Design of Dual Polarized Aperture Coupled Stacked Patch Antenna for S-Band Radar Applications

V.Kokila[1], S.Swarnalatha[2], M.Durgarao[3]
[1]*M.Tech,SVUniversity,Tirupati.*
[2]*Assoc.Professor,SVUniversity,Tirupati.*
[3]*Sci.Engg,'SF',NARL,Gadanki,Tirupati.*
(E-mail: chinnikokila25@gmail.com)

Abstract— In this paper, the proposed antenna is a dual polarized, aperture coupled, stacked feed antenna operated at a S-Band frequency of 3.2 GHz. The aim of this is to obtain the enhanced bandwidth and better isolation. This proposed antenna has been designed using ADS Software tool. The layout design with its simulated results also shown in this paper. This proposed antenna will be used in S-band weather radar applications due to its better performance.

***Keywords*—** *aperture coupled, stacked patch design, ADS software, isolation and bandwidth.*

I. INTRODUCTION

The most important component of the Wireless Communication system is the antenna, which is used for radiating or receiving the electromagnetic waves. There are different types of antennas like Horn, Yagi uda, Loop, Reflector, Micro strip Patch antennas etc. Among that, at present the Micro strip patch antennas are mostly preferable one due to its merits. Those merits include low profile, small weight, low cost, ease of installation, flexibility and mechanical robustness when composed on hard surfaces etc. Micro strip antennas most widely used in applications such as Wireless communications, Cellular mobile communications, Broadcast satellite system and Global positioning system, Military applications etc.

In general, micro strip patch antenna consists of a conducting patch of any planar or non-planar geometry on one side of a dielectric substrate with a ground plane on other side. The general micro strip patch antenna is shown in below figure.1.

Stacked micro strip patch antenna configuration is defined as when one or more patches are stacked on top of each other separated by one or more dielectric layers. The stacked configuration of the patch antenna is shown in below figure.2.

In this paper, dual feed arrangement with stacked mechanism is proposed. The aim of this dual feed arrangement is

- To obtain the better isolation between the two feeds.

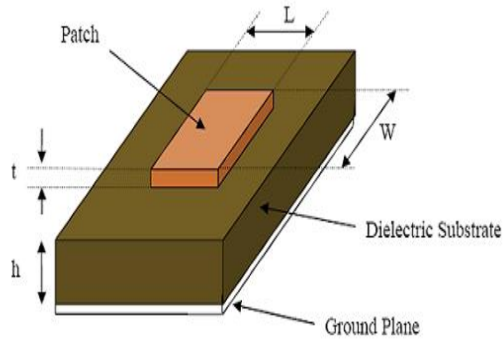

Figure.1.Micro strip patch antenna

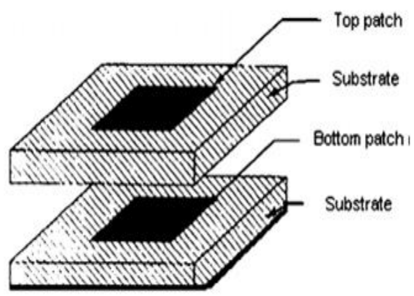

Figure.2. Stacked configuration of the patch

Here, the aperture coupled feed slot method is used. In order to obtain this aperture coupling, the radiating patch is etched on the top of antenna substrate and the micro strip line feed is etched on the bottom of the feed substrate.

The first aperture coupled slot antenna was introduced in 1985 by DM Pozar. The main advantage of this aperture couple feed method for micro strip patch antenna is:

- To enhance the bandwidth.

It is based on coupling of an aperture between the patch antenna and the micro strip feed line. Different slot shapes used for antenna design such as rectangular, H-shape, bow tie, dog bone etc. In this design, bow tie shaped slot is used. The advantage of this bow tie shaped slot is:

- To increase the bandwidth.

Hence, the proposed patch antenna can be designed using ADS software.

II.DESIGN GEOMETRY OF PROPOSED ANTENNA

Antenna design:

The proposed antenna is designed for a resonating frequency of 3.2GHz.The substrate material is FR4 whose relative permittivity,ε_r=4.6.The substrate thickness is 1.6 mm. Here the rectangular patch is used. The conductor is copper, whose conductivity is 5.8e7 siemens/m and loss tangent of TanD is 0.01.The dimensions of the proposed rectangular patch antenna can be calculated by using the following design equations.

i.width of the patch:

The width of the patch is given by,

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

Where,
C= velocity of light in free space (3×10^8m/sec).
f_r= resonant frequency.
ε_r= relative permittivity of the substrate.

The length of the patch can be determined by the following equations:

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

Where,
ε_{reff} is the effective dielectric constant and h is the thickness of the dielectric substrate.

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \qquad (3)$$

Where,
L_{eff} is the effective length of the patch.

$$\Delta L = 0.412 \times h\frac{(\varepsilon_{reff}+0.3)(\frac{w}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{w}{h}+0.8)} \qquad (4)$$

Where, ΔL is the extended length of the patch.

ii. Length of the patch:

By using equations 2, 3 and 4, the length of the patch is given by,

$$L = L_{eff} - 2\times\Delta L \qquad (5)$$

Where, L is the actual length of the patch.

- Here, two feeds are used, one is horizontal polarized and vertical polarized one and its dimensions can be obtained by using micro strip line calculator while giving its known impedance values and feed is of tuning fork shape.
- Typically slot dimensions are 10:1. But here, the length and width of the bow tie aperture slot are of 15:5 which is for bandwidth enhancement.

III.DESIGN OF PROPOSED ANTENNA IN ADS

Here, the proposed rectangular patch stacked dual Polarized antenna can be analyzed and simulated using ADS software. The layout diagram of proposed antenna is shown in below figure 3.

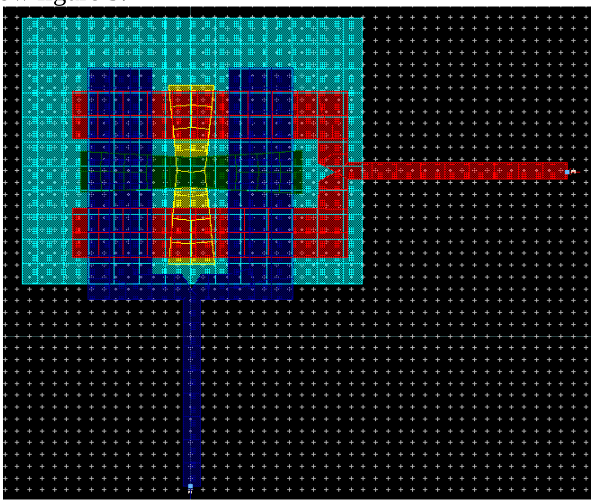

Figure 3.Layout of the proposed antenna.

In the layout, feed 1 (dark blue) is placed, then slot 1 (green) is placed, then feed 2 (orange-red) is placed, then slot 2 (yellow) is placed and finally patch is placed.

Ports can be inserted to its corresponding feeds

The substrates arrangement of proposed antenna is shown in figure 4.

Initially there is ground plane, substrate 1 is for feed 1, substrate 2 is for slot 1, substrate 3 is for feed 2,substrate 4 is for slot 2 and finally substrate 5 is for radiating patch.

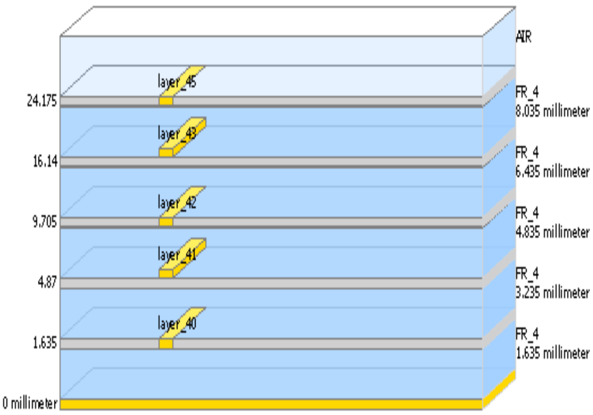

Figure 4.Substrates arrangement of the proposed antenna.

IV.SIMULATED RESULTS

In ADS, after designing the antenna in layout and arranging the substrates, then specify the frequency at 3.2 GHz.

After simulating, the S-parameters and return loss of the proposed antenna and its simulated results is shown in below figure.5.

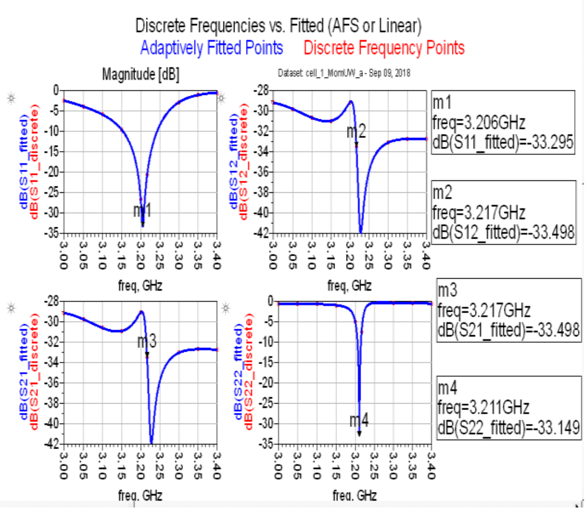

Figure.5. Return loss and S-parameter results.

From the above figure, the return loss of -33 dB and bandwidth is 329 MHz and isolation parameters, S_{12}= S_{21}= -33.49 dB.

$$BW = f_H - f_L \quad (6)$$
$$= 30.452-(-30.123)$$
$$= 329 \text{ MHz}$$

The below figure 5 shows the antenna parameters such as gain is 2 dB and directivity is 7.8 dB. The far field pattern of the proposed antenna also shown below.

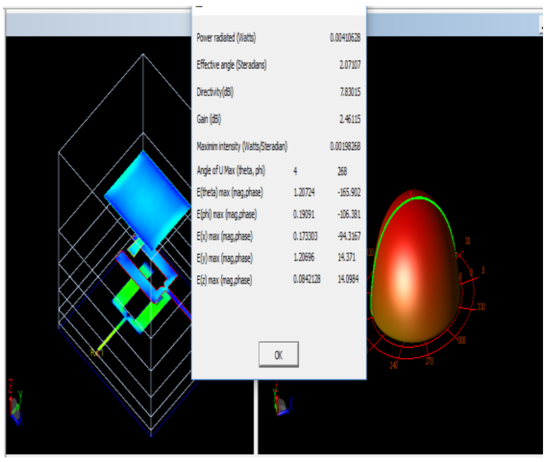

Figure.6.Parameters of proposed antenna.

V.CONCLUSION

In this paper, the proposed antenna thus provides a bandwidth of 329 MHz , Directivity is 7.8 dB, gain of 2.46 dB, isolation of -33.498 dB and return loss of -33.2 dB at desired s-band frequency of 3.2 GHz. Hence this proposed one gives better performance and it will be helpful in future purpose.

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V.Kokila, present studying M.Tech in Electronics communication and engineering, specialization is Communication systems at Sri Venkateswara University, Tirupati. I did this project in National Atmospheric Research Laboratory, Gadanki, Tirupati.