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Modified Inverted fork Patch Antenna for Microwave Applications

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Abstract: This paper presents a miniaturized inverted fork patch antenna with ground plane. This design is a modified design of [1]. This design offer proper impedance matching of patch antenna with tremendously increased bandwidth (1 GHz). It reduces return loss of antenna and increases the gain of antenna. This antenna has been simulated at 2.67GHz frequency using CST software. This modified design reduces back lobe radiations of patch antenna hence increases the directivity of antenna. The proposed antenna design has good directional properties and also miniaturize patch antenna so it can be widely used in microwave applications.

Keywords: Patch Antenna, Return loss, Bandwidth, Gain, Impedance Matching, Side lobes, CST Software

1. INTRODUCTION

Microstrip antennas are one of the most widely used antennas for wireless communication [2]. A Microstrip patch antenna is a type of antenna that offers a low profile, i.e. thin and easy manufacturability, which provides a great advantage over traditional antennas. Patch antennas are planar antenna used in

wireless links and other microwave applications. The Microstrip technique is a planar technique used to produce lines conveying signals and antennas coupling such lines and radiated waves. It uses conductive strips and/or patches formed on the top surface of a thin dielectric substrate separating them from a conductive layer on the bottom surface of the substrate and constituting a ground for the line or the antenna. A patch is typically wider than a strip and its shape and dimension are important features of the antenna.

Microstrip patch antennas are probably the most widely used type of antennas today due to their advantages such as light weight, low volume, low cost, compatibility with integrated circuits and easy to install on the rigid surface. Furthermore, they can be easily designed to operate in dual-band, multi-band application, dual or circular polarization. They are important in many Microwave applications.

However, microstrip patch antennas inherently have narrow bandwidth and bandwidth enhancement is usually demanded for practical applications, so for extending the bandwidth many approaches have been utilized. In addition some applications of the microstrip antenna in communication systems required smaller antenna size in order to meet the miniaturization requirements.

This paper presents a miniaturized inverted fork patch antenna with ground plane for microwave applications**,** which is suitable for the 2.67GHz frequency or S-band of microwave frequency operations. The prospect of this design is to obtain a small size, light weight and low cost miniaturized antenna with good antenna characteristics and ease of integration using feed-networks.

Impedance matching is an important parameter in designing of antenna. This mismatch degrades antenna performances, and is dependent on the external circuitry which is connected to the antenna [3]. Proposed design of patch antenna provides proper impedance matching for a patch antenna. All simulations have done by Computer simulation technique (CST) MW studio software [4].

II. DESCRIPTION OF ANTENNA

A patch antenna has simulated at 2.67GHz frequency. CST MW studio software is used to simulate rectangular microstrip patch antenna.

A. Desired Parametric Analysis [2], [5]*:*

Calculation of Width (W)

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad (1)$$

Effective dielectric constant is calculated from**:**

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right) \qquad (2)$$

The actual length of the Patch (L)

$$L = L_{eff} - 2\Delta L \qquad (3)$$

where

$$\text{Leff} = \frac{C}{2f_r\sqrt{\varepsilon_{eff}}} \qquad (4)$$

Calculation of Length Extension

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{w}{h}+0.8\right)} \qquad (5)$$

where,

ε_{reff} = Effective dielectric constant,

ε_r = Dielectric constant of substrate,

h = Height of dielectric substrate,

W = Width of the Patch,

L = Length of the Patch,

ΔL = Effective Length,

f_r = Resonating Frequency

The parameters of rectangular microstrip patch antenna are W= 37.6362mm, L=29.043mm, Cut Width= 5.5mm, Cut Depth= 10mm, length of transmission line feed= 17.2mm, with width of the feed=3mm shown in Figure 1. The rectangular microstrip patch antenna designed on one side substrate with ε_r = 4.3 and height from the ground plane d= 1.6mm.

Table 1: describe the specification of proposed patch antenna. Figure 1: shows the design view of patch antenna. Figure 2: shows the design and dimensions of ground plane.

TABLE 1: Rectangular microstrip patch antenna specification

Parameters	Dimensions	Unit
Dielectric Constant (ϵr)	4.3	-
Loss Tangent (tan ∂)	0.02	-
Thickness (h)	1.6	mm
Operating Frequency	1.8	GHz
Length (L)	29.043	mm
Width (W)	37.6362	mm
Cut Width(A)	5.5	mm
Cut Depth(B)	10	mm
Path Length(C)	17.2	mm
Width Of Feed(D)	3	mm

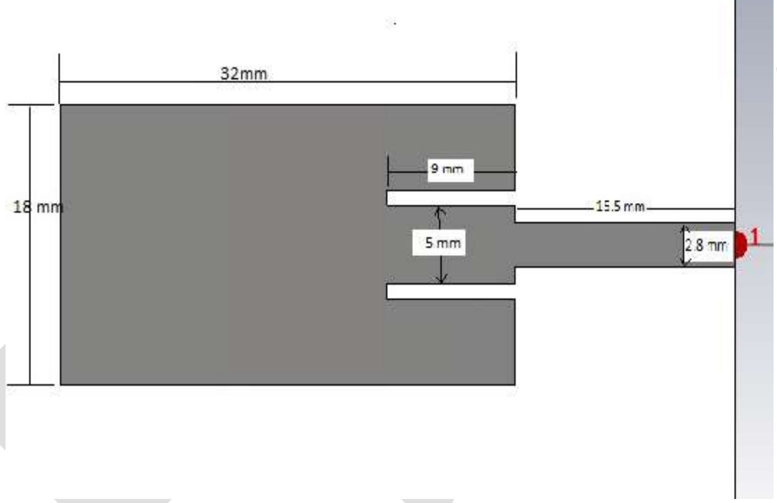

Figure 1: Design of proposed microstrip patch antenna (all dimensions in mm)

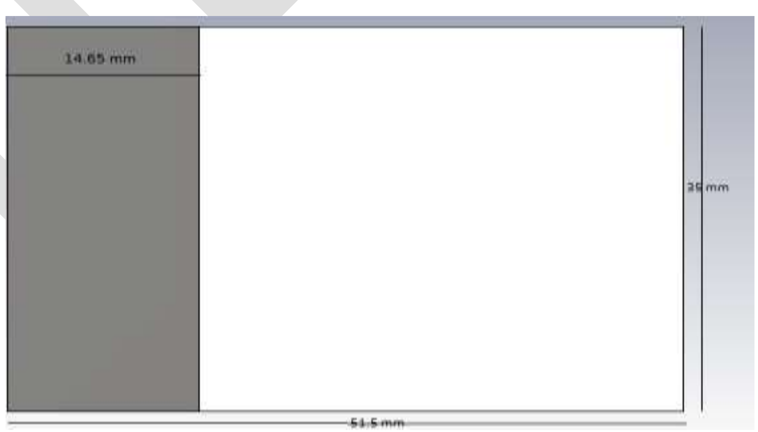

Figure 2: Ground plane of proposed rectangular microstrip patch antenna (all dimensions in mm)

III. RESULTS AND DISCUSSION

CST-MWS software in Transient Mode is used for simulations. First, patch antenna is designed and analyzed at the frequency of 2.62GHz. Figure 3 shows the graph between return loss and frequency which shows a return loss of -65.913dB. Figure 4 shows the smith chart [5] of the microstrip patch antenna, it shows that the impedance of the antenna is matched with feed i.e. 50Ω impedance is obtained.

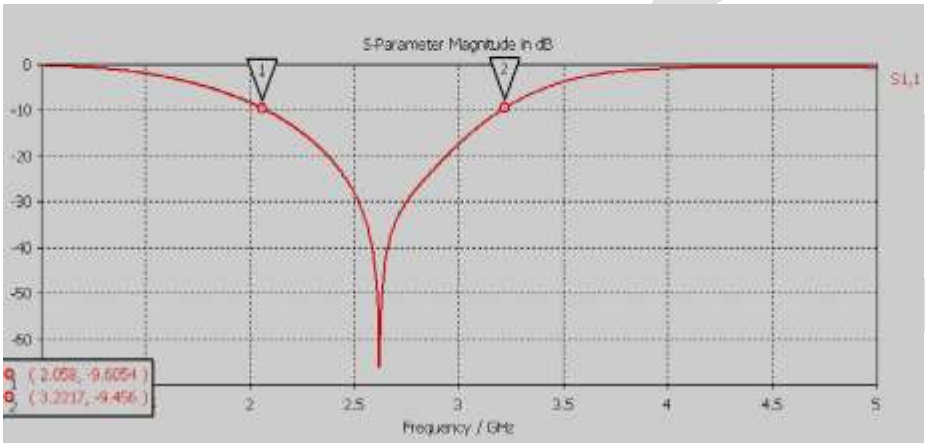

Figure 3: Simulated result of rectangular microstrip patch antenna without metamaterial

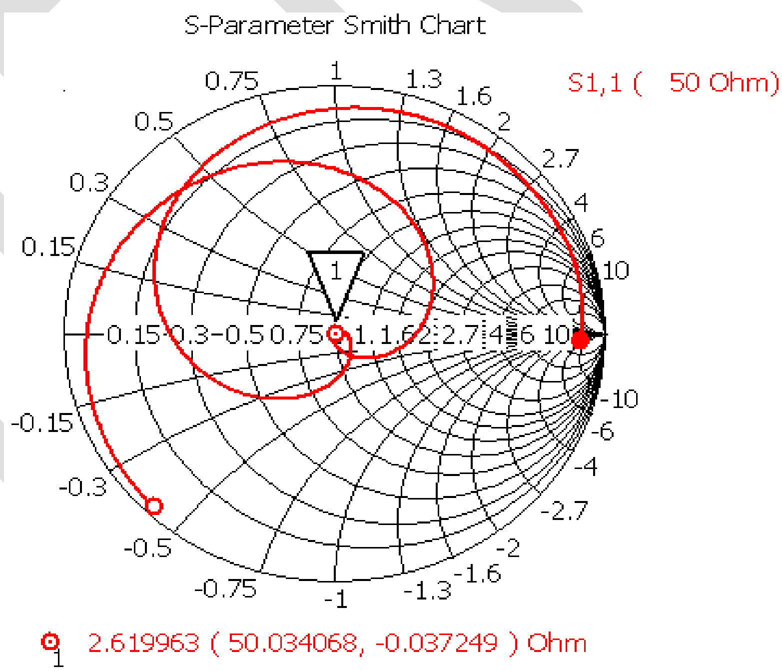

Figure 4: Smith chart of the rectangular microstrip patch antenna with Metamaterial

By investigation of both result shown in figure 3 and figure 4, it is clear that patch antenna shows greater reduction in return loss and miniaturize patch antenna..Impedance matching is analyzed by investigating the Smith chart of antenna. Figure 5 shows the gain of rectangular microstrip patch antenna. It is clear from figure 5 that 2.554dB gain and 96.27% radiation efficiency is obtained which is good.

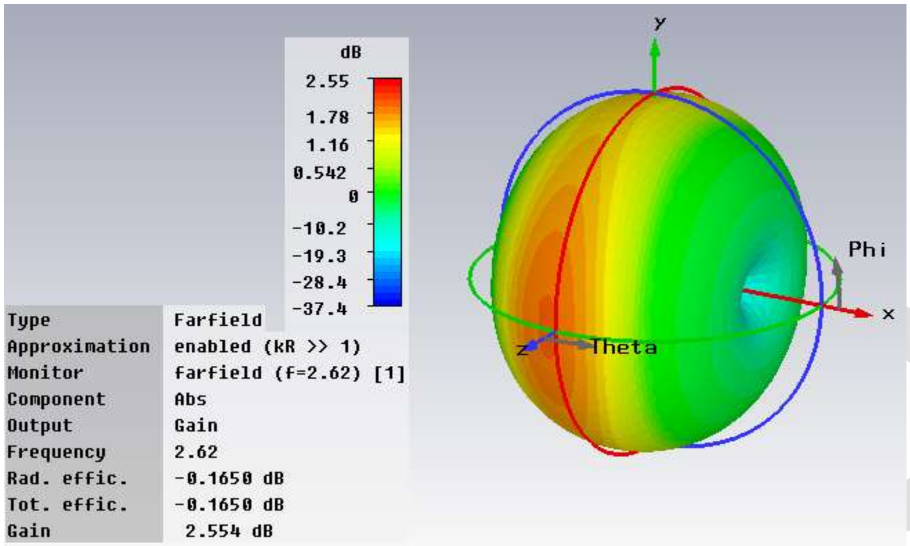

Figure 5: Radiation pattern and gain of proposed patch antenna

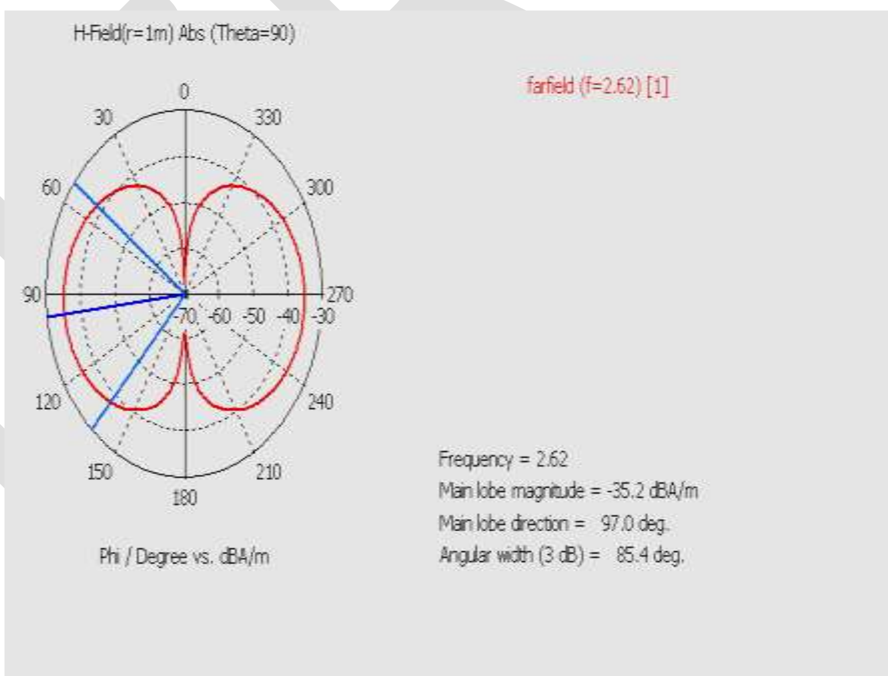

Figure 6: H-Field Radiation pattern of proposed microstrip patch antenna

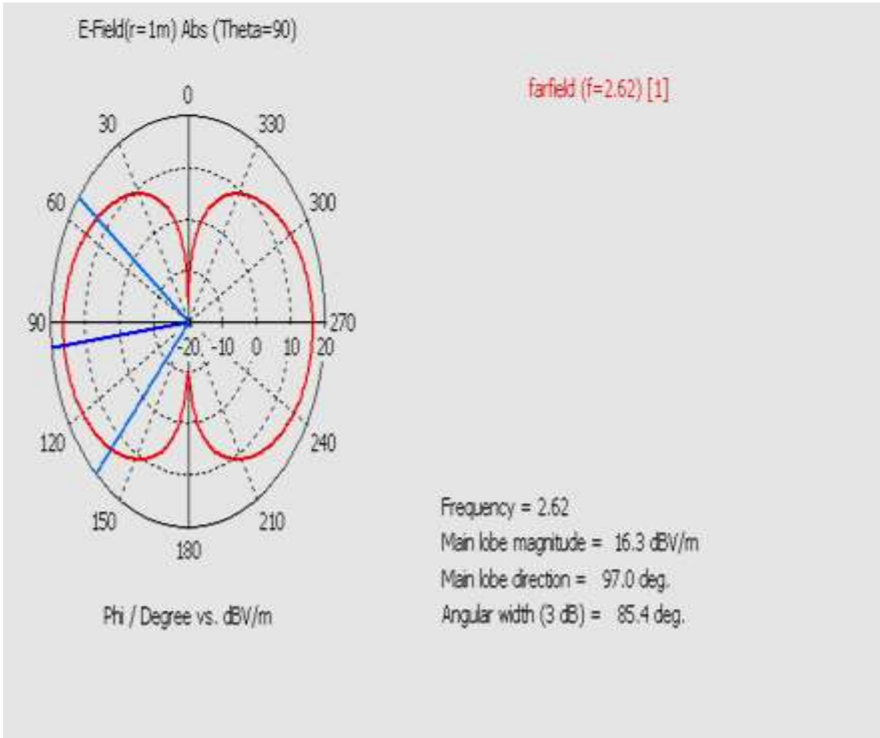

Figure 7: E-Field Radiation pattern of proposed microstrip patch antenna

Figure 6 shows H field Radiation pattern of antenna which shows main lobe magnitude of -35.2dBA/m, angular width (3dB) of 85.4Degree.

Figure 7 shows E-field Radiation pattern of antenna which shows main lobe magnitude of 16.3dBV/m, angular width (3dB) of 85.4Degree .Minor lobe or back lobe is very small. Minor lobe usually represents radiation in undesired direction and they should be minimized [13].

IV.CONCLUSION

Modified design of Microstrip patch antenna at 2.62GHz has been proposed in this paper. In the base design return loss is about -25dB and bandwidth is very less, while modified design shows return loss of -65.913 dB and bandwidth of 1GHz. In this work it is found that some changes in dimensions of patch antenna show the greater increment in bandwidth and reduction in return loss. This work on patch antenna also encourages the application of patch antennas as microwave sensor.

REFERENCES

[1] M. Ben Ahmed,M.Bouhorma, F. Elouaai, A. Mamouni, "Design of new multistandard patch antenna GSM/PCS/UMTS/HIPERLAN for mobile cellular phones",European journal of scientific research ISSN 1450-216X vol.32 No.2, pp 151-157, (2009)

[2] W.L. Stutzman, G.A. Thiele, "Antenna Theory and design", John Wiley & Sons, 2nd Ed., New York, 1998.

[3]. David M. Pozar, "Microwave Engineering", 3rd Edition, John Wiley & Sons, 2004.

[4]http://www.cst.com/content/products/mws/overview.aspx © 2012 CST Computer Simulation Technology AG.

[5] Constantine A.Balanis, "Antenna Theory and Design", John Wiley & Sons, Inc., 1997.

[6] J. S. Colburn and Y. Rahmat-Samii, "Patch antennas on externally perforated high dielectric constant substrates," IEEE Trans. Antennas Propag., vol. 47, no. 12, pp. 1785–1794, Dec. 1999