A New Bandwidth Enhancement Technique for Planar Antenna to be used in MIMO System

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***Abstract*— Slicing a substrate into two thin layer substrates, an impedance bandwidth of 12% is achieved while reducing the volume by 44.5%. The technique proposed shows that instead of single thick substrate if two thin substrates are used; an enhancement of impedance bandwidth takes place while maintaining high antenna gain and radiation efficiency. This is a new and novel technique for bandwidth enhancement in microstrip patch antenna and is quite different from stacked antenna. In this paper, we sliced a substrate into two thin substrates each of 1mm thick to achieve a bandwidth of 12%, radiation efficiency of 80.5549% and antenna efficiency of 79.5175% with an overall volume reduction of 44.5%. While a single substrate of thickness 2.5mm which is more than the total thickness of the discussed structure gives only 5% bandwidth for same antenna dimension. The proposed structure will find potential application in MIMO antenna system due to its volume reduction and other enhanced features.**

***Index Terms*—IE3D, Wideband width, micro strip antenna, slicing substrate.**

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I. INTRODUCTION

For last many years research on microstrip antenna is a topic of great interest [1-5]. Due to its attractive features like low cost, lightweight, low profile, case of fabrication it is suited for many applications such as Bio-medical & MIMO antenna system for wireless and mobile communication. There have been significant researches on microstrip antenna for improving the bandwidth, gain, directivity etc. [1, 4, and 5]. For improving the inherently narrow bandwidth of microstrip antenna, in this paper electrically thin substrates are used. A simple probe feed with shorting pin is proposed to reduce the size of the antenna while increasing the return loss and bandwidth. In this paper a microstrip antenna on 2.5mm thick substrate gives 5% bandwidth and the same shape antenna with two slicing substrate (each of 1mm thick) gives enhanced bandwidth of 12% while reducing the volume by 44.5%. The MOM based full wave simulation software "IE3D" is used for this study. Due care has been taken to keep the antenna size small while maintaining high gain.

II. ANTENNA CONFIGURATION

Fig 1.a shows the structure of the square patch antenna, the patch length and width both are equal i.e. 1.25 cm each. Total dimension of the substrate including ground plane is $18\times18\times2.5\ mm^3$. And fig.1 (b) shows its 3D view. Now to enhance the bandwidth while reducing the volume we sliced the substrate into two thin substrate of thickness 1mm each. Two metallic posts are used at (X=0.375mm, Y=6.25mm) & (X=2.75mm, Y=11.25mm) whose lower parts are shorted with the ground plane. The first post's width is 1.5mm and it is separated from1st and 7th slot by 0.5mm as shown in fig.1d. The width of 2nd post is 0.75mm and it is separated from 6th slot by 1mm distance. As this sliced structure use only one patch i.e. top patch, two shorting pins are placed at (X=6.25mm,Y=12.5mm)&(X=12.5mm,Y=4.00 mm) to short the slot no. 6 and 4 of the patch. Rectangular shorting posts are used to short the patch.

III. DISCUSSION

The microstrip is fed coaxially and the location of 50-Ω feed point is same for both the antennas (X=3.62mm, Y=4.00mm) from origin. In both the cases, the dielectric constant of the substrate is 2.2 but the antennas differ in number of substrate layers, number of shorting pins, thickness of the substrate and number of substrate. The 3-D diagrams of these antennas are shown in figure-1b and in figure-1d respectively. In fig.1b only one substrate with thickness of 2.5mm, length 18mm and width 18mm is taken where as in fig-1d there are two substrate layers with total thickness of 2mm i.e. each of 1mm,length 15mm and width 15mm are taken. The impedance bandwidth obtain from both the designed antennas are 5% and 12% respectively and its' comparison is given in fig-1e. The fig1e clearly shows an enhancement of bandwidth. The figure.1f & figure.1g shows the elevation patterns of the antennas and fig.1h shows the azimuth radiation pattern. As seen from figures there are a similarity of patterns. However the gain and directivity get slightly changed. The table 1.1 shows the simulation results of the sliced substrate of patch antenna.

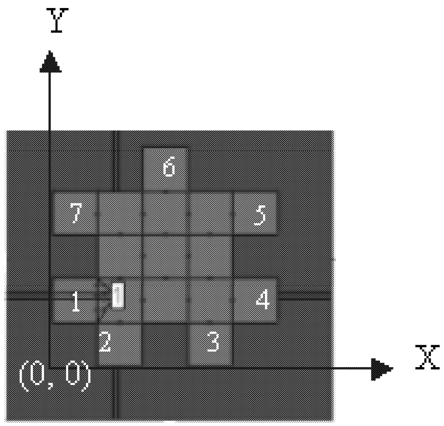

Fig.1a: Microstrip Antenna With substrate of thickness 2.5

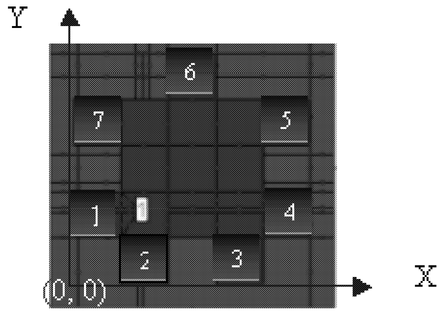

Fig.1c:Digram of Microstrip Antenna With Two Scliced Substrates of Thickness 1mm each

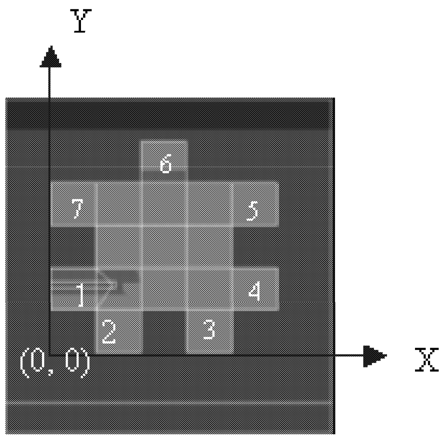

Fig.1b: 3D Digram of Microstrip Antenna With Substrate of Thickness 2.5mm

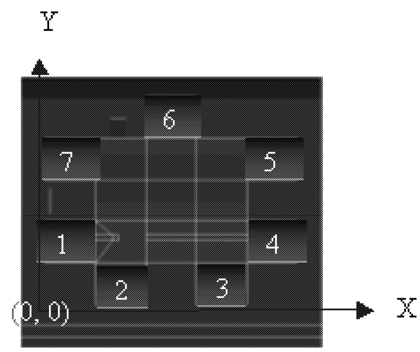

Fig.1d: 3D Digram of Microstrip Antenna With Two Scliced Substrates of Thickness 1mm Each

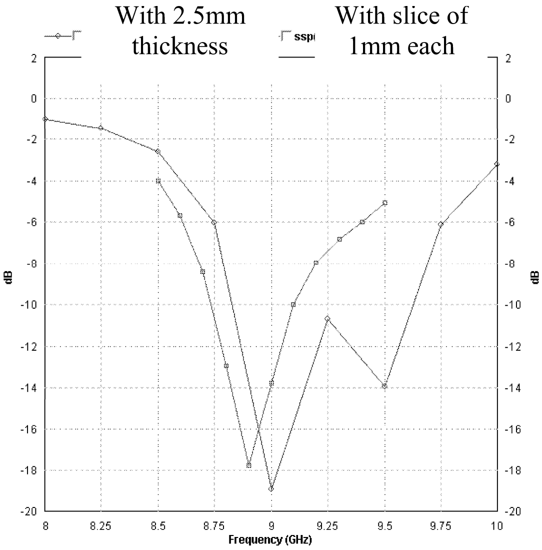

Fig.1e: Impedance Band Width

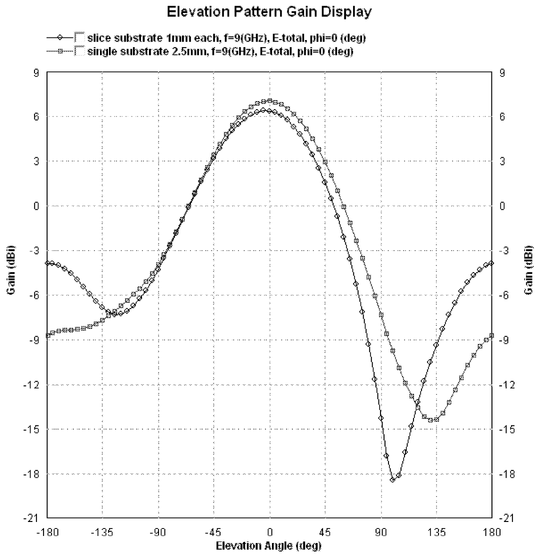

Fig 1f: Comparisons of single & sliced substrate microstrip antenna of Elevation pattern gain in Cartesian coordinate

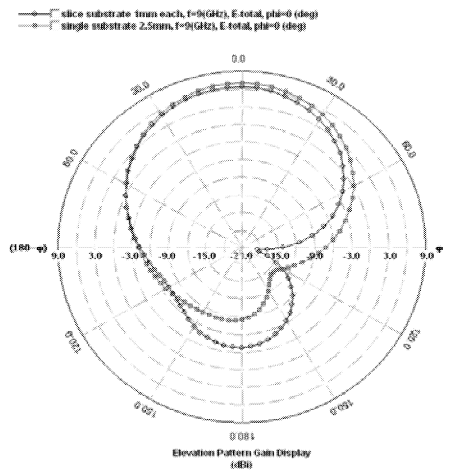

Fig 1g: Comparisons of single & sliced substrate microstrip antenna of Elevation pattern gain in polar co-ordinate

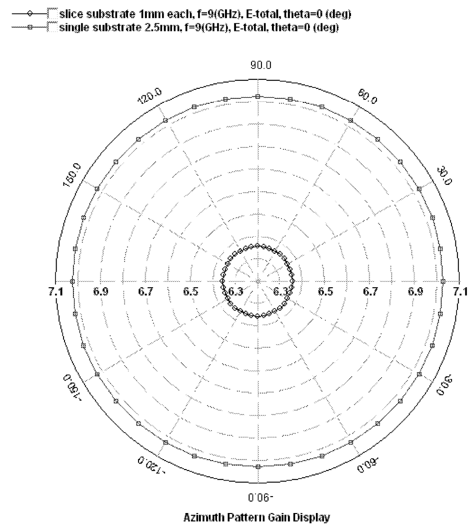

Fig 1h: Comparisons of single & sliced substrate microstrip antenna of Azimuth pattern gain in polar co-ordinate

No.	Radiation efficiency	Antenna efficiency	Gain	Directivity	3dB beam width	Band width
Sliced substrate	80.5549%	79.5175%	6.33264dBi	7.32803dBi	57.59 deg.	12%

Table 1.1 Results of the sliced substrates patch antenna

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IV. CONCLUSION

By using appropriate shorting on the ground plane, the quasi EM wave is guided and most of radiation takes place from slot to the patch side. Thus bandwidth increases by slicing the substrate equally with proper shorting pin. The reduction of volume and enhancement of bandwidth with considerably high antenna efficiency makes the design antenna a potential radiation for MIMO system. The approach of single top patch with sliced substrate layers seems to be an interesting method to enhance the bandwidth. However due care must be taken to place shorting pins and post for impedance compensation.

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