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A CPW Fed Slot Antenna with Triangular Serrated Stub

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ABSTRACT- This paper is aimed to focus on bandwidth enhancement of a slot antenna with coplanar waveguide feeding. The experimentation is performed on the general CPW structure which is having a signal conductor in the middle and two ground layers etched on either side of feed with some gap to allow a unique feature of uniplanar in construction. In this context, the study of a CPW transmission line discontinuity is applied to prepare a slot antenna and this is followed by the study of incorporating serrated shape in the structure.

KEYWORDS- UWB, WPAN, W-USB

I. INTRODUCTION

Nowadays, the communication systems are need to be enhanced with the characteristic features such as low power consumption, high capacity, low cost and complexity. Also, such communication systems require the incorporation of antennas with wider operating band characteristics with a low-profile architectures and good radiation performance so that the single antenna can be used in any frequency of application within the operating band and can be mostly apt for off-body communication, microwave imaging and radar applications. Compact patch antennas are required for such applications but unfortunately the nature of patch antennas is resonant/narrow band. The enhancement of bandwidth procedures is concentrated in this chapter.

The traditional CPW structure with semi-infinite ground planes supports the quasi-TEM propagating mode. This uniplanar structure simplifies the fabrication and reduces the radiation loss moreover the miniaturization is possible without limit with the penalty of higher losses. The microstrip antennas with CPW feed can be formed by widening the center signal conductor strip which forms a rectangular/square patch or other shape of the patch can be attached to it. This structure allows the low cross polarized radiation from the feed. In Figure 1, how a conventional CPW line can be modelled as a CPW slot antenna using the structural discontinuity concept. Some practical CPW circuits are having the discontinuities such as open end, short end, series gap in the center conducting strip, step change in width of signal conductor and quadrature bend etc., which are mostly found applications in MMIC circuits. The conventional CPW line is short ended which can be formed by abruptly ending the slots as shown in Fig 2 which makes the RF current to flow around the end of the slots and behind the slot termination the magnetic energy will be stored which contributes the inductive reactance Lsc

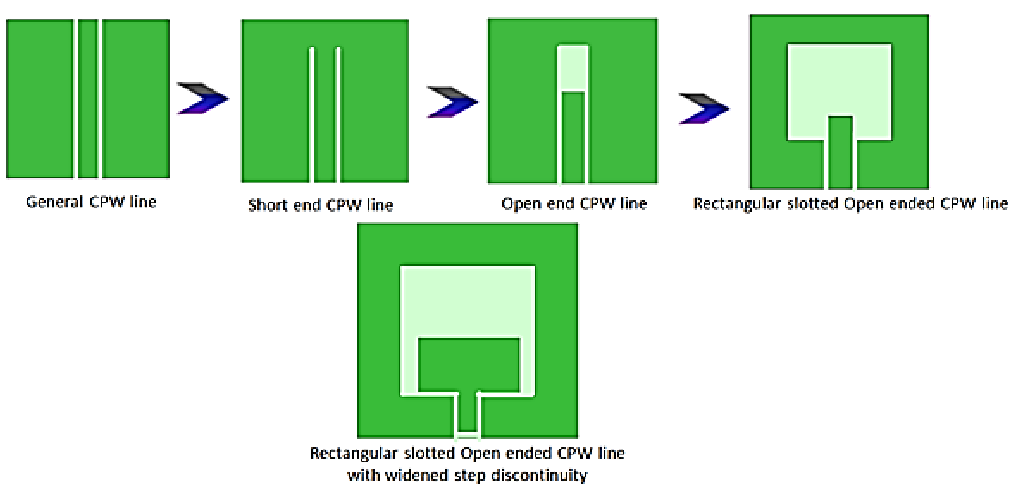

Figure 1: Evolution of CPW slot antenna from CPW discontinuity

Shashanl Khagarot, et al. [1] here the author used very compact antenna for analysis and the patch is split to overcome the narrow band analysis. Nooshin Valizade, et al. [2] proposed a model which works for both frequency and time domain of a novel antenna for ultrawideband applications.
The CPW is said to be open circuited by ending the signal conductor a shorter distance before the slot ends and thereby some gap 'g1' will be created. Between the terminated signal conductor and the surrounding ground conductor the electric field exists which gives rise to the capacitive reactance Coc..

II. DESIGN OF CPW FED SLOT ANTENNA WITH SERRATED RECTANGULAR STUB

The geometrical modelling details of a serrated rectangular stub monopole with CPW feed are discussed in this section. On a 72mm x 72mm x 1.6mm FR4 substrate having copper layer on single side, a slot with square shape of dimensions of 44mm x 44mm is etched. CPW center conductor is modelled with dimensions of width 'Wf'. The gap between the CPW line and ground is maintained as 'g'. The CPW signal conductor is extended on its other side with a length 'W' and it is widened as discussed in the previous section to provide step in change in width and this structure makes the rectangular stub and serves as the radiating element for this antenna. This stub is placed from distance 'S' from the edge of the ground. Later for improving the return loss characteristics, the serrated structure is incorporated on the top side of the rectangular stub with dimensions shown in Fig 3 and the parameter values are mentioned.

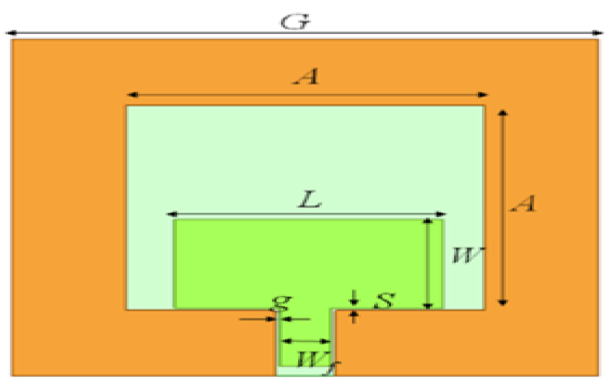

Figure 2: Geometrical configuration of CPW fed Slot Antenna with Rectangular Stub

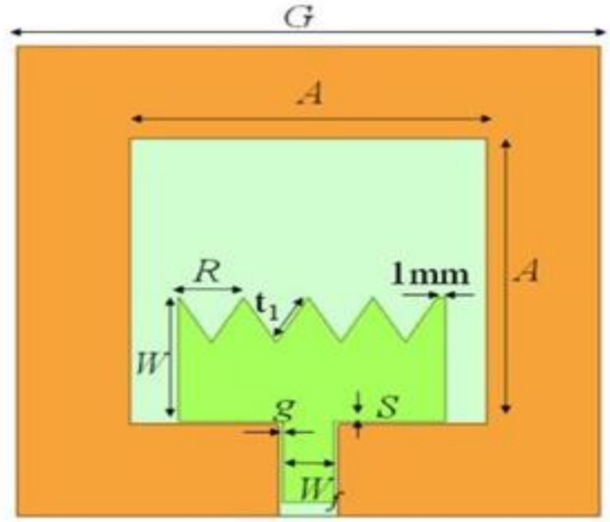

Figure 3: Geometrical configuration of CPW fed Slot Antenna with Serrated Rectangular Stub

G =72, A = 44, L = 32, W = 22.5, G = 0.5, Wf = 6.37, and S = 0.5, t1 = 7.975, R = 7.98 (all dimensions are in mm).

III. RESULTS AND ANALYSIS

The design and simulation of this antenna model is performed in HFSS software and the antenna is excited in even mode. The corresponding simulation results with parametric analysis are discussed in this section.

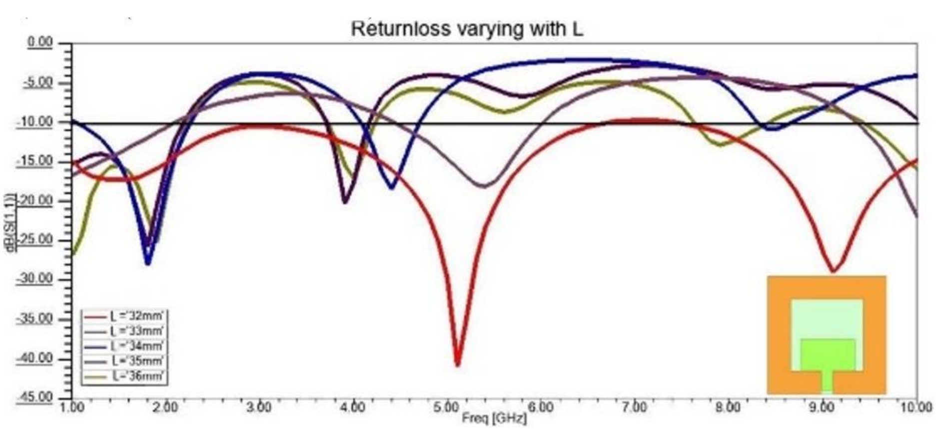

Figure 4: Parametric study on S11 with change in length of the stub 'L' parameter

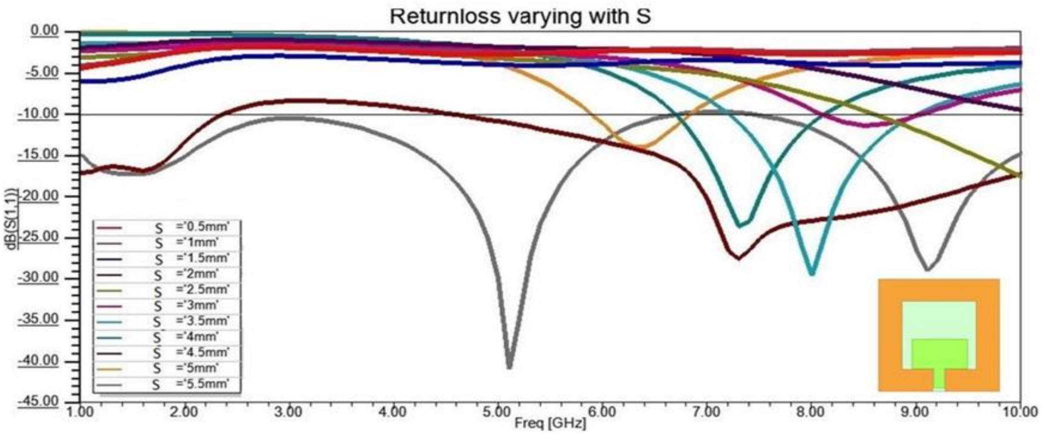

Figure 5: Parametric study on S11 with change in slot width 'S' parameter

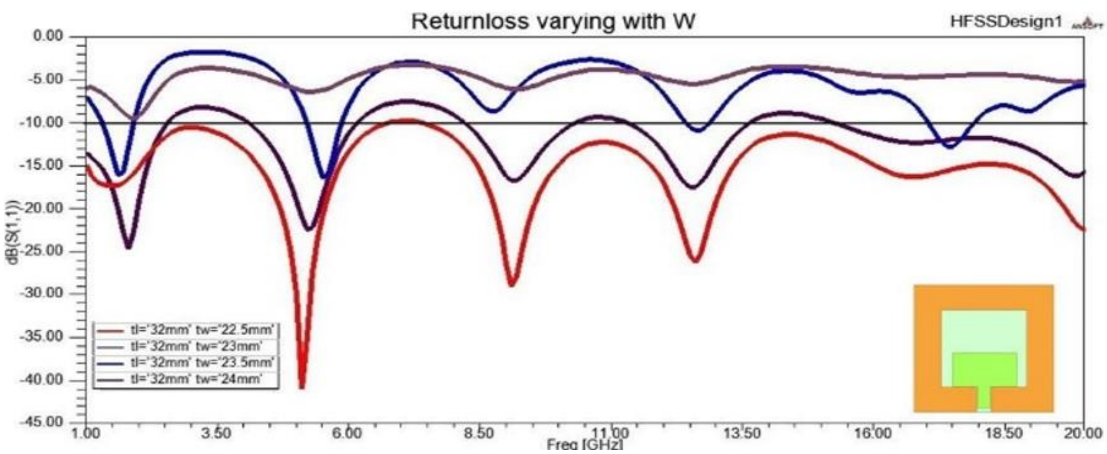

Figure 6: Parametric study on S11 with change in slot width 'W' parameter

The S11 characteristics with change in the rectangular stub width from 22.5mm to 24mm is presented. The resonant characteristics are slightly being generated as the width decreases from 24mm to 22.5mm. The value of 22.5mm is said to be optimum one to provide wide impedance bandwidth characteristics with improved resonant frequencies.

The far-field radiation characteristics of CPW fed slot antenna is plotted which is corresponding to the rectangular stub monopole. The patterns are simulated at resonant frequencies at 4 GHz, 9.1 GHz and 12.6 GHz respectively. Patterns on the left represents the radiation distribution in elevation plane whereas the right sided patterns are corresponding to the azimuth plane patterns.

At 5.1 GHz, in elevation plane the radiated power distribution is following bean shaped pattern and a bidirectional two lobe pattern observed in two mutually orthogonal planes. While observing the distribution in azimuthal plane the patterns are bidirectional and are oriented their maximum radiation towards the 300-azimuth angle. When the antenna radiates at 9.1 GHz the patterns are changes their orientation comparing to case observed at 5.1 GHz. The low radiation directions are slowly gets vanished and at theta=90deg the pattern looks like quad beam pattern. As the frequency increases to 12.6 GHz the transmitted/received radiation lobe of antenna will be having multiple beam patterns which is having directional properties. The quadrature tilt angle of patterns is observed in azimuth plane of the antenna when compared to the earlier patterns at other frequencies.

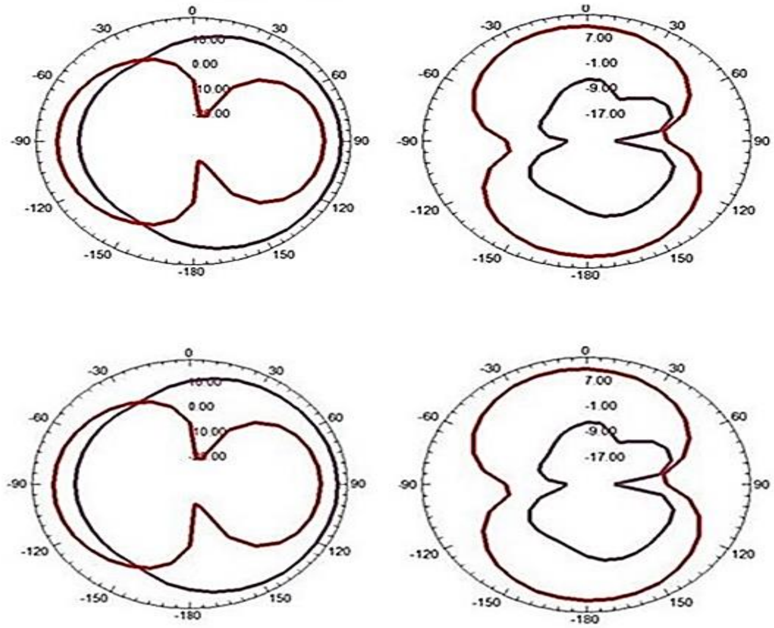

Figure 7: Simulated farfield characteristics

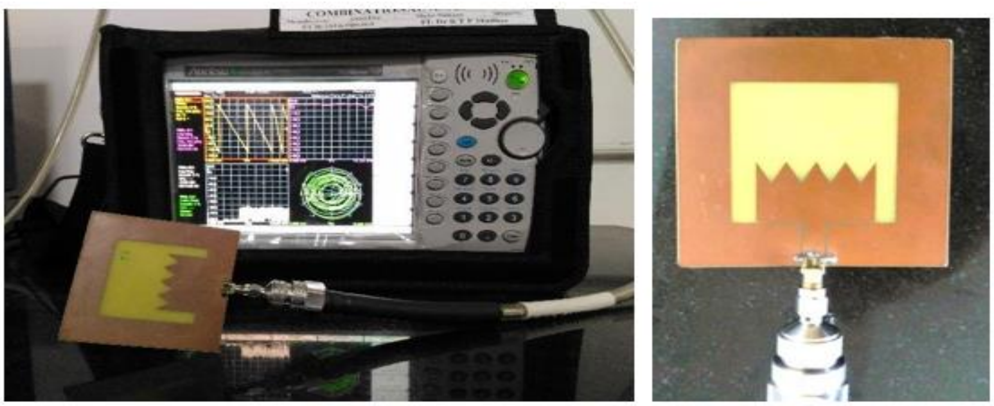

Figure 8: (a) S-parameter measurement setup with Anritsu VNA Master
(b) Fabricated antenna prototype with Type-N connector

The simulated radiation patterns of the serrated stub monopole antenna are presented in Fig 6. The patterns are having the radiation axially along the length wise alignment of the serrated stub in phi=0deg direction and in phi=90 cut plane the pattern resembles omni- directional. In azimuth plane, the patterns are bidirectional with a tilt of 100 from its boresight radiation direction, the peak gain, directivity, radiation efficiency parameters are computed at three discrete frequency points at 5.1 GHz, 9.1 GHz shown in Fig 6. The peak gain of the antenna when radiates at 5.1 GHz is noted as 0.37 dB and with directivity, radiation efficiency of 0.38dB, 94.3% respectively. The resonant frequency of 9.1 GHz gives raise to the peak gain and directivity to an extent of 0.75dB and 0.82dB respectively. The peak gain and directivity are comparatively decreased to a value of 0.63dB, 0.71dB when compared to the radiation characteristics at 9.1 GHz. The efficiency characteristics are being decaying from 91.2% at 9.1 GHz and 87.3% at 12.6 GHz which can be due to the multi-beam radiation pattern seen at higher frequency also can be due to higher order modes The peak gain and radiation efficiency characteristics are plotted in Fig 5.13 and Fig 5.14 respectively for the serrated stub monopole antenna iteration. The characteristics are observed at two resonant frequencies 9.2 GHz and 15.8 GHz. The S-Parameter measurement setup shown in Fig. 8 and antenna prototype shown in Fig. 8.

IV. CONCLUSION

Dual-band communication can play a significant role in current and future wireless sensor networks. Given the scarcity of relevant proper radiators, this paper described how printed antennas can be efficiently designed as simple, compact, device-integrated, dual-band antennas. During the evolution of modern antennas, the planar IFA inherited the properties of the microstrip "patch" antenna, while the printed IFA inherited those of the printed monopole. Printed monopoles are well-known wideband radiators; patch antennas are not. Reactive tuning of printed IFAs was applied in the form of four slotted configurations, in order to exert as much aggregate bandwidth as possible for use in two well-known unlicensed bands.

Electrical performance was characterized through numerous computed results. Slot loading showed a potential to increase the impedance bandwidth compared to prior implementations in terms of achievable. The study of SCDs revealed that most of the area of the element is used for radiation at both resonances. In radiation terms, the antennas provided satisfactory gains and high efficiencies (≥82%). A simple figure of merit was used to compare the performance of the three PIFAs head to head. The final comparison displayed in an emphatic way that modern antenna design is an art of compromise.

By exploring the potential for operation at 2.5 GHz and 5.5 GHz, it was discovered that a simple change in slot geometry can almost double the achievable operational bandwidth. Thus, the proposed antennas not only serve the 5.15–5.35 GHz U-NII band, but also the 5.725– 5.875 GHz ISM band. The proposed dual-band structures exhibited at the lower band an electrical size less or equal to that of the half-wavelength dipole. Nonetheless, these antennas can indeed be considered compact, even though they are not electrically small per se, since their dual-band capability enables them to do the job of two and even three separate antennas. Meanwhile, an educated choice of substrate can enable the combination of ease of fabrication and high radiation efficiency even at mid-C-band.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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