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Design of Microstrip Array Antenna for 5G Communications

A. Sangeetha, Ms. D. Rajeshwari,M.E.,

M.E. Communication Systems, Department of Electronics and Communication Engineering, Chendhuran College of Engineering and Technology, Lena Vilakku, Pilivalam Post, Thirumayam Tk, Pudukkottai, Tamilnadu, India

Assistant Professor, Department of Electronics and Communication Engineering, Chendhuran College of Engineering and Technology, Lena Vilakku, Pilivalam Post, Thirumayam Tk, Pudukkottai, Tamilnadu, India

ABSTRACT: The array antenna has simple, low cost, high gain microstrip array antenna with suitable feeding technique and suitable dielectric substrate for application in the range of 29.7 GHz. To Design an 4 element rectangular micro strip patch array antenna. The single patch evaluating the outcomes of antenna features; operation frequency, radiation patterns, return loss, efficiency and antenna gain, transformed it to a 1*4 array to increase directivity, gain, efficiency and better radiation patterns. it can be used for Ka-band applications and 5G cellular communication systems.

KEYWORDS: Ultra Wide Band (UWB); Wireless Local Area Network (WLAN); Industrial, Scientific, and Medical Band (ISMB).

I. INTRODUCTION

In radio telecommunications, among the antenna designs there are many different categories of micro strip antennas which are also known by the name printed antennas) the most common of which is the micro strip patch antenna or patch antenna. A patch antenna (also known as a rectangular micro strip antenna) is a type of radio antenna with a low profile, which can be constructed on a flat surface. It consists of a flat rectangular metallic sheet or "patch" of metal, mounted over a larger metallic sheet called a ground plane. The assembly is usually covered by a plastic radome, which saves the antenna structure from damage. Patch antennas are very simple to be fabricated and easy to be modified and customized. They are the original type of micro strip antennas which were given by Howell in the year 1972 in which the two metal sheets together produce resonance and form a resonant piece of micro strip transmission line with a length which is around one half wavelength of the radio waves. The radiation process arises from discontinuities or irregularities at each truncated edge of the micro strip transmission line. The radiation produced at the edges causes the antenna to act slightly bigger electrically than its actual physical dimensions, so in order for the antenna to be a resonanting piece of element, a length of micro strip transmission line slightly lesser than one half a wavelength at the frequency is taken. A dielectric substrate is used for the construction of patch antenna, using the same. The easiest and most simple patch antenna uses a patch which is one half wavelength long, created at a precise distance above a larger ground plane, using an intermediary such as a spacer made of a dielectric material between them.

Electrically large ground planes produce very rugged and stable patterns and lower environmental sensitivity but of course increase the size of the antenna. It isn't uncommon for the ground plane to be only slightly larger than the active patch. When a ground plane is near to the size of the radiator it can have the phenomenon of coupling and produce

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currents along the edges of the ground plane which also radiate. The antenna pattern is created as the combination of the two sets of radiating metallic elements. The current which flows is along the direction of the feed wire, so the magnetic vector potential and also the electric field follow the current. A simple and easiest patch antenna of this category radiates a linearly polarized wave. The radiation can be considered as being produced by a number of the "radiating slots'' at top and bottom, or simultaneously as a result of the current flowing on the patch and the ground plane. Commonly made micro strip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible and can be created. Some patch antennas do not use a dielectric substrate and instead are made by using a metal patch mounted above a ground plane using dielectric spacers; the resulting structure is less rugged but the bandwidth is much wider. Now as such antennas have a very low profile, are mechanically rugged and can be shaped and designed to conform to the curving skin of a vehicle, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated and operated into electronic devices such mobile radio communication equipments.

Antenna's features such as frequency, radiation pattern and polarization are reconfigured to achieve the demands for agile radio applications. A lot of researches focus on frequency reconfiguration as future communication systems such as cognitive radio needs an antenna that can do spectrum sensing and communication. In designing of reconfigurable frequency antennas, recently a reconfigurable wide-band to agile narrowband frequencies, using a printed log periodic dipole array antenna, was developed. A wideband slotted antenna has been produced using multifunctional reconfigurable frequency characteristics for various applications such Wireless LAN, WIMAX, Ultra wideband and UMTS has been proposed in a frequency reconfigurable antenna, made up of two structural elements ; one is an ultrawide band (UWB) and other is a frequency reconfigurable triangular shaped antenna, is proposed for cognitive radio applications Ultra-wide band antennas have already been used in applications such as satellite communication, remote sensing, ultra wide band radar technology and so on. Currently, the wireless area network (WLAN) in the 2.4-GHz (2.4-2.485 GHz) and 5-GHz (5.l5-5.875 GHz) bands is the most renowned networks for accessing the internet and also the antenna for an AP not only requires dual band operation but also needs to have an appropriate radiation profile in both bands, namely equal gain, wide beam width, and high front-to-back ratio. Wireless communications is enjoying exponential growth in Industrial, Scientific, and Medical (ISM) band. The future generation wireless networks require systems with broad band capabilities in various environments to satisfy numerous applications as smart grid, personal communications, home, car, and office networking .On the other hand, many modern wireless communication systems such as radar, navigation, satellite, and mobile applications use the circular polarized (CP) technology and radiation pattern. For the best UWB performance, the transmitter and receiver (T/R) antennas should have flat and high directive gain, narrow beam low side and back lobes over the operational frequency band; to achieve the largest dynamic range, best focused illumination area, lowest T/R coupling, reduced ringing and uniformly shaped impulse radiation.UWB has generally offers high data rates at short distances with low power, primarily due to high resolution bandwidth.

II. SYSTEM IMPLEMENTATION

A. ANTENNA DESIGN AND CONFIGURATION

The geometry and configuration of the proposed antenna is shown in the figure. Initially the design properties are selected by adjusting the local variables such as the substrate thickness, height, material, transparency and position as well. As shown in the figure the proposed antenna consists of a substrate on which a cylindrical coax of Teflon is developed. The cylindrical coax pin is made up of the material pec. Also the height and radius of the coax are –16.67mm and 0.283mm respectively. The feed pin is also cylindrical with a radius of 0.083mm and the height of 62mil. Before covering the design with a radiation air box the circular wave port on the substrate with a radius of 0.283mm is made. Finally the design is covered with a vacuum air box before the simulation and analysis.

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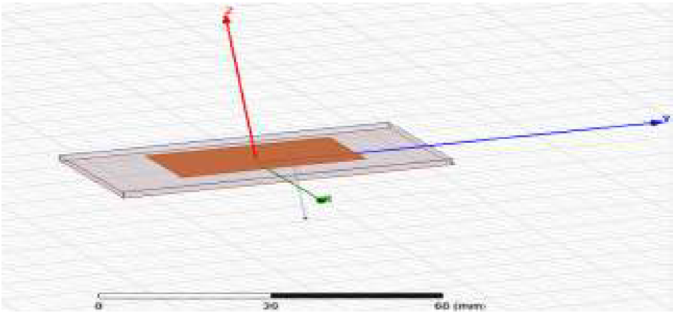

Fig.1 Rectangular patch antenna

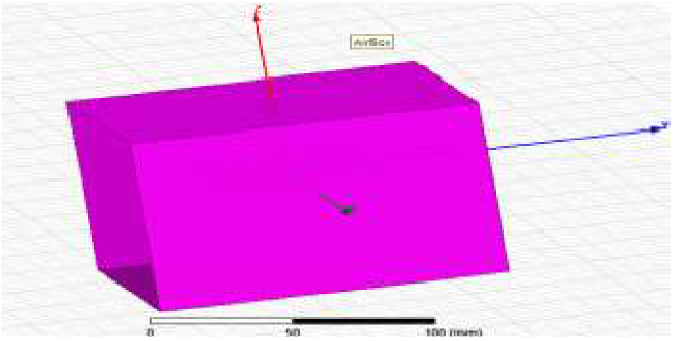

Fig. 2 Air box over the antenna

The impedance bandwidth of a patch antenna is strongly influenced by the spacing between the patch and the ground plane. As the patch is moved closer to the ground plane, less energy is radiated and more energy is stored in the patch capacitance and inductance: that is, the quality factor Q of the antenna increases. A patch printed onto a dielectric board is often more convenient to fabricate and is a bit smaller, but the volume of the antenna is decreased, so the bandwidth decreases because the Q increases, roughly in proportion to the dielectric constant of the substrate. Patch antennas utilized by industry often use ground planes which are only modestly larger than the patch, which also alters their performance.

A. Rectangular patch

The most commonly designed micro strip antenna is a rectangular patch. The rectangular patch antenna is around a one half wavelength long strip of rectangular micro strip transmission line. When air is taken as the antenna substrate, the length of the rectangular micro strip antenna is approximately one half of a free space wavelength. Antenna is loaded with a dielectric substrate. The length of the antenna reduces as the relative dielectric constant of the substrate element increases. The resonant length of the antenna is slightly lesser because of the increased electric "fringing fields" which increase the electrical length of the antenna slightly. An old model of the micro strip antenna is a section of micro strip transmission line with equivalent loads on either end to represent the radiation loss.

B. Planar inverted F Antenna

Another category of patch antenna is the Planar Inverted-F Antenna (PIFA) common in cellular phones with built-in antennas. (The Planar Inverted-F antenna (PIFA) is highly used in the mobile phone market. The antenna is resonant at a quarter-wavelength (thus decreasing the required space needed on the phone), and also typically has good SAR properties. This antenna resembles an inverted F, which explains the PIFA name. The Planar Inverted-F Antenna is renowned because it has a low profile and an Omni directional pattern. These antennas are produced from a quarter

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wave half patch antenna. The shorting plane of the half-patch is decreased in length which decreases the frequency of resonance. Often PIFA antennas have multiple branches for resonating at the multiple cellular bands. On some phones, grounded parasitic elements are applied to improve the radiation bandwidth characteristics. [14-16]

C. Advantages

Micro strip antennas are comparatively inexpensive to manufacture and fabricate because of the easy 2 dimensional physical constructions and geometry. They are usually employed at UHF and other higher frequencies because the size of the antenna is directly related to the wavelength at the frequency of resonance. A single patch antenna gives a maximum directive gain of around 6bB to 9dB. It is relatively easy to print an array of patches on a single (large) substrate and lithographic techniques are used for this. Patch arrays can give much higher gains than a single patch at little additional expense; matching and adjustment of phase can be performed with printed micro strip feed structures, again in the same operations that produces the radiating patches. The capability to create high gain arrays in a low-profile antenna is one reason that patch arrays are commonly used on airplanes and in other military applications. Such an array of patch antennas is an easy way to design a phased array of antennas with dynamic beam forming capability. An advantage inherent to patch antennas is the skill to have polarization diversity. Patch antennas can easily be fabricated to have vertical, horizontal, right hand circular (RHCP) or left hand circular (LHCP) polarizations or different kinds of polarizations, using multiple feed points, or a single feed point with asymmetric patch structures. This unique feature enables patch antennas to be used in many types of communications links that may have varied requirements.

III. LITERATURE SURVEY

Patch Array Antenna for UWB Radar Applications - Gaboardi P., Rosa L., Cucinotta A., and Selleri S. – 2010
This paper presents an antenna design for ultra wideband (UWB) radar applications. It consists of a patch array antenna designed to operate from 5.35 to 5.85 GHz. Details of the proposed antenna design, realization and measured results are presented and discussed

Size reduced multi-band printed quadrifilar helical antenna - Letestu and Ala Sharaiha - 2011 A simple and innovative method for designing a spiral folded printed quadrifilar helix antenna (S-FPQHA) for dual-band operations is presented. The axial length of a conventional PQHA is miniaturized of about 43% by meandering and turning the helix arms into the form of square spirals. Parametric studies are performed to explore the performance improvements. Based on the studies a dual band antenna working in L1/L5 GPS application is realized with a good gain and a good circular polarization. Measured results are presented to validate the concept.

A 65-nm CMOS fully integrated transceiver module for 60-GHz Wireless HD applications - A. Siligaris et al. - 2013 A fully integrated WirelessHD compatible 60-GHz transceiver module in 65-nm CMOS process is presented, covering the four standard channels. The silicon die is flip-chipped on top of a low-cost HTCC module which also includes an external 65-nm CMOS PA and large beamwidth antennas targeting industrial manufacturability. The module achieves a 16QAM OFDM modulation wireless link with 3.8 Gbps over 1 m. The transceiver consumption is 454 mW in RX mode (including PLL) and 1090 mW in TX mode (including PLL and external PA).

IV. SYSTEM ANALYSIS

A. Existing System
Higher Data Prices for Consumers & it Forced to buy a new device to support the 4G. It is impossible to compatible with 4G Network & Existing Mobile Phones cannot be used to access LTE network features. The problem avoided by multimode supported mobile phone, use can use other networks such as 2G,3G in case 4G is not available. The Processor as well as Modem and Power Management Technologies to deliver performance, size and battery life that demand.

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B. Proposed System

5G Technology offer high resolution for cell phone user and bidirectional bandwidth shaping. High quality service based on policy to avoid error. Broadcasting data are Giga bit supporting 65,000 connections. Greater Speed. Greater Capacity(1000 times of 4G). Allow access to parallel multiple services.

V. RESULTS AND DISCUSSION

In this section, we provided the simulated results of entire project with its practical proofs.

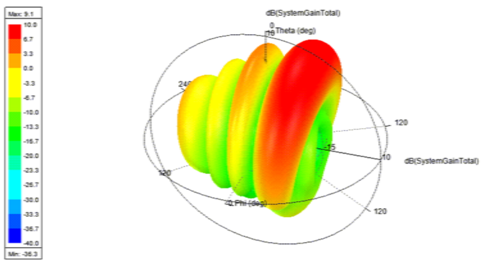

Fig.3 3D Radiation Pattern

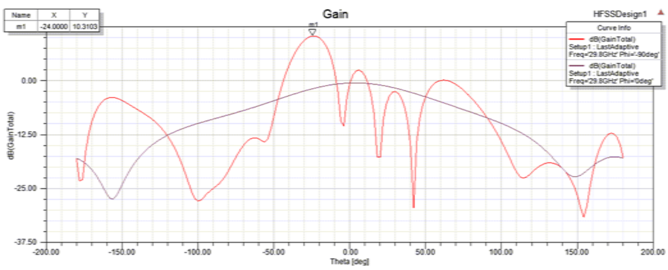

Fig.4 Gain

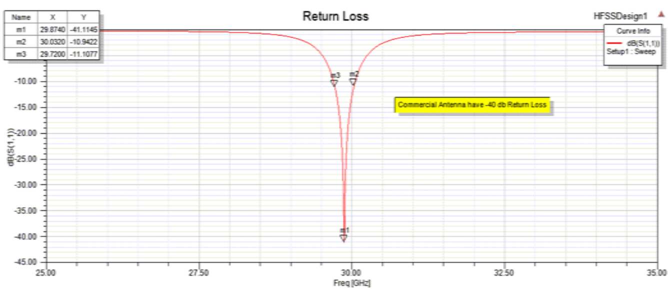

Fig.5 Return Loss

VI. CONCLUSION

The array antenna is increase the number of elements, antenna radiation parameters like gain, directivity etc. These designed antennas are very simple, cost effective and high efficiency for the application in GHz frequency ranges. The

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optimum design parameters (i.e dielectric material, height of the substrate, operating frequency) are used to achieve the compact dimensions and high radiation efficiency. The operating frequency of all designed antennas is about 29.7 GHz which is suitable for Ka-band applications.

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