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SUSTAINABLE DESIGN AND ANALYSIS OF WIDEBAND COMPOSITE SPIRAL ANTENNA

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ABSTRACT

Mainly the aim of this project is to design and develop a composite spiral antenna covering a frequency range of 05-18GHz with the dimension of 90mm having square configuration of 0.5-2GHz and round configuration of 2 -18 GHz and having strip width and strip gap of 0.5 mm. For airborne platforms size and weight are at premium. Square spiral is a better choice when compared to round spiral because of reduced aperture.The composite spiral antenna got gain from 0 to -9 db for different frequencies and VSWR of 1:2 with return loss better than 10 db.

Introduction:

In microwave systems, a spiral antenna is a type of RF antenna. It is shaped as a two-arm spiral, or more arms may be used. Spiral antennas were first described in 1956. Spiral antennas belong to the class of frequency independent antennas which operate over a wide range of frequencies. Polarization, radiation pattern and impedance of such antennas remain unchanged over large bandwidth. Such antennas are inherently circularly polarized with low gain. Array of spiral antennas can be used to increase the gain. Spiral antennas are reduced size antennas with its windings making it an extremely small structure. Lossy cavities are usually placed at the back to eliminate back lobes because a unidirectional pattern is usually preferred in such antennas.

Since the introduction of the composite spiral antenna, its popularity as an electronics support measures antenna, especially on aircraft has been second to none. They have been designed to cover octave or multi octave band from 0.5 to 40 GHz and if their manufacture is carefully controlled, can be made to track in gain to ± 100 spiral antennas have also been designed as transmitting source for about 100 Watts power. For high power case, the spiral is etched on a thermally conductive substrate, so that the heat is drained away via the cavity. Since the physical size of an antenna is proportional to wavelength, low frequency antennas become prohibitively

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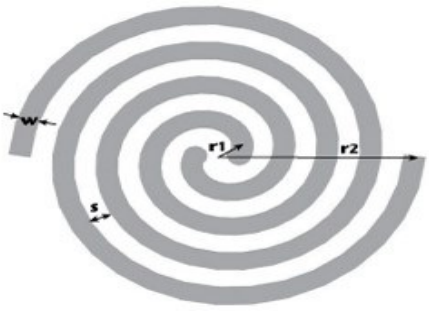
large for many installations, particularly in aircrafts. Hence significant size reduction becomes almost essential.

The design of composite spiral antenna includes the design of three basic components.

a) Design of spiral card
b) Design of balanced to unbalanced (Balun) transformer
c) Design of cavity

Design of Spiral Card

The smallest and largest diameters of the spiral antenna are decided by the highest and lowest frequencies. The diameter is given by $\lambda f \pi$ of the lowest frequency operation of spiral antenna. . It is mathematically described by the equation $r = a\ \theta + b$, where r is the radial distance from the origin (mils), a is the spiral growth rate (cm/radian), θ is the angular position (radians), and b is the initial radial offset from the origin (mils). For the spirals discussed here, the growth rate a =0.318cm/radian.



The spiral has a constant width of 0.5mm throughout the antenna. A computer program is developed for designing spiral circuit. Spiral coordinates are obtained from the program developed after feeding input data.

Design of balun

A **balun** is an electrical device that converts between a balanced signal (two signals working against each other where ground is irrelevant) and an unbalanced signal (a single signal working against ground or pseudo-ground). A balun can take many forms and may include devices that also transform impedances but need not do so. Transformer baluns can also be used to connect lines of differing impedance. The origin of the word balun is **bal**ance + **un**balance.

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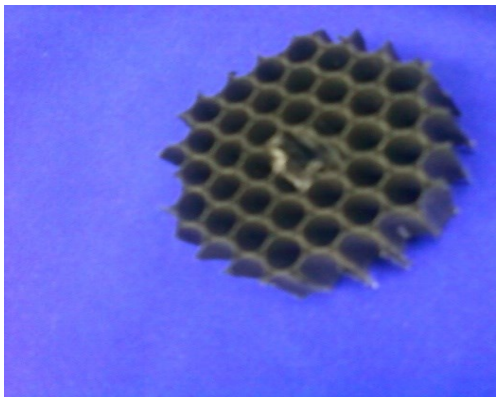
Design of cavity

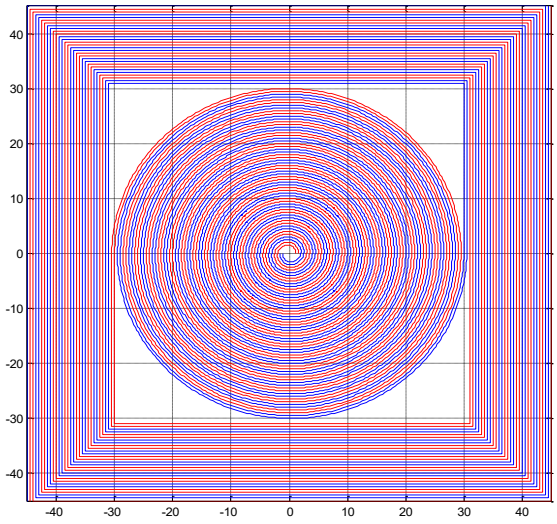
The property of spiral is to radiate in both the directions. As radiation in only one direction is required reflecting cavity is used so as to observe the radiation in one direction.

The cavity is loaded with honeycomb absorber (ECCOSORB HC-0.5) to avoid destructive interference of the reflected signal from the bottom of the cavity.

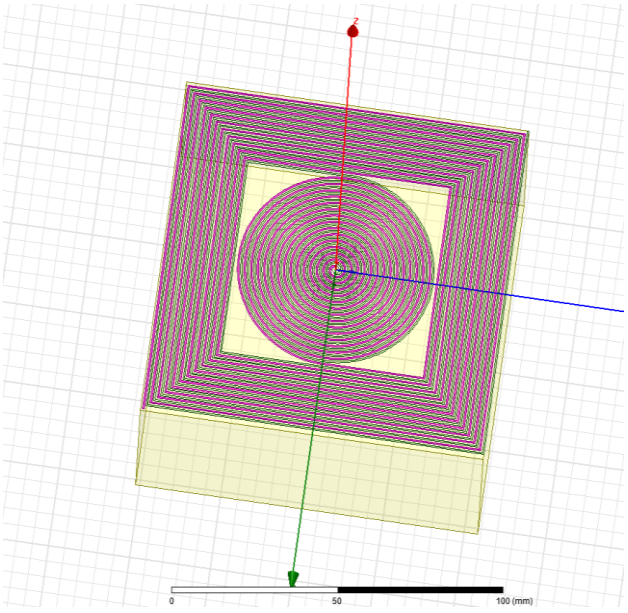


STEPS INVOLVED FOR DESIGN:

The design of spiral card and balun are done using a computer program generated in MATLAB software. This software generates the required co-ordinates for spiral as well as balun circuit. The necessary positive/negative films are generated in AutoCAD and the circuits are printed on substrate using photolithographic techniques. The composite spiral antenna has been simulated using HFSS software and various characteristics are verified by simulating the antenna patterns. The output for matlab program designed for composite spiral antenna



The output for composite spiral antenna using HFSS software and the radiation patterns and vswr has been plotted.



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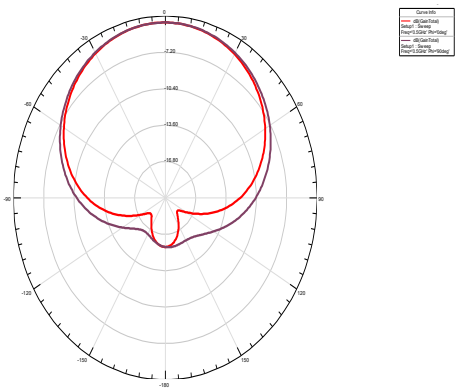
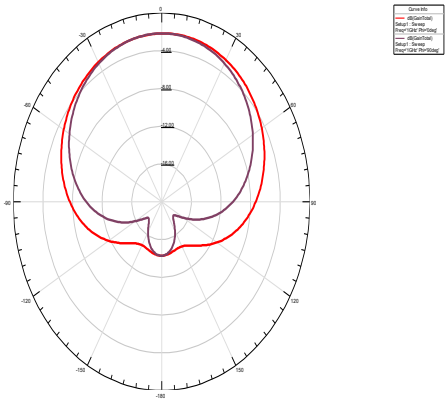
RADIATION PATTERNS FOR COMPOSITE SPIRAL ANTENNA:

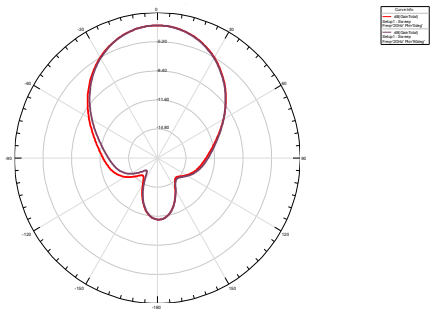
For 0.5 GHz



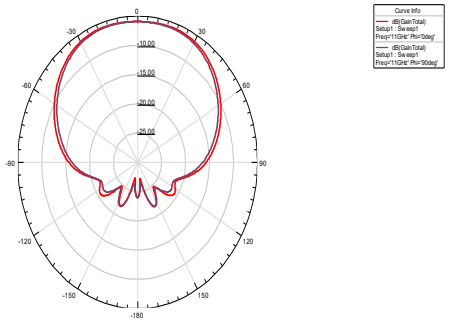
For 1 GHz



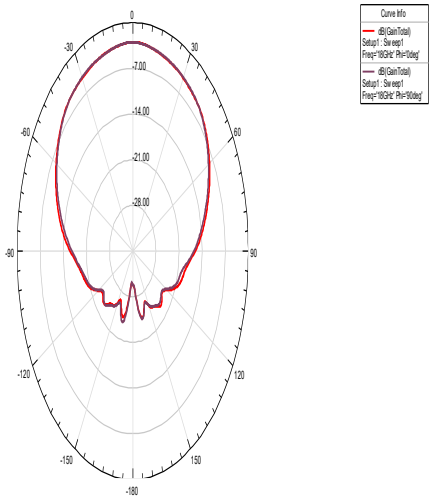
For 2 GHz



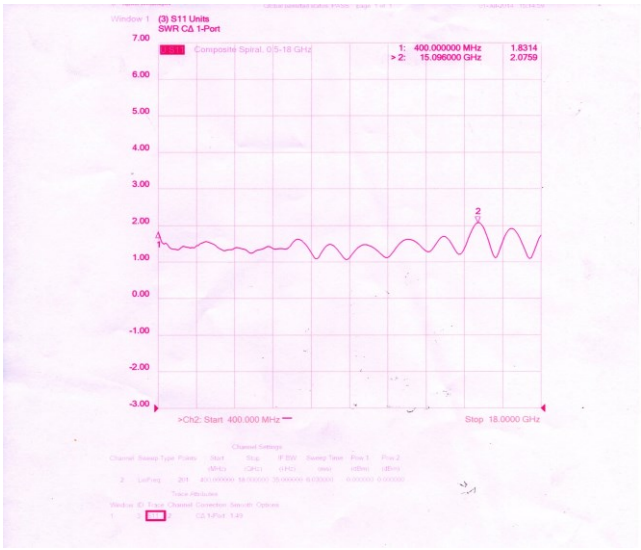
For 11 GHz



For 18 GHz



VSWR of Composite spiral antenna



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