International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org, editorijaiem@gmail.com
Volume 2, Issue 4, April 2013 ISSN 2319 - 4847

Wide band RH Circular Polarized Antenna; Design and Analysis

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ABSTRACT

The data link, mobile satellite, base station, flight termination system and in signal monitoring applications helical antennas are popularly used. Present paper coaxial feed wide band circular polarized helical antenna with three turns of helix structure is designed to operate at 3.8GHz in Ansoft HFSS software. The results of return loss, impedance, VSWR, gain are studied and presented.

Keywords: Pitch of Helix, Gain, Return Loss

1. INTRODUCTION

The Helical antennas are popular from long time in the applications of VHF to microwave frequency. A Helical antenna consists of conducting wire wound in the form of helix and are mounted over a ground plane. The feed line is connected between bottom of helix and ground plane. It operates either in normal mode or axial mode. In axial mode the dimensions of helix are comparable to wave length. It functions as directional antenna radiates circularly polarized radio waves. To prevent the radiation in other direction other end of helix is terminated with flat metal sheet which reflects waves to forward. The direction of twist of helix determine the polarization of radio waves, left handed helix radiates left circularly polarized radio waves, right handed helix radiates right circularly polarized radio waves.

The dimensions of the helix are determined by the wavelength λ of the radio waves used, which depends on the frequency. In axial-mode operation, the spacing between the coils should be approximately one-quarter of the wavelength (λ/4), and the diameter of the coils should be approximately the wavelength divided by pi (λ/π). The length of the coil determines how directional the antenna will be as well as its gain; longer antennas will be more sensitive in the direction in which they point.

2. DESIGN

The helical antenna is formed by winding a wire on a cylindrical surface while maintaining constant spacing between turns

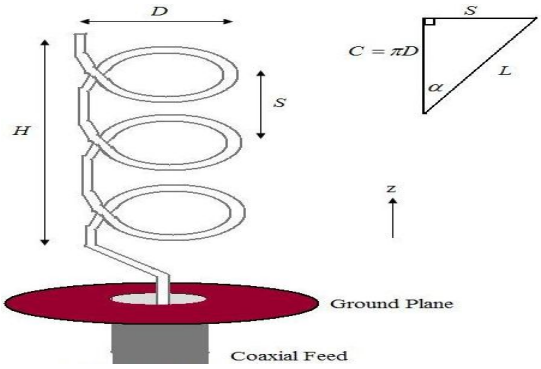


Fig 1: Basic Helical Antenna

The geometry consists of

D = diameter of helix
C = Circumference of helix = πD
S = Space between turns(center to center)
L_0= Length of one turn
n= number of turns

L=axial length
a= radius of helix wire conductor
T he helical to operate in axial mode, the dimension helix circumference is of one wave length at centre frequency with a helix pitch of 12 to 14 degrees. The pitch angle (α) is the angle formed by the line tangent to the helix wire and a plane normal to the helix axis.
$\alpha = \text{Tan}^{-1}(S/\pi D)$
where S is the spacing from turn to turn
D is diameter

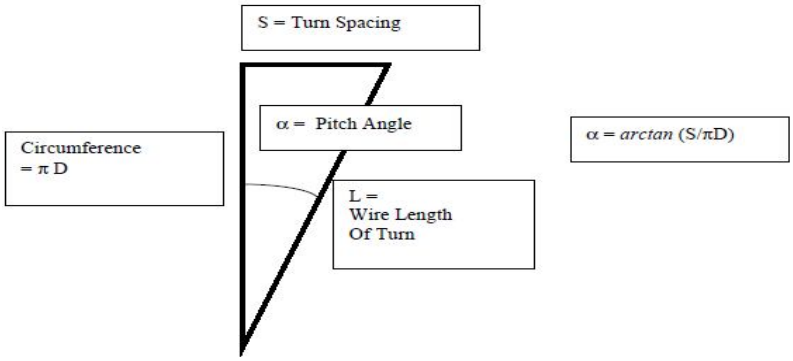


Fig 2: Pitch Angle Measurement

The triangle explains clearly the relationships between the circumference, diameter, pitch, turn spacing, and wire length. The helix radius corresponding to a circumference for one turn is $3\lambda/4<C<4\lambda/3$. The sense of circular polarization depends on the sense of winding of helix. When the wound in left hand sense left hand circular polarization exists. The design formulas of gain, and half power beam width provided by J.D.Kraus.
$G = 15C_\lambda^2 nS_\lambda$
Where $C_\lambda = C/\lambda$ (normalized circumference)
$S_\lambda = S/\lambda$ (Space between turns)
$HPBW = 52/ C_\lambda Squrt(nS_\lambda)$ degree

3. NUMERICAL DESIGN

Present design of coaxial feed helical antenna with three helix turns were designed to operate at 3.8GHz. the dimension are, helix diameter 3.18cm, spacing 2.216cm, number of turns 3.341, diameter of wire 0.56cm, winding direction is right. The ground dimensions are 11.278cm, 11.278cm respectively

4. SOFTWARE FOR DESIGN

Availability of latest software, it became easy for upcoming antenna designers to execute and test their proposals and compare with conventional designs. Present proposal is designed in Ansoft HFSS version 13 which use Finite element method for analysis of structure.

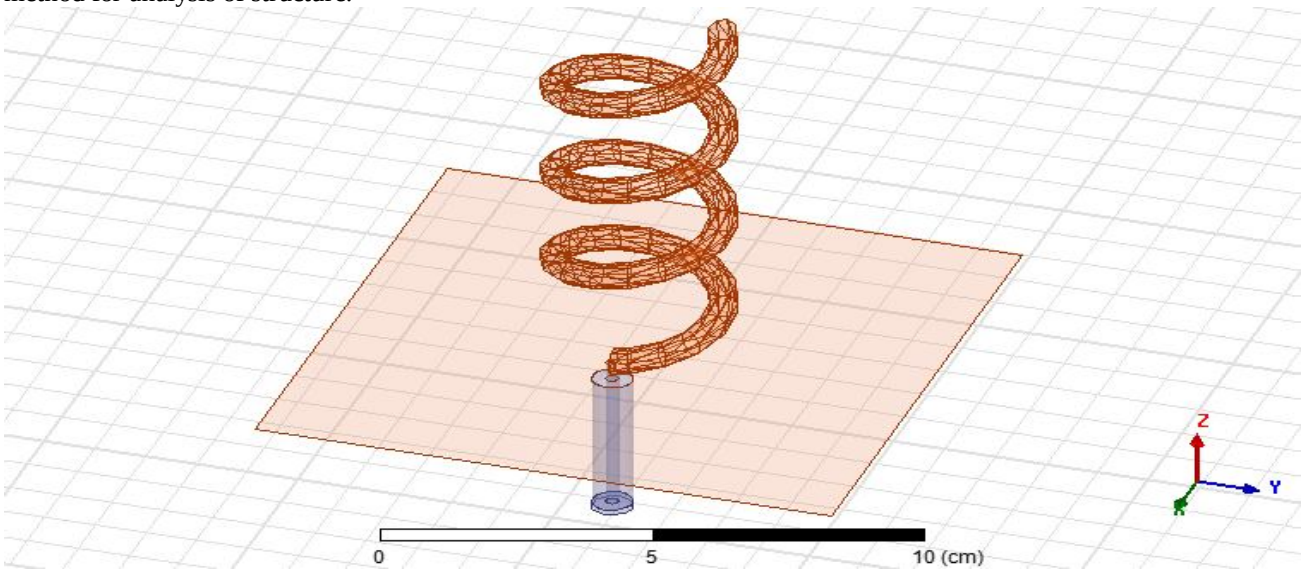


Fig 3: Software Design of Helical Antenna

5. RESULTS & DISCUSSION

a. Return Loss

Fig 4: Return Loss

b. Impedance

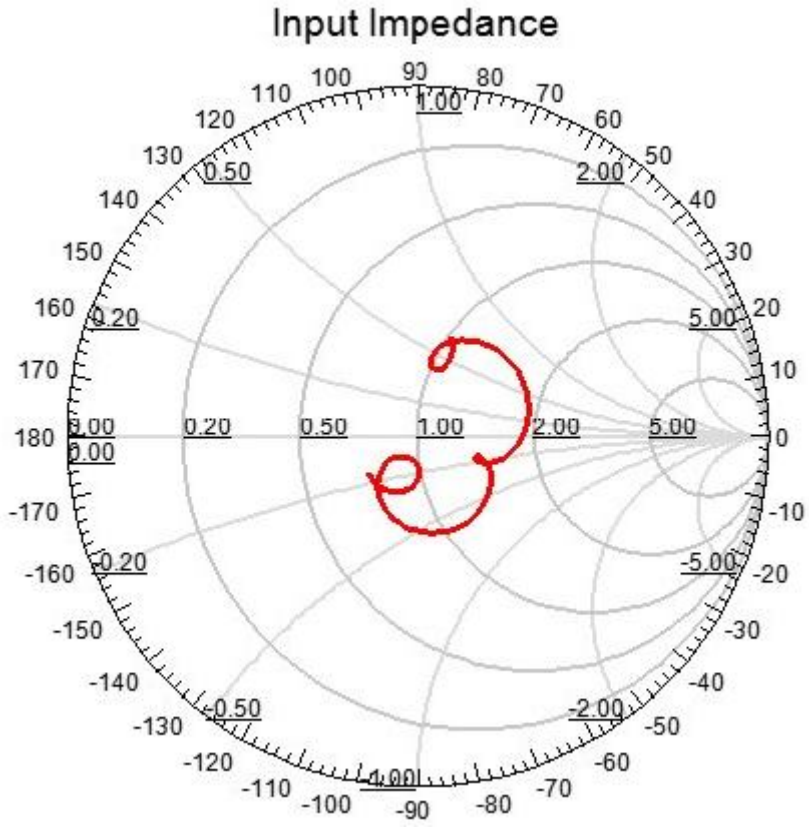


Fig 5: Impedance

c. Gain (RHCP)

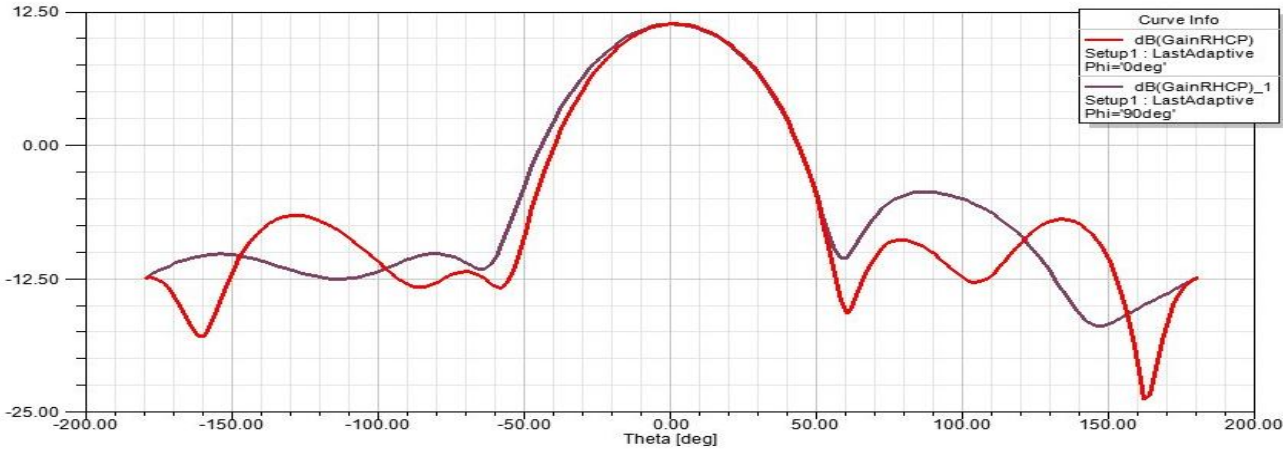


Fig 6: Gain

d. Gain (polar plot)

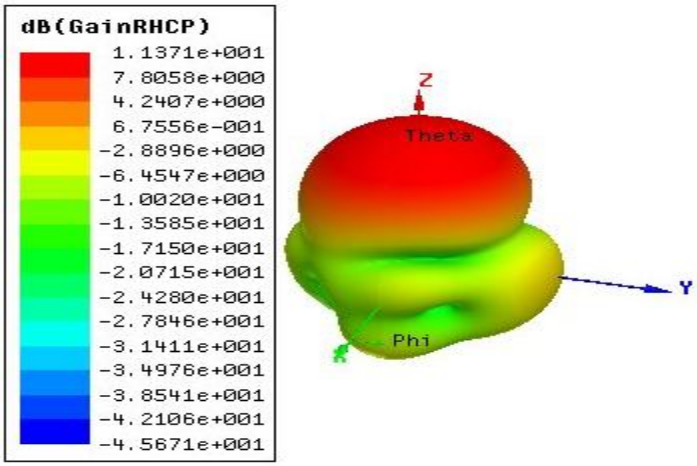


Fig 7: Polar Plot

e. Radiation Pattern

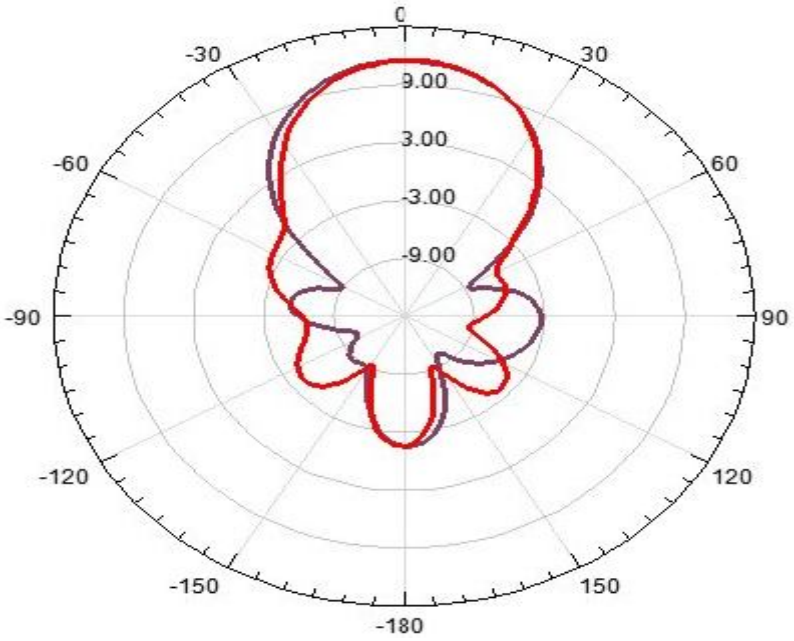
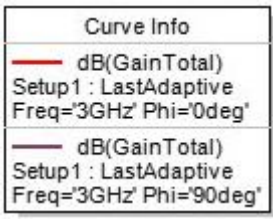


Fig 8: Radiation Pattern



f. Axial Ratio

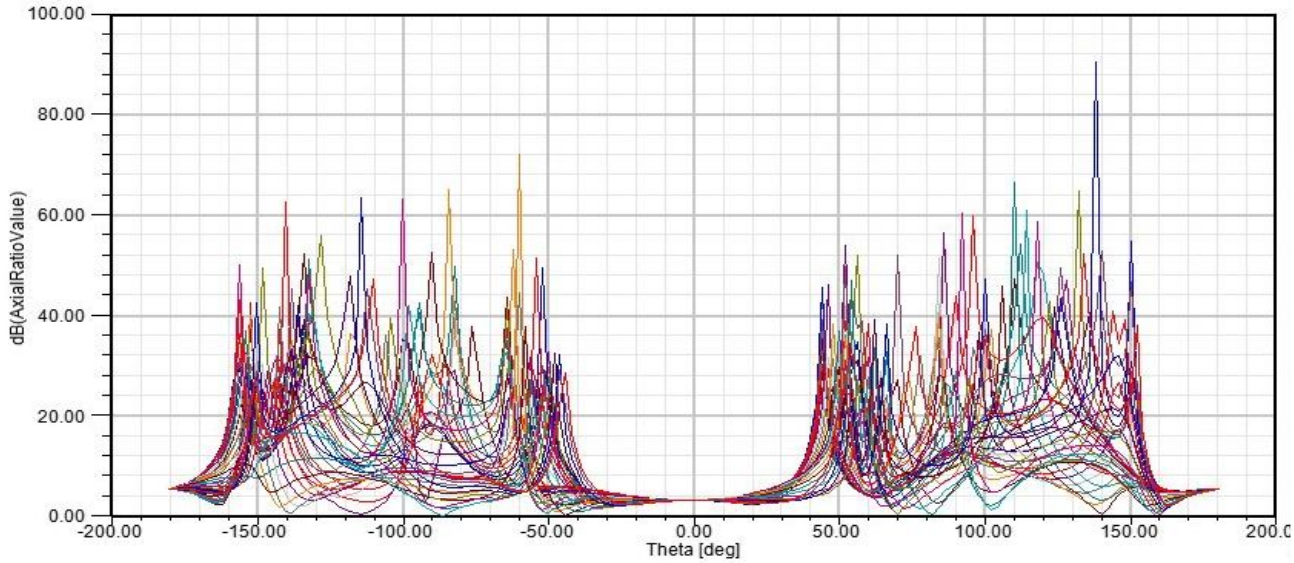


Fig 9: Axial Ratio

g. Antenna Parameters

Quantity	Value
Max U	0.0108571(W/sr)
Peak Directivity	13.8455
Peak Gain	14.1766
Peak Realized Gain	13.6209
Radiated Power	0.00985429(W)
Accepted Power	0.00962416(W)
Incident Power	0.0100168(W)
Radiation Efficiency	1.02391
Front to Back Ratio	20.763
Decay Factor	-0

rE Field	Value	(Theta, Phi)
Total	2.86116	(0.0349066, 0.261799)
X	2.32803	(0.0349066, 0.349066)
Y	1.66129	(0.0349066, 0.261799)
Z	0.69964	(0.453786, 0.436332)
Phi	2.34912	(0, 1.74533)
Theta	2.35513	(0.0349066, 0.174533)
LHCP	0.64998	(0.872665, 2.61799)
RHCP	2.81388	(0.0349066, 0.261799)
Ludwig3/X dominant	2.32937	(0.0349066, 0.261799)
Ludwig3/Y dominant	1.66143	(0.0349066, 0.349066)

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ACKNOWLEDGEMENT
The author expresses his sincere thanks to the management of Mahatma Gandhi Institute of Technology, Hyderabad, India for the technical and logistic support given in carrying out advanced research in allied fields.

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