Dual band circularly polarized microstrip antenna with single stub with Ansoft HFSS

Abhishek Joshi, Narendra Yadav, Rabindra Kumar

Abstract— **Design and analysis of a single-feed arrangement of hexagonal patches is proposed, which is proficient of providing circular polarization along with broadband implementation. An antenna is designed on a glass epoxy FR-4 substrate with overall thickness of the structure less than 1.6 mm or $0.11A_0$. Axial ratio bandwidth better than 4.3 % at 5.7 GHz, 6.8% at 8.2GHz and impedance bandwidth better than 27% may be achieved with the proposed hexagonal geometry. Calculated gain and axial ratio variations of the proposed antenna with frequency are compared to simulated results for better understanding. The measured E-plane and H-plane radiation patterns in the entire impedance bandwidth are exactly same in shape, and the direction of maximum radiations is normal to the patch geometry designed. In the complete axial ratio bandwidth range of the proposed hexagonal patch antenna, the E-plane left circularly polarized patterns are nearly 15 dB higher than the corresponding right circularly polarized patterns.**

Index Terms— **Axial ratio bandwidth, circularly polarized, radiation patterns, broadband, hexagonal microstrip antenna.**

I. Introduction

The Compact circularly polarized broadband microstrip antennas are becoming useful structures for modern communication systems including mobile, wireless, and global positioning systems [1], [2]. Microstrip antennas are small in size, and can be integrated with other planer components. Three main limitations associated with the conventional microstrip structures are their capability to resonate at a single frequency, narrow impedance bandwidth, and low gain. However with the demand of compact-size antennas for modern communication systems, several alterations in these antennas were proposed [3]-[5]. The bandwidth of conventional microstrip antennas may be

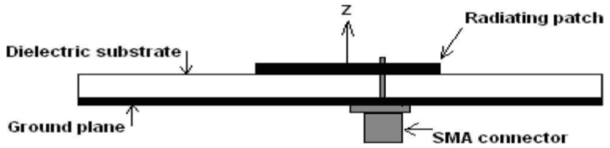

Fig. 1. Side view of heaxagonal patch antenna

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improved considerably by applying suitable narrow stub [6], [7] at an appropriate location on the patch [9]. Circular polarization in conventional patches may be achieved by suitable selection of the feed location [10]. With conventional patches, it is extremely difficult to achieve large impedance bandwidth and large axial ratio bandwidth simultaneously. In this paper, the design and performance of a compact single-feed arrangement of an antenna for circularly polarized broadband performance is reported. The proposed antenna provides improved impedance and axial ratio bandwidths and also presents improved gain.

II. Antenna Design and Results

A. Single-Layer Hexagonal Microstrip Antenna with a Stub

First, we have considered a single-layer hexagonal patch antenna with a narrow slot as shown in Fig. 2. This antenna is designed on a glass epoxy FR-4 substrate (ε_r -4.4, tanδ - 0.025, substrate thickness h - 1.58 mm). The simulation analysis of this antenna is carried out by applying HFSS simulation software [11]. The antenna is fed through a single inset feed arrangement by using an SMA connector. The patch has patch dimensions radius of 5mm. With optimization in stub dimensions 5mm x 2mm, it is realized that the best performance with such an antenna may be achieved by feeding diagonally.

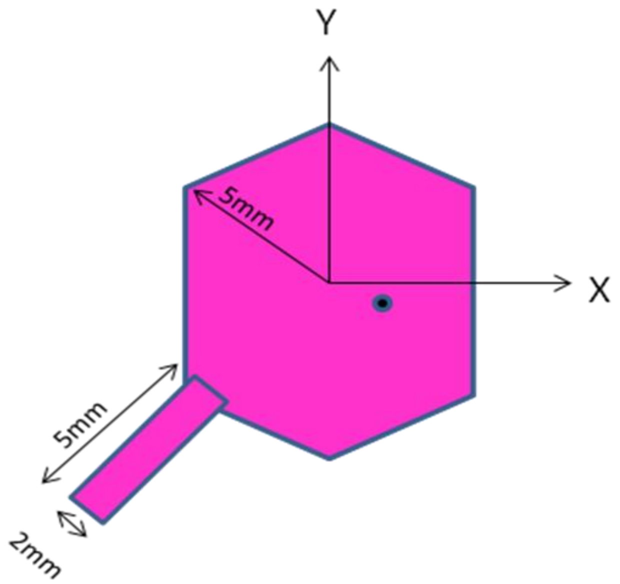

Fig. 2. Proposed design of heaxagonal patch antenna

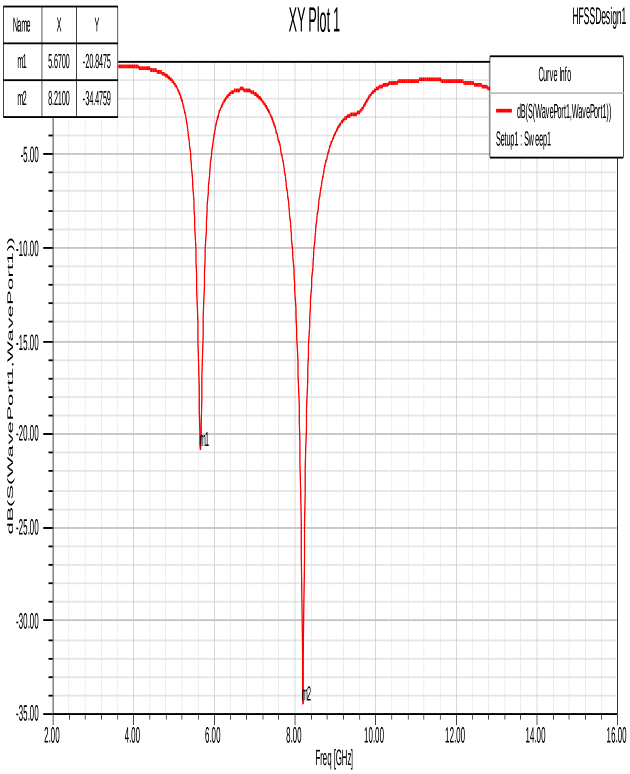

Fig. 3. S-Parameter of single layer hexagonal patch with a stub

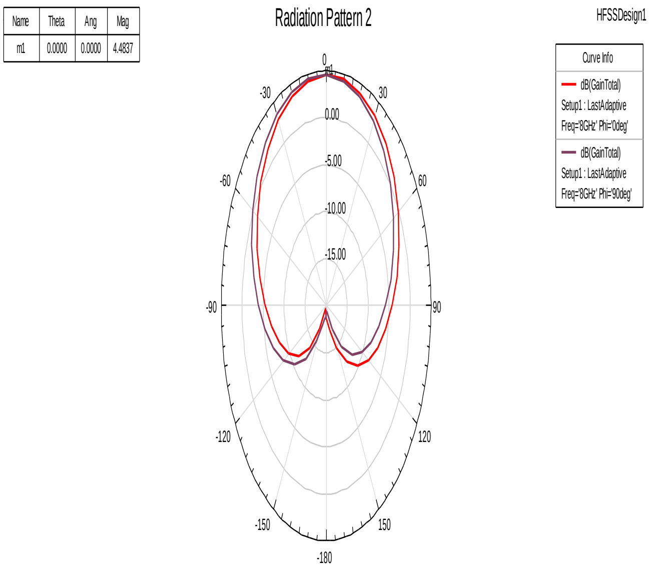

Fig. 4. Total Field Gain curve for single layer hexagonal patch with a stub

The measured variation of the reflection coefficient (S_{11}) with frequency, as shown in Fig.3, shows that the antenna resonates at two frequencies, 5.6 GHz and 8.2 GHz, corresponding to two different modes of excitation. The measured input impedances presented by the antenna at these frequencies are near about 50 *iX*, but the simulated gains at these frequencies are very low. The impedance bandwidths of this antenna (for S_{11} < -10 dB) at both resonance frequencies (5.6 and 8.2 GHz) are narrow.

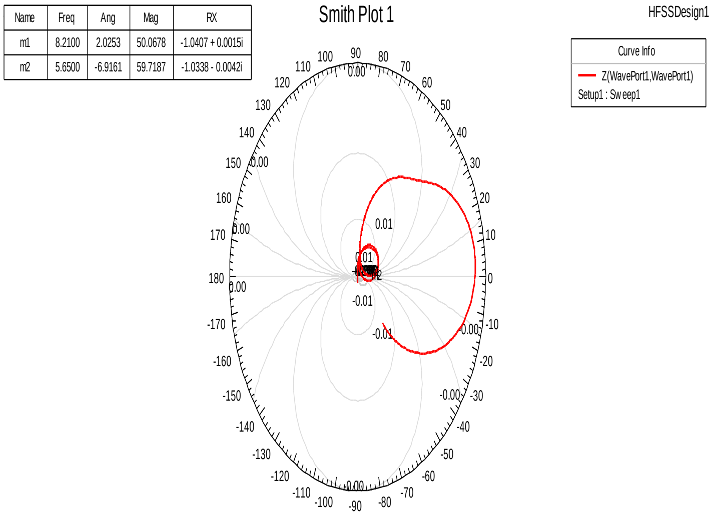

Fig. 5. Polarization of single layer Hexagonal patch with a stub

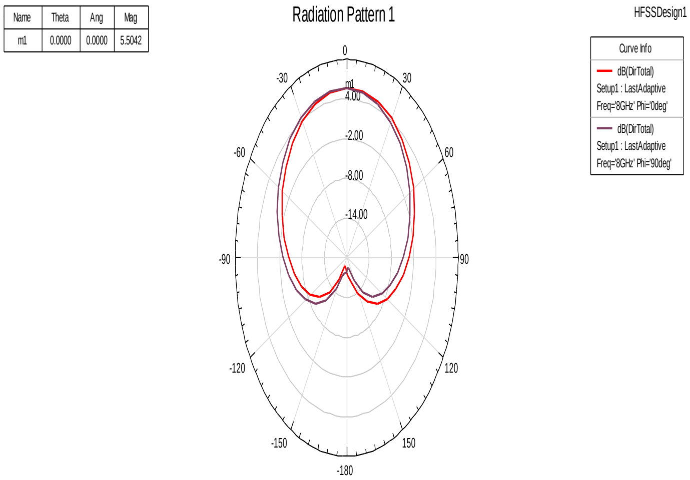

Fig. 6. Directivity curve for single layer hexagonal patch with a stub.

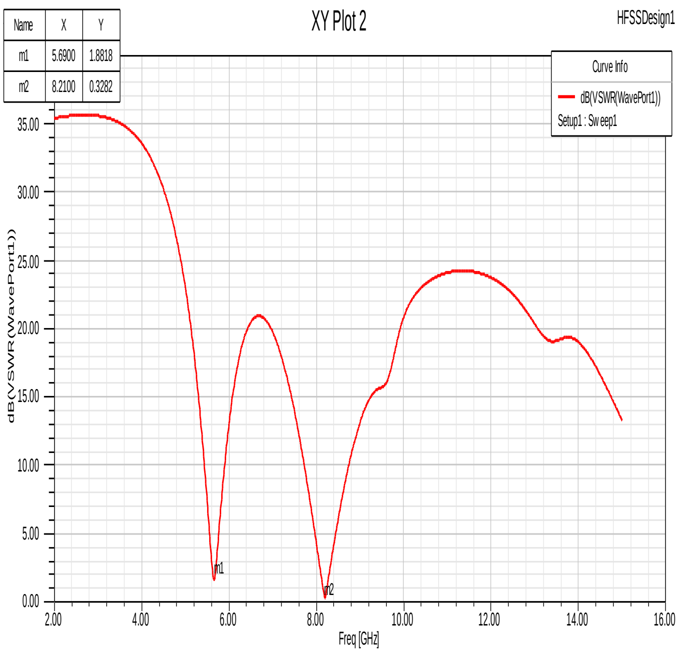

Fig. 7. VSWR for single layer hexagonal patch with a stub

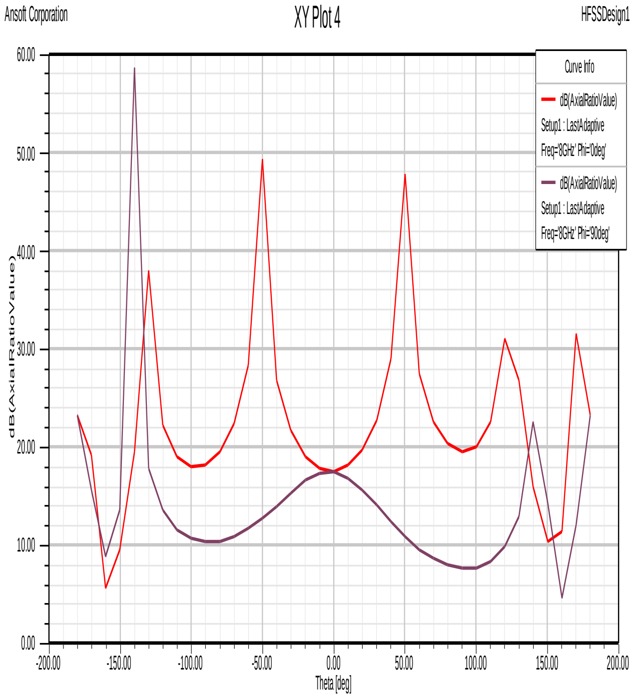

Fig. 8. Axial Ratio for single layer hexagonal patch with a stub

The circular polarization behavior of the antenna is realized during the design of the antenna with simulation software. By varying the feed location on the patch, variation in axial ratio with frequency is obtained. The feed point is adjusted until the axial ratio attains a minimum value close to 1 dB. The simulated and measured variations of the axial ratio as a function of frequency are shown in Fig. 8, which indicates that the measured axial ratio attains a minimum value at resonance frequency 8.2 GHz. The axial ratio below 3-dB range are 8.1~ 8.25 GHz (~150 MHZ) the entire axial bandwidth.

III. Conclusion

This paper presents the design and performance of a single-feed hexagonal patches on a glass epoxy FR-4 substrate. The designed antenna presents improved impedance and axial ratio bandwidths and larger gain than a single-layer linear polarized antenna. These improved parameters are achieved without much increase in the thickness of the structure. In several modern-day wireless and satellite communication systems, circularly polarized radiations with higher axial ratio bandwidth are desired, and this antenna may prove to be a useful structure for these systems.

Acknowledgment

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