

A Review Paper on Rectangular Microstrip Patch Antenna

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Abstract- In this rapid changing world in wireless communication, dual or multiband antenna has been playing a key role for wireless service requirements. Antenna is basically a guiding transitional that is used for radiating or receiving radio waves. Microstrip patch antenna has many advantages like low cost, compact size, simple structure and compatibility with integrated circuitry. It has tremendous applications in military, radar systems, mobile communications, global positioning system (GPS), remote sensing etc. Wireless local area network (WLAN) and Worldwide Interoperability for Microwave Access (WiMAX) have been widely applied in mobile devices such as handheld computers and smart phones. These two techniques have been widely considered as a cost-effective, flexible, reliable and high-speed data connectivity solution, enabling user mobility. This paper presents a literature survey of dual band rectangular patch antenna for WLAN and WiMAX application

figure 1. Microstrip antennas have attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts. A Microstrip device literally means a sandwich of two parallel conducting layers separated by single thin dielectric substrate. The lower conductor is called Ground Plane & the upper conductor is a simple resonant circular/rectangular Patch. The metallic patch (usually Cu or Au) may take many geometries viz. rectangular, circular, triangular, elliptical, helical, ring etc.

I. INTRODUCTION

Wireless communication is the fastest growing field of technology which has captured the attention of social life in the present century. Modern wireless local area networks are implemented in many homes, business centers and campuses. The first well-known antenna experiment was conducted by the Heinrich Rudolf Hertz in 1886, which consisted of the dipole antenna is also called the Hertz (dipole) antenna. Then Guglielmo Marconi developed and commercialized wireless technology by introducing a radiotelegraph system, where he used Monopole antennas (near quarter-wavelength).manuscripts [1]. The concept of microstrip antenna was first proposed by Deschamps in 1953 [2]. However, practical implementation of this concept of microstrip antennas was not achieved until late 1970s, by Munson and Howell [3]. A conventional microstrip antenna in general consists of a conducting patch printed grounded microwave substrate with ground plane below, as shown in

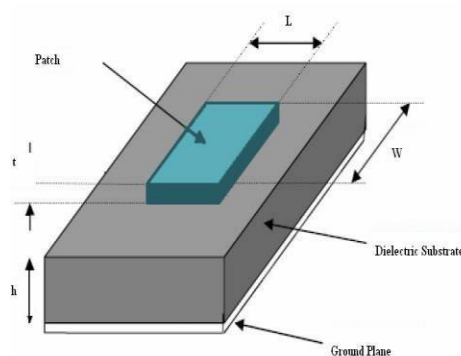


Figure 1. Structure of Microstrip Patch Antenna

The Microstrip patch antenna is commonly excited using a microstrip edge feed or a coaxial probe. The canonical forms of the Microstrip antenna are the rectangular and circular patch MSAs. The rectangular patch antenna is fed using a microstrip edge feed and the circular patch antenna is fed using a coaxial probe. The dielectric substrates used are RT Duroid Bakelite, FR4 Glass Epoxy and Taconic TLC. The height of the substrates is constant i.e., 1.6 mm.

Table I

Properties of different substrates for microstrip patch antenna design

Parameter	RT Durod	Bakelite	FR 4	Taconic
Dielectric constant	2.2	4.78	4.36	3.2
Density	2200kg/m ³	1810kg/m ³	1850kg/m ³	-
Surface resistivity	3×10 ⁷ Mohm	5×10 ¹⁰ Mohm	2×10 ⁵ Mohm	-

II. LITERATURE SURVEY

Antenna is one of the important elements in the RF[1] system for receiving transmitting signals from and into the air as medium. Without proper design of the antenna, the signal generated by the RF system will not be transmitted and no information or signal can be received at the receiver. Antenna design is an active field in communication for future development. Many types of antenna have been designed to suit with

most devices. One of the types of antenna is the micro strip patch antenna (MPA). The microstrip antenna has been said to be the most innovative area in the antenna engineering with its low material cost and easy to fabricate which the process can be made inside universities or research institute. The concept of microstrip antenna with conducting patch on a ground plane separated by dielectric substrate was undeveloped until the revolution in electronic circuit miniaturization and large-scale integration in 1970. In this section, the microstrip antenna literature survey is discussed. Design of stacked miniaturized slotted antenna with[7] enhanced bandwidth for WiMax application has been proposed. In this paper asymmetric U- slot on lower patch and a rectangular slot on upper patch is presented. The aim of this paper is to design smaller size microstrip patch antenna by increasing the path length of the surface current which is obtained by cutting the slot in the radiating patch .It can be observed that antenna well suited for WiMax application in 3.40-3.69 GHz and 5.25-5.85 GHz band. A microstrip E shaped patch antenna has been [8] proposed for wireless application. The antenna is capable of switching its polarization from right hand circular polarization (RHCP) to left hand circular polarization (LHCP) and vice versa. The antenna design exhibits a 7% effective bandwidth with maximum realized gain of 8.7 dBic at 2.45 GHz. A microstrip patch antenna with parasitic ring slot [10] proposed for L band satellite system application. The key feature of the design is employing capacitive- coupled four-probe feeds to increase impedance bandwidth and adopting coplanar parasitic ring slot patch to enhance CP bandwidth. L slotted rectangular microstrip patch antenna has been proposed for wireless system and RF application.[4] Dual frequency operation is achieved by loading two pair of narrow L slots in rectangular patch, parallel to the non radiating edge and better impedance bandwidth is achieved. The impedance bandwidth of 130MHz and 1.45GHz band is obtained in this design. In this paper[13], the different types of broad-banding techniques

have been used to alleviate the narrowband limitation of antenna. Four types of patch antennas have selected and compared with proposed H-shaped patch antenna. The results obtained clearly indicate the main factors that affect the bandwidth of a particular micro strip antenna are thickness of the dielectric substrate, the size of the metallic patch, the dielectric constant of the dielectric substrate, the feed type to be used and the coupling level to some extent. In this paper[14], many techniques are suggested and analyses for rectangular micro strip antenna (RMSA) operating in X-band for 10 GHz center frequency. These approaches are: lowering quality factor, shifting feeding point, using reactive loading and modification of the patch shape. The design of a RMSA is made to several dielectric materials, and the selection is based upon which material gives a better antenna performance with reduced surface wave loss. Duroid 5880 and Quartz are the best materials for proposed design to achieve a **broader Bandwidth (BW)** and better mechanical characteristics than using air. The overall antenna BW for RMSA is increased by 11.6 % with Duroid 5880 with shifted feeding point and with central shorting pin while that for Quartz is 17.4 %.

In this paper[15], different thickness of dielectric substrate ($h = 4, 6$ and 8 mm) are used to increase bandwidth. A rectangular micro strip patch antenna that meets the requirement of operation at (2.4 GHz), the proposed configurations are simulated and analyzed using microwave office 2000 software package. The VSWR, input impedance, radiation patterns and S11 performance are used for the analysis of the different configurations. Feed point on the patch that gives a good match of 50 ohm, input impedance was found by a method of trial and error. For substrate thickness (4mm) the first design antenna had a (155.1) MHz bandwidth (6.46 % of central frequency). Whereas when the thickness as used (6mm), the bandwidth increased to be (200) MHz. In this paper[16], a new design technique for enhancing bandwidth that improves the performance of a conventional micro strip

patch antenna is proposed. This paper presents a novel wideband probe fed inverted slotted micro strip patch antenna. The design adopts contemporary techniques; coaxial probe feeding, inverted patch structure and slotted patch. The composite effect of integrating these techniques and by introducing the proposed patch, offer a low profile, broadband, high gain, and low cross-polarization level. In this paper[17], the performance of a micro strip elliptical patch antenna is investigated using different substrate materials. The Micro strip antenna is studied with different substrates for a radiating elliptical patch of fixed dimensions. The effects of the dielectric constant of the perfect and lossy substrates on the resonant frequency, bandwidth and gain are investigated. A gain drop of 1.3 dB per decade is observed. Return loss, input impedance, radiation patterns and current distributions are investigated and presented with the help of Ansoft-HFSS. Performance evaluation of the micro strip elliptical patch antenna on different substrate materials with permittivity varying from 1.006 to 4.4 is simulated. Bandwidth of 88% achievement obtained in the case of RT-duroid, whereas by using FR4 only 63% is achieved.

In this paper[18], to enhance the impedance bandwidth, a new wideband and small size star shaped patch antenna fed by a small diamond shape patch is proposed. HFSS high frequency simulator is employed to analyze the proposed antenna and simulated results on the return loss, the E- and H-plane radiation patterns and Gain of the proposed antenna are presented at various frequencies. The antenna is able to achieve in the range of 4-8.8 GHz an impedance bandwidth of 81% for return loss of less than -10 dB.

In this paper[19], a dual band rectangular micro strip antenna with parasitic element fed by L-probe is used for band width improvement. The aim of the proposed research is to achieve dual band by electromagnetically coupling the two patches where one is driven and the other is parasitic. An L-shaped probe feeds the driven patch. The impedance bandwidth achieved is

63.35%, centered at 9.981 GHz and 33.48% centered at 13.99 GHz with a return loss >-10 dB. The antenna gain for the operating frequencies within the impedance bandwidth is 6 dBi.

III. FEEDING TECHNIQUES

There are variety of feed technique to microstrip patch antennas. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a microstrip line as a connecting element. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the micro strip line and the radiating patch. The feed of microstrip antenna can have many configurations like microstrip line, coaxial, aperture coupling and proximity coupling. But microstrip line and the coaxial feeds are relatively easier to fabricate. Coaxial probe feed is used because it is easy to use and the input impedance of the coaxial cable in general is 50 ohm. There are several points on the patch which have 50 ohm impedance. We have to find out those points and match them with the input impedance.

Table II
Comparison of the different feeding techniques

Characteristics	Microstrip Line Feed	Coaxial Feed	Aperture coupled Feed	Proximity coupled Feed
Spurious feed radiation	More	More	Less	Minimum
Reliability	Better	Poor due to soldering	Good	Good
Ease of fabrication	Easy	Soldering and drilling needed	Alignment required	Alignment required
Impedance Matching	Easy	Easy	Easy	Easy
Bandwidth (achieved with impedance matching)	2-5%	2-5%	2-5%	13%

IV. PARAMETERS

Different parameter such as VSWR, Return Loss, Antenna Gain, Directivity, Antenna Efficiency and Bandwidth are analyzed

A. Gain

Gain is the parameter which measures the degree of the directivity of the antenna's radiation pattern. It is defined as the ratio of the radiated power P_r to the input power P_i . The input power is transformed into radiated power and surface wave power while a small portion is dissipated due to conductor and dielectric losses of the materials used. Antenna gain can also be specified using the total efficiency instead of the radiation efficiency only. This total efficiency is a combination of the radiation efficiency and efficiency linked to the impedance matching of the antenna. High gain antenna have the advantage of longer range and better signal quality but must be aimed carefully in particular

direction.

B. Radiation Pattern

The radiation pattern is defined as a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates.

C. Antenna Efficiency

It is a ratio of total power radiated by an antenna to the input power of an antenna.

D. VSWR

Voltage standing wave ratio is defined as $VSWR = V_{max}/V_{min}$. It should lie between 1 and 2. VSWR is defined as the ratio of the maximum voltage to the minimum voltage in a standing wave pattern. A standing wave developed when power is reflected from a load. This happens because of improper impedance matching. According to the maximum power transfer theorem, maximum power can be transferred only if the impedance of the transmitter Z_s is match with impedance Z_{in} . Voltage Standing Wave Ratio (VSWR) can be defined as:

$$VSWR = V_{max}/V_{min}$$

E. Return Loss

Return loss is the reflection of signal power from the insertion of a device in a transmission line. Hence the RL is a parameter similar to the VSWR to indicate how well the matching between the transmitter and antenna has taken place. The RL is given as by as:

$$RL = -20 \log_{10} (\Gamma) \text{ dB}$$

For perfect matching between the transmitter and the antenna, $\Gamma = 0$ and $RL = \infty$ which means no

power would be reflected back, whereas a $\Gamma = 1$ has a $RL = 0 \text{ dB}$, which implies that all incident power is reflected. For practical applications, a VSWR of 2 is acceptable, since this corresponds to a RL of -9.54 dB.

V. ANTENNA DESIGN

To design a rectangular microstrip patch antenna following parameters such as dielectric constant (ϵ_r), resonant frequency (f_0), and height (h) are considered for calculating the length and the width of the patch.

Width of Patch (W) :

$$W = \frac{C}{2f_0 \sqrt{\frac{\epsilon_r + 1}{2}}}$$

Effective dielectric constant of antenna (ϵ_{eff}):

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left| \frac{1}{\sqrt{1 + 12 \left(\frac{h}{W}\right)}} \right|$$

Effective Length of antenna:

$$L_{eff} = \frac{C}{2f_0 \sqrt{\epsilon_{eff}}}$$

The extended length of antenna (ΔL):

$$\Delta L = 0.412h \frac{(\epsilon_r + 0.3) \left(\frac{W}{h} + 0.264\right)}{(\epsilon_{eff} - 0.258) \left(\frac{W}{h} + 8\right)}$$

The length of the patch

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

VI. ADVANTAGES AND DISADVANTAGES

Microstrip patch antenna has several advantages over conventional microwave antenna. Also microstrip patch antenna has some disadvantages.

Sr No.	Advantages	Disadvantages
1	Low weight	Low efficiency
2	Low profile	Low gain
3	Thin Profile	Large Ohmic loss in the feed structure of array
4	Required no cavity backing	Low power handling capacity
5	Linear and circular polarization	Excitation of surface waves
6	Capable of dual and triple frequency operation	Polarization purity is difficult to achieved

CONCLUSION

From this review, it is understood that many efforts are going on to overcome some of the limitations of conventional microstrip antenna characteristics. A theoretical survey on microstrip patch antenna is presented in this paper. After study of various research papers it concluded that Lower gain and low power handling capacity can be overcome through an array configuration and slotted patch. Some characteristics of feeding

technique and various antenna parameters are discussed. Particular microstrip patch antenna can be designed for each application and different merits are compared with conventional microwave antenna.

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