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Design of Micro Strip Patch Antenna Array

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Abstract: **Recently due to decrease in the size of communication devices there is a need for more compact antenna. Microstrip antenna is popularly known as patch antenna, which fulfils this need. It consists of metal patch on one side of the dielectric substrate and ground plane on the other side. The metal patch is generally etched on the substrate and takes a variety of continuous shapes such as rectangle, circular, elliptical, square etc.**

Keywords: **Micro strip patch antenna.**

1. INTRODUCTION

Due to the continued demand for low cost, less weight, highly reliable, minimal profile antennas for air borne vehicles, it poses a new challenge for the design of antenna in radar communications. In recent years there is a need for more compact antennas due to rapid decrease in size of communication devices.

Microstrip patch antennas were first proposed in early 1970s and since then activity in this area of antenna engineering has occurred, probably more than in any other field of antenna research and development. Microstrip patch antennas have various well known advantages over other antenna structures. Due to these merits, the microstrip patch antennas have been utilized in many applications such as mobile communication, space borne satellite communication systems, telemetry and radar applications.

2. FEEDING TECHNIQUES

Micro-strip antenna can be fed by variety of methods. The feeding techniques in microstrip antenna can be broadly classified as -

1. Contacting
2. Non-contacting

These can be further categorised as

i. Micro-strip line

ii. Co-axial probe

iii. Aperture coupling

iv. Proximity coupling

Antenna is a passive device and hence power must be fed for it to radiate. The feeding technique employed plays an important role in the characteristics of the antenna. The feeding technique used in this design is a microstrip line feed. In this feed technique impedence matching is difficult to achieve. Hence the microstrip line is “inset” in the patch. This provides better impedence matching.

Microstrip inset feed technique is adopted to reduce the input impedence and provide better matching.

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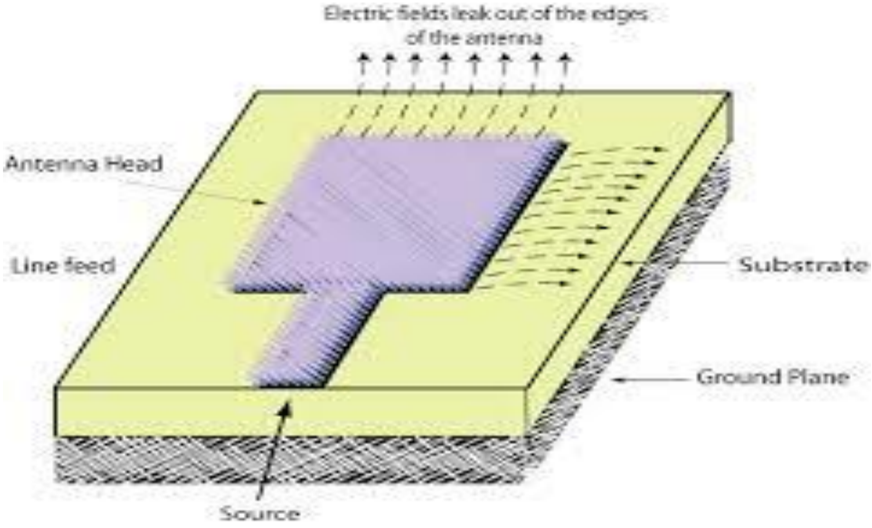

Figure 2.1: figure shows the microstrip line fed patch antenna

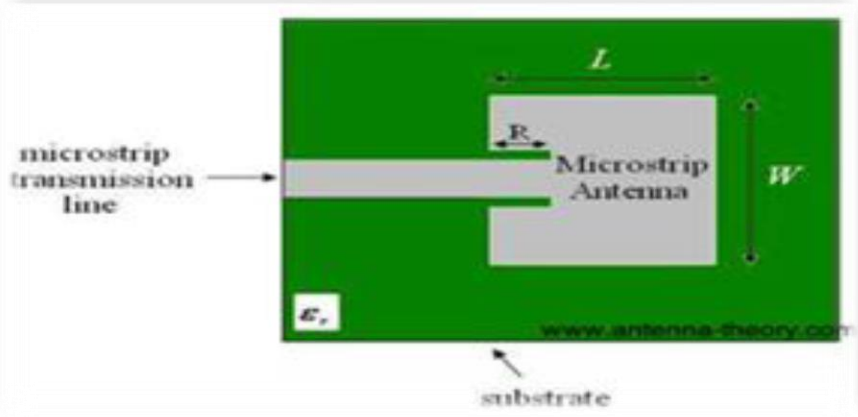

Figure 2.2: figure shows the microstrip inset fed patch antenna.

3. DESIGN EQUATIONS

STEP 1: Calculation of inset width

$$\mathrm{W(i)\backslash h} = \frac{2}{\pi}\left(B - 1 - \ln(2B-1) + \frac{\varepsilon_R - 1}{2\varepsilon_R}\left(\ln(B-1) + 0.39 - \frac{0.61}{\varepsilon_R}\right)\right)$$

$$B = \frac{377\pi}{2z_0\sqrt{\varepsilon_R}}$$

STEP 2: Calculation of $\varepsilon_{\mathrm{Reff}}$

$$\varepsilon_{\mathrm{Reff}} = \frac{\varepsilon_R + 1}{2} + \frac{\varepsilon_R - 1}{2}\left(1 + \frac{12h}{W(i)}\right)^{\frac{-1}{2}}$$

STEP 3: Calculation of patch length

$$L = \frac{C}{2f\sqrt{\varepsilon_{\mathrm{Reff}}}}$$

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

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

STEP 4: Calculation of patch width

$$w = \frac{c}{2f\sqrt{\frac{\varepsilon_R + 1}{2}}}$$

STEP 5: Calculation of inset length

$$z = \frac{60\lambda_0}{\omega}$$

$$\lambda_0 = \frac{c}{f}$$

$$Z_{in}(R) = z(0) + \cos^2\left(\frac{\pi R}{L}\right)$$

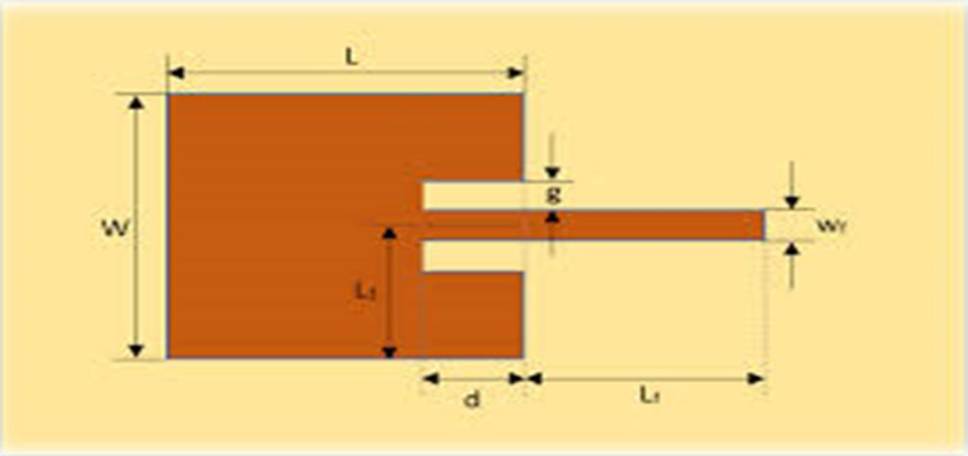

Figure 3.1: figure shows the inset fed patch antenna parameters

4. DESIGN GUIDELINES FOR PATCH ANTENNA

The following guidelines are must for designing patch antenna fed by Microstrip lines:

1. The length of the patches may be changed to shift the resonances to the centre of the fundamental frequency of the individual patch elements. This is true in general, even for more complicated microstrip antennas that weave around the length of the longest path on the microstrip controls the lowest frequency of operation.

$$f_c \propto \frac{c}{2l\sqrt{\varepsilon_r}}$$

2. The resonant input resistance and radiation pattern of a single patch can be decreased by increasing the width of the patch. The wider the patch becomes the lower the input impedance. This is acceptable as long as the ratio of the patch width to patch length (W/l) does not exceed two; since the aperture efficiency of a single patch begins to reduce as, (W/l) increases beyond two.

3. The permitivity ε_r of the substrate controls the fringing fields. Lower permitivities have wider fringes and therefore better radiation. Reducing the permittivity also increases the antenna bandwidth. The efficiency is also improved with a lower value for the permitivity.

4. The height of the substrate h also controls the bandwidth increasing the height increases the bandwidth. The fact that increasing the thickness of a patch antenna improves its bandwidth can be understood by recalling the general rule that "an antenna occupying more space in a spherical volume will have a wider bandwidth". Increase in the height increases the efficiency of the antenna.

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$$BW \propto \frac{\varepsilon_r - 1}{\varepsilon_r} * \frac{w}{l} * h$$

5. SIMULATION, MEASURED RESULTS AND DISCUSSION

The software used to model and simulate the Microstrip patch antenna is High Frequency Simulation Software HFSS version 13. It is commonly used in the design and simulation of patch antenna. It can be used to determine and plot various antenna parameters such as Voltage Standing Wave Ratio (VSWR), Radiation patterns, Polar Plots etc. band-width of the simulation and measurements can be accomplished.

Table 5.1: Design specifications

PARAMETER	MSPA	MSPAA
Operating frequency	5 GHz	5 GHz
Substrate used	ROGERS ULTRALAM 2000	ROGERS ULTRALAM 2000
Thickness	1.6mm	1.6mm
ε_R	2.5	2.5
Loss tangent	0.0019	0.0019
Length of patch	18.32mm	17.82 mm
Width of patch	22.60mm	23mm
Inset feed length	5.5mm	4.3mm
Width of feed	4.54mm	1.5mm

Analysis of the design gave the following results:

The return loss plot for the single microstrip patch and the 2×1 array is as shown in figure 5.1(a) and (b) respectively.

The plot shows return loss of the microstrip patch antenna. The return loss must be less than 10db for better reception of power

The radiation pattern of the rectangular microstrip patch antennas shown in figure 5.1 (d) and (e) is found to be unidirectional and a gain of 7.4dBi for single patch and 10.13 dBi for 2×1 array is achieved. Hence it becomes better choice for communication as there is reduction in cost of power

The figure5.1 (e) shows the VSWR plot vs. frequency plot

From the plot value of VSWR is found to be 1.2 at a frequency of 5 GHz and VSWR must be less than for antenna to work properly and receive power with minimum reflection

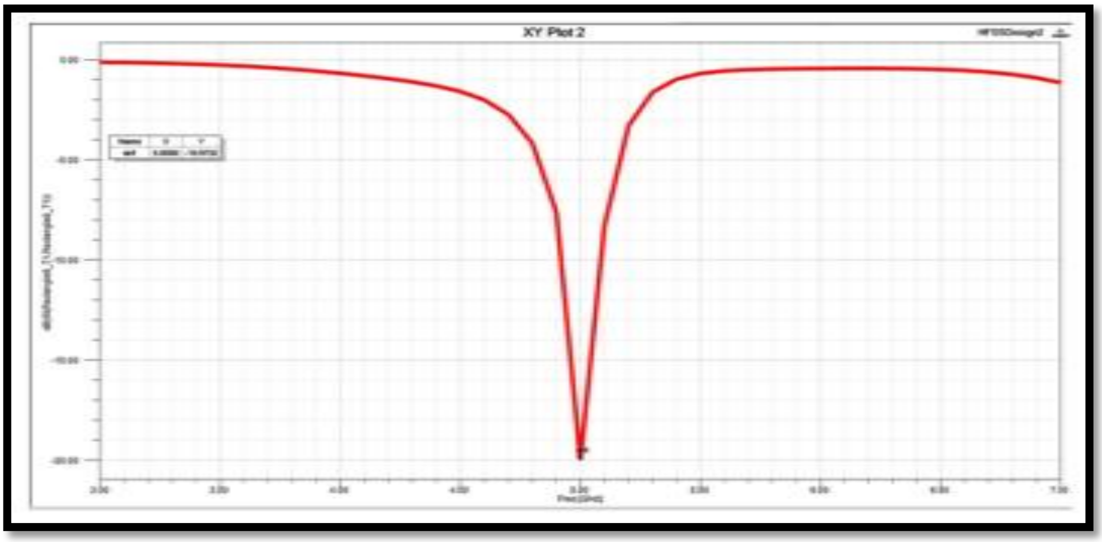

Figure 5.1(a): figure shows return loss plot of a single microstrip patch antenna.

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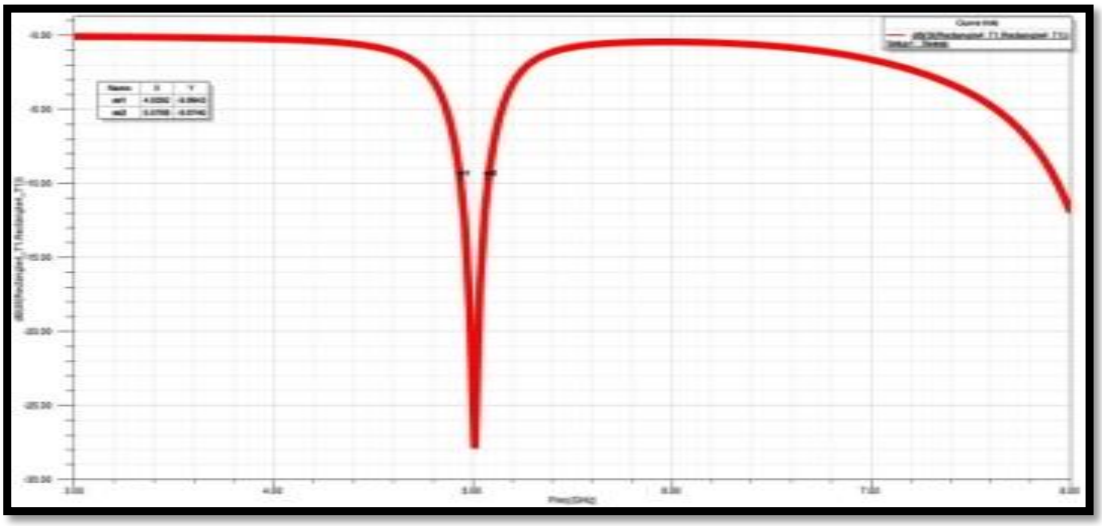

Figure 5.1(b): figure shows return loss plot of a 2×1 microstrip patch antenna array.

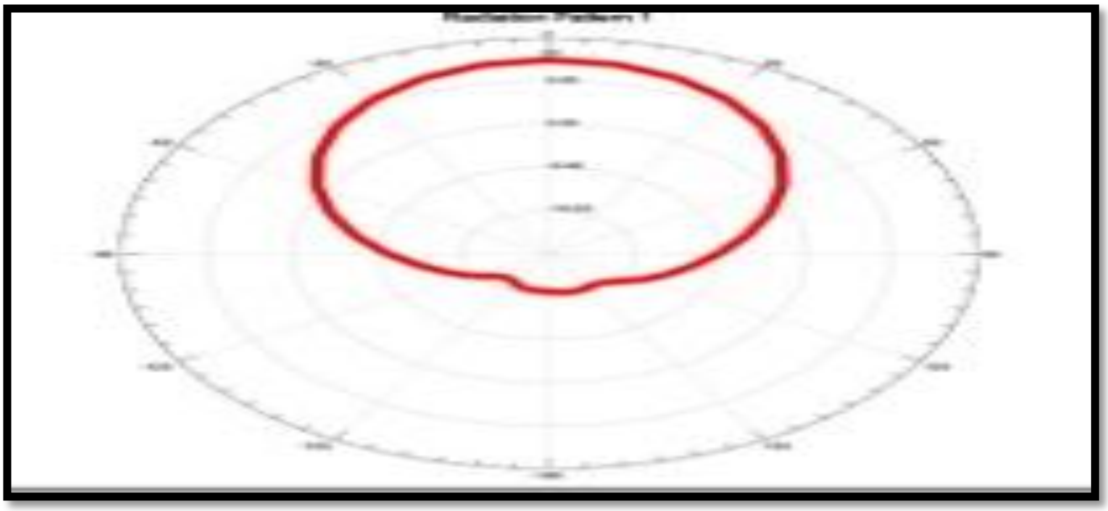

Figure 5.1(c): figure shows radiation pattern of a single microstrip patch antenna.

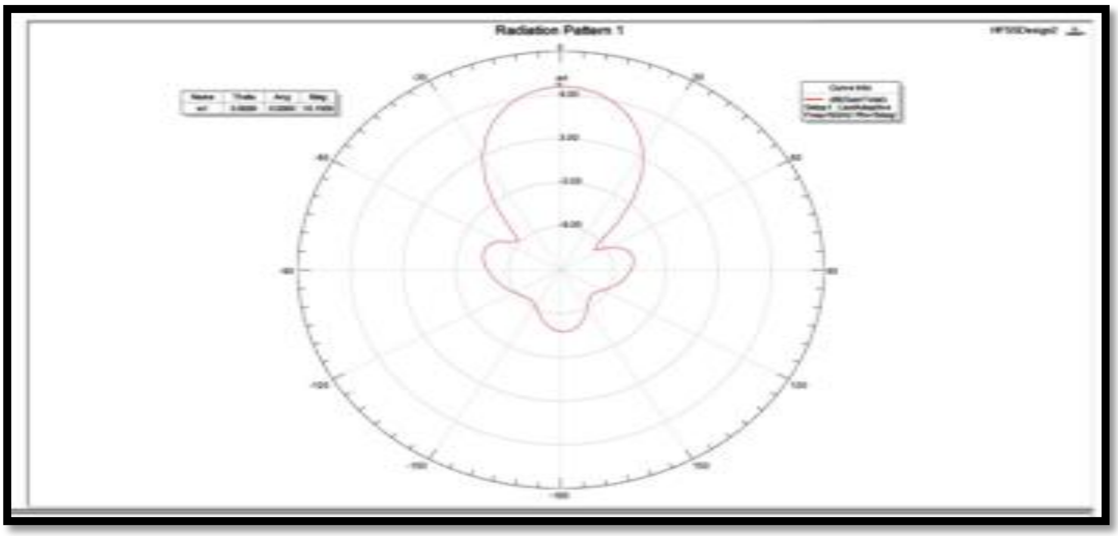

Figure 5.1(d): figure shows radiation pattern of a 2×1 microstrip patch antenna array.

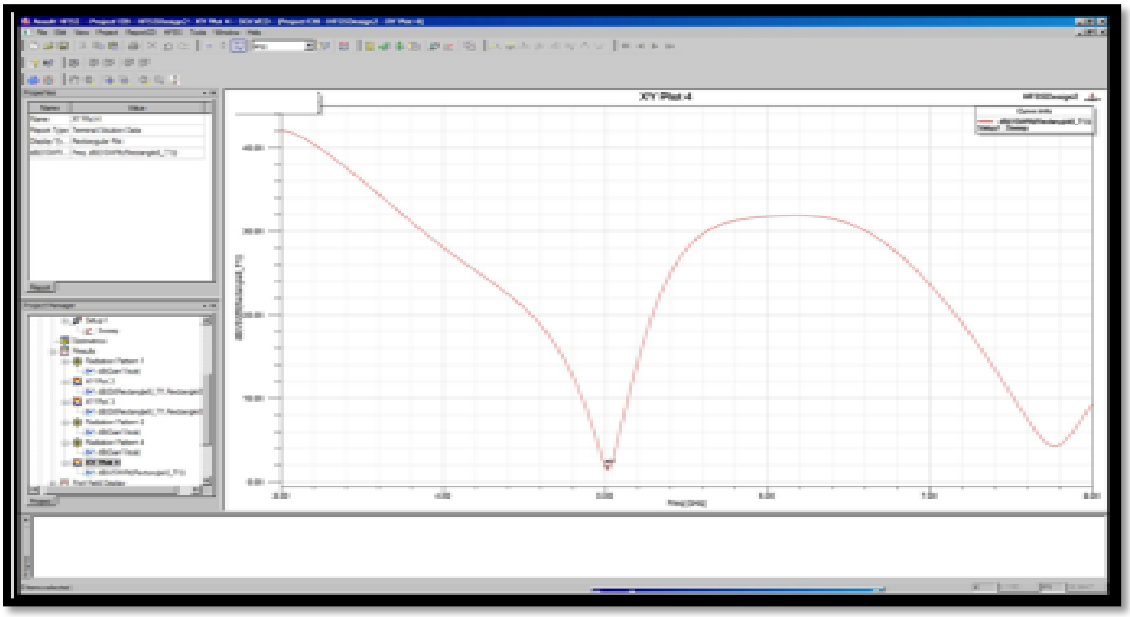

Figure 5.1(e): figure shows VSWR plot of a 2×1 microstrip patch antenna array.

6. CONCLUSION

In this work the microstrip patch antenna and 2×1 array are designed and its results are reported. The important parameters such as gain, return loss, VSWR, and radiation pattern have been observed.

REFERENCES

[1] R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, 2000.

[2] C. A. Balanis, Antenna Theory, Analysis and Design, John Wiley & Sons, New York, 1997.

[3] D. M. Pozar and D. H. Schaubert, “Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays”, IEEE Press, 1995