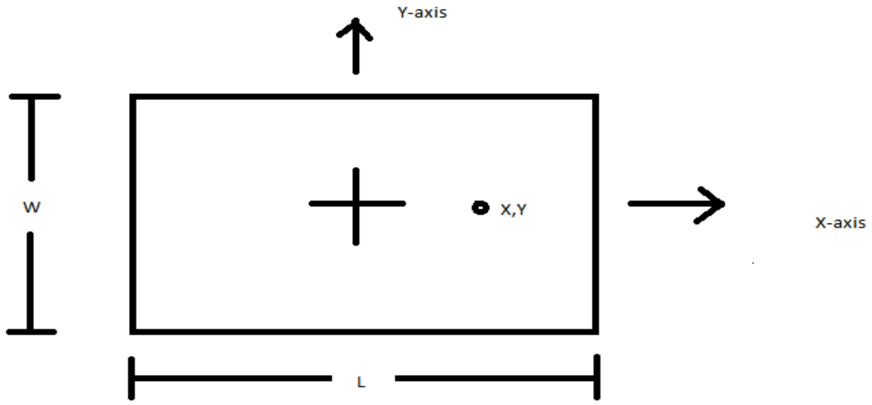

Figure1. Top view of the metallic patch (X,Y are the coordinates of the coaxial feed)

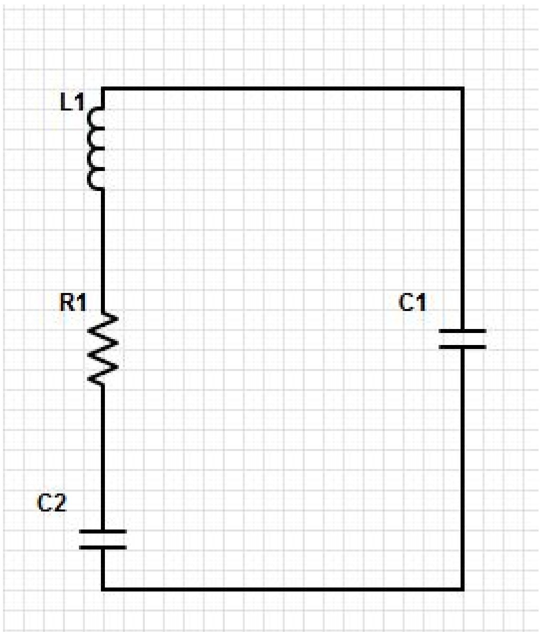

Figure2. Equivalent electrical circuit of the design.

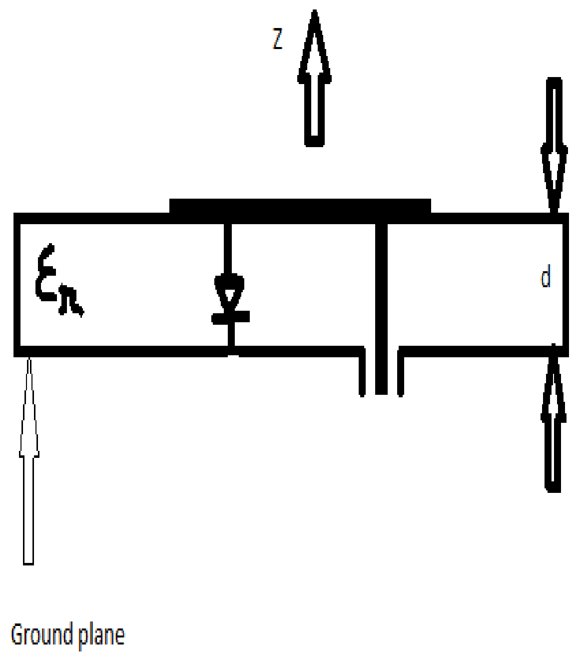

Figure3. Lateral view of the design.

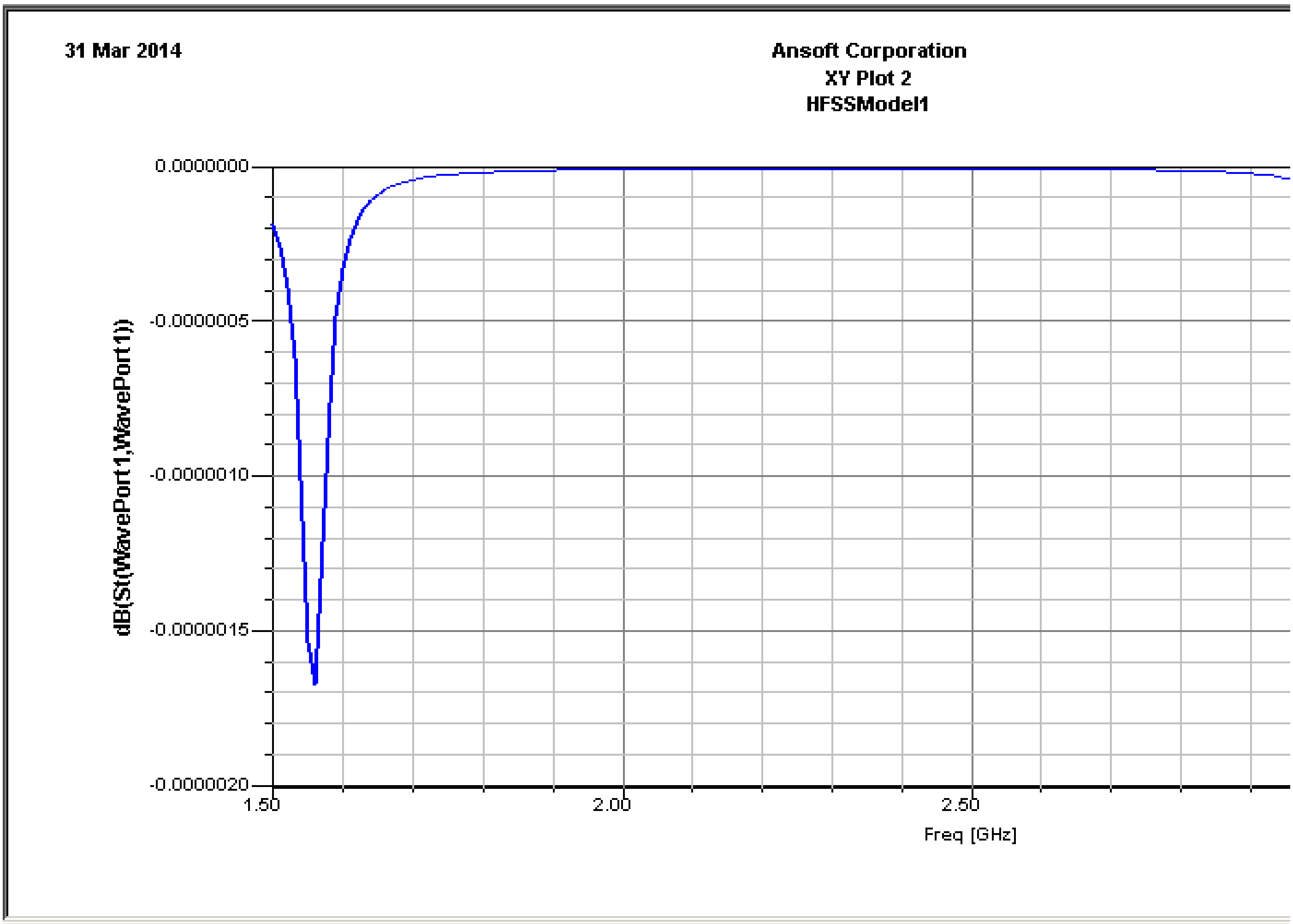

Figure4. VSWR of the design without the varactor.

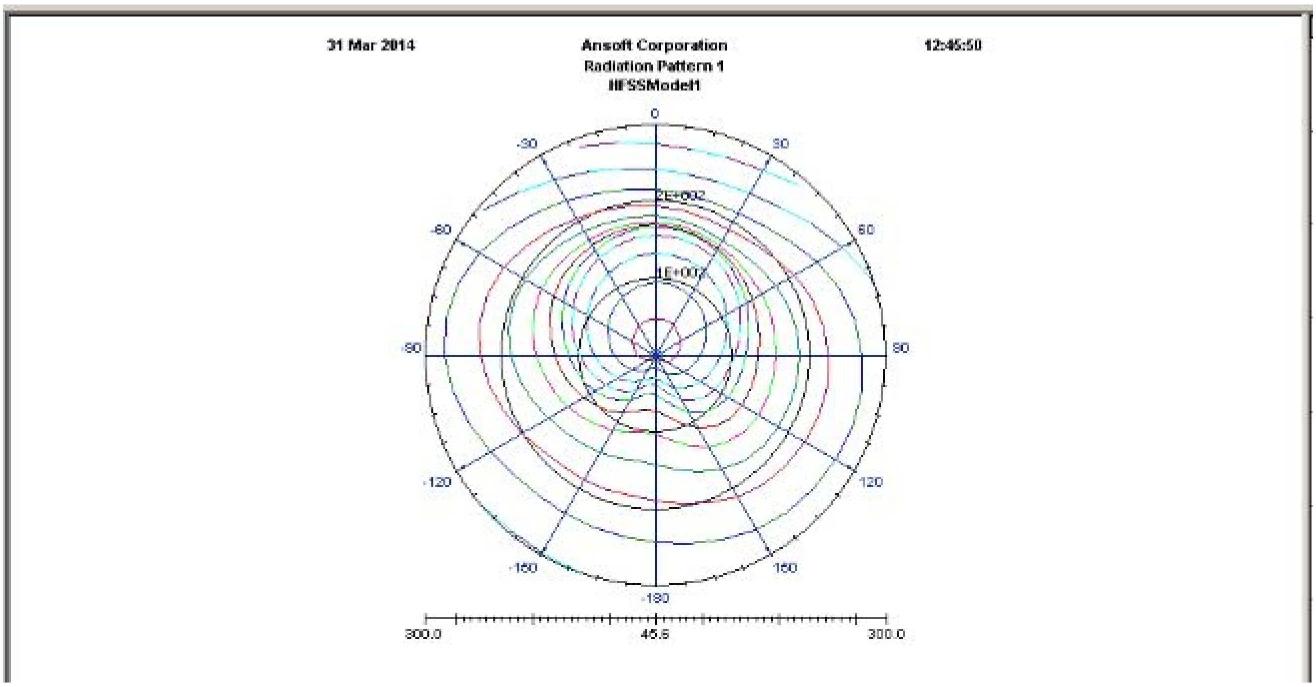

Figure5. Radiation Patterns of the design without varactor.

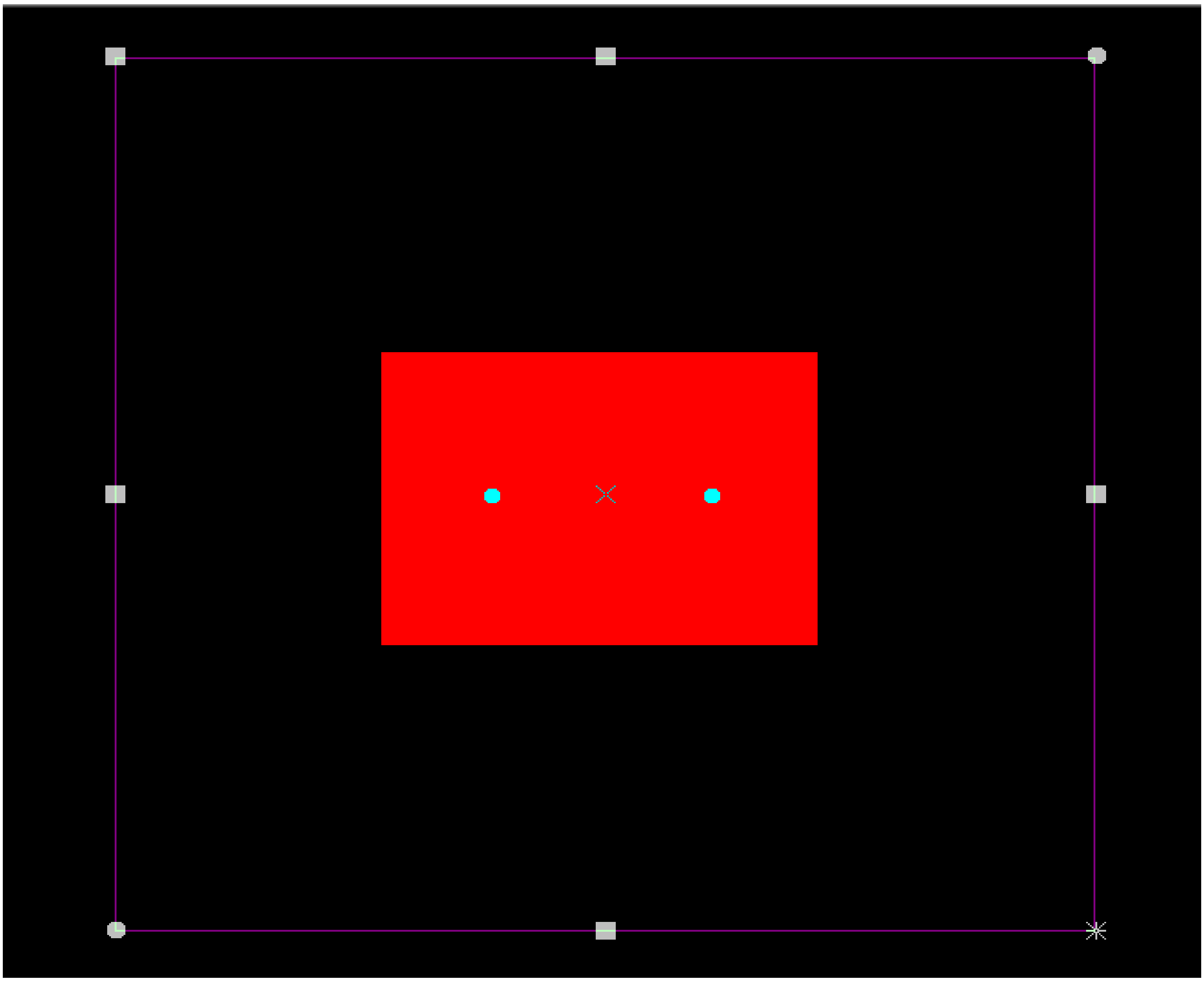

Figure 6. Input to the LPKF circuit board plotter (.gerber file) designed using CircuitCam.

Dimensions :

1. **Substrate : width=89.95mm, height=89.9mm**
2. **Metallic patch : width=40.059mm, height=30.009mm**
3. **Hole diameter=1.5mm**

Holes are located at (10mm,0) and (-10mm,0), considering the cross mark as the origin.

One hole is for co-axial probe feed and the other one is for varactor diode.

References:

1. Girish Kumar, K.P. Ray : 'Broadband Microstrip Antenna'(Artech House, London,2003)

2.R.B. Waterhouse, N.V. Shuley : 'Full characterisation of varactor-loaded, probe fed, rectangular, microstrip patch antennas'.

List of Components

#	Item Name	Qty.	Provided by (Dept/Self/Guide)	Price (Rs.)
1.	Varactor	1	Self	403
2.	FR4 epoxy	1	Guide	
3.	SMA conector	1	Self	150

Total =Rs 553/-

***The Department will provide up to Rs. 1000 per group for the purchase of components. Specialised items like**

FPGA kit, Kinect, WebCams etc should be provided by the students or the faculty supervisor.

Signature of Group Member #1

Signature of Faculty Supervisor #1

Signature of Group Member #2

Signature of Faculty Supervisor #2