Series Micro Strip Patch Antenna Array For Wireless Communication

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Abstract- The concept of Microstrip Antenna Array with high efficiency for wireless communication has been proposed / discussed / suggested in this paper. Microstrip antenna arrays are widely used in various applications, for example wireless communication system, satellite communication, Radar systems, Global positioning systems, Radio Frequency Identification (RFID), Worldwide interoperability for microwave access (WiMax), Rectenna applications, Telemedicine applications, Medicinal applications of patch. In this article, we have discussed about the design of a series microstrip square patch antenna, reason being its wide band and wide scan properties which can give more information at high data rate. The proposed antenna consist of a straight feeding microstrip line and square radiating elements connected directly to the micro strip line at their corners without dividers and impedance transformers in order to realize lower feeding line loss. In this paper, the model of microstrip series antenna array is designed and analyzed using the HFSS Software. The parametric study of the antenna characteristics has been done to know how the microstrip series antenna array meets the wireless properties for geometric parameters. This paper micro strip series antenna array will be designed at 2.4 GHz (S- band) frequency.

Key words: Microstrip Antenna (MSA), Microstrip Patch Antenna (MPA), Feeding Techniques, High efficiency Index Terms: Microstrip Antenna (MSA), Microstrip Patch Antenna (MPA), Feeding Techniques, High efficiency

I. INTRODUCTION

Communication plays an important role in the worldwide society now days and the communication systems are rapidly switching from "wired to wireless". Wireless technology is a less expensive alternative and a flexible way for communication. Antenna is one of the most important elements of the wireless communications systems. No wonder antenna design has become one of the most active fields in the communication studies. One of the much talked about type of antenna is Micro strip patch antenna. Antenna is a Radiating element which Radiates Electromagnetic Energy uniformly in Omnidirectional pattern or in some systems its used for point to point communication purpose in which increased gain and reduced wave interference is required. Antenna is a transducer designed to transmit or receive electromagnetic waves. Microstrip antennas have several advantages over conventional microwave antenna and therefore are widely used in many practical applications. Microstrip antennas in its simplest configuration are shown in Fig1. It consists of a radiating patch on one side of dielectric substrate (Єr≤10), this has a ground plane on other side.

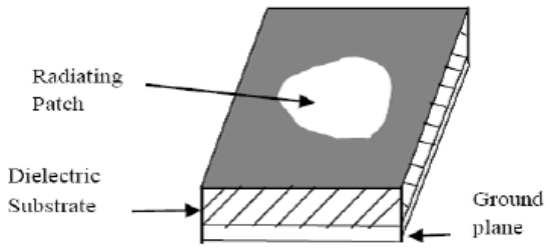
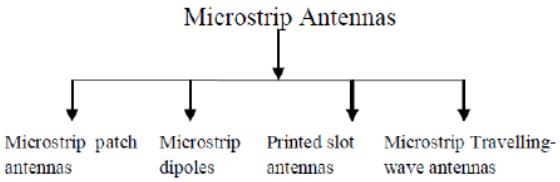


Fig 1 Microstrip antenna configuration

Microstrip antennas are characterized by a larger number of physical parameters unlike conventional

microwave antennas. They can be designed to have various geometrical shapes and dimensions [2]. All Micro strip antennas can be divided into four basic categories:



The specifications for the design purpose of the structure are as mentioned below:

- Number of elements : 4
- Input impedance : 50 Ω
- Resonance frequency : 2.4GHz
- VSWR: 1 – 1.4

These specifications were chosen to design a lightweight and compact Microstrip Array Antenna at S-band for Man packs Wireless Communication. The design of the whole structure is performed in the following steps:

i) To design a single Microstrip patch antenna
ii) To design the power divider to feed the antenna
iii) To design the complete array

II. MICRO STRIP PATCH ANTENNA

A Microstrip patch antenna (MPA) consists of a conducting patch of any planar or non planar geometry on one side of a dielectric substrate with a ground plane on the other side. It is a popular printed resonant antenna for narrow-band microwave wireless links which require semi-hemispherical coverage. Because of its planar configuration and ease of integration with Microstrip technology, the Microstrip patch antenna has been heavily studied and is often used as elements for an array. A large number of Micro strip patch antennas have been studied to date. An exhaustive list of the geometries along with their salient features is available [1].

The rectangular and circular patches are the basic and most commonly used Microstrip antennas. These patches are used for the simplest and the most demanding applications. Rectangular geometries are separable in nature and their analysis is also simple. Microstrip patch antennas (MPAs) have attracted widespread interest due to their small size, light weight, low profile and low cost and for the fact that they are simple to manufacture. A rectangular Microstrip patch antenna in its simplest form is shown in Figure 2. In principal, wide bandwidth of Micro strip patch antennas (MPAs) or bandwidth enhancement can be achieved by several efficient approaches [3], namely (i) increasing the substrate thickness (ii) optimizing impedance matching (iii)reducing the substrate effective permittivity or (iv) incorporating multiple resonance. Much effort has also been increasingly devoted to increasing the frequency agility of (MPAs) [3].

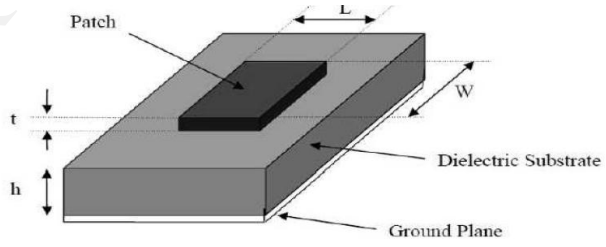


Fig 1 Rectangular Microstrip patch antenna

The characteristics of Microstrip patch antennas, Microstrip sot antennas and printed dipole antennas are compared in table 1.

Sr. No.	Characteristics	Microstrip Patch Antenna	Microstrip Slot Antenna	Printed Diopole antenna
1.	Profile	Thin	Thin	Thin
2.	Fabrication	Very easy	Easy	Easy
3.	Polarization	Both linear and circular	Both linear and circular	Linear
4.	Dual-Frequency operation	Possible	Possible	Possible
5.	Shape flexibility	Any shape	Mostly rectangular and circular shapes	Rectangular and triangular
6.	Spurious radiation	Exists	Exists	Exists
7.	Bandwidth	2-50%	5-30%	-30%

In this proposed paper square patch antenna is used for wireless communication because square patch antenna have quite a few benefits, including the aforementioned inexpensive price, versatility, and ease of manufacture. The low profile nature of patch antenna is also obvious as well as the small size needed to generate a sizable directive gain.

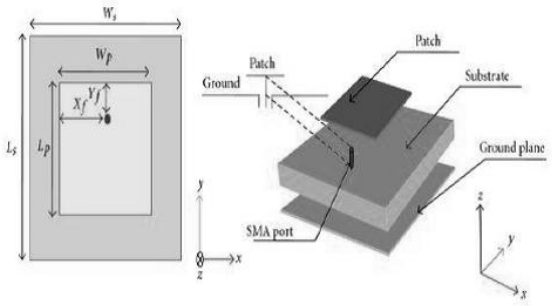


Fig 3: structure of square microstrip patch antenna

In the structure of square patch antenna height and width are both same. They usually consist of a square Metal patch which is mounted on a dielectric-coated ground plane (circuit board). Micro strip antennas consist of a very thin metallic strip (patch) placed on a small fraction of wavelength above a ground plane. The square patch and the ground plane are separated by a dielectric sheet referred to as the substrate.

III. FEEDING TECHNIQUE

A feed line is also a conducting strip normally of smaller width. Coaxial line feeds where the inner conductor of the coaxial line is attached to the radiating patch are widely used. A feed line is used to excite to radiate by direct or indirect contact. There are many different techniques of feeding and four most popular techniques are coaxial probe feed, microstrip line, aperture coupling and proximity coupling [2]

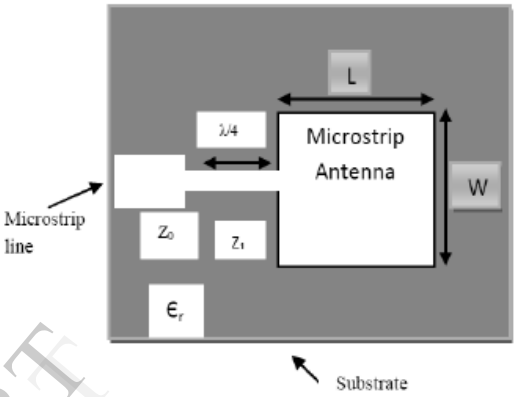


Fig 4: Micro strip line series feed patch antenna

Here in this article, series feed patch antenna is used to design the micro strip patch antenna array for mobile communication. Series feed arrays are frequency-sensitive and lead to bandwidth restrictions. When the frequency is changed, the phase at the radiating elements changes proportionately to the length of feed line so that the phase at the aperture tilts in a linear manner and the beam is scanned. This effect can be useful for frequency-scanning arrays, but normally it is undesirable. The increased electrical path length to each radiating element has to be computed as a function of frequency and taken into account when adjusting the phase shifters.

It is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is

simple to model and easy to match by controlling the inset position. However the disadvantage of this method is that as substrate thickness increases, surface wave and spurious feed radiation increases which limit the bandwidth.

The microstrip transmission line consists of three layers: -

1. The ground layer
2. The dielectric substrate
3. The metal strip

IV. DESIGN CONSIDERATION OF 4X1 SERIES MICROSTRIP PATCH ANTENNA ARRAY

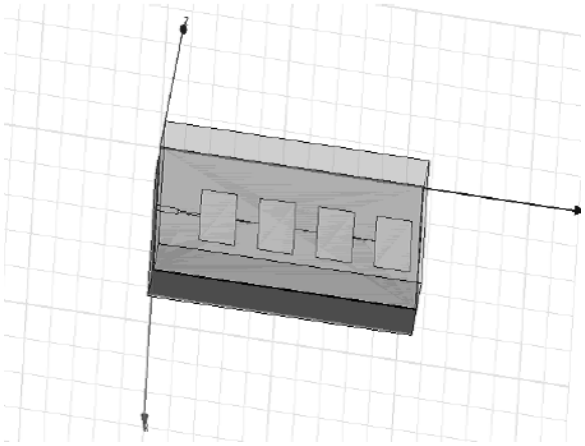


Fig 5: 4x1 Element Micro strip series Antenna Array

In this proposed paper a 4X1 Series Antenna Array of individual Microstrip 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 (εr = 4.2) and height h=1.6mm).The length of the each matching line of Antenna Array is X size is 1.1mm and Y size is 18.381mm.The design starts with the simple Square Micro strip antenna with transformer series 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 (εr = 4.2) and height of 1.6 mm. Finally the Micro strip antenna is measured and compared with the simulated values. The dimension of the patch is 29 mm x 29 mm with transformer feed at 8 mm. The width of the transmission line is 3mm.

V. SIMULATION RESULTS

To design the series Micro strip patch antenna, has been simulated by varying two parameters, (i) position of the feeding line from the edge of the substrate. (ii) Width of the Microstrip feed. By selecting these parameters, the proposed antenna can be tuned to operate within the frequency range 2.4GHz. Figure 5 shows simple design of the series square Microstrip patch antenna. Figure 6 shows its S11 graph (Return Loss).

Return Loss

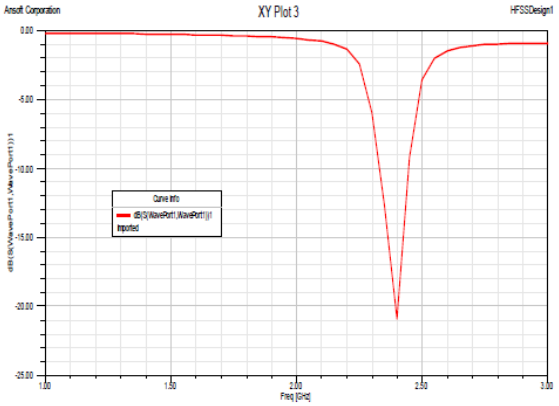


Fig 6: Measured Return loss of 4x1 Square Microstrip patch Antenna Array

The figure 6 it found that the S11 frequency is 2.4GHz at -20.9dB. The bandwidth for simulation and measurement are 16% and 18%.

VI. 3D POLAR PLOT OF SQUARE PATCH ANTENNA ARRAY

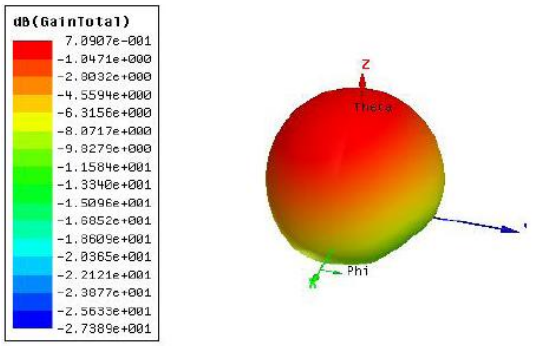


Fig 7: 3D Polar Plot of square patch antenna gain pattern

The patch has a good performance with slightly over 10 dBi gain as shown in figure 7. The gain pattern has a 31° beam width with the bore sight of the antenna being normal to the plane of the patch in a broadside configuration. The front to back ratio of the antenna is 21 dB showing a good efficiency with getting the energy where it is desired for the design.

VII. CONCLUSION

Four compact Micro strip patch antennas are proposed for WLAN 802.11b communication standard at 2.4 GHz. bands. The characteristics of the proposed compact Microstrip patch antennas are compared with each other and with that of a simple square patch antenna. The proposed patch antennas show a significant size reduction compared to the simple square patch antenna. The gain and bandwidth of the proposed antennas can be increased significantly using stacked Configuration.

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