A Review Paper on Rectangular Microstrip Patch Antenna

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Abstract. *Because of their smaller size, microstrip patch antennas are more often utilized in current communication equipment than traditional antennas. In order to design an effective, low profile, small, compatible, and affordable microstrip antenna, authors have used a survey of commonly used techniques and designs found in microstrip antenna papers. These techniques are primarily used to design reconfigurable, multiband, and wideband antennas. Following this, a starter patch design with dimensions is provided, along with the technique that will be used to analyses various antenna parameters.*

Keywords:- Microstrip antenna, techniques, wideband, conventional, Directivity, Gain.

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 finure 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) may take many geometrics viz. rectangular, circular, triangular, elliptical, helical, ring etc.

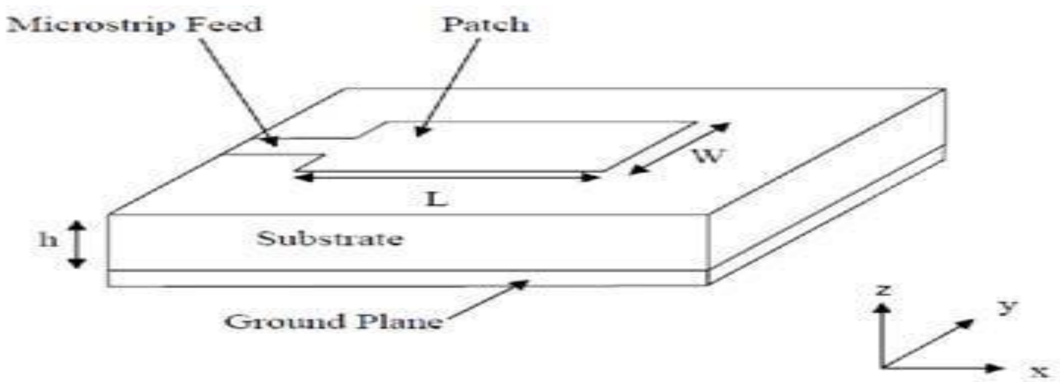

Figure 1: Microstrip Patch Antenna.

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 in is fed using a microstrip edge feed and the circular patch antenna is fed using a coaxial probe. The dielectric substrates used are, FR4 Glass Epoxy and Taconic TLC. The height of the substrates is constant i.e., 1.7 mm.

Table 1: Properties of different substrates for microstrip patch antenna design.

Parameter	RT Duriod	Bakelite	FR 4	Tac onic
Dielectric constant	2.2	4.78	4.3 6	3. 2
Density	2200k g/m 3	1810kg /m3	1850k g/m 3	-
Surface resistivity	3×107 Mohm	5×1010 Mohm	2×105 Mohm	-

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 observe d 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 8.7dBic at 2.41GHz. A microstrip patch antenna with parasitic rings lot[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 then on 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. Glass Epoxy 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 by11.65 %with Duroid 5880 with shifted feeding point and with central shorting pin while that for Quartz is 17.42 %. 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 (2.41 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 (155.11) 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 microstrip 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 An soft-HFSS. Performance evaluation of the micro strip elliptical patch antenna on different substrate materialswithpermittivityvaryingfrom1.006to 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.

Feeding Techniques

Microstrip patch antennas can be fed in a variety of ways. Depending on the approach, these techniques can be both contacting and non-contacting. Using a connecting device like a microstrip line, the RF power is directly delivered to the radiating patch in the contacting approach. Power is transmitted by electromagnetic coupling in the non-contacting manner between the radiating patch and the microstrip line. Although there are many other feed mechanisms, the four most often utilised ones are proximity coupling, aperture coupling, coaxial probe (both contacting schemes), and microstrip line (both non-contacting systems).

Table 2: 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%

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 Pr to the input power Pi. 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=Vmax/Vmin.Itshouldliebetween1and
2. VSWR is defined as the ratio of the maximum voltage to the minimum voltage in a stading 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 Zs is match with impedance Zin. 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: $RL=-20\log 10(\Gamma)$ 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 $RL = 0$ 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.

Antenna Design

To design a rectangular microstrip patch antenna following parameters such as dielectric constant (€r), resonant frequency (fo), and height (h) are considered for calculating the length and the width of the patch.
Width of Patch(W):

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$$W=\frac{c}{2f_0\sqrt{\frac{(\varepsilon_r+1)}{2}}}$$

Effective dielectric constant of antenna (€reff):

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

Effective Length of antenna:

$$L_{eff}=\frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

The extended length of antenna (ΔL):

$$\Delta L=0.412h\frac{(\varepsilon_r+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{eff}-0.258)(\frac{W}{h}+8)}$$

Therefore the length of the patch

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

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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