EFFECT OF SUBSTATRE PARAMETERS ON RETURN LOSS AND RADIATION CHARACTERISTICS OF INSET FED ANTENNA

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Abstract Microstrip Line Feed is used in which a conducting strip is connected directly to the edge of the microstrip patch. The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position.

After analysis of result it is concluded that gml 1000 which has a dielectric constant of 3.2 with height 1.5mm of the substrate performs best.It has also been observedKeeping the same substrate and increasing the height of the substrate the antenna size become more compact. The resonant frequency and the value of return loss depend on width of the inset feed and the dimensions of the slot above and below the feed.Also it has been analyzed after number of simulations that an antenna with lower dielectric constant having thicker substrates performs better.

1. Introduction

The ongoing evolution in the field of wireless communication and the future technologies needs a simple, reliable, economical, small, low profile and lightweight antennas for application in mobile and satellite communication, phased array, electronic warfare, radar, missile telemetry, space and airborne microwave remote sensing systems etc. and which are capable of performing efficiently in the wide range of frequencies.Presently there are many government and commercial applications, such as mobile radio and wireless communication that have similar specifications. To meet these requirements microstrip patch antennas can be used.

Microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side. Due to its advantages such as low weight, low profile planar configuration, low fabrication costs and capability to integrate with microwave integrated circuits technology, the microstrip patch antenna is very well suited for applications such as wireless communications system, cellular phones, pagers, Radar systems and satellite communications systems [1, 2, 3]. Several designs have been investigated and reported to decrease the size of the antenna [4] and to improve the bandwidth of the antenna [5, 6].

Feed Techniques

2 Feed Techniques

Microstrip patch antennas can be excited by a variety of methods. These methods can be classified into two categories- contacting method and non-contacting method. In the contacting method, the RF power is fed directly to the radiating patch using a bonding element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch [7]. There are four most popular feed techniques used which are microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

2.1 Microstrip Line Feed

In this type of feed technique, a conducting strip is attached directly to the edge of the microstrip patch as shown in Figure 3.3. The conducting strip has small width as compared to the width of the patch. This kind of feed arrangement has an advantage that the feed can be etched on the same substrate with the patch to provide a planar structure.

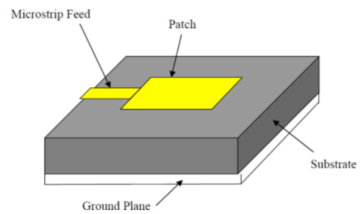


Figure 3.3 Microstrip Line Feed

2.2 Coaxial Feed

The Coaxial feed or probe feed is a very common technique used for feeding microstrip patch antennas. The inner conductor of the coaxial connector extends through the dielectric substrate and is soldered to the radiating patch, while the outer conductor is connected to the ground plane [15] as shown in Figure 3.5.

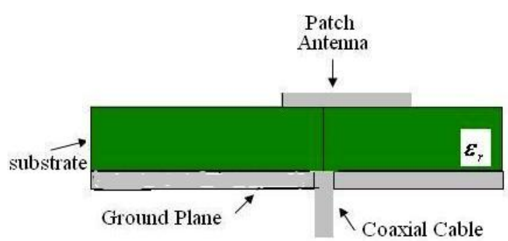


Figure 3.5 Coaxial Feed

2.3 Aperture Coupled Feed

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane as shown in Figure 3.6. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane.

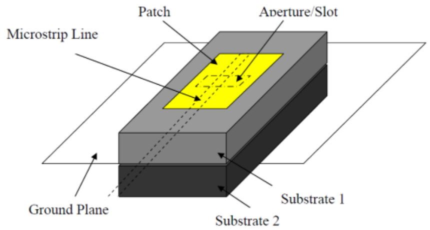


Figure 3.6 Aperture Coupled Feed

2.4 Proximity Coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. As shown in Figure 3.7, two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13%) [7], due to overall increase in the thickness of the microstrip patch antenna. This scheme also provides choices between two different dielectric media, one for the patch and one for the feed line to optimize the individual performances.

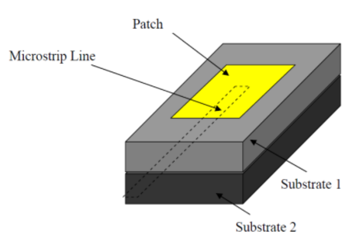
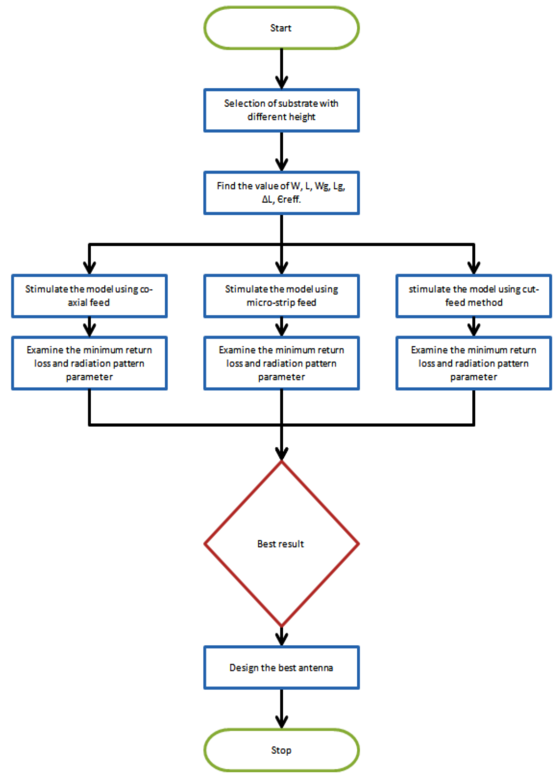


Figure 3.7 Proximity Coupled Feed

3 Effect of Feeding Techniques on the Radiation Characteristics of Patch Antenna

3.1 Concept diagram available related work.



Algorithm:Design Procedure of antennas

Algorithm

Step 1 Select a dielectric material with a substrate height.

Step 2 Calculate the value of W, L, L_{eff}, ΔL, Lg, Wg and ε_{reff}.

Step 3 Simulate the model of the antenna by calculating the parameters in step 2 having coaxial feed.

Step 4 Simulate the model of the antenna by calculating the parameters in step 2 having microstrip line feed.

Step 5 Simulate the model of the antenna by calculating the parameters in step 2 by cut feed method.

Step 6 Analyze the Return loss and radiation pattern of the antenna of different antenna simulated in step 3, step 4, step 5.

Step 7 Finalize the best result which has good radiation pattern parameters and return loss.

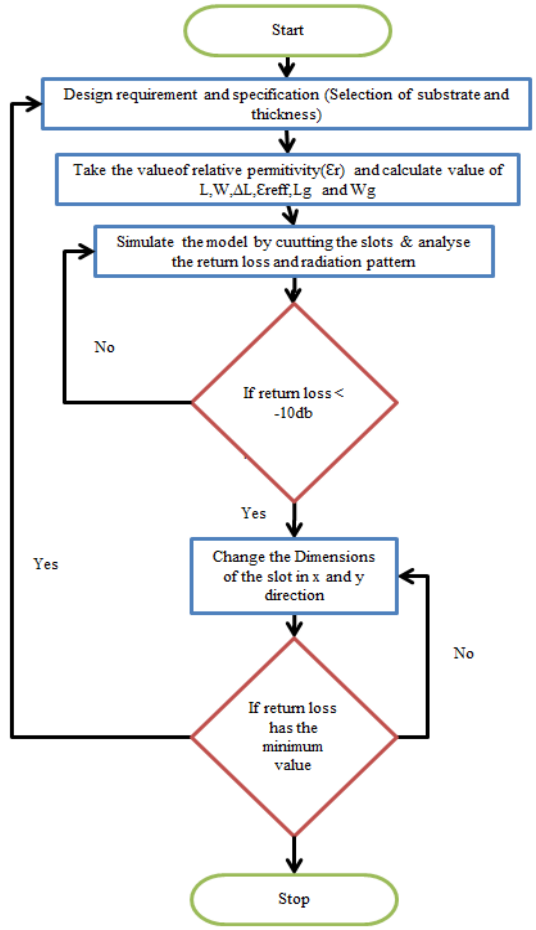
3.3 Comparison of Different Parameters

Parameters	Coaxial	microstrip	Cut
Peak Directivity	6.0168	4.5092	6.1806
Peak Gain	5.7867	4.2914	5.8705
Radiated Power	0.005925	0.008791	0.0093989
Radiation Efficiency	0.96176	0.95171	0.94989
Return Loss	-18.8037	-11.1503	-19.7630

After observing the obtained results and antenna parameters we can clearly say that out of three feed techniques i.e coaxial feed, Microstrip feed and Cut feed, the cut feed is giving efficient results. The gain, directivity are higher on comparing with others.

4 Concept of modified purposed technique

4.1Methodolgy



Algorithm: Design Procedure of proposed antennas

Step 1 Select a dielectric material with a substrate height.

Step 2 Calculate the value of W, L, L_{eff}, ΔL, Lg, Wg and ε_{reff}.

Step 3 Simulate the model of the antenna by calculating the parameters in step 2 having an inset feed.

Step 4 Cut slots above and below the inset feed to get desired results.

Step 5 Analyze the Return loss and radiation pattern of the antenna.

Step 6 Simulate the model by changing slots dimension till the return loss is less than -10 dB.

Step 7 Simulate by changing the dimensions of the inset feed and slot till the minimum return loss is obtained.

Step 8 After getting a final result goes to step 1 again for a different value of dielectric constant and height.

Step 9Finalize the best result which has good radiation pattern parameters and return loss.

Design Procedure

Step 1: Calculation of width of the patch (W)

The width of the microstrip patch is given by:

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

Where c is the velocity of speed in free space.

f_o is the resonant frequency, εr is the value of the dielectric constant.

Step 2: Calculation of effective dielectric constant (ε_{reff})

The effective dielectric constant is given by:

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

Step 3: Calculation of the Effective length (L_{eff}):

The effective length is given by:

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

Step 4: Calculation of the length extension (ΔL):

The length extension is given by:

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

Step 5: Calculation of actual length of patch (L):

The actual length is obtained by:

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

Step 6: 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 [9] 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:

$$L_g = 6h + L$$

$$W_g = 6h + W$$

Where L and W are the length and width of the patch simultaneously.

4.3 Simulation Setup and Results

The proposed work will be modeled and simulated using CST Microstripes 2009 tool. CST MICROSTRIPES is a powerful 3D electromagnetic simulation tool, used extensively for solving challenging radiation problems including complex antenna structures.

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