Design of High Performance Antenna Array with Microstrip Patch Antenna Elements

Neha[1], Dr. R.V. Purohit[2]

1. M. Tech Student AKGEC, Ghaziabad

2. Asst. Prof. AKGEC, Ghaziabad

Abstract*— Microstrip patch antenna arrays are proposed for wireless communication applications. In this paper, a three element antenna array with high performance characteristics is presented for the application of wireless local area network (WLAN). The antenna array is designed on FR-4 substrate. Maximum gain of antenna array is obtained by adjusting the thickness of dielectric substrate and the geometry of array structure. Greater the number of radiating elements, better the gain of antenna array would be realized. The array design is operated at the frequency of 3.4 GHz. The array configuration is designed and analyzed by Ansoft HFSS simulation software. The performance characteristics are measured in terms of return loss and gain.

***Index Terms*—Microstrip patch antenna array, WLAN application, FR-4, HFSS simulator.**

I. INTRODUCTION

Communication is an act of conveying messages from one place to other through the exchange of ideas, feelings and intentions as by speech and text. Communication system is required when the information is to be transferred over a distance. Nowadays communication systems are switching from wired to wireless. Wireless technology offers inexpensive alternative and a flexible way for communication. Wireless LAN and worldwide interoperability for microwave access (Wi-MAX) technology are the most fast developing area in the field of modern wireless communication. This provides the mobility to users to move around within a wide coverage range and still be connected with the network. This delivers greatly improved freedom and flexibility. For the home user, wireless technology has become prevalent due to simplicity in installation. Obviously, these applications need antennas. Antenna is one of the important devices of the wireless communication systems. It is required for creating the communication link. Basically, antenna is a transducing device that transforms electromagnetic waves into electronic signals. Transmission lines then guide these waves to the receiver front end. Sometimes, a single antenna can be used for both purposes i.e. for transmission as well as for reception. One of the categories of antenna is the Micro strip patch antenna. Microstrip antennas have various advantages over conventional microwave antennas and thus are broadly used in many practical applications. A microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate whereas ground plane on the other side of it. The rectangular, square and circular patches are the basic and most commonly used microstrip antennas. These are used for simplest and most demanding applicaions. Microstrip patch antennas (MPAs) are extensively used due to their small size, low cost, light weight, and low profile as well as to the fact that they are easy to fabricate. These features are major design considerations for useful applications of microstrip antennas. A microstrip patch antenna is shown in Fig. 1.

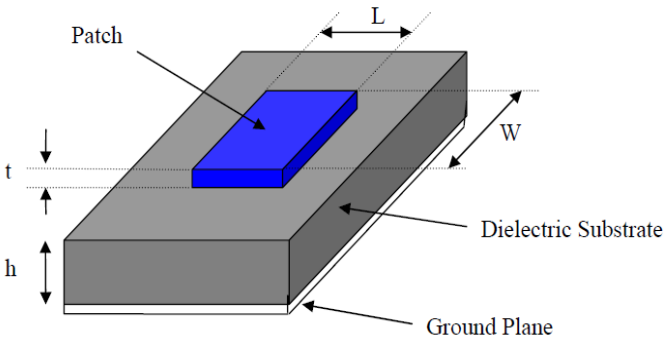

Fig.1 Microstrip Patch Antenna

Microstrip patch antenna has some drawbacks such as low gain and small bandwidth. Gain of the antenna can be increased by using an array of patch elements to achieve maximum radiation characteristics. In this paper, a 3 element microstrip patch antenna array with high performance characteristics is presented at the frequency of 3.4 GHz. The simulation of the proposed array antenna is carried out using Ansoft HFSS software.

II. FEEDING TECHNIQUES

Microstrip patch antennas can be fed by any of the feeding methods which are as follows:

- Microstrip line feed
- Co-axial feed
- Aperture coupled feed
- Proximity coupled feed
- Inset feed

In this project, three element microstrip patch antenna array is designed using microstrip feed as well as inset feed

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simultaneously. First patch element is fed by microstrip line and other two elements are excited by inset feeding. Inset feeding is used because at the ends of radiating patch, the current is small and it rises towards the centre. So, the impedance could be decreased if feeding is done at the centre. This is done by using an inset feeding technique as shown in Fig. 2.

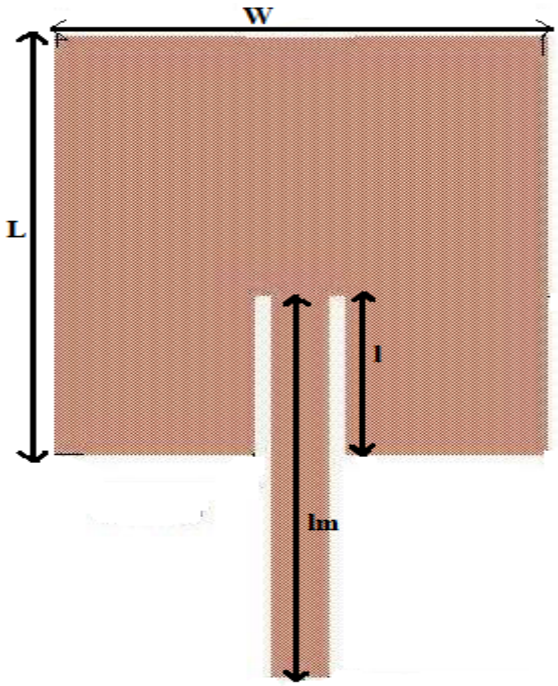

Fig. 2: Inset feed microstrip patch antenna

The magnitude of voltage also reduces by the same amount that the current raises. Hence, the input impedance is expressed by using Z=V/I,

$$Z_{in}(R) = \cos^2(\pi R/L)\, Z_{in}(0) \qquad (1)$$

Where, $Z_{in}(0)$ is the input impedance if the patch is fed at the end. Hence by feeding the patch antenna using inset feeding method, the input impedance can be decreased.

III. DESIGN CONSIDERATION OF MICROSTRIP PATCH ANTENNA ARRAY

In this paper, three element microstrip patch antenna array is designed to achieve high performance characteristics because single antenna is not sufficient to attain high gain. This antenna has been designed to operate at 3.4 GHz with input impedance of 50 Ω. The proposed array antenna is designed on FR-4 dielectric substrate with dielectric constant of $\varepsilon_r = 4.2$ and height of 1.6 mm. The substrate's dielectric constant as well as thickness is important design parameters.

Thick substrate with low dielectric constant enhances the radiated power. Three element microstrip patch antenna array is shown in Fig. 3.

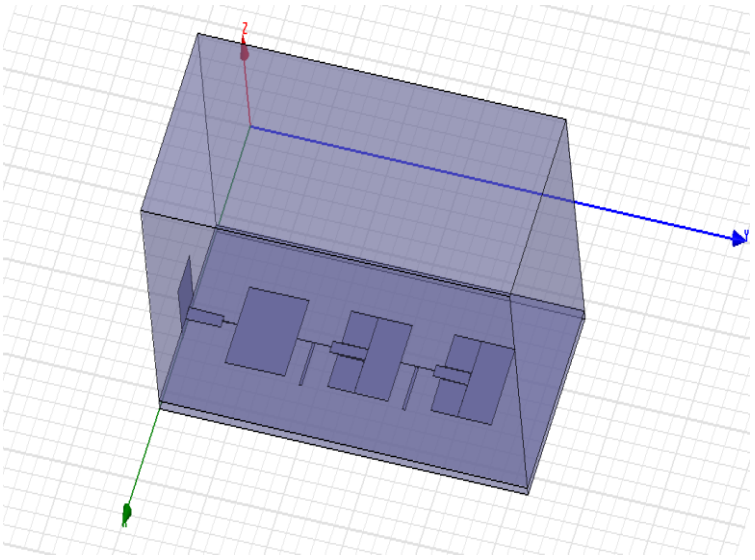

Fig. 3: Design of three element array antenna

IV. SIMULATION AND RESULTS

The simulation is done by using the commercially available electromagnetic simulation software HFSS (high frequency structure simulator). Fig. 4 shows the simulated return loss of proposed array antenna.

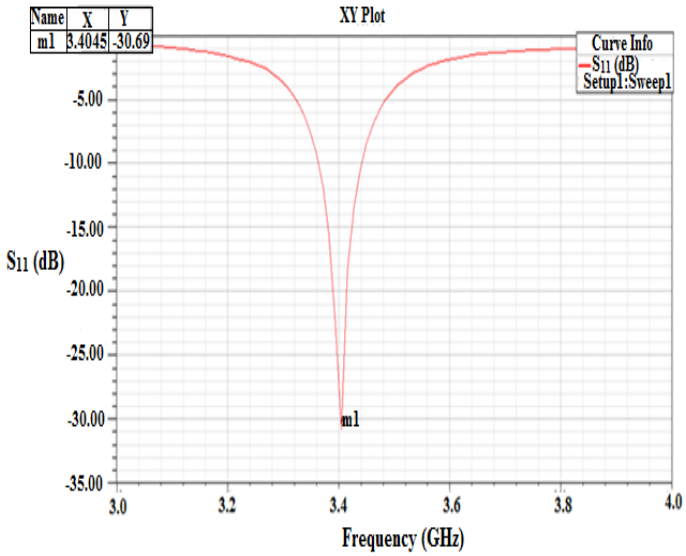

Fig. 4: Simulated Return Loss of proposed array antenna.

It is found that at 3.4 GHz, return loss is -30.69 dB. Fig. 5 shows the gain of proposed array antenna.

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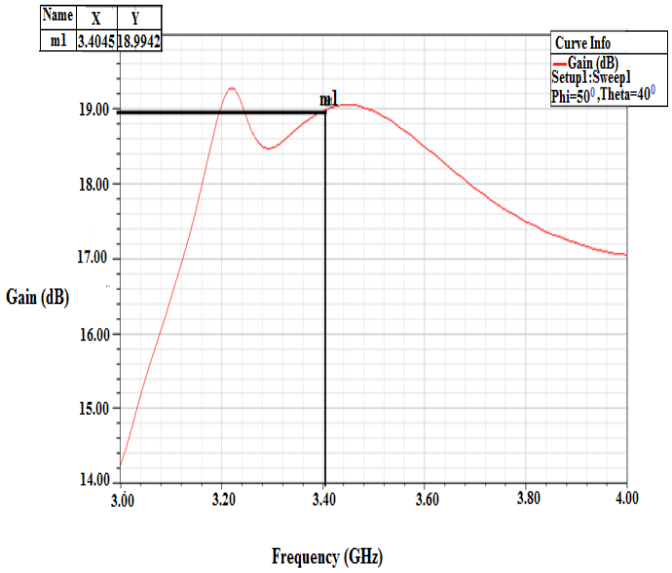

Fig. 5: Gain of proposed array antenna

V. CONCLUSION

A distinctive feature of microstrip antenna is its simplicity to get high performance characteristics. In this paper, a three element microstrip patch antenna array is presented at the frequency of 3.4 GHz. The simulated return loss and gain are 30.69 dB and 18.99 dB respectively. The simulated results show that the inset feeding technique gives better performance and perfect impedance matching as compared to the other feeding lines. Hence, the proposed array antenna is suitable for wireless communication system application such as cellular systems, WLAN and WiMAX systems.

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AUTHOR

Neha received the B.Tech degree in Electronics & Communication Engineering from Amity School of Engg & Tech., Amity University, Noida in 2012. Now she is pursuing M.tech in Electronics & Communication Engineering from AKGEC, Ghaziabad in 2014. Her research area is Antenna design.

Dr. Rahul Vivek purohit has received his BE and M.Tech from R.G.P.V. university Bhopal, India in 2002 and 2005 respectively. He has received his PhD from Jamia Milia Islamic University, New Delhi. His research is in the field of pattern recognition techniques used in sensors. Currently he is working as Asst. Prof. in electronics and communication deptt Ajay Kumar Garg Engineering College, Ghaziabad (U.P.), India.

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