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Design and Simulation of a Triple Band Microstrip Antenna for Wireless Applications

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Abstract- ***Modern wireless systems need compact, low-cost antennas that can work at multiple frequency bands where as traditional designs use multiple antennas complex structures which increases size , cost and power usage. To solve this, we design a compact triple microstip antenna using CST Microwave Studio. The antenna uses a hexagonal patch with modified slots, inclined strips and feedline geometry.***

These changes helps in:
- ***Better return loss & Impedance matching***
- ***Wider bandwidth***
- ***Higher gain***

The antenna works in the 3 to 15 GHz range, covering WLAN, satellite communication, radar and wireless services.

Index Terms: Microstrip Antenna, Multiband Antenna, WLAN, CSS, Reconfigurable Antenna

I. INTRODUCTION

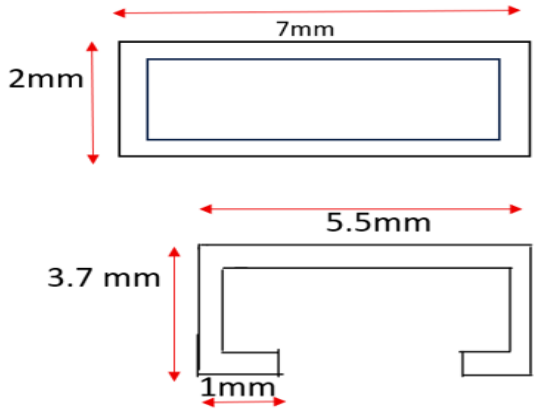
In modern wireless communication systems compact and multiband antennas are highly required to support multi-ple applications. Instead of using multiple antennas for different frequency bands, a single multiband antenna can improve efficiency and reduce size. Microstrip patch antennas are widely used due to their low cost, light weight, and ease of fabrication. Various techniques such as slots, defected ground structures (DGS), and parasitic elements are used to achieve multiband operation. In this work, a hexagonal microstrip patch antenna is proposed to operate at three different frequency bands suitable for WLAN, satellite TV, and radar applications.

II. METHODOLOGY

The proposed antenna is designed on an FR4 substrate with the following specifications:
- Dielectric constant (εr): 4.4
- Thickness: 1.6 mm
- Substrate size: 15 × 17 mm²

Dimensional parameters of antenna are:

Parameter	Value(mm)
Lsub	17
Wsub	15
Ls	5
Lf	5
Wf	2.5
Lg	4
D	12.5
aH	6.25



The diameter of hexagonal patch is given by

$$D = 2 \times aH$$

Height of the hexagonal patch (H) is $H = \sqrt{3}aH$

$$H = \sqrt{3} \times 6.25 = 10.82 \text{ mm}$$

The radiating element is a hexagonal patch fed using a 50-ohm microstrip line. The design includes:
- Two inclined strips
- Modified Slots
- Partial ground plane

These structural modifications help in achieving triple band operation

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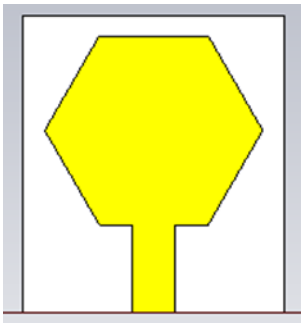
III. ANTENNA DESIGN

The design process is carried out in multiple stages:



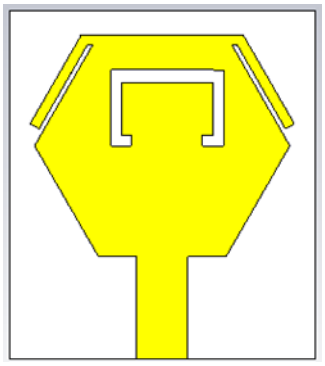
Iteration1

In the first step, a hexagon-shaped antenna is designed and excited with a microstrip line of length L_f and width W_f. The antenna operates over a wide frequency range of 6.00–12.42 GHz, and the input impedance varies between 50 Ω and 80 Ω for the entire range of operation

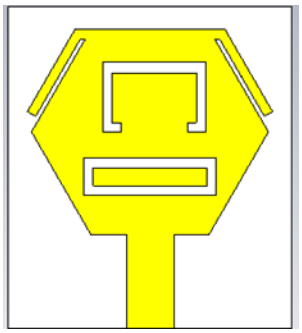
We use FR4 substrate

Substrate Dimensions:15mmx17mmx1.6mm

Partial ground is created



Iteration2

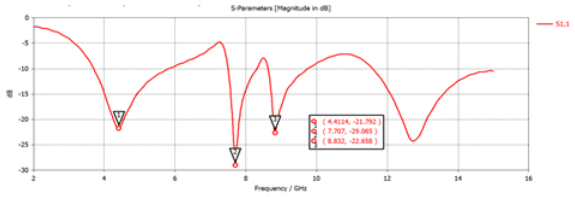


Iteration3

In third Iteration O-Shaped slot is inserted.
In iteration 2, two inclined strips are connected to the upper side of the radiating patch, and also a trapezium shaped slot and a small rectangular slot of 1 × 0.5 mm are etched in the ground for matching purpose.

Due to the connected strips, it converts the antenna as a triple band antenna.

Results
S11 parameters
S-parameters describe how signals behave in an RF system. In our antenna, S11 is the important parameter, which represents the reflection coefficient. The S11 graph shows three dips at around 4.5 GHz, 6.5 GHz, and 8.5 GHz, indicating triple-band operation. Although the dips in our modified design are slightly less deep than the base paper, they are still below –10 dB, confirming proper impedance matching and good antenna performance.



In above Figure s11 is less than -10db which represents antenna is working properly

Vswr Results
The Diagram represents the vswr results.
We get vswr less than 2 then the antenna is working properly

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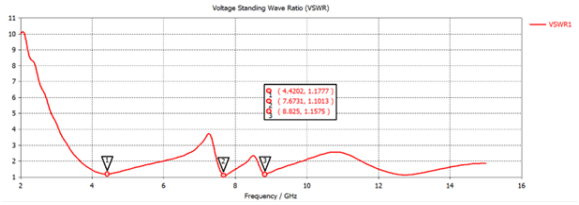


Surface currents

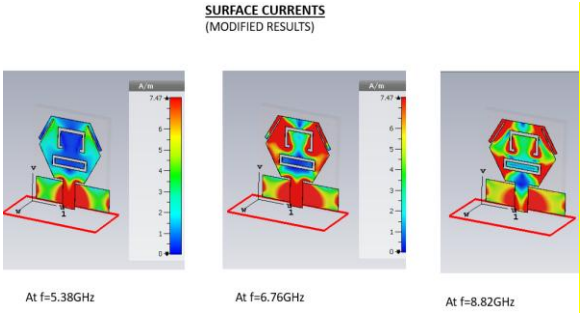
The below diagram represents surface currents parameters of modified design results. It shows how much current is distributed in antenna.

The colours represents:

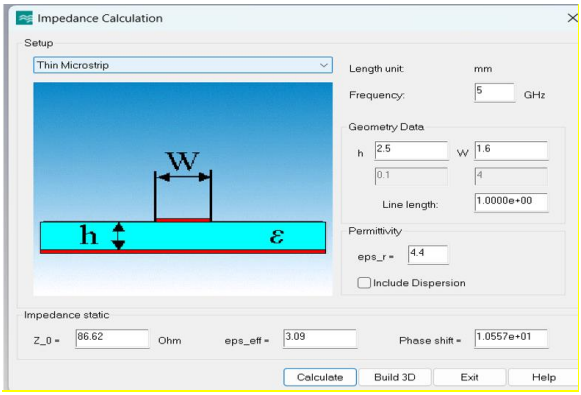
Red-More current

Orange-Moderate current

Blue-less current

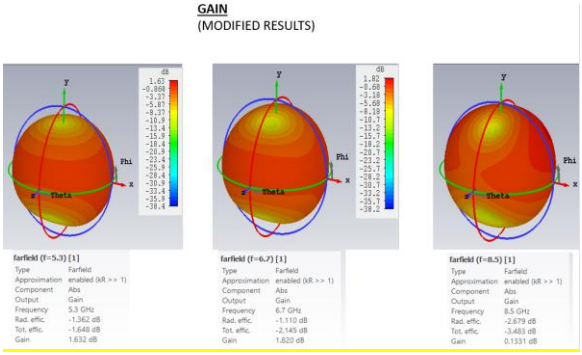


Impedance Calculation



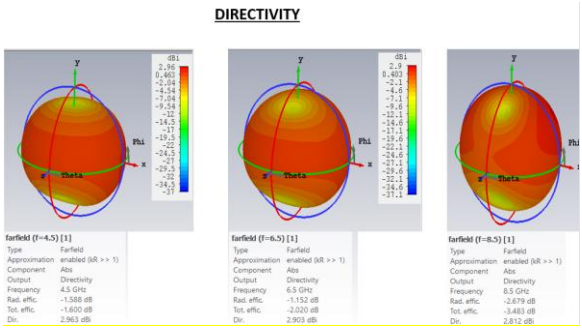
GAIN

Gain is the measure of how efficiently an antenna radiates power in a particular direction. It depends on both directivity and efficiency. In our project, gain is evaluated using CST far-field analysis at 4.5 GHz, 6.5 GHz, and 8.5 GHz. The gain ranges from about +1 dB to –1.5 dB. This is slightly low due to structural modifications and losses, but it is acceptable for a compact triple-band antenna.



Directivity

Directivity is the measure of how focused the antenna radiation is in a particular direction. It indicates how directional the antenna is



VI. CONCLUSION

- A compact triple-band microstrip antenna was designed using CST Microwave Studio.
- The antenna is based on a hexagonal patch with inclined strips, slots, and a partial ground plane.
- Iterative modifications converted a wideband design into a triple-band antenna.
- The achieved operating bands are around 4 – 13GHz
- The design shows good return loss and proper impedance matching across all bands.
- Wide bandwidth and stable gain make it suitable for practical wireless systems.
- The proposed antenna is applicable for WLAN, Satellite TV, and Radar applications.
- We improved the design parameters (S11,VSWR,Gain,Directivity,Surface Currents).

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