A Broadband Low Profile Microstrip Antenna with Capacitive Coupling for C-Band Applications

Hanumanth Rao Bandari[1], Manoj Kumar Singh[2], Balramudu P.[3]

Abstract—**This paper presents the design and simulation of co-axial fed microstrip antenna for C-Band (4-8 GHz) application with capacitive coupling technique. The antenna designed from antenna theory (manual calculation) for centre frequency 5.6 GHz and later optimized for broadband using HFSS (High Frequency Structural Simulator) software. Dielectric substrate FR-4 epoxy with dielectric constant 4.4 is used. The proposed antenna exhibits a much higher impedance bandwidth 53% (S11<-10dB). An attempt has been made to fabricate the design and test the performance of the same.**

Index Terms—**Dielectric substrate, epoxy, HFSS, Return Loss, VSWR.**

I. Introduction

Wireless technologies have become more popular in recent developments and have become the main areas of research in the communication world of systems today. Without proper understanding of the operation of radiating systems, the study of communications systems is incomplete, especially in case of planar antennas. Due the rapid advancement and developments of various applications, these planar antennas are made to work at several frequency bands such as dual, triple and multiband operations as required. Therefore, antennas capable of operating at these bands are suitable candidates to meet such requirements.

In the literature, people have tried various methods like patch array, L-probe fed array antenna and air as dielectric medium to achieve maximum bandwidth.

In this paper one such effort has been made to design and develop broad band antenna. This paper also shows the implemented results.

II. DESIGN THEORY

This paper demonstrates the design, optimization, of co-axial fed micro strip antenna for broadband application. The proposed antenna is fed with a co-axial feeding and the technique of capacitive coupling being used. The SMA connector has been used to make contact with rectangular patch which transfers the energy to a radiating patch by co-axial feed. The length and width are designed to obtained broad band frequency range. The proposed antenna has been successfully optimized using HFSS simulation software. As shown in the Fig.1.

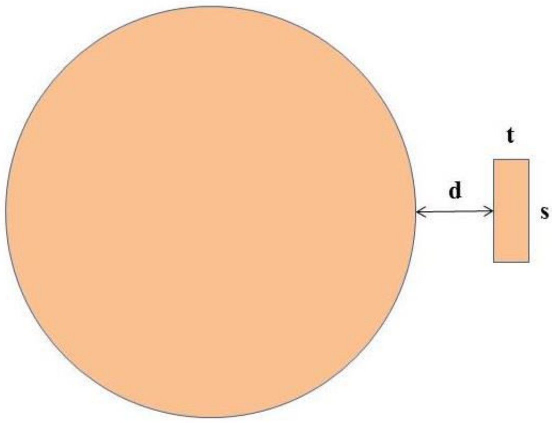

Fig.1. Feed Structure, top view

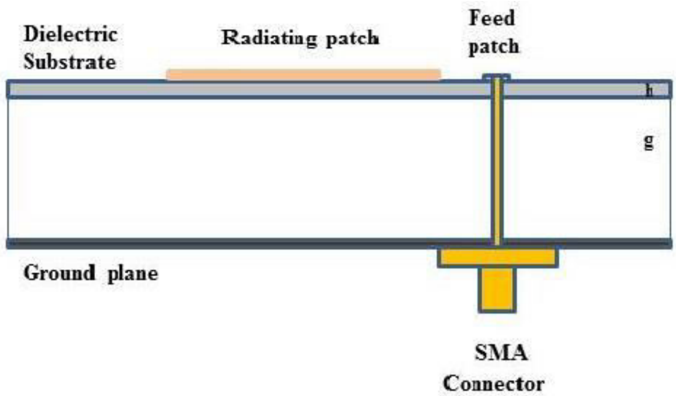

Fig.2. Feed Structure, side view

Since the structure of the patch is considered as a circular loop, the actual radius of the circular patch is given in the Balanis, 1982, as

$$a = \frac{F}{\{1 + \frac{2h}{\pi\varepsilon_r\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]}}$$

... (i)

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$$F = \frac{8.791 \times 10^9}{f_r\sqrt{\varepsilon_r}}$$

Equation (i) does not take into consideration the fringing effect.

$$a_e = a\left\{1 + \frac{2h}{\pi\varepsilon_r a}\left[ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{\frac{1}{2}} \quad \ldots \text{(ii)}$$

Hence, the resonant frequency for the dominant mode TMz110 is given in Balanis, 1982, as

$$(f_r)_{110} = \frac{1.8412V_0}{2\pi a_e\sqrt{\varepsilon_r}}$$

v_0: speed of light in the free space.

III. OPTIMIZATION

The antenna designed from antenna theory (manual calculations) for centre frequency 5.6 GHz and later optimized for broadband using HFSS software. Parameters taken for optimization include 1. Radius of the Circular Patch (R) 2. Feed strip length (s) 3. Feed strip width (t) 4. Distance between feed strip and the patch 5. Air gap height between substrates (g) . Optimized results are shown in figures (2), (3) & (4). Table-1 shows the initial values and optimized values for proposed design.

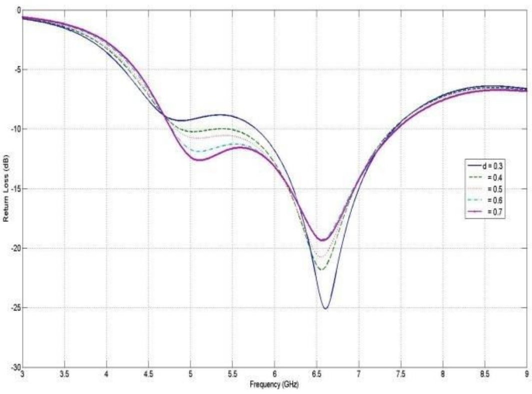

Fig.2. Return Loss performance; **d** varies (Distance between feed strip and patch)

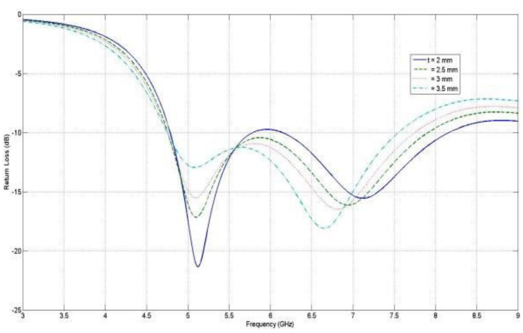

Fig.3. Return Loss performance; **t** varies (Width of feed strip)

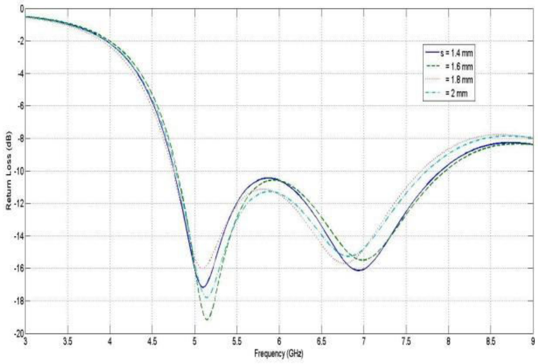

Fig.4. Return Loss performance; **s** varies (Length of feed strip)

Table-1

S.no	Parameters	Calculated Values (in mm)	Optimized values (in mm)
1	Radius of the Circular Patch (R)	8.0	8.0
2	Feed strip length (s)	1.4	1.4
3	Feed strip Width (t)	3	4
4	Distance between feed strip and the patch (d)	0.5	0.5
5	Air gap height between substrates (g)	4	4
6	Thickness of Substrate (h)	1.6	-
7	Dielectric constant	4.4	-
8	Loss tangent (tan d)	0.02	-

IV. IMPLEMENTATION AND RESULTS

An attempt has been made to fabricate the patch antenna design manually. Prototype shown in the figure below used FR-4 epoxy, air as dielectric media and SMA connector for feeding the signals.

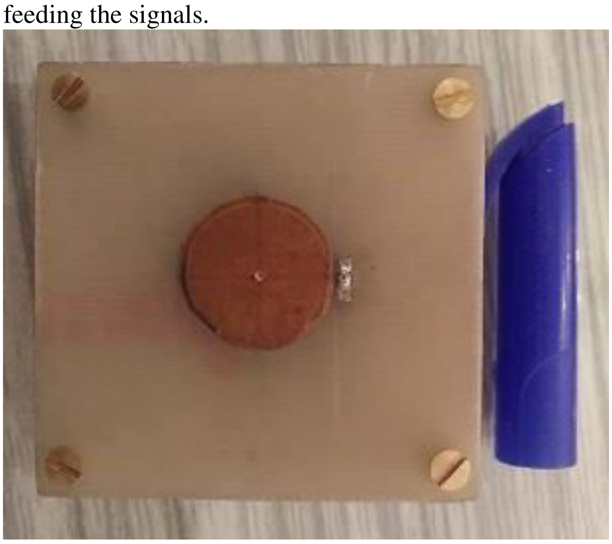

Fig.5. Feed Prototype, Top view

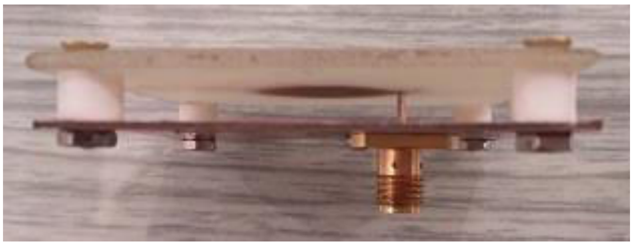

Fig.6. Feed Prototype, Side view

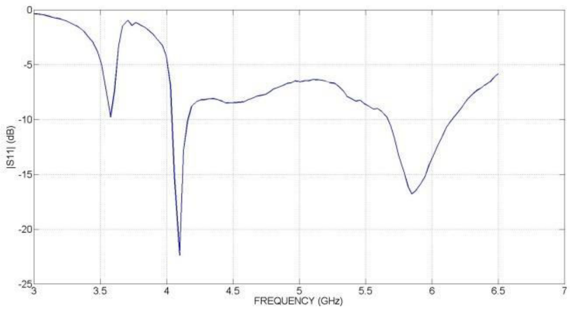

Fig.7. Return Loss performance (measured).

V. CONCLUSION

The capacitive coupled circular patch antenna with co-axial fed has been presented. Proposed geometry is very low profile antenna design and has very less parameters to optimize. The proposed antenna shows the |S11| return loss below -10 dB. With optimized feed dimensions, antenna offers an impedance bandwidth of 53% (BW < -10 dB). Wideband characteristics, which is very much useful for various wireless applications and also where compact antenna requirement is high.

The inaccuracy of the results is due to the manual fabrication technique, where the required patch has been covered with tape and itched out the un-covered surface with ferric chloride (feCL3). Fabrication can be done with standard manufacturers to get better agreement with the simulations, which is our near future work.

ACKNOWLEDGMENT

The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments. Avoid expressions such as "One of us (S.B.A.) would like to thank ... ." Instead, write "F. A. Author thanks ... ." **Sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page**.

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