Circularly Polarized Spiral Antenna for Defence Application (2-18GHz)

Nidhi joshi1, Parul Singh2, Aniruddh Pandey3, Yadav Amit Ramesh4 , Aboli Moharil5

1Department of Electronics and Telecommunication, Shree L.R. Tiwari College of Engineering, Thane, Maharashtra, India
Nidhi.joshi@slrtce.in
2Department of Electronics and Telecommunication, Shree L.R. Tiwari College of Engineering, Thane, Maharashtra, India
Parul.singh@slrtce.in2
3Department of Electronics and Telecommunication, Shree L.R. Tiwari College of Engineering, Thane, Maharashtra, India
Aniruddh.pandey@slrtce.in3
4Department of Electronics and Telecommunication, Shree L.R. Tiwari College of Engineering, Thane, Maharashtra, India
Amit1.yadav@slrtce.in4
5Department of Electronics and Telecommunication, Shree L.R. Tiwari College of Engineering, Thane, Maharashtra, India
Aboli.Moharil@slrtce.in5

ABSTRACT

In order to accomplish its intended objective, this project seeks to design and develop a "Circularly Polarized Spiral Antenna for Defense Application" that can receive signals from 2 GHz to as high as 18 GHz. It is determined that an Archimedean spiral antenna Ansus HFSS Antenna Simulation tool will be used to simulate topology. Building and testing a sample antenna to ensure it satisfies all requirements or necessary to measure, contrast, and analyses the antenna gain, output return losses, voltage standing wave ratio, and radiation patterns for different frequencies..

Keyword :- *Archimedean Spiral Antenna, Circular Polarization*

1. INTRODUCTION

In the world of information today, antenna development is accelerating quickly. It is utilised in satellite transmission and wideband applications. The RADAR programme also makes use of this antenna. The antenna is used to send and receive signals over a medium or in open space. In that, spiral antennas are utilised for frequency spectral tracking and wideband communications. Typically, spiral antennas have circle polarisation. The pinnacle radiation course of the winding receiving apparatus is typically the opposite of the winding plane. (Radiation from the left). The rotation of a fixed point is continuous. Approximately 225 BC, Canon and Archimedes both examined this spiral. Although compass and straightedge division can be done using Archimedes' Spiral.

The Archimedean spiral antenna is a type of planar antenna that has a unique and compact design. It is widely used in various applications due to its broadband and circular polarization characteristics. The Archimedean spiral antenna has a logarithmic spiral geometry, which provides a continuously varying radiating element. In this paper, an Archimedean spiral antenna operating in the frequency range of 2 to 18GHz is presented. The antenna is designed using a copper trace on a dielectric substrate, and its performance is analysed using Ansus HFSS simulation software.

2. DESIGN OF ARCHEMEDIAN SPIRAL ANTENNA

The Archimedean spiral antenna with a two-arm configuration is the suggested antenna design. The antenna has a broad frequency spectrum, a dielectric constant of 4.4, a loss tangent of 0. The antenna consists of a series of spirals that are connected to form a continuous radiating element. The antenna is fed using a microstrip line that is connected to the spiral trace through a slot in the substrate. The dimensions of the spiral antenna are optimized using HFSS simulation software to achieve the desired performance characteristics.

The strip width of each arm can be found from the following equation,

$$s = \frac{r2-r1}{2N} - w = w$$

assuming a self-complementary structure. Thus, the spacing or width may be written as,

$$s = w = \frac{r2-r1}{4N}$$

where r2 is the outer radius of the spiral and N is the number of turns. The above equations apply to a two-arm Archimedean spiral.

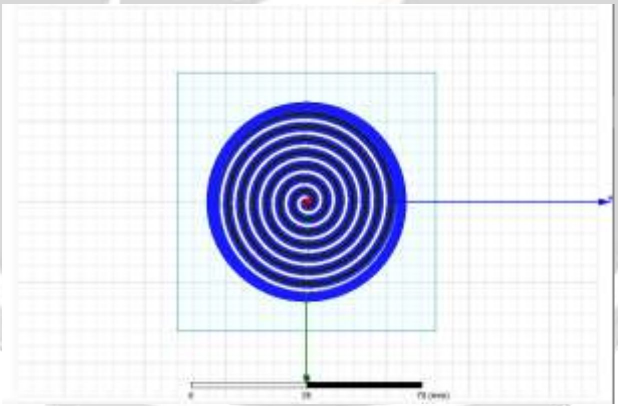

Fig. 1 Spiral antenna

Figure 1 depicts the Archimedean Spiral Antenna developed using HFSS software. The design's essential parameters are displayed in Table 1.

Frequency range	2-18GHz
Dielectric Substrate	FR4_epoxy
Dielectric constant ε_r	4.4
Loss Tangent	0.02
Dielectric substrate dimensions	75mm*75mm
Height of the substrate	0.8mm

Width	1mm
No. of turns	6.5
Radius	27.8mm

Table 1: Spiral antenna parameters

3. ANTENNA PARAMETER

3.1 Antenna Gain

The antenna's power gain, widely known as gain, is a crucial performance measure that combines the antenna's electrical efficiency and directivity. Gain in a transmitting antenna refers to how successfully the antenna transforms input power into radio waves travelling in a particular direction.

The gain of a receiving antenna, on the other hand, refers to how successfully the antenna transforms radio waves that are returning from a certain direction into electric power.

The ratio of the facility generated by the antenna from a far field source on the antenna's beam axis to the facility provided by a hypothetical lossless isotropic antenna, which is equally sensitive to signals from all directions, is the usual way that antenna gain is defined.

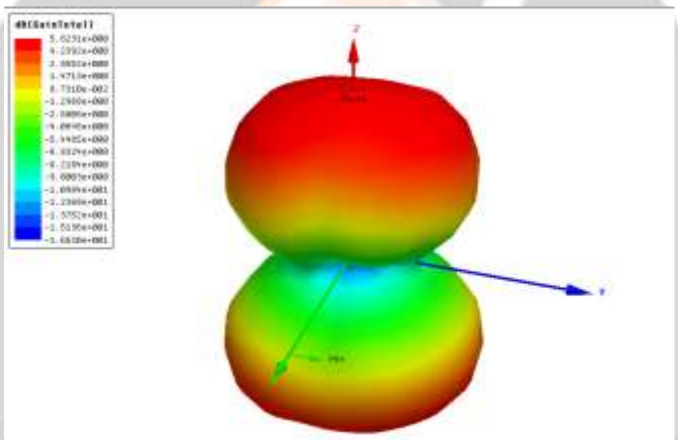

Fig. 2 Overall gain

3.2 VSWR (Voltage Standing Wave Ratio)

VSWR stands for Voltage Wave Standing Wave Ratio and is also referred to Standing Wave Ratio (SWR). It is a function of the reflection coefficient, which describes the power reflected from the antenna. If the reflection coefficient is Γ, then VSWR is given by:

$VSWR = ((1 + \Gamma)/(1 - \Gamma))$

The reflection coefficient is also known as the s11 parameter or return loss. The range of VSWR should be from 0 to 2 as a VSWR value under 2 is considered suitable for most antenna applications. The VSWR is frequency dependent. Frequency dependency means the VSWR for the carrier signal could also be different than for the harmonic signal. Generally, the VSWR is specified as a maximum value for the frequency range of a component.

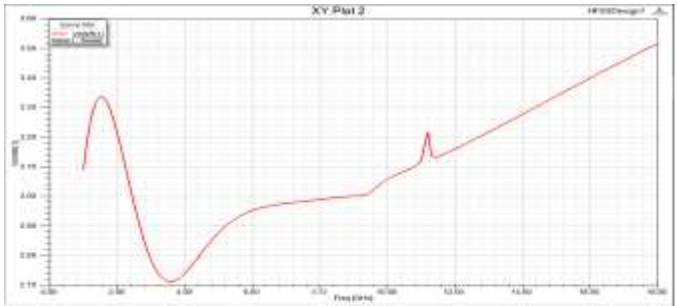

Fig. 3 VSWR

3.3 Radiation Pattern:

The radiation pattern of an antenna is the geometric pattern of the relative strengths of the field emitted by the antenna. The radiation pattern reflects the 'sensitivity' of the antenna in all different directions.

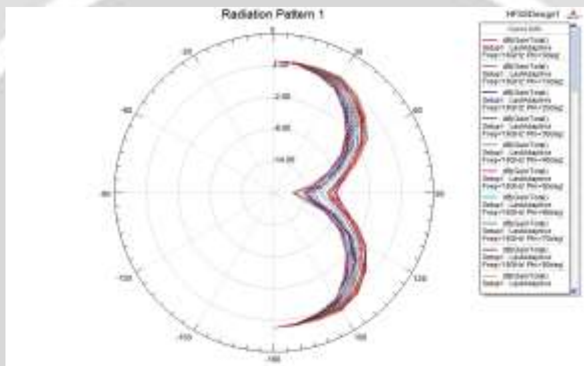

Fig. 4 Radiation Pattern

4. CONCLUSION

The Archimedean spiral antenna in this study was created using Ansus HFSS. The spiral plane receives radiation from the antenna on both sides. We come to the conclusion that our suggested spiral antenna is effective and displays circular polarisation after thoroughly studying all the characteristics. Our simulation findings demonstrate excellent directivity, side lobe-free VSWR of 2:4.

5. REFERENCES

[1]. A. Roy, K. J. Vinoy, N. Martin, S. Mallégol and C. Quendo, "Performance Improvement of Archimedean Spiral Antenna for 2–18 GHz Applications," in IEEE Antennas and Wireless Propagation Letters, vol. 21, no. 7, pp. 1383 1387, July 2022, doi: 10.1109/LAWP.2022.3169274

[2]. A. Ali, M. Hamza, and W. T. Khan, “Smallest form factor, high performance 2–18 GHz cavity-backed Archimedean spiral antenna,” in 2017 International Symposium on Antennas and Propagation (ISAP), pp. 1-2, Phuket, Thailand, November 2017.

[3]. H. Oyanagi, H. Nakano, J. Yamauchi, and S. Sasaki, “Cavity-backed Archimedean spiral antenna with strip absorber,” IET Microwaves, Antennas & Propagation, vol. 2, no. 7, pp. 725–730, 2008.

[4]. NIRALI HEMANT PATEL, “Design & Implementation Of Archimedean Spiral Antenna With Fr4_epoxy Sheet” , International Journal of Industrial Electronics and Electrical Engineering, ISSN(p): 2347-6982, ISSN(e): 2349-204X Volume-8, Issue-7, Jul.-2020