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SIMULATION AND IMPLEMENTATION OF ELLIPTICAL MICRO STRIP ANTENNA AT 750MHZ

Kiran Rathod, Tushar Tanna, Raj Davda, Paresh Prajapati,

K J Somaiyya College of Engineering, Mumbai, India

kiranrathod@gmail.com,tanna48@gmail.com,raj4kjsieit@gmail.com, ppparesh12@gmail.com

Abstract

In telecommunication industry, several types of antennas are used. The most common of which are the micro strip patch antennas (also known as printed antennas) or patch antenna. Patch antennas can be used in many types of communications links that may have varied requirements. A single patch antenna provides a maximum directive gain of around 6-9 dBi. We can design it to work at multiple frequencies. It is available in various shapes and configuration, most common of which is a rectangular micro strip antenna (RMSA).In this project we are designing single fed annular ring micro stripantenna. The software used to model and simulate the micro strip patch antenna is ZeelandInc's IE3D software. IE3D is a full-wave electromagnetic simulator based on the method of moments. It analyzes 3D and multilayer structures of general shapes. It has been widely used in the design of MICs, RFICs, patch antennas, wire antennas, and other RF/wireless antennas. An evaluation version of the software will be used to obtain the results.

I. Introduction

Microstrip antennas (MSAs) have several advantages, including that they are lightweight and small-volume and that they can be made conformal to the host surface. In addition, MSAs are manufactured using printed-circuit technology, so that mass production can be achieved at a low cost.In high performance aircrafts, spacecrafts, satellites, missiles and other aerospace applications where size, weight, performance, ease of installation and aerodynamics profile are the constraints, a low or flat/conformal profile antenna may be required. In recent years various types of flat profile printed antennas have been developed such as Microstrip antenna (MSA).

MSAs, which are used for defense and commercial applications, are replacing many conventional antennas. However, the types of applications of MSAs are restricted by the antennas' inherently narrow bandwidth (BW). Accordingly, increasing the BW of the MSA has been a primary goal of research in the field. This is reflected in the large number of papers on the subject published in journals and conference proceedings. In fact, several broadband MSA configurations have been reported in the last few decades.

II. Overview

The concept of microstrip radiators was first proposed by Deschamps as early as 1953. The first practical antennas were developed in the early 1970's by Howell and Munson. Since then, extensive research and development of microstrip antennas and arrays, exploiting the new advantages such as light weight, low volume, low cost, low cost, compatible with integrated circuits, etc., have led to the diversified applications and to the establishment of the topic as a separate entity within the broad field of microwave antennas.

III. Working of Microstrip Antenna

The patch acts approximately as a calls on the sides). In a cavity, only certain modes are allowed to exist, at different resonant frequencies. If the antenna is excited at a resonant frequency, a strong field is set up inside the cavity, and a strong current on the bottom surface of the patch. This produces significant radiation (a good antenna).

IV. Feeding Technique

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. As seen from Figure 3.5, the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. However, its major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates ($h > 0.02\lambda_o$). Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems. It is seen above that for a thick dielectric substrate, which provides broad bandwidth, the microstrip line feed and the coaxial feed suffer from numerous disadvantages. The non-contacting feed techniques discussed below, solve these problems.

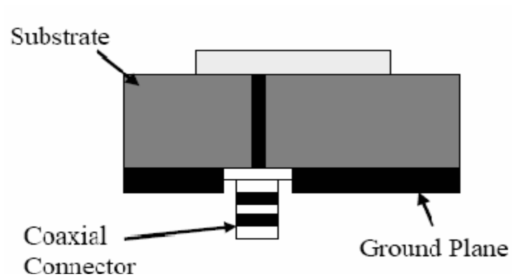

Fig.1 : Block Diagram

a. Design Procedure

The transmission line model described in chapter will be used to design the antenna.

Step 1: Calculation of Major axis (a): The width of the Micro strip patch antenna is given by equation (3.6) as:

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

Substituting c = 3e8 m/s, εr = 4.3and fo = 750 Mhz, we get:

W = 0.122 m = 122.00 mm

Step 2: Calculation of Effective dielectric constant (ε reff): Equation (3.1) gives the effective dielectric constant as:

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

Substituting εr = 4.3 , W = 122.0 mm and h = 1.6 mm we get:

εreff = 4.16

Step 3: Calculation of the Effective length (Leff): Equation (3.4) gives the effective length as:

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

Substituting, c = 3e8 m/s and f o = 750 MHz we get:

L eff = 0.11554 m = 115.54 mm

Step 4: Calculation of the length extension (ΔL): Equation (3.2) gives the length extension as:

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

Substituting εref f = 4.16, W = 122.0 mm and h = 1.6 mm we get:

ΔL = 0.771528 mm

Step 5: Calculation of actual length of patch (L): The actual length is obtained by re-writing equation (3.3) as:

L= Leff −2Δ L

Substituting L eff = 115.54 mm and ΔL = 0.771528 mm

we get: L = 0.114 m = 114.00 mm = 2a

Step 6: Calculation of Minor axis (b): The width of the Micro strip patch antenna is given by equation (3.6) as:

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

Substituting c = 3e8 m/s, εr = 4.3and fo = 900 Mhz, we get:

W = 0.102 m = 102.00 mm

Step 7: Calculation of Effective dielectric constant (ε reff): Equation (3.1) gives the effective dielectric constant as:

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

Substituting εr = 4.3 , W = 122.0 mm and h = 1.6 mm we get:

εreff = 4.15

Step 8: Calculation of the Effective length (Leff): Equation (3.4) gives the effective length as:

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

Substituting, c = 3e8 m/s and f o = 750 MHz we get:

L eff = 0.09543 m = 95.43 mm

Step 9: Calculation of the length extension (ΔL): Equation (3.2) gives the length extension as:

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

Substituting ε_{reff} = 4.15, W = 102.0 mm and h = 1.6 mm we get:

ΔL = 0.7716 mm

Step 10: Calculation of actual length of patch (L): The actual length is obtained by re-writing equation (3.3) as:

$L = L_{eff} - 2\Delta L$

Substituting L_{eff} = 95.43 mm and ΔL = 0.7716 mm

we get: L = 0.093 m = 93.00 mm = 2b

Step 11: Calculation of the ground plane dimensions (L_g and W_g) :

The transmission line model is applicable to infinite ground planes only. However, for practical considerations, it is essential to have a finite ground plane. It has been shown by that similar results for finite and infinite ground plane can be obtained if the size of the ground plane is greater than the patch dimensions by approximately six times the substrate thickness all around the periphery. Hence, for this design, the ground plane dimensions would be given as:

$L_g = 6h + 2a = 6(1.6) + 114.00mm = 123.6$ mm

$W_g = 6h + 2b = 6(1.6) + 93 = 102.6$ mm

Step 12: Determination of feed point location (X_f, Y_f) :

A coaxial probe type feed is to be used in this design. As shown in Figure 4.1, the center of the patch is taken as the origin and the feed point location is given by the co-ordinates (X_f, Y_f) from the origin. The feed point must be located at that point on the patch, where the input impedance is 50 ohms for the resonant frequency. Hence, a trial and error method is used to locate the feed point. For different locations of the feed point, the return loss (R.L) is compared and that feed point is selected where the R.L is most negative. According to there exists a point along the length of the patch where the R.L is minimum. Hence (x_f ,y_f)=(30mm, 28mm)

b. **Radiation Pattern plots**

Since a microstrip patch antenna radiates normal to its patch surface, the elevation pattern for $\varphi = 0$ and $\varphi = 90$ degrees would be important. Figure 4.2 shows the gain of the antenna at 4 GHz for $\varphi = 0$ and $\varphi = 90$ degrees.

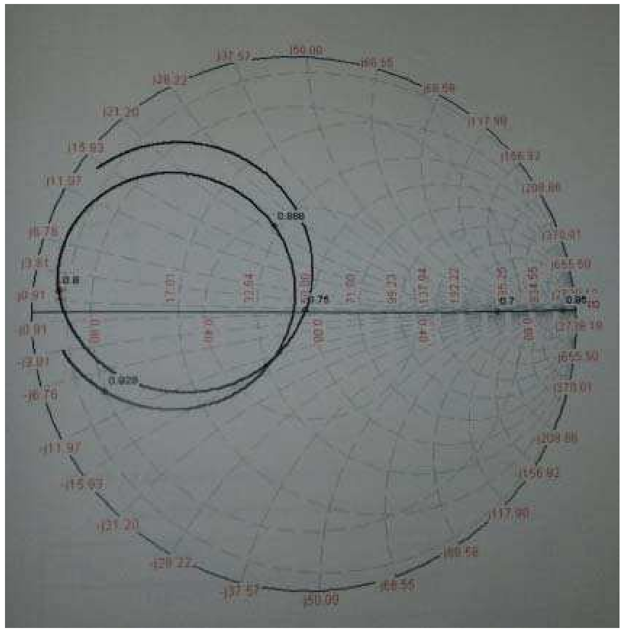

Figure 4.2 Elevation Pattern for Φ = 0 and Φ = 90 degrees

The maximum gain is obtained in the broadside direction and this is measured to be 6.02 dBi for both, Φ = 0 and Φ = 90 degrees.

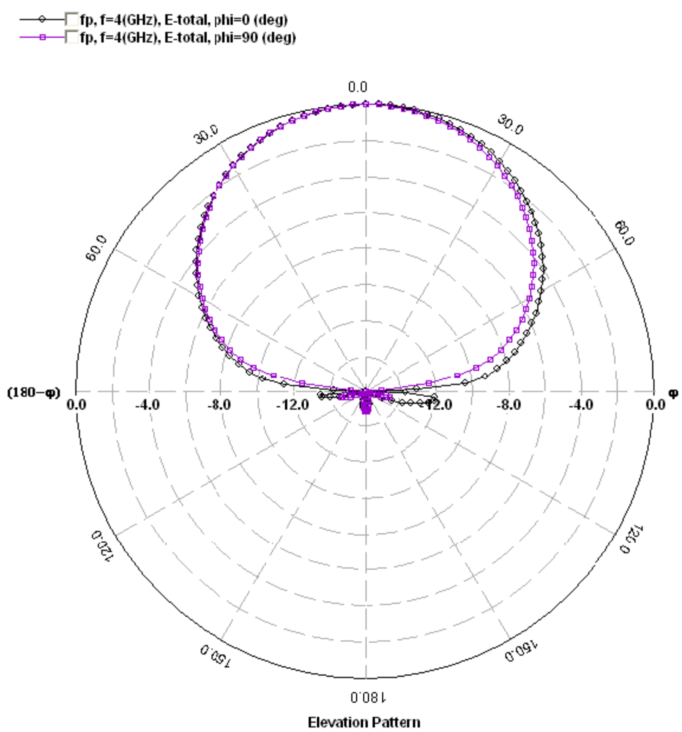

Figure 4.3. Radiation pattern in E-plane and H-plane

The back lobe radiation is sufficiently small and is present due to finite ground plane. The average current distribution in the feed patch is shown in figure 4.4. Figure 4.4. Current distribution in Microstrip antenna

c. 3-D Radiation Pattern

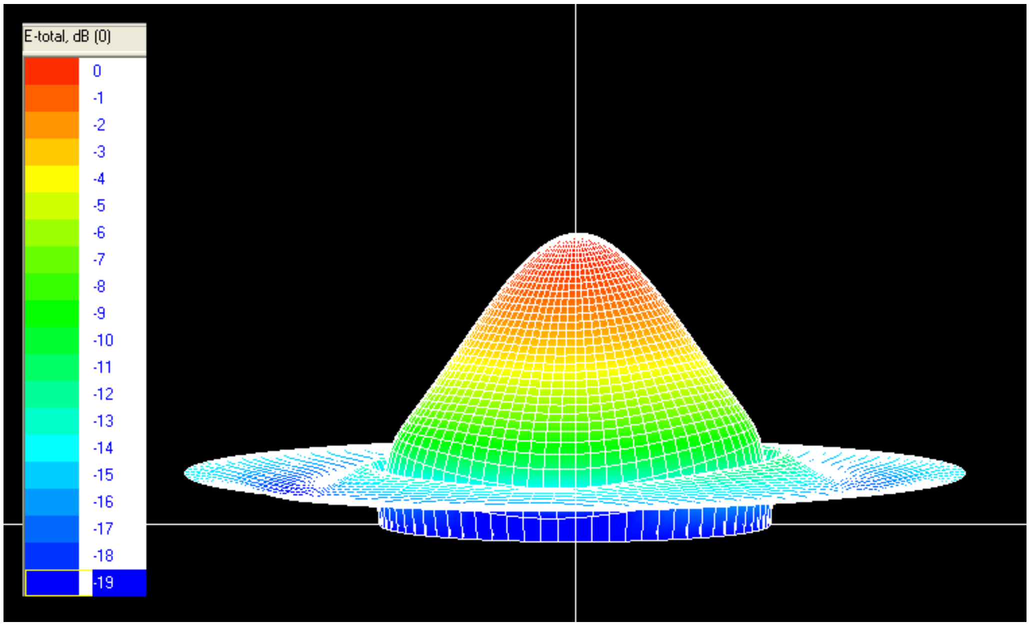

Figure 4.5. 3-D Radiation Pattern Microstrip antenna

V. Information:

Comparison of different feeding technique

Characteristics	Microstrip Line Feed	Coaxial Feed	Aperture coupled Feed	Proximity coupled Feed
Spurious feed radiation	More	More	Less	Minimum
Reliability	Better	Poor due to soldering	Good	Good
Ease of fabrication	Easy	Soldering and drilling needed	Alignment required	Alignment required
Impedance Matching	Easy	Easy	Easy	Easy
Bandwidth (achieved with impedance matching)	2-5%	2-5%	2-5%	13%

VI. Applications

1. Used in telecommunication industry
2. Used in aircrafts and missiles
3. Designed for multiple frequency

4. Due to its excellent frequency response can be used in various field

VII. Scope in Future

The micro strip antenna finds various applications in various important fields. The fact that micro strip antenna is used for planar and non-planar surfaces it can be used extensively in almost all kinds of applications. The major field where the micro strip antenna can be used is aircraft satellites and in missions of celestial bodies. The micro strip also has ability to be fabricated on a PCB which makes it distinctly unique and thus allowing the it to be used in micro-applications as well. The micro strip can be used in high frequency application which also is an added advantage. All these reasons just assert the fact micro strip antenna is "The" antenna for future applications in this technologically advancing world.

VIII. Conclusion:

The results obtained in this study reveal that the elliptical microstrip antenna is suitable for wireless communication. In this paper microstrip antenna for wireless communication have been designed using FR4 substrate.

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