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PERFORMANCE ANALYSIS OF DIFFERENT FEEDING TECHNIQUES OF RECTANGULAR PATCH ANTENNA FOR WLAN APPLICATIONS

Dr. K C B Rao
Dept. of Electronics and Communication Engineering
University College of Engineering,
Vizianagaram, AP, India

***Abstract* - Microstrip patch antennas are widely used in many civilian, military and industrial applications due to their low profile, ease of fabrication and conformal structure. However, these antennas are suffering with the effect of lower bandwidth, low polarization purity and lower efficiency. These effects can be decreased by choosing proper feeding techniques. A good impedance matching condition between the line and patch without any additional matching element also depends on feeding technique used. The present paper describes four verities of feeding methods applicable to the rectangular microstrip patch antenna. The effects on antenna performance with four feed techniques of contacting and non contacting are discussed by varying the feed dimensions and location of the feed- as the feed dimensions and the location of the feed are going to have effect on the current distribution on the patch. The proposed method are designed, simulated and analyzed with respect to Return loss, Bandwidth and VSWR. Simulation has been done with HFSS (High Frequency Structure Simulator) software.**

Keywords— VSWR; return loss; microstrip line; coaxial feed; aperture coupled feed; proximity feed; resonant frequency; HFSS

I. INTRODUCTION

Microstrip patch antennas (MPAs) are attractive for their well known efficient features such as compatibility with monolithic microwave integrated circuits. The utilization of MPAs has become diverse because of their small size and light weight. Rapid cost effective fabrication is especially important when it comes to prototyping of antennas for their performance evaluation. As wireless applications require more and more bandwidth, the demands for wideband antennas operating at higher frequencies become inevitable. Inherently microstrip antenna has narrow bandwidth and low efficiency and their performance greatly depends on the substrate parameters such as its dielectric constant, uniformity and loss tangent. In this regard several comparative studies have been performed
MPAs can be fed in a variety of ways: 1)contacting and 2) non-contacting. In contacting method RF power is fed directly to the radiating patch using a connecting element, they are microstrip feed and co axial feed. In non contacting method electromagnetic coupling is done to transfer the power between the feed line and radiating patch they are aperture coupled feed and proximity coupled feed. In this study a comparative analysis have been done considering all the feed techniques. Microstrip antennas have found applications especially in the field of medical, military, mobile and satellite communications. The antennas are simulated using HFSS software.

II. DESCRIPTION OF ANTENNA GEOMETRY

The patch has been designed on FR-4 substrate of relative permeability Єr=4.4 and thickness h=1.6mm because FR-4 substrate is taken for this antenna design. From the design equations the obtained ground plane dimensions are 48mm X 38mm and rectangular patch dimensions are 38mm x 27mm The design of Microstrip antenna with all feeding methods is simulated for different variations in feed positions as well as feed dimensions using HFSS software.

III. DIFFERENT FEEDING TECHNIQUES

A. Stripline Feeding

A conducting strip is directly connected to the patch edges at any one end of the microstrip patch antenna. The dimensions of the strip are very less comparing with patch dimensions. This feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. No additional matching elements are required in this method. The impedance matching can be achieved by inserting an inset cut in the patch in a predetermined position. Ease of fabrication, simplicity in modeling as well as better impedance matching made this feeding method more popular and advantageous.

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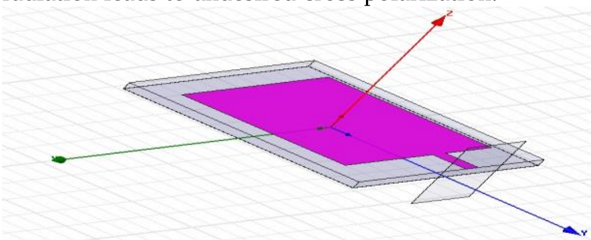
However, the antenna is affected with surface waves, spurious feed radiation due to increment in the substrate thickness. This feeding scheme provides narrow bandwidth. The spurious feed radiation leads to undesired cross polarization.



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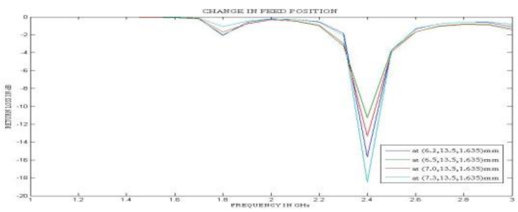

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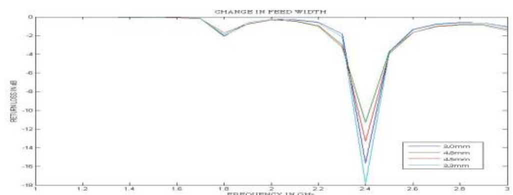

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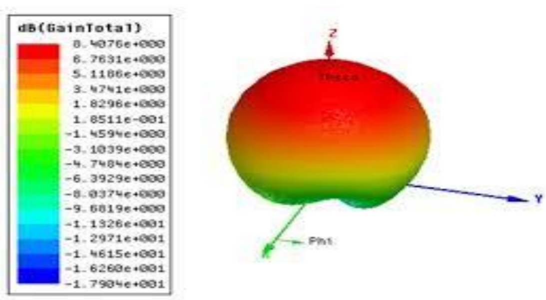

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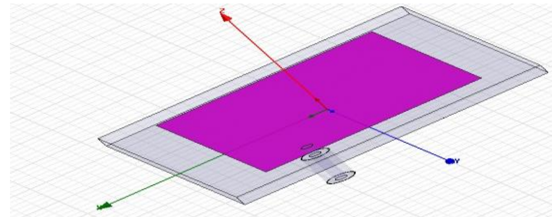
Fig 1. Rectangular patch antenna with strip line feed
a) Design b) Return loss for different feed positions
c) Return loss for different feed width d) Radiation pattern

B. Coaxial Feeding Technique

The most common type of feeding technique used is co-axial or probe feed. In this method, the inner conductor is directly connected to the patch and outer conductor to the ground. This technique is more popular since the input impedance can be easily matched by choosing the desired location of feed inside the patch The spurious radiation is decreased in this method. However, the fabrication of the antenna is complex procedure in this model since a hole has to be drilled in the substrate to make the antenna completely planar. The bandwidth of the model is narrow. And for thicker substrates, the increased probe length makes the input impedance more inductive, which leads to the mismatching.



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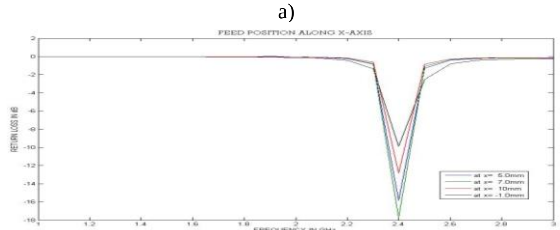

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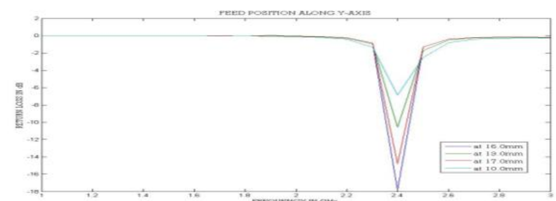

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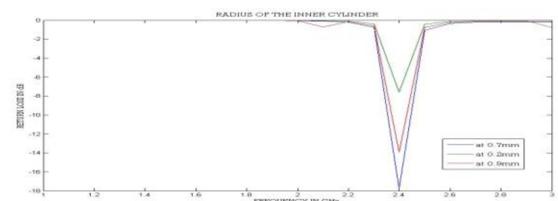

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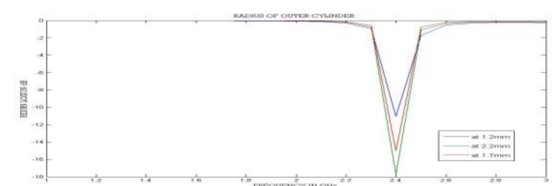

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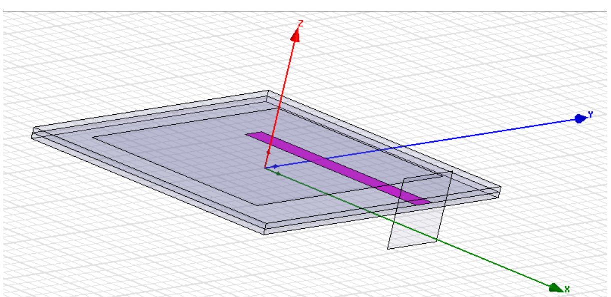
Fig 2. Rectangular patch antenna with strip line feed a) Design b) Simulated return loss for different feed positons along X-axis c) Simulated return loss for different feed positons along Y-axis d) Simulated return loss for different radius of the inner cylinder e) Simulated return loss for different radius of the outer cylinder f) Radiation pattern

C. Proximity Coupled Feeding Technique

No additional matching elements are required in this method. The impedance matching can be achieved by inserting an inset cut in the patch in a predetermined position. Ease of fabrication, simplicity in modeling as well as better impedance matching made this feeding method more popular and advantageous. However, the antenna is affected with surface waves, spurious feed radiation due to increment in the substrate thickness. This feeding scheme provides narrow bandwidth. The spurious feed radiation leads to undesired cross polarization.



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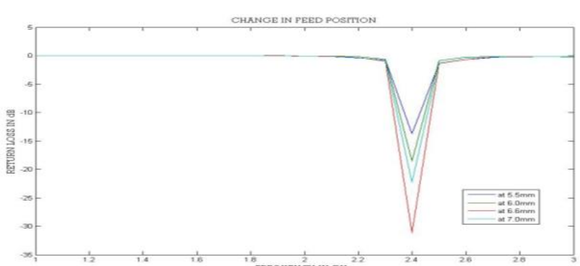

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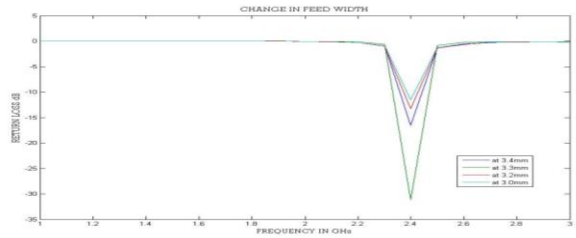

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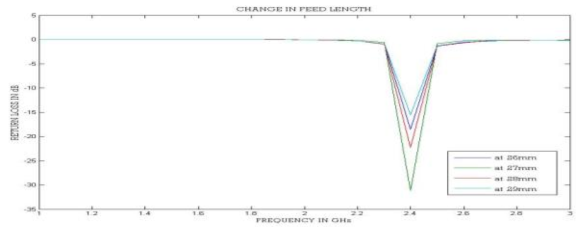

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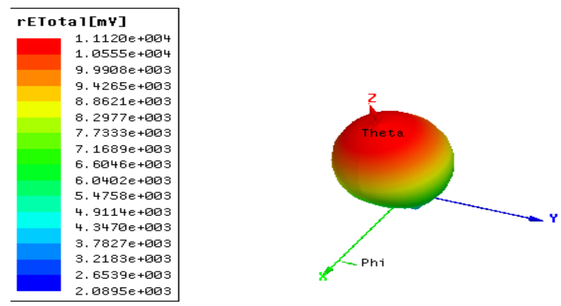

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Fig 3. Rectangular patch antenna with proximity coupled feed a) Design b) Return loss for different feed positions c) Return loss for different feed widths
d) Return loss for different feed lengths e) Radiation pattern

D. Aperture Coupled Feeding Technique

In this type of feeding technique, the ground plane separates the patch and the feed line. Coupling is achieved by locating a slot or an aperture between the feed line and the patch. The aperture coupling is usually centered under the patch, to decrease cross polarization effect due to symmetry of configuration. The shape, size and location of the aperture influence the amount of coupling. The effect of spurious radiation is minimized by incorporating ground between patch and feed. Generally the dielectric constant of the upper dielectric is more when compared with the lower to optimize the radiation from the patch. The complex structure of this type of feeding with multiple layers of dielectrics makes the fabrication process difficult. It also affects the optimum thickness of the antenna. This feeding scheme provides the bandwidth upto 21%. The length the aperture is taken as 18mm and the width of the aperture is taken as 2mm.

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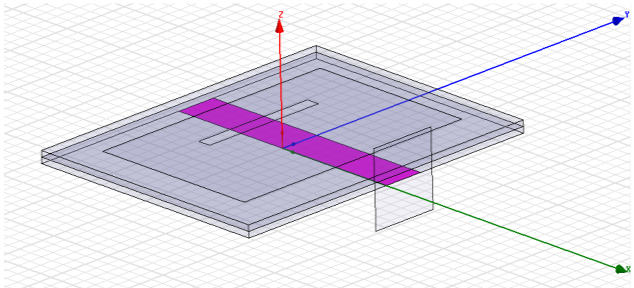

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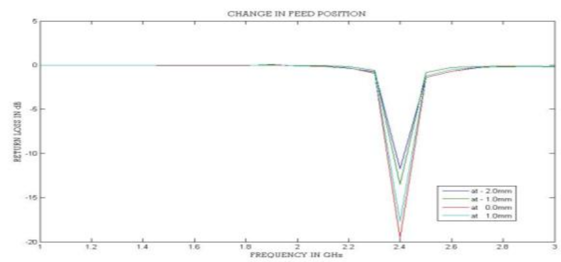

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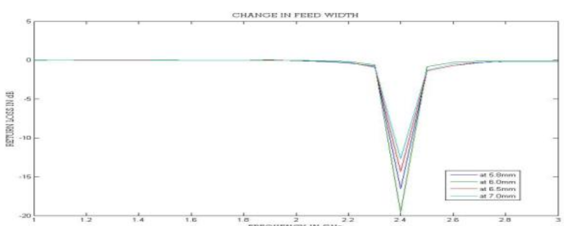

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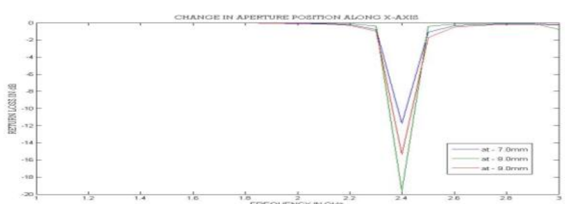

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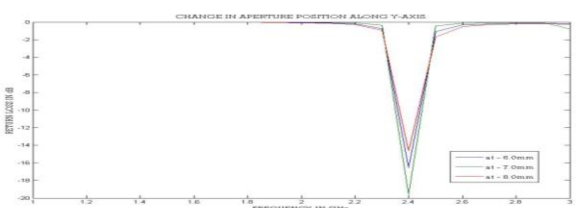

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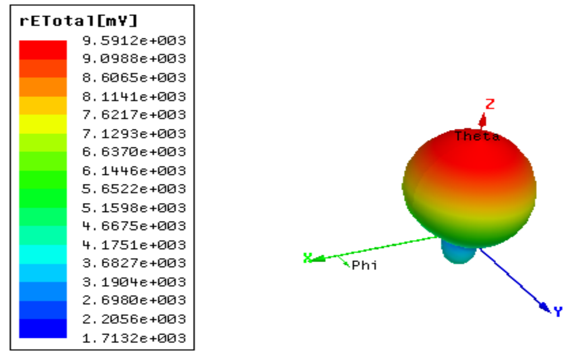

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Fig 4. Rectangular patch antenna with Aperture coupled feed a) Design b) Return loss for different feed positions c) Return loss for different feed widths
d) Return loss for different aperture positions along X axis e) Return loss for different aperture positions along X axis f) Radiation Pattern

IV. RESULT ANALYSIS AND CONCLUSION

This paper describes variety of feeding techniques applicable to microstrip patch antenna which is one of the important aspects. A good impedance matching condition between the line and patch without any additional matching element depends heavily on feeding techniques used. In this paper four types of feeding techniques are used and the effects on antenna performance with four feed techniques are discussed by varying the feed dimensions and location of the feed- as the feed dimensions and the location of the feed are going to have effect on the current distribution on the patch. Specifically feed structure should not disturb the current distribution for high gain and for efficient radiation. Also radiation patterns for the different feeds are obtained. Work is under progress for enhancement of gain and bandwidth. Also the same analysis is to be done on fractal antennas which are expected to give much more interesting results.

TABLE I. COMPARISON OF DIFFERENT FEEDS

Parameter	*Strip line feed*	*Co-axial probe feed*	*Proximity coupled feed*	*Aperture coupled feed*
Feed position (mm)	(7.3,13.5,1.635)	(-1,10,1.635)	7 mm (along Y axis)	1 mm (along Y axis)
Feed width	3.3 mm	Inner : 0.7mm Outer : 2.2mm	3 mm	7 mm
Return loss	-18dB	-18dB	-31dB	-19.5dB
VSWR	1.29	1.29	1.06	1.22
Reflection coefficient	0.126	0.126	0.028	0.100
Through power	98.42	98.42	99.92	99.00
Reflected power	1.58	1.58	0.08	1.00
Mismatch loss	0.069	0.069	0.003	0.044

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