Dr.Naveen Hemrajani, Mrs.Sandhya Sharma, Mr. Rashid Hussain, Ravi Kumar / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 5, September- October 2012, pp.1932-1935

Bandwidth Enhancement In Wireless Applications By Using H-Shape Slot Microstrip Aperture Coupled Antenna

Dr.Naveen Hemrajani*, Mrs.Sandhya Sharma, Mr. Rashid Hussain**, Ravi Kumar*****
*Associate Professor, CSE, Suresh Gyan Vihar University, Jaipur,India.
** Associate Professor, E&C, Suresh Gyan Vihar University, Jaipur,India.
*** (M-Tech Scholar-DWCE, Suresh Gyan Vihar University, Jaipur,India)

ABSTRACT

In this paper a wideband dual polarized antenna is designed, manufactured and measured. Slot coupled patch antenna structure is considered in order to achieve the wideband characteristic. Although rectangular shaped slot coupled patch antennas are widely used in most of the applications, their utilization in dual polarized antenna structures is not feasible due to space limitation. For a rectangular slot, the parameter that effects the amount of coupling is the slot length. On the other hand when a H-shaped slot is considered, both the length of the center arm and the length of the side legs determine the coupling efficiency. This flexibility about the optimization parameters of the H-shaped slot makes it possible to position the two coupling slots within the boundaries of the patch antenna. In order to investigate the effects of slot and antenna dimensions on the bandwidth of the antenna, a parametric study is performed by HFSS simulator.

Keywords: **MSA, patch antenna, slot coupled patch antenna.**

I. INTRODUCTION

The need for antennas to cover very wide bandwidth is of continuing importance, particularly in the field of electronic warfare and wideband radar and measuring system. Although microstrip patch antennas have many very desirable features, they generally suffer from limited bandwidth. So the most important disadvantage of microstrip resonator antenna is their narrow bandwidth. To overcome this problem without disturbing their principle advantage (such as simple printed circuit structure, planar profile, light weight and cheapness),a number of methods and structures have recently been investigated. In this regard we can mention multilayer structures [1], broad folded flat dipoles [2], curved line and spiral antennas [3], impedance matched resonator antennas [4], resonator antennas with capacity coupled parasitic patch element [5], log periodic structures [6,7], modified shaped patch antenna (H-shaped [8]). In the present paper H-shaped microstrip patch antenna analyzed and compared with rectangular patch antenna.

The H-shaped patch antenna here has a size less than the rectangular patch antenna with larger bandwidth. The larger bandwidth is because of a reduction in the quality factor (Q) of the patch resonator, which is due to less energy being stored beneath the patch. Consider figure 1 below, which shows a rectangular microstrip patch antenna of length L, width W resting on a substrate of height h. The co-ordinate axis is selected such that the length is along the x direction, width is along the y direction and the height is along the z direction. Fig-1

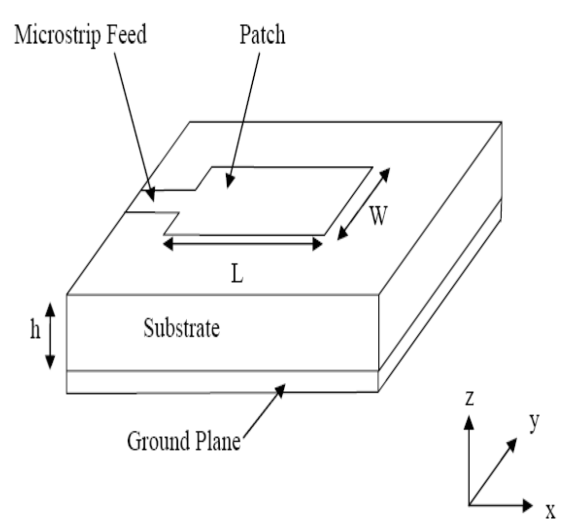


Fig-1 microstrip patch antenna

II.ANALYSIS METHOD FOR MICROSTRIP ANTENNA

The preferred models for the analysis of microstrip patch antennas are the transmission line model, cavity model, and full wave model (which include primarily integral equations/Moment Method). The transmission line model is the simplest of all and itngives good physical insight.

1. TRANSMISSION LINE MODEL

This model represents the microstrip antenna by two slots of width W and height h, separated by a transmission line of length L. The microstrip is essentially a nonhomogeneous line of two dielectrics, typically the substrate and air.

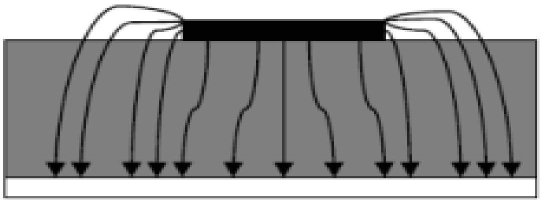


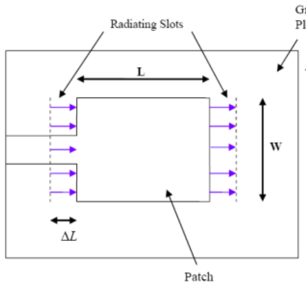
Fig 2 Electric field lines between patch and ground plane

Hence seen from figure 2 most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this transmission line cannot support pure transverse electric – magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate. Instead, the dominant mode of propagation would be the quasi-TEM mode. Hence, an effective dielectric constant (ε_{re}), must be obtained in order to account for the fringing and the wave propagation in the line. The value of ε_{re} is slightly less than ε_r because the fringing fields around the periphery of the patch are not confined in the dielectric substrate but are also spread in the air as shown in figure above . The expression for ε_{re} is

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Where ε_{reff} = Effective dielectric constant
ε_r = Dielectric constant of substrate
h = Height of dielectric substrate
W = width of the patch

In order to operate in the fundamental TM10 mode, the length of the patch must be slightly less than λ/2 where λ is the wavelength in the dielectric medium and is equal to $\lambda_o/\sqrt{\varepsilon_{reff}}$ where λ_o is the free space wavelength. In figure 3 shown given below, the microstrip patch antenna is represented by two slots, separated by a transmission line of length L and open circuit at both the ends. Along the width of patch the voltage is maximum and current is minimum due to the open ends. The fields at the edges can be resolved into normal and tangential components with respect to the ground plane.



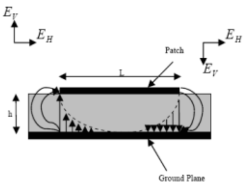


Fig. 3 Top View of Antenna. **Fig.4** Side View of Antenna

It is seen from figure 4 that the normal components of the electric field at the two edges along the width are in opposite directions and thus out of phase since the patch is λ /2 long and hence they cancel each other in the broadside direction. The tangential components (seen in figure 4), which are in phase, means that the resulting fields combine to give maximum radiated field normal to the surface of the structure. Hence the edges along the width can be represented as two radiating slots, which are λ/2 apart and excited in phase and radiating in the half space above the ground plane. The fringing fields along the width can be modeled as radiating slots and electrically the patch of the microstrip antenna looks greater than its physical dimensions. The dimensions of the patch along its length have now been extended on each end by a distance ΔL, which is

$$\frac{\Delta L}{h} = 0.412\left(\frac{\left(\varepsilon_{eff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{eff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}\right)$$

The effective length of the patch Leff now becomes
Leff =L+2ΔL

III. DESIGN OF RECTANGULAR MICROSTRIP PATCH ANTENNA

Rectangular aperture coupled antenna is investigated with resonant frequency at 2.21 GHz. The parametric analysis is done for each variable Design, analysis and simulation results obtained for rectangular Aperture coupled microstrip antenna at 2.21GHz will be presented, with the evaluation of various parameters' effects on the optimization of design. The parameters are analyzed one by one, with the particular effect on antenna performance, within the next subsections. Figure 5 shows the antenna

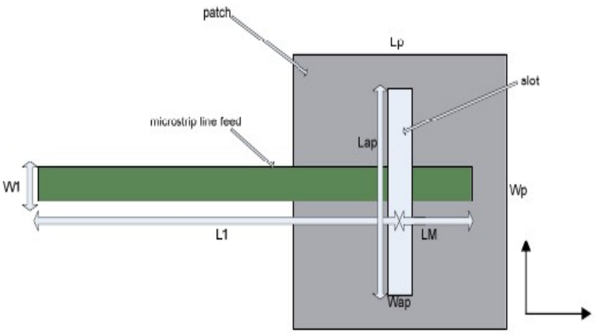
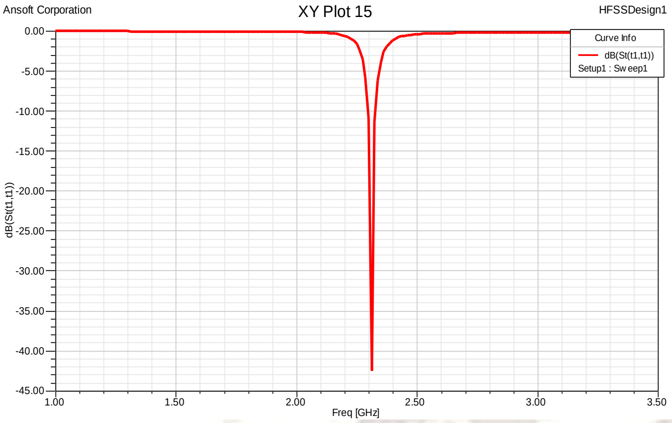


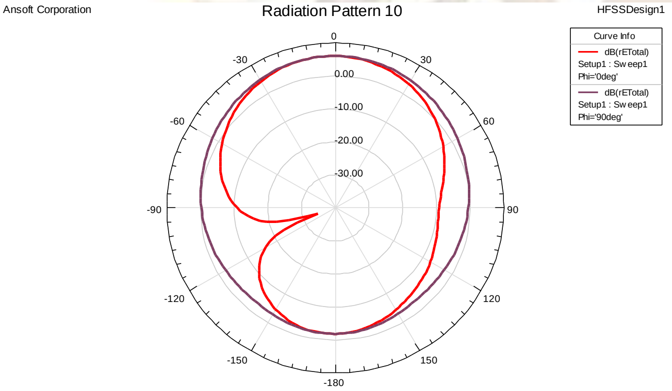
Fig. 5 Rectangular slot MSA

Where L_p = Patch Length=40mm, W_p = Patch Width=30mm, W_{ap} = Width of rectangular Aperture=1.55mm, L_{ap} = Length of rectangular Aperture=12mm, L1 = Microstrip feed line length=50mm, W1 = Microstrip redline width=4.42mm, x_{of} = offset in x direction (resonance direction)=0mm, y_{of} =offset in y direction (direction orthogonal to resonance direction)=0mm, LM = Stub length=16mm.

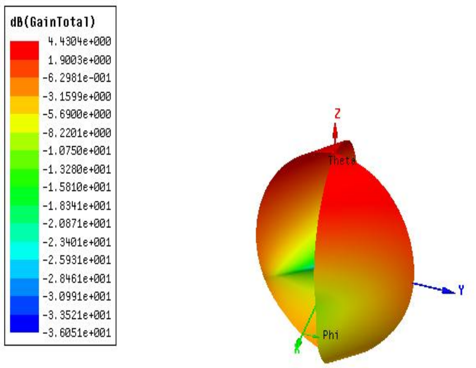
Terminal S-Parameter Plot –Magnitude is



Radiation Pattern:



Gain:



IV DESIGN OF H-SHAPED MICROSTRIP PATCH ANTENNA

H-shaped aperature coupled antenna is investigated with resonant frequency at 2.21 GHz. The parametric analysis is done for each variable. Figure 6 the antenna.

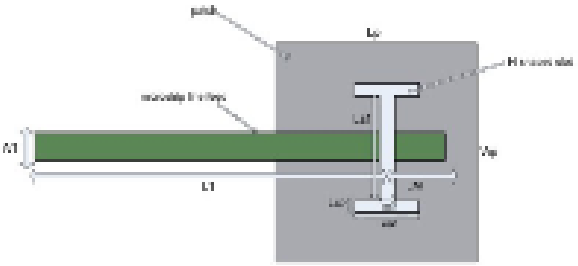
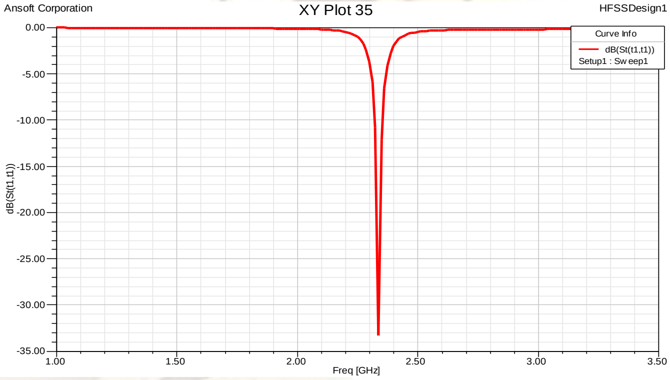


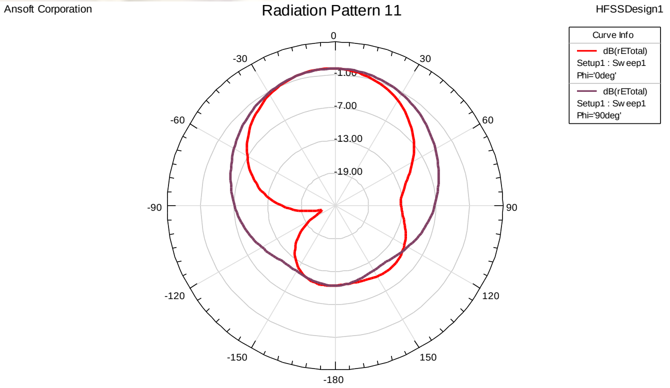
Fig.6 H-shaped slot MSA

Where L_p = Patch Length=40mm, W_p = Patch Width=30mm, ls1=length of H Aperture center leg=6mm, ws1=width of H Aperture center leg= ls2=length of H Aperture side leg=1.55mm, ws2=width of H Aperture side leg=4mm, L1 = Microstrip feedline length=50mm, W_f = Microstrip feedline width=4.42mm, x_{of} = offset in x direction (resonance direction)=0mm, y_{of} =offset in y direction (direction orthogonal to resonance direction)=1 mm, LM = Stub length=20mm.

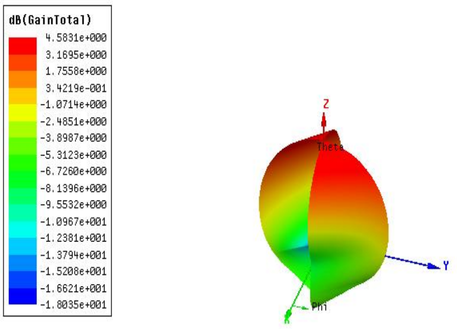
Terminal S-Parameter Plot –Magnitude is:



Radiation Pattern:



Gain:



Comparative analysis

Antenna type/ Properties	Rectangular MSA	H-Shaped MSA
Resonance Frequency	2.21Ghz	2.21Ghz
Bandwidth	2.75%	3.73%
Return Loss	-43	-24.3
Gain	4.43	4.6864

VI. CONCLUSION

Two aspects of microstrip antennas have been studied. The first aspect is the design of typical rectangular antenna and the second is the design of slot cut H-shaped microstrip antenna. The main concern is to study the bandwidth improvement of the microstrip antenna. Antenna design is done by using High Frequency Structure Simulator (HFSS). H-shaped MSA has higher bandwidth (3.73 %) than rectangular MSA (2.75 %).The bandwidth is enhanced **35.63 %** by using H shape slot.

REFERENCES

[1]. Hall, P.S. Ward,C and Garrett,C,"wide bandwidth microstrip antennas for circuit integration",Electron let. 15 pp 458-460,1979

[2]. Dubost,G.,Nicolars,M. and Havot,H."Theory an application of broadband microstrip antennas", proceedings of the 6th European microwave conference, Rome,pp 215-219,1976.

[3]. Ward,C,"curved microstrip lines as compact wideband circularly polarized antennas",IEE J.MICROWAVES,opt & acoust 3 pp5-13,1989.

[4]. Van De capelle, A, De Bruyne J. Verstraete, M.pues H. and Vandensande J. "microstrip spiral antennas", proceeding of the international IEEE Symposium on Antennas & Propagation, Seattle,pp 383-386,1999.

[5]. Pues H.F. and Van De Capelle A.R. "Impedance matching of microstrip resonator antennas" proceeding of the north American radio science meeting , quebec P.189.1980.

[6]. H.Pues ,Ir.J.. Bogarers,Ir. , R.pieck,Ir and A. Van De Capelle, Dr. Ir. "Wideband quassi-log periodic microstrip antenna",IEE PROC,Vol 128,pt. H,No.3,pp 159-163,june 2009.

[7]. V.B.Romodin,V.I.Oznobikhin and V.V. Kopylov,"log periodic microstrip array", IEE-Russia Conference mia-mep 9,1999.

[8]. Ravikant and D.C.Dhubkarya,"Design and Analysis of H-shape microstrip patch antenna", publication in the "Global Journal of Research in Engineering ",Vol.10 Issue 6 (Ver 1.0), PP 26-29,Nov.2010.