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Investigation of Microstrip Line and CPW Fed Asymmetrical T-Slot Antennas for Improved Bandwidth

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***Abstract*— A rational analysis to enhance bandwidth required easy to fabricate antenna designs. Given the different techniques to increase the bandwidth uni-planar designs become prominent due to less misalignment error. In this paper, a bandwidth enhancement technique of asymmetrical T-slot antennas using microstrip line and coplanar waveguide (CPW) feed are investigated. The bandwidth of T-slot antennas obtained is 21.6% and 29.4% when excited by microstrip line and CPW feed respectively. The designed antennas are simulated using Ansoft HFSS and argumentation over reflection co-efficient and radiation pattern are presented.**

***Keywords*— Bandwidth percentage, co-planar waveguide feed, microstrip Line, slot antennas.**

I. INTRODUCTION

Ensuring bandwidth enhancement without significantly increasing size is perhaps the biggest and serious challenge for antenna designers. Higher bandwidth, small size, fabrication ease, and ability to integrate with monolithic microwave integrated circuits are desirable factors in antenna design and it is for this reason that a broadband microstrip antenna is recognized in commercial applications such as wireless local area network (WLAN) and Bluetooth personal network. In the last decade, an intensive research has been carried out for developing broadband antenna with reduced size. This culminated in various designs such as different shapes of patch [1-2], stacked patch [3-4] and shorted patch antenna [5]. Slot antenna with different geometrical configurations ensures bandwidth enhancement [6-7]. In achieving the broadband operation, there are attractive merits that can be obtained from wideband slot antennas [8-15] such as low profile, low cost, easy fabrication and wide impedance bandwidth. The core of the design was an appropriate combination of different configurations and applications. The need for such a combination came from the understanding that slot antennas can be conformed to any configuration such as H-slot [8], T-slot [9], E-slot [10], wide rectangular slot with U-shaped stub [11], open L-slot [12], wide slot [13], multi-via holes [14], rectangular stub to the circular radiating patch [15], and can be conveniently energized with a coaxial transmission line or a waveguide. The key of the success of the above designs depend on alignment error in microstrip line fed slot antenna.

In this paper, misalignment is viewed as an issue because when the antenna is fed by a microstrip line, misalignment can result because etching is required on both sides of the dielectric substrate. In the view of this, two feeding techniques were used for bandwidth enhancement: a microstrip line fed and CPW fed asymmetric rectangular slot antennas. This reflects the importance given to alignment error and ease in fabrication.

II. ANTENNA DESIGN

A. Microstrip line fed Asymmetric T-slot Antenna

In microstrip fed slot antenna, experience with slot cut in the ground plane perpendicular to the strip conductor demonstrates that slot excitation is efficient where there is termination of the strip conductor in an open circuited stub beyond the edge of the slot as shown in Fig. 1.

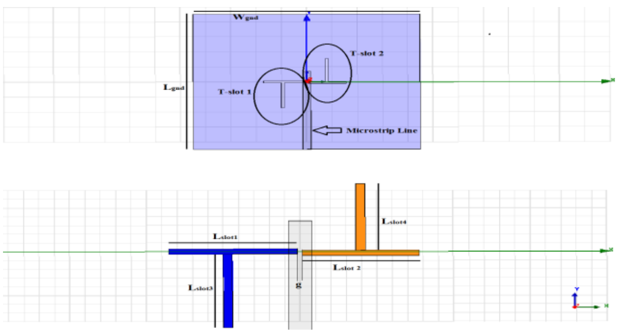


Fig.1. Microstrip line fed asymmetric T-slot antenna simulated using HFSS

The overall dimension of the antenna is 90mm x 90mm. The open slot antenna is fed by a 50-Ω microstrip line of width 3.08mm and length 52mm. A dielectric substrate of ε_r =4.4 and height h=1.6mm is used. To obtain improved bandwidth four rectangular slots in T-shape with one inverted are cut in the ground plane. The optimum design parameters of the rectangular slots are as follows: L_{slot1} = 16.8 mm, L_{slot2} = 15.2mm, L_{slot3} = 16.8 mm, L_{slot4} = 15.2 mm and W_{slot}= 1.2mm. The gap between the T-slots is g = 0.6mm.

B. CPW fed Asymmetric T-Slot Antenna

The implementation of the CPW fed slot antenna requires a uni-planar design as shown in Fig. 2.

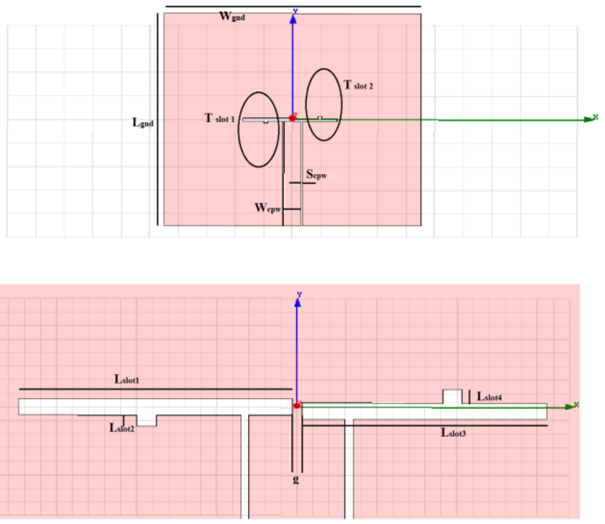


Fig.2. A CPW fed asymmetric T-slot antenna simulated using HFSS

The proposed antenna contains two T-slots; one inverted and a copper layer built on FR4 epoxy substrate of ε_r = 4.4 and height, h=1.6 m. A 50-Ω CPW transmission line is used to excite the two T-slots of asymmetric length. The width and spacing of the CPW line are evaluated as 6mm and 0.5mm respectively. The optimum design parameters of the rectangular slots are as follows: L_{slot1} = 17.1 mm, L_{slot2} = 0.8 mm, L_{slot3} = 15.3 mm, L_{slot4} = 1mm and W_{slot} = 1.2 mm.

III. SIMULATION RESULTS AND DISCUSSION

The microstrip line and CPW fed asymmetric T-slot antennas are simulated using Ansoft High-frequency structure simulator (HFSS) software and argumentation over reflection coefficient, surface current distribution and radiation pattern are laid out.

A. Microstrip line fed Asymmetric T-Slot Antenna

The microstrip fed T-slots give duple resonance as shown in Fig.3

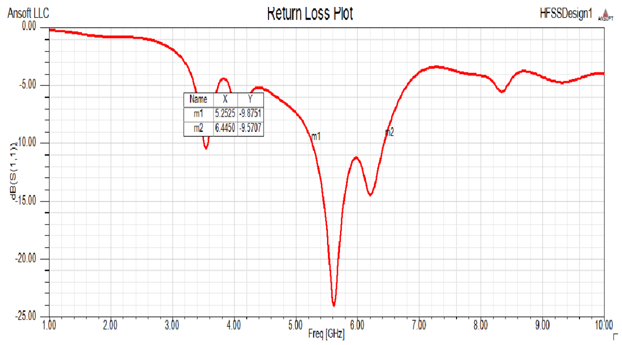
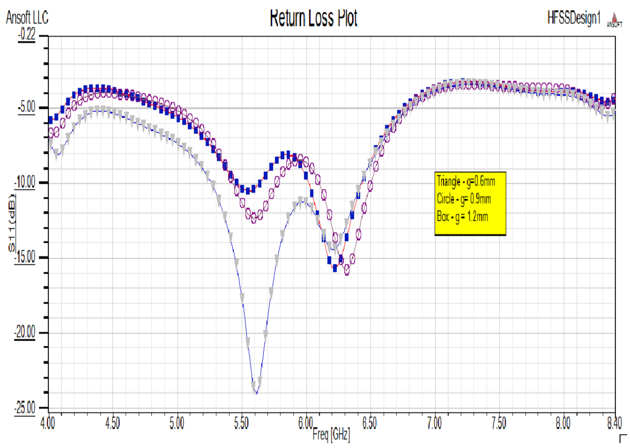


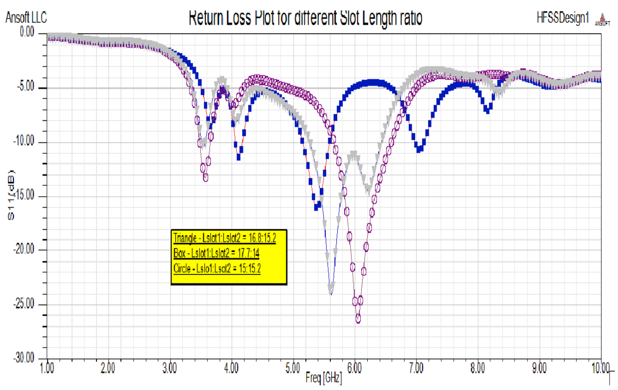
Fig.3. Simulated return loss plot for microstrip fed asymmetric T-slot antenna

From Fig. 3 the simulated return loss plot for microstrip fed asymmetric T-slot gives a bandwidth of 21.6% and establishes broadband operation.

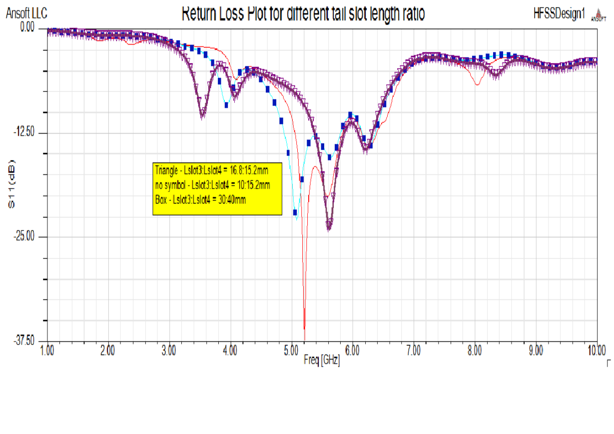
There are two factors that can potentially affect the position of resonances. First is the gap distance between the two T-slots. Second is the length ratio of asymmetric slots



(a)



(b)



(c)

Fig.4. Return loss variation for different (a) gap. (b) Slot length ratio. (c) tail slot length ratio.

From Fig. 4, the maximum bandwidth is attained for gap between T-slots of 0.6mm and slot length ratio of 16.8 mm : 15.2mm. Slot length ratio was identified as dominant and lofty factors in shaping performance of antenna.

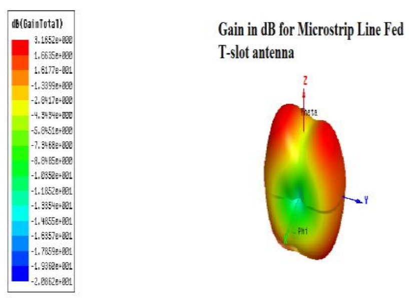


Fig.5. Simulated 3D gain in dB plot for microstrip fed asymmetric T-slot antenna

From Fig. 5, the 3D gain plot for microstrip fed asymmetric fed T-slot antenna depicted uniform radiation in all theta angles with gain of 3.16-dB.

B. CPW fed Asymmetric T-Slot Antenna

CPW fed asymmetric T-slot also exhibits dual resonance as shown in Fig. 6 below

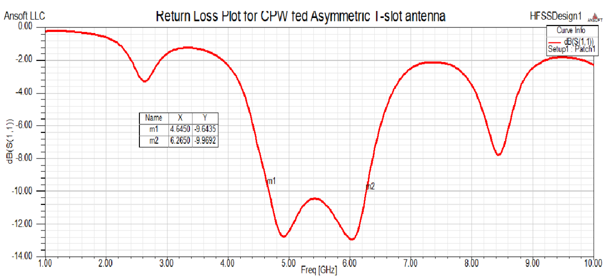
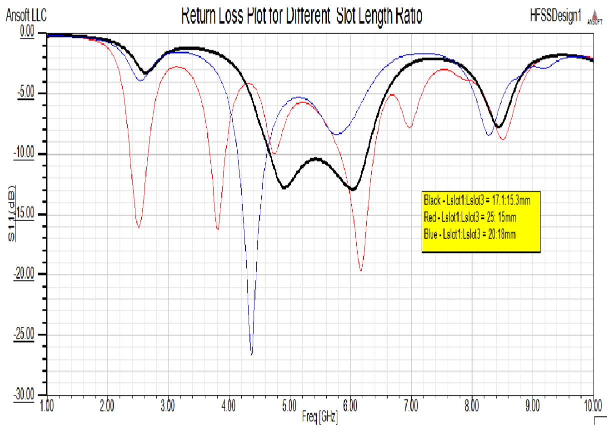
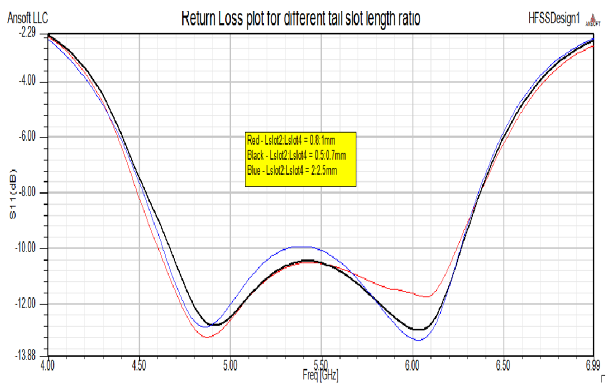


Fig.6. Simulated return loss for CPW fed asymmetric T-slot antenna

From Fig. 6 the simulated return loss plot for CPW fed asymmetric T-slot gives a bandwidth of 29.4% and establishes broadband operation



(a)



(b)

Fig. 7 Simulated return loss variation for different (a) slot length ratio. (b) tail slot length ratio

From Fig. 7 the maximum bandwidth is attained for sloth length ratio of 17.1 mm : 15.3 mm and tail slot length ratio of 0.5 mm : 0.7 mm. Alike microstrip fed T-slot antenna, slot length ratio is a dominating factor in shaping antenna performance.

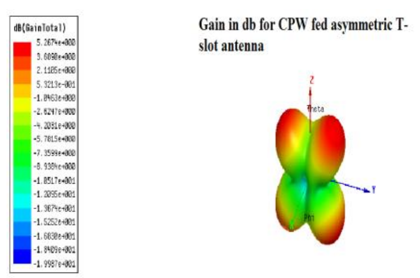


Fig.8. Simulated 3D gain in dB for CPW fed asymmetric T-slot antenna

From Fig. 8, the 3D gain plot for microstrip fed asymmetric fed T-slot antenna depicted stable radiation in entire bandwidth with increased gain of 5.27-dB compared to microstrip fed asymmetric T-slot antenna.

The summary of the simulation results obtained are presented in Table.1

TABLE 1: SUMMARY OF SIMULATION RESULTS

Parameters	Microstrip line Feed	CPW Feed
Bandwidth percentage	21.6%	29.4%
Gain	3.16dB	5.27dB

From Table.1 it is observed that CPW fed symmetric T-slot antenna is beneficial than microstrip line fed T-slot antenna.

IV. CONCLUSION

In this paper, a novel design of slot antennas has been implemented to allow broadband operation using two different feeding techniques such as microstrip line and CPW feed. As experienced in different techniques of feed shows, when uni-planar the design is like CPW feed, not only is the bandwidth better, but targeting errors due to misalignment are reduced thereby ensuring the ease in fabrication. The maximum bandwidth achieved is 21.6% and 29.4% for microstrip line and CPW feed respectively. The dominating factors affecting the performance of the antenna are also discussed. The gain obtained from simulation is 3.16-dB and 5.27-dB for microstrip line and CPW fed respectively. The proposed slot antennas are beneficial for WLAN application. In future, the designed antennas can be fabricated and tested in real time environment.

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