International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-3, Issue-1, January 2015

Design and analysis of Rectangular Microstrip Patch Antennas

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***Abstract*— Wireless technology is one of the main areas of research in the world of communication systems today and a study of communication systems is incomplete without an understanding of the operation and fabrication of antennas . In order to meet the miniaturization requirements of portable communication equipment, researchers have given much attention recently to compact microstrip antennas. Many related compact designs with broadband dual-frequency operation, dual polarized radiation, circularly polarized radiation, and enhanced antenna gain have been reported. Many significant advances in improving the inherent narrow operating bandwidth of microstrip antennas have been published in the open literature since 1997The aim of this paper is to design a microstrip patch antenna at 9.5GHz [1]**

***Index Terms*— Wireless, communication, microstrip antennas.**

I. INTRODUCTION

Conventional microstrip antennas in general have a conducting patch printed on a grounded microwave substrate, and have the attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts [1]. However, microstrip antennas inherently have a narrow bandwidth, and bandwidth enhancement is usually demanded for practical applications. In addition, applications in present-day mobile communication systems usually require smaller antenna size in order to meet the miniaturization requirements of mobile units. Thus, size reduction and bandwidth enhancement are becoming major design considerations for practical applications of microstrip antennas. For this reason, studies to achieve compact and broadband operations of microstrip antennas have greatly increased. Much significant progress in the design of compact microstrip antennas with broadband, dual-frequency, dual polarized, circularly polarized, and gain-enhanced operations have been reported over the past several years

II. MICROSTRIP PATCH ANTENNAS

Microstrip antennas consists of a very thin metallic strip(patch) placed a small fraction of a wavelength above a ground plane. The microstrip patch is designed so its pattern maximum is normal to the patch. This is accomplished by properly choosing the mode of excitation beneath the patch. For rectangular patch, the length L of the element is usually $\lambda 0/3 < L < \lambda 0/2$.The strip(patch) and the ground plane are separated by a dielectric sheet(substrate) as shown in figure

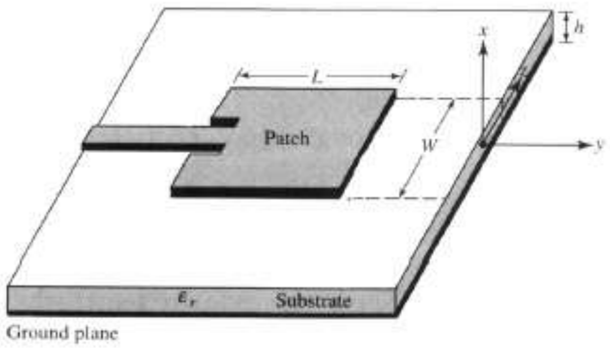

Figure 1: Microstrip antenna

There are numerous substrates that can be used for the design of microstrip antennas, and their dielectric constants are usually in the range of $2.2 \leq \epsilon r \leq 12$.The ones that are most desirable for antenna performance are thick substrates whose dielectric constant is in the lower end of the range because they provide better efficiency, larger bandwidth ,loosly bound fields for radiation into space, but at the expense of larger element size. Thin substrates with higher dielectric constants are desirable for microwave circuitry because they require tightly bound fields to minimize undesired radiation and coupling, and lead to smaller element sizes ;however ,because their greater losses ,they are less efficient and have relatively smaller bandwidths. Since microstrip antennas are often integrated with other microwave circuitry, a compromise has to be reached between good antenna performance and circuit design

III. COMPACT BROADBAND MICROSTRIP ANTENNAS

With a size reduction at a fixed operating frequency, the impedance bandwidth of a microstrip antenna is usually decreased. To obtain an enhanced impedance bandwidth, one can simply increase the antenna's substrate thickness to compensate for the decreased electrical thickness of the substrate due to the lowered operating frequency, or one can use a meandering ground plane or a slotted ground plane These design methods lower the quality factor of compact microstrip antennas and result in an enhanced impedance bandwidth. By embedding suitable slots in a radiating patch, compact operation with an enhanced impedance bandwidth can be obtained. However, the obtained impedance bandwidth for such a design is usually about equal to or less than 2.0 times that of the corresponding conventional microstrip antenna. To achieve a much greater impedance bandwidth with a reduction in antenna size.

Manuscript received January 18, 2015.
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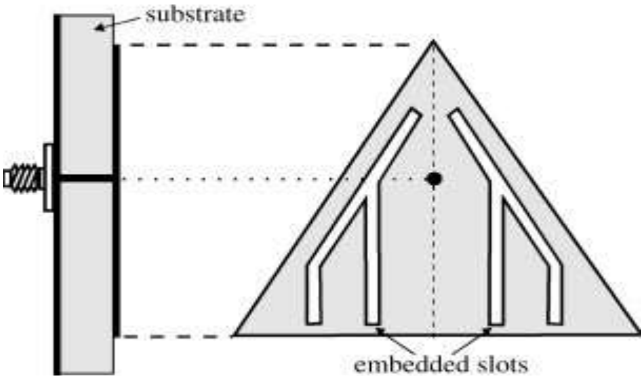

FIGURE 2- Geometry of a probe-fed slotted triangular microstrip antenna for compact broadband operation

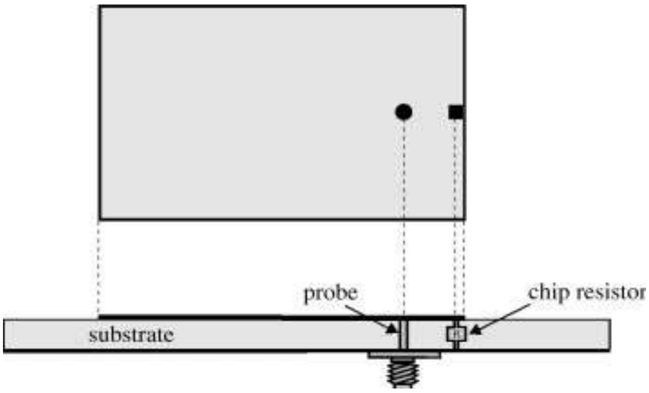

FIGURE 3- Geometry of a compact broadband microstrip antenna with chip-resistor loading.

IV. Design of Rectangular Microstrip Patch Antennas

Based on the simplified formulation a design procedure is outlined which leads to practical designs of rectangular Microstrip antennas. The procedure assumes that the specified information includes the dielectric constant of the substrate (Єr),the resonant frequency(fr), and the height of the substrate h [1].The procedure is as follows:

Specify:

Єr,fr (in Hz), and h

Determine: W,L

Design procedure:

For an efficient radiator practical width that leads to good radiation efficiencies is

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{v_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$$

Determine the effective dielectric constant of the Microstrip antenna

determine the length ΔL using

$$\frac{\Delta L}{h} = \frac{0.412[(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{\left|(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)\right|}$$

The actual length of the patch can now be determined by

$$L = \frac{1}{2f_r\sqrt{\varepsilon_{reff}}\sqrt{\mu_0\varepsilon_0}} - 2\Delta L$$

Antenna Design at 9.5 GHz

IE3D is a software simulator.we can define different antenna parametes with the help of this software [14].As the inset feed-point moves from the edge toward the centre of the patch the resonant frequency also change.

Design parameters for MS antenna at 9.5 GHz

Substrate dielectric constant = 2.2
Height (h) = 1.588 mm
Patch dimensions (L) = 9.06 mm
Patch dimensions (w) = 11.86 mm
Feed Distance = 1.404 mm

V. Simulation Results

Return Loss

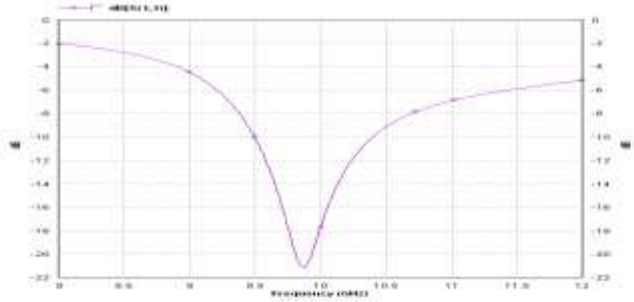
Figure 4 Simulated return loss characteristics at 9.5 GHz

Directivity-is a measure of the concentration of radiation in the direction of the maximum and is easily estimated from the radiation pattern: as a ratio expressed in dB.

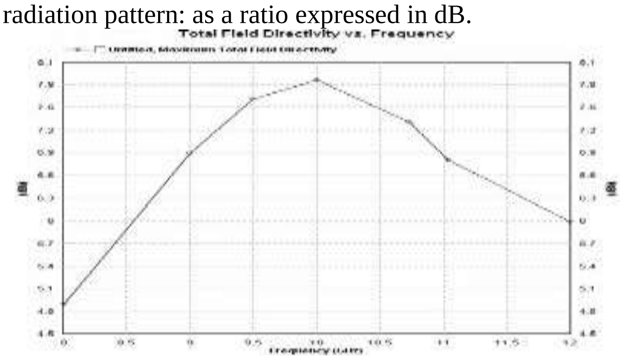

Figure 5- Total Field Directivity Vs frequency characteristics at 9.5 GHz

Gain- on the other hand, must be measured and is related to directivity by an efficiency

factor: as a ratio expressed in Db

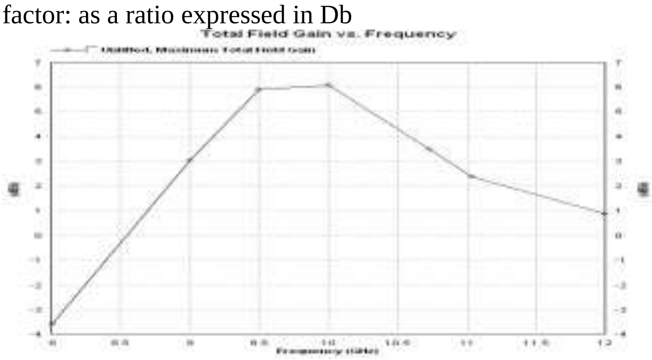

Figure:6- Total Field Gain Vs frequency characteristics at 9.5 GHz

Antenna Efficiency

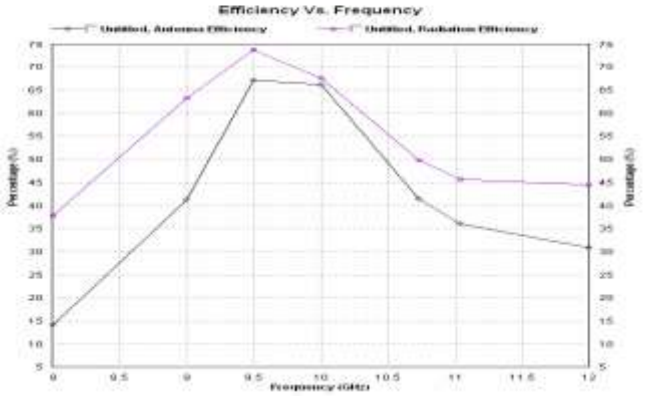

Figure 7 : Efficiency Vs frequency characteristics at 9.5 GHz

VI. Result

it is seen that the bandwidth is improved for Microstrip antenna rather than normal antenna and also the return loss characteristics significantly improved consequently a proper matching occurs

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