Designing of Axial Mode Helical Antenna

Nimisha N.Rajput[1] Priyanka Shah[2]
[1]M.E. Student [2]Assistant Professor
[1,2]Department of Electronics & Communication Engineering
[1,2]Parul Institute of Technology, Limda

Abstract— In helical antenna mostly Metal wires are used. These are generally used as the radiator of helical antenna. helical antenna results like - Gain can be determined by the helical coil number namely the longer helical wire is the higher gain of antenna. However when the number of turns is too large the improvement of result is weak and the fabrication of antenna becomes very complicated. Axial-mode helical antenna will be employed to improve gain. To provide reliable communication. Simulation and optimizing of helix antenna will be done by electromagnetic software-Computer Simulation Technique (CST) MWS. Optimized results of return loss, gain, efficiency, etc. It can be improvised by proposed design of helical antenna.

Key words: Axial mode, helical Antenna,(CST)MSW

I. INTRODUCTION

Antenna is the simple metallic structure. It is designed for radiating and receiving electromagnetic energy. An antenna acts as a transitional structure between the guiding device (waveguide, transmission line) and the free space.

A. *Helical Antenna:*

A helical antenna is an antenna consisting of a conducting wire wound in the form of a helix. In most cases, helical antennas are mounted over a ground plane. The feed line is connected between the bottom of the helix and the ground plane. Helical antennas can operate in two principal modes: Normal mode and axial mode. The most popular travelling wave antenna is a helical antenna (helix) that produces radiation along the axis of the helix in axial-mode and normal mode. The basic geometry of the helix antenna is shown in Fig 1.

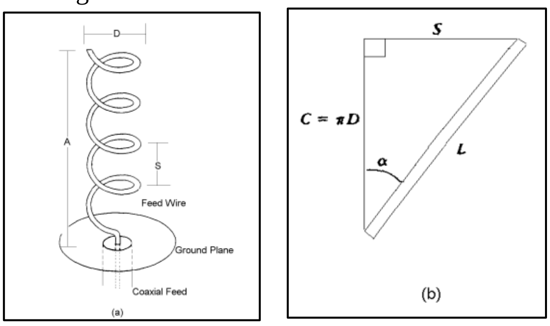

Fig. 1: (a) Geometry of Helical Antenna (b) Unrolled turn of helical antenna [6]

For a helical antenna with dimensions much smaller than wavelength, the current may be assumed to be of uniform magnitude and with a constant phase along the helix [6]. The maximum radiation occurs in the plane perpendicular to the helix axis. This mode of operation is referred to as the "normal mode" [6]. When the circumference of a helix is of the order of one wavelength, it radiates with the maximum power density in the direction of its axis. This radiation mode is referred to as "axial mode" [6]. In circular polarization, this mode is found to operate over a wide range of frequencies [6]. When the circumference (*C*) and pitch angle (α) are in the range of "3/4 $\lambda < c < 4/3\ \lambda$" and "$12^0 < \alpha < 15^0$", the radiation characteristics of the axial-mode helix remain relatively constant [6].

II. GEOMETRY OF AXIAL MODE HELICAL ANTENNA

A. *Geometrical Parameters:*

The geometry of a conventional helix is shown in Fig.1 (a). The parameters that describe a helix are summarized below.
D = diameter of helix
S = spacing between turns
N = number of turns
C = circumference of helix =π D
A = total axial length = NS
α= pitch angle

If one turn of the helix is unrolled, as shown in Fig. 1(b) the relationships between S, C, and the length of wire per turn L, are obtained as:

S = L sin= C tan (1) S = L sinα = C tanα   Eq. (1)

$$L=(S^2 + C^2)1/2$$

$$=(S^2 + \Pi^2\ D\text{^}2\ )1/2 \qquad \text{Eq. (2)}$$

B. *Empirical Relations for Radiation Properties of Axial-Mode Helix:*

1) *Directivity:*

An approximate directivity expression is given as

$$D = 12\text{c}^2\text{ns} \qquad \text{Eq. (3)}$$

C and S are, respectively, the circumference and spacing between turns of the helix normalized to the free space wavelength (λ).Since the axial-mode helix is nearly lossless, the directivity and the gain expressions are approximately the same.

2) *Half-Power Beamwidth:*

The empirical formula for the half-power Beamwidth is.

$$HPBW = \frac{52}{C\sqrt{NS}}\ \text{degree} \qquad \text{Eq.(4)}$$

3) *Input Impedance:*

The empirical formula for the input impedance is as in.

R 140C/ λ (ohms)   Eq. (5)

The input impedance, however, is sensitive to feed geometry.

4) *Bandwidth:*

an empirical expression for gain bandwidth, as frequency ratio, has been developed:

F_u/F_l Eq. (6)

$$\text{Axial Ratio}=\frac{(2N-1)}{2N} \qquad \text{Eq. (7)}$$

C. *Required Parameters Range for Optimum Performance of Axial Mode Helix:*

S. No	Parameter	Optimum range
1	Circumference	3/4 λ<c<4/3 λ
2	Pitch angle	$12^0 < \alpha < 15^0$

3	Number of turns	3<N<15
4	Wired diameter	Negligible effect
5	Ground plane diameter	At least 1/2 λ

Table 1: Parameter of Axial mode helical antenna

III. DESIGN PARAMETER

Fig.2 shows the front view geometry and the structure designed on CST Microwave Studio software of proposed axial mode helical antenna with at 1.5GHz.

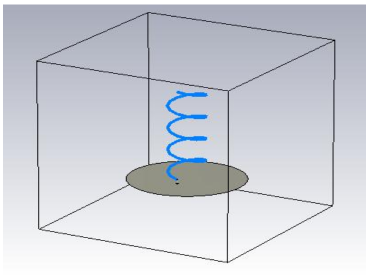

Fig. 2: Proposed Helical Antenna

S.No	Parameter	Optimum range
1	Circumference	19.83mm
2	Pitch angle	13^0
3	Number of turns	4
4	Spacing between number of turns	6mm
5	Axial length	24mm

Table 2: Parameter of helical antenna

IV. SIMULATION RESULTS

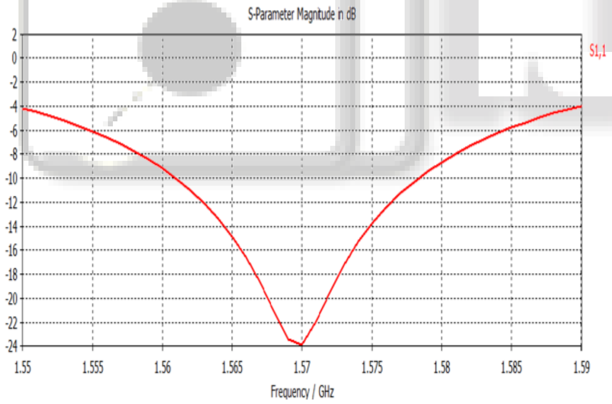

Fig. 3: Return loss graph at (1.5GHZ)

In above result shows that the return loss in axial mode helical antenna. Return loss is -24db at center frequency 1.5GHZ

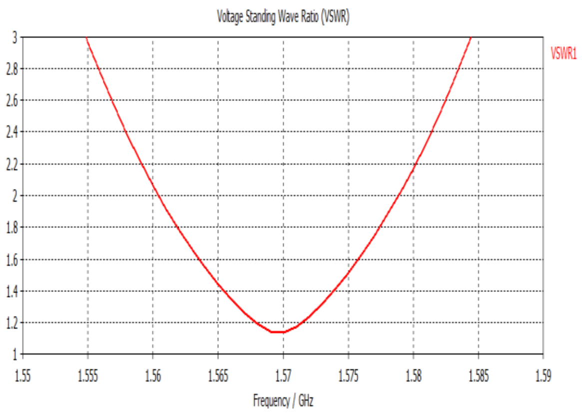

Fig. 4: VSWR graph at (1.5GHZ)

In above result shows the VSWR in axial mode helical antenna. VSWR is 1.2 at center frequency 1.5GHZ

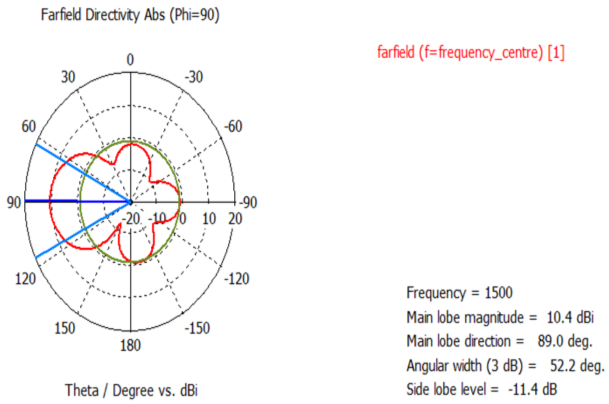

Fig. 5: Directivity (2D) at 1.5GHZ

In above result shows that the Directivity 2d in axial mode helical antenna. it will shows right hand side circular polarization. Directivity is 10.4dbi at center frequency 1.5GHZ

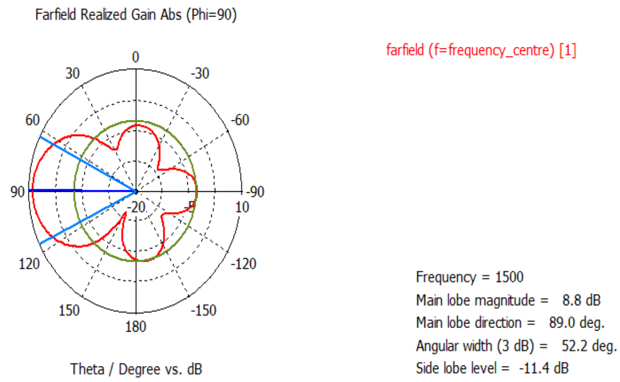

Fig. 6: Total gain at 1.5GHZ

In above result shows the total gain in axial mode helical antenna. It will shows right hand side circular polarization. Gain is 8.8 db at center frequency 1.5GHZ

V. CONCLUSION

This Work Present design of Axial mode Helical Antenna at 1.5GHz by using CST (MWS) software for simulation purpose. The proposed axial mode Helical Antenna optimized VSWR 1.2, Directivity 10.4dbi, Gain 8.8db, Return loss S11 -24db. It improves gain and provides reliable communication.

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