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# A Review Cellular Networks Design and Simulation of Micro Strip Patch Antennas

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**ABSTRACT: Microstrip patch antennas are versatile in terms of their geometrical shapes and implementation. The light weight construction and the suitability for integration with microwave integrated circuits are two more of their numerous advantages. Additionally the simplicity of the structures makes this type of antennas suitable for low-cost manufacturing. And this is also one key feature why microstrip patch antennas are used in mobile communication applications. Inhibiting characteristics of a single microstrip patch, like low gain and smaller bandwidth, make it more necessary for array configuration. In this work the design and simulation of microstrip patch antenna array was done. The design involved 1- patch, 4 x 1 liner arrays, with an element spacing of a half of a free space wavelength. The antenna was designed to operate at 1.8GHz band, which is almost standard for base station applications.**

**Keywords:** Dielectric, Microstrip, patch antennas, free space wavelength.

## I. INTRODUCTION

In recent years, there has been rapid growth in wireless communication. With the increasing number of users and limited bandwidth that is available, operators are trying hard to optimize their network for larger capacity and improved quality coverage [1]. This surge has led the field of antenna engineering to constantly evolved and accommodate the need for wideband, low cost, miniaturized and easily integrated antennas [1]. The quest to solve these problems led to the study of microstrip antennas. The microstrip patch antennas are associated with several advantages of being low profile, versatile, conformal and low-cost devices. The advantages of microstrip antennas make them suitable for various applications like, vehicle based satellite link antennas [2], global position systems (GPS), radar for missiles and telemetry [3] and mobile handheld radios or communication devices. The Microstrip Antennas (MSAs) are low profile, mechanically robust, inexpensive to manufacture, light weight and ability of integration with electronic or signal processing circuitry. With respect to radiation properties, microstrip antennas are versatile in terms of resonant frequencies, polarization, pattern and impedance. They allow the use of additional tuning elements like pins or varactor diodes between the patch and the ground plane. Designing active/passive microwave circuits, on the other hand, requires understanding of both mathematicalrelations (i.e. theory) and application (i.e. Computer simulations as well as measurements). Mathematical relations exist for only simple, idealized microstrip structures and may help to understand the fundamentals. Fortunately, powerful numerical simulation methods are available which can be used to design complex microstrip. Among the others are the finite difference time domain (FDTD), the transmission line matrix (TLM), the finite element method (FEM), and method of moments (MoM). In [4], Johan Lagerquits analyzed and designed "An Electrically steerable Microstrip Antenna for Ground to Air use", this is a single-feed polarized microstrip antenna array, operating at 2.45GHz. The antenna was intended tobe used for reception of a video signal transmitted from an unmanned aircraft, but can be used for other applications as well. Due to the fact that it was supposed to be used in a switched system, the beam width was quite narrow. Measurements of the antenna showed that it had a half power beam width of 40o for a VSWR lower than 1.5 and an axial ratio lower than 3dB, the bandwidth was 80MHz centered at 2.44GHz.

This work describes the design and simulation of rectangular microstrip patch antenna array for the wireless communication systems which operates at 1.8GHz band. specifications shown in the table below.

**Table 1**
**Array Antenna Specifications**

| Features | Required Values |
|---|---|
| Centre Frequency | 1.8.GHz |
| Array Antenna Configuration | Liner Array |
| Microstrip Radiator used | Rectangular Patch |
| Polarization | Linear |
| Antenna Gain | ≥ 10dB |
| Antenna impedance BW | ≥ 5% |

## II. STRUCTURE OF A MICROSTRIP ANTENNA

In its basic form, microstrip antennas are similar to parallel plate capacitors. Both have parallel plates of metal layer and a sandwiched dielectric substrate between them.But in microstrip antenna, one of these metal plates is infinitely extended than the other, to form the ground plane; whereas the smaller metal plate is described as radiating patch.Since the size of the patch is often proportional to frequency of the propagating signal, this class of antenna is classified as resonant antennas. This contributes to the basic shortcoming of the microstrip antennas related with its narrow bandwidth, usually only a few percent [1] of the resonant frequency. So far, several shapes of microstrip patches, such as rectangular, circular, triangular, semicircular, sectoral and annular etc, are successfully used as radiating antenna elements employed various communication control devices. When the patch is excited by a feed line, charge is distributed on the underside of the patch and the ground plane. At a particular instance of time the attractive force between the underside of the patch and the ground plane tend to hold a large amount of charges to the edge of the patch, creating a large density of charge at the edges. These are the sources of fringing field. Radiation from the microstrip antenna can occur from the fringing field between the periphery of the patch and the ground plane [1]. Assuming no variations of the electric field along the width (w) and the thickness (t) of the microstrip structures, the electric field excited by the patch is shown in fig. 2.

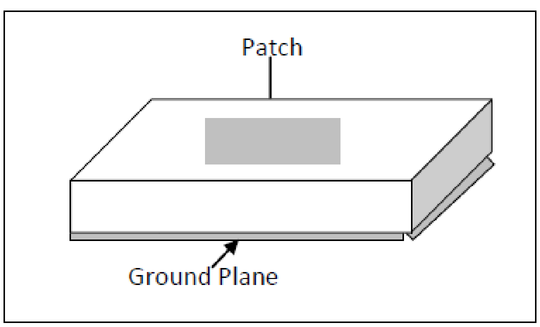


**Fig. 1.** Microstrip rectangular patch antenna.

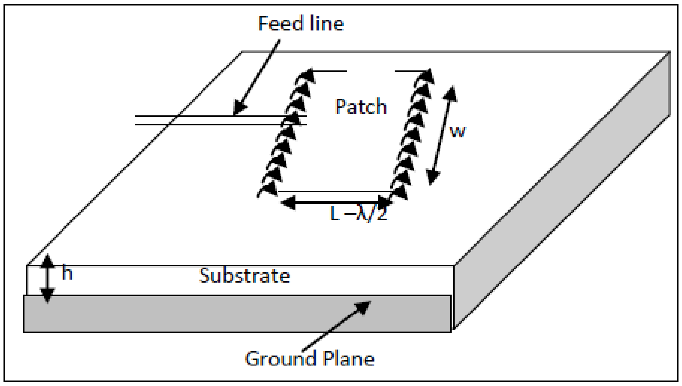


**Fig. 2.** Radiation mechanism associated with microstrip patch.

Radiation is ascribed mostly to the fringing field at the open circuited edge of the patch length. The fields at the end can be resolved into normal and tangential components with respect to the ground plane. The normal components are 180o out of phase because the patch is λ/2 long; therefore the four field radiation produced by them cancels in the broadside direction [2], the tangential components (those parallel to the ground plane) are in phase, and the resulting field combine to give minimum radiated field normal to the surface of the structure i.e., broadside direction. Therefore, the patch may be represented by two slots λ/2 apart

In today world of wireless communication, recent developments in wireless communication industry continue to derive requirement of small, compatible and affordable microstrip patch antennas. A patch antenna is a narrowband, widebeam 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 [4].The EM waves is produced by an antenna which is so called transducer because it transform electric current in to EM waves and by receiving vice versa [8]. Radiation of antenna by changing the current

inside a conductor wire is the concept of radiations of antenna. By accelerating or decelerating the current in a straight wire, the current will create a flow which makes the antenna radiate, if current will not flow antenna never radiate [15]. Common microstrip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is

possible. 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 [8]. They are often mounted on the exterior of aircraft and spacecraft or are incorporated into mobile radio communications devices. Microstrip antennas are best choice for wireless devices because of characteristics like low profile, low weight, ease of fabrication and low cost. Since it is common practice to combine several radios into one wireless and use single antenna. Microstrip antenna suffers

## III. LITERATURE SURVEY

Alsath et al.[1] proposed approach to enhance isolation in microstrip patch antenna arrays is described. A Defect is introduced called as meander line resonator by creating defect known as band notch function. Resonator is designed to block surface current at resonant frequency of two patch antenna. This antenna provided an improvement in isolation by 16 dB with reduced edge to edge spacing of 7 mm. This design and simulation has been carried out using antenna simulation software. The resonator is designed to block the surface current at the resonant frequency of the two patch antennas coupled along H-plane and operating at a frequency of 4.8 GHz. The interelement isolation before and after the implementation

### *A. Aperture Coupled Microstrip Antennas*

The first aperture coupled microstrip antenna was fabricated and tested by a graduate student, Allen Buck, on August 1, 1984, in the University of Massachusetts Antenna Lab. This antenna used Duroid substrates with a circular coupling aperture, and operated at 2GHz [19]. It was found that this antenna worked perfectly – it was impedance matched, and the radiation patterns were good.

Most importantly, the required coupling aperture was small enough so that the back radiation from the coupling aperture was much smaller than the forward radiation level [7]. A new feed configuration for the microstrip antenna has been proposed by Pozar. It is preferable to mount the antenna elements on the low dielectric constant substrate in order to increase the bandwidth, efficiency. With the two layer design, the antennas are located on different substrate, which yields optimal array performance. The ground plane shields the antenna half space from the spurious radiation emitted by feed line. So, aperture coupling overcomes the problems related to probe feeds. [8] D. M Pozar and R.Pous in the year 1990 found that the frequency response can be controlled by adjusting the size of the coupling aperture. Also, by the proper arrangement of size of coupling aperture, frequency selective surface can be made to pass linear or dual polarized wave.[9] Slot aperture coupled microstrip antenna are attractive antenna elements because of their light weight, thin structure and ease of fabrication and compatibility with multi-layered feed networks. For mobile-satellite communication use, they at same time are required to fulfill other specifications like wide frequency bandwidth.[10]. **Table 2: Comparative analysis of different techniques.**

TABLE 1: TABLE FOR THE COMPARATIVE ANALYSIS OF DIFFERENT TECHNIQUES.

| S. No. | Proposed Antenna | Technique Applied | Remarks |
|---|---|---|---|
| 1 | Implementation of Slotted Meander-Line Resonators for Isolation Enhancement in microstrip Patch Antenna Arrays | A Defect is introduced called as meander line resonator by creating defect known as band notch function. Resonator is designed to block surface current at resonant frequency of two patch antenna. | To enhance isolation in microstrip patch antenna arrays and it has concluded that that technique only implemented on array antennas. |
| 2 | Wide Band Dual-Beam U-Slot microstrip Antenna | Bandwidth of antenna is obtained by making use of u shaped patch. Conventional U slot patch antenna, parametric analysis is analyzed. | The proposed design was used for stationary terminals of various indoor wireless communication networks. |
| 3 | circular symmetric slotted microstrip patch antenna with compact size | obtained by cutting shapes in diagonal directions of microstrip patch antenna. | 3 dB axial-ratio (AR) bandwidth of around 0.7% (6.0 MHz) with 2.0% (18.0 MHz) impedance bandwidth was achieved |
| 4 | Triband bowtie antenna using slot technique | obtained by inserting two pairs of slot with different length of isosceles triangle without increasing area of triangle. | Antenna was resonated at three different bands but its dimensions were made for middle frequency band. This antenna was |

**Bandwidth enhancement of Aperture Coupled Microstrip Patch Antenna**

An approach to increase the bandwidth and to increase the gain, an antenna with two parasitic elements has been designed. One parasitic element increases the bandwidth and other is used to increase the gain.[12] In the year 1997, Shashi, Paul and Harokopus concluded that Smart antennas are required to increase the coverage of the base station for personnal communication systems. Although they provide high gain and coverage over the whole cell but still microstrip antennas are preferred as they provide high gain and coverage but are also flat in appearance and provide dual polarization.

It reduces weight, while yielding excellent electrical performance.The dual polarization provides the required bandwidth to cover the entire transmit and receive bands [13]. For many wireless applications, bandwidths of 10-15% are required and can be easily achieved by using large aperture with fairly thick antenna substrate. By using stacked antenna bandwidth in excess of 50% has been realized [14]. For maximum coupling, the patch should be centered over the slot, moving the patch relative to the slot in H-plane direction has low effect, while moving it in the direction of
E-plane decreases the coupling level, so for maximum coupling, the feed line should be at right angle to center of the slot.[15]

In the year 2006, Manoj, S.K. Koul showed the effect of the slot length, stub length and dielectric constant, and the variations that occur in return loss and resonant frequency and also studied that as the aperture length is reduced the input resistance of the antenna is decreases. This might be thought of as decreasing the coupling factor between the feed
line and the antenna [16]. Due to the current trend, one way of improving and making maximum use of wireless communication is by using array antennas. As the number of arrays in the antenna increases, there is an increase in gain, return loss, bandwidth [17]. Use of the long microstrip line can effectively couples the energy first from the aperture
cut from the ground plane and then to the patch. Also larger the ground plane, lesser will be the back radiation. As the ground plane size at low frequency is relatively smaller in terms of wavelength than at higher frequency, larger back radiation are expected at low frequency band.[18]

**Antennas with Defected Ground Structure**

In the year 2003, Y.J. Sung, M. Kin, Y.S. Kin gave a method to reduce the higher order harmonics with the help of Defected Ground Structure. A H-shaped defect on the ground plane helped to reduce the harmonics. Then its comparison with a conventional antenna is made and it was found that radiated power was drastically reduced which is based on the
stop band characteristics of defected ground structure cell [19]. A Novel structure called Defected Ground Structure & Defected Microstrip Structure, which has widely used in several applications such as reducing the size of patch antennas without degrading the performance of the antenna as better efficiency, better bandwidth etc. DGS/DMS has other application is suppression of harmonics without introducing a big attenuation in the fundamental frequency. This concept is given by Himanshu Singh, Y.K. Awasthi and A.K. Verma in the paper titled Microstrip Patch Antenna with the Defected Ground Structure and Defected Microstrip Structure [20]. In the year 2011, Halappa R. Gajera, Anoop C.N, M M Naik. G, Archana S. P, Nandini R Pushpitha B.K, Ravi Kumar M.D proposed their design of rectangular microstrip patch
antenna (RMPA). The glass epoxy substrate with height 1.6mm and the dielectric constant is 4.4 is used. The half circular slot etched on the patch at the top right as DMS, two circular slots etched on the ground plane as DGS. The DGS helps in shifting the resonant frequency to desired frequency. DGS was used to improve the bandwidth and reduce the size of patch to make antenna, thereby achieving the gain of 4.65dBi. [24] In the year 2012, Rajeshwar Lal Dua, Himanshu Singh, Neha Gambhir proposed the rectangular patch antenna designed with swastik structure DGS in the year 2012. Here, the radiating patch area is smaller as compared to the conventional antenna without DGS. So, this antenna design with DGS not only improve the parameters of the antenna without DGS but also can provide a smaller size of radiating patches, which will cause an overall reduction in antenna size.[25]

## IV. CONCLUSIONS

The design of E-Shape Micro strip patch antennas are widely used in satellite, radar and wireless communication. In this field are design antenna is light weight, compact size, and easy of manufacturing. The E- Shape microstrip patch antenna is design for dual band frequency. The optimum results of proposed antenna simulate and tested in IE3D simulator. The simulated results of IE3D simulation give the result is three notch 2,6 & 8 GHz frequency .In 2 GHz is Return loss = -27.69dB, 6 GHz is return loss is = -13.71 dB, 8 GHz is – 20.35 dB. The proposed antenna give three bandwidth 2 GHz frequency up to 33%, 6 GHz is upto 31% and 8 GHz is up to 54%. Antenna Efficiency is 88%.

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