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Wideband Coaxial Fed Rotated Stacked Patch Antenna for Wireless Applications

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Abstract
A novel circularly polarized coaxial fed rotated stacked patch antenna is proposed and its performance characteristics are presented in the current work. The antenna consisting of four parasitic patch, each one being rotated by 30^0 relative to its adjacent patches. The proposed antenna is giving return loss less than -10 dB with VSWR<2 and bandwidth 700 MHz (5.8 to 6.5 GHz) with axial ratio less than 3dB. The analysis of the antenna is explained through parametric study and HFSS simulation results are presented in the current work.
Keywords: Coaxial Feeding Rotated Stacked Patch, Performance Characteristics.

I. Introduction

Miniaturization of microstrip patch antennas (MPAS) is a very challenging field to investigate due to the increasing interest in integrating such antennas in MMIC circuits. The conventional dimensions of MPAS are around a half waveguide wavelength. Several miniaturization techniques are appearing to reduce such dimensions. These techniques can be classified in: 1) Use of high permittivity substrates; 2) Use of magnetic substrates; 3) Increase electrical length; 4) Short-circuits; 5) Superstrates and 6) Combinations of them [1]. Using high permittivity substrates, the antenna size can be considerably reduced. One of the main problems is the surface-wave mode excitation causing a reduction of surface-wave radiation efficiency. Moreover, as the substrate has finite dimensions, the diffracted field due to the surface-wave mode, degrades the radiation pattern increasing the side-lobe level and increasing also the cross polar field. In arrays, the mutual coupling caused by surface wave modes limits beam-steering [2].

One of the methods of generating circular polarization with broad AR bandwidths is the application of stacked multilayered patch structures. In [3]–[5], various configurations of stacked patch antenna structures have achieved dB relative bandwidths of 13.5%, 9.6%, and 13.5%, respectively. In [6], a microstrip antenna composed of an L-shaped feed network, a wide slot, and a parasitic patch has obtained a bandwidth of 45% with a gain of 4 dBic. However, the antenna radiates in a bidirectional radiation pattern. Among microstrip antennas, aperture stacked patch (ASP) antennas [7]–[10] are appealing due to their wide-VSWR bandwidth. In this paper, a novel method is presented for the generation of circular polarization by a modification of an ASP antenna composed of four patches, each one being oriented at an angle of 30 with respect to its adjacent lower and upper patches. The advantages of the proposed antenna are its high gain, wide CP bandwidth, simple design, ease of fabrication, and appropriate geometry to be used in an array configuration.

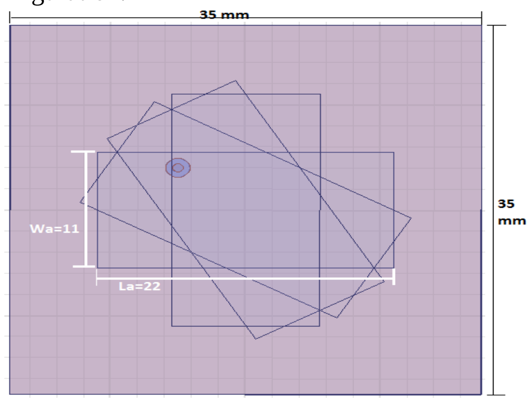

Fig 1 Coaxial Fed Rotated Stacked Patch Antenna

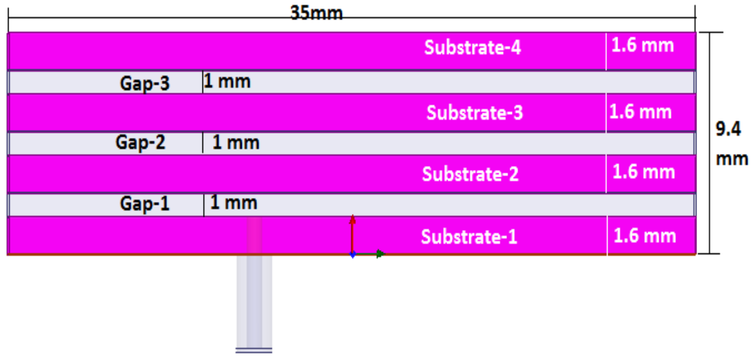

Fig 2 Side View of the Model

II. Antenna Specifications

Fig 1 and 2 shows the proposed antenna model with rotated stacked patches and side view of the antenna. The stacked patches are taken on FR4 substrate materials with separation of 1.6 mm thickness of each substrate. Table 1 shows the antenna specifications.

S. No	Specification
1	4-Layers
2	All are FR-4 Substrates
3	3 air gaps
4	Patches are rotated 30 degrees consecutively
5	Feed location: (-5mm, 4mm)
6	Dimensions: 35mm x 35mm x 1.6mm
7	Patch dimensions: 22mm x11mm

III. Results and Discussion

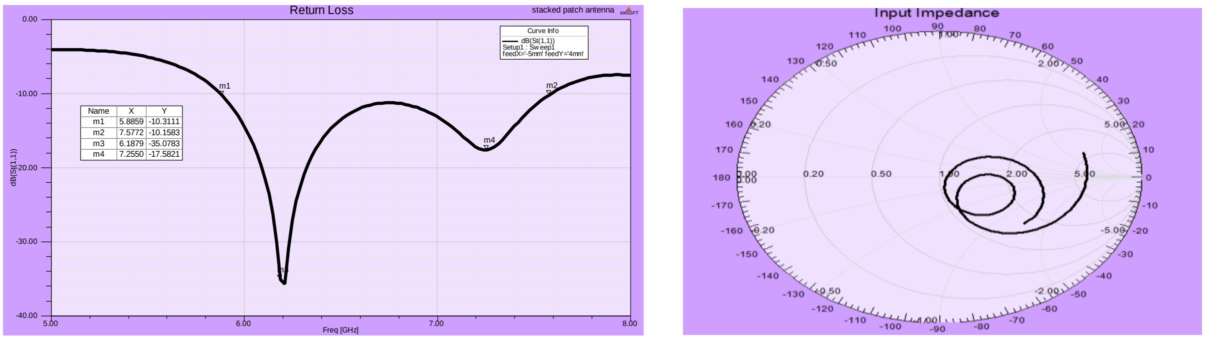

Fig 3 Return loss Vs Frequency and Smith Chart

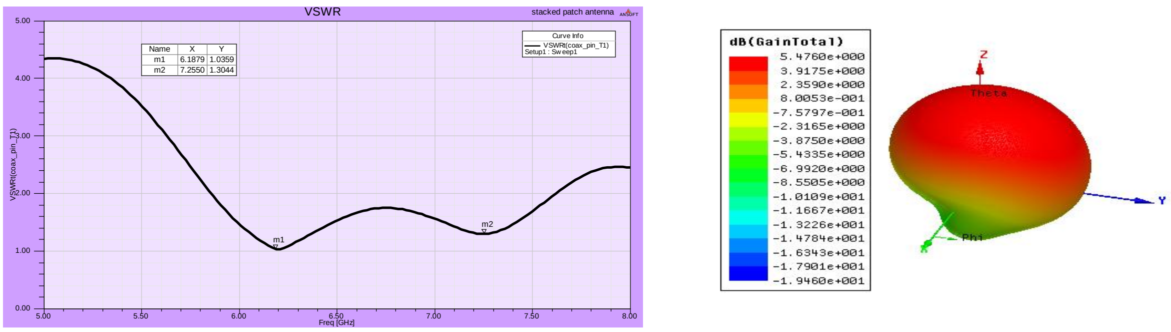

Fig 4 VSWR and 3D gain of the Antenna

The input impedance smith chart for the proposed antenna and return loss simulated at selected frequencies is shown in the figure (2). The return loss curve shows the amount of energy that is lost at the resonating frequencies when load is connected. The frequency responses of the reference antenna-namely gain, VSWR and AR—versus frequency are shown in Fig 5 and 7. Circular polarization is achieved if two perpendicular components are simultaneously excited with equal amplitude and ± 90^{0}out of phase. By rotating each patch, both components of a linear polarization, i.e., $a\square_x$ and $\square_y$, are excited and the distances between patches lead to a phase difference between adjacent patches.

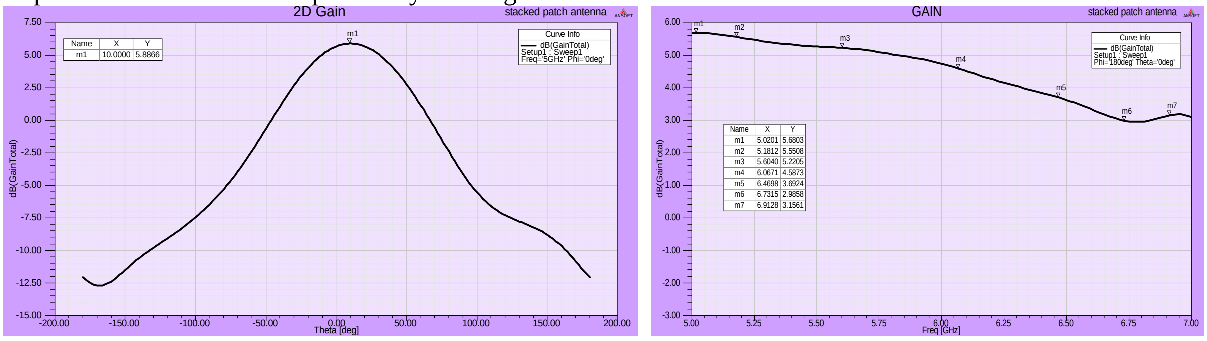

Fig 5 2D gain curve and Frequency Vs Gain Curve

Antenna radiation pattern is the display of the radiation properties of the antenna as a function of spherical coordinates (θ, □). In most cases the radiation pattern is determined in the far field region for constant radial distance and frequency. For a linearly polarized antenna, the E and H planes are defined as the planes containing the direction of maximum radiation and the electric and magnetic field vectors respectively. Figure 6 shows the radiation pattern of the antenna in E and H plane.

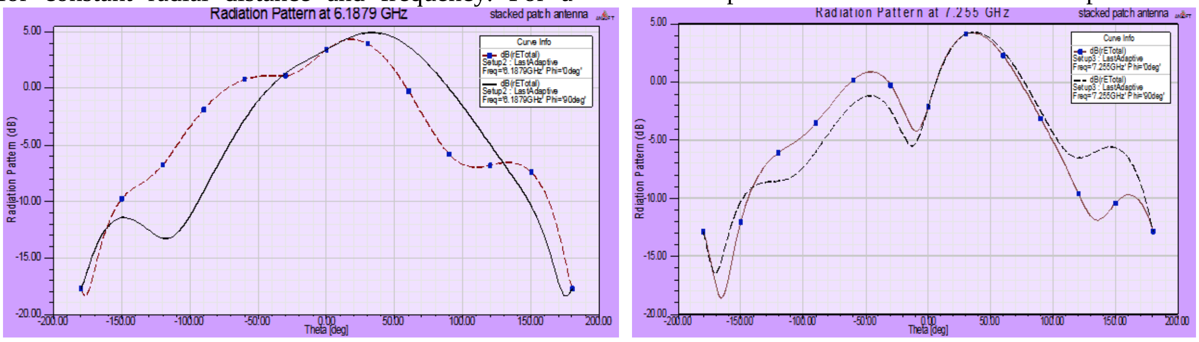

Fig 6 Radiation Pattern in E and H Fields

Observe that the antenna with a single patch can also generate a circularly polarized radiation pattern. In this case, the patch should be oriented at the angle of 45 relative to the feed slot.

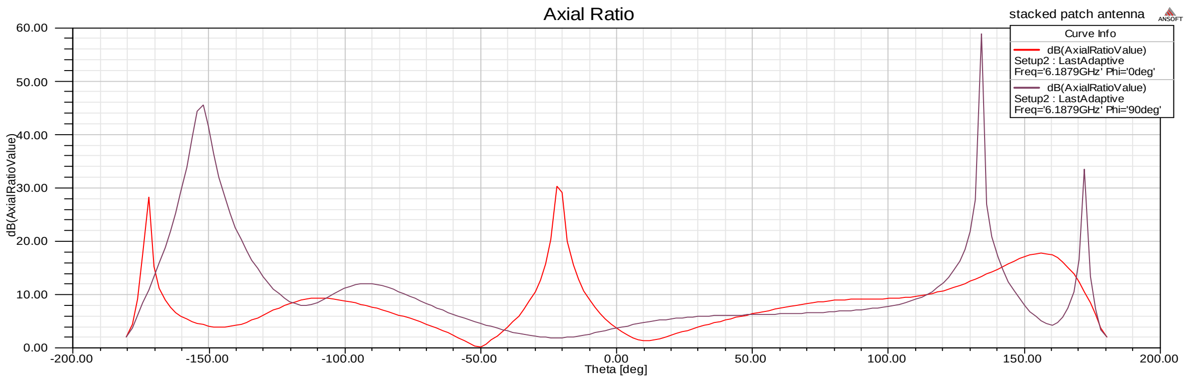

Fig 7 Axial ratio frequency Curve

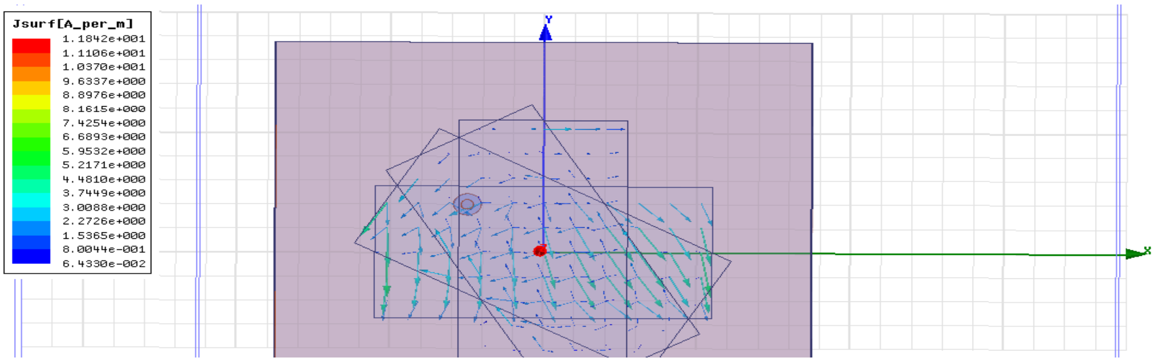

Fig 8 Current Distribution of antenna at 6.1 GHz

IV. Conclusion

Circularly polarised microstrip stacked patch antenna with rotated patches is presented in this work. The current design is operating with good performance characteristics and stable gain throughout the desired frequency band. All the antenna parameters are simulated using HFSS and their analytical presentation is given in this paper. Axial ratio less than 3dB and VSWR less than 2 are the reasonable things for applicability of this antenna in the real time environment.

V. Acknowledgments

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