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A CPW-Fed Wideband And Multiband Rectangular Microstrip Patch Antenna For Wireless Applications

D. Ujwala[1], A. Gnandeep Reddy[2], K. Gopivasanth Kumar[3], K. Harika[4], N.Jaswanth[5], G. Gopinath Chowdary[6]

[1]*Assistant Professor,Department of ECE,K L University,A.P.,India*
[2,3,4,5,6] *Students,B.Tech,Department of ECE,K L University,A.P.,India*

Abstract: *In this paper a rectangular patch antenna is proposed for both the multiband and wide band operations with a coplanar waveguide (CPW) feeding. The proposed antenna has a size of 30x40x1.57mm^3 including the ground plane and it is designed on FR4 substrate with a dielectric constant of 4.4. The proposed antenna resonates at four distinct frequency bands, centered at 3.03, 4.84, 7.94 and 8.85 GHz. The return loss for the above mentioned frequency bands can be controlled and can be adjusted with parametric analysis of E-slot. The various terms and parameters associated with the antenna like return loss, radiation patterns, VSWR, current distributions and gain are analyzed and are optimized by the simulations carried out using finite element method based Ansoft High Frequency Structural Simulator(HFSS).*

Keywords: *Coplanar waveguide feed line, E-slot antenna, Antenna Performance characteristics.*

I. INTRODUCTION

The aim of this paper is to design an antenna with a low profile and high gain which can be in turn used for wireless applications. In order to achieve these attractive features such as low profile and high gain we prefer the micro strip path antennas which are most suited for millimeter wave frequency band applications and widely used for mobile communications, wireless communications and aerospace applications [1]. This Microstrip patch antennas are very simple in their construction using the conventional microstrip fabrication technique. The antennas in future must not only have multiband operation, should also possess wider bandwidths, simple structures and should have the ability to integrate with the RF circuits [2]. The Phenomenon of frequency agility, broad bandwidth, feed line flexibility and beam scanning can be easily obtained from these antennas [3]. Generally, the dimensions of microstrip patch antennas are around a half waveguide wavelength[4] and there are many miniaturization techniques that can be adopted in reducing such dimensions, they are classified as 1) Using high permittivity substrates 2) Increasing electrical length 3)Short circuits 3) Superstrates 4) Using magnetic substrates[5].

In the proposed antenna design a coplanar waveguide transmission line is employed, which enables us to design a wide range of characteristic impedances and the CPW structures usually provide wider bandwidths [6] and have many attractive features including low radiation losses, less dispersion and easy integration.

In this paper, an E- shaped slot is cut on the ground plane for multi and wide band operations; this E-shaped slot on ground plane also creates a longer current path. There are varieties of configurations that can be realized for generating multi wide operations in a single antenna are already proposed. e.g., using coupled V-slot [7], double L- slit[8] ,U- slot antenna[9] inverted- L monopole antenna [10] etc. Most of these antennas could not cover low frequency applications but can be used for multi wide band operations.

Antenna Geometry

The Antenna Structure shown in the Figure 1 represents the antenna Configuration and figures 1(a) ,1(b) represents ground Plane (Bottom view) and patch(Top view) respectively. An E-Shaped slot is cut on the ground plane to create a longer current path and at the same time to achieve both wideband and multiband operations. The proposed antenna is designed on a FR4 Substrate with an overall area of 30x40mm^2 and thickness of 1.57mm.The whole system is fed by coplanar waveguide feeding and the design of antenna is optimized using the Ansoft High Frequency Structural Simulator with the main dimensions shown in the figures 1(a) and 1(b).

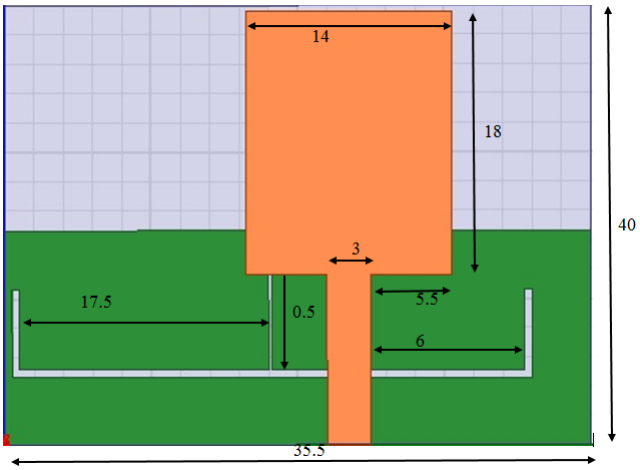

Figure1: Proposed Antenna Geometry

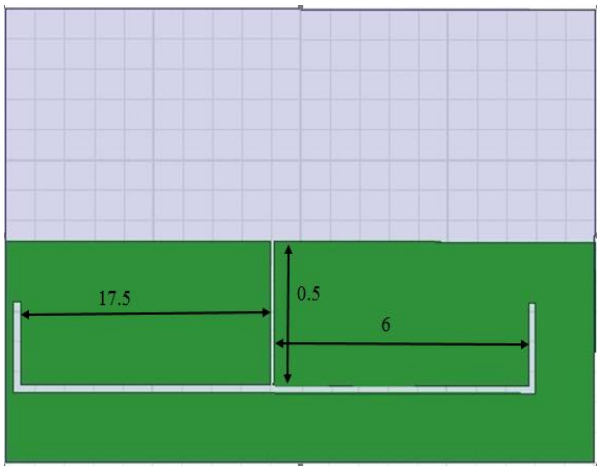

Figure 1(a): E-Slotted Ground

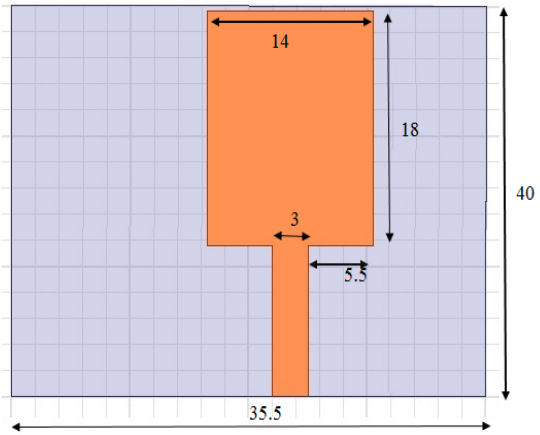

Figure 1(b): Top View Plane

II. Results And Discussions

The Proposed antenna is resonated at four different frequencies 3.03GHz, 4.84GHz, 7.94GHz and 8.85GHz and the corresponding return loss at these four frequencies are -12.94dB at 3.03GHz, -21.39 dB at 4.84GHz ,-20.25 dB at 7.94GHz and -14.93 dB at 8.85GHz. As shown in the figure 2.

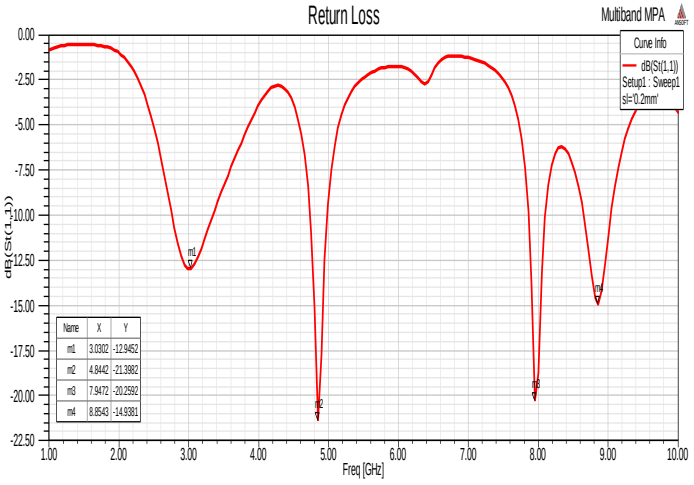

FIGURE 2: RETURN LOSS (DB) VERSUS FREQUENCY (GHZ)

The voltage Standing wave Ratio,a function of reflection coefficient which represents the power power reflected from the antenna. The Impedance matching will be perfect when the value of VSWR lies between 1 and 2. Figure 3 represents the VSWR plot. The values of VSWR at four resonant frequencies are 1.58,1.18,1.21 and 1.43 respectively.

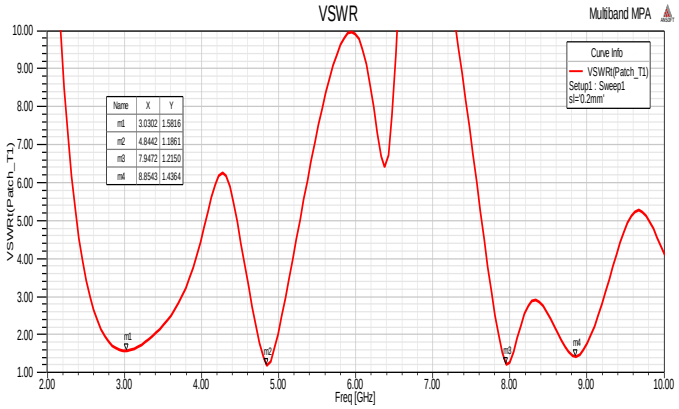

Figure 3: VSWR versus Frequency(GHz)

The E-plane Radiation patterns at 4.8Ghz and 7.94Ghz for phi=0 degrees and phi=90 degrees are shown in figure 4.

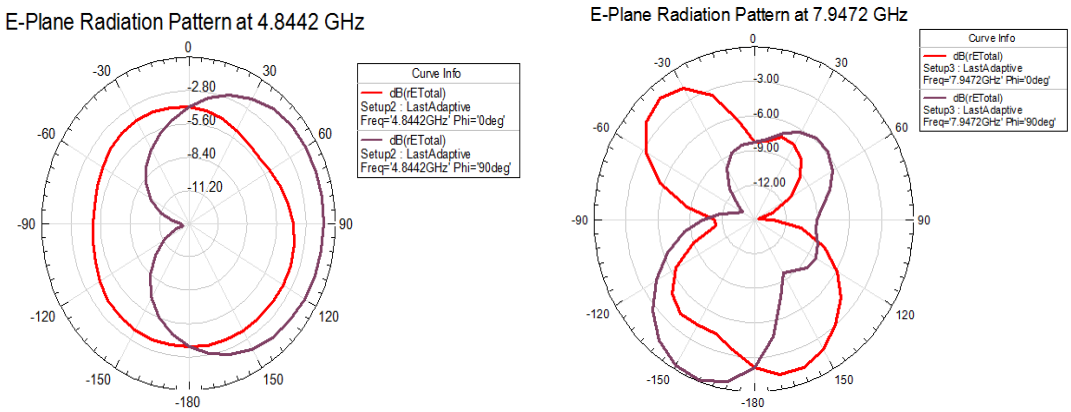

Figure 4: E-plane Radiation patterns at 4.84GHz and 7.94 GHz

The H-plane radiation patterns at 4.8 Ghz and 7.94 Ghz for Theta=0 degrees and Theta=90 degrees are shown in figure 5.

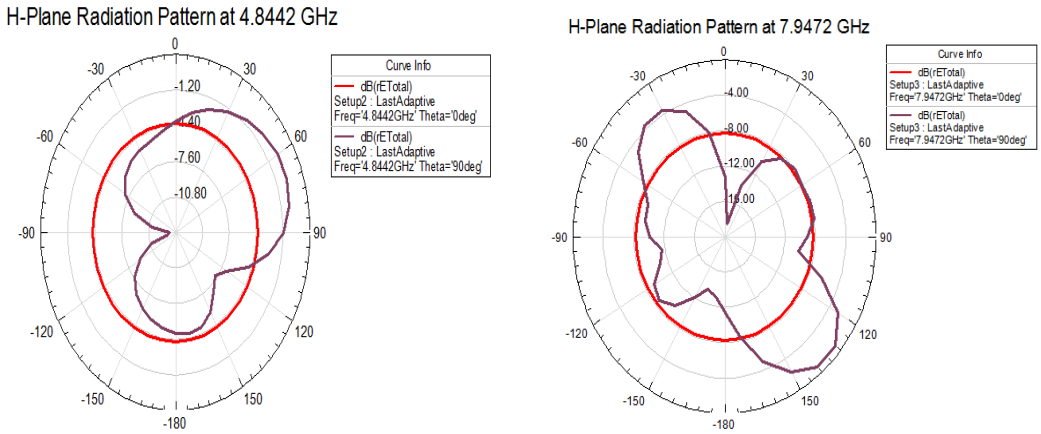

Figure 5: H-plane Radiation patterns at 4.84GHz and 7.94 GHz

The behaviour of antenna can be further studied using current distribution. The current distribution on the circuit can be measured directly by using a magnetic probe composed of an antenna in the vicinity of the circuit. However, the direct estimation of the current distribution is difficult for the case of the multilayer circuit. Here we used single patch element on the substrate, so the electric current can be estimated easily at resonant frequencies. The resonant frequencies 3.03,4.84,7.94,8.85GHz are been used for current distribution studies. The surface current distributions at 4.84 and 7.94GHz resonant frequencies is shown in the figure 6(a) and 6(b).

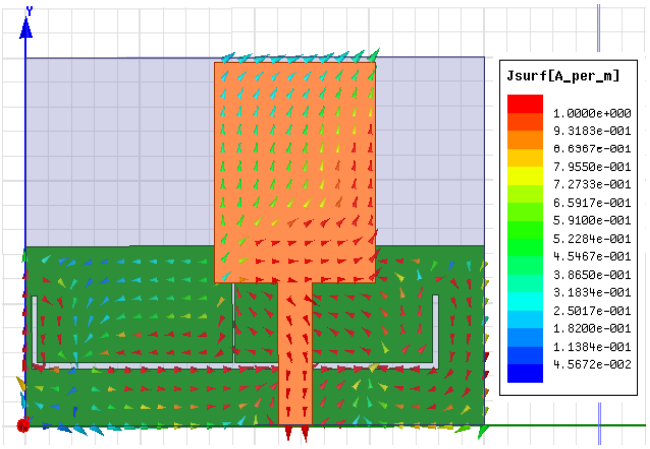

Figure 6(a): Surface Current distribution at 4.84GHz Frequency

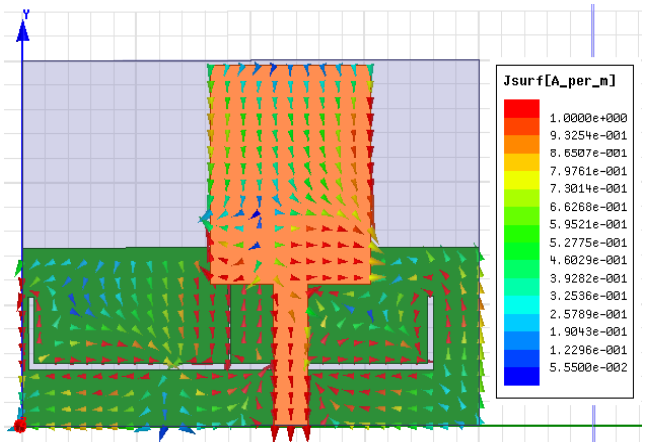

Figure 6(b): Surface Current distribution at 7.94GHz frequency

The simulated peak gain of the proposed Antenna is observed and displayed as shown in the figure 7 for both 4.84 and 7.94GHz resonant frequencies as 2.4 and 3.6 dBi respectively.

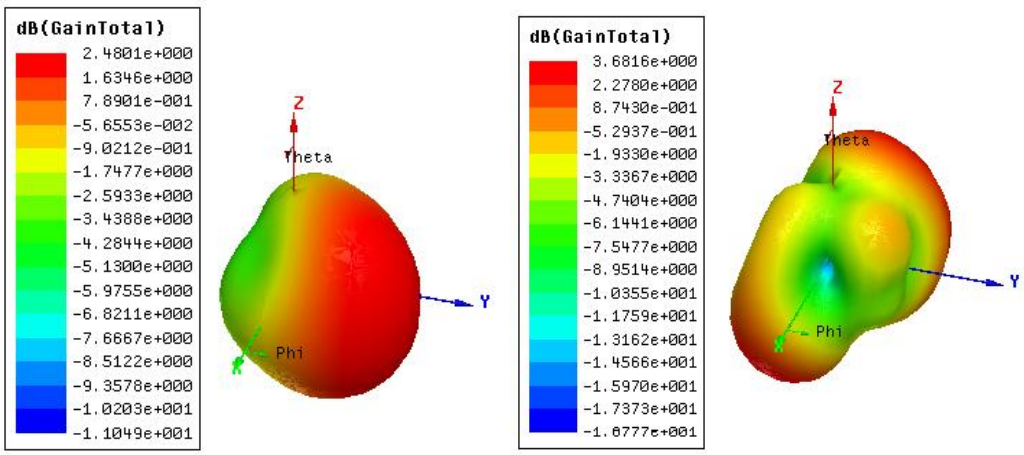

Figure7: Antenna Gain at 4.84 and 7.94GHz Frequencies

III. Conclusion

The Technique of using an E-shaped slot in the ground plane for a rectangular microstrip patch antenna with CPW feeding is to obtain both multiband and wideband characteristics in a single antenna is examined. Investigation on antenna shows that wide impedance bandwidths are achievable by varying size and shape of the ground plane. Along with the conventional parametric studies the current distribution analysis is also done in order to further realize the antenna performance. The Simulation results show that the proposed antenna presented in this paper has a high gain, high efficiency and stable radiation pattern at all the four resonant frequencies.

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D. Ujwala born in A.P, India in 1987. Completed B.Tech in 2008 from Koneru Lakshmaiah College of Engineering affiliated to Acharya Nagarjuna University. Worked as Associate Software Engineer for K L University from 2009-2010. Completed her M.Tech, Communication and Radar Systems from K L University in 2012. Currently working as Assistant Professor in K L University.

A. Gnandeep Reddy was born in A.P.,India in 1994.He is pursuing his B.Tech in Electronics and Communication Engineering from School of Electrical Sciences,K L University.with the Specialization in Communication Systems. He is a member of IETE.Till date,He has published 2 papers in International Journals and Presented Technical Papers in National Level Technical Symposiums of reputed institutions like NIT,Warangal.Vignan University,Guntur.His Research interests include Antennas, RF System Design, Transmission Line modeling and Satellite Communications.

K. Gopivasanth Kumar was born in A.P.,India in 1994.He is pursuing his B.Tech in Electronics and Communication Engineering from K L University with the specialization in Communication Systems.He has published 2 papers in International Journals and presented papers in National Level Technical Symposiums of reputed institutions like IIIT,Hyderabad and NIT,Warangal.His research interests include RF and Microwave Engineering,Antennas and VLSI Design.

K. Harika was born in A.P., India. pursuing her B.Tech in Electronics and Communication Engineering from School of Electrical Sciences, K L University. She is a member of IETE. She has presented various Technical papers in National Level Technical Symposiums. Her research interests include Wireless Communications and Antenna Design.

N. Jaswanth was born in A.P, India. He is pursuing his B.Tech in Electronics and Communication Engineering from School of Electrical Sciences, K L University with the specialization in Signal Processing. He is a member of IETE. His research interests include Image Processing, Digital Signal Processing and Antennas.

G. Gopinadh Chowdary was born in A.P., India in 1994.He is pursuing his B.Tech in Electronics and Communication Engineering from K L University with the specialization in Networking. He is a member of IETE. His research interests include Medical Image Processing, Satellite Communications and Digital Electronics.