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Multiband Microstrip Patch Antenna for RFID Applications

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Abstract: This paper presents a compact multiband microstrip patch antenna for RFID applications which resonates at 912 MHz and 5.8 GHz. The multi-frequency behaviour is obtained by etching four asymmetric square-shaped slots and slits in the patch. Coaxial feeding technique is used to design this antenna. The design is simulated using Computer Simulation Technology (CST) Microwave Studio software. Finally, the results obtained from the simulations are demonstrated.

Keywords: Microstrip Patch Antenna, RFID, Multiband, Slits.

I. INTRODUCTION

An antenna is an electrical device which converts electric power into radio waves, and vice-versa. Antennas play a very important role in the field of wireless communications. During the recent years, microstrip antennas have attracted an important interest in modern communication systems because of their significant characteristics of small size, light weight, low cost on mass production and thin profile [1, 2]. Modern mobile and wireless communication systems require compact size, broadband and dual/multi frequency antennas, thus the possibility to apply these antennas for modern communication systems is reinvestigated by applying modifications in their patch geometries [3].

Nowadays, Radio Frequency Identification (RFID) systems have been gaining growing interest in telecommunication system. The capability to mark objects and people with passive transponder (tag), allows easy development of cost-effective and low power consumption wireless sensor network. RFID (Radio Frequency Identification) enables identification from a distance, and unlike earlier bar-code technology, it does so without requiring a line of sight [4]. RFID tags support a larger set of unique IDs than bar codes and can incorporate additional data such as manufacturer, product type, and even measure environmental factors such as temperature. These advancements have the potential to revolutionize supply-chain management, inventory control, and logistics. Furthermore, RFID systems can discern many different tags located in the same general area without human assistance [5, 6].

Due to the merits of high data transfer rate and broad readable range, passive RFID systems at the UHF band are preferred in many applications. The total frequency span of the UHF band used for RFID systems is 840–960 MHz. However, there is not a UHF range accepted worldwide for the RFID applications [7]. The system operates at the bands of 902–928 MHz in America, 865–867 MHz in Europe, and 840–955 MHz in Asia-Pacific region. In Asia-Pacific region, the UHF RFID frequency range is different in different countries: China (840.5–844.5 MHz, 920.5–924.5 MHz), Japan (952–955 MHz), India (865–867 MHz), Hong Kong (865–868 MHz, 920–925 MHz), Taiwan (920–928 MHz), Korea (908.5–910 MHz, 910–914 MHz), Singapore (866–869 MHz, 923–925 MHz), Australia (920–926 MHz), etc [8].

In the past years, a large number of microstrip patch antennas for RFID applications have been studied and reported in the literatures. A Patch antenna with a large dimension working in ISM band was proposed in [9]. A low power slotted patch antenna for RFID tag reader applications was proposed in [10] which has an operating frequency band of 2.3-2.4 GHz. A novel asymmetric cross slotted patch antenna was proposed in [11] for circular polarized radiation for UHF RFID reader and WiMAX applications which offers better bandwidth and reduction in VSWR. In [12], a compact microstrip patch antenna for RFID and WLAN applications has been presented.

In this paper, we proposed to design a microstrip patch antenna by etching four squares along the diagonal directions of the square patch. The slits are also introduced along the orthogonal diagonal directions of the microstrip patch to improve return loss and bandwidth. The proposed antenna resonates at 912 MHz UHF band and 5.8 GHz ISM band.

II. ANTENNA DESIGN

The proposed antenna is simulated on Computer Simulation Technology (CST) software and designed on RO4003 substrate which has a permittivity of 3.5 and loss tangent of 0.0027 with dimensions of 90 × 90 × 4.572 mm^3. The configuration of the proposed RFID antenna is

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shown in Fig-1. The coaxial feed-location is at a distance of 15.0 mm from the slotted square patch center. The square slots are embedded along the diagonal directions of the square patch. For the improvement of the return loss, the dimensions of the square patch are optimized. The etched square and slots, as illustrated in Fig-1 are L_1 = 8.83 mm, L_2 = 17.25 mm, L_3 = 21.25 mm, L_4 = 27 mm, L_S = 1, 2, 3 mm, W_S = 0.1, 0.2, 0.3 mm, L_P = 78 mm and W_P = 78 mm.

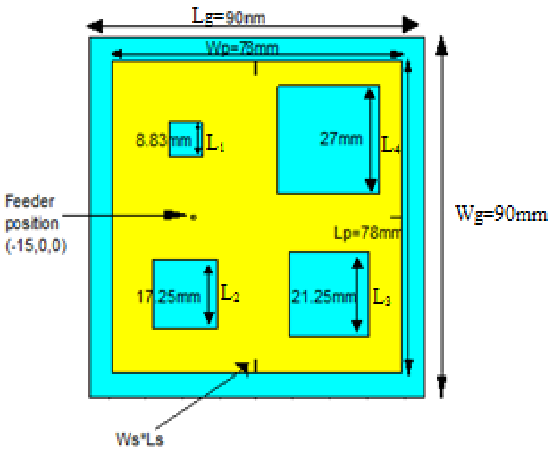

Figure 1: Top view of the proposed antenna

III. SIMULATIONS AND DISCUSSION

The simulation results of antenna parameters like return loss, bandwidth, gain and directivity are obtained by using CST Microwave Studio. The parametric studies show that by changing the size of the etched square slots, the return loss will change. The proposed antenna only with etched squares has frequency band of 36.86 MHz at 912 MHZ and 28.3 MHz at 5.8 GHz resonant frequency.

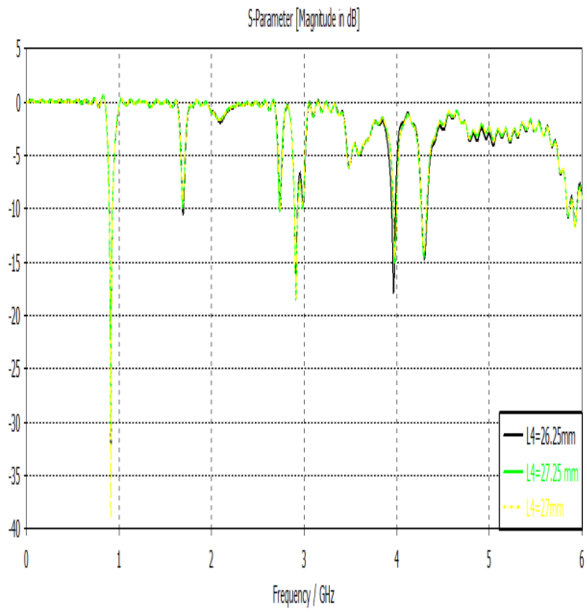

Figure 2: Simulated return loss with etched squares

It is observed from Figure 3 & 4 that return loss shifted as the length and width of the slit increases.

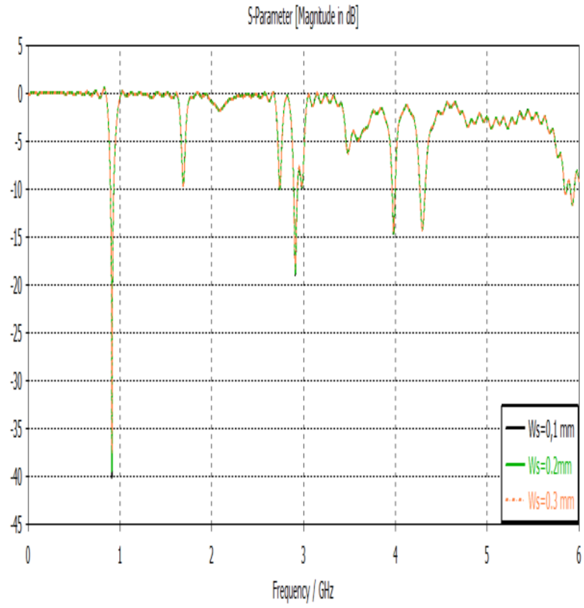

Figure 3: Simulated results of the antenna by changing the width of the slits

From the observations from Figure 3, it is clear that the return loss of -40.1 dB and bandwidth of 36.41 MHz at 912 MHz and at 5.8 GHz, the return loss of around -10.5 dB and bandwidth of 24.4 MHz is best for our antenna.

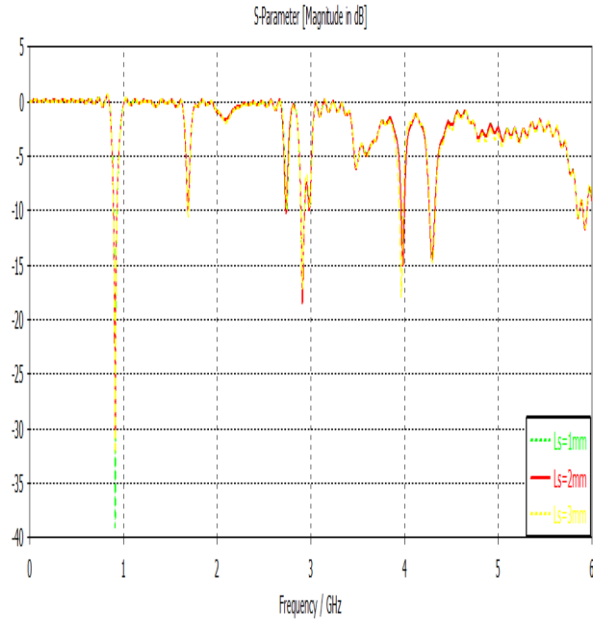

Figure 4: Simulated results of the antenna by changing the length of the slits

From the observations from Figure 4, it is clear that at 912 MHz resonant frequency, the return loss of -39.06 dB and bandwidth 36.41 MHz and at 5.8 GHz frequency, return loss of around -10.6 dB and bandwidth of 26 MHz is best for our antenna.

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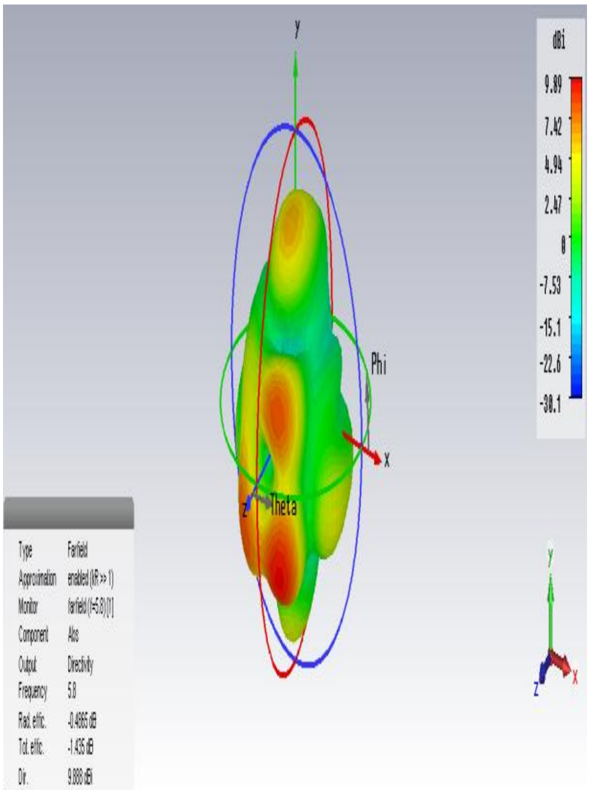

Figure 5: Far-field view for directivity at 912 MHz

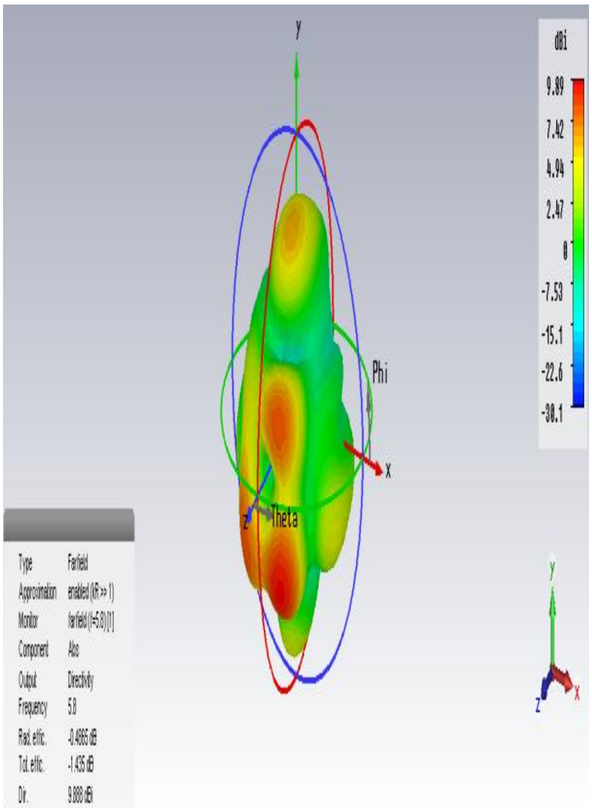

Figure 6: Far-field view for directivity at 5.8 GHz

Figure 5 & 6 shows the far-field view for directivity at 912 MHz and 5.8 GHz respectively. The directivity is 4.79 dBi at 912 MHz and 9.89 dBi at 5.8 GHz.

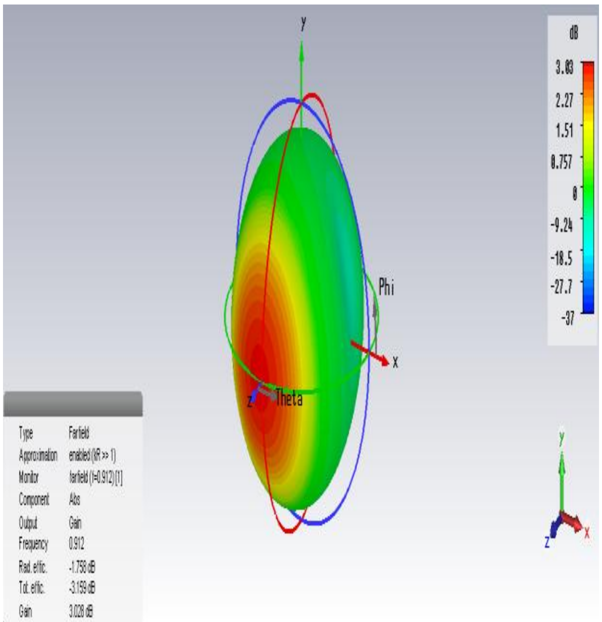

Figure 7: Far-field view for gain at 912 MHz

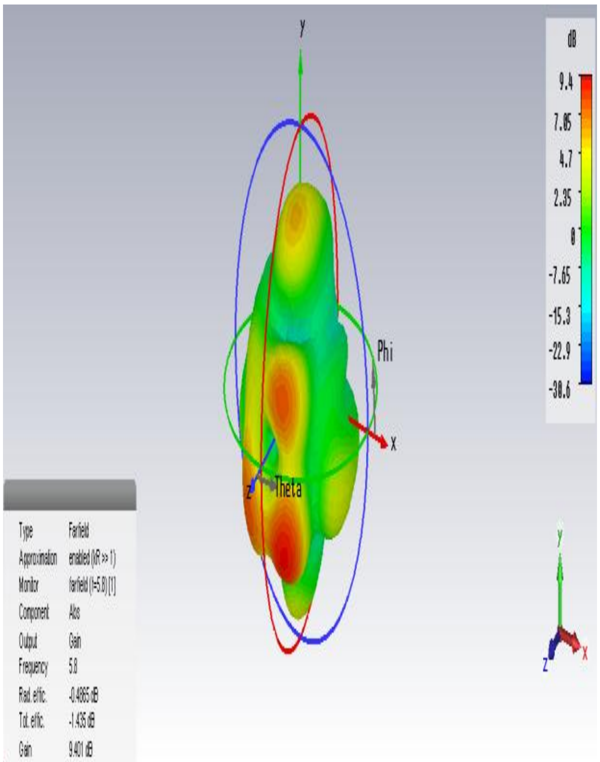

Figure 8: Far-field view for gain at 5.8 GHz

Figure 7 & 8 shows the far-field view for gain at 912 MHz and 5.8 GHz respectively. The gain is 3.03 dB at 912 MHz and 9.4 dB at 5.8 GHz.

IV. CONCLUSION

Novel asymmetric square-shaped slotted square microstrip patch antenna with slits has been presented for the radio frequency identification applications. It has been shown that by changing the dimensions of the square slots and

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slits, the return loss of the antenna varies. The proposed antenna is compact and and can be conveniently used in applications such as in handheld / portable UHF RFID applications.

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