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DESIGN OF MICROSTRIP SQUARE-PATCH ANTENNA FOR IMPROVED BANDWIDTH AND DIRECTIVE GAIN

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Abstract—the design of microstrip antenna for improved bandwidth and directive gain is a challenge for researchers. This paper proposes the design of a Microstrip Square-Patch antenna with enhanced Bandwidth and Directive Gain. The design and simulation of this antenna has been done with the help of Ansoft HFSS. The simulated results give significant improvement in terms of directive gain and bandwidth. This antenna can be used for many modern communication systems.

Keywords— Bandwidth, Directive Gain, Microstrip Square-patch antenna, VSWR, Radation pattern, Return loss.

1. INTRODUCTION

Microstrip patch antennas have drawn the attention of researchers over the past few decades. However, the antennas inherent narrow bandwidth and low gain is one of their major drawbacks [1, 2]. This is one of the problems that researchers around the world have been trying to overcome. Throughout the years, authors have dedicated their investigations to creating new designs or variations to the original antenna that, to some extent, produce wider bandwidths.

The patch antenna has been rapidly used in various fields like space technology, aircrafts, missiles, mobile communication, GPS system, and broadcasting. Patch antennas are light in weight, small size, low cost, simplicity of manufacture and easy integration to circuits. More important is these can be made out into various shapes like rectangular, triangular, circular, square etc [1].

Many techniques have been suggested for achieving the high bandwidth. These techniques includes: using parasitic elements either in same or other layer [8], utilization of thick substrates with low dielectric constant [4], and slotted patch [5]. We have used a thick dielectric substrate having a low dielectric constant which provides better efficiency, larger bandwidth and better radiation. However, such a configuration leads to a larger antenna size. In order to design a compact Microstrip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence a compromise must be reached between antenna dimensions and antenna performance.

2. MICROSTRIP PATCH ANTENNA

Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 1.

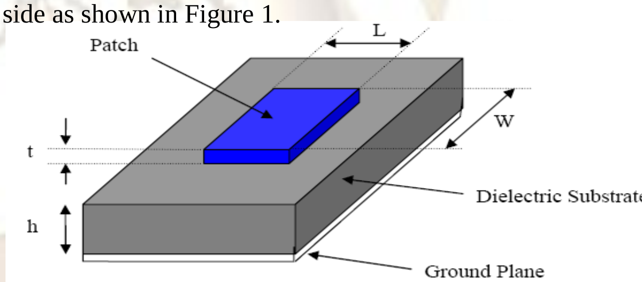

Figure.1 Microstrip Patch Antenna

The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate [1, 3]. The patch is selected to be very thin such that $t << \lambda o$ (where t is the patch thickness). The height h of the dielectric substrate is usually $0.003\ \lambda o \leq h \leq 0.05\lambda o$. The dielectric constant of the substrate (εr) is typically in the range $2.2 \leq \varepsilon r \leq 12\ r$. Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure. Therefore they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers etc. The telemetry and communication antennas on missiles need to be thin and conformal and are often Microstrip patch antennas. Another area where they have been used successfully is in Satellite communication.

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3. FEED TECHNIQUE

Microstrip patch antennas can be fed by a variety of methods [1, 2]. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular feed techniques used are the microstrip line (fig.2), coaxial probe (fig.3) (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

This paper uses microstrip line feeding technique.

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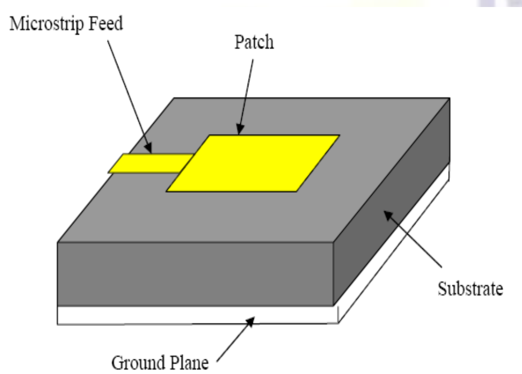


Figure. 2 Microstrip Line Feed

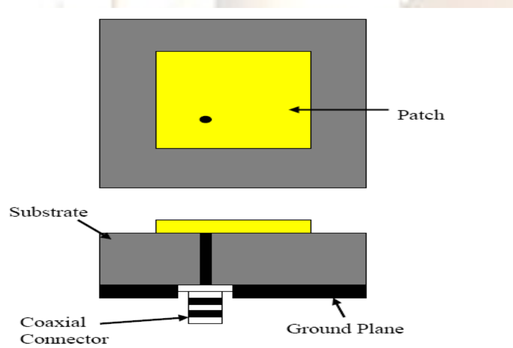


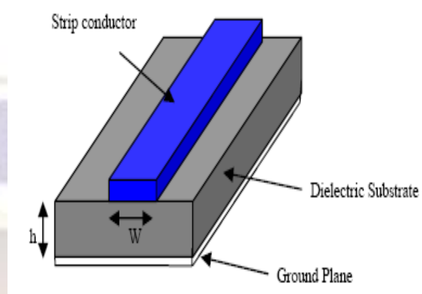
Figure. 3 Coaxial Feed

4. METHODS OF ANALYSIS

The most popular 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) [1,3]. The transmission line model is the simplest of all and it gives good physical insight, but it is less accurate. The cavity model is more accurate and gives good physical insight but is complex in nature. The full wave models are extremely accurate, versatile and can treat single elements, finite and infinite arrays, stacked elements, arbitrary shaped elements and coupling. These give less insight as compared to the two models mentioned above and are far more complex in nature. In this paper Transmission line model is used for designing the patch antenna.

4.1 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. The formulae used in this model for calculation of the dimensions are discussed in next section.



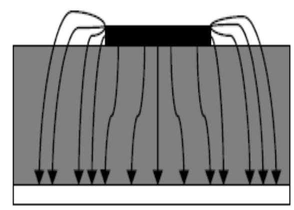


Figure 4: Microstrip Line Figure Figure5: Electric Field Lines

5. Microstrip Square Patch Antenna Design

Design of microstrip patch antenna depends mainly upon three parameters, namely substrate and its dielectric constant, height of the substrate and resonant frequency. In this paper, selected three parameters are: Resonant Frequency (f_r) = 3.6 GHz, Dielectric constant (ε_r) = 2.2, Height of the dielectric substrate (h) = 1.57 mm. Fig.6 represents the designed Microstrip Patch antenna.

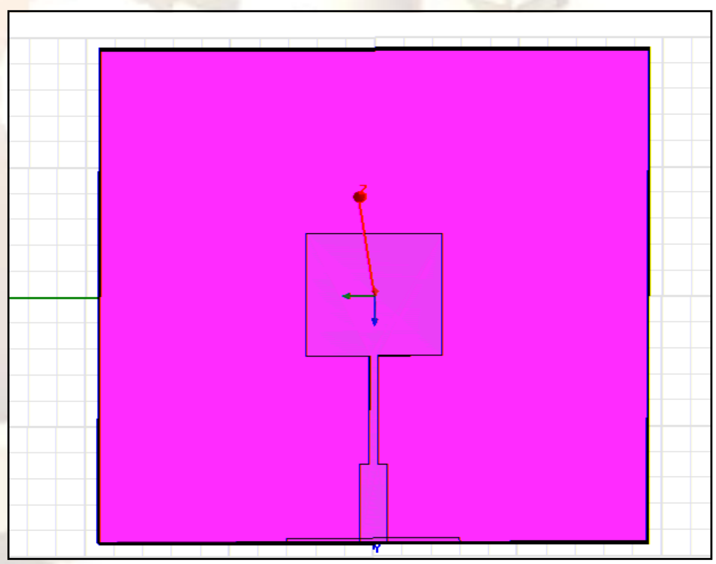


Figure 6: Microstrip square patch antenna

5.1 Calculation of the width (W):

The width of the Microstrip patch antenna is given by equation (1) [1, 2]:

$$W = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad \text{-----------------} \quad (1)$$

The calculated width of proposed square patch antenna from equation (1) is W= 32.94 mm, where c is the speed of light.

5.2 Calculation of Effective dielectric constant (ε_{eff}):

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 10\frac{h}{W}\right]^{1/2} \text{-------} \quad (2)$$

The calculated effective dielectric constant from equation (2) [1], Ɛ reff = 2.329.

5.3 Calculation of the Effective length (Leff):

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{eff}}} \text{--------------------} \quad (3)$$

From above equation the effective length is comes out to be [1, 3], Leff=27.30mm

5.4 Calculation of the Length Extension (ΔL):

$$\Delta L = 0.412h\frac{(\varepsilon_{eff} + 0.3).(W/h + 0.264)}{(\varepsilon_{eff} - 0.258).(W/h + 0.8)} \text{-----} \quad (4)$$

Which comes out to be [1, 2] ΔL =0.8008mm.

5.5 Calculation of the resonant length of patch (L):

$L = L_{eff} - 2\,\Delta L$ ------------------- (5)

This comes out to be 25.698mm.

5.6 Calculation of radiation conductance (G):

The radiation conductance for a parallel-plate radiator as [1, 2]

$$G = \frac{W\pi}{\eta\lambda_0}\left[1 - \frac{(kh)^2}{24}\right] = 3.2944\text{MS.} \text{----------------} \quad (6)$$

5.7 Calculation of input resistance of the patch (R):

$$R = \frac{1}{2G} = 151.768\text{OHMS}\text{-----------------} \quad (7)$$

6. Results and Discussions:

The proposed antenna has been designed and simulated using Ansoft HFSS software. Figure 7 represents the variation of Return Loss with Frequency. Plot shows resonant frequency at 3.58 GHz with minimum -30.25 dB returns loss available at resonant frequency.

Bandwidth of the antenna is defined as the range of frequencies, over which the performance of the antenna with respect to some characteristic conforms to a specific standard. The bandwidth of the antenna depends on the patch shape, resonant frequency, dielectric constant and the thickness of the substrate [4, 7]. The bandwidth enhancement of a microstrip antenna has been directed towards improving the impedance bandwidth of the antenna element. Impedance bandwidth is usually specified in terms of a return loss. The VSWR of microstrip square patch antenna is shown in figure 8.

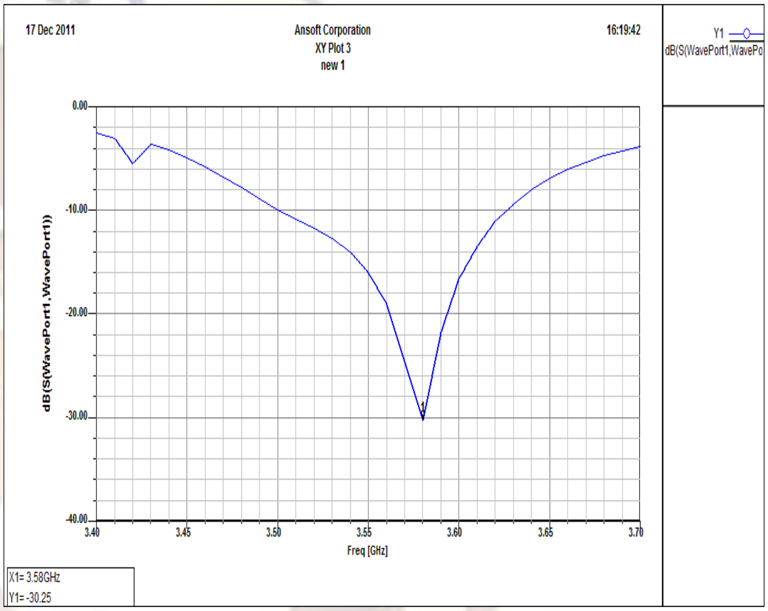


Figure 7: Return Loss vs. Frequency

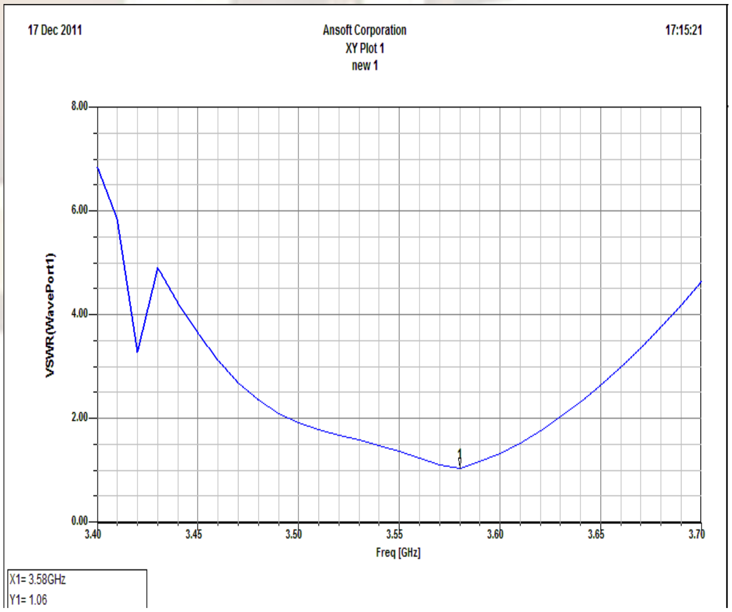


Figure 8. VSWR vs. frequency

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From figure 8, the bandwidth of proposed microstrip square patch antenna comes out to be **135 MHz** for the value of vswr below 2. The directivity of the microstrip square patch antenna is shown in figure 9.

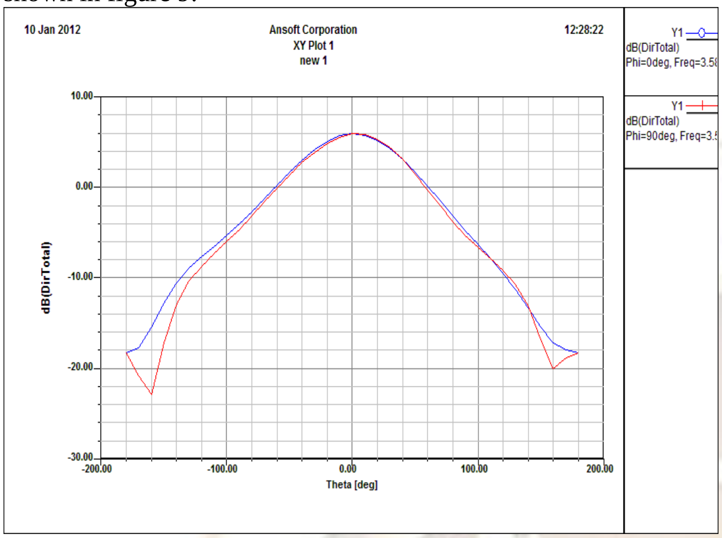

Figure 9. Directivity of microstrip square patch antenna

And the radiation pattern of the microstrip square patch antenna is shown in figure 10.

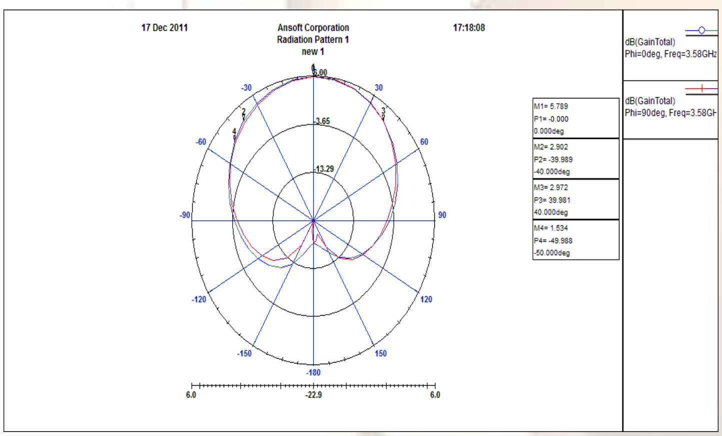

Figure 10. Radiation pattern of microstrip square patch antenna

The results for proposed microstrip square patch antenna are shown in the Table 1.

S.No.	Parameters	Values
1.	Bandwidth	135MHz
2.	Return loss	-30.25dB
3.	Directivity	6dB
4.	VSWR	1.06
5.	Gain	5.789dB

Table 1. Results

7. Conclusion and Future Scope

A square patch microstrip antenna design has been proposed and successfully implemented. The proposed structure has been simulated by using the Ansoft HFSS software. The square patch antenna enhances bandwidth, gain and good return loss (S_{11} parameters) of -30.25dB is achieved along with broad side radiation pattern. The square patch microstrip antenna can be used for wireless local area network (WLAN, IEEE 802.11) application. The use of thicker substrate increases the size of the patch antenna, which is the area that can be improved with the proposed design.

8. References

[1] J Constantine A. Balanis; *Antenna Theory, Analysis and Design*, John Wiley & Sons Inc. 2nd edition. 1997.

[2] Garg, R and Ittipiboon, A; *"Micro strip Antenna Design Handbook"*, Artech House, 2001.

[3] D.M. Pozar, "Microstrip Antennas", Proc.IEEE, vol.80, No.1, January 1992.

[4] Neeraj Rao,"Gain and Bandwidth Enhancement of a Microstrip Antenna using Partial substrate removal in multiple layer dielectric substrate", PIER proceedings, Suzhou, China, Sept.12-16, 2011.

[5] Isha Puri,"Bandwidth and Gain increment of microstrip patch Antenna with Shifted elliptical Slot", IJEST, vol.3No.7, Iuly, 2011.

[6] Bimal Garg,"Design of Broad band Rectangular Microstrip patch Antenna Inset 'L'shaped feed", IJCA, vol.29 No.1, Sept, 2011.

[7] A.A. Abdelaziz,"Bandwidth enhancement of Microstrip Antenna", Progress In Electromagnetic Research, PIER-63,pp. 311-317,2006.

[8] Wood.C,"Improved Bandwidth of Microstrip Antenna using parasitic elements", IEEE vol.127, Issue4, 11Nov, 2008, pp.-231-234.