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Performance Comparison of Non-Contact and Contact Feeding Technique for Rhombus Shaped Microstrip Antenna

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ABSTRACT: Microstrip patch antennas are fed by different feeding techniques. These feeding techniques can be classified into two categories- contacting and non-contacting. In this paper, weare present a comparative analysis between two different feeding techniques belonging to two different categoriesthat are used for Rhombus shaped Microstrip antenna. The feeding techniques used are Microstrip line feeding technique (contacting feeding technique) and proximity coupled feeding technique (non-contacting feeding technique). Through comparison, it is found that proximity coupled feeding technique will give a good bandwidth of 73.64MHz with again of 1.112dBi. The Simulation is carried out using IE3D software and practical results are measured with Vector Network analyzer(VNA). Practical results are agreement with the simulated results.

KEYWORDS: Rhombus shaped Microstrip Antenna, feeding technique, Microstrip line and Proximity coupled.

I. INTRODUCTION

Microstrip antennas [1] are one of the most rapidly developing fields in last twenty years. Nowadays, these antennas have variedapplication [4] and play an important role in mobile radio systems, integrated antennas, satellite navigation receivers, satellite communications [12], direct broadcast radio, television etc. Interest in microstrip antennas [6] has peaked,due to their considerable advantageover conventional microwave antennas such as beinglightweight [2], consumption of low volume, conformability, low price compactness[7]and ease of manufacture. Despite of all this, microstrip antennas are weighed down when it comes to their limited bandwidth [3].

There are different feeding techniques which are used to feed microstrip antennas.Rhombus shaped microstrip antenna can be fed through contact and non-contact feeding [5].In this paper we are going to present a comparison between two feeding techniques belonging to two different categories, proximity coupled [8]and microstrip line feed technique [9-10], for Rhombus shaped microstrip antenna.In contact method [11], RF power is fed directly to the radiating patch, using a SMA connector. In non-contact scheme, electromagnetic field coupling is done to transfer power between radiating patch and microstrip line feeding.

II. ANTENNA DESIGN

Rhombus shaped microstrip patch antenna is designed for three essential parameters, which are as follows:

I. Frequency of operation (f_0): Resonant frequency of the designed antenna is 2.58GHz.

II.Dielectric constant of the substrate (ε_r): The dielectric material selected for design purpose is glass epoxy, which has a dielectric constant of 4.4.

III.Height of dielectric substrate (h): As microstrip patch antenna should not be bulky, height of the dielectric substrate is selected as 1.6mm.

Radiating patch of Rhombus shaped Microstrip Antenna is designed using following formulae.

$$\lambda o = \frac{c}{f}$$

Where f is the resonant frequency and c is the velocity of light.

$$\text{Width of patch } W=\frac{C}{2fr}\left(\frac{\varepsilon r+1}{2}\right)^{-1/2}$$

$$\text{Length of Patch } L=\frac{c}{2f_r\sqrt{\varepsilon_e}}-2\Delta L$$

$$\text{Effective length } \Delta L = 0.412h*\frac{(\varepsilon_e+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_e-0.258)\left(\frac{w}{h}+0.8\right)}$$

$$\text{Where } \varepsilon_e=\frac{\varepsilon_r+1}{2}+\frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{-\frac{1}{2}}$$

Substituting in above shown equations, we get W=35.38mm and L =27.34mm. Optimized resonating frequency of the designed antenna which is operating at 2.58GHz for that we are considered length and width of a radiating patch is 27mm.

The proposed rhombic shaped microstrip antenna with proximity couple feeding is shown in Fig.1. The Rhombus shaped microstrip antenna whose radiating patch size is 27mm x 27mm is printed on a dielectric substrate S1 of thickness 1.6mm. The Substrate material used is glass epoxy with dielectric permittivity of ε_r=4.4, which is designed to operate at 2.58GHz.

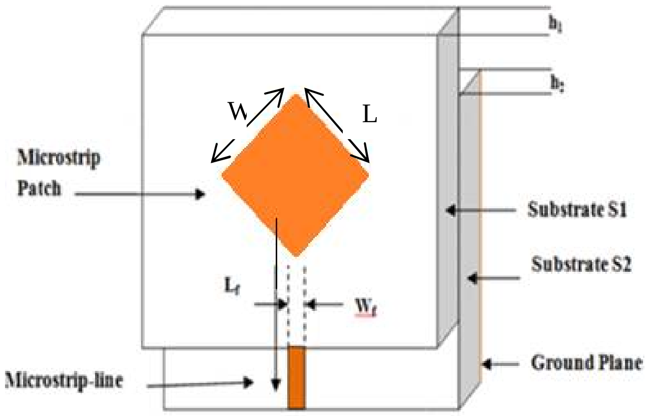
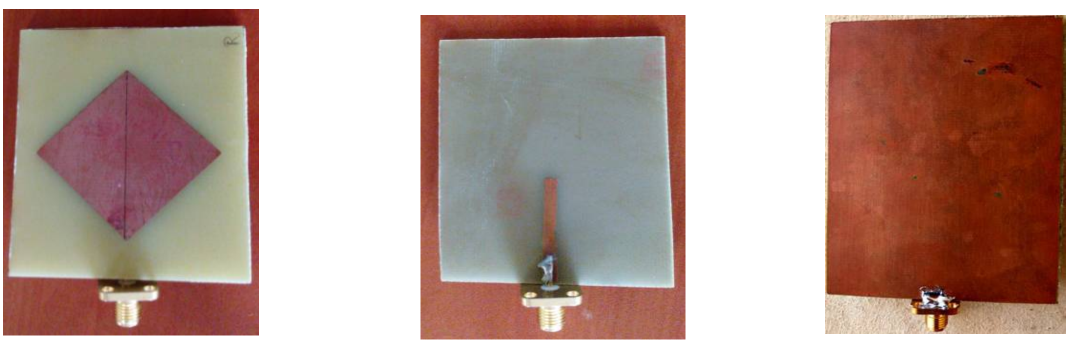


Fig 1: Geometry of Rhombus shaped Proximity couple antenna

The optimized designed dimension of designed antenna are as follows:h_1=1.6mm,L=27mm, W=27mm, L_f=18mm, W_f=3mm and h_2=1.6mm.With a ground plane of dimension (54 x 58) mm^2, the feeding patch is placed between two substrates and it is connected through SMA connector. The Photograph of top and bottom viewof practical Rhombus shaped microstrip antenna with proximity coupled feed shown in Fig.2.



a) Top view of substrate1 b) Top view of substrate 2 c) Bottom view of substrate 2

Fig 2: Rhombus shaped microstrip antenna with proximity coupled feeding (top and bottom view)

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The proposed rhombic shaped microstrip antenna with microstrip line feeding is shown in Fig.3.The Rhombus shaped microstrip antenna whose radiating patch size of 27mm x 27mm is printed on a dielectric substrate of thickness 1.6mm. The Substrate material used is glass epoxy with dielectric permittivity of ε_r=4.4, which is designed to operate at 2.58GHz.

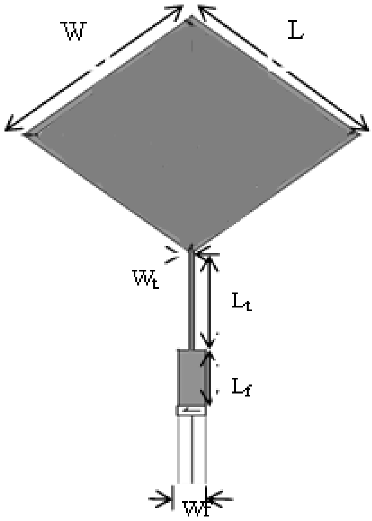

Fig 3: Geometry of Rhombus shaped microstrip line feeding antenna

The optimized designed dimension of a rhombus shaped MSA antenna using microstrip feed technique are as follows: h=1.6mm, L=27mm, W=27mm, L_t=15.4mm andW_t=0.3mm, L_f=15.4mm, W_f=3mmthey are mounted on a ground plane of dimension (78.45 x 57.4) mm^2.The antenna with feeding patch is connected through SMA connector.The Photograph of top and bottom view of practical Rhombus shaped microstrip antenna with microstrip line feed is shown inFig.4.

Fig 4: Rhombus shaped microstrip antenna with microstrip line feeding top and bottom view

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III. EXPERIMENTAL RESULTS

The return loss characterization of simulated and practical rhombus shaped microstrip antenna (RMSA) with proximity coupled feeding shown in Fig 5, the return loss and bandwidth values are summarized in table 1.

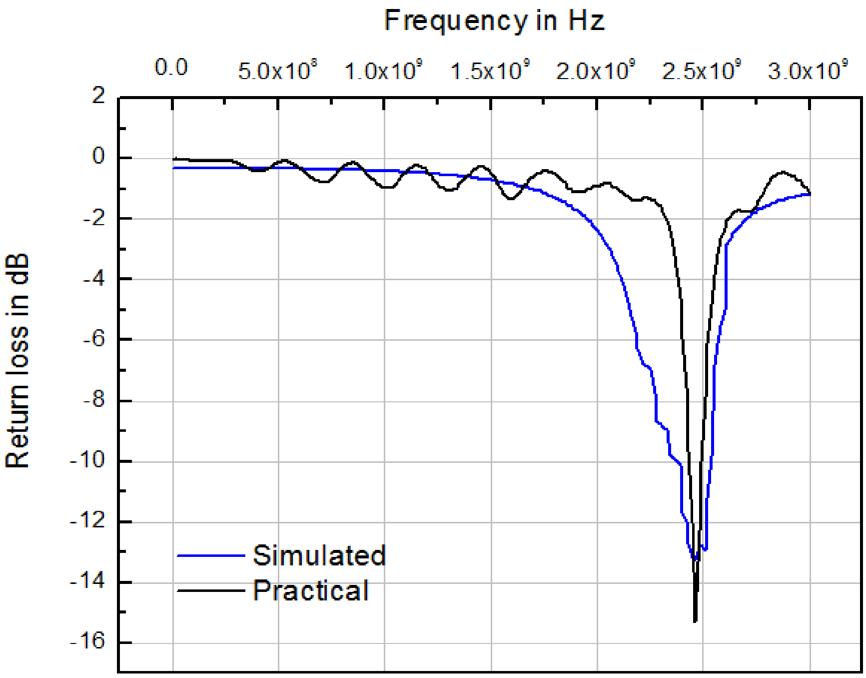

Fig 5.Variation of return loss versus frequency of rhombus shaped Proximity coupled MSA.

The Fig 6 shows the performance gain characteristic of rhombus shaped microstrip antenna (RMSA) with proximity coupled feeding, with a maximum gain of 1.112dBi at resonant frequency.

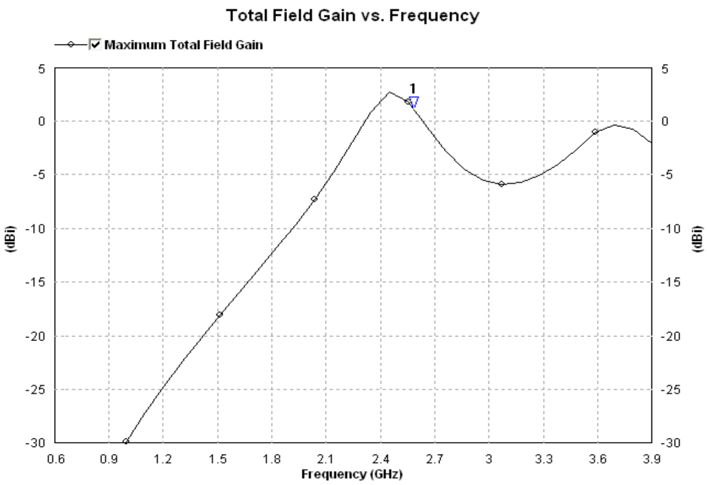

Fig 6. Variation of Gain versus frequency of rhombus shaped Proximity coupled MSA

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The radiation pattern and current distribution of rhombus shaped microstrip antenna (RMSA) with proximity coupled feeding as show in Fig 7 and Fig 8.

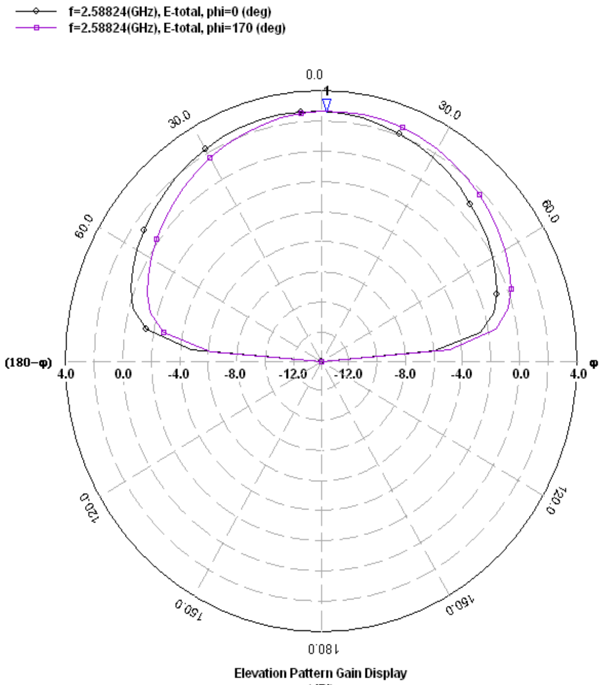

Fig 7.Radiation pattern of rhombus shaped Proximity coupled MSA

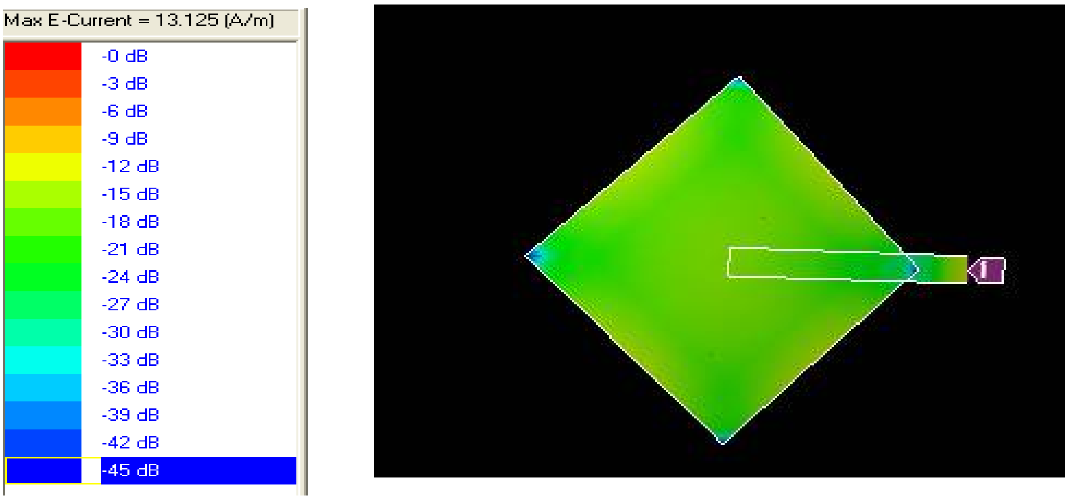

Fig 8.Current distribution of rhombus shaped Proximity coupled MSA

The return loss characterization of simulated and practical rhombus shaped microstrip antenna (RMSA) with microstrip line feeding shown in Fig 9, the return loss and bandwidth values are summarized in table 1.

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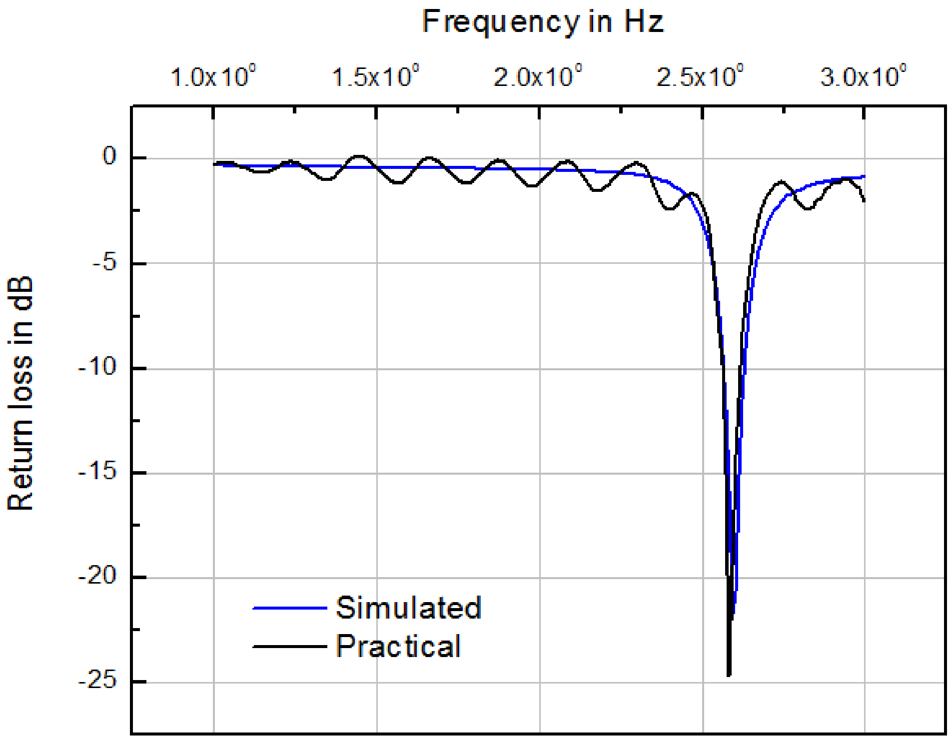

Fig 9. Variation of return loss versus frequency of rhombus shaped microstrip line feed MSA.

The Fig 10 shows the performance gain characteristic of rhombus shaped microstrip antenna (RMSA) with microstrip line feeding, with a maximum gain of o.68dBi at resonant frequency.

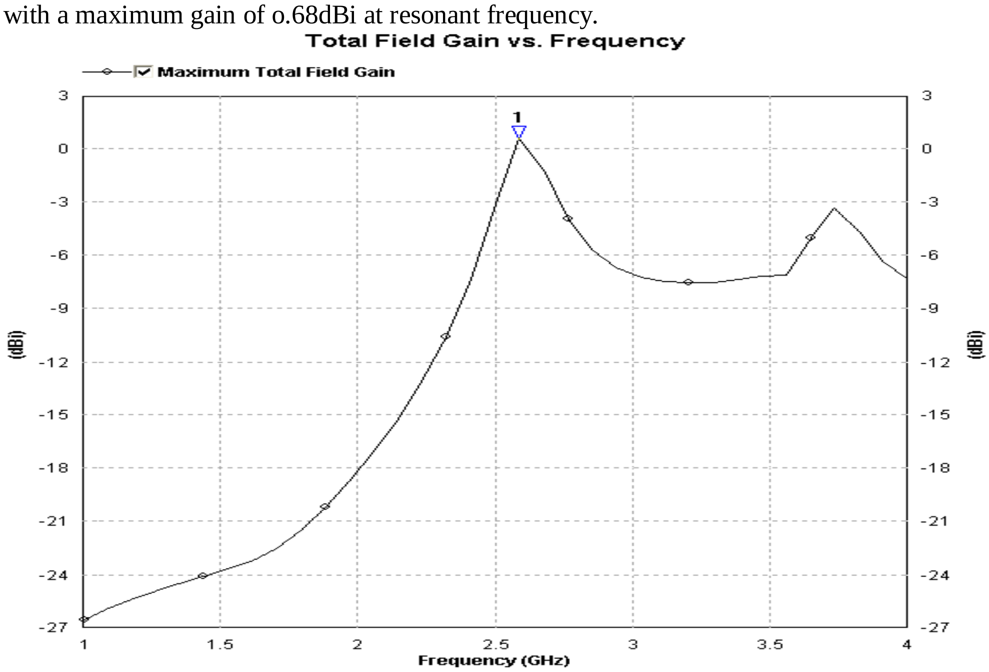

Fig 10. Variation of Gain versus frequency of rhombus shaped microstrip line feed MSA

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The radiation pattern and current distribution of rhombus shaped microstrip antenna (RMSA) with microstrip line feeding as show in Fig 11 and Fig 12.

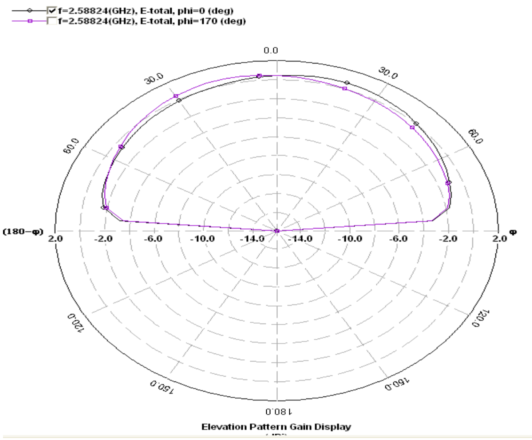

Fig 11.Radiation pattern of rhombus shaped microstrip line feed MSA

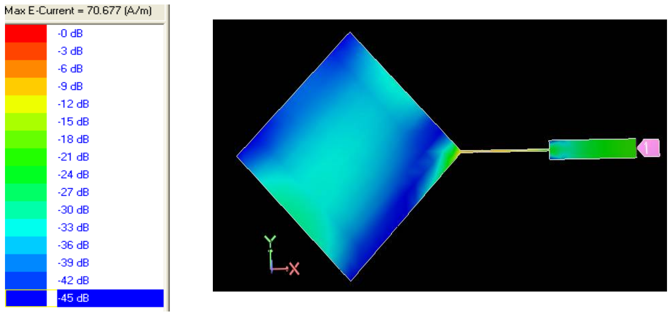

Fig 12. Current distribution of rhombus shaped microstrip line feed MSA

SL No	Prototype Antenna	Resonant Frequency f_r (GHz)		Return Loss (dB)		Bandwidth (MHz)		Impedance (Ω)		Gain (dBi)
		Simul.	Pract.	Simul.	Pract.	Simul.	Pract.	Simul.	Pract.	
1	Rhombus shaped microstrip antenna with Proximity coupled feeding	2.588	2.576	-13.25	-15	116.21	73.64	43	54	1.112
2	Rhombus shaped microstrip antenna with microstrip line feeding	2.588	2.57	-20.63	-27	109.42	60	43.67	52.2	0.68

Table 1: Performance comparison of the proposed antennas

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The prototype of Non-contact and contact feeding technique for RMSA are measured by Vector Network Analyzer (VNA) as shown in Fig.13.

Fig 13. Vector Network Analyzer

IV. CONCLUSION

Rhombus shaped microstrip antenna(RMSA) with proximity coupled feeding technique will give a good bandwidth of 73.64MHzwith acceptable gain of 1.112dBiin comparison with rhombus shaped microstrip antenna(RMSA) with microstrip line feeding technique which givesan equivalent bandwidth of 60MHz and the corresponding gain of 0.68dBi.To summarize, there is a substantial increase in bandwidth by 13.64MHz and gain by 0.432 dBi as compared to rhombus shaped microstrip antenna(RMSA) with microstrip line feeding technique. The simulation results obtained aregood agreement with experimental results.

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BIOGRAPHY

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