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Symmetrical Slot on C-Shape Microstrip Patch for Tri-band Application

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ABSTRACT
A new triple band microstrip patch antenna is presented in this paper for wireless communication. By adjusting the dimension of ground plane and patch, its fractional bandwidth at primary resonance mode can increased sufficiently to achieve desired bandwidth of proposed antenna. In proposed design, it has been found that the symmetrical position of patch over ground plane have clear impact on overall antenna performance. Many antenna structures have been modeled to demonstrate the effects of these parameters on the resulting triple band response. We design antenna for (1.07-1.75GHz), (3.22-4.35) and (5.78-6.5GHz).

Keywords
Microstrip antenna, Dielectric Patch antenna, Length; Losses; strip width; strip length.

1. INTRODUCTION
Ahmed H. Reja [1] proposed Study of Micro Strip Feed Line Patch Antenna experimentally increase the Return Loss -33.60dB at 2.5GHz frequency and VSWR is 1.5 by using CAD for RT DUROID 5880. Santanu Kumar Behera and Y. Choukiker [2] proposed Design and Optimization of Dual Band Micro Strip Antenna using Practical Swarm Optimization maximize the return loss for dual band Frequency at 2.4GHz is -43.9dB and at 3.08GHz is -27.4dB. M. A. S. Alkanhal[3] proposed microstrip antenna by integrating various shapes to get reduced size and maintain performance of antenna for triple band. A A Deshmukh and G Kumar [4] proposed compact L-Shape patch broadband Microstrip antenna experimentally increase bandwidth up to 13.7%. Z M Chen [5] further increase bandwidth of this antenna up to 23.7% - 24.43%. K F Lee [6] proposed U Shape slot shorting post small size Microstrip Antenna and increase bandwidth up to 42%. S C Gao [7] used uniplanar photonic band gap structure for enhancing band width and gain. M Khodier [8] New wideband stacked microstrip antennas for enhancing band width. Major issue for micro strip antenna is narrow Bandwidth. Asymmetrical patch on ground plane affect overall performance of antenna. K. Song et. al [10] designed asymmetrical L-shaped patch antenna for UWB application with -10dB return loss and peak gain 2.22 to 6.1 dBi for operating bandwidth 3.01-11.30 GHz frequency.

In this paper we tested our design by using electromagnetic simulator HFSS. Researchers are focusing on how to design microstrip antennas for various band. Due to its advantages such as low-cost, small size low weight and capability to integrate with Microwave integrated circuits, the microstrip patch antenna is a very good candidate for integrations in applications such as wireless communication systems, mobile phones and laptops. In this paper a single C-slot microstrip antenna with two symmetrical strip (Figure 1) is designed and simulated for the frequency range of 0.5-7 GHz. This antenna presents an extension to the single C-slot antenna presented at LAPC 2009 [8, 9]. The proposed antenna has a gain of 3.8 dBi and presents a size reduction of 33% when compared to a conventional square microstrip patch antenna. Extensive simulation results using Advanced Design Systems by Agilent (uses the MOM method) will be presented.

2. PROPOSED DESIGN
The results of proposed triple band microstrip patch antenna verified in HFSS Simulator with optimization. The initial antenna is shown in Figure 1 and Figure 2. It consists of a single c-slot with two slot symmetrical to c-slot at the center of patch. Each end and placed within the patch [7]. The resulting antenna structure has the following parameters; the patch shape length W_p = 28.5 mm, and its width L_p =24.5 mm. The size of the ground plane has been found to be of L_{g1} = 40mm and W_{g1} = 40mm. The height of substrate is h= 1.5 mm and dielectric constant ε_r = 4.4. A 50 Ω inset microstripline feed is attached to the microstrip and has a width L_t = 2.6mm and length W_t = 54mm. The length and width of c-slot that is S_3 is 21mm and 1mm respectively.

We will conduct a simulation study on the structure of Figure 1 by adjusting the dimension of slot placed above and below of c-shape slot that is S_1 and S_2. The resulting dimension of slot S_1 and S_2 after simulation antenna structure are 1.5mm×21 and 2mm×21mm respectively. Initially we put ground position for entire patch. As we reduce ground material, it is found that return loss is getting reduced from –9dB to -15dB. The ground substrate length on backside of patch is reduced and simulated for different dimension; it is observed that we get second (3.22-4.35 GHz) and third band (5.78-6.5GHz) with sufficient return loss, the resulting return loss responses obtained by reducing ground plane, we obtain optimized return loss as presented in figure 3. Further we simulated for different dimension of ground plane that is ground plane at front side of patch. Again we simulated for different dimension of ground plane to get optimized result, in this case it observed that we get first, second and third band with sufficient return loss, the resulting return loss presented in figure 4 and figure 5. From above result the finalized dimension of ground plane are, dimension of backside and front side ground plane are 40mm×43mm, 14mm×36mm respectively.

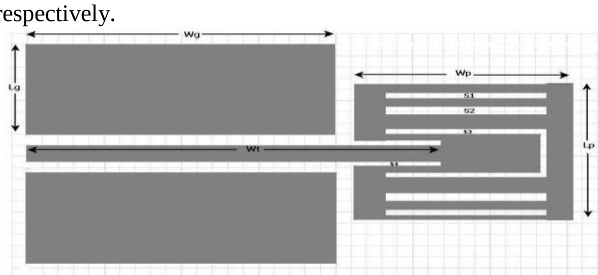

Figure 1. Proposed antenna design (Front side)

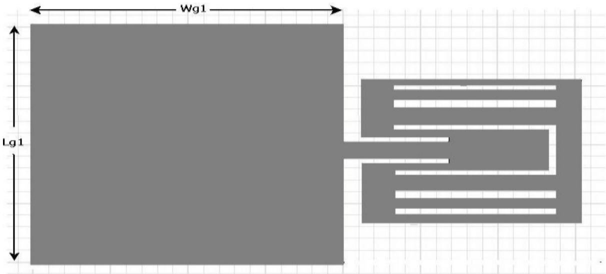

Figure 1. Proposed antenna design (Back side)

From figure 4 and figure 5, it is observed that, we get minimum return loss that is -45dB, -25dB and -35dB at 1.5GHz, 3.9GHz and 5.9GHz respectively.

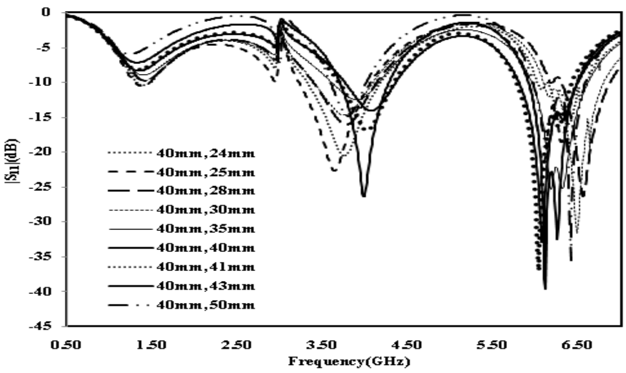

Fig 3: Return loss of antenna for variation in ground plane (backside)

Results of the variation of the size of the ground plane, as Figure 1 implies, that the tripple band response deteriorates for ground plane width other than the reference value.

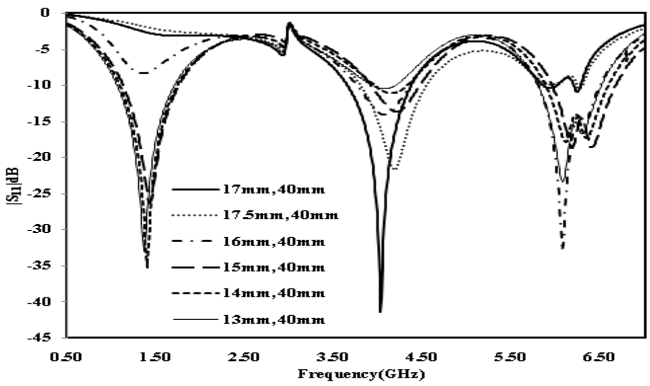

Fig 4: Return loss of antenna for variation in ground plane (frontside)

However, tripple-band responses are obtained with increased or decreased higher resonating bands. The effect of the width of ground has been demonstrated in Figure 3, Figure 4 and Figure 5. For larger values of the width of ground, the antenna offers a one-band resonant behavior, and the triple-band resonance occurs as the width is made smaller and approaches that of the reference antenna.

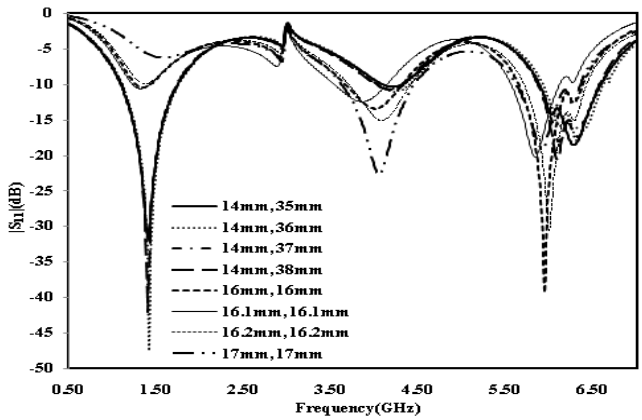

Fig 5: Return loss of antenna for variation in ground plane (frontside)

Figure 6 depicts the radiation pattern for first band that is 1.5GHz frequency since return loss at this frequency is -45dB. Similarly Figure 7 presents radiation pattern for second band that is 3.9GHz since the return loss at this frequency. The current distribution for is also presented in figure 3 that is the resulting current distribution for second band that is at 1.5 GHz since return loss at this frequency is -10.04. Gain of antenna at 2.4 GHz is 4dBi and radiation pattern of antenna as presented in figure 4 and figure 5 respectively.

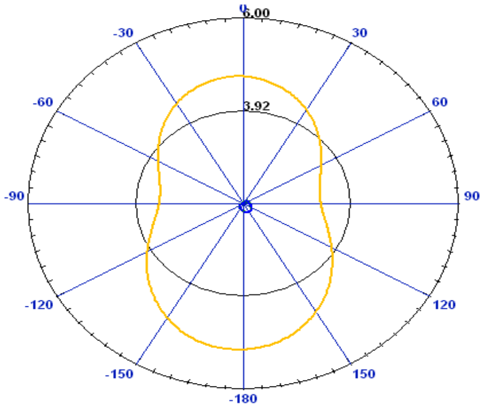

Fig 6: Radiation pattern at 1.5GHz

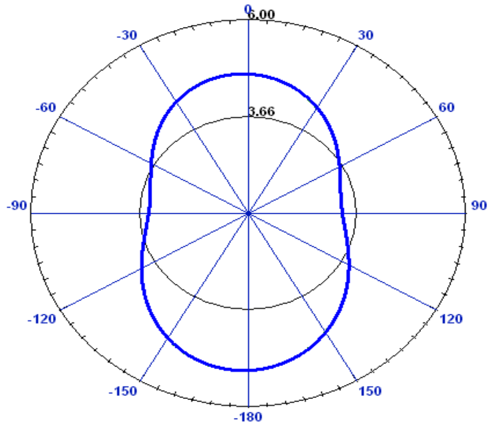

Fig 7: Radiation pattrn at 3.9GHz

3. CONCLUSION

The design optimization of a dual slot patch antenna has been presented and discussed. It has been shown that with correct selection of slot dimensions on patch and shape of ground plane, a triple band frequency response can be achieved. With this antenna, we get much improved bandwidth this design is obtained method, as a candidate for use for triple band that is (1.07-1.75 GHz), (3.22-4.35 GHz) and (5.78-6.5GHz). The antenna has been modeled and its performance has been analyzed using a HFSS simulator. The proposed antenna has been found to possess a miniaturized size and a width making it suitable for compact size triple band applications. The simulated results of HFSS at 1.5GHz is Return loss = -45dB, at 3.9GHz Return loss = -25 dB and at 5.9 GHz Return loss = -35. VSWR at 1.5 GHz is 2.01, Gain = 3.4dBi at 1.9 GHz Efficiency= 90%..

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