A Novel Design of Micro Strip Antenna For Satellite Application

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Abstract— In this paper Micro strip antenna is proposed. FR-4 epoxy is used as a substrate .The proposed antenna resonates at 6.7, 7.85 GHz, VSWR<2 in 5.65-8.4Ghz frequency band.This antenna works for wideband applications. In this paper return loss, radiation pattern, VSWR, gain have been studied. Ansoft HFSS tool is used for designing and simulation. It works for satellite (6.1-7.1GHz) application.

Key words: Antenna,Return ,Signal,Radiation.

I. INTRODUCTION

An antenna is an electric device which converts electric power in to radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. Since Federal Communication Comission(FCC) released a frequency band of 3.1-10.6 GHz for commercial application. UWB system have various merits such as lower power consumption and high data transmission rate. Micro strip Antenna is become very popular due to their attractive features of low profile, light weight, easy fabrication, large bandwidth and radiation pattern.

A micro strip antenna consists of a metallic pattern on one side of a dielectric substrate and ground plane on the other side of the substrate. Micro strip antenna has disadvantages like low return loss, less bandwidth and low gain.[2] Micro strip antenna are widely utilized in many commercial application such as mobile, radio and wireless communication.[4]

II. ANTENNA GEOMETRY

The structure of the proposed antenna shown in the fig.1 below.

The Antenna is comprised six cut slots on the patch and two cut slot on ground. Five rectangular slot and one circular slot cut in the antenna. The design procedure begins with the dielectric substrate, the patch, the ground, the feed line.In this FR-4 Epoxy substrate is taken having thickness of 1.5mm.In this dimension of patch are 23mm by 31mm . The antenna design and analysis is used by Ansoft HFSS software and the optimal dimensions is

L=23mm, W=31mm, L_1=6mm, W_1=4mm, W_2=3.2mm, L_f=5mm, W_f=2mm, R=2mm. In this three rectangles of 6 by 4 have been cut from the patch and two rectangles of 6 by 3.2 have been cut in the first iteration.

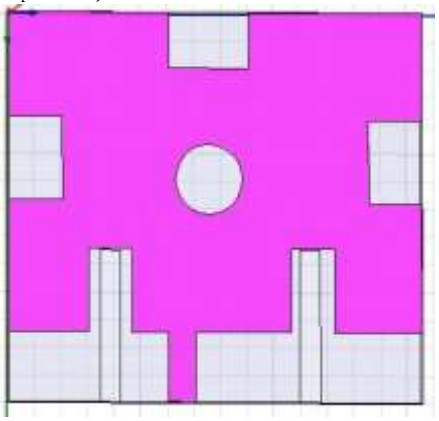

Fig. 1: Proposed Microstrip antenna

Table of Antenna Dimensions

Parameter	Value
Length of substrate	31mm
Width of substrate	34mm
Length of patch	23mm
Width of patch	31mm
Thickness of substrate	1.5mm
Dielectric constant of substrate	4.4
Loss tangent of substrate	0.02
Feed to patch	Micro strip feed line

Table 1: Antenna dimensions

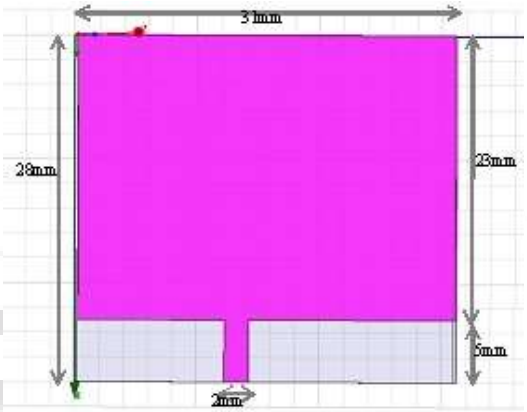

Fig. 2: simple patch antenna zeroth iteration

This is the simple rectangular micro strip patch. Now five rectangles slots are cut into this patch in the first iteration. Three rectangular slot of dimensions 6 by 4 is cut from the patch and two rectangles of dimension 6 by 3.2 as shown in figure3. After it on one circular slot cut in the centre of patch in the second iteration in figure4.

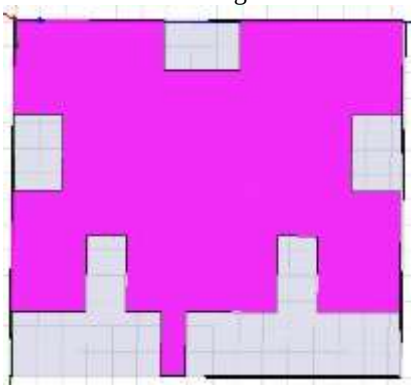

Fig. 3: first iteration of antenna

In the third iteration two rectangular slots are cut from ground .This two rectangular slot of dimension is 11 by 1.5 in the ground in figure 5. The rectangular patch slot antenna design with defected ground shows better return loss.

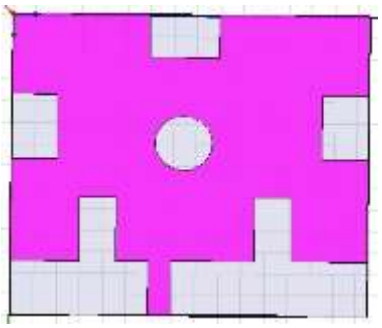

Fig. 4: second iteration of antenna

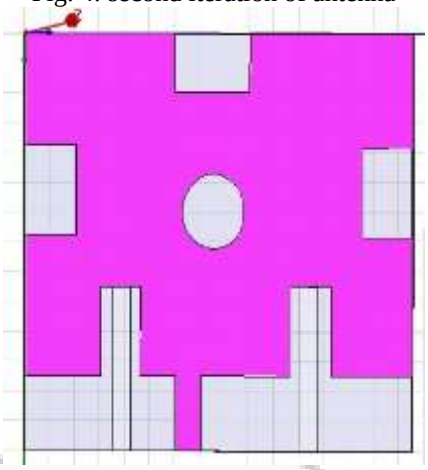

Fig. 5: third iteration of antenna

III. DESIGN REQUIREMENTS

There are three essential parameters for the designing of a micro strip antenna. Firstly, the resonant frequency (f_0) of the antenna must be selected.

Secondly, the dielectric material of the substrate (ε_r) selected for this design is FR- 4 Epoxy which has a dielectric constant of 4.4 and loss tangent is 0.02.The dielectric constant is important design parameter.

Lastly, substrate thickness is important design parameter. Thick substrate increase the fringing field at the periphery or the radiating patch.

A. Physical Parameters of the Antenna

The antenna parameters of this antenna can be calculated as[3]:

Width of the patch

$W=c/2f_0(\sqrt{(\varepsilon_r+1)/2})$

Effective Permittivity

$\varepsilon_{reff}=(\varepsilon_r+1)/2 +(\varepsilon_r-1)/2[1+12h/w]^{-1/2}$

Calculate the extended length of patch

$\Delta L=0.421h(\varepsilon_{reff}+0.3)(w/h+0.264)/(\varepsilon_{reff}-0.258)(w/h+0.8)$

Calculate the Patch Length

$L=\lambda_0/2-2\Delta L$

Calculate effective length of the Patch

$L_{eff}=L+\Delta L$

IV. SIMULATION AND RESULTS

A. Return losses

The proposed antenna is constructed and studied .The return losses of the antenna are measured using an Ansoft HFSS tool. Figure 6 shows the simulated results of return losses in different iterations. In this, return losses in the zeroth iteration are -51.78dB and –20.6dB at 5.75GHz and 6.65GHz respectively .In the first iterartion return losses are -23.51dB, -17.44dB, -16.6dB at 5.85GHz, 6.65GHz, 7.95GHz respectively. Return losses are in second iteration are -24.4dB, -31dB at 6.65 GHz and 7.85 GHz respectively. In the final iteration return losses are -60.86 dB, -39.0 dB at 6.7 GHz and 7.85 GHz.

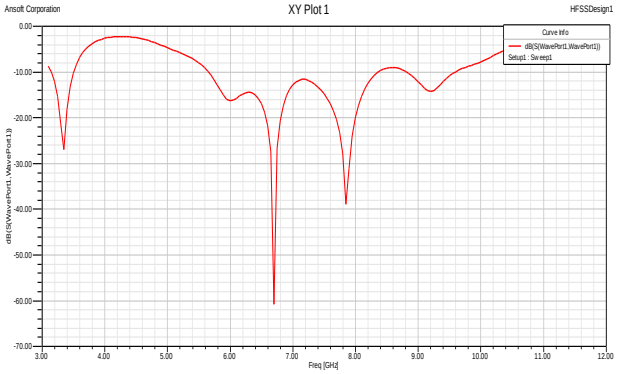

Fig. 6: Result of return loss of proposed antenna

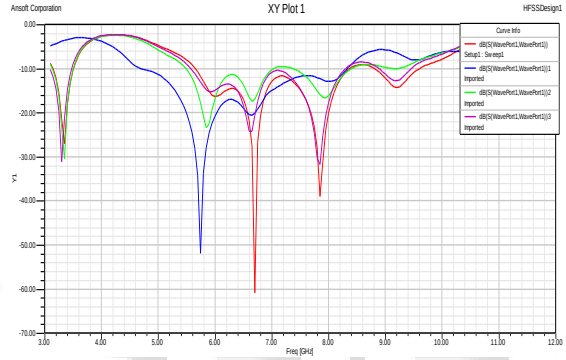

Fig. 7: Simulated results of return losses versus frequency

B. Effect of Parameter Variation on Antenna Performance:

1) Substrate material Variation

In this case there are comparisons of return loss with the variation in the materials of substrate. In this investigation of effect generally Roger 4003, Rogers 3003 & Fr4 are considered. With Fr4 first lobe of return loss -60.86dB occur at 6.7GHz and second lobe of -39.0 dB at 7.85GHz whereas with Rogers4003 the first lobe of return loss of -34.5 dB at 7.35GHz and second lobe of -31.5 dB at 8.7 GHz and Rogers3003 the first lobe of return loss of -23.22 dB at 7.9 GHz and the second lobe of return loss of -25.53 at 9.4 GHz. So it can be concluded that Fr4 act as better material.[3]

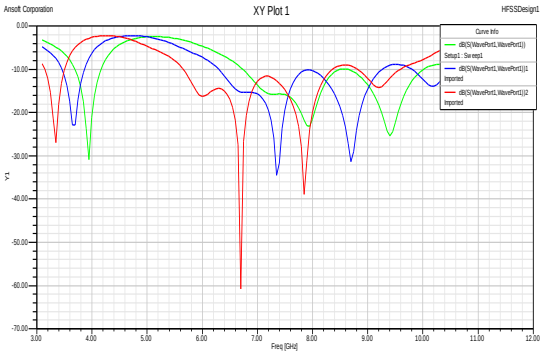

Fig.8: Result of comparison of material

2) Effect of Feed Technique

In this design of micro strip antenna we are taking the different feed technique to calculate their effect on performance. Feed techniques are micro strip line feed, Co-Planar Wave feed, Inset feed. The micro strip feed technique

is easy to fabricate. CPW is a planar microwave transmission line consisting of a central signal line situated between two ground planes, and which is separated from them by a specified gap[3]. In microstrip feed line result is better than CPW and Inset feed.

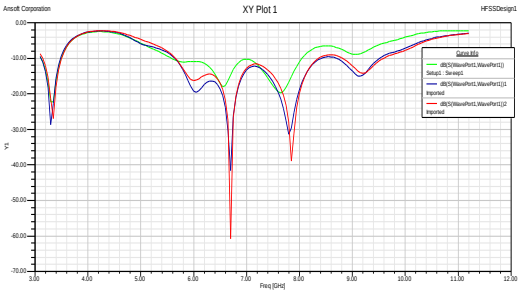

Fig. 9: Result of various technique

C. Radiation Pattern

An antenna radiation pattern or antenna pattern is defined as "a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates. Radiation properties include power flux density, radiation intensity, field strength, directivity, phase or polarization."[1] The radiation property of most concern is the two- or three dimensional spatial distribution of radiated energy as a function of the observer's position along a path or surface of constant radius. In this paper, radiation pattern is taken in terms of gain (dB).Figure9 shows the simulated results of radiation pattern at 0db and figure 10 shows the simulated results at 90 db.

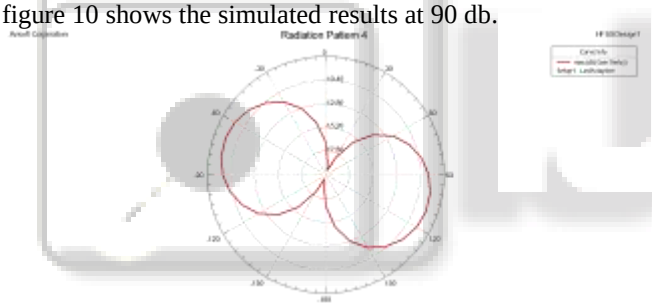

Fig. 10: Radiation Pattern at 0db

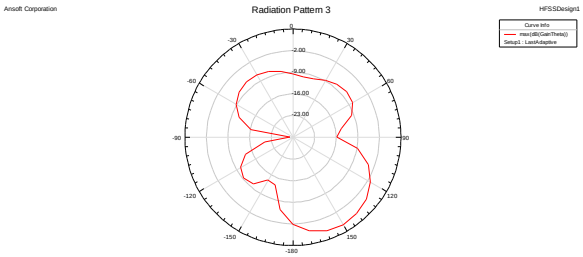

Fig. 11: Radiation pattern at 90 db

D. VSWR

VSWR (voltage standing wave ratio) should be <2.In this design, VSWR <2 in 5.65-9.65 GHz frequency band.

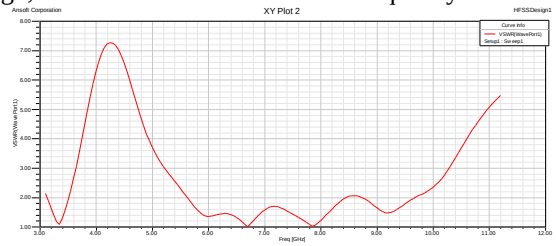

Fig. 12: VSWR versus frequency

V. CONCLUSION

In this paper Micro strip antenna is studied. In this Microstrip feed line is used to excite the antenna. The new patch antenna is improved with better return loss, VSWR. Therefore antenna is work better in satellite communication.In this studied that antenna wideband applications. It has several applications like WiMax , satellite(6.1-7.1Ghz). Efficiency is 87% achieved of proposed antenna.

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