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Analysis of A Dual Band Micro strip Antenna

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Abstracts - In modern wireless communication systems and increasing other wireless applications, wider bandwidth, multiband and low profile antennas are in great demand for both commercial and military applications. Since the microstrip antenna has its various advantages like low profile, small size, inexpensive cost and ability to be integrated with VLSI design. The current paper proposes a simple, methodical approach to design a microstrip antenna. Where the antenna behaviors are investigated. Simulation result of this antenna shows a dual band with little wider band width. From the return loss plot, it is concluded that a single antenna has two resonance frequencies, which are at 5.2Ghz and 7.69Ghz. Operating frequency of proposed antenna is 5.2 Ghz. Traditionally, each antenna operates at a single or multi frequency bands, where different antenna is needed for different applications. In addition to the theoretical design procedure, numerical simulation was performed using Methods of Moments and IE3D software.

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I. INTRODUCTION

The first idea to use micro strip antenna began since the beginning of 1950's and design concept introduced by Deschamps. Several years later, Gutton and Baissinot have patented the basic micro strip antenna. It was first published in 1952 by Grieg and Englemann. Figure 1.1 shows the basic structure of micro strip antenna which consists of radiating patch, dielectric substrate and ground plane. Bottom layer of dielectric substrate is fully covered by conductors that act as a ground plane[1]. The thickness of substrate layer can increase the bandwidth and efficiency, but unfortunately it will generate surface wave with low propagation that causes loss of power. There are several approaches to analyze micro strip antenna. Among the favorites are transmission line, cavity model, and full-wave analysis. Transmission line model is the simplest way of analysis and the most precise method for analysis is full-wave model, but it needs to go through a difficult process.

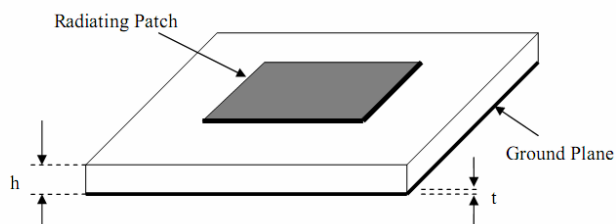


Figure 1.1 : Basic structure of micro strip antenna.

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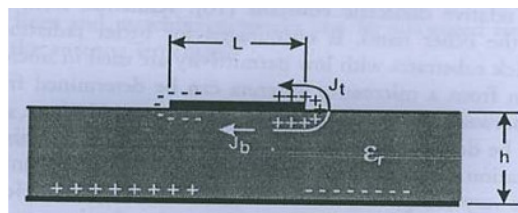


Figure 1.2 : Charge distribution and current density on a micro strip antenna

When a micro strip antenna is connected to a microwave source, it is energized. The charge distribution will establish on the upper and lower surfaces of the patch, as well as on the surface on the ground plane[2]. The positive and negative charge distribution then arises. Micro strip antennas have got high attention because of their good characteristics like :
Light
Cheap

Easily to integrate with other circuit Can be used widely in many applications both in commercial or military. Not needed complicated part.

However there are several weaknesses or disadvantages of using micro strip antennas :

- Narrow bandwidth
- Low gain
- Surface wave excitation
- Low efficiency
- Low power handling capacity

a) Antenna Properties

The performance of the antenna is determined by several factors that are also called antenna properties as follows.

i. Input Impedance

Generally, input impedance is important to determine maximum power transfer between transmission line and the antenna. This transfer only happens when input impedance of antenna and characteristic impedance of the transmission line are matched. Otherwise reflected wave will be generated at the antenna terminal and travel back towards the energy source, reducing system efficiency. The input impedance is given by

$$Z_{in} = Z_0 \left(\frac{1 + S_{11}}{1 - S_{11}} \right)$$

ii. VSWR

Voltage Standing Wave Ratio (VSWR) is the ratio between the maximum voltage and the minimum

voltage along transmission line. The VSWR, which can derive from the level of reflected and incident waves, is also an indication of how closely or efficiently an antenna's terminal input impedance is matched to the characteristic impedance of the transmission line. Increasing in VSWR indicates an increase in the mismatch between the antenna and the transmission line. A decrease VSWR means good matching with minimum VSWR is one. The VSWR is given by:

$$VSWR = \frac{1 + S_{11}}{1 - S_{11}}$$

iii. Bandwidth, BW

The term bandwidth simply defines the frequency range over which an antenna meets a certain set of specification performance criteria. The important issue to consider regarding bandwidth is the performance tradeoffs between all of the performance properties described above. There are two methods for computing an antenna Bandwidth. An antenna is considered broadband if $f_H/f_L \geq 2$. Narrowband by %

$$BW_p = \frac{f_H - f_L}{f_o} \times 100\%$$

Broadband by ratio

$$BW_b = \frac{f_H}{f_L}$$

Where f_o = operating frequency
 f_H = higher cut - off frequency
 f_L = lower cut - off frequency

iv. Polarization

The polarization of an antenna describes the orientation and sense of the radiated wave's electric field vector i.e behavior of electromagnetic wave.

There are three types of basic polarization:

linear polarization
 elliptical polarization
 circular polarization

Generally most antennas radiated with linear or circular polarization. Antennas with linear polarization radiated at the same plane with the direction of the wave propagate. For circular polarization, the antenna must radiate in circular form.

v. Radiation Pattern

The radiation patterns of an antenna provide the information that describes how the antenna directs the energy it radiates. All antennas, if are 100% efficient, will radiate the same total energy for equal input power regardless of pattern shape. Radiation patterns are generally presented on a relative power dB scale. It can

be shown on 360 degree polar plot. Example of radiation pattern is shown in Figure 2.2.1. In many cases, the convention of an E-plane and H-plane pattern is used in the presentation of antenna pattern data. The E-plane is the plane that contains the antenna's radiated electric field potential while the H-plane is the plane that contains the antenna's radiated magnetic field potential. These planes are always orthogonal.

II. ANTENNA DESIGN

In this paper, a microstrip transmission line feeding patch antenna design is presented. This antenna has basic parameters Dielectric Constant, $E_{pr} = 3.2$, operating frequency $f_o = 5.2$ GHz, thickness of substrate $h = 1.57$ mm and loss tangent equal to 0.001. Simulation for the basic patch with transmission line feeding resulted in antenna size of length 15.04mm and width 20.85 mm. Proposed antenna was design using ie3d software.

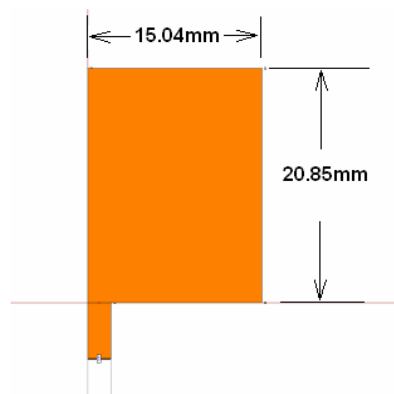


Figure 2 : Microstrip transmission line feed patch antenna.

Figure 2 shows simple patch antenna of transmission line feeding which has resonance $f_o = 5.2$ GHz.

a) Simulation Results

i. Return loss Result

When the basic patch the dimensions as mentioned in Figure2.when the Sierpinski Carpet Antenna is simulated. The simulation results with a feed of 2mm width by 5mm length are as shown by the Figure 2.2.1,

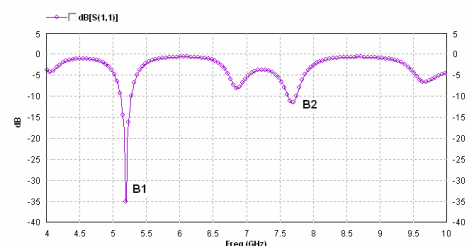


Figure 2.1.1 : Return loss of the patch

Band	f (GHz)	S_{11} (dB)	BW(MHz)	Antenna Efficiency (%)
B1	5.20	- 35.2	173.44	78.41
B2	- 7.69	11.69	146.09	56.36

Table 2.1.1 : Return loss of the patch

There exist two possible frequency bands for operation that have return loss less than 10dB; one centered at 5.2GHz and another at 7.7GHz. The band B2 does not have good return loss but has a quite wide bandwidth below -10dB or VSWR less than 2.

b) Radiation Patterns

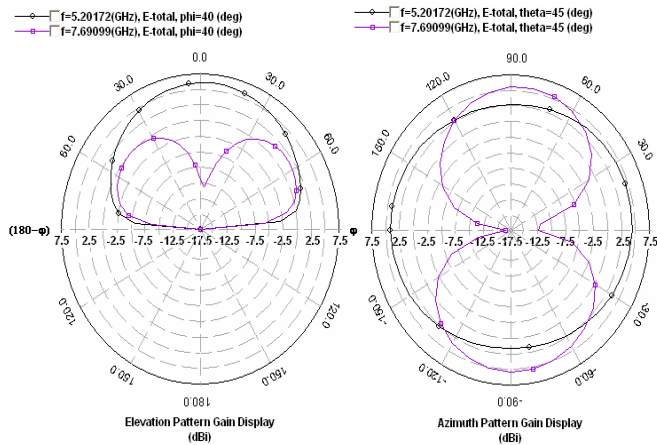


Figure 2.3.1 : Radiation pattern for dual band microstrip antenna at B1 & B2.

III. CONCLUSION

From results and discussions, it can be concluded that: We can define the microstrip antenna with transmission line feed. A single antenna works on two bands as shown in the simulated result. With this property, simulated antenna is called dual band antenna. This work can be extended to the multi-band behavior of the antenna using fractal shape.

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