Design and Analysis of Broadband Printed Compact Antenna for WLAN

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Abstract : **A broadband printed compact antenna is designed and analyzed for WLAN applications. This paper presents a low-profile, single layered rectangular printed compact microstrip patch antenna designed to operate for 2.4GHz and 4.8GHz frequency band of IEEE 802.11.a. With minor changes in the design, the same antenna can be used for broadband/GPS frequencies. Printed compact planar antennas are advantageous towards simplified configuration with high gain and broad bandwidth efficiency. The dimensions of the antenna are chosen finally as 18x7.2 mm which met the gain requirement compared to other configurations. The bandwidth of the planar antenna is enhanced by the mutual coupling between the S-strip and the T-strip. It has been demonstrated by simulation and experiment that the compact planar antenna can achieve a bandwidth of more than 50% for return loss 10 dB with an almost unchanged radiation pattern.**

***IndexTerms* –Compact,broadband antenna,bandwidth,gain**

I. Introduction

The bandwidth requirement for any antenna that is linearly polarized must be at least 40% for WLAN applications. In this paper a bandwidth of 50% has been achieved while maintaining the compactness of the antenna. The antenna that is designed has a planar configuration while most other GPS and WLAN antennas that work in frequency range 1.5GHz to 1.6GHz have non-planar configuration [1]. The dielectric constant of the antenna should be as low so as to enhance the fringing effects which accounts for radiation. Compact broadband antennas are studied which are non-planar and requires a reasonable thickness [2]. The dimensions of the antenna are 18 mm 7.2 mm 0.254 mm. The main disadvantage of microstrip patch antenna is narrow bandwidth and deterioration of radiation efficiency. These two parameters have been taken into consideration in this paper and a printed compact antenna has been designed which is more compact than previous antenna [3]. The design flow of the Broadband Printed Compact Antenna (BPCA) is described in next section and the simulation and experimental results are furnished in Section III.

II. Design Flow

The top view detail of the BPCA is shown in fig. 1. The Duroid planar substrate is used which has a dielectric of 2.2 and thickness of 254µm. The planar antenna consists of an S-shaped strip and a T-shaped strip which are printed on the two sides of the substrate. No direct electrical connection is there between the front and rear side. Feed Line has an impedance of 50-Ohms and S shaped is terminated with grounding .For better performance of the antenna, the height of the planar antenna can be adjusted. The antenna is configured in the shape of folded dipole to achieve good impedance matching and also improves the broadband performance because of mutual coupling between both the strips. By this method of approach we get accurate measurement.

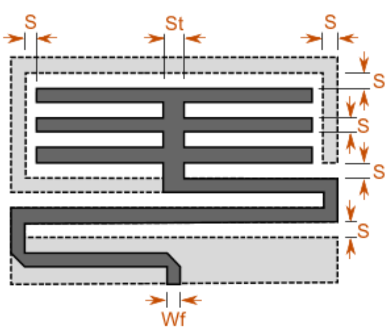


Fig.1 Top view of BPCA

Fig.2 Strip Model View

Configuration of a compact broadband planar antenna (S = 0.9 mm, S_t = 1.2 mm, W_f = 0.75 mm, t = 0.254 mm, and L = 15 mm).The strip model view is shown in figure 2. The dimension of the antenna is considered based on the bandwidth efficiency and radiation efficiency. If the feed line is adjusted to the middle of the top section of the ground plane accurate measurement can be obtained. The performance of the antenna is based on variation of length of ground plane and that is simulated and analyzed for different lengths. If the feed line is adjusted to the bottom section of the ground plane, the length of the ground plane is increased by attaching co-axial cable to the feed line. Usually in the realistic topologies of WLAN antennas, ground plane is mounted on top of printed circuit board and RF front end connects the planar antenna. Hence, this model does not require any co-axial cable attachment.

III. Simulation Results

The simulation results were obtained by using CST Studio Suite 2018. Microstrip line of impedance 50 Ohms is chosen as the feed line and we have achieved good impedance matching by maintaining VSWR less than 2. The port of microstrip at an absorbing boundary is not suitable for the ground length plane. So the height of the antenna is adjusted in such a way that the absorbing boundary impedance matches with the antenna plane. The variation of return loss with three different heights is shown in fig.3 for three different heights, namely, 6.2, 7.4, and 8.6 mm. Note that the height H is adjusted by changing the number of the equidistant crossbars of the T-strip, e.g., 2, 3, and 4 crossbars for 6.2, 7.4, and 8.6 mm, respectively. It is observed from Fig. 3 that the planar antenna has a maximum bandwidth at 7.4 mm. The maximum bandwidth is close to 50%. The total size of the planar antenna is 18 mm 7.2 mm 0.254 mm, which is more compact than the previously published antennas,e.g., 30 mm 10 mm 2mm in [3], 62 mm 10 mm 6 mm in [4], 27 mm 12.5 mm 3.5 mm in [5], 22 mm 5 mm5 mm in [6], and 20 mm 17 mm 4.7 mm in [7].Length of ground plane Vs return loss is also plotted in fig 4.The optimum value of the planar antenna is obtained through this Graph is 65mm. The ground plane is acting as a radiating element so there is a dependence of length. By increasing the length from 55mm to 75mm, the antenna frequency of resonance decreases with improved impedance matching. So the maximum bandwidth is obtained when the strip length is 65mm. This shows that the impedance bandwidth can be controlled by length and the optimum bandwidth is achieved when the length is 7.4mm. The planar antenna is applicable for WLAN communications in the frequency range of 2.4GHz. This antenna can be fabricated using RT/Duroid 5880 substrate with 0.5 oz copper on front and back by wet etching process. A layer of photoresist can be patterned and using 30% to 40 % FeCl solution, the unwanted copper can be removed. The reflection coefficient in fig.5 shows the impedance matching efficiency and fig.6 and fig.7 shows simulated output of the power and far field angle.

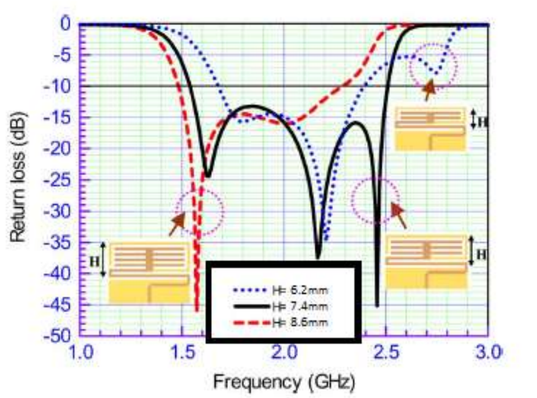


Fig. 3. Simulated results for return loss of different heights (H=6,2,7.4,8.6mm)

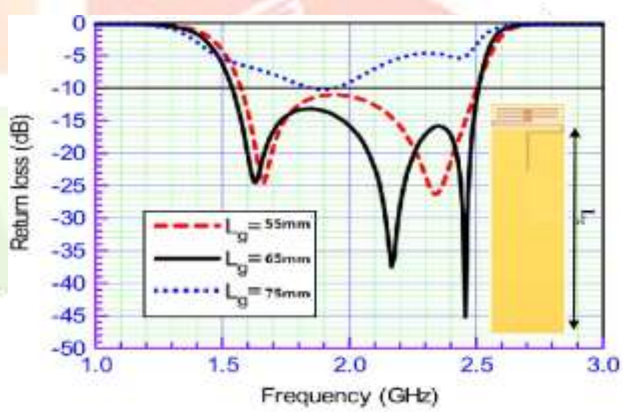


Fig. 4. Simulated results for different leg lengths for height of 7.4mm

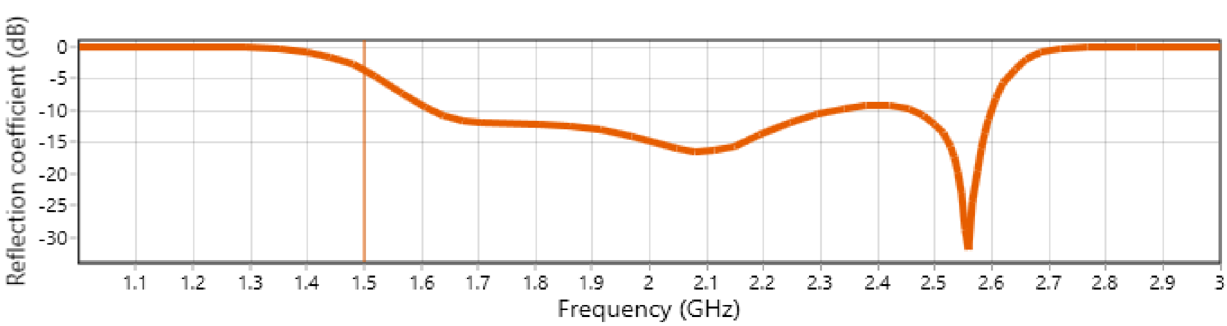


Fig.5. Reflection coefficient Vs Frequency

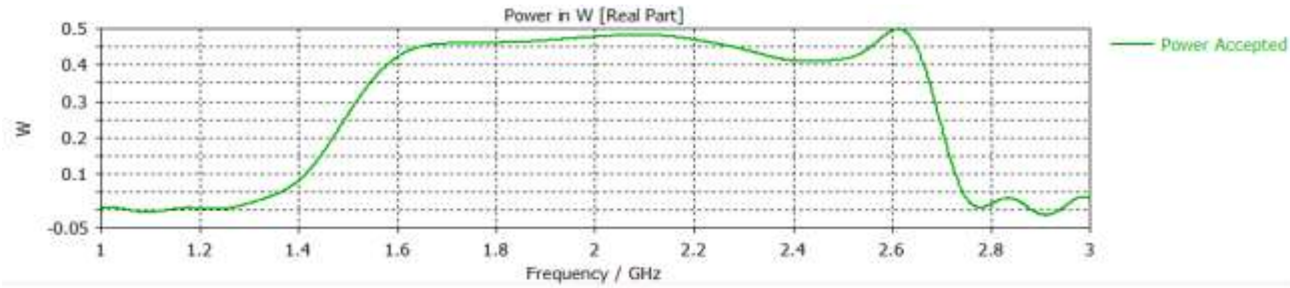
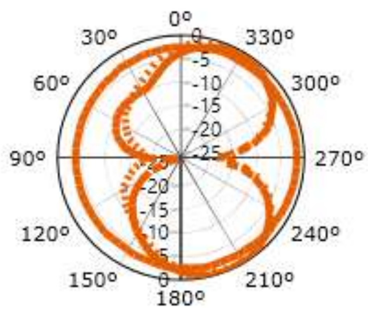


Fig.6. Power Vs Frequency



Maximum gain value	2.067 dBi	3.708 dBi	3.415 dBi
Angle value at maximum gain value	-90 °	-155 °	-25 °
Beamwidth (above 3.0 dB below the peak level)	360 °	51.81 °	62.21 °
Beamwidth (above 10.0 dB below the peak level)	360 °	135.3 °	120.8 °

Fig.7. Far field vs Angle

IV. CONCLUSION

It is observed that the performance of the antenna is improved by modification in the ground plane and radiating patch geometry. To enhance the impedance bandwidth, the radiating batch is slotted in the form S and T-shape and the variations in the length and height from the feed point to the ground plane. It is analyzed that when the impedance bandwidth is increased by making the slits in the open ended slot, the bandwidth obtained ranges from 2.4 GHz to 3.3 GHz or ~46.23% with respect to the central frequency which is suitable for WLAN applications.

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