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A REVIEW ON DIFFERENT SHAPES OF PATCH ANTENNAS

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ABSTRACT

In this review paper, various shapes available for microstrip patch antennas are studied. One of the advantages of microstrip patches over conventional antennas is their small size. In integrated circuits technology, emphasis is laid on reducing the area covered on the chip. Thus, antennas required in such fields require minimum realizable area with a required gain and bandwidth. However, there are many present day applications where even these small radiators are too large. A microstrip antenna incorporated with a single shorting pin is found to provide reduction in overall area with respect to a conventional patch. The paper discusses four different shapes available for patch antennas with reduction in areas. The simulation software used in each of the references is IE3D.

KEYWORDS: *microstrip, antenna, return loss, VSWR, HFSS*

I. INTRODUCTION

An antenna is a device used to transform an RF signal, traveling on a conductor, into an electromagnetic wave in free space. Microstrip patch antenna has many advantages like low cost, compact size, simple structure and compatibility with integrated circuitry. It has tremendous applications in military, radar systems, mobile communications, global positioning system (GPS), remote sensing etc. Microstrip Patch Antenna in its simplest form consists of radiating patch on one side of a dielectric substrate and a ground plane on the other side. Conventional microstrip antennas in general have a conducting patch printed on a grounded microwave substrate. The radiating patch could be of any arbitrary shape, but it is generally taken as a regular shape for the ease of analysis and understanding of the antenna characteristics.

IE3D is a full-wave electromagnetic simulator based on the method of moments. IE3D solves the Maxwell's Equations in an integral form through the use of Green's functions. It can be used to calculate and plot the *S*11 parameters, VSWR, current distributions as well as the radiation patterns It can model structures with finite ground planes and differential feed structures, can model true 3D metallic structures in multiple dielectric layers in open, closed or periodic boundary.

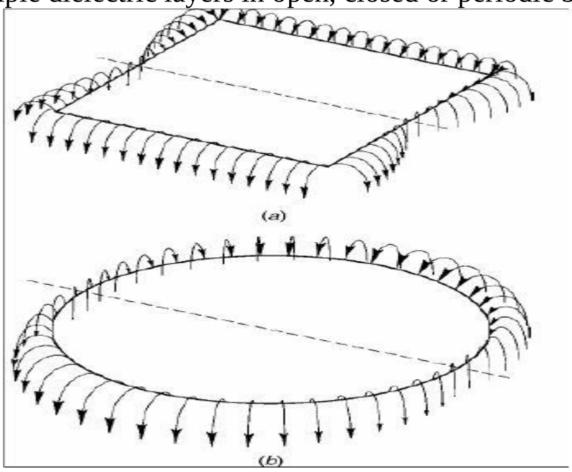

Fig.1 Fringing Fields in Patch Antennas

As shown in fig. 1, microstrip antennas are planar resonant cavities that leak from their edges and radiate. Thus, more number of edges with less complexity of designing would be preferable.

II. RECTANGULAR PATCH ANTENNA

Fig. 2 provides the view of simple rectangular patch antenna [1] with length and width (L, W) 41.08mm, length of transmission line feed is 15mm and width is 4.84mm. in this simulation quarter wave transformer is used of length 24.05mm and width 0.72mm the antenna is designed using Duroid (tm) substrate having relative permittivity of =2.2 having the height from the ground plane is 1.57mm. Frequency for the solution is used as 2.4 GHz. Fig. 3 shows the graph between return loss and frequency. Fig. 4 shows radiation pattern.

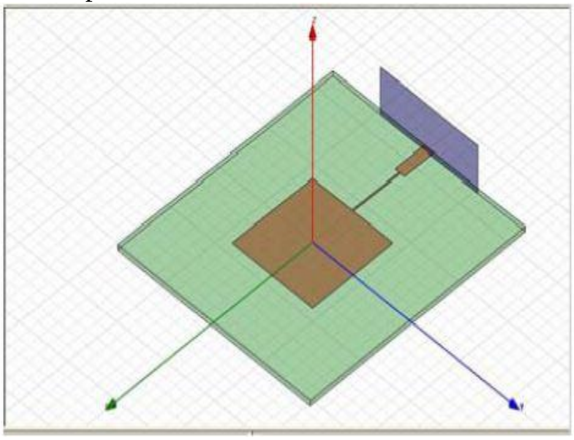

Fig. 2. A schematic representation of rectangular patch antenna.

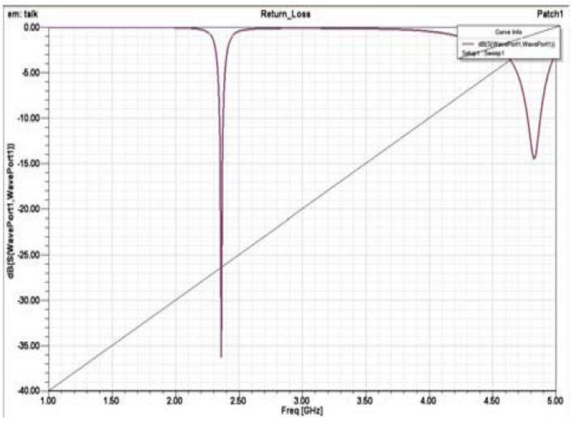

Fig. 3. Band width vs. return loss of rectangular patch antenna.

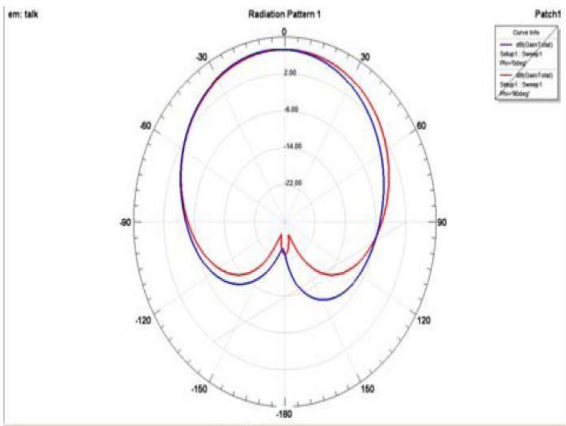

Fig. 4. Radiation pattern of rectangular patch antenna.

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III. TRIANGULAR PATCH ANTENNA

The equilateral triangular patch antenna [1] is designed at the frequency of 5.8 GHz for the Wi-Max applications this band is used for the IEEE 802.11c standard and other medical and scientific purposes. The triangular patch antenna configuration is chosen because it has the advantage of occupying less metalized area on substrate than other existing configurations rectangular and circular geometries are most commonly used, its dimension that tends to be small can make the overall dimension of the antenna very small too. The geometry of triangular patch antenna is shown in Fig. 5. It is a triangular patch antenna with two cuts one at the base and other at one arm of equilateral triangle. In this design the side length is taken as S=38mm with the substrate height of 1.55mm. Dielectric substrate of FR4 is taken having =4.4. In this design co axial probe feed technique is used.

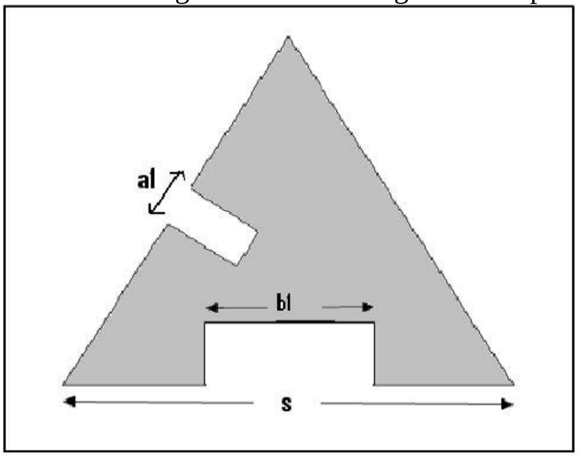

Fig. 5. Geometry of triangular patch antenna with S=38, al=2,bl=5.

The figures show the return loss curves and radiation pattern for a triangular patch. It is clear that at lower range of frequencies rectangular patch antenna works better but as the frequency increases towards the Wi-Max Applications which are more than 5GHz triangular patch antenna gives better result.

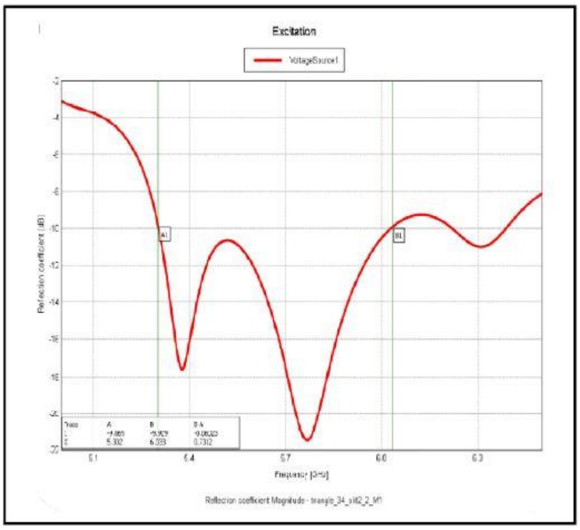

Fig. 6. Bandwidth VS return loss for triangular microstrip antenna.

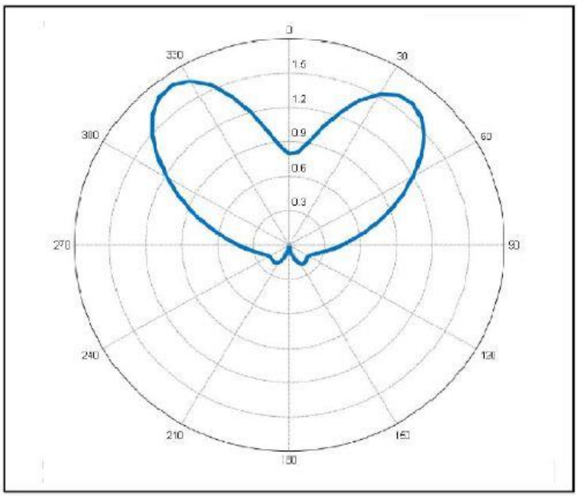

Fig.7. Radiation pattern of triangular micro strip antenna.

IV. CIRCULAR PATCH ANTENNA

Microstrip patch antenna [2] is used at 5.8GHz as resonance is achieved at this point. Coaxial feeding technique is used in the design because of its feature that it is easy to obtain input matching by adjusting feed position. Input impedance matching is critical requirement to achieve required bandwidth, if it doesn't occur than efficiency will be lower. Line fed rectangular patches may be fed from the radiating or the non-radiating edge. To find an impedance match along the non-radiating edge Transmission Line Model may be used. The input impedance along the non-radiating edge is lowest at the center since two equally high impedances at the two ends are transformed into a low value at the center and connected in parallel with each other [3]. The thickness of substrate tried to be kept minimum so that maximum bandwidth with bin the limit of $.003\lambda o < h < .05\ \lambda o$ can be achieved. FR4 epoxy material is chosen because it has Ɛr minimum as relative permittivity is inversely proportional to the bandwidth. RT-Duroid 5880 kept as a substrate layer above which a FSS superstrate is kept between them air gap of 28.96mm is adjusted to improve the bandwidth.

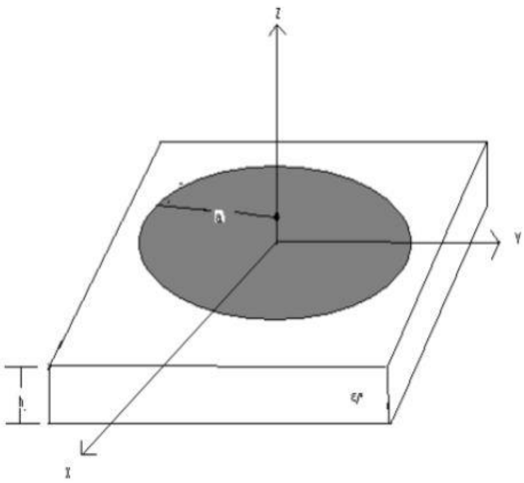

Fig. 8. Geometry of Circular Patch Antenna

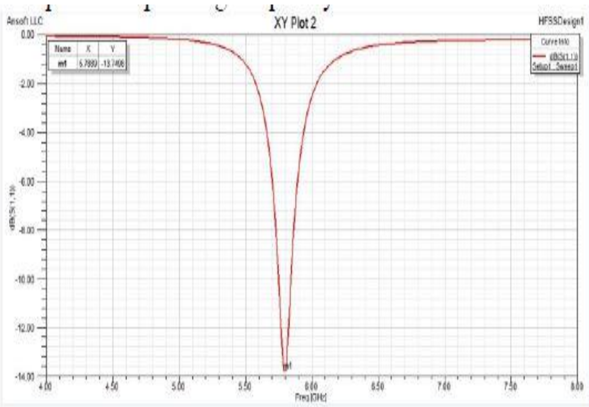

Fig. 8 . Return loss.

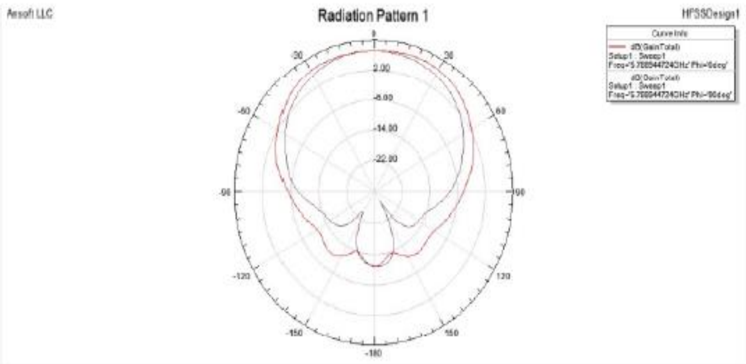

Fig. 9 Radiation pattern.

V. RHOMBUS SHAPED PATCH ANTENNA

At the frequency of 2 GHz, a rhombus shaped antenna [3] is presented initially the most popular shapes were rectangular and square but to reduce the weight and to achieve better antenna parameters other shapes were taken in to account.

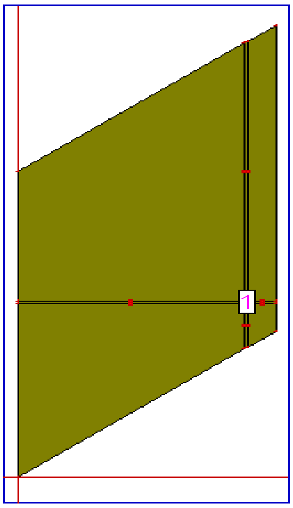

Fig.9. Rhombus patch geometry.

The return loss for rhombus shaped antenna simulated is shown in figure, which is around -23Db.

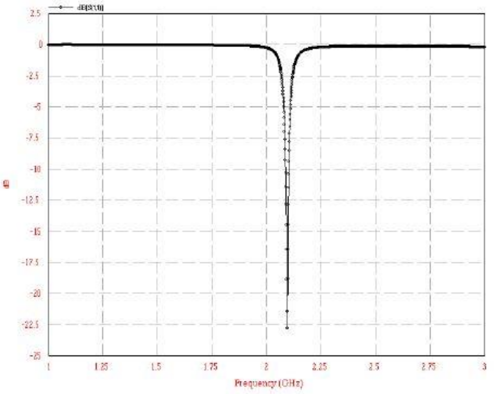

Fig.10. Return loss for rhombic patch.

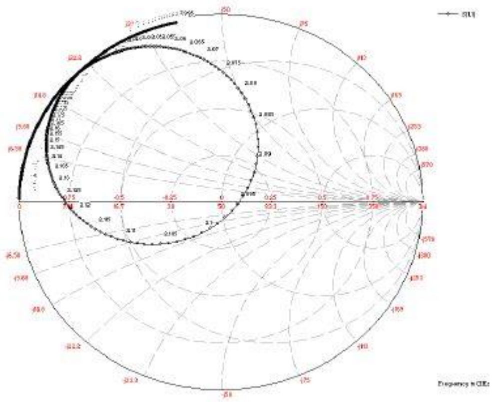

Fig.11. Radiation pattern for rhombic patch.

VI. RESULT DISCUSSION

The return loss curves and radiation patterns for each shape is discussed. The rectangular patch has a higher return loss though it shows a better gain through radiation pattern. The return loss is reduced in the triangular patch but with a decrease in gain and an uneven radiation pattern. The circular patch exhibits a high return loss value at resonant frequency with better radiation pattern as compared to the triangular patch. The rhombus shape exhibits a lesser return loss with an appreciable radiation pattern.

VII. CONCLUSION

In this paper, the different shapes of microstrip patch antennas are taken into account and analyzed. Apart from the return loss curves and the radiation pattern of each shape, the difference in area is also noted. While triangular patch has a smaller area, it has lesser edges. The circular patch antenna has reduced area but is complex in construction. The square shape, as compared to the rhombus shaped array antenna, having equal sized edges as the square shape, has reduced area due to the tilted geometry while having the same length of edges.

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