Circular Slot Microstrip Patch Antenna for Wireless Communications

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Abstract

This article elaborated the detailed performance analysis of circular slot etched on the surface of square shape microstrip patch antenna. The antenna is designed with easily available and cost effective FR4 dielectric material. A critical analysis by varying the radius of the circular slot has been performed to indicate the effectiveness of slot dimensions. The achieved results confirm that the implementation of slot of radius 5 mm not only reduces the size but also provide the improved reflection coefficient of -33.15 dB at 3.13 GHz resonant frequency. These results support the suitability of proposed antenna for wireless communications systems.

Keywords

Antenna, microstrip, reflection coefficient, slot

1. Introduction

During last two decades, microstrip patch antennas are very popular among the antenna system design engineers. The low profile and easy to design feature of these antennas adds several degrees of freedom for antenna element designs [1-2]. In literature various shapes and structures of micrsostrip patch antennas has been explored in an extensive manner. Among them implementation of slots on the radiating patch is one of the many ways to achieve the improved resonating and radiation characteristics [3]. It is well established fact that the slots on the radiating patch are capable to provide wider bandwidth, additional resonant frequencies, better gain and high impedance matching [4, 5]. In light of the similar phenomena, a simple attempt has been made here to illustrate the potential of slot structures to enhance the performance parameters of the microstrip patch antennas.

2. Design and Structure

In order to better understand the effect of slot, a very simple square shape design of radiating element along with circular slot has been considered in this study. The small size square has side length of 20 mm and it is based on the fixed ground plane size of 30mm side length. FR4 substrate because of its reliable and low cost features has been chosen as the dielectric material. A thin microstrip feed having width of 1mm is utilized here to obtain the good input impedance matching. Further to improve the radiation and resonating parameters of presented radiator, a small circular slot of radius, *r* has been etched from the patch. Figure 1 depicted the structure of the presented radiator with and without circular slot.

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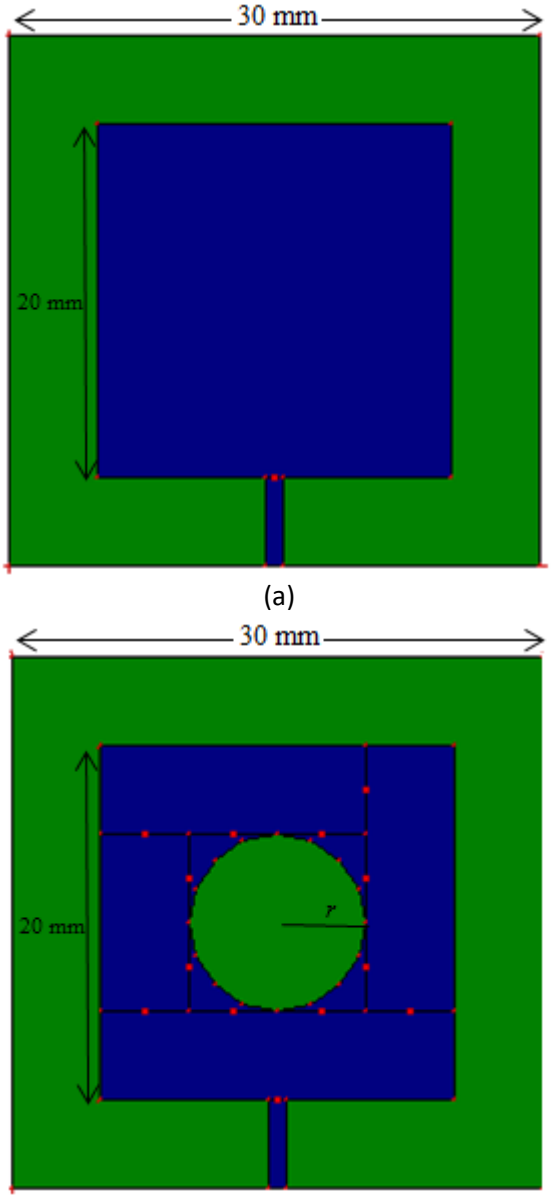

Figure 1: Geometry of the Antenna (a) patch (b) patch with circular slot

3. Results and Discussion

The simulations on the presented antennas have been performed using full wave IE3D simulator.

3.1. Resonating Characteristics of Presented Antenna

The results obtained from the simulations gives that simple square shape radiating element possess the resonating frequencies of 3.37 GHz with -22.99 dB reflection coefficient and 5.40 GHz with -19.45 dB reflection coefficient. It has been observed that after employment of circular slot, besides the size reduction of around 20 % in terms of radiating patch, the antenna possess resonance at 3.13 and 4.63 GHz with reflection coefficient of -33.15 and -16.78 respectively. The proposed antenna is also possessing better impedance matching than its counterpart. The S-parameters of the proposed antenna with and without circular slot is given in Figure 2.

As far as the industrial significance is concern, the proposed work is presented the low cost, small size and simple planar antenna design that can be printed easily on the circuit board and integrate efficiently to the other microwave devices. These advantages make the designed antenna a strong candidate for wireless communication systems.

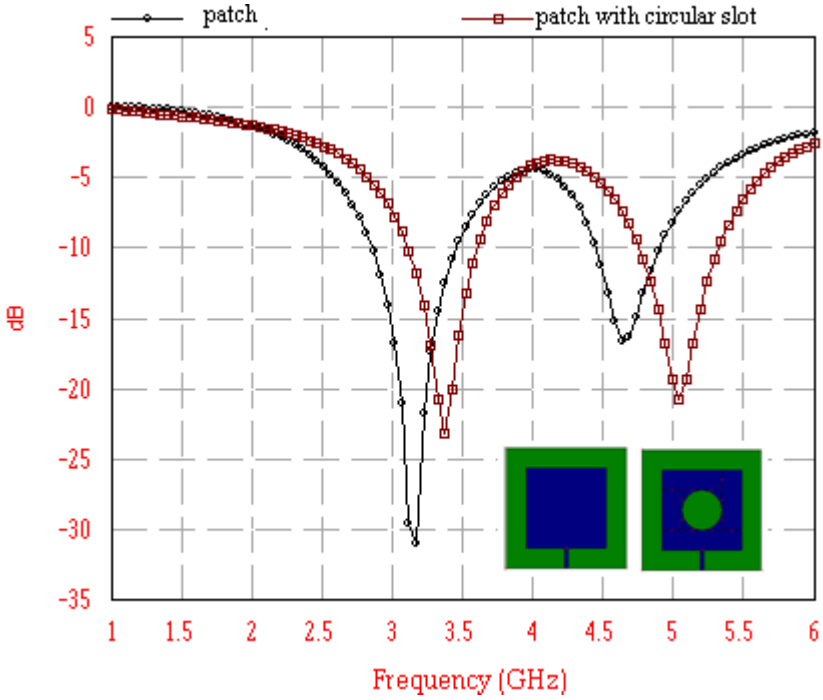

Figure 2: S-parameters of the proposed antenna with and without circular slot

3.2. Analysis by varying the Radius of the Circular Slot

The analysis by varying the core dimension that is radius of the circular slot has been done to evaluate the performance of the antenna. It is very much clear from the results given in Figure 3 that the best results in terms of the reflection coefficient is obtained when the radius of the circular slot has been fixed to 5mm.

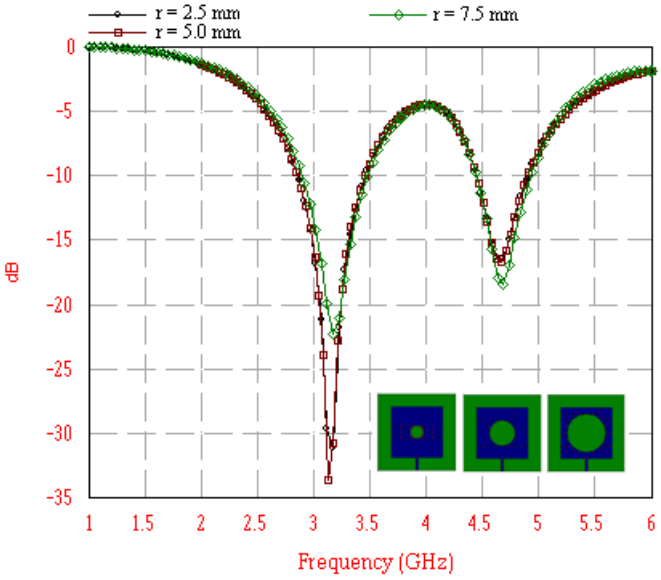

Figure 3: S-parameters of the proposed antenna with varying slot radius

3.3. Radiation Patterns

Radiation patterns of the presented radiating patch element with circular slot has been simulated and examined rigorously. This examination has been performed in the two principle planes as shown in Figure4. The result from the simulations reveals that the antenna is possessing bidirectional radiation patterns in the elevation plane and omni-directional radiation patterns in the azimuthal plane.

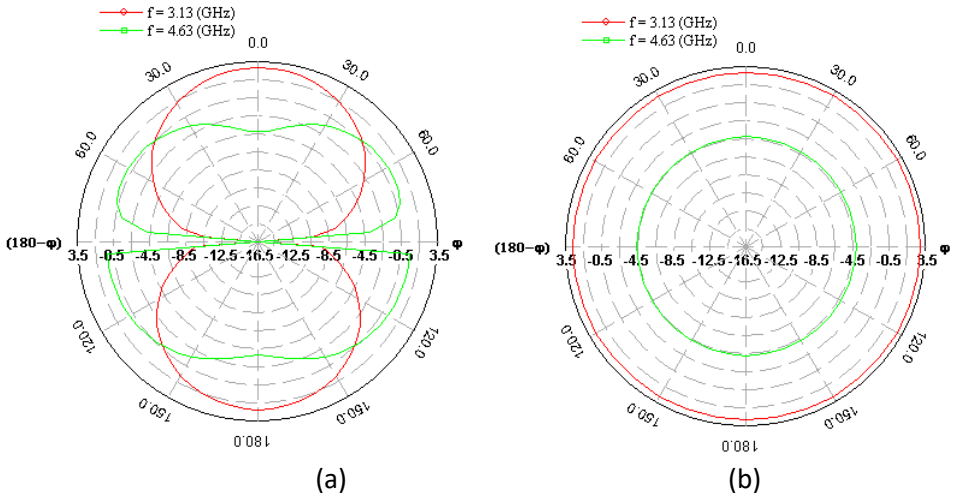

Figure 4: Radiation patterns of the antenna in (a) elevation plane (b) azimuthal plane

3.4. Gain

The gain of the proposed antenna within the simulated frequency range is depicted in Figure 5. It has been observed that the circular slot antenna provides gain of 2.86 dBi at 3.17 GHz resonating frequency and 3.66 dBi at 4.636 GHz resonating frequency

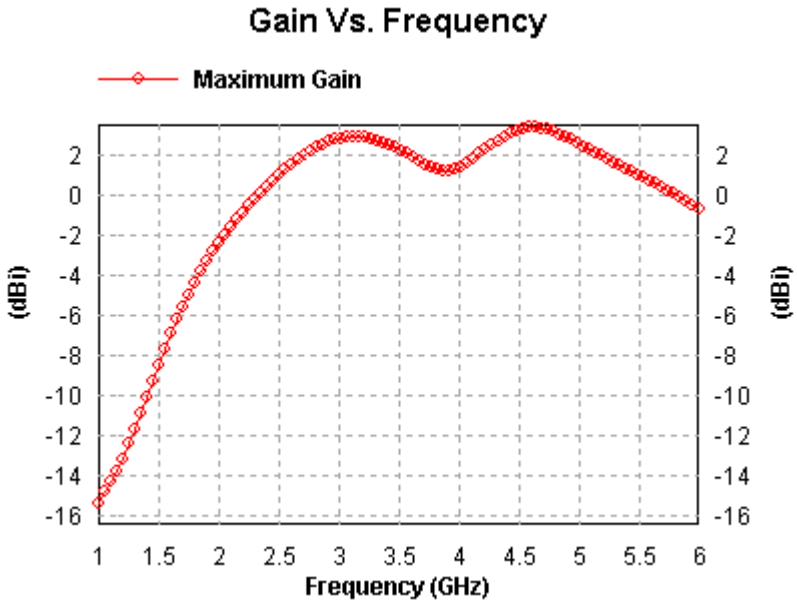

Figure 5: Gain of the proposed antenna

4. Conclusion

A simple approach to identify the effect of circular slot on the square shape patch antenna is attempted here. In order to get in to deeper details, a critical analysis by varying the radius of the circular slot has been made. The observations conclude that the presented antenna not only achieves miniaturization but also possess better resonating and radiating properties after the employment of circular slot.

5. References

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