Simulation of Micro-Strip Patch Antenna Using HFSS: A Review

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

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], micro-strip 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 micro-strip antenna in its easy form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The top as well as side views of a rectangular MSA (RMSA) are shown in fig.1.1. However other shapes, such as the square, circular, triangular, semi-circular, sectorial and annular ring shapes shown in fig.1.2. 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.1.2. The radiating Patch and the feed lines are typically photo etched on the dielectric substrate. A broad dielectric substrate which having dielectric constant is desirable as this provides improved efficiency, large band with better radiation [3] is done for the better performance.

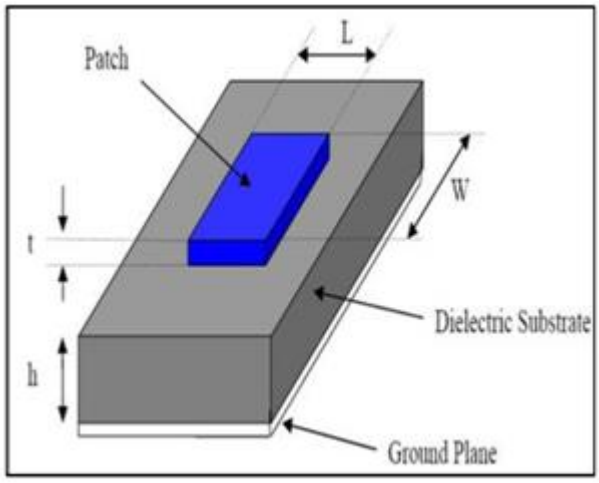

Figure 1.1: Structure of a Micro-strip Patch Antenna

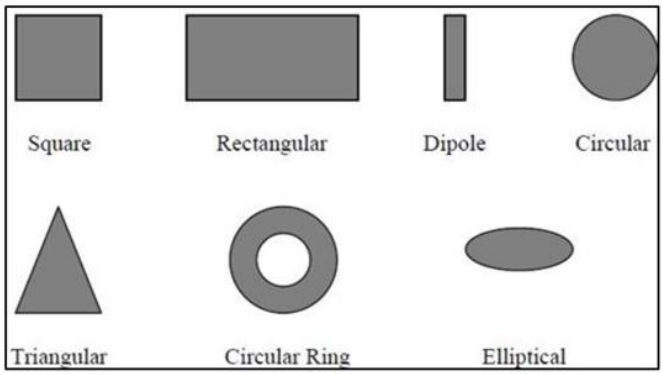

Figure 1.2: Common shapes of micro-strip patch elements

Dielectric Substrate - The dielectric substrates used areBakelite, FR4 Glass Epoxy, RO4003, Taconic TLC and RTDuroid. The height of the substrates is constant i.e., 1.6 mm.[6]

Table 1.1: Properties of different substrates for micro-strip patch antenna design

Parameter	Bakelite	FR4	RO3400	Taiccon	Du RTriod
Dielectric constant	4.78	4.36	3.4	3.2	2.2
Loss tangent	0.03045	0.013	0.002	0.002	0.0400
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	20-28kv	55 kv	-	-	>60kv
Peel Strength	-	9N/nm	1.05N/nm	12N/nm	5.5N/nm
Density	1810kg/m3	1850kg/m3	1790kg/m3	-	2200kg/m3

II. LITERATURE SURVEY

In this section, the micro-strip antenna literature survey is discussed.

Compound wound – type slot antenna with wideband width [4] has been proposed and designed on a Ga As substrate and fabricated by integrated circuit process. The fabricated antenna has a small size of 6.2×4.1 mm2 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 L1, L2 and GSM 1800bands 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 L1, L2 and GSM. Patch Antenna Design Analysis for wireless communication [3] has been analysed a hexadecimal faced micro-strip antenna with slits on the edge. It is simulated in HFSS software. The antenna proposed can be built and measured to compare the real results with those obtained from the simulation as future work.

III. FEEDING TECHNIQUES

The micro-strip antenna may be fed in various ways. The feed of micro-strip antenna can have many of configurations like micro-strip coaxial aperture coupling and proximity coupling [6]. I discuss micro-strip line feed and coaxial feed. *Micro-strip line* – The micro-strip line is also a conduction strip, usually much smaller width compared to the patch. The micro-strip 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

Antenna gain is defined as the ratio of the power created by the antenna from a far-field source on the antenna's beam axis to the power produced by a hypothetical lossless isotropic antenna, which is uniformly sensitive to signals from all directions. Usually this ratio is expressed in decibels, and these units are referred to as "decibels-isotropic" (dBi).

The antenna gain can be expressed as

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

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.

$$D=4\pi.U/Prad \qquad [4.2]$$

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.
η=power radiate/total input power = Pr /PL [4.3]

E. VSWR

Voltage standing wave ratio is defined as the ratio of maximum voltage to minimum voltage and given as. VSWR= Vmax / Vmin [4.4]

F. Return Loss

Return loss is the reflection of signal power from the insertion of a device in a transmission line. Therefore the Return Loss (RL) is a parameter analogous to the VSWR that indicates how well the matching between the transmitter and antenna has taken place. The RL is given as by as

RL= -20log10 (Γ) dB. [4.5]

V. ANTENNA DESIGN MODEL

Following calculations will be taken to design a rectangular micro-strip patch antenna.

A. Calculation of Width

The width of patch micro-strip patch antenna is

$$w = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_\gamma+1)}{2}}} \quad [4.6]$$

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

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

Calculation of effective length –

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}} \quad [4.8]$$

Calculation of the length extension (ΔL) –

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

Calculation of actual length of Patch (L) –

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

VI. ADVANTAGES AND DISADVANTAGES

Micro-strip 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

VII. CONCLUSION

A theoretical analysis on micro-strip patch antenna is obtainable 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. The conventional microwave antenna and wireless communication compared to the different merits with a particular micro-strip patch antenna are designed for each application.

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