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Design of Microstrip Patch Antenna Array for WLAN Application

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Abstract- In this paper Micro strip Patch Antenna Array are designed and analyzed for WLAN application, which operating at S-band frequency Range of 2.4 GHz. Antenna arrays are used to achieve higher gain. The larger number of antenna elements, the better gain of antenna array is achieved. In this paper feeding element and power divider is used to design the 4 X 1 micro strip patch antenna array. Micro strip line feed and Power divider are used to design parallel Micro strip patch antenna array. The measured radiation pattern and Return loss of 4X1 elements antenna array are presented.

Index Terms: **Micro Strip Antenna Array.**

I. INTRODUCTION

In spacecraft or aircraft applications, where size, weight, cost, performance, ease of installation, low profile antennas are required. In order to meet these specifications Micro strip or Patch antennas are used. Antenna plays an important role in communication system. An antenna is a device that converts a signal transmitted from a source to a transmission line into electromagnetic waves and that is used to broadcast into free space and vice versa. An antenna is concentrating the radiation energy in some directions and to suppress it in the other directions at certain frequencies. An antenna must me tuned to the same frequency band of the radio system to which it is connected; otherwise the reception and the transmission will be impaired. A good antenna design can improve overall performance of the system which is depending on the physical size.

Micro strip patch antenna is popular for low profile applications at frequencies above 100 MHz. Micro strips Antenna is used in wireless communications, satellite communications, and radar, due to low profile, low weight, and low cost, easy fabrication into arrays. The major disadvantage of micro strip antennas are their inefficiency and very narrow frequency bandwidth which is typically only a fraction of percent or few percent, limited power capacity and tolerance problem. To overcome the bandwidth limitation, number of antenna elements or feeding matching networks may be employed in order to satisfy the bandwidth requirement for the particular application. Antennas play an important role in today's wireless communication. Without the use of antenna, signals are not able to be transmitted out or received. The antenna designer must also consider the electrical characteristics of the antenna which include: Return loss, Bandwidth, Gain and radiation pattern, Operating frequencies, VSWR.In this present paper, a 4 element high gain micro strip antenna array by feeding network at S-band is presented. The simulation of the proposed antenna has been carried out using Ansoft HFSS software.

II. MICROSTRIP PATCH ANTENNA DESIGN ANTENNA ARRAY ARCHITECTURE

A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common micro strip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible. Some patch antennas do not use a dielectric substrate and instead made of a metal patch mounted above a ground plane using dielectric spacers; the resulting structure is less rugged but has a wider bandwidth. Because such antennas have a very low profile, are mechanically rugged and can be shaped to conform to the curving skin of a vehicle, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices. The radiation pattern of a single element is relatively wide and each element provides low values of directivity (gain). In many applications, especially for point to point communication system it is necessary to design antennas with very directive characteristic (high gain) to meet the demands of long distance communication.

Antenna is composed of four parts which are air, two radiation substrates and feed substrates. To be compatible with the feed excitation of the antenna array elements, a Centre coupled edge feed and square patch have been chosen. The Micro strip square patches (29mmX29mm) are etched on the top of the radiation substrates separated by air (0.1 free space wavelengths at the Centre frequency) and Micro strip feed line (16.994mmX18.381mm) are etched on the both side of the feed substrate. The Centre of patches and slots are situated in a line and feed line is positioned at the Centre of the slot for maximum coupling. A thicker substrates result in wider bandwidth, but less coupling for a given aperture size. The dielectric constant 4.2mm and the thickness of the substrate 1.6mm have been chosen as the material for the substrate for both the patches.

A.The Feed Network of Antenna Array

Existing methods to feed Micro strip arrays can be categorized into parallel and series feed. The parallel or corporate feed has a single input port and multiple feed lines in parallel the output port. Each of these feed lines is terminated at an individual radiating element. The series feed usually consists of a continuous transmission line from which small proportion of energy are progressively

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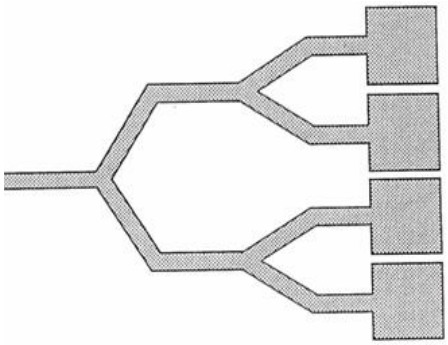
coupled into the individual element disposed along the line. The series feed constitutes a traveling wave array if the feed line is terminated in a matched load. Here the difference between the series feed and corporate feed.

A corporate feed is most widely used parallel feed configuration. For a uniform aperture distribution, the power is equally split at each junction. However different power divider ratios can be chosen to generate a tapered distribution across the array. The disadvantages of this type of feed is that it requires long transmission lines between radiating elements and the input port hence the insertion loss of the feed network can be prohibitively large thereby reducing the overall efficiency of the array. In this paper the corporate feed with inset feed is being discussed for the antenna array design. When feeding is bed, the total efficiency could be reduced to a low level which makes the whole system to be rejected.



(a) Corporate feed

(b) Series feed

Fig. 1 Type of Feed Network in Micro Strip Antenna Array

In the present paper T- junction power divider is used in Micro strip patch antenna array. The structure of the power divider is symmetric. Here the two lines having a characteristics resistance square root of 2Z0 and length at the Centre frequency f0 and with Z=2Z0, the divider is matched, S11=S22=S33=S44=0 at f0 and port 1 will split equally and at the Centre frequency. It is easy to achieve the required input impedance because of its simple and symmetric structure. The effects of the feed network are important in high gain Micro strip antenna array with large number of radiating elements and complicated feed network.

B. Design Consideration Of 4x1 Microstrip Patch Antenna Array

In this proposed paper a 4X1 array of individual Micro strip patch antenna is designed to achieve higher gain, better bandwidth, and input impedance of the antenna array. Because single antenna is not enough to achieve high bandwidth it has limited bandwidth. The square patch is chosen because it simplifies and analysis and performance prediction. This antenna has been designed to operate at 2.4 GHz with input impedance of 50 Ω, using FR4 (ε_r = 4.2) and height (h=1.6mm). The design starts with the simple rectangular Micro strip antenna with inset feed. Then, the Micro strip antenna is simulated using the Ansoft HFSS Software. After the simulation, the Micro strip antenna is fabricated using FR4, with dielectric constant (ε_r = 4.2) and height of 1.6 mm. Finally the Micro strip antenna is measured using the network analyzer and the measured values are compared with the simulated values. There is a single element design is shown in figure 3. The dimension of the patch is 29 mm x 29 mm with inset feed at 8 mm. The width of the transmission line is 3mm.

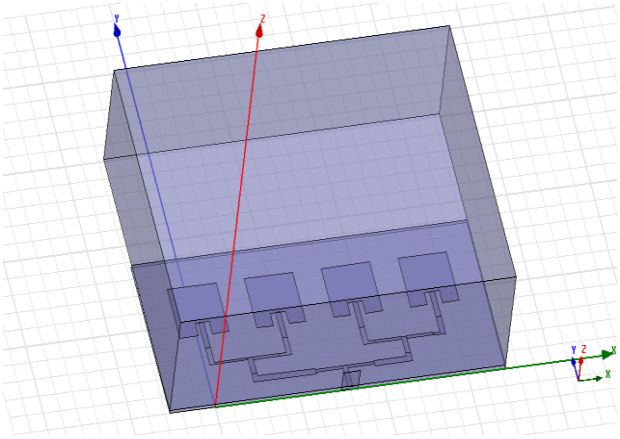


Fig 2: Four Elements Rectangular Patch Antenna

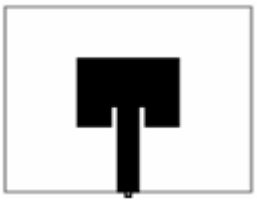


Fig 3: Single Element Rectangular Patch Antenna

III. SIMULATION RESULTS

The parameters that will measure are Return loss and Radiation pattern. The first measurement that was performed is Return Loss. It is ensure that antenna exactly operate at 2.4GHz.

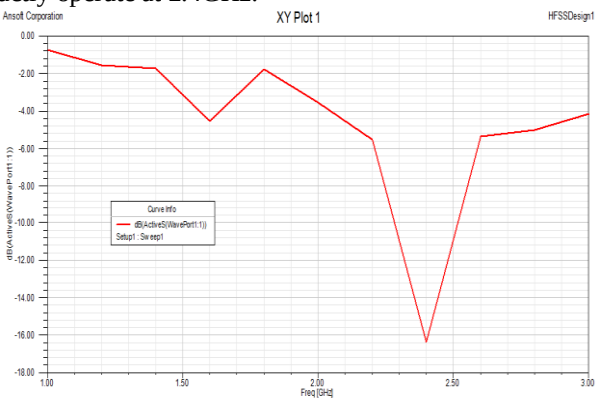


Fig 4: Measured Return loss of 4x1 Micro strip patch Antenna Array

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The figure 4 it found that the S11 frequency is 2.4GHz at -16.3dB. The bandwidth for simulation and measurement are 16% and 18%. In the figure 5, 3D radiation pattern of patch antenna is measured. There are the two types of radiation pattern H-Plane and E-plane Radiation Pattern. H-Plane will have a circular and omnidirectional pattern means its perfect circle but E-Plane is not uniform.

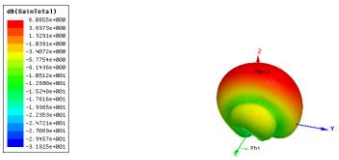

Fig 5: Measured Patch 3D Radiation Pattern

IV. CONCLUSION

In this paper, 4 elements parallel Micro strip patch antenna array by aperture feed stacked at S-band are presented. They achieve higher gain and better bandwidth with practical technology and theoretical analysis. Numerical calculation clarified that the Radiation coefficient of radiating elements was varied widely. In this paper S-band Micro strip patch antenna arrays may be employed in communication links, seekers, and detection arrays. From the above result it is noticed that the increase in the thickness of substrate had increased the impedance bandwidth of the antenna and also decreased VSWR values.

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