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Design and Performance Evaluation of Archimedean Spiral Antenna For Detecting Electromagnetic Signals

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Abstract
This research presents design and performance evaluation of Archimedean Spiral Antenna broadband antennas for detecting electromagnetic signals. The performance parameter that is evaluated is the gain of antenna for frequency range from 4 GHz to 10 GHz. Designed structure of antenna is evaluated using High Frequency Structure Simulator.
Index Terms— Reflector Antenna**,** VSWR, Bandwidth, Return loss.

1. Introduction

With the rapid growth of wireless technology the need of ultra-wide band is increasing continuously. Ultra wide band or Broad band antenna can be used to attain almost same characteristics over a wide bandwidth. Rumsey principal suggest that characteristics of antenna will be frequency independent if its shape is specified only in terms of angle. Antenna whose shape is specified in terms of angle and which is infinite long is truly frequency independent. However, in reality infinite long antenna do not exist. It is the dimensions of antenna which decides the frequency range over which antenna will be frequency independent. Archimedean Spiral Antenna meets the requirements as laid down by Rumsey and it can be made frequency independent by adjusting its dimensions [1-6]. The structure of Archimedean Spiral Antenna is as shown in Fig (1).

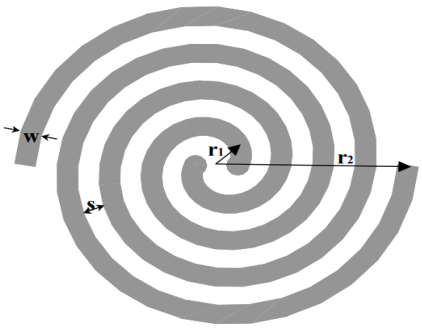


Figure 1 Archimedean Spiral Antenna

The parameters of interest of Archimedean Spiral Antenna includes
(a) Inner radius (r_1)
(b) Outer radius (r_2)
(c) Width of each arm (w)
(d) Spacing between the arms (s)

Each arm of spiral is linearly dependent on angle (φ) so condition of specifying the shape by angle is met here.
Each arm of spiral is specified by

$$r = \varphi\, r_o + r_1 \; and \; r = (\varphi - \varphi_o)\, r_o + r_1$$

Here r_1 is the inner radius of the spiral. And φ_o is the off-set angle.
The width of each arm (w) and Spacing between the arms (s) are related by

$$s = w = \frac{r_2 - r_1}{4N}$$

r_2 here is the outer radius and N is the total number of Turns.
Constant of proportionality r_o is specified by the width of each arm (w) and Spacing between the arms (s).

Here $r_o = \frac{S+W}{\pi}$

The low frequency operating point of the spiral is determined by the outer radius of the spiral and high frequency operating point is determined by the inner radius of the spiral.
And are given by

$$f_{low} = \frac{c}{2\pi r_2}$$

$$f_{high} = \frac{c}{2\pi r_2}$$

Based on above equations the design parameters of Archimedean Spiral Antenna for frequency range from 4 to 10 GHz are given below

Table 1

S.No.	Design Parameter	Value
1	Inner radius	.48 cm
2	Number of turns	1.14
3	Offset angle	90°
4	Number of arms	2

2. Results and Discussion

The structure of Archimedean Spiral Antenna designed using high frequency structure simulator is as shown in Fig (2).

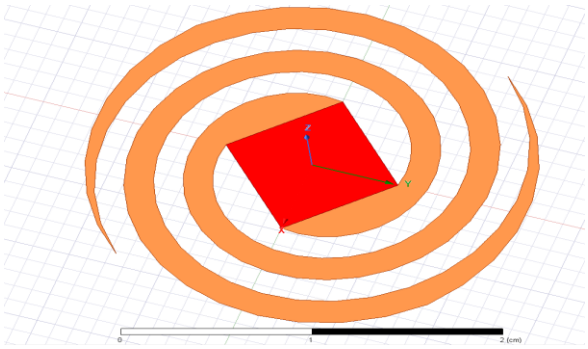


Figure 2 Archimedean Spiral Antenna

The scattering parameters S_{11} of designed antenna are shown in fig (3). From the derived parameters it is evident that designed antenna bears low reflected power from 4 to 10 GHz.

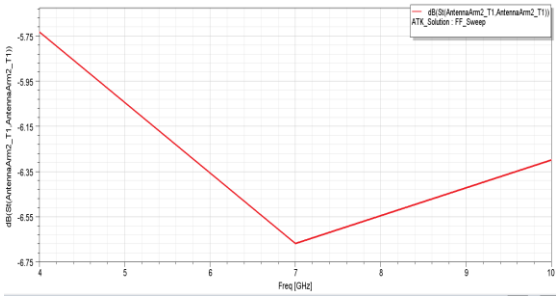


Figure 3 S_{11} parameters

The obtained graph of designed antenna is as shown in Fig (4). For frequency range from 4 to 10 GHz
The obtained VSWR varies from 3.15 to 2.70.

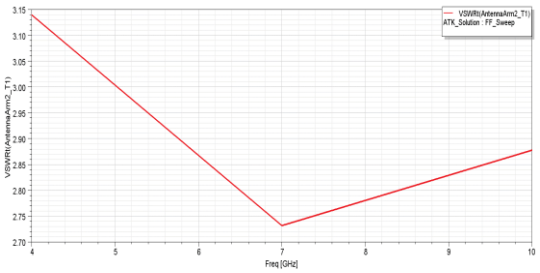


Figure 4 VSWR Graph

The radiation pattern of antenna at 4 GHz is shown in Fig (5). From the radiation pattern a directive gain of 2.9 dB is observed at 4 GHz.

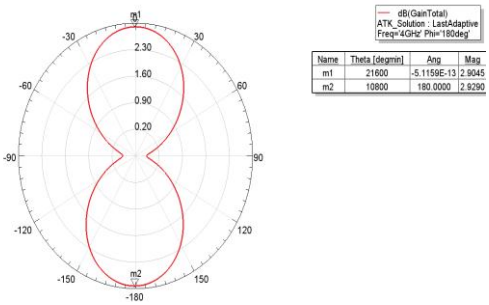
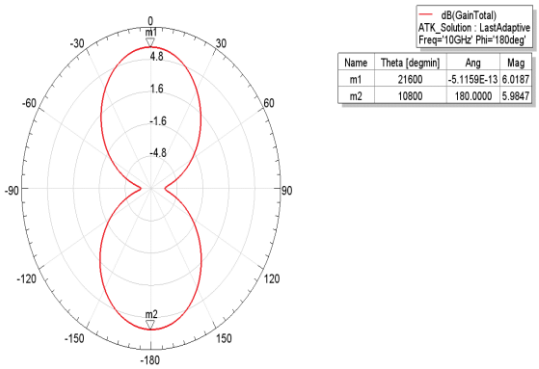


Figure 5 Radiation Pattrn at 4 GHz

The radiation pattern of antenna at 10 GHz is shown in Fig (6). From the radiation pattern a directive gain of 6 dB is observed at 10 GHz.



Conclusion

A Broad band Archimedean Spiral Antenna for frequency range from 4 to 10 GHz is designed and simulated. The directive gain of antenna achieved at 4 GHz is 2.9 dB and directive gain at 10 GHz is 6 dB.

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