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Design and Analysis of Patch Antenna for Wire-Less Applications

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Abstract:

In this paper, a multi-slot micro strip patch antenna for Ku bands with 1GHz is designed and the results are analyzed. As the antenna has dual band, we use the dielectric substrate of permittivity 4.4, loss tangent 0.002 and substrate height of 1.575mm.The simulation of antenna on HFSS software, at 1 GHz frequency, shows the bandwidth of 2.93GHz at frequency of 12.99GHz and 15.93GHz .Simulated results of return loss, VSWR, gain, directivity, 3D-radiation pattern of patch antenna design are shown.

Keywords **— micro strip patch antenna, Ku bands, dual bands, HFSS software**.

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I. INTRODUCTION

Radar and modern communication systems such as synthetic aperture radar (SAR), global position system (GPS) and wireless local area networks (WLAN) often require low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a large spectrum of frequencies. Dual band or multi frequency operations are main requirement of this type communication. Main disadvantage of Micro strip patch antenna is the bandwidth limitation which is due to the resonant characteristic of the patch structure. Dual-frequency micro strip antenna is the alternate method for bandwidth enhancement, which required in various applications for the operation of two separate sub bands. For generating a dual frequency behaviour in the single-fed micro strip antenna, by creating or etching slots on the radiating element of the micro strip patch antenna [1-2]. The proposed antenna has been used in WLAN and WIMAX because of some good features like low cost, low profile, easy to fabricate and nearly Omni directional characteristics. Feed line is the important component of printed antenna structure. The feed line used in proposed antenna is CPW in which micro strip antenna consist of a parallel conducting layers separating a dielectric medium referred as substrate which have a attractive feature such as wider bandwidth, better impedance matching and easy integration with active device [3]. However, conventional micro strip patch antenna suffers from very narrow bandwidth, typically about 5% bandwidth with respect to the center frequency. To increase the bandwidth of patch antennas, such as the use of thick substrate, cutting a resonant slot inside the patch, the use of a low dielectric substrate, multi-resonator stack configurations, the use of various impedance matching and feeding techniques, and the use of slot antenna geometry.

However, the bandwidth and the size of an antenna are generally mutually conflicting properties, that is, improvement of one of the characteristics normally results in degradation of the other [4-5]. Now-a-days, antennas with multiband capabilities have been widely required in satellite and mobile communication systems to meet the growing system complexity. Recently, many communication standards like WIMAX etc are developed for high frequency and high speed communication[6-7].Resonant frequencies 12.997 GHZ and 15.9337 GHZ having a gain of 10db .The proposed antenna is used for WLAN and WIMAX applications.

2. ANTENNA DESIGN

The antenna with diamond and triangular slots are shown in the figure below. The model was

designed with three layers; the lower layer consists of a ground plane covers the partial rectangular shaped substrate, the middle layer consists of a substrate made of FR4 epoxy resin having a dielectric constant ϵr=4.4 and height as 1.575mm. The upper layer, which is the patch, covers the rectangular top surface. The feed line used is the CPW to all portions of the rectangular patch, and a micro strip feed line is at the bottom of the rectangular patch. The diamond shapes are etched from the rectangular patch and three triangular shaped slots are at the right side of the patch, L-slots and T shaped slots on the feed shown in Figure1.Above design gives a bandwidth of 1.3976 with certain resonant frequencies of 1.5060 GHZ and 2.9036 GHZ which are necessary for wireless application. And we design a rectangular patch antenna with multi slots at both side of the patch without CPW feed and there is a band width enhancement at the resonant frequencies of 12.997 GHZ and 15.9337 GHZ, which are used for high frequency applications shown in fig2. And we modify the above, design by applying the CPW feed it produces an improvement in band width and gain which are necessary for WLAN and WIMAX Applications shown in the fig3 dimensions of patch Antenna design are shown in table 1.

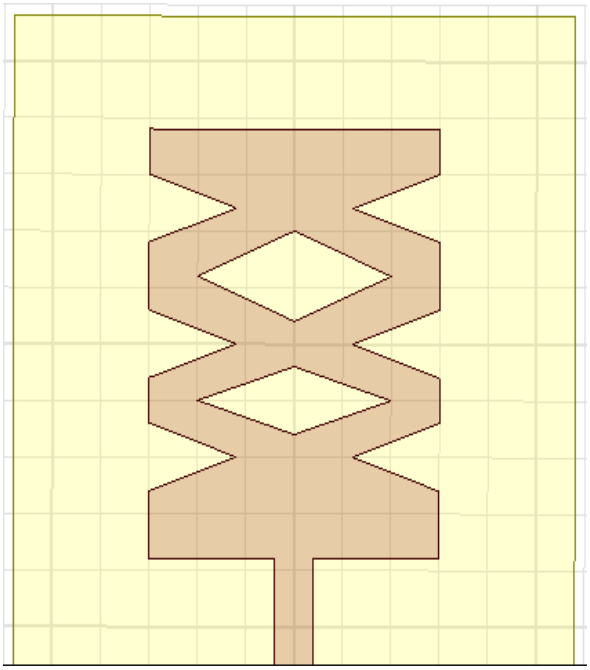


Fig.2

3.Figures and TABLES

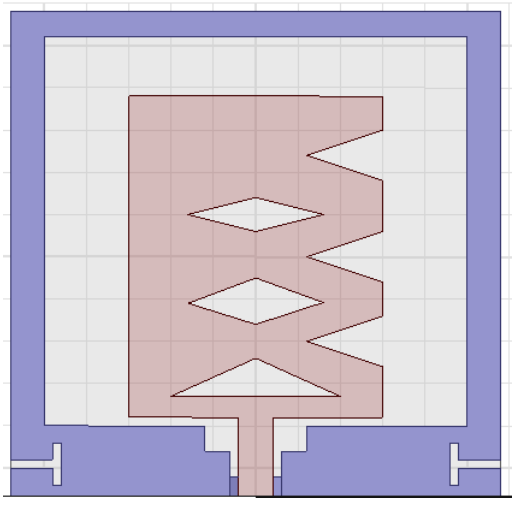


Fig.1

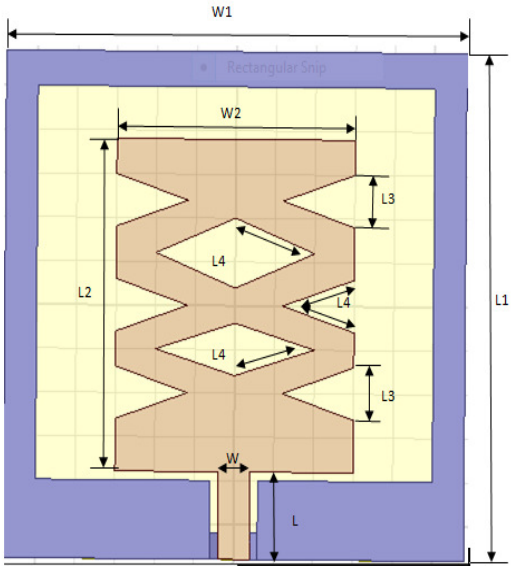


Fig.3

Table.1 Dimensions of fig.3

PARAMETER	LENGTH(mm)
L	10
L1	58
L2	38
L3	6
L4	10.4
W	4
W1	58.5
W2	30

4. RESULTS AND DISCUSSIONS:

The antennas were simulated using finite-element based electromagnetic simulator HFSS (High-Frequency Structure Simulator).The fig4 shows the simulated return loss versus antenna frequency of the patch antenna having a band width of 1.3976 GHZ at resonant frequencies 1.5060 GHZ and 2.9036 GHZ and a gain of 3.5133 db for the design having T and L-slot .The fig5 shows the simulated return loss versus antenna frequency of the patch antenna having multi slots at both sides of the patch which gives a band width enhancement of 2.1953 GHz at resonant frequencies 13.6932 GHz and 15.8886 GHZ and gain of 5.2388 db. The fig6 shows the simulated return loss versus antenna frequency of the patch antenna having multi slots at the both sides of the patch with a CPW feed gives a better band width enhancement of 2.9367 GHz at resonant frequencies 12.997 GHz and 15.9337 GHz with a gain of 10db which is used for WLAN and WIMAX applications. Fig7 shows the comparative results of the above mentioned designs which are used for WLAN and WIMAX applications. Fig8 shows the VSWR versus frequency plot for the fig3.And the gain is shown in fig9.The radiation pattern for the E-plane and H-plane patterns are shown in the fig10. For 0 and 90 degrees.

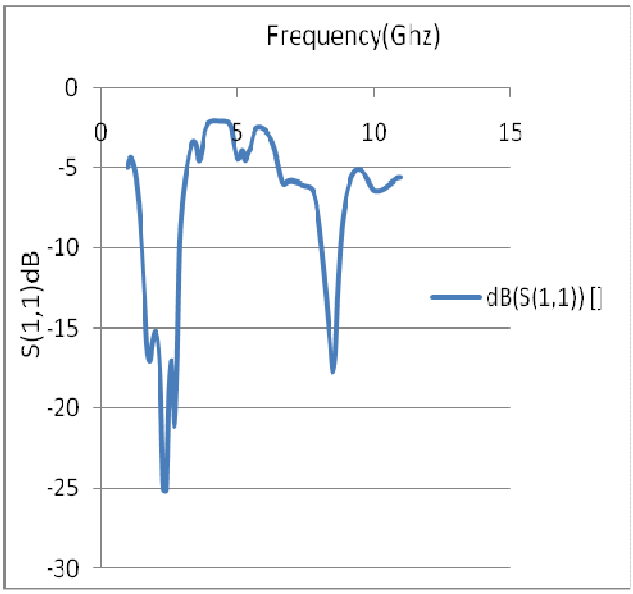


Fig.4 Return Loss of T and L slot patch antenna

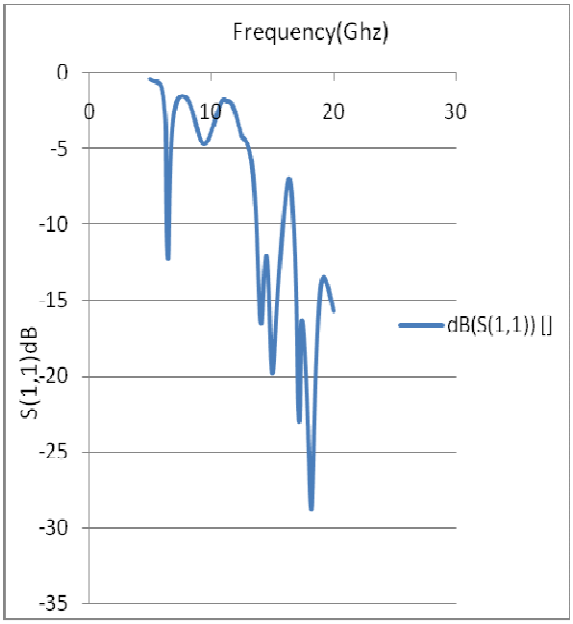


Fig.5 Return Loss of dual slots of the patch without CPW

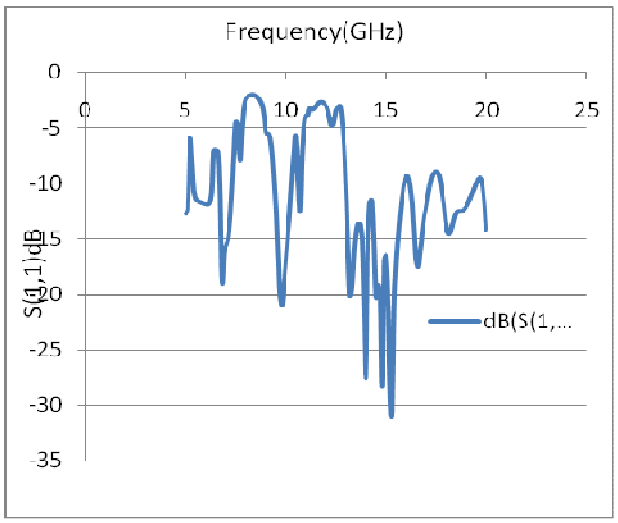


Fig.6 Return Loss of dual slots of the patch with CPW

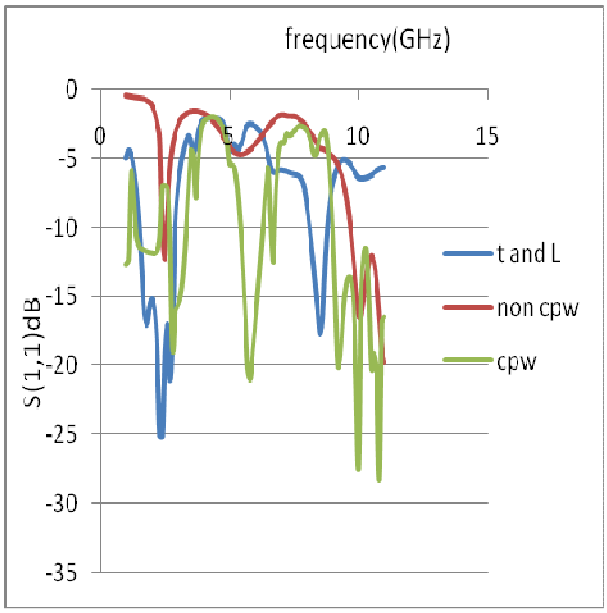


FIG.7 Comparison between three design results

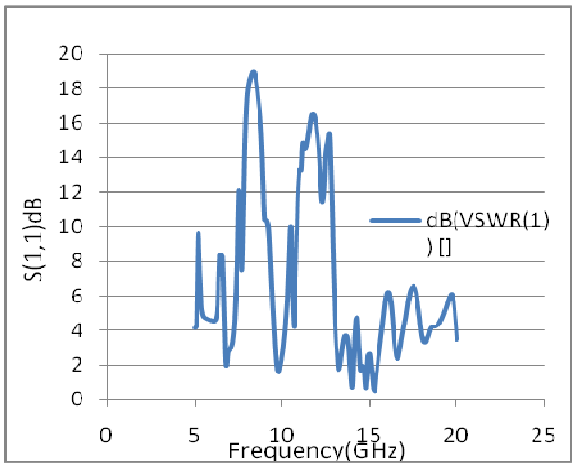
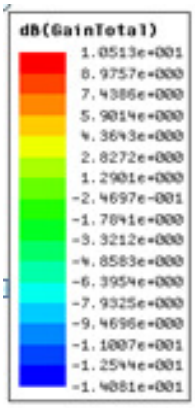


FIG.8 VSWR



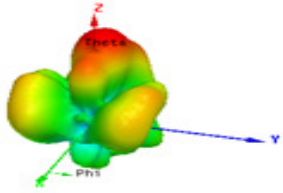


Fig.9 Gain

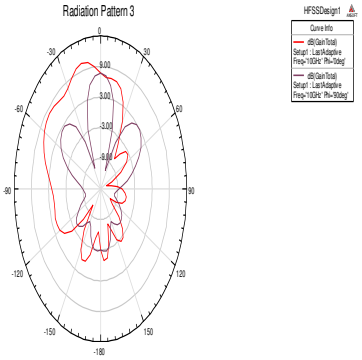


Fig.10 Radiation Pattern

5.CONCLUSION

This paper presents design and analysis of patch antenna with triangular and diamond slots using Ansoft HFSS simulation software. Antenna having bandwidth of 2.9367 GHz and gain of 10db which is acceptable, when fed by coplanar waveguide feed technique.

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