ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

A Review on Rectangular Patch Antenna with Symmetric Slot for WLAN Applications

Meenu Sharma[1], Sandeep Kumar Agrawal[2],

PG Student, Dept. of ECE, Rustamji Institute of Technology BSF Academy Tekanpur, Gwalior, M.P, India[1]

Professor, Dept. of ECE, Rustamji Institute of Technology BSF Academy Tekanpur, Gwalior, M.P, India[2]

ABSTRACT: This paper focuses mostly on design and analysis of microstrip patch antenna using metamaterial as well as effects of slots made on patch antenna to improve the bandwidth. Microstrip patch antenna are preferred over other antennas in today's modern word scenario for their compatibility to be fit in Mobile , Aircraft , Satellites owing to very small sizes. Hence design and development of superior and cost effective microstrip patch antenna has become an active research area. Microstrip patch antennas are mostly known for their versatility in terms of possible geometries that makes them applicable for many different situations. The lightweight construction and the suitability for integration with microwave integrated circuits are two more of their numerous advantages. Patch antenna has a narrow bandwidth so it has a complexity in tunings, so there is a requirement to increase the bandwidth of patch antenna. This paper presents a rectangular microstrip patch antenna with FSS and Slotted patch to enhance bandwidth of 2-6 GHz simple rectangular microstrip patch antenna which works on IEEE 802.11b and IEEE 802.11g standard applications. We will design an antenna is mounted on rectangular patch with air gap to enhance bandwidth for WLAN applications.

KEYWORDS: Bandwidth, Microstrip Patch Antenna, Resonance Frequency, VSWR, Microstrip Feed

I.INTRODUCTION

"Microstrip antenna consist a very thin metallic strip, called patch placed above ground plane. The strip and ground plane are separated by dielectric sheet called substrate". The patch is generally made of conducting material such as copper or gold and can take any possible shape. It consists four parts:

a) A very thin flat metallic region called radiating patch

b) A dielectric substrate

c) A ground plane

d) A feed, which supplies the RF power to radiating patch.

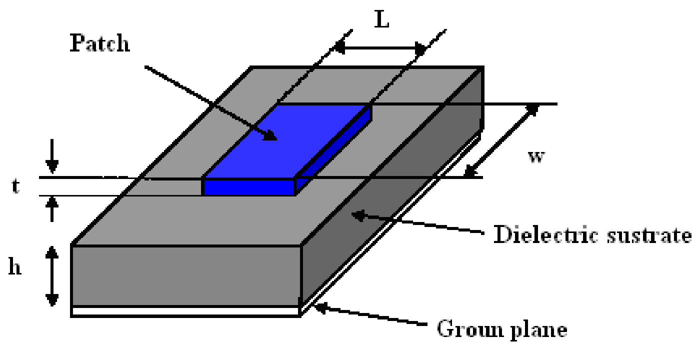

Figure.1: Diagram of Patch antenna

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Different Shapes:
There are different shapes available according to our desire, often few shapes are mostly used like rectangular, square, dipole, circular, elliptical, triangular etc as the requirement. The radiating element and the feed lines are usually photo etched on the dielectric substrate. These shapes are most common because of ease of analysis and fabrication and their attractive radiation characteristic, especially low cross-polarization radiation.

Feeding Methods:

Micro Strip Line Feed: this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation.

Coaxial Feed: The Coaxial feed or probe feed is a very common technique used for feeding Micro strip patch antennas. As seen from Figure, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane.

Aperture Coupled Feed: In this type of feed technique, the radiating patch and the micro strip feed line are separated by the ground plane as shown in Figure. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane.

Proximity Coupled Feed: This type of feed technique is also called as the electromagnetic coupling scheme. As shown in Figure, two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth, due to overall increase in the thickness of the micro strip patch antenna

II.SYSTEM MODEL

Transmission Line Model: The structure is considered as a transmission line along the line joining the radiating aperture loaded by impedances at its radiating edges. The radiating wall may be characterized by an equivalent admittance, the susceptance being due to the fringing field and the conductance due to radiation loss.

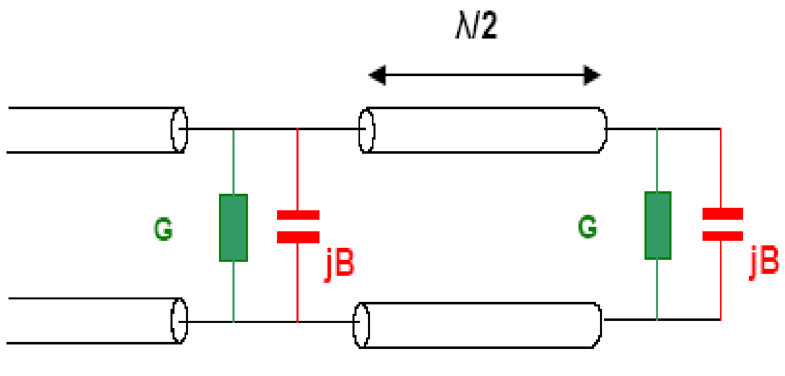

Figure.2: Diagram of Transmission line model

Design Procedure
By using below mentioned formulas we are calculating the patch length, width, effective length, effective dielectric constant etc.

A. WIDTH OF METALLIC PATCH (W)

$$W = \frac{c}{2 f_o \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where,
c = free space velocity of light
ε_r = Dielectric constant of substrate
The effective dielectric constant of the microstrip antenna to account for fringing field is calculated from:

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$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

B. LENGTH OF METALLIC PATCH (L)

$$L = L_{eff} - 2\Delta L\,,$$

Where

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_{reff}}}$$

C. CALCULATION OF LENGTH EXTENSION

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

$$\in eff = \frac{\in r + 1}{2} + \frac{\in r - 1}{2}\left(\frac{1}{\sqrt{1 + \frac{12h}{w}}}\right)$$

Antenna Efficiency: The efficiency can be expressed in terms of equivalent resistance

$$\eta\,\% = (Rr/Rt)*100$$

Bandwidth: The bandwidth may be increased by increasing the inductance of radiator by cutting holes or slots in them or by adding reactive components to improve the match of the radiator to the feed line.

Directivity or Gain: The directivity (D) of antenna can be defined as the ratio of the maximum power density in the main beam to the average radiated power density. The gain is given by:

$$G = \eta D$$

Beam width: The half power beam width is equal to the angular width between directions where the gain decrease by 3dB, or radiated field reduces to half of the maximum value. The half power beamwidth in H and E planes.

III.LITERATURE REVIEW

In June 2015 Paper "Design and Fabrication of E-SLOT Microstrip Patch Antenna for WLAN Application" authors Shailander Singh Khangarot, Gajendra sujediya, Tejpal Jhajharia & Abhishek Kumar design an E slot microstrip patch Antenna for WLAN Application. The design targets the WLAN IEEE 802.11 n frequency band (5.47 GHz) simulated design is working from 5.39 GHz to 5.49 GHz whereas fabricated antenna is working from 5.38 GHz to 5.5 GHz which covers the WLAN frequency band. The E-slot microstrip patch antenna has minimum simulated return loss is -23.574 dB at 5.44GHz whereas after fabrication minimum achieved return loss is -24.007 dB at 5.43 GHz. The simulated 2-D and 3-D Radiation Pattern provides omni directional pattern. The proposed E-slot microstrip patch antenna is very promising for various modern communication applications such as WLAN and in C-band applications

In 2015, Swastika Shaped Microstrip Patch Antenna for ISM Band Applications Author Udit Raithatha,S. Sreenath Kashyap & D. Shivakrishna This paper represents the design of Swastika shaped microstrip patch antenna for Industrial Scientific and Medical (ISM) band applications. The design has four slots as same as Swastika shape into it and it resonates at 2.416 GHz frequency. Feeding method used for this design is Inset feed. Gain, Bandwidth, Return loss, Voltage Standing Wave Ratio (VSWR) and Directivity are investigated.

In 2015 "New Compact Design of Rectangular Slotted Hexagonal Microstrip Patch Antenna" Author Prakalp Mishra, Prashant Yadav, Pankaj Gupta & Shushant Jain. In this paper a HEXAGON shaped Microstrip Patch Antenna has been designed & simulated. The designed antenna operates in the frequency range of 1.45 to 2.62 GHz having the optimum bandwidth.

In 2014 "Rectangular Microstrip Patch Antenna with FSS and Slotted Patch to Enhance Bandwidth at 2.4 Ghz For WLAN Applications" Authors Dharmendra Rishishwar, Laxmi Shrivastava. This paper presents a rectangular microstrip patch antenna with FSS and Slotted patch to enhance bandwidth of 2.4 GHz simple rectangular microstrip

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patch antenna which work on IEEE 802.11b and IEEE 802.11g standard applications. This antenna is mounted on rectangular patch with air gap to enhance bandwidth for WLAN applications.

In 2015 "Dual Band David Fractal Microstrip Patch Antenna for GSM and WiMAX Applications" David fractal microstrip antenna offers good performance in the1.754-1.816 GHz and 3.37-3.415 GHz bands and is suitable for GSM 1800, WiMAX applications. The use of David fractal geometry offers miniaturization of the antenna structure. The proposed first iteration fractal configuration is fabricated and measured results along with simulation results are presented. Good radiation patterns and moderate gain are also obtained.

In 2015 "Gain Enhancement of Microstrip Patch Antenna for WLAN Application using Array configuration" Author Mohit Joshi, Utkarsh Shah Microstrip Antenna (MSA) is a simple radiating structure fabricated on the dielectric substrate with one side radiating patch element and another side ground plane. Microstrip patch antennas are of low weight, low cost, small size compare to other antennas. The limitations of MSA are narrow band, small gain and lower power handling capacity. This paper presents various array configuration of rectangular patch element. Simulation results show that here maximum gain is about 9.8dBi using FR4 substrate.

In 2015 "Design And Analysis Of S-Shaped Microstrip Patch Antenna for Gps Application" author D.Preetha, L. Ashok kumar, R. Logapriya and I.Hemushree In this paper, an S-shaped patch antenna array is designed for GPS application. The antenna array is designed to enhance the overall performance characteristics of a radiating system at 1.6 GHz. Simulation models are developed for S-patch antenna and S-patch antenna array using High Frequency Structure Simulator (HFSS). Finally, a comparison among the developed simulation models is performed and conclusions are extracted.

In 2015 "Design of U-shape microstrip patch antenna at 2.4GHz" Author Rajratan kamble , Pradeep Yadav ,Vijay Umbarkar, Prof. A.A.Trikolikar in these paper we have simulated microstrip patch antenna in U-shape at range of frequency 2.4GHz with the help of HFFS software.in that project we have using 2 material, ones FR4 material and other is copper material.so, in that we have design and simulated microstrip patch antenna at particular range of frequency at 2.4GHz and also calculated the parameter such as return loss, gain, bandwidth, current distribution and VSWR of antenna.

In 2015 "Design and Analysis of Circle head Shape Microstrip Patch Antenna" Author Renuka Baban Singh & Nitin Agarwal in this research work, we have designed the Circle head-shaped slotted patch antenna. Here bandwidth is obtained 40% of the center frequency which is the extremely large than the parasitic patch antenna. A 3D field solver is used to simulate the performance of the proposed antenna by inputting the sizes of the physical structure. Coaxial probe feeding technique is used to feed the antenna.

IV. ADVANTAGES & DISADVANTAGES OF MICROSTRIP ANTENNA

Advantages of Microstrip Antenna

- Light weight, low volume, and thin profile configuration, which can be made conformal.
- Low fabrication cast readily amenable to mass productions.
- Linear and circular polarizations are possible with simple feed.
- Duel frequency and dual-polarization antennas can be easily made.
- No cavity backing is required.
- Can be easily integrated with microwave integrated circuit.
- Feed lines and matching networks can be fabricated simultaneously with the antenna structure.

Disadvantages of Microstrip Antenna

- Large ohmic loss in the feed structure of arrays.
- Most Microstrip antennas radiate into half-space.
- Complex feed structure required for high-performance arrays.
- Polarization purity is difficult to achieve.
- Poor end-fire radiator, except tapered slot antennas.
- Extraneous radiation from feeds and junctions.
- Lower power handling capability.
- Reduced gain and efficiency as well as unacceptably high levels of cross-polarization and mutual coupling within an array environment at high frequencies.
- Excitation of surface waves.

- Microstrip antennas fabricated on a substrate with a high dielectric constant are strongly preferred for easy integration with MMIC RF front-end circuitry.

V.CONCLUSION & FUTURE WORK

The technique for enhancing bandwidth of the microstrip antenna has been proposed and it can be used for WLAN applications as it fully utilizes the entire 2-6 GHz band. Performance has been increased in term of Bandwidth, Gain, Return loss, VSWR, and Directivity as mentioned. Disadvantages such as it increase the height of the microstrip antenna. Therefore, trade-off issues need to be considered in this design the modified antenna not only resonates at two different frequencies but also presents marked Improvement in the bandwidth. The, return loss and VSWR are measured for simple patch antenna and circular patch antenna with different shaped slot. Reasonably good matching of modified antenna with the feed network is obtained for both the resonance frequencies. The designed antennas have been characterized using the commercially available software IE3D. With the help of this we discuss reflection coefficient, transmission coefficient, VSWR, radiation pattern etc. All the designs have the same dielectric constant 4.4, substrate thickness of 1.6 mm and loss tangent of 0.02.

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