A COMPACT DUAL BAND PLANAR RMSA FOR WLAN/WIMAX APPLICATIONS

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ABSTRACT

Presentation of a compact dual band planar rectangular microstrip antenna (RMSA) antenna for a WLAN (2.4GHz IEEE standards 802.11b/g)/WiMAX(2.6GHz IEEE standards802.16e)applications. The two resonant modes of the presented RMSA antenna are associated with various length and width of the planar strips in which a centre strip contributes for the lower resonant frequency 2.4GHz(2.26-2.4GHz with impedance bandwidth 240MHz) and two lateral strips contributes for the higher resonant frequency2.8GHz(2.73-2.95GHz with impedance bandwidth220MHz). By proper adjustment of the coupling between the two lateral strips and embedded centre strip enables the operation of dual band with a -10dB return loss, a near directive radiation pattern and a good antenna gain with sufficient bandwidth. The antenna is simulated using Ansoft HFSS and fabricated on an FR4 substrate with dielectric constant 4.4 and thickness 1.6mm occupies an area of 65mm x50mm.The simulation results are found to be in good agreement with the measured results. The proposed antenna is suitable for wireless communication applications requiring a small antenna.

KEYWORDS: *Rectangular Microstrip Antenna (RMSA), Wireless Local Area Network (WLAN),WiMAX, Strips, monopole dual band.*

I. INTRODUCTION

Rapid progress in wireless communication services have led to an enormous challenge in antenna design. Patch antennas for dual and multi frequency band operation has increasingly become common, mainly because of many advantages such as low profile, light weight, reduced volume and compatibility with microwave integrated circuits(MIC) and monolithic microwave integrated circuit (MMIC).WLAN is one of the most important applications of the wireless communication technology that takes advantage of licence free frequency bands[ISM] due to high speed connectivity between PCs, laptops, cell phones and other equipments in environments. In the near future WiMAX technology with different standards is going to occupy the market. Wireless data services have evolved and continues to grow using various technologies, such as 2G/3G. The impact of such diverse technologies is on the use of frequency band in different technologies will need to occupy different frequency allocations, Such as WLAN/WiMAX , it likely to be prominent candidate to serve for wireless data in near future. Therefore there is a need to develop a dual band antenna for both WLAN/WiMAX applications occupying 2.4/2.6GHz frequency bands.

Above several papers on dual band antennas for IEEE standards have been reported.[1-2] proposed printed double T-monopole antenna can cover the 2.4/5.2 GHz WLAN bands and offers narrow band width characteristics and planar branched monopole antenna for DCS/2.4GHz. For WLAN it can provide excellent wide frequency band with moderate gain .[3] The proposed planar monopole antenna is capable of generating good Omni directional monopole with radiation in all the frequency bands.[4-5]proposed printed dipole antenna with parasitic element and Omni-directional planar antenna for WiMAX applications, can operate either in wide band or dual band , which cover 3.25-3.85,3.3-3.8 and 5.15-5.85 GHz with return loss of -10dB.[6] Broad band printed L- shaped antenna for wireless communication is reported with good radiation patterns and better return loss.[7] physical design features proper geometry and dimension for microstrip antenna array using transformer λ/4 for the feed line matching technique.[8] proposes compact terminal antenna incorporates open-end slots in the ground plane ,which reduces size and operates at acceptable band width.[10] use of various feeding techniques can give dual or multiband operations.

In this paper a compact dual band antenna structure for WLAN and WiMAX are proposed. The proposed antenna is simple to design and offer an effective control over two operating bands by controlling the dimensions of three rectangular strips. The antenna can easily be fed using a 50Ω probe feed with transformer λ/4 technique for impedance matching. Also the planar RMSA structure antenna is attractive from the package point of view. The advantage of λ/4 technique feeding method is to match the transmission line characteristics impedance to the input impedance.

II. ANTENNA GEOMETRY AND DESIGN

The geometry of the proposed antenna structure is shown in figure 1. It is etched on a substrate of dielectric constant ε_r=4.4 and thickness h=1.6mm with tangent loss 0.09. The antenna has ground plane dimension of length L_g=50mm and width W_g=65mm. The radiating structure consists of three rectangular strips with dimensions of length l_p=28.5mm and centre strip width w_{p1}=18mm, lateral strips width w_{p2}=10mm with a slot gap width g=0.5mm.The centre strip is fed by a designed 50Ω microstrip line width 0.5mm,the optimum feed point antenna is λ/4Transformer method with 3mm width and 0.2mm height for good impedance matching. Thus it can be connected with a SMA connector. The resulting antenna resonates at 2.4 GHz and 2.8 GHz. From simulation and experimental studies, it is found that the dimensions of the middle rectangular strip are optimized to resonate at 2.4GHz while dimensions of the lateral symmetrical strips are optimized to resonate at 2.8 GHz. Thus the proposed antenna provides effective control of the two operating bands. In addition, ground plane dimensions are also optimized to achieve the desired dual band operation, as it affects the resonant frequencies and operating band widths in two bands.

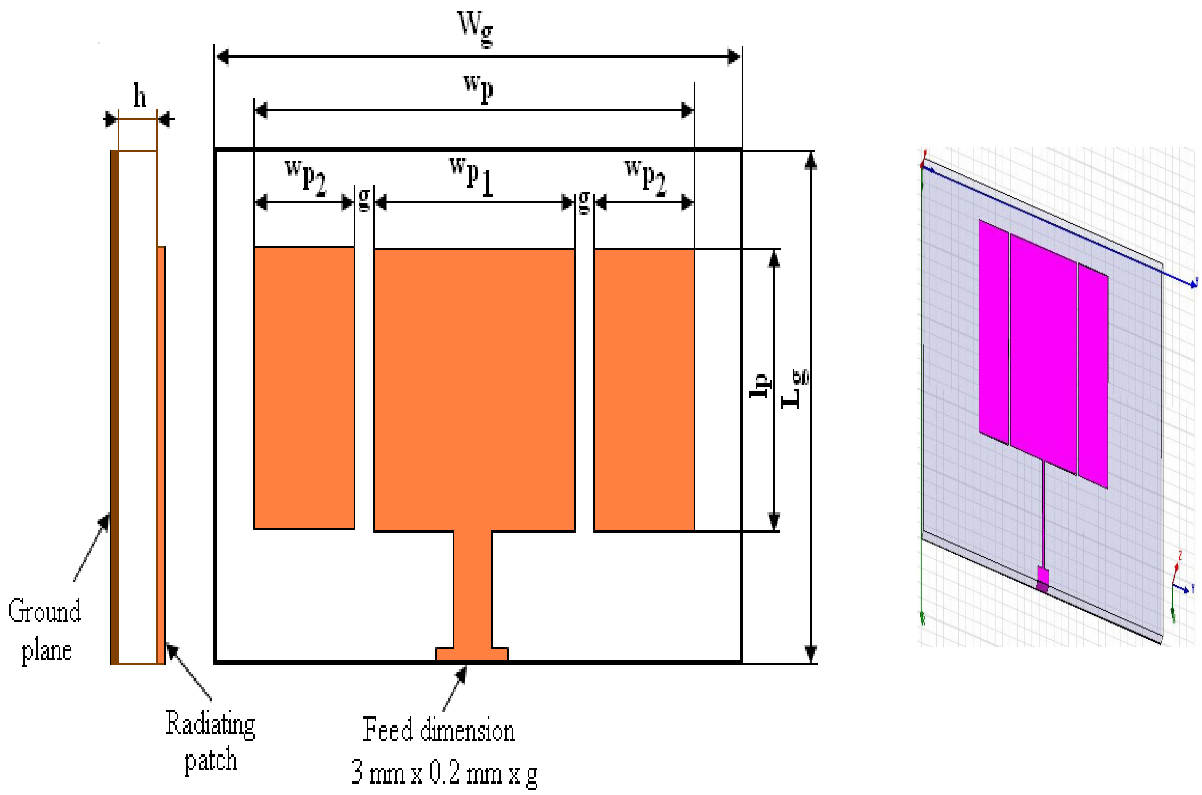

Figure.1. Geometry of the proposed planar RMSA, a) side view, b) top view, c) simulated view.

III. SIMULATION AND EXPERIMENTAL RESULTS

Ansoft HFFS is used for simulation and analysis of the structure. Simulation process involves setting up of the optimum geometric dimension to satisfy the desired centre frequency, as well as the bandwidth requirement for specified return loss requirements in each band. The simulation was iteratively conducted until the desired results were found. The proposed antenna is fabricated by using photolithographic process which gives goods accuracy for the etched patterns. The fabricated antenna parameters are measured by experimental set up characterization which consists of vector network analyzer from Hewlet Packard, with S-parameter test-set and an anechoic chamber. Radiation patterns, E-field &H-field, S-parameters and gain were measured. The following sections describe the details of measured and simulated results. Measurement of return loss is most important because our main interest in this research is to produce dual band characteristics within the specified centre frequency with sufficient impedance bandwidth requirement.

3.1 Return loss

Figure.2 shows the simulated and experimental return loss of the proposed dual band antenna. From the simulation, the impedance bandwidth of the lower frequency band determined by -10dB return loss approximately 240MHz of bandwidth (2.26-2.50GHz), which is 13% of bandwidth for the frequency band of 2.4 GHz. For the upper frequency band the impedance bandwidth is approximately 220MHz (2.73-2.95GHz), i.e. about 10% for the frequency band of 2.8GHz. The centre frequencies the two bands are determined by adjusting the rectangular dimensions of strips. To achieve the maximum results the gap distance between the two strips adjusted and length of the microstrip feed line 50 ohm need to be controlled. The experimental curve shows that a dual band is obtained for both the resonance with good matching.

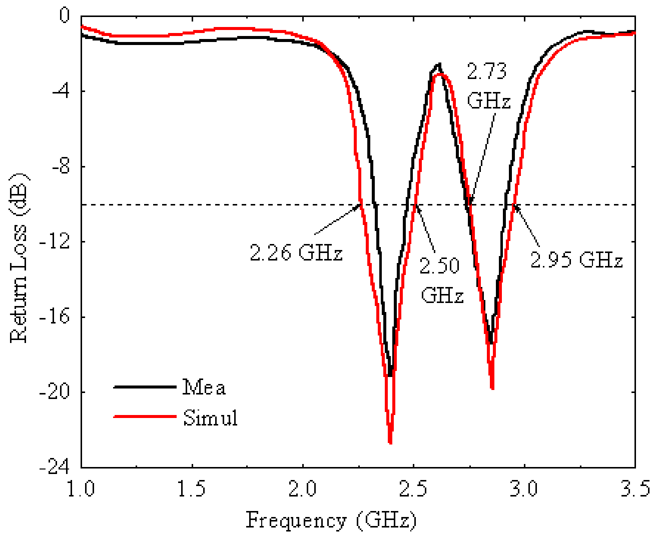

Figure.2. Simulated and measured return loss characteristics of antenna structure.

3.2 Radiation Patterns

The simulated and measured radiation patterns of the proposed antenna operating at 2.4GHz and2.8GHz are shown in figure 3 & 4 respectively. It is found that the antenna has relatively stable radiation patterns over its operating band, a near Omni directional pattern is obtained in the two bands. Because of symmetry in the antenna structure the radiation patterns are as good as those of a conventional monopole. In the elevation plane (azimuth angle)as shown in the plots, asymmetrical radiation patterns are seen in the x-y and x-z planes. The measured radiation patterns are stable and quasi –Omni directional in the entire operational band which is highly suitable for the proposed modern wireless communication bands.

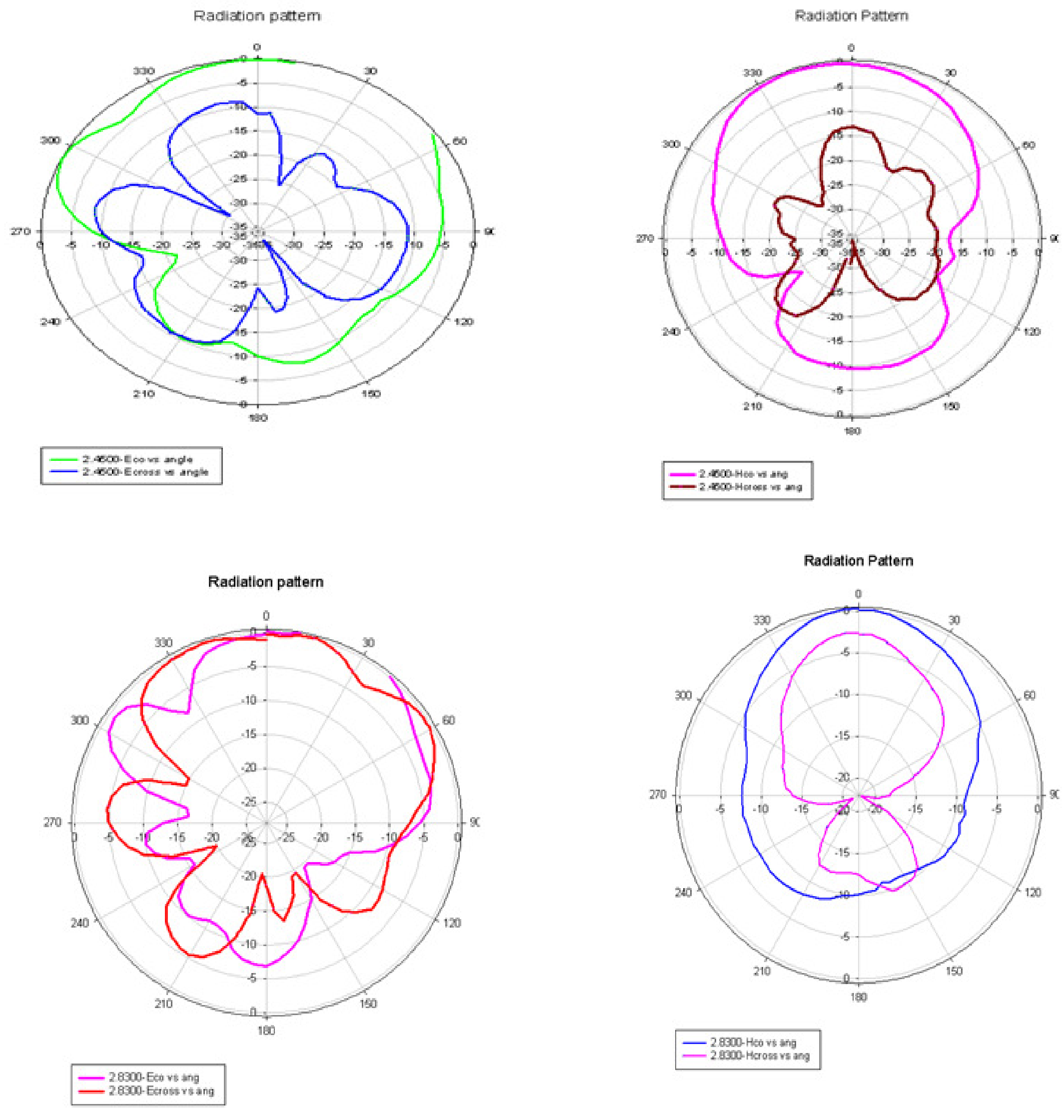

Figure.3. Simulated co-polar and cross-polar radiation patterns of the planar RMSA AT 2.4GHzand 2.8GHz.

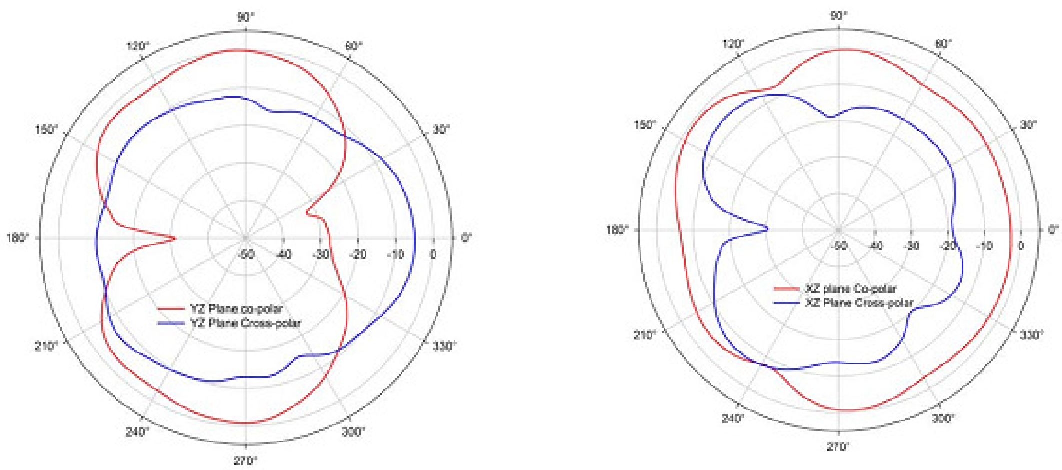

Figure.4. Measured radiation patterns at 2.4GHz and 2.8GHz.

3.3 Current Distribution Characteristics and 3-D plot

A better understanding of the antenna behaviour can be obtained by analyzing the current distributions at peak resonant frequency 2.4 GHz, as shown in figure 5. It is evident from that at 2.4GHz the central strip acts as a quarter wave monopole where as for the higher resonance the predominant effect is seen at the edges of the lateral strips.

Figurer.6 shows the 3D simulated radiation pattern at 2.4GHz. It is found that the planar antenna provides almost Omni directional radiation coverage and can be used for WLAN applications.

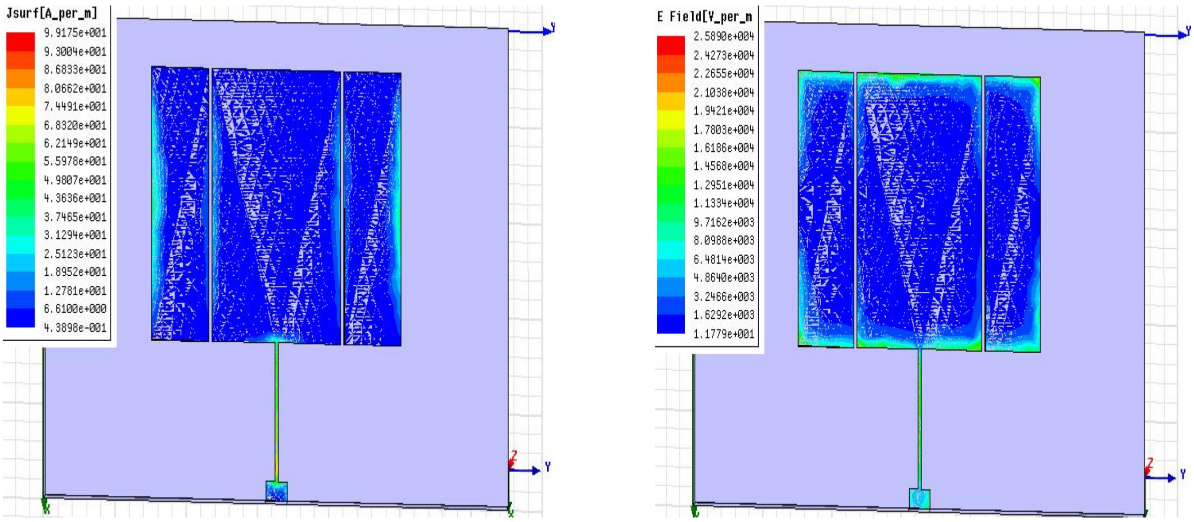

Figure.5 current distribution and e-field distribution of the planar RMSA

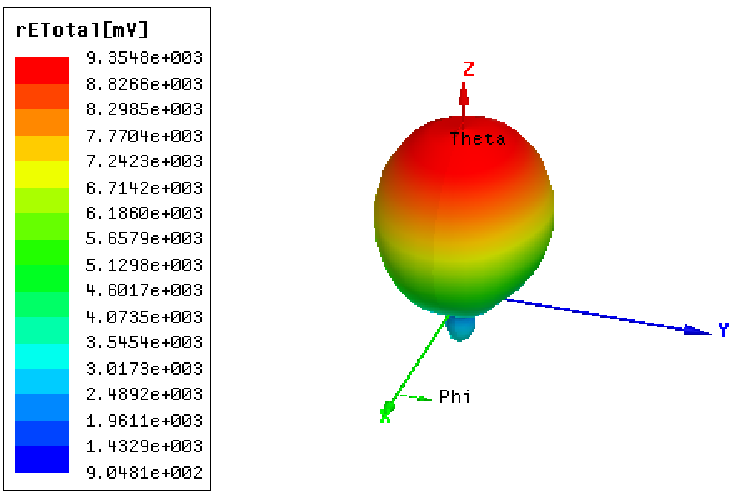

Figure.6 Simulated 3D radiation pattern of the planar RMSA

3.4 Gain characteristics

The peak gain of the antenna measured at each frequency points by comparison method. Figure.7 shows the measured antenna gain versus frequency. Average gain at different frequencies of both bands are shown where as at 2.4GHz frequency band is approximately 2.95dBi and at 2.8 GHz frequency band is approximately 3.8dBi and then continue for higher frequencies.Figure.8 shows photo of the fabricated planar RMSA and tested by measuring its parameters particularly return loss and antenna gain, to validate the simulation result as well as to verify the antenna design specification.

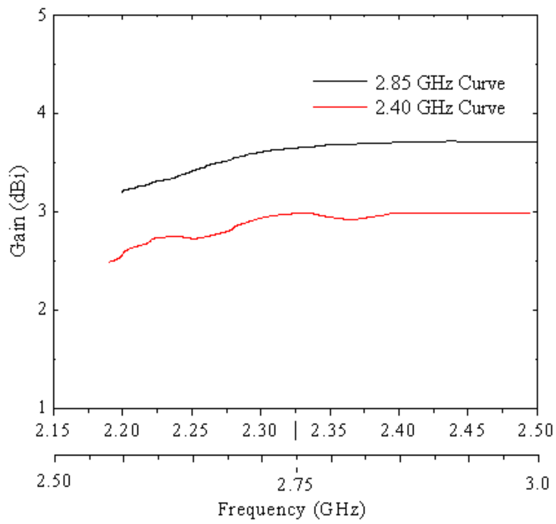

Figure.7 Measured peak antenna gain for the dual band planar RMSA at 2.4GHz and 2.8GHz.

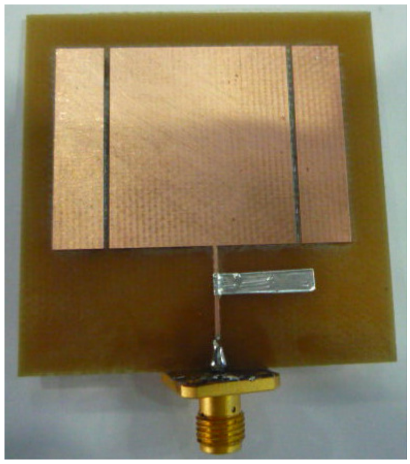

Figure.8 Photo of fabricated planar RMSA

IV. CONCLUSION

A study of construction and experimental verification of compact dual band planar RMSA structure for the operation in the 2.4/2.8GHz WLAN/WiMAX bands is presented. The dual band operation is achieved by using planar three rectangular strips. A good band width characteristics is observed in each strips which covers 2.26- 2.5GHz and 2.73-2.95GHz bands with an impedance bandwidth of nearly 240MHz at lower band and at the upper band the impedance bandwidth 220MHz when compared with the simulation , measured results exhibits good agreement, except for small variation due to measurement error. From our design it is found that the lower resonant band is due to centre strip and the higher resonant band due to lateral strips. This is because good impedance matching, gain and radiation pattern can be obtained by tuning the coupling between the rectangular strips and the gap, as well as the feed length of the feed line, Hence the proposed antenna is suitable for wireless local area network (WLAN) and multichannel multipoint distribution service (MMDS)WiMAX communication applications.

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