Design and analysis of gain for rectangular microstrip patch antenna using symmetrical cuts

Rampal Kushwaha[1], Prof. Kanchan Cecil[2]
[1,2]Department of Electronics and Telecommunication
Jabalpur Engineering College, Jabalpur, India
E-mail: mail4rampal@yahoo.com, cecil.kanchan@gmail.com

Abstract

The low gain of microstrip antenna is one of the important features that that restrict its wide usage. This paper presents Bandwidth radiated microstrip patch with enhanced gain has been designed with centre frequency of 2GHz. In order to achieve gain enhancement a rectangular cut structure have been introduced in the rectangular patch antenna. Gain enhancement of 10dB at 2GHz is achieved. It is just because of Return loss is increasing in negative side as it goes from (-24dB) to (-34dB).

Keywords: Gain, rectangular microstrip antenna, symmetrical cuts, return loss.

I. INTRODUCTION

Microstrip antennas are used in a wide range of applications because of their advantageous features in terms of low profile, low cost, light weight and easy fabrication. However two major disadvantages are low gain and narrow bandwidth when high dielectric constant material is used for fabrication of the microstrip antenna. An individual microstrip patch antenna has a typical gain of about 6dB. Several approaches have been used to enhance the by perturbing the higher order mode by interpolating surface modification into patch geometry. Gain enhancement by cutting rectangular hole on another inserted layer. A symmetrical hole on inserted layer is used in simulation at 2GHz which is the key frequency in modern wireless communication era. The gain enhancement of approximate 10dB is achieved at 2GHz by inserting another symmetrical rectangular layer.

II. ANALYSIS OF SIMPLE RECTANGULAR PATCH ANTENNA

Figure 1, shows the simple rectangular patch antenna. The length, L= 35mm, and width, W= 45mm, Cut width= 10mm and cut width= 5mm, length of transmission line feed= 32mm, with width of the feed= 3mm. The rectangular microstrip patch antenna designed on one side of the glass/epoxy structure with ε_r = 4.4 and height from the ground plane= 1.6mm. Figure 2(a), shows the graph between return loss and frequency, fig. 2(b) shows the graph between VSWR and frequency. The above analysis and designing of antenna is done in the IE3D simulator software. The VSWR Directivity, Gain, Radiation pattern of designed antenna are calculated.

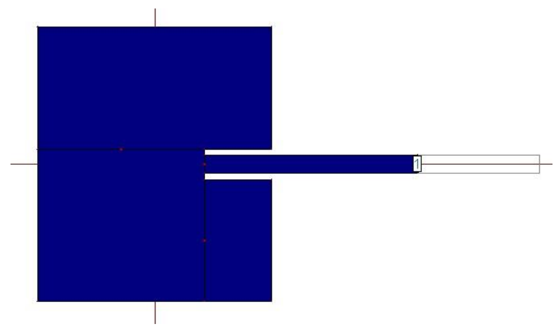

Fig. 1: Rectangular Patch Antenna

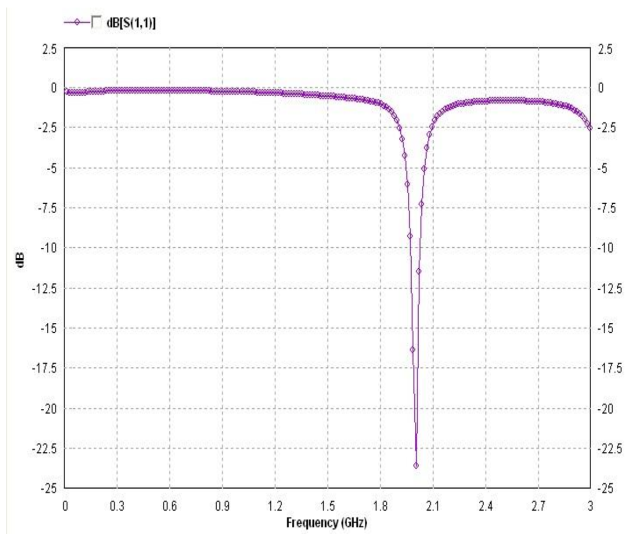

Fig. 2(a): Graph between return loss and frequency

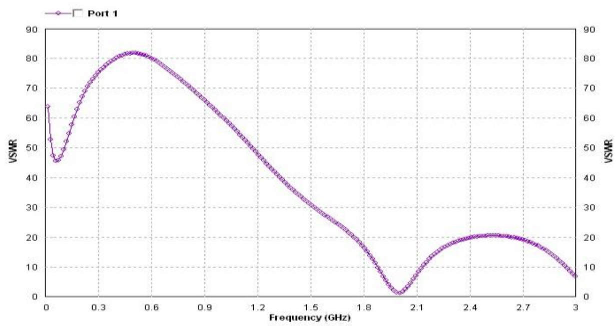

Fig. 2(b): Graph between VSWR and frequency

III. MICROSTRIP PATCH ANTENNA WITH SYMMETRICAL RECTANGULAR CUTS ON THE INSERTED LAYER

Figure 3, shows the microstrip patch antenna with symmetrical rectangular cuts on the inserted layer at the height h= 3.2mm. The length, L= 35.2535, and width, W= 45.63mm, Cut width= 10mm and cut width= 5mm, length of transmission line feed= 32.815mm, with width of the feed= 3.009mm. The rectangular microstrip patch antenna designed on one side of the glass/epoxy structure with ε_r = 4.4 with tangent loss 0.002. Figure 4(a), shows the graph between return loss and frequency for the patch antenna with symmetrical rectangular cuts.

The width of the patch element (W) is given by:

$$W = \frac{c}{2f_0\sqrt{(\varepsilon_{reff}+1)/2}}$$

The effective length is given by

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

The length extension (ΔL) is given by

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

The actual length (L) of patch is obtained by:

$$L = L_{eff} - 2\Delta L$$

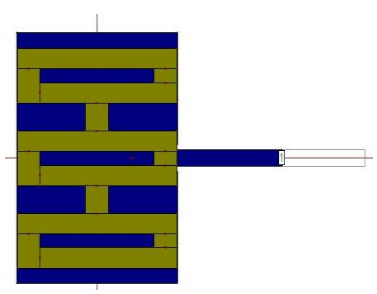

Fig. 3: Microstrip patch antenna with symmetrical rectangular cuts

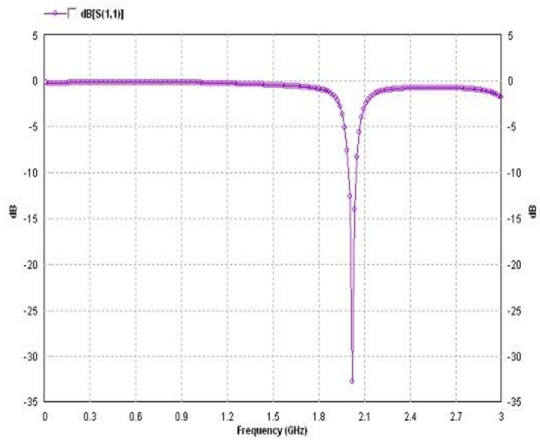

Fig. 4: Graph between return loss and frequency for Symmetrical rectangular cuts on inserted layer

IV. CONCLUSION

The comparison between the simple rectangular patch antenna and microstrip patch antenna with symmetrical rectangular cuts on new inserted layer at h= 3.2mm is shown in the below figure 5, which shows the decrease in the return loss and hence increase in gain of the new design.

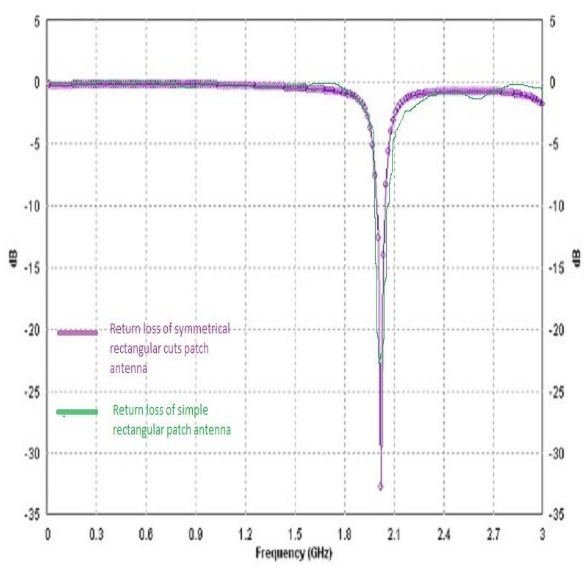

Fig. 5: Comparison of return loss of simple rectangular patch and symmetrical rectangular cuts on inserted layer patch antenna

REFERENCES

[1] D. M. Pozar and D. H. Schaubert, *Microstrip antennas the analysis and design of microstrip antennas and arrays*. New York IEEE Press, 1995.

[2] Y.J. Wang, C.K.Lee and W.J.Koh *"Single –patch and Single –layer square microstrip antenna with 67.5% bandwith"* IEE Proc-Microw. Antennas Propag. Vol.148,No.6,December 2001

[3] Ravi Pratap Singh Kushwah MITS Gwalior M.P. *"BOW-Shape Single Layer With Single Probe Feed Microstrip Patch Antenna"* 0-7803-9433-X/05/$20.00 ©2005 IEEE

[4] J. Milan Polivka, Premysl Hudec, "*10 GHz Broadside Radiated Linearly Polarized Microstrip Patch with Enhanced gain"*. Microwave Conference. 2005 European, Volume 3, Issue 4-6 Oct. 2005.

[5] Romeu, J., Borja, C. Blanch, S., *High Directivity Modes in the Koch Island fractal patch antenna*, 2000 IEEE *Int. Antennas Propagat. Symp. Dig.* Vol. 38, July 2000, pp. 1696-1699.

[6] Pramendra Tilanthe, Prof. Dr. P. C. Sharma, "*An equilateral triangular patch antenna with T-shaped notch for enhanced gain.* IEEE 2008.