Design and Development of Tapered Spiral Helix Antenna

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Abstract**—**
This paper is designed to develop a tapered spiral helix antenna covering the frequency range 1-18GHz. Tappered spiral helix antenna is a compact state-of-the-art circularly polarized antenna, which works over multi-octave frequency bandwidth(1-18GHz). The spiral helix consists of a spiral antenna with a spiral radiator, the balanced to unbalanced (balun) transformer, backing cavity and a helical antenna where the outer ends of spiral antenna are terminated with a helix. The helix is placed with its axis at90^0 to the spiral lies behind it is designed to produce circularly polarized radiation over a range from 1-18GHz. In general spiral helix antenna provide frequency coverage unattainable in a single device.

The design of spiral circuit will be done using a computer generated program in MATLAB software. The design of helix is done in CST studio suite software and finally , combined results are simulated by using CST software..

Index Terms— **balun, CST, polarization, tappered.**

INTRODUCTION

Defense systems require antennas having wide bandwidth capable of receiving signals coming from any direction with any polarization in the absence of priori information about the threat signal. Cavity backed spiral antennas can be used extensively for airborne systems because of their inherent characteristics of broadband, circular polarization, compact size, lightweight and flush mounting ability.

The spiral helix antennas maintain consistent gain and input impedance over wide bandwidths with circular polarization and hence a wide range of applications exists, ranging from military surveillance, ECM ECCM to numerous commercial and private uses including consolidation of multiple low gain communication antennas on moving vehicles.

For airborne platform size and weight are at premium. Many applications such as direction-finding systems or reflector feeds require a broadband antenna element that provides orthogonal senses of polarization. Polarization capability such as vertical and horizontal or right and left circular from a common aperture with coincident phase centers is of particular interest. Therefore, we are going for the design of spiral antenna which is similar in size to the spiral element, has a beam width and gain approximately the same as the spiral, but provides two orthogonal senses of polarization

I. DESIGN OF HELIX

- *Number of turns = 5.5*
- *Pitch angle =7*
- *Radius change = -0.8*
- *Polygon radius =0.5*
- *Start helix radius = 17*
- *Radius ratio =0.65*
- *Angle =5.5*360*
- *Ground plane Diameter = 56.2*
- *Radius = 30*

A. MEASURED RESULTS

The measured VSWR and radiation pattern with respect to frequency are illustrated in the following figures.

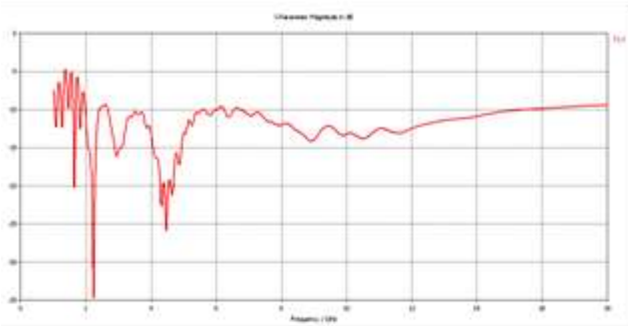


Fig. 1 VSWR measurement of Spiral Helix Antenna 1-18 GHz

The figure 1 represents the VSWR pattern of spiral helix antenna 1-18 GHz. From this diagram measured Maximum VSWR is -5.

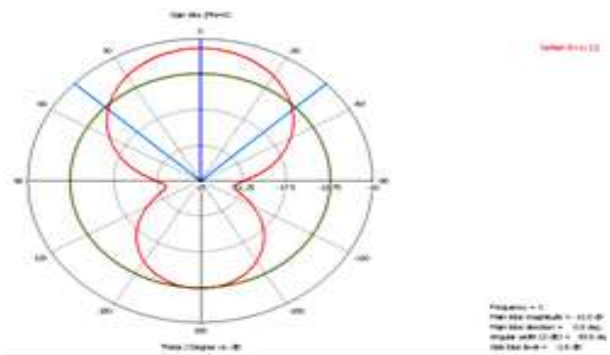
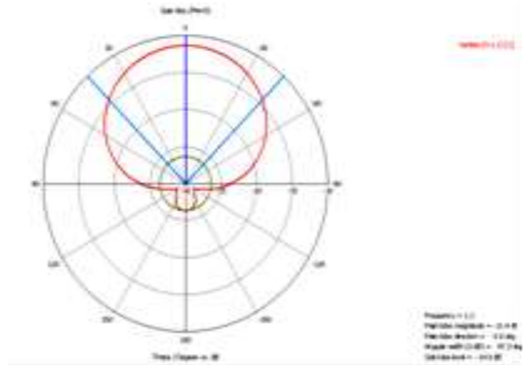


Fig. 2 Radiation Pattern of Spiral Helix Antenna at 1 GHz

The figure 2 represents the radiation pattern at 1 GHz. From this diagram measured gain is 1.11dB, beam width is 94°, and squint is 1°.



The figure 3 represents the radiation pattern at 1.2 GHz. From the diagram shown above the measured gain is -11.4 dB, beam width is 87.3°.

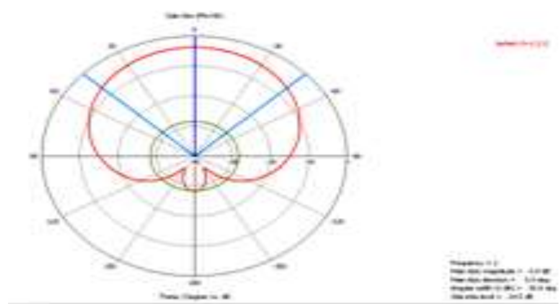


Fig 4 Radiation Pattern of Spiral Helix Antenna at 2 GHz

The figure 4 represents the radiation pattern at2 GHz. From the diagram shown above the measured gain is 4.598 dB, beam width is 94°, squint is 0° and axial ratio is 0.2.

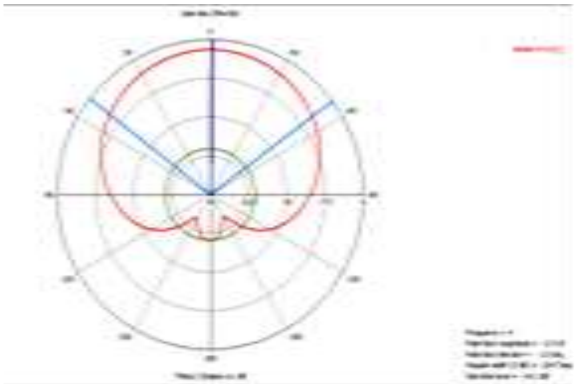


Fig 5. Radiation Pattern of Spiral Helix Antenna at 4 GHz

The figure 5 represents the radiation pattern at 4 GHz. From the diagram shown above the beam width is 105°, squint is 5° and axial ratio is 0.8.

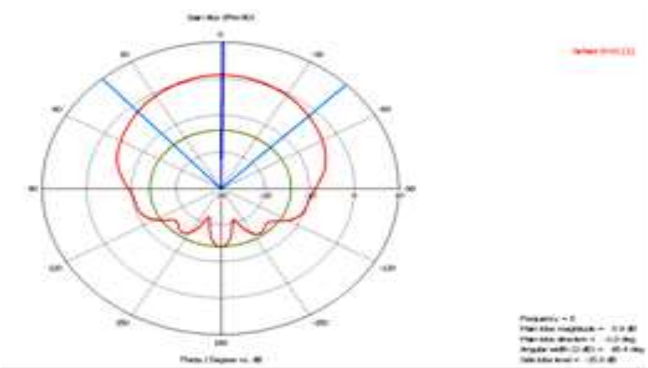


Fig 6. Radiation Pattern of Spiral Helix Antenna at 8 GHz

The figure 6 represents the radiation pattern at 8 GHz. From the diagram shown above the measured gain is 2.765dB, beam width is 86.4°.

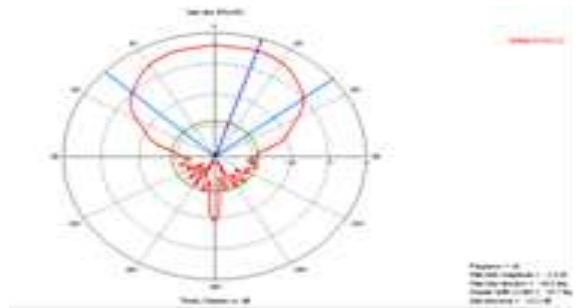


Fig 7. Radiation Pattern of Spiral Helix Antenna at 18 GHz

The figure 7 represents the radiation pattern at 18GHz. From the diagram shown above the measured gain is 3.89 dB, beam width is 98°, squint is -6° and axial ratio is 0.5.

B. SIMULATED RESULTS

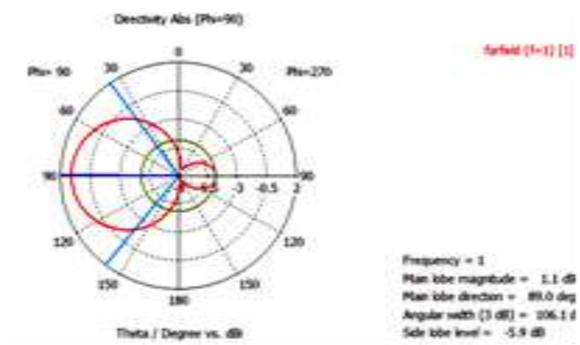


Fig. 8. Directivity

C. Model of simulated antenna

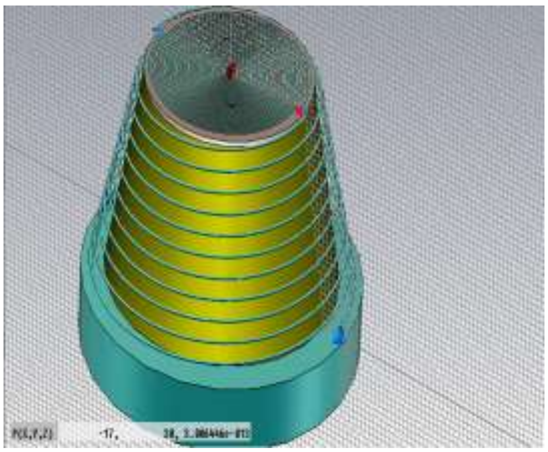


Fig.9 Model of Simulated Antenna

D. 3d results

These 3Dimensioanal results are represented in figure10, figure11, figure12&figure 13. These results are obtained at different frequencies.

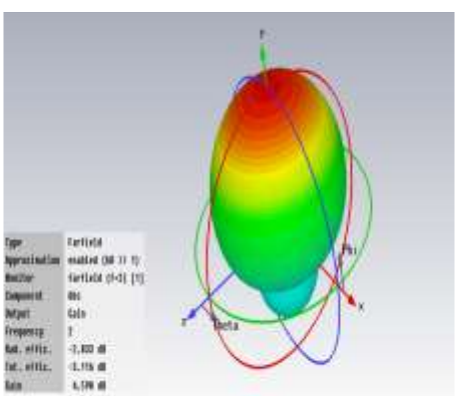


Fig 10. 3d representation operating at frequency=2Ghz

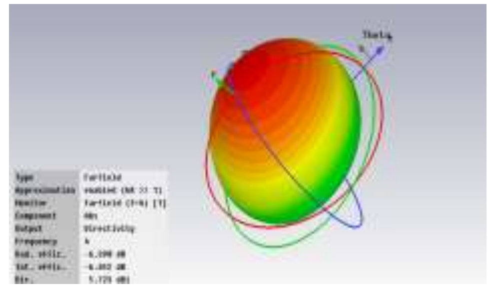


Fig11 .3d representation operating at frequency=4Ghz

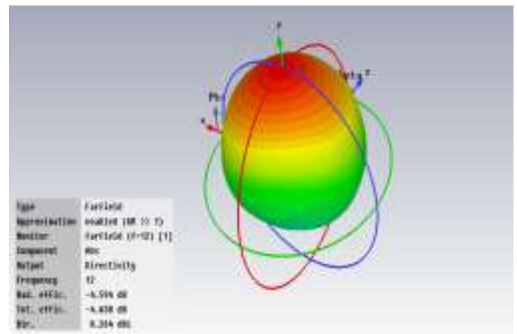


Fig 12. 3d representation operating at frequency=12Ghz

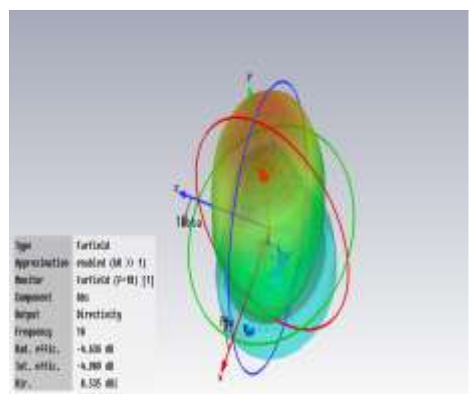


Fig 13. 3d representation operating at frequency=18Ghz

CONCLUSIONS

This paper presents the complete theoretical analysis, and evaluation of an electrically small spiral helix antenna covering the frequency range of 1-

18GHz.The design of the cavity is very critical particularly when it is to operate over multi-octave bands. The complete design considerations of the cavity were also brought out in this report. The performance characteristics show that the antenna exhibited very good radiation characteristics over 1-18 GHz. The measured VSWR of the Antenna is less than 3.65:1 over the entire band.

FUTURE SCOPE

Further scope of research is recommended in the following areas

1. In this paper a spiral helix antenna operating in 1 - 18GHz is designed.
2. Research work can be done on this type of antenna because of its advantages over conventional cavity backed spiral antennas

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