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2.45 GHz of Elliptical Shape Patch Antenna

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Abstract – **This paper describes the design of multiple element of co-polarization elliptical patch antenna operating at 2.45GHz. Computer Simulation Technology (CST) Microwave Studio is used as an effective tool for 3D electromagnetic simulation of high frequency design. In this paper, different dimensions with three elliptical shaped slots are implemented and attached with main radiating element while power has been excited from coaxial feeding. Radius of 14 different cylindrical dots are located at the left most center of the smallest elliptical slot. The analysis on performance will be based on the obtained result especially in radiation pattern, bandwidth and return loss. The antenna is capable of functioning with a maximum directivity of 6.948dBi and a return loss of -22.87dB.**

Keywords-co-polarization, directivity and efficiency

I. INTRODUCTION

Antenna is a part of a transmitting or receiving system which is designed to radiate or to receive electromagnetic waves. Co-polarization means that polarization which the antenna is intended to radiate. Cross-polarization discrimination is the measure of discrimination to oppositely polarized electromagnetic waves [1].

A patch antenna is a type of radio antenna with a low profile, which can be mounted on a flat surface. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. The assembly is usually contained inside a plastic random, which protects the antenna structure from damage. Patch antennas are simple to fabricate and easy to modify and customize. They are the original type of microstrip antenna; the two metal sheets together form a resonant piece of microstrip transmission line with a length of approximately one-half wavelength of the radio waves.

The radiation mechanism arises from discontinuities at each truncated edge of the microstrip transmission line. The radiation at the edges causes the antenna to act slightly larger electrically than its physical dimensions, so in order for the antenna to be resonant, a length of microstrip transmission line slightly shorter than one-half a wavelength at the frequency is used. A patch antenna is usually constructed on a dielectric substrate, using the same materials and lithography processes used to make printed circuit boards [2-6].

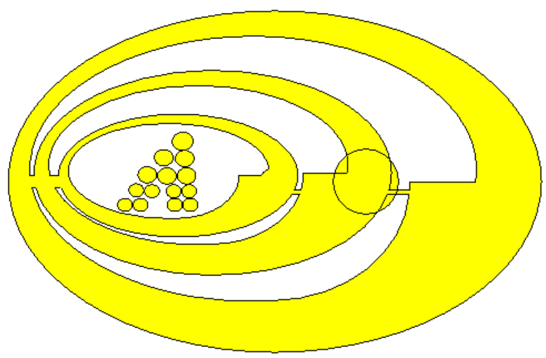
It has been realized that an elliptical microstrip antenna has potential to radiate circularly polarized waves which requires only coaxial feed and the design is simple enough to to be calculated in standard coordinate systems [7]. However, discovering the performance and behavior of this elliptical antenna with different coaxial port locations is the main point of this paper.

For this antenna, even with the existence of arbitrary and unsymmetrical slots, the antenna still produces a large bandwidth of 172.2MHz. As the antenna uses the substrate FR4, the fabrication is economical [10-20]. Dimension wise, the antenna has a width of 28.32mm and height of 15.81mm where it produces the frequency centered at 2.45GHz.

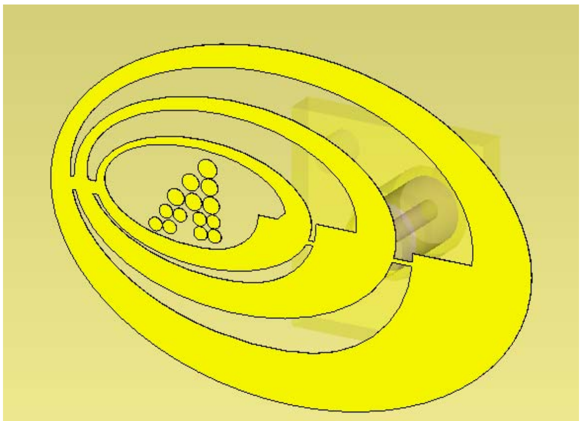
II. METHODOLOGY

This paper is about to investigate the capability of the elliptical antenna to radiate at 2.45GHz. The design has 3 layers consist of ground plane, substrate and the patch. Since an ellipse has 2 focus points, the distance from the center to one of the focus points will be 11.784 mm. In Figure 1(a), the first elliptical slot follows the shape of cylinder with an outer radius of 0.8mm, while the second slot is created using a torus of outer radius 1.2mm and inner radius 1.1mm.

The largest slot is created using torus of large radius 2.4mm and small radius 2.28mm. The slots created are separated from each other and a connector was placed to connect the slots, as shown in Figure 1(b). Dimension wise, the connector has a length of 2.5mmm with a width of 0.4mm.



(a)

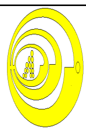
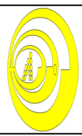
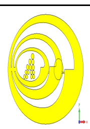


(b)
Figure 1: Elliptical antenna at 2.45GHz (a) Front view. (b) Layout view

III. Result and Discussion

The different between those results for return loss, bandwidth, gain, radiation efficiency, total efficiency are shown in Tables 1 with multiple designs.

Table 1: Result for different location of coaxial ports

Design	A	B	C	D
				
Return Loss(S11)	-19.719	-26.58	-14.7	-11.713
% Bandwidth	2.3	2.77	2.34	2.81
Directivity Gain(dBi)	-1.906	-4.051	-5.742	1.126
Radiation efficiency	0.1590	0.08108	0.07491	0.2411
Total efficiency	0.1568	0.07901	0.07180	0.1066
VSWR	1.269	1.3782	1.512	1.6827

From Table 1, the return loss for design A is -19.719 dB, meanwhile -26.58 dB, -14.7 dB and -11.713 dB are stated for design B, C and D respectively. Higher bandwidth makes the antenna much better. So in this case, designs D have a higher bandwidth. Designs D also have a high gain, high radiation efficiency and high total efficiency compared with other design. Different design will make different result. Design D is the improvement from design A, B and C. The different design A, B, and C is the coaxial feed. Design A have a coaxial feed at the outer while designs B have a coaxial feed at the inner. And designs C have a coaxial feed at the center. Bridged are using to create design D to make good surface current and more high gain.

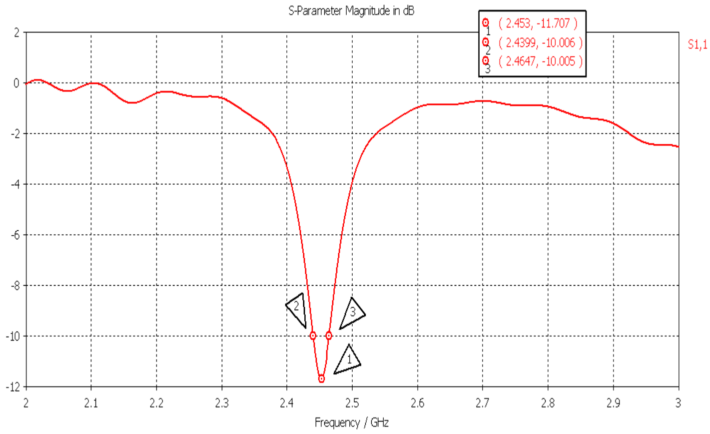


Figure 2: Return loss of proposed antenna at 2.45GHz

Figure 2 shows the proposed antenna is successfully operated with return loss of -11.707 dB at 2.45GHz. The proposed antenna's load impedance (Z_L) is matched with the Z_0 (reference impedance) as depicted by Figure 3.

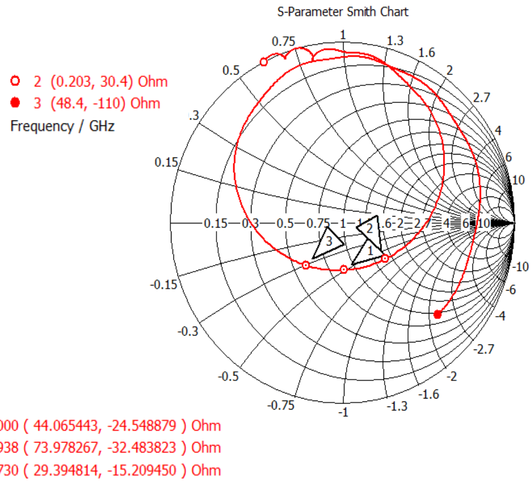


Figure 3: Smith chart of elliptical antenna

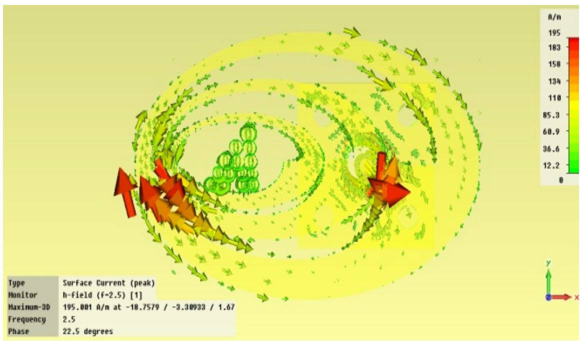
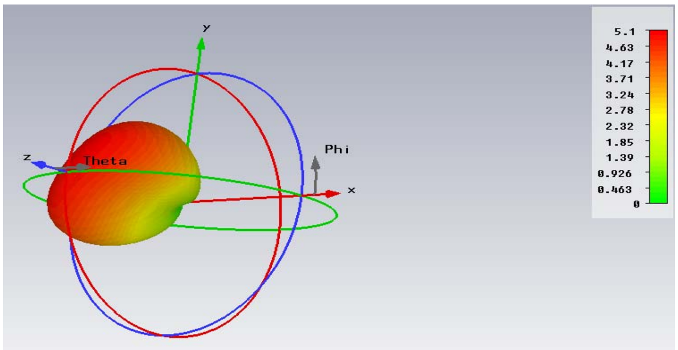
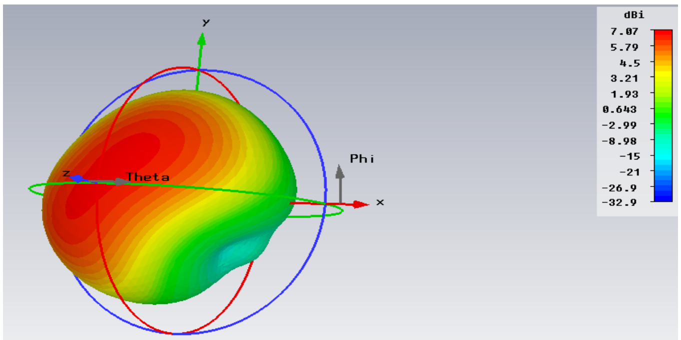


Figure 4: Surface current of elliptical antenna

Figure 4 shows the surface current of the proposed antenna while Figure 5(a) and (b) presents the simulated directivity for linear and non-linear radiation pattern.



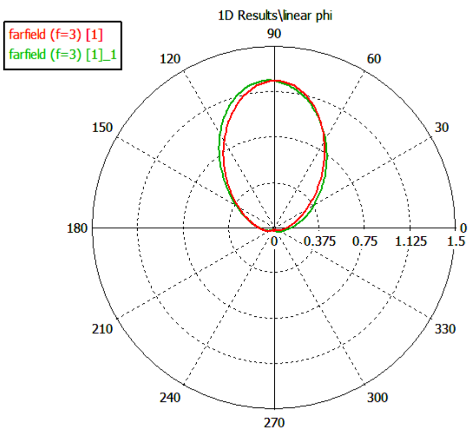
(a)



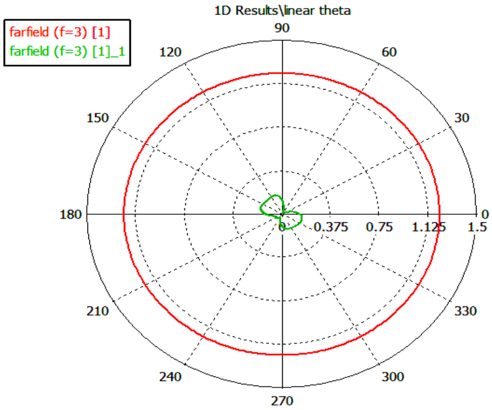
(b)

Figure 5: Directivity of the elliptical antenna (a) Linear (b) nonlinear

It is observed that the directivity of elliptical antenna stated as high as 5.1 dB and 7.07 dB for linear and non-linear respectively. The co-polarization and cross-polarization radiation pattern have been described in Figure 6(a) and (b).



(a)



(b)

Figure 6: 2-D far field gain in linear (a) Phi = 90° (b) Theta = 90°

IV. Conclusion

This paper has successfully designed an elliptical patch antenna operating at 2.45GHz. It is found that three elliptical shaped slots contributed significantly to the achievement gain of 7.07 dB. The antenna also capable functioning at 2.45 GHz with a return loss of -22.87dB. The antenna has a big potential for a wider Wi-Fi application.

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