Review Paper on Microstrip Patch Antenna for Wireless Communication

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Abstract— This paper describes the design of Microstrip Patch Antenna and shows the different feeding techniques that is microstrip feed line and coaxial probe feed. These antennas are designed on a thin dielectric substrate for the application of microstrip antenna. This paper also presents literature survey of dual band and rectangular Patch antenna for wireless Communication and also discusses the basic of microstrip antenna design model and antenna parameter with advantages and disadvantages.

Key words: Antenna, Wireless Communication

I. INTRODUCTION

With the rapid development of Wireless Communication, Personal Communication (PCs), Mobile Satellite Communication, Direct Broadcast Television (DBS), Wireless Local Area Network (WLANs), and Intelligent Vehicle Highway System (IVHs), [1], microstrip antenna has become one of the most popular antenna because it has numerous advantage such as its low weight, small printed circuit technology, led to the design of several configuration for various application. [2].

A microstrip antenna in its simple form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The top and side views of a rectangular MSA (RMSA) are shown in fig. (1). However other shapes, such as the square, circular, triangular, semicircular, sectoral and annular ring shapes shown in fig. (2). Are also used [2]. 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. For better antenna performance, a thick dielectric substrate having dielectric constant is desirable since this provides better efficiency, large band width and better radiation. [3].

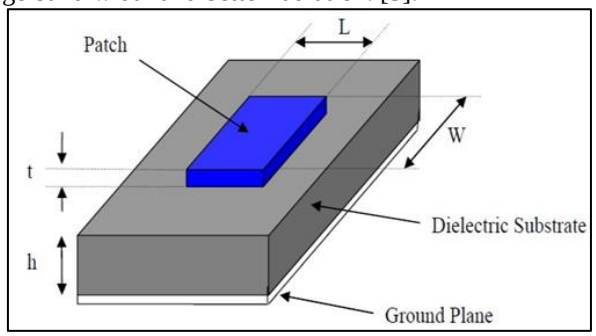

Fig. 1: Structure of a Microstrip Patch Antenna

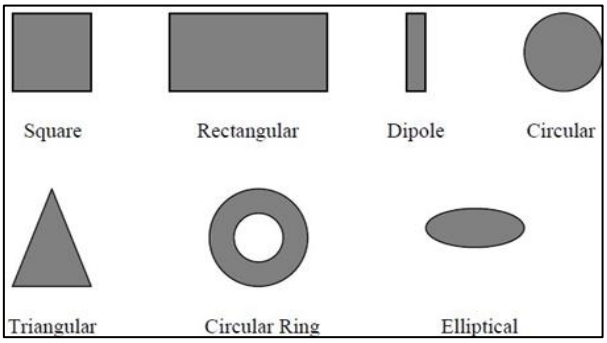

Fig. 2: Common shapes of microstrip patch elements

Dielectric Substrate - 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. [7]

Parameter	Bakelite	FR4	RO4003	Taconic	RT Duroid
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	<310 MPa	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

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

II. LITERATURE SURVEY

In this section, the microstrip antenna literature survey is discussed.

Compound wound – type slot antenna with wide band width [4] has been proposed and designed on a GaAs substrate and fabricated by integrated circuit process. The fabricated antenna has a small size of 6.2×4.1 mm^2 and a wide -10 dB band width of 300 MHz at 5.8 GHz.

Stacked – Patch Dual – polarized antenna for triple Band Hand held terminals [5] for GPs L_1, L_2 and GSM 1800 bands has been proposed. The antenna can operated in three distinct frequency bands with a desired performance through a design optimization. This antenna can work effectively in the mobile and wireless communication products that integrated satellite and terrestrial communication, such as GPs L_1, L_2 and GSM.

Patch Antenna Design Analysis for wireless communication [3] has been analyzed a hexadecimal faced microstrip antenna with slits on the edge. It is simulated in IE3D software. The antenna proposed can be built and measured to compare the real results with those obtained from the simulation as future work. Possible applications of this antenna include RFID, UHF application.

A wideband inset feed microstrip patch antenna [6] has been designed for high – speed wireless communication system. The return loss bandwidth is measured 31.84% below -10dB from 2.07 to 2.861 GHz frequency band. The maximum radiation efficiency is achieved 95%. The proposed geometry is designed using glass epoxy as a dielectric substrate between the ground plane and patch. These features are very useful for portability of wireless communication equipment.

III. Feeding Techniques

The microstrip antenna may be fed in various ways. The feed of microstrip antenna can have many of configurations like microstrip coaxial aperture coupling and proximity coupling [7]. I discuss microstrip line feed and coaxial feed.

Microstrip line – The microstrip line is also a conduction strip, usually much smaller width compared to the patch. The microstrip line is easy to fabricate, simple to match by controlling position and rather simple to mode. However as the substrate thickness increased surface waves and spurious feed radiation increases.

A. Coaxial Probe

It is also called as probe feed where the inner conductor of the coax is attached to the radiation patch while the outer conductor is connected to the ground place. It is easy to adjust input impedance by selecting feed point in the type, but the induction effect dominant is easy to fabricated and match. It has narrow bandwidth and difficult to manufacture, especially for thick substrate.

IV. Antenna Parameters

A. Radiation Pattern

The radiation Pattern or an antenna pattern is a graph of the antenna response as a function of the angle of arrival of the radio signal. The radiation pattern is obtained in the far field region and is represented in terms of directional coordinator.

B. Antenna Gain

The gain of an antenna may be defined as the ration of radio intensity in a given direction to the radiation intensity that would be obtained if the power accepted by antenna were radiated isotropically. The antenna gain can be expressed as

$$G=4\pi.U(\theta, \Phi)/Pin \quad [4.1]$$

Where, U (θ, Φ) is intensity in a given direction, Pin is input power.

C. Directivity

The directivity of an antenna is defined as the ration of radiation intensity in a given direction to average radiation intensity and is given as.

$$D=4\pi.U/P_{rad} \quad [4.2]$$

D. Antenna Efficiency

Antenna efficiency is denoted by 'η' and is defined as the ratio of power radiated by antenna to total input power supplied to antenna i.e.

$$\eta=\text{power radiate}/\text{total input power} = P_r/P_L \quad [4.3]$$

E. VSWR

Voltage standing wave ratio is defined as the ratio of maximum voltage to minimum voltage and given as.

$$VSWR= V_{max} / V_{min} \quad [4.4]$$

F. Return Loss

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

The R_L is given as by as

$$R_L= -20\log_{10}(\Gamma)\ dB. \quad [4.5]$$

V. Antenna Design Model

Following calculations will be taken to design a rectangular microstrip patch antenna.

A. Calculation of Width

The width of patch microstrip patch antenna is

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r+1)}{2}}} \quad [4.6]$$

Calculation of effective dielectric constant (ε_{reff}) –

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \quad [4.7]$$

Calculation of effective length -

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} \quad [4.8]$$

Calculation of the length extension (ΔL) –

$$\Delta L = 0.412h\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad [4.9]$$

Calculation of actual length of Patch (L) –

$$L = L_{eff} - 2\Delta L \quad [4.10]$$

VI. Advantages and Disadvantages

Microstrip patch antenna has several advantages and disadvantages. These are given below in table (2).

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

Table 2: Advantages and Disadvantages of patch antenna

VII. CONCLUSION

A theoretical survey on microstrip patch antenna is presented in this paper. After study of various research papers it concluded that wide bandwidth 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 and wireless communication.

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