Microstrip Antenna for Broadband Applications using structure shaped substrate and CPW-Feed

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Abstract : This paper focuses on Coplanar Waveguide (CPW)-fed wideband microstrip antenna which best suites for wireless applications. In order to optimize the size of microstrip antenna, the substrate is taken in the form of structure-shape. The rectangular substrate is etched in the form of semi-circular disc to attain this structure shape. An inverted L-strip radiating patch is mounted over the semi-circular disc substrate. The overall size of antenna is 22mm × 22mm × 0.77mm. The proposed antenna has gain of 2.73dB, and exhibits parameters such as efficient group delay, perfect radiation patterns with acceptable impedance bandwidth of 100.7% at 6.85 GHz centre frequency and covers the entire operating bandwidth of range 3.4 to 10.3 GHz. High Frequency Structure simulator (HFSS) software is used for designing and simulation of CPW-fed microstrip antenna. The designed antenna is used in various c band applications.

***Keywords* - CPW-feed, Inverted L-strip radiator, microstrip antenna, structure-substrate.**

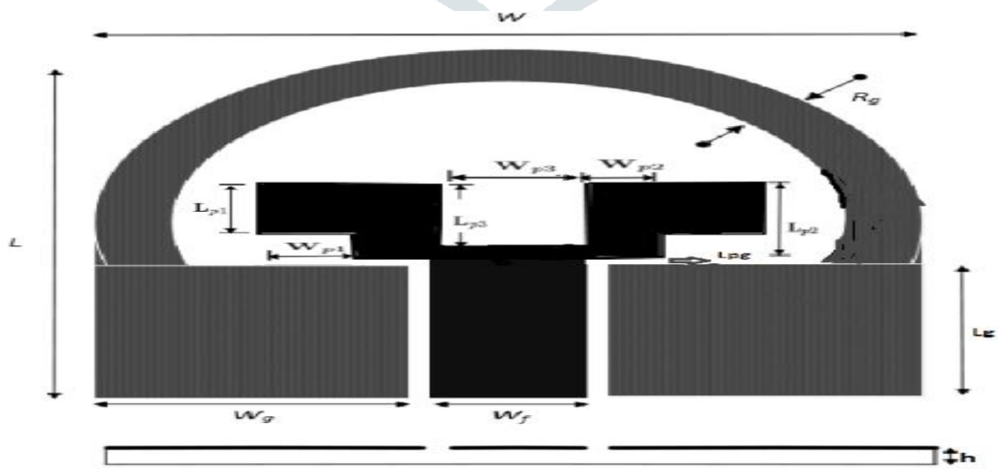
I. INTRODUCTION

Due to the growth of modern wireless communication systems there is a tremendous requirement for wideband, customised and low-cost antennas [1-4]. Because of their low profile, minimum designing cost and simple feeding techniques [5], microstrip patch antennas had various applications in modern communication system. However, the minimization of antenna size is the challenging task for all researchers. Various shapes of patches such as circular [6], inverted [7], butterfly [8], U [9], rhombus [10] etc. are used to attain wide bandwidth. Also, research on different techniques and structures like CPW-fed technique is in progress to attain compact broadband antenna [11-16]. In general, the area around the radiating patch is not utilized effectively by considering the normal rectangular or square shaped substrates. A lot of research is being done on structure-shaped substrate [17].

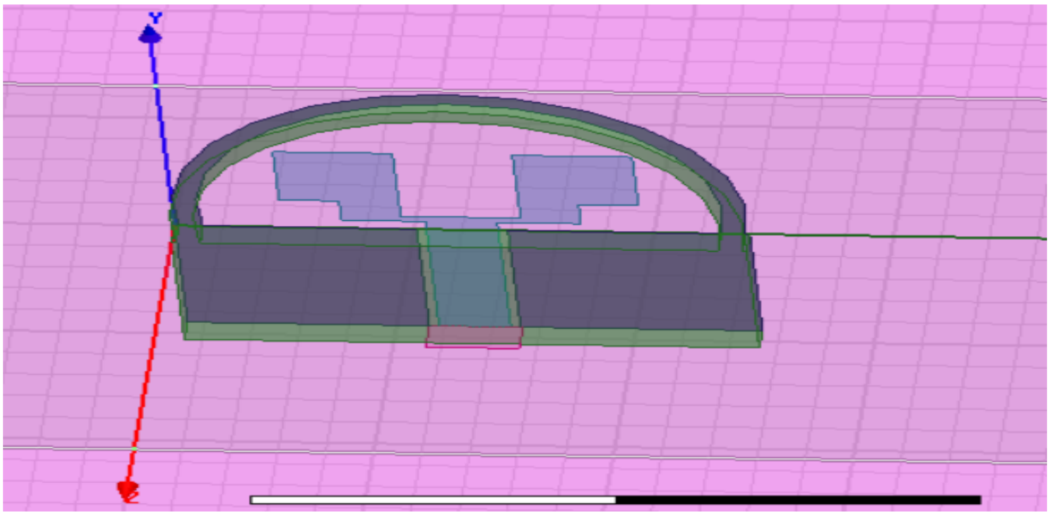
The present paper represents the design of CPW (coplanar waveguide)-fed microstrip patch antenna. A novel technique is used to obtain the structure shape of a substrate. By considering the structure shaped substrate the size of antenna gets minimized with high impedance bandwidth and best radiation patterns that covers the operating bandwidth in the range 3.4 GHz to 10.3 GHz. In CPW-fed technique, the ground plane and patch are kept on same side of the substrate which leads to effective utilization of area around the radiating patch. For designing CPW–fed antenna inverted L-strip patch is required which reduces antenna's height. Section 2 gives the detailed discussion of Antenna design. In section 3 experimental results are discussed. Finally, section 4 concludes the paper.

II. DESIGN OF CPW-FED ANTENNA

The overall dimensions L×W of CPW-fed broadband antenna is shown in figure1(a). Side view of designed antenna that is simulated in High Frequency Structure Simulator (HFSS) software [18] is given by figure1(b). In the designed antenna, inverted L-strip radiating patch is mounted over a 22mm × 22mm ground plane. In order to design the required CPW-fed broadband antenna, the conventional FR4 substrate with 0.77mm as thickness(h), relative permittivity ε_r=4.4 and loss tangent tan δ=0.0019 is used. In CPW transmission line, a gap of 0.4mm is placed between signal strip and the coplanar ground plane through which feeding is provided for the antenna. The finite ground planes, which are placed on either side of the CPW feed line are equal in dimensions as $W_g \times L_g$, and a semi-circular path is attached to it with thickness (R_g) as shown in figure1(a).



(a)



(b)

Figure-1(a) CPW-fed antenna configuration with inverted L-strip patch, (b) Side View of Antenna design in HFSS software.

By providing 0.8mm (L_{pg}) gap between radiator and ground plane results in achieving good capacitive coupling, to obtain an inverted L-strip radiating patch a rectangular patch with length L_{p2} and width W_{p3} is considered. Extension of rectangular patch from top view of radiator gives the vertical and horizontal L-strips having dimensions as $L_{p2} \times W_{p2}$ and $L_{p1} \times W_{p1}$, respectively. For the considered rectangular substrate a semi-circular disc shape is obtained by etching it with a radius of 11mm. The proposed antenna is designed for 50Ω transmission line and its complete dimensions are as shown in Table 1.

Table-1: Proposed Antenna Parameters

Parameters	L	W	h	L_{p1}	L_{p2}	L_{p3}	L_{pg}
Unit s(mm)	22	22	0.77	4	5	4.5	0.8
Parameters	L_g	W_g	R_g	W_{p1}	W_{p2}	W_{p3}	W_g
Units (mm)	8	9.1	1	2	2	4	3

III. SIMULATION RESULTS

3.1 Return Loss: The proposed CPW-fed microstrip antenna is simulated and the return loss curve of the antenna for different frequencies is observed and is illustrated by Figure 2. The resultant bandwidth is very large due to the CPW which covers the bandwidth of range 3.4 to 10.3 GHz with two resonating bands at 3.8GHz &7.7GHz, respectively and also the s11 parameter is less than -10dB.

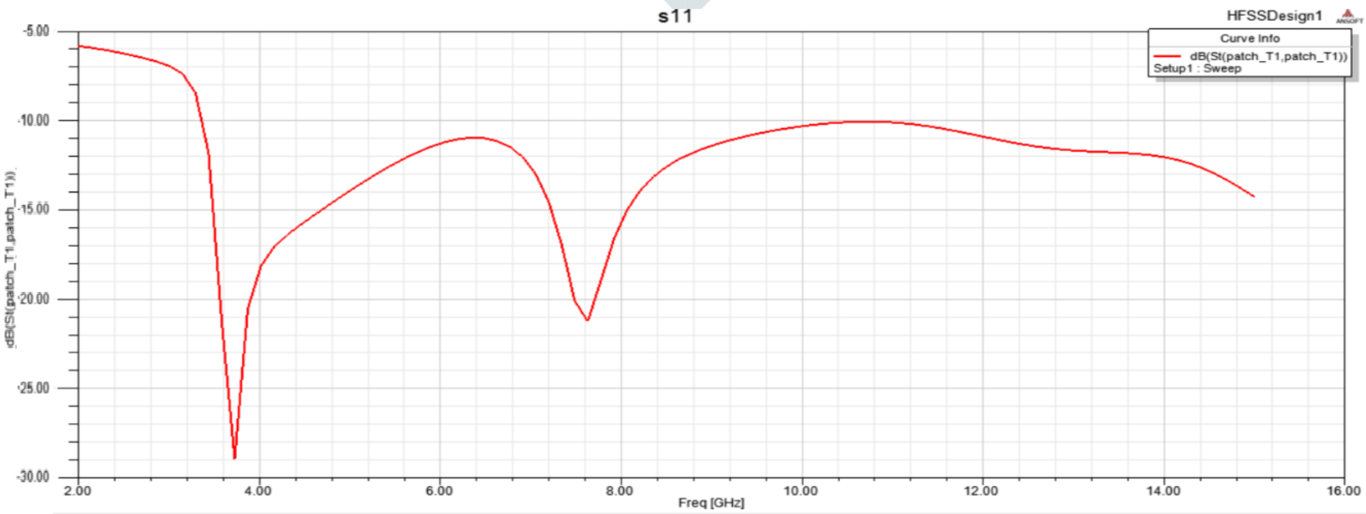
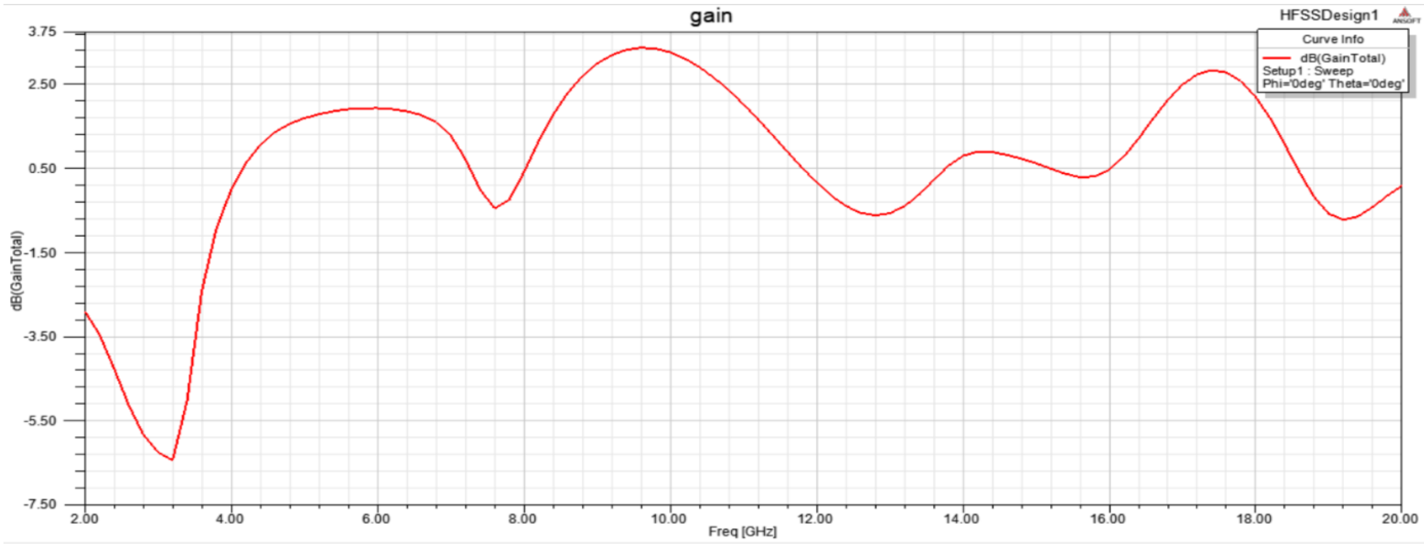
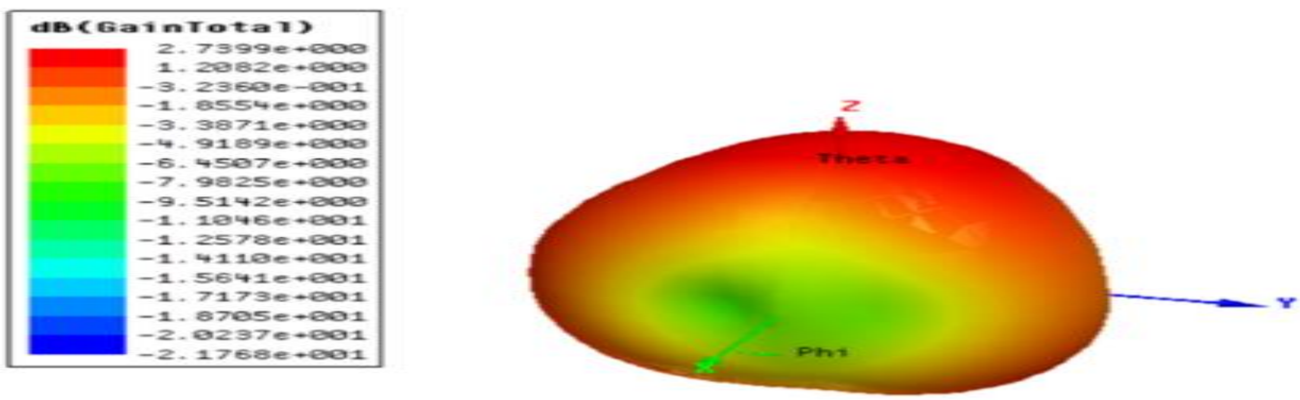


Figure-2: Return loss Vs Frequency plot.

3.2 Gain: The simulated characteristics of antenna Gain for different frequencies are shown in Figure 3(a). The designed CPW-fed antenna achieved a maximum gain of about 2.73dB in operating frequency range and is also represented in 3D-Polar plot as shown in Fig 3(b).



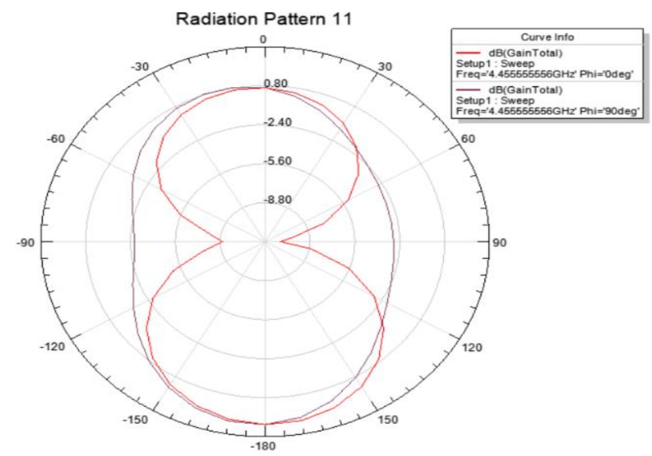
(a)



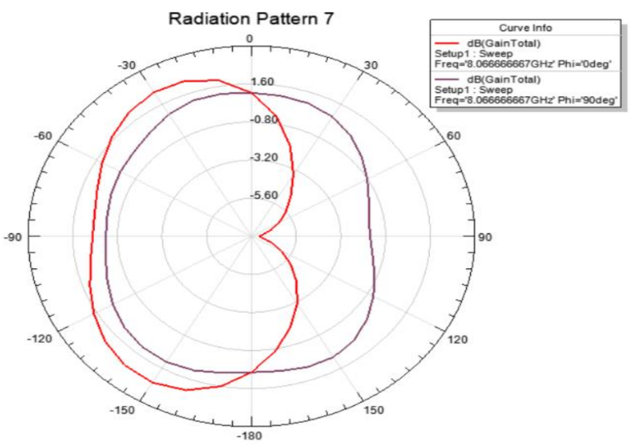
(b)

Figure-3 (a) Gain Vs Frequency plot (b) 3-D polar plot of Gain in dB.

3.3 Radiation Pattern: Figure-4(a) and 4(b) shows the simulated 2-D far-field radiation patterns, each with Phi=0deg and Phi=90deg, at sampling frequencies of 4.4GHz & 8GHz respectively. By observing the Radiation pattern of the designed antenna, it is suited in all frequency bands as well as for wireless application equipment.



(a) 4.4GHz



(b) 8.0GHz

Figure-4: Radiation patterns at (a) 4.4GHz and (b) 8.0GHz.

IV. CONCLUSION

An optimal CPW-fed structure-shape substrate with inverted L-strip patch antenna is designed and simulated for broadband applications. Satisfied results are achieved by simulating the antenna and observed the following characteristics: return loss, antenna gain and radiation patterns. An impedance bandwidth of 100.7% is obtained over entire operating bands. In addition to wideband characteristics, the proposed antenna is miniatured which makes it suitable for wireless communication systems.

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