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Novel Approach to the Design and Simulation Of Square Spiral Antenna

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Abstract:

In this paper a square spiral antenna is design and simulate. To reduce the size of antenna, achieve high gain, and UWB. Wireless Technology is one of the main researches in the world of communications systems today. A study of communications system is incomplete without an understanding of the operation and fabrication of antennas. In the world of modern wireless communication, engineer who wants to specialize in the communication field needs to have a basic understanding of the roles of electromagnetic radiation, antennas, and related propagation phenomena. In the war scenario we don't have prior information about signal from enemy target. We don't know about the frequency information and polarization information of the signal. To cater these requirements, the antennas should be capable of operating over wider bandwidths with circular polarization. The circular polarized antennas are capable of receiving any type of linearly polarized signal oriented in any direction. Spiral antenna is one of the most useful and popular antennas for microwave direction finding since it exhibits wide frequency band. As a member frequency independent antenna, spiral antennas meet this requirement with their inherent features like ultra wideband bandwidth, circular polarization and flush mounting capability. Size of the spiral antenna can be reduced by implementing modulation technique at the end terminals. Mainly the aim of this project is to design and simulate spiral antenna covering a frequency range of (2-3) GHZ. The design of spiral antenna will do by using MENTOR GRAPHICS IE3D TOOL.

Keywords — **spiral antenna, UWB, mentor graphics ie3d SOFTWARE.**

1. INTRODUCTION

Over the past few years there has been an increasing interest in the development and use of efficient antenna systems that have certain desirable characteristics and can be easily integrated into the various shaped bodies, conforming their outer surfaces. Equal attention has been given to the need for reducing the size of antennas, especially in cases where there are space limitations and the antennas must be conformal to the surfaces. At first glance, satisfying these requirements would appear to be a formidable task because, despite the difficulties involved in achieving these goals in most antenna systems there can be no sacrifice in electrical performance. However, antenna systems that can be designed to include these features can solve many problems and have numerous applications.

In microwave systems, a spiral antenna is a type of RF antenna. It is shaped as a twoarm 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.

In this paper design and simulate square spiral antenna to achieve good impedance, improve far field performance, high gain, directivity, size reduce implementing in ie3d software. Mainly this antenna is used for Direction Finding (DF) systems mounted on aircrafts, missiles and ships Military surveillance Satellite tracking systems. The block diagram of spiral antenna is shown:

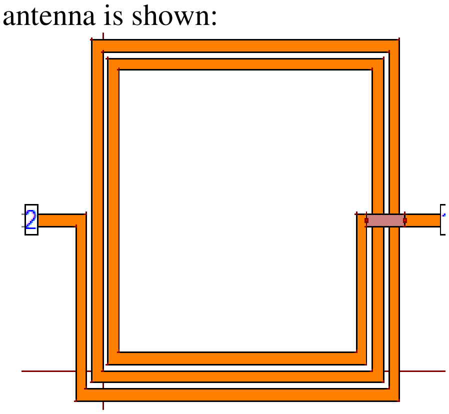

Fig 1.1: square spiral antenna

2. DESIGN SPECIFICATION

Different design parameters are to be considered while designing square spiral antenna. The parameters which define the spiral antenna are:

- Spacing between the turns.
- Width of arm.
- Inner Radius of spiral
- Outer Radius of spiral
- Feed length.

The inner radius is measured from centre of the spiral to centre of the first turn while the outer radius is measured from centre of the spiral to centre of the outermost turn.

We can calculate R1 and R2 by using

$$F_{high}=c/2\pi R_1$$

$$F_{low}=c/2\pi R_2$$

Where $R_2 > R_1$

Different design of spiral antenna can be obtained by varying number of turns it contains, the spacing between its turns and the width of its arms. a dielectric medium is used with a specific permittivity and dimension over which the spiral is printed. The dielectric medium is Rogers RT Duroid is use. It help to reducing the physical size of antenna. The Loss Tangent (tan δ) =0.001 and input impedance is 50ohm.

Frequency of operation (fo): The resonant frequency of the antenna must be selected appropriately. The frequency operate over (2-3)GHZ. Hence the antenna designed must be able to operate in this frequency range. The resonant frequency selected for my design is 3.0 GHz.

Dielectric constant of the substrate (εr): The dielectric constant is 2.2. A substrate with a low dielectric constant has been selected since it increases the radiation of the antenna.

Thickness Of Patch(t): The wall thickness, t is governed by:

$$t < \lambda / [20 \times (\varepsilon r)1/2]$$

Where λ is wavelength at highest frequency and εr is the dielectric constant of FRP and resin matrix. At 2 GHz the maximum thickness must be less 5mm. in this paper, the thickness, t=2mm used.

Spiral width and height:

Width and height the is calculate from the frequency is equal to λ/2mm.strip width is a=w/4.

Inner and outer radius of spiral: the inner radius of spiral is less than the outer radius. R1<R2.the gap width is 0.2mm and strip width is 0.4mm.

Spacing: the spacing between the turns is

$$S=\frac{R2-R1}{4N}$$

Where;
R_1=inner radius of spiral
R_2=outer radius of spiral
N= number of turns

Analysis Of Square Spiral Antenna

Given specifications were,
1. Dielectric constant (ε_r) = 2.2
2. Frequency (f_r) = 3.0 GHz.
3. Thickness (t)=2 mm.
4 .Velocity of light (c) = 3×108 ms-1.
5. Practical length (L)=Practical Width (W) = 5mm.
6 .Loss Tangent (tan δ) = 0.001.
7. Gap width= 0.2mm
8. Strip width is 0.4mm

3. SIMULATION IN IE3D

Procedure to simulate spiral antenna in ie3d:
1. Design a square spiral antenna using ENTITY.
2. Select port to define the ports from port for edge group, exit port.
3. Save the file with spiral.geo
4. Select the process and select meshing 5.Then the design can be simulated using SIMULATION in the process tab.
7. The output can be observed using either PATTERN VIEW or using WINDOW tab in M grid

4. RESULTS

4.1 CURRENT DISTRIBUTION

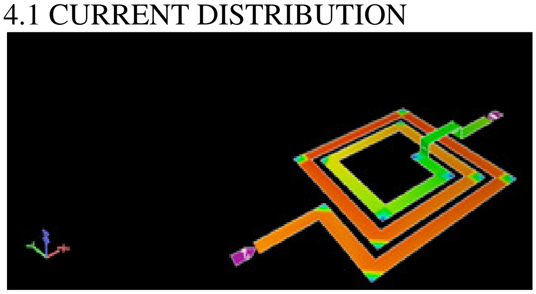

Fig 4.1: Current Distribution

The above fig shows the current distribution of antenna.

4.2: 3D RADIATION PATTERN

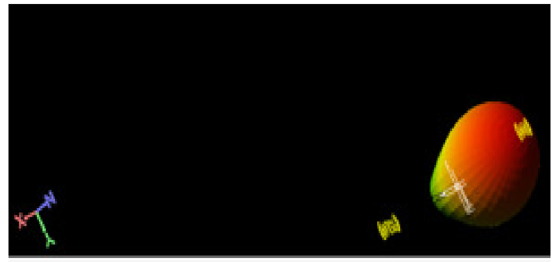

Fig 4.2: Radiation Pattern

The simulation result of radiation is shown. Radiation pattern of an antenna is a graphical representation of the relative field strength transmitted from or received by the antenna. Obviously the graph of radiation pattern S will be three dimensional and hence cannot completely be represented on a plain paper.

4.3 VSWR (Voltage Standing Wave Ratio):

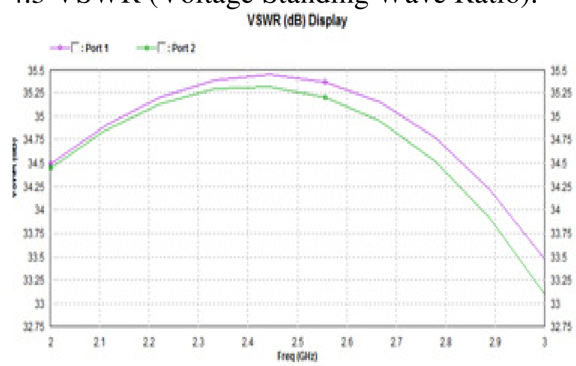

Fig4.3: VSWR

The ratio of the peak amplitude of the standing wave to the minimum amplitude of the standing wave. The above fig shows the VSWR port1 and port2.

4.4 smith chart:

Smith chart is one of the most useful graphical tools for high frequency circuit applications. The chart provides a clever way to visualize complex functions and it continues to endure popularity decades after its original conception. From a mathematical point of view, the Smith chart is simply a representation of all possible complex impedances with respect to coordinates defined by the reflection coefficient

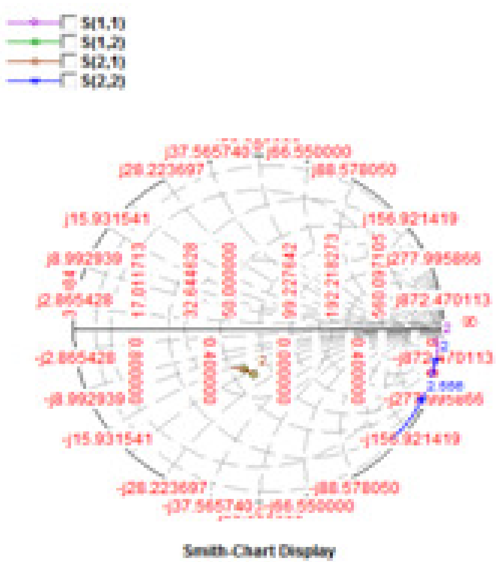

Fig4.4 : smith chart

4.5 Directivity Vs Frequency:

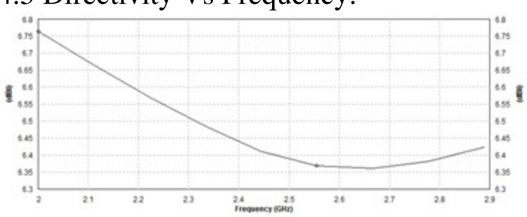

Fig4.5: Directivity Vs frequency

The directivity of an antenna is equal to the ratio of the maximum power density to its average value over a sphere as observed in the far field of an antenna.The directivity versus frequency graph antenna is shown in above figure.the directivity at 3GHZ is 6.42db.

4.6 Gain Vs Frequency:

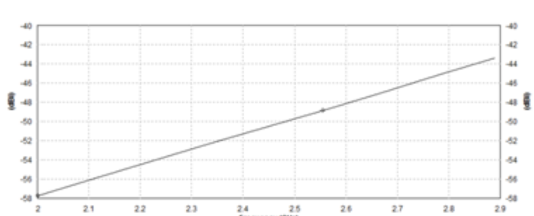

Fig4.6: Gain Vs Frequency

The gain G of an antenna is an actual or realize quantity which is less than the directivity D due to Ohmic losses in the antenna**.** At 3GHZ frequency the maximum gain is -43.5db.

4.7. Back scatter

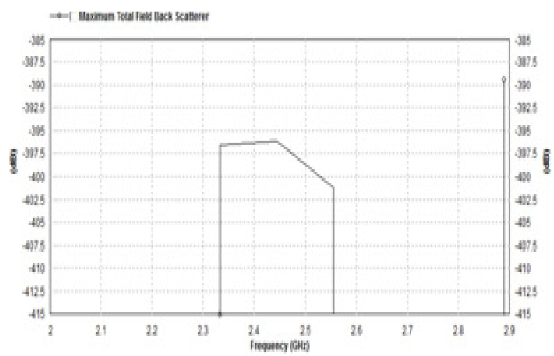

Fig4.7: Back scatter

The above fig shows the back scatter at different frequencies.

5. ANALYSIS OF PARAMETERS AT DIFFERENT FREQUENCIES

Frequency(GHZ)	2	2.3	2.5	2.7	3
Gain(dBi)	-57.675	-52.354	-48.8492	-45.2417	-42.2315
Directivity(dBi)	6.76132	6.48561	6.36832	6.38239	6.54324
Radiation efficiency	0.2827%	0.1715%	0.1968%	0.2552%	0.001%
Antenna efficiency	3.6005%	0.0001%	0.0003%	0.0066%	0.0071%
Voltage source gain(dBi)	-49.9276	-46.6924	-44.5856	-42.417	-40.218
VSWR(dB)	Potr1-34.5 Port2-34.30	Potr1-35.28 Port2-35.25	Potr1-35.30 Port2-35.15	Potr1-35 Port2-34.75	Potr1-34.15 Port2-34.80
VSWR	Potr1-53 Port2-52.9	Potr1-58 Port2-57.8	Potr1-59 Port2-58	Potr1-56.3 Port2-55	Potr1-51 Port2-49
Gain Vs Freq	-58	-53	-49.5	-46.2	-43.5
Directivity Vs Freq	6.75	6.5	6.4	6.36	6.42
Efficiency Vs Freq	0.29	0.17	0.19	0.23	0.29

Table 5.1

From the table we can observe the directivity, gain, at different frequency ranges. As frequency increases the gain is high as shown in the table.

6. ADVANTAGES

1. Small size

2. Low cost
3. Avoiding self-interference

7. APPLICATIONS

1. Military surveillance
2. Wideband communications
3. Monitoring of the frequency spectrum.
4. Spiral antennas are useful for microwave direction-finding

8. CONCLUSION AND FUTURE SCOPE

The design of spiral antennas has been successfully simulated in the IE3D tool and the design analysis has been studied. This design can also be analyzed by varying the dielectric constant, substrate materials. This software also helps in physical realization of spiral antennas with the help of PCB circuit board. Different spiral antenna can be design and simulate using different frequencies. Observing the result in ie3d .as the frequency increases the gain increases. The size of antenna reduce, efficiency is 0.0071%.mainly used in wide band communication and military surveillance.

Future Scope

Further scope of this paper is recommended in the following areas:

1. Polarization is important characteristic of EW antennas.

2. Further reduction in size and improvement in performance can be taken up by modulated rectangular spiral antennas with gradual modulation.

3. Further DF systems are going to be extended up to 40GHz.Hence an ultra-broadband antenna can be designed over the frequency range of 0.5-40 GHz by extending techniques described in this project.

REFRENCES

1. "Wideband Monostatic Simultaneous Transmit and Receive (STAR) Antenna", Ehab A. Etellisi, IEEE.

2. J. R. Wait," Introduction to Antennas and Propagation", Peter Peregrines, Ltd, London.

3.Constantine A Alanis," Antenna theory - Analysis and Design" .New York: Harper Row, 2nd Edition.

4.IEEE Standard definition of terms for ANTENNAS March.

5. A.W.Rudge, K.Milne, A.D.Olver, P.Knight,"The Handbook of Antenna Design" volumes1&2.

6.Clayton R.Paul, Syed A.Nasar, "Introduction to Electromagnetic" by M C Graw Hill International Editions.

7. www.mentor graphics IE3D .com website for information about tool.

8.V.H.Rumsey,"Frequency Independent antennas",IRE Nat Conv.Rec.

9. A.W.Rudge, K.Milne, A.D.Olver, P.Knight,"The Handbook of Antenna Design"volume1&2.