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Dual Band Stacked Microstrip Antenna for Wireless Applications

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Abstract: **In this paper stacked configuration of microstrip antenna is used to produce broad dual band which is suitable for various wireless applications. Using triangular slot and stacking of foam substrate of dielectric constant 1, two bands of bandwidth 18.10% and 6.20% is obtained.. The antenna is fed by coaxial probe feeding technique. The proposed patch antenna is designed on the foam substrate and simulated on the Zeland IE3D software. The antenna parameters such as return loss, impedance bandwidth, VSWR and radiation characteristics such as gain, radiation efficiency and radiation patterns have been studied.**

Keywords: Dual Band, Wideband, and Slotted MSA.

I - INTRODUCTION

Microstrip patch antennas are good candidate for wireless communication due to their various attractive features such as low-profile, directive with high transmission efficiency, light weight, low profile, conformal and planar structure, compactness, low cost and ease of integration with microwave circuit. There has recently been considerable interest in the two layer probe fed patch antenna consisting of a driven patch in the bottom and a parasitic patch. By stacking a parasitic patch on a microstrip patch antenna, the antenna with high gain or wide bandwidth can be realized. These characteristics of stacked microstrip antenna depend on the distance between a fed patch and a parasitic patch.

In this paper a dual band slotted microstrip antenna with stacked configuration is presented which gives a dual bandwidth of 18.10% & 6.20%. There are various methods which are used to increase the bandwidth of microstrip antenna such as increase the substrate thickness, use of a low dielectric constant substrate, use of various feeding techniques and impedance matching use of slot antenna geometry and multiple resonators.

II – DESIGN OF RECTANGULAR PATCH

The rectangular microstrip patch antenna has been designed by calculating the length and width from the given equations,

$$W = \frac{c}{2f\sqrt{(\varepsilon_r + 10)/2}} \qquad (1)$$

Where **c** is the velocity of light, ε_r is the dielectric constant of substrate, ***f*** *is* the antenna working frequency, **W** is the patch width, the effective dielectric constant and the length extension are given as,

$$\varepsilon_{eff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 10\frac{h}{W}\right]^{-\frac{1}{2}} \qquad (2$$

$$\frac{\Delta l}{h} = 0.412\frac{(\varepsilon_{eff} + 0.300)\left(\frac{W}{h} + 0.262\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{W}{h} + 0.813\right)} \qquad (3)$$

By using above equations we can find the value of actual length of the patch as,

$$L = \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta l \qquad (4)$$

III ANTENNA GEOMETRY AND ANALYSIS

Figure 1 shows the layout of a coaxial probe-fed slotted patch antenna. First the ground plane of Length L and Width W is made and then a rectangular patch of same dimensions is fabricated above the ground plane to increase the bandwidth of microstrip antenna which is done at a height of 10mm from the ground. In the topmost layer a triangle is slotted whose base is of 10mm and height 12mm. The vertical probe feed to drive the patch is given which gives a dual bandwidth of 18.10% and 6.20%.

In the cavity model, the region between the patch and the ground plane is treated as a cavity that is surrounded by magnetic walls around the periphery and by electric walls from the top and bottom sides since thin substrates the field inside the cavity is uniform along the thickness of the substrate. The fields underneath the patch for regular shapes can be expressed as a summation of various resonant modes of two dimensional resonators. The fringing fields around the periphery are taken care of by extending the patch boundary outward so that the effective dimensions are larger than the physical dimensions of the patch.

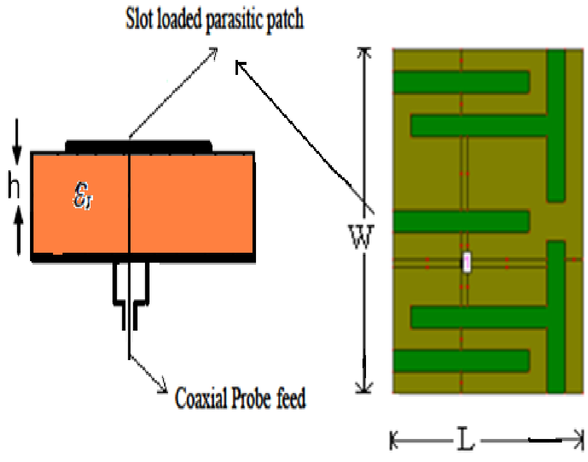

Figure 1. Geometry of proposed microstrip antenna.

The effect of the radiation from the antenna and the conductor loss are accounted for by adding these losses to the loss tangent of the dielectric substrate. The far field and radiated computed from the equivalent magnetic current around the periphery.
From the cavity model explained above, the electric field is assumed to act entirely in the z-direction and to be a function only of the x and y coordinates i.e. [6-7]

$$\vec{E} = \hat{Z}Ez(x, y) \tag{5}$$

The z-component of the electric field E_z satisfies the two-dimensional wave equation.

$$\frac{\partial^2 E_Z}{\partial \chi^2} + \frac{\partial^2 E_Z}{\partial y^2} + K^2 E_Z = 0 \tag{6}$$

The outward current flowing on the perimeter of the patch must be zero (since the patch boundary is an open-circuit). So

$$\frac{\partial E_Z}{\partial \chi} = 0 \tag{7}$$

Where n is the outward normal vector at the perimeter of the patch by using the separation of variables, the electric field of the m and n mode number is

$$E_Z = E_0 Cos\left(\frac{m\pi\chi}{W}\right)\left(\frac{n\pi y}{L}\right) \tag{8}$$

In order to calculate the far field, the aperture model is used. By using Green's function the following general form of the far field for any (m, n) mode

$$E(r) = \frac{jke^{-jkr}}{2\pi r}\left\{\bar{i}_\theta\left[E_x\cos\varphi + E_y\sin\varphi\right] + \bar{i}_\varphi\left[-E_x\sin\varphi\cos\theta + E_y\cos\varphi\cos\theta\right]\right\} \tag{9}$$

Where

$$E_x = \left[\left(-1-(-1)^m\right)j\sin\left(\zeta\frac{W}{2}\right) + \left(1-(-1)^m\right)\cos\left(\zeta\frac{W}{2}\right)\right]\times$$

$$h\cdot E_0\frac{L}{2}\sin c(\zeta a)j^n\left[\sin c\left(\eta\frac{L}{2}+\frac{n\pi}{2}\right)+(-1)^n\sin c\left(\eta\frac{L}{2}-\frac{n\pi}{2}\right)\right]$$

and

$$E_y = \left[\left(-1-(-1)^n\right)j\sin\left(\eta\frac{L}{2}\right) + \left(1-(-1)^n\right)\cos\left(\eta\frac{L}{2}\right)\right]\times$$

$$h\cdot E_0\frac{W}{2}\sin c(\eta a)j^m\left[\sin c\left(\zeta\frac{W}{2}+\frac{m\pi}{2}\right)+(-1)^m\sin c\left(\zeta\frac{W}{2}-\frac{m\pi}{2}\right)\right]$$

Then the far field components are

$$E_\theta = \frac{jke^{-jkr}}{2\pi r}\left(E_x\cos\varphi + E_y\sin\varphi\right) \tag{10}$$

$$E_\phi = \frac{jke^{-jkr}}{2\pi r}\left(-E_x\sin\varphi\cos\theta + E_y\cos\varphi\cos\theta\right) \tag{11}$$

Where

$$\zeta = KSin\theta Cos\varphi, \qquad \eta = KSin\theta Sin\varphi$$

$K = \frac{2\pi}{\lambda_0}$ and λ_0 =wavelength in free space.

Equation (9) enables one to plot the radiation pattern for every mode of the rectangular micro strip patch antenna.

IV – RESULTS AND DISCUSSIONS

The stacked microstrip antenna has been designed and resonant properties of the presented antenna has been optimized by designing the antenna structure with the aid of Zeland IE3D software based on Methods of Moments. Figure 2 shows the return loss graph of microstrip antenna. The slotted antenna resonate at 1.72 GHz &2.22 GHz frequency giving bandwidths of 18.10% & 6.20% (at- 10db Return loss & VSWR < 2) in Fig 4.

Figure 3 shows the radiation pattern of antenna simulated on IE3D. The proposed antenna gives a appreciably better efficiency of about 80% shown in fig 6. Radiation characteristics of the proposed antenna is also better than the Conventional microstrip antenna. Fig 5 shows the Gain Vs frequency plot of proposed antenna at various frequencies. As depicted in the figure the maximum achievable gain is 4dBi which is better as found in other conventional microstrip antenna. The 3D structure and 3D radiation pattern is shown in fig. 7 & fig. 8.

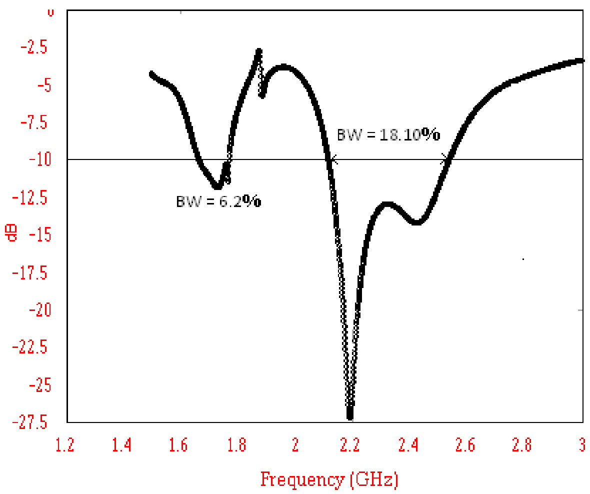

Figure 2. Return lossVs frequency plot of proposed Antenna

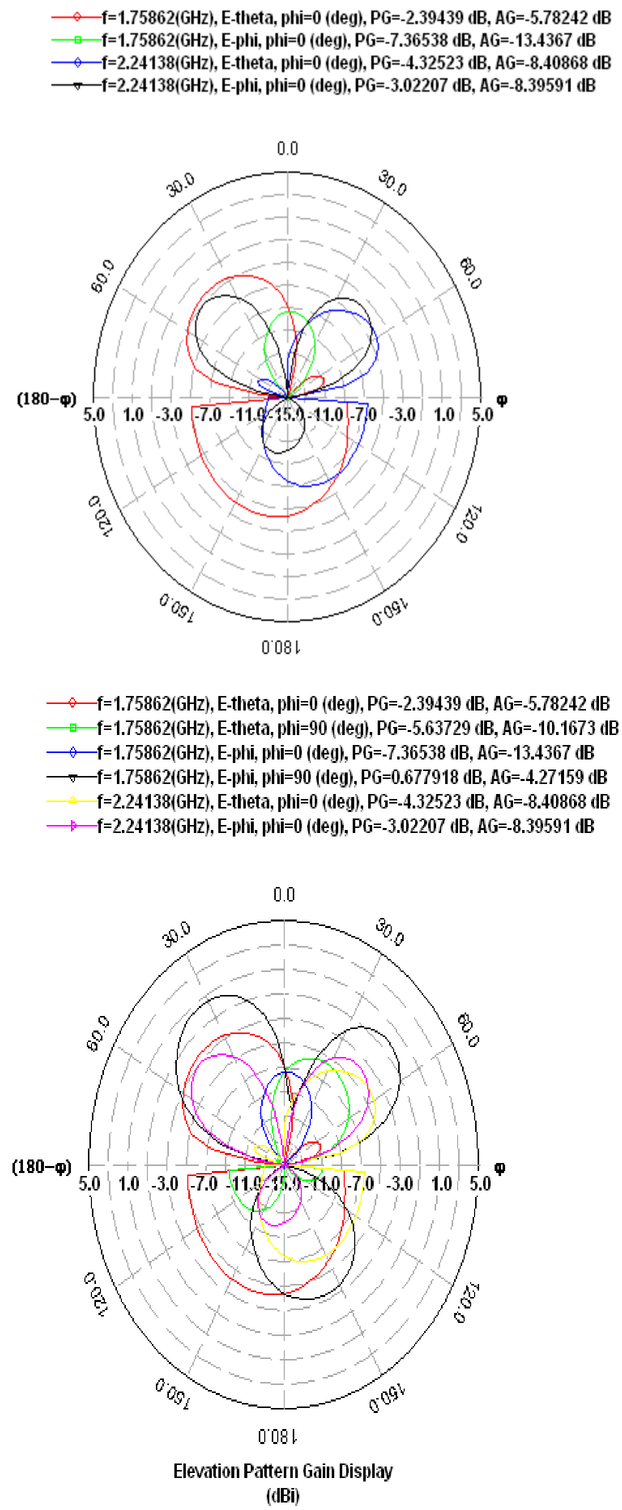

Figure 3. Radiation Pattern of the proposed Antenna.

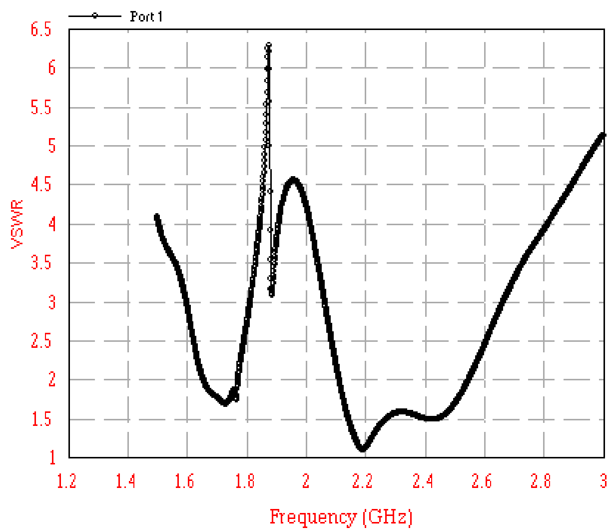

Figure 4. VSWR Vs frequency of proposed antenna.

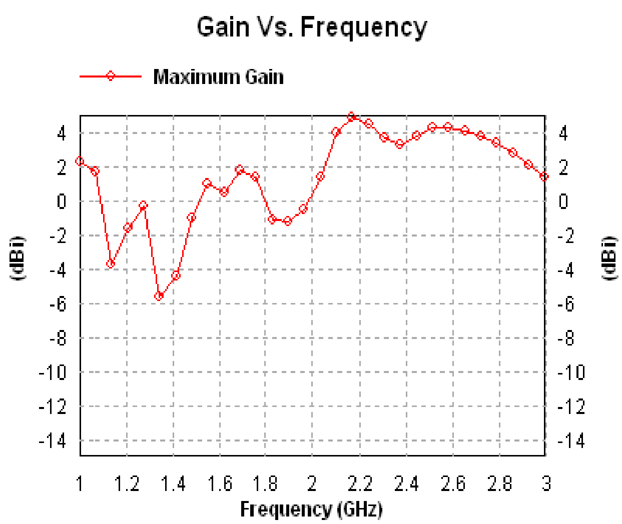

Figure 5. Gain Vs fequency plot of proposed antenna

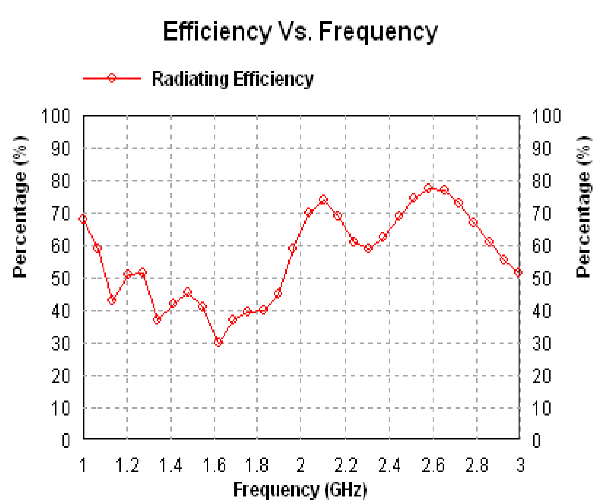

Figure 6. Efficiency Vs frequency plot of proposed microstrip antenna.

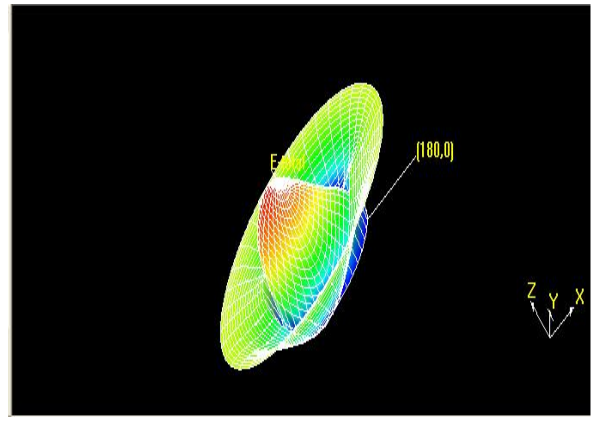

Figure 7.3D radiation pattern plot of proposed antenna

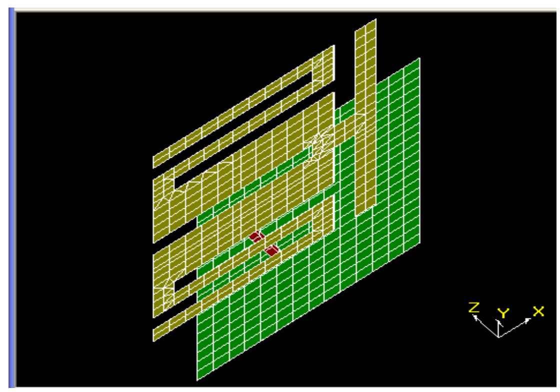

Figure 8.3D structure of proposed microstrip antenna

V – CONCLUSION

A dual band slotted stacked microstrip antenna on foam substrate has been designed.The antenna parameters such as return loss, impedance bandwidth, gains and radiation patterns have been studied The proposed antenna is designed using stacked configuration to give wide *dual bandwidths of 18.10% & 6.20%.*.The simple coaxial vertical probe feed is used as a feeding technique to drive the stacked patch.

VI – REFERENCES

[1] Ali, Zakir; Singh, Vinod Kumar; Singh, Ashutosh Kumar;Ayub, Shahanaz; "E *shaped Microstrip Antenna on Rogers substrate for WLAN applications*" International Conference on Computational Intelligence and Communication Networks"IEEE proc. pp 342-345, Oct. 2011.

[2] A. Ghorbani, M. Ansarizadeh, and R. A. Abd-alhameed "*Bandwidth Limitations on Linearly Polarized Microstrip Antenna*" IEEE Transactions on Antennas and Propagation, Vol. 58, no. 2, pp 250-257, February 2010

[3] Mohammad Tariqul Islam, Norbahiah Misran, Mohammed Nazmus Shakib, and Baharudin Yatim, "Stacked Multiple Slot Microstrip Patch Antenna for Wireless Communication System," ICECE 2008, pp-20-22 December 2008, Dhaka, Bangladesh.

[4] Ayoub, AFA, " *Analysis of Rectangular microstrip Antenna with air substrate*" Journal of Electromagneti waves & applications" Vol 17 no-12 pp 1755-1766, 2003.

[5] K. L. Wong and W. H. Hsu, "A broadband rectangular patch antenna with a pair of wide slits," IEEE Transactions on Antennas and Propagation, vol. 49, pp. 1345-1347,September 2001.

[4] J. Y. Sze and K. L. Wong, "Slotted rectangular microstrip antenna for bandwidth enhancement," IEEE Transactions on Antennas and Propagation, vol. 48, pp. 1149-1152, August 2000.

[5] S. Egashira and E. Nishiyama,"Stacked microstrip antenna with wide bandwidth and high gain," IEEE Transactions on Antennas and Propagation, vol. 44, pp. 1533–1534, November 1996.

[6] Nasimuddin Z.N. Chen "*Aperture coupled asymmetrical c-shaped slot microstrip antenna for circular polarization*"**,** IET Microw Antennas Propag. , Vol. 3, Iss. 3, pp. 372–378, 2009.

[7] Shivnarayan & Babu R Vishvakarma "*Analysis of notch-loaded patch for dual-band operation*", Indian Journal of Radio & Space Physics. Vol.35, pp.435-442.

[8] Mohammad A. A. Subhi H. Ahmad A. K. and Juma S. M. "*Cavity model analysis of rectangular microstrip antenna operating in TM03 mode*", IEEE proc. pp. 0-2218-2223, 2006.

[9] S**.** K Satpathy, Vijay Srinivasan, K P Ray and G Kumar, "*Compact microstrip antennas for personal mobile communication*", IEEE proc. pp. 245-248, 1998.

[10]G. A. Deschamps, "*Microstrip microwave antennas*," Presented at the Third USAF Symposium on Antennas, 1953.

[11] Vinod K. Singh**,** Zakir Ali, "*Dual Band U- shaped microstrip antenna for wireless Communication*" International Journal of Engineering Science Technology, India, VOL 2 (6), pp 1623-1628, June,2010.

[12] Pandey V. K. & Vishvakarma B R, "*Theoretical analysis of linear array antenna of stacked patches"*, indian j radio & space physics, 2005.

[13]J. R. James and P. S. Hall, "*Handbook of microstrip antennas*," Peter Peregrinus Ltd, London, 1989.

[14] E. F. Bolinder, "*Geometrical analysis of partially polarized electromagnetic waves,"* IEEE Trans. Antennas Propag., Vol. AP-15, No. 1, pp. 37–40, January 1967.

[15] B.K. Ang & B.K. Chung " *A wideband E shaped Microstrip patch antenna for 5-6 GHz Wireless communications* " PIER,75, pp- 397-407. 2007.

