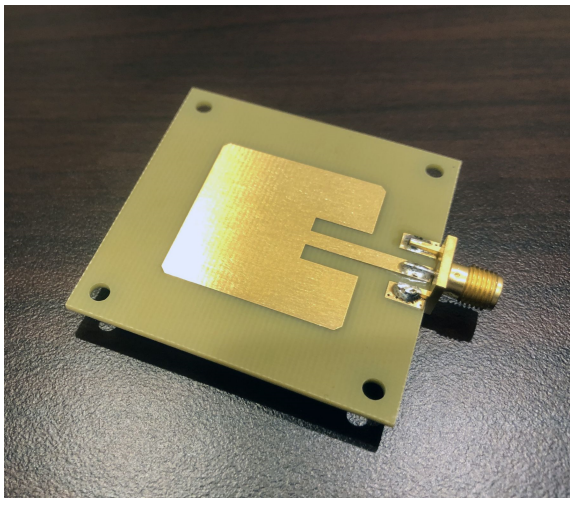
Designing a Tri Band Microstrip Patch Antenna at resonating frequencies 2.4GHz, 3.7 GHz and 4.7 GHz(WLAN System)

By:-

- **Sanil Sanjay Sattarkar** → BT20ECE001
- **Yash Kumar Sharma** → BT20ECE023

Under the Guidance of
Dr. Paritosh Peshwe(Assistant Professor, ECE Department)



Abstract:

In this report, a tri band microstrip patch antenna is designed which is used for 2.4GHz, 3.7GHz and 4.7 GHz. WLAN connections are used around the home and offices to eliminate the use of cables when sharing printers, scanners, and high-speed internet connections. Optimum design is used to get maximum output characteristics. We aim to design a tri band antenna with maximum gain at a frequency of 2.4 GHz.

Keywords:

Directivity, S-Parameters, Gain(IEEE), Feeding techniques, FR4-epoxy, Etching chemical, Coating of Patch on Substrate.

A. Rectangular patch antenna design equations:

- Step number one is utilized to discover the frequency of a specific receiving wire (i.e., specific plan).
- The frequency of reception apparatus is λ = c0/freq
  Where, c0 = speed of light = 3×10^(8) m/s = 3×10^(11) mm/s ; freq = resounding recurrence
- Step number two is utilized to discover the width of the fix
  Patch Width, w = (c0 / (2*freq)) * (2 / (εr + 1)) ^ (0.5)
  Where, εr = relative permittivity of the material that has to choose.
- Step number three is used to find the length of the patch
  Patch Length, L = Leff - (2*ΔL)
  Where, Leff = effective length and ΔL = extension length.
  Leff and ΔL have separate formulas.
  The effective length is Leff = c0 / (2*freq*(εreff)^(0.5))
  Where εreff = effective dielectric constant and it is given by
  εreff = ((εr + 1) / 2) + (((εr - 1) / 2) * (1 + (12 * (h/w)))^(-0.5))

B. Tri Band microstrip patch antenna Design Specifications:

The tri band microstrip patch antenna design specifications are shown in the table below.

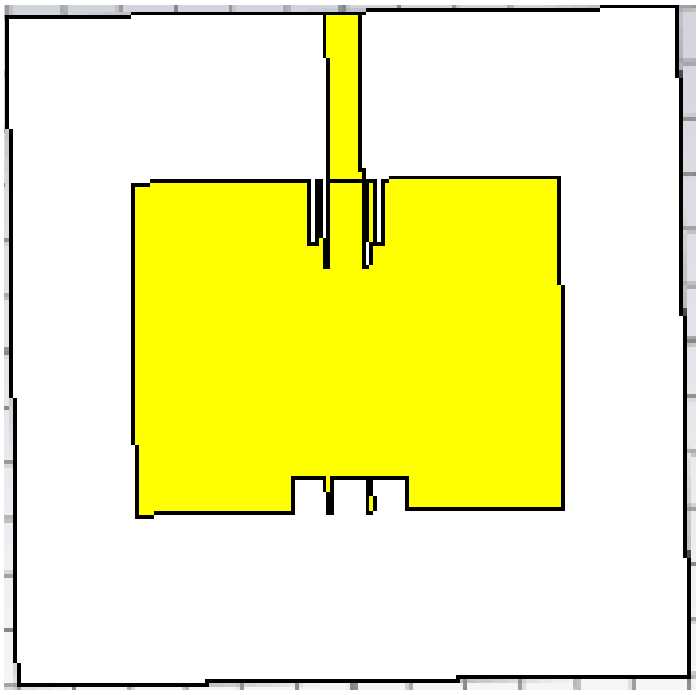
TABLE I: TRIBAND PATCH ANTENNA SPECIFICATIONS

Parameter	Value
Operating frequency	2.4GHz
Substrate dielectric material	FR4 epoxy
Substrate Dielectric Constant(εr)	4.3
Substrate thickness(h)	1.6mm
Patch Width(x)	38.393448021219mm
Patch Length(y)	29.7786240130609mm
Patch Height(hc)	0.035mm
Width of the Ground Plane (ws)	60mm
The Length of the Ground Plane (ls)	60mm
Feed Line Width	3mm
Feed Line Length	15.11068799346955mm
Lumped Port Feed Width	3mm
Lumped Port Feed Height	-3.6mm
Feeding technique	Micro Strip Feed Line

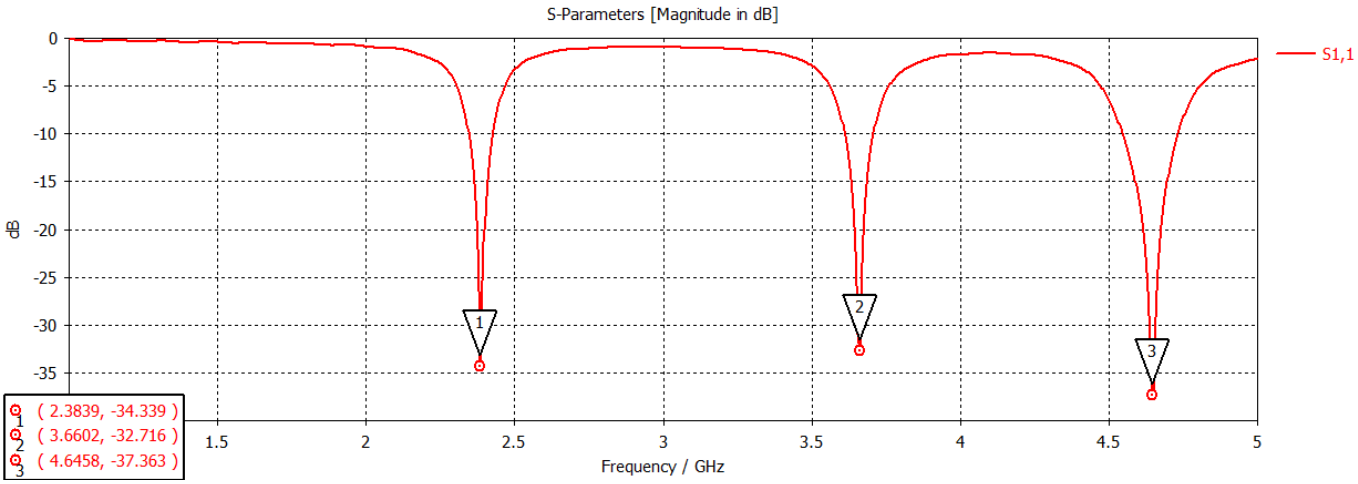
C. *Design Characteristics:*

- We create a total of 4 slots of 0.6mm width, 2 on either side of the feeding line with their lengths of 22mm and 24mm respectively.
- Also 3 square slots above the patch of side length 3mm symmetrically adjusted.
- Their contribution in this configuration is to get such a value of impedance that we can get the desired resonant frequencies with satisfactory S-Parameters.
- The antenna is being designed using **CST Studio 2019 Suite**.
- The port is being connected to the feed using the waveguide port function by calculating its port extension coefficient.

D. *Antenna(CST Studio)*



E. *Simulation(CST Studio)*



F. Fabrication(Actual Design)

Components:

- FR4 Epoxy Sheet(60mm x 60mm)
- Sand Paper
- Iron
- Filer and Cutter
- Photo Paper with Patch and Ground
- Permanent Marker
- $FeCl_3$ solution
- Motor pump
- SMA Connector(RF Connector)
- Soldering Wire and Gun
- Anritsu Antenna Analyzer

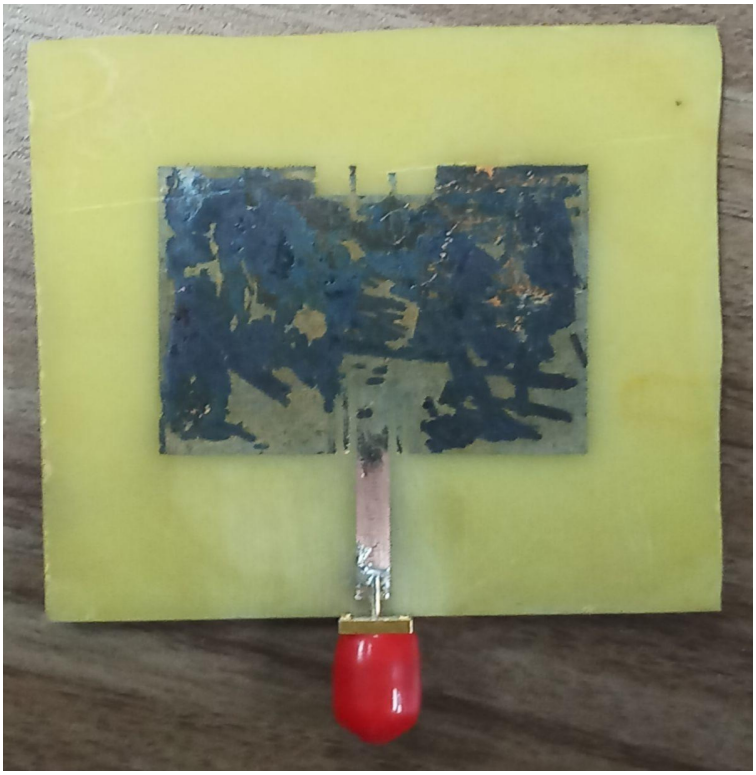
Procedure:

- First cut the **FR4 epoxy sheet** as per the prescribed substrate dimensions and sharpen them using a filer.
- Next, take a printout of patch and ground on the same **photo paper** in B/W format and cut the shape in such a way to apply the laser printer powder onto the substrate.
- Now use a **sandpaper** and remove the rust on the substrate.
- Keep the patch and ground printout as per the exact dimensions of the antenna.
- Keep a hot **iron** ready meanwhile, applying brute force press it on the paper such that the carbon impression is seen on the substrate. After pressing, keep a 5 minute gap to remove the paper for cooling purposes.
- If there are any substrate impressions seen, write them off using a permanent marker and keep a **$FeCl_3$solution** ready along with the **motor pump** in working condition.
- Immerse the antenna into the solution and keep until we see the etching of the substrate fully.
- Now use the sandpaper again to create a port feed onto the microstrip for soldering purposes.
- Use a **RF Connector** and keep the center part onto the microstrip and remaining two onto the backside i.e., ground for soldering.
- Now keep the **soldering apparatus** ready and perform soldering to make the antenna ready for soldering purposes.

Anritsu Antenna Analyzer:

This setup has an antenna port connector and a software which has to be installed by which it tests the actual **S-Parameters** of the fabricated antenna. This data can be matched along with the simulated results of CST Studio.

The Fabricated Antenna:



Inspection:

The supervisor successfully tested the above fabricated antenna and thanked us for giving us a **clean resonance** at the desired resonating frequencies, thereby indicating that the antenna is successfully simulated and brought into hands-on experience by fabrication means.

Inference:

Therefore we have designed a tri band microstrip patch antenna for the desired frequencies of 2.4GHz, 3.7GHz and 4.7GHz successfully by software as well as through fabrication.