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2.4 G HZ MINIATURISED RECTANGULAR MPA WITH DEFECTED GROUND AND PATCH

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*Abstract***— This study aimed to develop a miniaturised rectangular microstrip patch antenna with a resonance frequency of 2.4 GHz. In order to achieve this, an initial microstrip antenna's resonance frequency was shifted from 3 GHz to a lower frequency by employing a defective ground structure (DGS) with a triangular-shaped slot into the ground plane. Also Triangular ring slots used defect the patch to improve co- and cross-polarization separation. Finally, a successful downsizing of up to 28% along the length and 18% along the width of the patch is achieved compared to the traditional 2.4 GHz microstrip antenna. The findings of the experiments have been obtained using high-frequency structure simulator software (HFSS). The substrate used in this work is RT/ Duroid 5880, which has a dielectric constant of 2.2 and a thickness of 1.575 mm.**

Keywords— **Microstrip Patch antenna, DGS, Miniaturised**

I. INTRODUCTION

The antenna is a metal structure used to send and receive radio waves and electromagnetic waves. When transmitting, the antenna changes electrical energy into electromagnetic waves, and when receiving, it does the opposite. Antennas exist in a wide variety of sizes and configurations, from rooftop designs that receive television broadcasts to those that capture signals from satellites located millions of kilometers away [1]. Modern society is greatly impacted by the rapidly expanding field of wireless technology. This shifted the current trend in research to make antennas smaller, which makes them possible to use in hand held wireless communication systems. This has led to a variety of antenna designs for modern wireless communication technologies.

A well-organized antenna for a wireless domain has the characteristics of small size, low return loss, wide band width and very high gain with a frequency range of 2 GHz to 4 GHz, and a wavelength range of 75–150 mm, known as the S-band [2, 3]. Due to the great characteristics of MPA (Microstrip Patch Antenna), including low profile, lightweight, affordability, durability, and simplicity of manufacture, MPA is frequently used in wireless communication [4]. In a MPA, a metallic radiating patch is a crucial component, and it is paired with a grounded and dielectric substrate as shown in figure 1 [5]. The MPA can represent a variety of shapes, including circular, trigonal, hexagonal, and rectangular ones [9,10,11,12]. The MPA's size and performance are determined by the various dielectric substrates used in the device.

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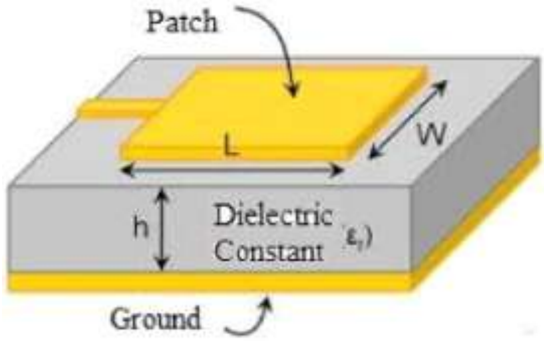

Fig. 1. Structure of Microstrip Patch Antenna

In [6], a microstrip antenna based on the DGS and horizontal patch gap (HPG) was designed to satisfy bandwidth and higher performance criteria. [7] presents a compact wideband slotted hexagonal patch antenna for WiFi-5/6 communication with a modified ground structure. The reduced antenna size is significantly impacted by the redesigned ground plane structure. The performance of the antenna has been significantly enhanced by the slotted patch. An omni-directional radiation pattern with a gain and directivity range of 3.1 dB to 4.1 dB and 3.6 to 4.9 dBi is suited for WiFi-5/6 connectivity. Additionally, a suggested downsized 3 GHz resonant microstrip antenna based on DGS was designed and evaluated against a traditional one. The [4] proposes a method for shifting the antenna's resonance frequency using DGS. At first, the resonance frequency was considered to be 5.7 GHz. However, by applying DGS, the resonance frequency changed to 3 GHz. The standard antenna and proposed DGS microstrip antenna are then compared at 3 GHz.

This research suggests a miniature microstrip patch antenna for wireless communication. The proposed antenna initially resonates at 3 GHz; however, by using DGS, the resonance frequency is changed to 2.4 GHz. Triangular ring slots are used on the patch to improve co- and cross-polarization separation.

II. PROPOSED METHODOLOGY

In this paper, a RT/ Duroid 5880 substrate with a dielectric constant of r = 2.2 is employed, and an inset feed is used to improve the input impedance. The substrate has a thickness of 1.575 mm. There are many different approaches that have been proposed as potential ways to design the microstrip antenna. The cavity model and the transmission line model are two examples of these models. In this configuration, the rectangular patch having a resonant frequency of 3 GHz is designed using the transmission line model as the starting point.

To achieve a smaller antenna profile with resonance frequency of 2.4 GHZ, we have introduced DGS with a triangular shaped slot on the metallic ground plane as shown in figure 2. The defect geometry etched on the ground plane disrupts the current distribution in a microstrip antenna. Due to this the capacitance and inductance of the transmission line are modified by the interference. As a result, an increase in effective capacitance and inductance [8] caused by the introduction of DGS in a microstrip antenna might affect the input impedance and current flow of the antenna, causing it to become smaller in size in relation to the resonance frequency.

In addition, a triangular ring slot are used to defect the patch in order to improve co-polarization and cross-polarization separation by disrupting the current distribution. The table 1 shows the physical dimension of the proposed antenna calculated using standard formula.

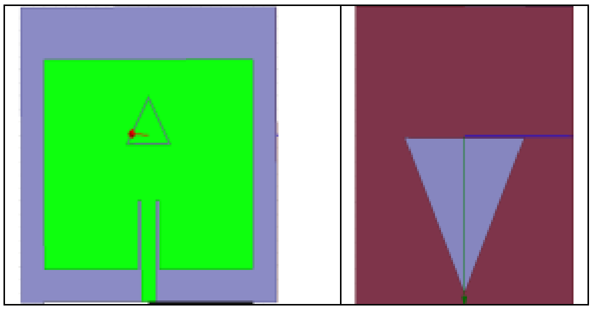

Fig. 2. Top and bottom view of miniaturised rectangular microstrip patch antenna with a resonance frequency of 2.4 GHz

Table -1 Physical dimensions of proposed rectangular MPA

Parameters	**Dimensions of conventional 2.4 GHz antenna in mm**	**Dimensions of proposed antenna in mm**
Width of patch	49	40
Length of patch	41	32
Width of substrate	59	49
Length of substrate	51	45
Width of ground	59	49
Length of ground	51	45

III. EXPERIMENT AND RESULT

A comparison is made between the S11 vs frequency graphs of the rectangular microstrip antenna with defects and antennas without defects. It can be seen from analyzing figure 3 that the microstrip rectangular antenna is capable of resonating at 3 GHz with an S11 value of -25.66dB when there is no defective ground structure present. The microstrip antenna is discovered to concurrently resonant at 2.4GHz after defects were introduced in the ground plane of the microstrip antenna as shown in figure 4. The reflection coefficient curve, the voltage standing wave ratio (VSWR), and the gain are used to report on the performance of the proposed antenna. When it comes to narrow band antennas, a return loss of -15.7 dB, gain of 4.77

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dB with VSWR of 1.39, is considered acceptable. Figure 4 makes it quite easy to see that the suggested antenna has a resonant frequency of 2.4 gigahertz with a bandwidth of 64.5 MHz (2.4359-2.3714GHz).

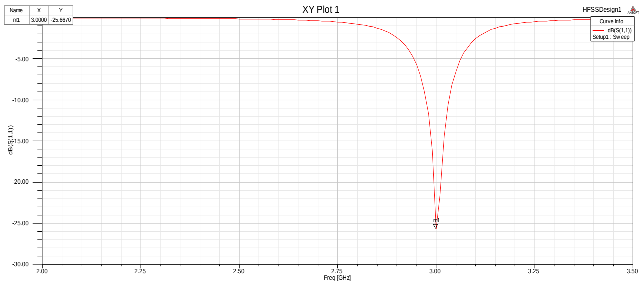

Fig. 3. Return loss of MPA without defect.

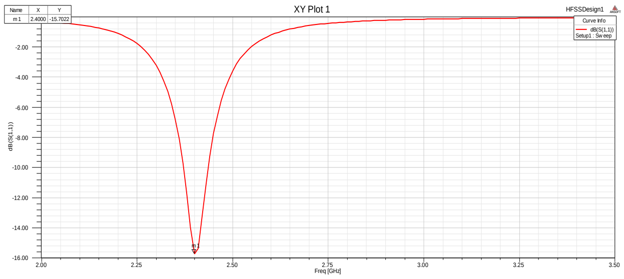

Fig. 4. Return loss of MPA with defect

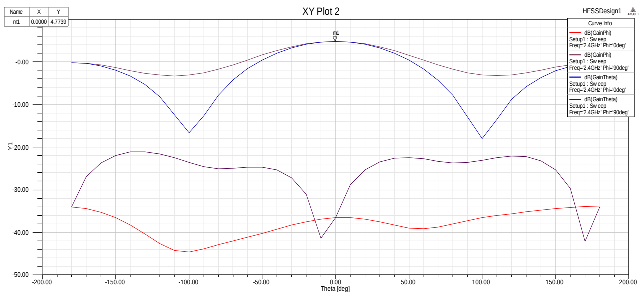

Fig. 5. Co and cross pole polarization

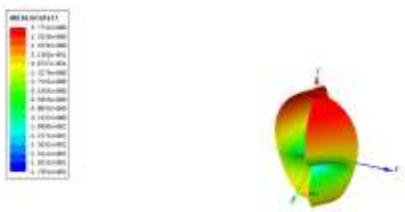

Fig. 6. Gain of MPA

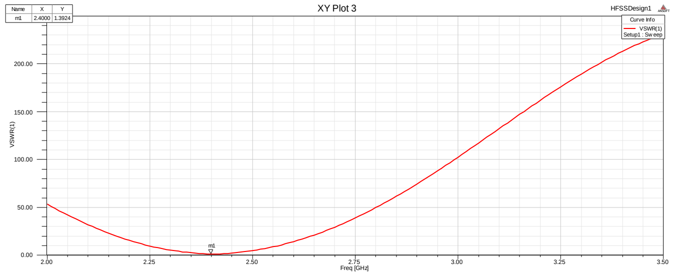

Fig. 7: VSWR

IV.CONCLUSION

The design of a miniaturised microstrip patch antenna with a defective ground and patch structure that resonates at 2.4 GHz has been implemented. ANSYS HFSS was employed for the design process, simulation, and optimization of the proposed antenna.

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