# Design, Simulation and Fabrication of Dual-Band Polarized Microstrip Patch Antenna

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***Abstract*—A new design of a simple dual-band and dual-polarised microstrip patch antenna is presented with a single feeding. Paper present two designs to make antenna compact without much alteration results. The proposed antennas are designed, simulated and fabricated and tested to be used in dual frequency bands which are GSM900 and 1800 bands. The Design I can be operated at frequency ranges from 924MHz to 1790MHz for simulation and real measurement from 938MHz to 1837MHz. Meanwhile, the operating frequency ranges for Design II from 900MHz to 1760MHz for simulation and real measurement between 904MHz to 1775MHz. The results show the simulated and measured result are in good agreement.**

***Index Terms*—Microstrip Patch Antenna; Frequency Band; The Real Measurement.**

## I. INTRODUCTION

The early communications between humans are sound through voice. In ancient times, they used visual methods such as signal flags and smoke signals as their medium of communications. Nowadays, communications are the main key for survival in our world, and the advancements in communication have changed our lifestyle to allow us to view the world from completely different perspective. To allow this type of communication, many technologies are necessary, and one of those is the antenna technology. The antenna can work in more than one frequency region either for transmitting or receiving electromagnetic wave. In other words, an antenna is a device that provides a means for radiating and receiving the radio waves. Dual-band antenna is more complex than the single band antennas in their design, structures and operations [1]-[3]. Currently, the most famous antenna is microstrip patch antenna which is used in most developing field and has many features.

## II. ANTENNA DESIGN CONFIGURATIONS

Both antennas are designed using CST Microwave studio based on the rectangular microstrip patch element. A single printed circuit board (PCB) is used as the substrate for the proposed design [4]. The substrate of PCB is FR-4 epoxy with a relative permittivity $\varepsilon_r = 4.3$, a loss tangent $\tan\delta = 0.035$ and thickness $h = 1.6$mm. It is also designed one feed located near the center of the inner element. The feed consists of 50Ω input impedance. The copper act as a ground and it is etched on the bottom layer of the substrate. The basic geometry of the proposed microstrip antennas are shown in Figure 1 and Figure 2 and their dimensions illustrated in Table 1 and Table 2.

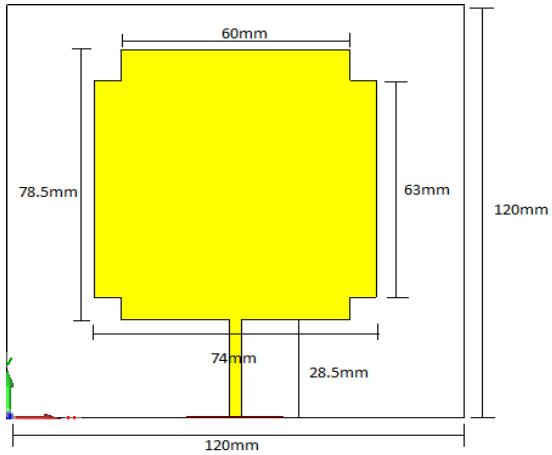



Figure 1: Schematic Diagram for Design I

Table 1
Dimensions of Design I

| Descriptions | Dimensions |
|---|---|
| Substrate (base) | 120mm x 120mm |
| Patch 1 | 74mm x 78.5mm |
| Patch 2 | 60mm x 63mm |
| Feed / Port | 3mm x 28.5mm |
| Ground plane | 120mm x 120mm |

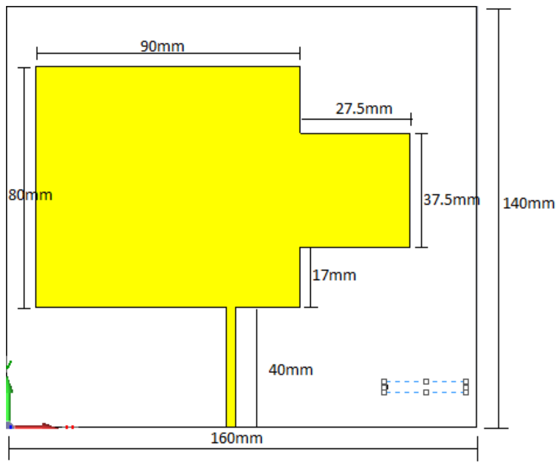



Figure 2: Schematic Diagram for Design II

Table 2
Dimensions of Design II

| Descriptions | Dimensions |
|---|---|
| Substrate (base) | 160mm x 140mm |
| Patch 1 | 90mm x 80mm |
| Patch 2 | 37.5mm x 27.5mm |
| Feed / Port | 3mm x 40mm |
| Ground plane | 160mm x 140mm |

Both proposed designs are fabricated as in Figure 3 and Figure 4. The performances are measured by using a network analyser.

(a)

(b)

Figure 3: Photo of Fabricated Antenna: (a) Design I and (b) Design II

## III. Simulated and Measured Results

S-parameter is expressing the input-output of the relationship between ports or terminals in an electric system. This s-parameter or return loss expressed as a ration in dB relative to the transmitted signal power. For the proposed Design I, it has only one port which then S11 presents the power transferred from one port only. The input return loss is measured using Agilent technologies E5071C network analyser and for simulation is using CST software. The return loss simulated, and measured result is shown in Figure 4. The graph in Figure 4 (upper and lower) produced look similar, but antenna resonances are at differences frequencies. Simulation CST software shows antenna frequency resonance at 924MHz and 1790MHz while at network analyser show frequency resonance at 938MHz and 1837MHz. There are small-scale different between simulated and measured result.

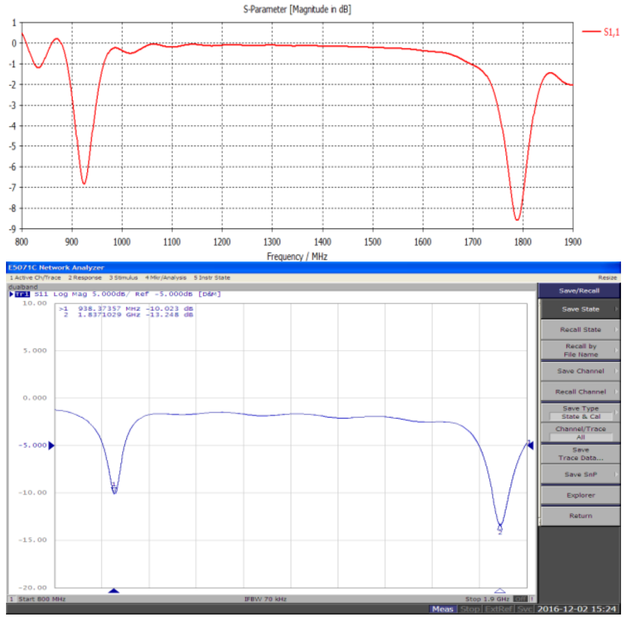
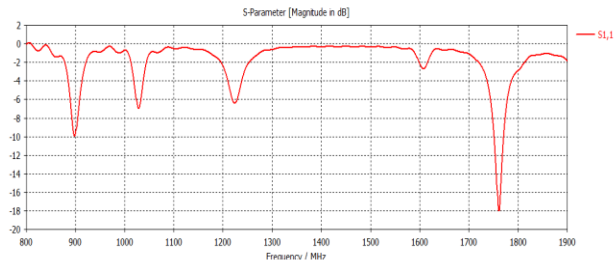



Figure 4: Return loss for Design I using CST Software (upper) and Network Analyzer (lower)

For Design II, s-parameter produced by CST software and network analyser are almost the same and achieve the required resonances frequency. Based on Figure 5 (upper), the start frequency exactly at 900MHz but at the end of the wanted frequency it resonance at 1760MHz. For Figure 5 (lower), the resonance frequency at 904MHz and 1775MHz. In between frequency range of 904MHz and 1775 MHz, there are two unwanted frequencies that also resonance at range 1000MHz and 1240MHz. This means antenna Design II cannot operate very well because s-parameter shows antenna has some short or noise which disturb the performance of the antenna.



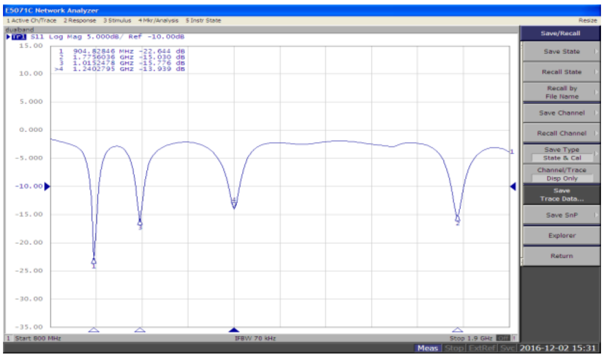


Figure 5: Return loss for Design II using CST Software (upper) and Network Analyzer (lower)

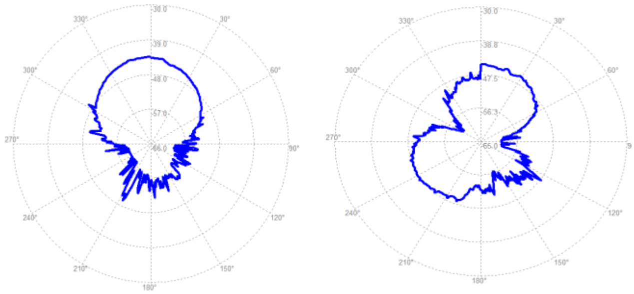
## IV. Radiation Pattern

The radiation patterns are shown in Figure 6 and Figure 7 respectively. It can be observed that radiation pattern E-plane Figure 6 for 938MHz; there is a major lobe and one minor or back lobe. From angle 0° until angle 60° the losses is slowly increase. After angle 60°, the losses start fluctuated until it reach 60dB. At angle 90° until 120°, the losses are achieve a high losses. From angle 90° up to 300°, the signal received in unstable condition. After angle 300° the losses reduce and antenna start to receive a stable signal. The E-plane at frequency 1837MHz produced two major lobes, one back lobe and a bit tilted position. From angle 300° up to 85° is label as major lobe one while angle 160° until 300° label as major lobe two. For major lobe one, at angle 0° up to 60° and 330° up to 360° the losses slowly increase between range -44dB until -50 dB and after angle 60° and 330° losses gradually increase to -60dB.

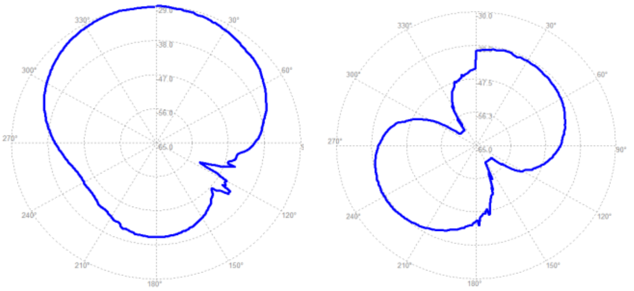
Next, the H-plane is tested in the horizontal plane. Radiation pattern for the H-plane frequency at 938MHz shows consistent losses at angle 330° until 30°. However, after angle 30°, the losses slowly increases and at angle 118° losses have sharply increase up to -52dB. After angle 120° losses start to decrease. For the next testing antenna which is H-plane frequency at 1837MHz, the radiation pattern contains of two major lobes and its tilted position. At the beginning of major lobe one (angle 0° until 60°) the losses is constant and this constant losses also happen at major lobe two which is from angle 210° until 270°. Unfortunately, at major lobe one it has fluctuated losses at angle 330° up to 360°.

Based on Figure 7(a), the radiation pattern produced one main lobe and one back lobe. Starting from 0°, the losses is -44dB and it slowly increases until 60°. After 60°, the pattern becomes unstable which is at 90° to 120° and 270° to 300°. At angle 190° and 310°, the radiation pattern become more stable. The E-plane antenna operate at frequency 1775MHz, the radiation pattern produce two main lobes but it is a little bit tilted. The radiation pattern becomes unstable only at certain angle which is 120° and at 310°. As can see, at 150° the radiation pattern becomes constant until 270° and starting at 300° the signal becomes unstable.

The H-plane radiation pattern frequency at 904MHz produced one main lobe and one back lobe. Starting at 300° the radiation pattern is in constant condition while after 360° or 0° the losses start to increase. At 65° and 210°, the radiation pattern is unstable to receive the signal. Next, at 65°, the back lobe happens up to 210°.

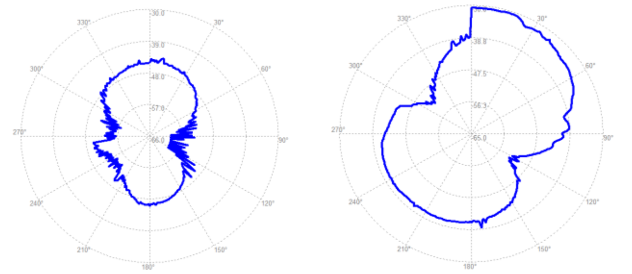


(a) E-plane at 938MHz (b) E-plane at 1837MHz

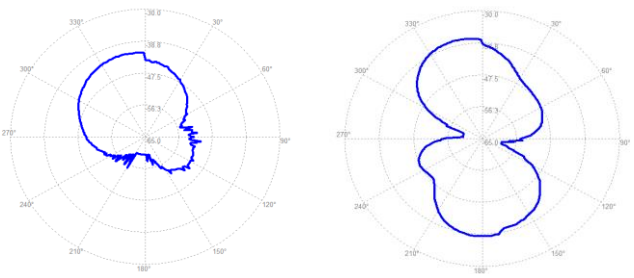


(c) H-plane at 938MHz (c) H-plane at 1837MHz

Figure 6: Simulated Radiation Pattern Design I



(a) E-plane at 904MHz (b) E-plane at 1775MHz



(c) H-plane at 904MHz (d) H-plane at 1775MHz

Figure 7: Simulated Radiation Pattern Design II

## V. Conclusion

A new dual-band microstrip patch antenna is presented in this paper. The element configuration consists of a rectangular patch antenna with a single feeding. Design I and Design II prototypes are designed, simulated and fabricated to be used in a GSM900 and 1800 band [5]. Using the described antenna designs, a good impedance matching is obtained at both designs in both bands using single feed is an advantage due to simplicity. Finally, the good agreement has been obtained between simulation and measurement results.

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