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Research Paper

VSWR AND BANDWIDTH ENHANCEMENT OF AN INSET-FED PATCH ANTENNA

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Micro strip patch antenna became very popular today because of its ease of design, fabrication, low cost, light weight, easy to feed and their superior radiation characteristics. Although patch antenna has numerous advantages, it has also some drawbacks such as restricted bandwidth and low gain. Many antenna engineers have developed various techniques to improve these parameters, however the performance of these antennas need to be further improved. This paper is focused on the improvement of gain of the rectangular slotted patch antenna at 2.0675 GHz by inclusion of notches into the design and to compare their results. The antenna is fed by Inset feeding technique, which is simple and obtaining good impedance matching. The antenna design has been simulated using the CST studio suite tool. Comparative study of simulated parameters like Gain, Bandwidth, Directivity and Radiation pattern have been done and presented in this paper.

Keywords: Microstrip patch antenna, Bandwidth, Gain, Inset feeding, VSWR, Return loss

INTRODUCTION

Microstrip patch antenna has many advantages such as low profile, compactness, easy to fabricate, easy installation, low cost etc but it has a major disadvantage of narrow bandwidth which proved to be a challenge for engineers to meet high data rate for various broadband application. Bandwidth of antenna can be increased by various methods such as by increasing the thickness of substrate with low dielectric constant, by probe feeding, by cutting slot, by cutting notches and by different shapes of antenna. Deshmukh and Kumar ((2001)) proposed compact L Shape patch broadband Microstrip antenna experimentally increase bandwidth up to 13.7%. Chen (1985) further increase bandwidth of this antenna up to 23.7-24.4%. George (2009) proposed

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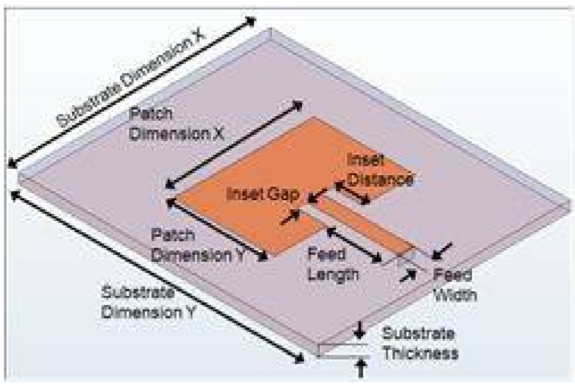
optimal angle between feed line and patch for enhancing bandwidth. K F Lee (Chen and Chial, 1985) proposed U Shape slot shorting post small size Microstrip Antenna and increase bandwidth up to 42%. Z M chen Tsai K F Lee (Chen and Chial, 1985) (Lee *et al*., 1996) used low permittivity in proposed design for enhancing Bandwidth. Garg *et al*. (2001) demonstrated significant increase in bandwidth by increasing height of dielectric material. Latif *et al*. (2009) enhances gain and bandwidth by novel technique form ring by depositing multiple conductor layer separated by laminating dielectric. Gao *et al*. (2001) used uniplanar photonic band gap structure for enhancing band width and gain. Khodier and Christodoulou (2000). New wideband stacked microstrip antennas for enhancing band width. W. S. Yun, Wideband microstrip antennas for PCS/IMT-2000 services. Our proposed 5.9 RT DUROID 5880 substrate slot shaped antenna provides optimum results at 2.0675GHz VSWR is 1.03:1 and return loss is 36.18dB. The results of proposed antenna have been verified in CST studio Simulator.

FEEDING TECHNIQUE

Microstrip line feed is one of the easier methods to fabricate as it is a conducting strip connecting to the patch and therefore can be considered as an extension of patch. It is simple to model and easy to match by controlling the inset position. Since the current is low at the ends of a half-wave patch and increases in magnitude towards the center, the input impedance (Z=V/I) could be reduced if the patch was fed closer to the center. One method of doing this is by using an inset feed (Figure 1).

Figure 1: Inset Feeding Technique



ANTENNA DESIGN AND RESULTS

For this design, the selected three parameters are: Resonant Frequency (f_r) = 2.0675 GHz, Dielectric constant (ε_r) = 2.2 and height of the dielectric substrate (h) = 5.9 mm. The first step is the selection of dielectric material and the selected is RT Duroid 5880. Length and width of the substrate is 150 mm x 150 mm. After that, the designed patch was created on the substrate material using calculated mathematical dimensions. After this, a micro strip feed line (50 Ù) is also drawn on the same substrate. A radiation box is also created maintaining a minimum height of $\lambda/4$. First a simple inset-fed patch antenna is designed to resonate at 2.0675 GHz and the results were analysed and are presented. Then, a slight modification was done for the patch antenna with different inset gap for the same inset feeding. The results of this antenna were also observed and are presented. Furthermore the antenna results were analysed by making notch at the patch antenna and it is observed that there is a significant improvement in the return loss and bandwidth of the patch antenna.

Figure 2, shows the geometry of inset fed rectangular Microstrip antenna. The antenna is designed for the resonance frequency of 2.0675GHz. It consists of radiating patch of length *L* and width *W*.

Figure 2: Simple Inset Fed Patch Antenna

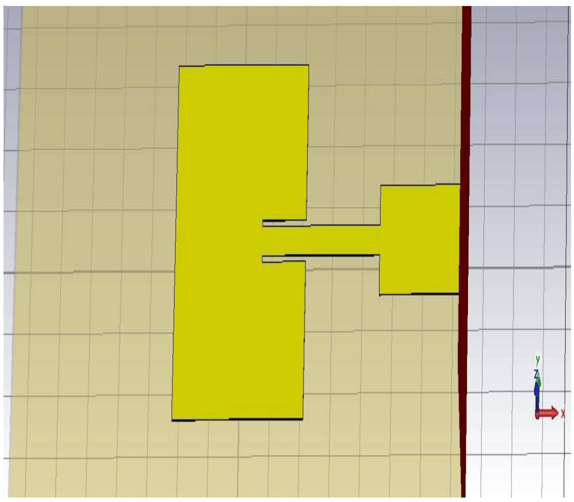


Figure 3, shows the variation of return loss versus frequency plot of simple inset fed Microstrip antenna. The antenna resonates at 2.0675GHz frequency. The return loss is -11.75 dB and The overall bandwidth at (2.0675GHz) is found to be 8.95% (that is 41.9MHz).

Figure 3: Return Loss

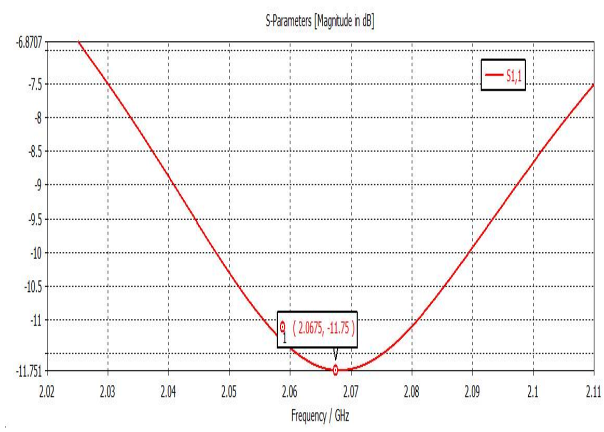


Figure 4, shows the variation of VSWR versus frequency plot of simple inset feed microstrip antenna. The antenna resonates at 2.0675GHz frequency and The VSWR at (2.0675GHz) is found to be 1.69.

Figure 4: VSWR

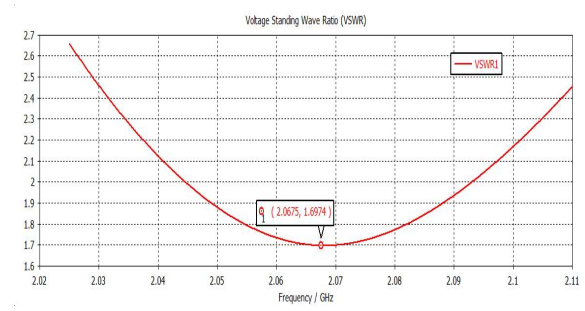


Figure 5, shows the Farfield Gain plot of simple inset fed microstrip antenna. The antenna resonates at 2.0675GHz frequency and The overall Gain at (2.0675GHz) is found to be 7.5 dB.

Figure 5: Farfield Gain

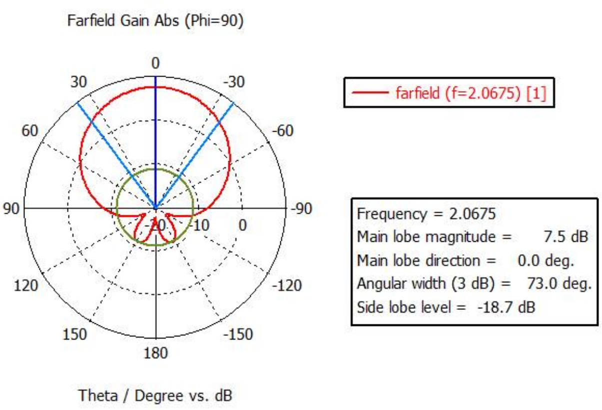


Table 1, shows performance analysis of a simple inset fed patch antenna as a function of inset gap.

Table 1: Performance Analysis as a Function of Inset Gap

Inset Gap	Antenna Gain (db)	S11 (dB)	-10 dB Bandwidth (MHz)
w/2	7.5	-11.75	41.9
w/5	7.73	-12.02	44.3
w/10	7.83	-24.21	81.3
w/15	7.84	-24.42	82.2
w/20	7.84	-23.28	84.2
w/25	7.84	-22.51	86.7
w/30	7.84	-22.05	89
w/35	7.83	-21.69	90
w/40	7.83	-21.42	91.5

From Figure 6, it was observed that with a decrease in notch width, the resonant frequency shifts away from 2.0675 GHz. There is a resonance shift of 0.0066 GHz and the bandwidth is increased about 50MHz when inset gap is decreased from W/2 to W/40.

Figure 6: Return Loss as a Function of Inset Gap

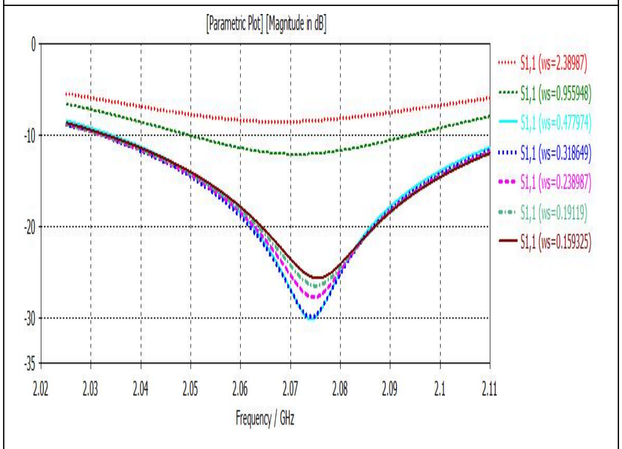


Figure 7, shows the geometry of inset fed rectangular Microstrip antenna with a single slot. The antenna is designed for the resonance frequency of 2.0675 GHz.

Figure 7: Single Notch Patch Antenna

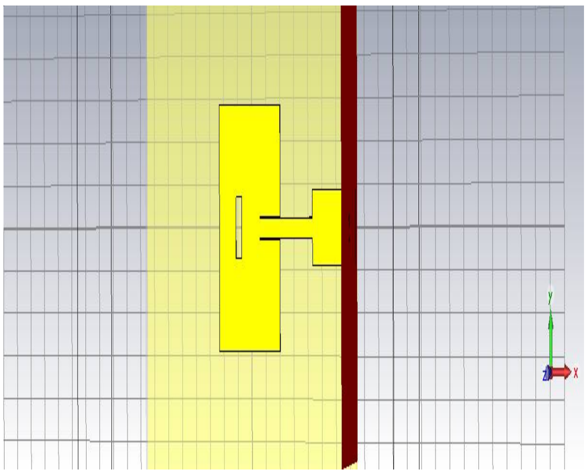


Figure 8, shows the variation of return loss versus frequency plot of inset fed Microstrip antenna with a single slot. The antenna resonates at 2.0666GHz frequency which is close to the designed frequency of 2.0675GHz. The return loss is -64.55 dB and The overall bandwidth at (2.0675GHz) is found to be 91.5MHz .this improvement of bandwidth is as a result of the slot.

Figure 8: Return Loss

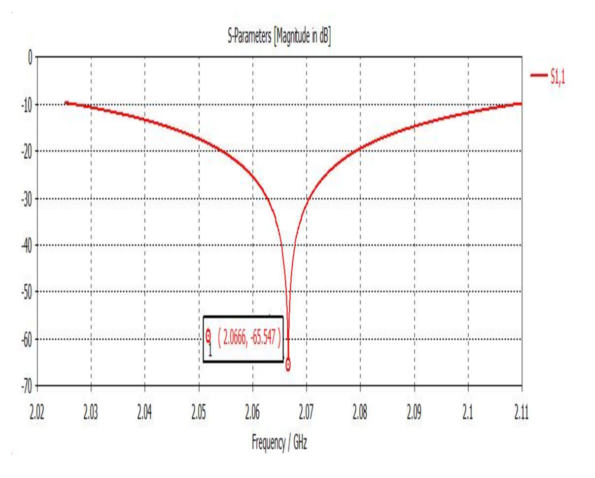


Figure 9, shows the variation of VSWR versus frequency plot of slotted inset fed Microstrip antenna. The antenna resonates at 2.0666GHz frequency which is close to the designed frequency of 2.0675GHz. The VSWR is 1.001and improvement in VSWR is due to slot.

Figure 9: VSWR

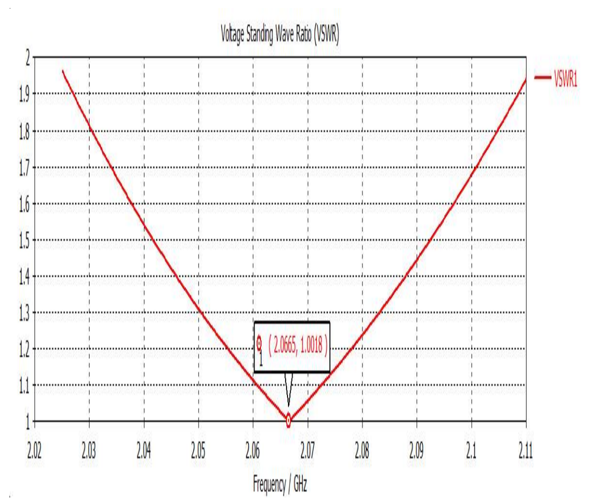


Figure 10, shows the Farfield Gain plot of slotted inset fed Microstrip antenna. The antenna resonates at 2.0675 GHz frequency and the overall Gain at (2.0675 GHz) is found to be 7.79 dB

The following are the design parameters for the inset fed patch antenna.

Table 2: Parameters

S. No.	Parameter	Value (mm)
1.	Substrate length x width	150 X 150
2.	Substrate height	5.9
3.	Patch length	43.2552
4.	Patch width	57.3569
5.	Feed line width	4.78

The summary of the results obtained is as below:

Table 3: Return Loss

S. No.	Antenna	Value (mm)
1.	Simple Inset fed Patch	-24.42
2.	Single notch inset fed patch	-42.72

Table 4: VSWR

S. No.	Antenna	Value (mm)
1.	Simple Inset fed Patch	1.128
2.	Single notch inset fed patch	1.014

Table 5: Bandwidth

S. No.	Antenna	Value (mm)
1	Simple Inset fed Patch	0.077
2	Single notch inset fed patch	0.0834

CONCLUSION

Microstrip antennas have become a rapidly growing area of research and development. Their potential applications are limitless, because of their light weight, compact size, and ease of manufacturing. One limitation is their inherently narrow bandwidth. However, recent studies and experiments have found ways of overcoming this obstacle. A variety of approaches have been taken, including modification of the patch shape, experimentation with substrate parameters. We have designed a simple and low cost patch antenna. With the proposed double notch E-shaped patch antenna, satisfactory results have been obtained which have shown a significant improvement with respect to the simple inset fed patch antenna in terms of Bandwidth and VSWR parameters.

FUTURE SCOPE

For broadband applications, bandwidth, gain and VSWR are very important features. In future other different type of patch shapes can be used to improve the overall performance of the antenna without missing the optimized parameters in the action**.**

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