RESEARCH ARTICLE OPEN ACCESS

Review of Microstrip Patch Antenna for WLAN and WiMAX Application

Neha Parmar[#], Manish Saxena[#], Krishnkant Nayak[#]
[#]Bansal Institute of Science and Technology, Bhopal

ABSTRACT
In this rapid changing world in wireless communication, dual or multiband antenna has been playing a key role for wireless service requirements. 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 with variety of substrate, feed techniques and slots. In this paper we also discuss the basics of microstrip antenna, various feeding techniques, design model and antenna parameters with their advantage and disadvantages.
Keywords- Microstrip antenna, feed techniques, Dielectric, Patch width, Patch Length.

I. INTRODUCTION

The study on microstrip patch antennas has made a great progress in the recent years. Compared with the conventional antennas, microstrip patch antennas have more advantages and better prospects. In this era of next generation networks we require high data rate and size of devices are getting smaller day by day. In this evolution two important standards are Wi-Fi (WLAN) and Wi-MAX. For success of all these wireless applications we need efficient and small antenna as wireless is getting more and more important in our life. This being the case, portable antenna technology has grown along with mobile and cellular technologies. Microstrip antennas (MSA) have characteristics like low cost and low profile which proves Microstrip antennas (MSA) to be well suited for WLAN/Wi MAX application systems.

A Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side and overview of MSA shown in fig 1. The patch is generally made of conducting material such as copper or gold and can take any possible shape shown in fig 2. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. The EM waves fringing off the top patch into the substrate and are radiated out into the air after reflecting off the ground plane. For better antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation.

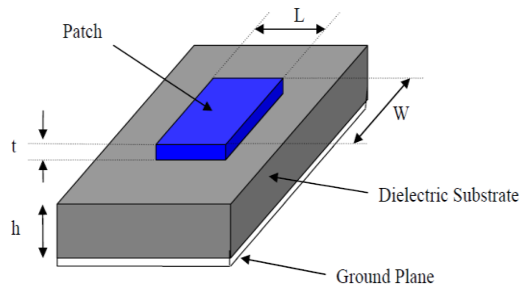

Figure 1 Structure of a Microstrip Patch Antenna

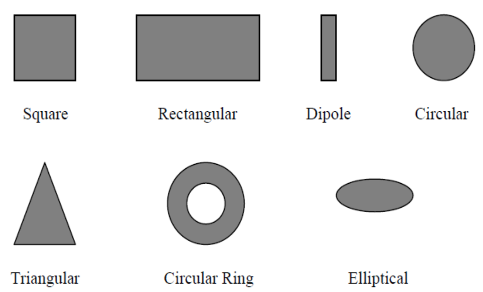

Figure 2 Common shapes of microstrip patch elements

The dielectric substrates used are Bakelite, FR4 Glass Epoxy, RO4003, Taconic TLC and RT Duroid. The height of the substrates is constant i.e., 1.6 mm.

Table 1 Properties of different substrates for microstrip patch antenna design

Parameter	Bakelite	FR4	RO4003	Taconic	RT Duriod
Dielectric constant	4.78	4.36	3.4	3.2	2.2
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	60MPa	<310MPa	141MPa	-	450MPa
Volume Resistivity	3×10^{15} Mohm.cm	8×10^{7} Mohm.cm	1700×10^{7} Mohm.cm	1×10^{7} Mohm.cm	2×10^{7} Mohm.cm
Surface resistivity	5×10^{10} Mohm	2×10^{5} Mohm	4.2×10^{9} Mohm	1×10^{7} Mohm	3×10^{7} Mohm
Breakdown voltage	20-28 kv	55 kv	-	-	>60kv
Peel Strength	-	9N/nm	1.05N/nm	12N/nm	5.5N/nm
Density	1810kg/m^3	1850kg/m^3	1790kg/m^3	-	2200kg/m^3

II. LITERATURE SURVEY

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. After that many researcher have described the radiation from the ground plane by a dielectric substrate for different configurations. The early work of Munson on micro strip antennas for use as a low profile flush mounted antennas on rockets and missiles showed that this was a practical concept for use in many antenna system problems. Various mathematical analysis models were developed for this antenna and its applications were extended to many other fields. The micro strip antennas are the present day antenna designer's choice. In this section, the microstrip antenna literature survey is discussed.

A double L-slot microstrip patch antenna [1] array with CPW feed technology has been proposed for microwave access and wireless local area network applications. This paper results in compact antenna with good omnidirectional radiation characteristics for proposed operating frequencies. It can be observed that the peak gain can be higher than 3dBi at 3.5 GHz.

A microstrip patch antenna [2] for dual band WLAN application is proposed. In the paper a dual band L-shaped Microstrip patch antenna is printed on a FR-4 substrate for WLAN systems, and achieves a frequency range from 5.0GHz to 6.0 GHz with maximum gain of 8.4 and 7.1 dB in lower and higher frequency bands respectively.

A microstrip slot antenna [3] fed by a microstrip line has been proposed in this paper. In this bandwidth of antenna has been improved. This antenna was presented for WLAN and satellite application.

A Broadband patch antenna [4] for WiMAX and WLAN is developed. In this proposed antenna exhibits wideband characteristics that depend on various parameters such as U-slot dimensions, circular probe –fed patch. This antenna shows 36.2% impedance bandwidth with more than 90% antenna efficiency and is suitable for 2.3/2.5GHz WiMAX and 2.4 GHz WLAN application.

A dual Wideband printed antenna[5] is proposed for WLAN/WiMAX application. A microstrip feedline for excitation and a trapezoidal conductor- backed plane used for band broadening. The measured 10dB bandwidth for return loss is from 2.01 to 4.27 GHz and 5.06 to 6.79 GHz , covering all the 2.4/5.2/5.8 GHz WLAN bands and 2.5/3.5/5.5 GHz WiMAX bands.

This paper [6] has been proposed for describing various feeding techniques. In this a circular polarized patch antenna of shape similar to alphabet 'I' on FR4 substrate for BLUETOOTH applications has been investigated. This paper describes a good impedance matching condition between the line and the patch without any additional matching elements.

A compact rectangular patch antenna [7] has been presented for Wi-MAX and WLAN application. This antenna has compact, cost effective, simple structure and suitable for all frequency bands of Wi-MAX and WLAN applications.

III. FEEDING TECHNIQUES

A feed is used to excite to radiate by direct or indirect contact. 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. These points are find out through a mathematical model

Table 2: comparing the different feeding techniques

Characteristics	Micro strip line	Coaaxial feed	Aperture coupled	Proximity coupled

	feed		**feed**	**feed**
Spurious feed radiation	more	More	Less	Minimum
Reliability	Better	Poor due to soldering	Good	Good
Easy of fabrication	Easy	Soldering and drilling needed	Alignmen t requried	Alignment required
Impedance matching	Easy	Easy	Easy	Easy
Bandwidth	2-5%	2-5%	2-5%	13%

IV. ANTENNA PARAMETERS

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

(a) Gain

The gain of an antenna is defined as the ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically. Formula for gain is G=4π.U(θ,Φ) /Pin, where, U(θ,Φ) is a intensity in a given direction, Pin is input power.

(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.It should lie between 1 and 2.

(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, Γ = 0 and *RL* = ∞ which means no power would be reflected back, whereas a Γ = 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):

$$W=\frac{c}{2fo\sqrt{\frac{\varepsilon r+1}{2}}}$$

Effective dielectric constant of antenna (€reff):

$$\varepsilon reff=\frac{\varepsilon r+1}{2}+\frac{\varepsilon r-1}{2}\left[1+12\frac{h}{w}\right]^{-1/2}$$

Effective electrical length of antenna:

$$Leff=\frac{c}{2fo\sqrt{\varepsilon reff}}$$

The extended length of antenna (ΔL):

$$\frac{\Delta L}{h}=\frac{0.412(\varepsilon reff+0.3)(\frac{w}{h}+0.264)}{(\varepsilon reff-0.258)(\frac{w}{h}+0.8)}$$

The length of the patch is:

$$L=Leff-2\Delta L$$

V. ADVANTAGE AND DISADVANTAGE

Microstrip patch antenna has several advantages over conventional microwave antenna with one similarity of frequency range from 100 MHz to 100 GHz same in both type. The various advantage and disadvantage are given in table 3.

Table 3: Advantage and disadvantage of patch antenna

Sr.No.	Advantage	Disadvantage
1	Low weight	Low efficiency
2	Low profile	Low gain
3	Thin profile	Large ohmic loss in the feed structure of arrays
4	Required no cavity backing	Low power handling capacity
5	Linear and circular polarization	Excitation of surface wave
6	Capable of dual and triple frequency operation	Polarization purity is difficult to achieve
7	Feed lines and matching network can be fabricated simultaneously	Complex feed structure required high performance arrays

VI. CONCLUSION

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.

VII. ACKNOWLEDGMENT

I Neha Parmar & Mr. Manish Saxena are thankful to the Chairman, Bansal Institute of Science & Technology Bhopal for giving permission to send the paper for publication. I would also like to thank Mrs. Bhupendra K. shukla(Ph.D* from MANIT, Bhopal) Assistant Professor at sagar institute of research and technology-Excellence, Bhopal for their help and support to provide the basic knowledge and understanding about the Antenna concepts.

REFERENCES

[1] R. Jothi Chitra,V. Nagarajan ,2013. "Double L-slot microstrip patch antenna array for WiMAX and WLAN applications", *IEEE Transactions on Antennas and Propagation*, Vol. 39, pp 1026-1041

[2] Bharath Kelothu, K.R. Subhashini, *IEEE* Transactions 2012."A compact high-gain microstrip patch antenna for dual band WLAN application".

[3] Xu-bao Sun ,Mao-Young Cao, 2012. "A rectangular slot with *Transactions* improved bandwidth", *Elsevier Science Direct*, Vol. 66, pp 465-466.

[4] M A Matin, M.P Saha, H. M. Hasan, 2010 " Design of broadband patch antenna for WiMAX and WLAN", IEEE.

[5] Chien- Yuan Pan, Tzyy-sheng horng, 2007. "Dual wideband printed monopole antenna for WLAN/WiMAX application", IEEE.

[6] Govardhani Immadi, M.S.R.S Tejaswi, 2011. "Design of coaxial fed microstrip patch antenna for 2.4 GHz Bluetooth Applications", *Journal of emerging trends in computing and information sciences*, Vol.2, pp 686-690

[7] Lin Dang, Zhenya Lei, 2010. "A compact microstrip slot Triple-band Antennna for WLAN / WiMAX applications", *IEEE Antennas and Wireless Propagation Letters*, Vol.9, pp 1178-1181.