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An Approach of Microstrip Patch Antenna for WLAN and WiMAX-A Review Application

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Abstract

In this fast growing world, dual and multiple band antennas have been playing a very vital role for the wireless service needs in the field of wireless communication. WLAN and WiMAX are the techniques that are broadly used in mobile networks such as handheld computers and smart phones. The above techniques are considered extensively worldwide as a cost-effective, flexible, reliable and high speed data connection that enables user mobility. For the application of WLAN and WiMAX, a rectangular microstrip patch antenna (MPA) of dual band consisting of wide variety of substrates, feeding techniques and slots is dealt in this paper. Here, we will also discuss about the basics of microstrip antenna with various feeding techniques, antenna parameters and design model along with advantages and disadvantages.

Keywords: electromagnetic waves, microstrip patch antenna, WiMax, WLAN

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INTRODUCTION

In recent years, the studies of microstrip antennas have made a great development. When it is related to the conventional type antennas, these microstrip antennas have more benefits and a better future. In this growth and development, WLAN and WiMAX are the two main standards. To make all these wireless applications successful, we require an efficient and mini antennas as this wireless technology is becoming a very crucial in our daily life. This being the cause, along with the increase in mobile and cellular technologies there is also a growth in the portable antenna technology. Microstrip antennas are better suited for the WLAN and WiMAX application systems because they have the features like low cost and profile. Basically a microstrip antenna consists of a dielectric substrate, where radiating patch is present on one side and other side consists of a ground plane. The overview of microstrip antenna is shown in Figure 1. Generally, the patch is assumed to be of any shape and it is made up of conducting materials like gold or copper, this is shown in Figure 2. Upon the dielectric substrate we have both radiating patch and feed lines usually being photo etched. The electromagnetic (EM) waves fringing off from the top patch into the substrate gets reflected from the ground plane and then is radiated out into the air. For the better performance of the antenna a very thick dielectric substrate of less dielectric constant is considered, as it provides a good efficiency, larger bandwidth and enhances the radiation pattern (Table 1).

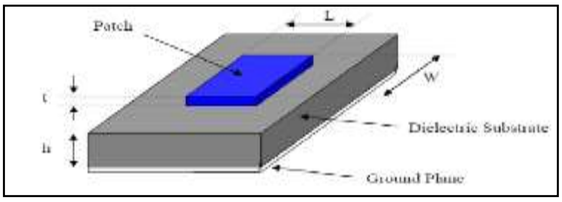

Fig. 1. *Structure of Microstrip Patch Antenna.*

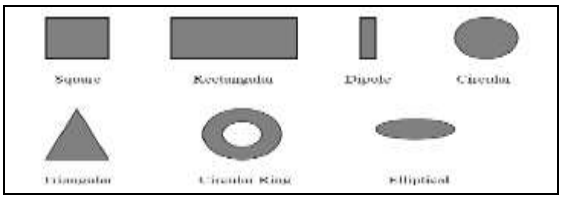

Fig. 2. *Common Shapes of Microstrip Patch Elements.*

Some of the most commonly used dielectric substrates are as follows: RT Duroid Bakelite, RO4003, Taconic TLC and FR4 Glass Epoxy. The height of the substrates is maintained constant i.e., 1.6 mm.

Table 1. *Properties of Various Substrates Required for Microstrip Antenna Design*

Parameter	Bakelite	FR4	RO4003	Taconic	RT Duroid
Dielectric constant	4.78	4.36	3.4	3.2	3.2
Loss tangent	0.03045	0.013	0.002	0.002	0.0004
Water absorption (%)	0.5–1.3	<0.25	0.06	<0.02	0.02
Tensile strength (MPa)	60	<310	141	–	450
Surface resistivity (MΩ)	5*10^10	2*10^5	4.2*10^9	1*10^7	3*10^7
Breakdown voltage (KV)	20–28	55	–	–	>60
Peel strength (N/nm)	–	9	1.05	12	5.5
Density (kg/m^3)	1810	1850	1790	–	2200

LITERATURE SURVEY

Until 1970, the concept of microstrip antenna having conducting patch on the ground plane which is separated by a dielectric substrate was not developed until the revolutionary change in the electronic circuit miniaturization and large-scale integration. Later many researchers have elaborated radiations from the ground plane of various dielectric constants. The work done by Munson in the past regarding microstrip antennas was used as a low profile level antennas placed on rockets and missiles has proved the applied idea for the use in other antenna system problems. Large numbers of mathematical models have been developed regarding for this antenna and its applications are further extended to various fields. At present, microstrip antennas are considered to be the designer’s choice. Now, the literature survey is been discussed in this section.

For the purpose of wireless local area network applications and microwave usage, a double L-slot microstrip antenna[1] array along with a CPW feeding technology is been suggested. The paper discussed here will result in the reduced antenna size with good unidirectional radiation characteristics for the suggested operating frequencies. The peak gain can be greater than 3 dBi at 3.5 GHz can be observed here.

It is been suggested that for dual a band WLAN application a microstrip antenna[2] is used. For a WLAN system, an L-shaped microstrip patch antenna of dual band is considered and FR-4 substrate is printed on it and this is been discussed in this paper. Its frequency ranges from 5 to 6 GHz having a maximum gain of 8.4 and 7.1 dB for minimum and maximum frequency bands, respectively.

Here, a microstrip slot antenna[3] that is fed by a microstrip line is suggested in this paper. The bandwidth of the antenna is improved and is used for WLAN and satellite applications.

For WLAN and WiMAX applications a broadband patch antenna is proposed for its development and exhibits a wideband features that depends upon variety of parameters like U-slot dimensions, circular probe-fed patch. This broadband patch antenna shows 36.2% impedance bandwidth and it as antenna efficiency more than 90%. It is suitable only for 2.3/2.5 GHz WiMAX and 2.4 GHz WLAN applications.[4]

For these two applications (WLAN and WiMAX) a dual wideband printed antenna[5] is been suggested. Here, a microstrip feed line is used for excitation and also a trapezoidal conductor is used as a backed plane for widening the band. The 10 dB bandwidth is measured for return loss and it is from 2.01 to 4.27 GHz and 5.06 to 6.79 GHz. It covers all 2.4/5.2/5.8 GHz WLAN bands and 2.5/3.5/5.5 GHz WiMAX bands.

Various feeding techniques are been described in this paper.[6] Here, a circular polarized patch antenna of which is in the shape that is similar to the alphabet "I" on FR4 substrate that is used for Bluetooth applications is been discovered.

Without including any additional matching elements, the paper discussed here, regarding the line and patch of a microstrip antenna has a very good impedance matching condition (Table 2). A reduced rectangular patch antenna[7] is been used for the WiMAX and WLAN application. The antenna used here is small, cost effective, normal structure and is suitable for all types of frequency bands of WiMAX and WLAN applications.

FEEDING TECHNIQUES

A feed is generally used to radiate by direct or indirect contact. In microstrip antenna the feed can have various configurations such as proximity coupling, coaxial, aperture coupling and microstrip line. Among these configurations, microstrip line and the coaxial feeds are comparatively easier to fabricate. Out of these two configurations, coaxial probe feed is used popularly as it is easy for usage and its input impedance is in the order of 50 Ω. There are many points on the patch that have 50 Ω impedance. Now, we have to find out those patch points and correlate it to input impedance. The points are found out through a mathematical model.

Table 2. *Comparison of Various Feeding Techniques*

Characteristics	Microstrip Line Feed	Coaxial Feed	Aperture Feed	Proximity-Coupled Feed
Spurious feed radiation	More	More	Less	Minimum
Reliability	Better	Poor due to soldering	Good	Good
Impedance matching	Easy	Easy	Easy	Easy
Bandwidth (%)	2–5	2–5	2.50	13
Easy of fabrication	Easy	Soldering and drilling needed	Alignment required	Alignment required

ANTENNA PARAMETERS

Various parameters such as antenna gain, antenna efficiency, voltage standing wave ratio (VSWR), return loss, directivity, and bandwidth have been discussed here.

i. Antenna gain

Antenna gain is usually defined as the ratio between the radiation intensity, in a specific direction to the intensity that is calculated when the power received by the antenna is radiated isotropically.

$G = 4\pi.U(\theta,\Phi) /Pin,$

where U(θ,Φ) is the radiation intensity in a specific direction,
Pin is input power.

ii. Radiation pattern

Radiation pattern is defined as portraying the radiation properties of the antenna which are the functions of space coordinates.

iii. Antenna efficiency

Antenna efficiency is defined as the ratio of total power that is radiated by the antenna to its input power.

iv. VSWR

VSWR is defined as the ratio of maximum voltage to its minimum voltage and its value ranges between 1 and 2.

VSWR = V_{max}/V_{min}

v. Return loss

Return loss is defined as the reflection of the power from the insertion of the device in a transmission line. It is similar to the VSWR to show how better the matching between the transmitter and antenna is taking place.

The equation for RL is given by, RL = −20 log10 (Γ) dB

For the perfect match between the transmitter and the antenna, Γ = 0 and RL = ∞, it means that no power will be reflected back, whereas if Γ = 1 has an RL = 0 dB, means that all incident power is reflected. For all practical applications, a VSWR of 2 is acceptable, as it corresponds to the RL of −9.54 dB.

ANTENNA DESIGN

For designing a rectangular microstrip patch antenna following are the parameters [such as dielectric constant (€r), resonant frequency (fo), and height (h)] that are to be considered for calculating length and patch width (Table 3).

Width of Patch (w)

$W = c2fo\ \varepsilon r+12$

Effective Dielectric Constant of Antenna (€reff)

$\varepsilon reff = \varepsilon r+12+\varepsilon r-12\ 1+12hw\ -1/2$

Effective Electrical Length of Antenna

$Leff = c2fo\ \varepsilon reff$

Extended Length of Antenna (ΔL)

$\Delta Lh = 0.412\ \ \varepsilon reff+0.3\ \ (wh+0.264)\ \varepsilon reff-0.258\ (wh+0.8)$

Length of the Patch

$L = Leff-2\Delta L$

Table 3. *Patch Antenna Advantages and Disadvantages.*

S No	Advantages	Disadvantages
1	Needs no cavity backing	Obligates a low power handling capacity
2	Proficient of dual and triple frequency operation	Polarization purity is hard to attain
3	Both feed lines and matched network is fabricated in parallel	Complex feed structure needs high performance arrays
4	Less profile	Less gain
5	Thin profile	Large Ohmic loss is present in the feed structure of arrays
6	Less weight	Less efficiency
7	Linear and circular polarization	Excitation of surface wave

CONCLUSION

Here in this paper, a theoretical study on microstrip patch antennas is been presented. By referring many research papers, we can conclude stating that lower gain and less power handling capacity can overcome an array configuration and slotted patch. Few characteristics of feeding technique and many more antenna parameters are discussed. In specific, microstrip patch antenna can be designed for every application and varieties of merits are compared with conventional microwave antenna.

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