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Design of Helical Antenna with Balun at 2.2 GHz

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Abstract: **The design of a helical antenna having following specification are presented:**
Operating frequency: 2.2 GHz
Gain: >5dBi
Polarization: Circular
Design platform is HFSS.

Keywords: Helix, Balun, Coax, Axial-Ratio Bandwidth, Polarization

1. Introduction

Helical antenna is a broad band radiator fed using a coaxial cable. It is basically a conducting wire wound in the form of a screw thread forming a helix. Helical antenna is usually designed in the presence of a ground plane of minimum diameter of $3\lambda/4$. Two modes of operation is possible, axial and normal mode.in normal mode the field radiated by the antenna is maximum in the plane normal to the helical axis and in axial mode the maximum will be along the axis of the helix. Axial mode is more practical as it can achieve circular polarization over a wider band width. The terminal impedance of a standard helix will be around 100-200 ohms and the impedance of a standard feed line is 50 ohms. To get impedance matching between these two, a balun is designed.

2. HELICAL ANTENNA DESIGN

The antenna is designed in axial mode.

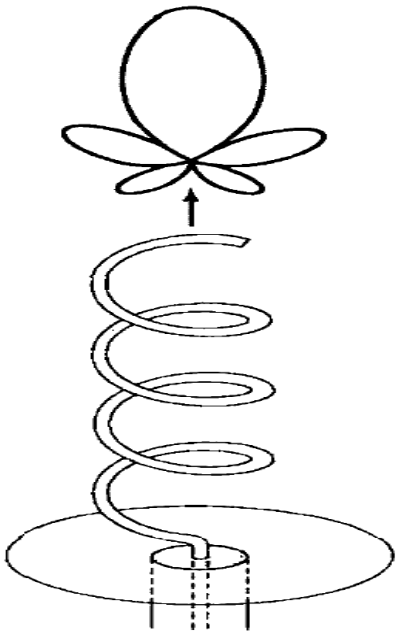

Fig 1: Helical antenna in axial mode

To excite this mode, the diameter D and the spacing S must be large fractions of wavelength. To achieve circular polarization primarily in the major lobe the circumference C of the helix must be in the range $3/4<C/\lambda<4/3$ and spacing S approximately = $\lambda/4$.
The pitch angle α is usually $12° \leq \alpha \leq 14°$. The ground plane diameter is at a minimum of $\lambda/2$ and is fed by a coaxial line.
Radius of helix = 0.01989m
Radius of wire = 0.001m
Pitch = 0.03123m
Number of turns =4

3. BALUN DESIGN

The calculated resistance R of this helix is approximately.
R~140(C/λ) ~140 ohms
The characteristic impedance of a standard coaxial line is 50 ohms. To provide a better match between these two, there are many ways. One common method is to reduce the input impedance of the helix by properly designing the first ¼th turn of the helix and bring it down to 50 ohms. For this the wire of first ¼ turn should be flat in the form of a strip and the transition to helix must be gradual. Design and construction of such a structure can turn out to be tedious and it need not be accurate.
A new alternative is to design a balun, which can act as an impedance converter. A thin metal strip of length $\lambda/4$ is implemented as a balun. The balun will be connected from inner conductor of the coax to the tip of the helix.

Length of the balun = 0.03125 m
Width of the balun = 0.001m
Thickness of the balun =0.00025m

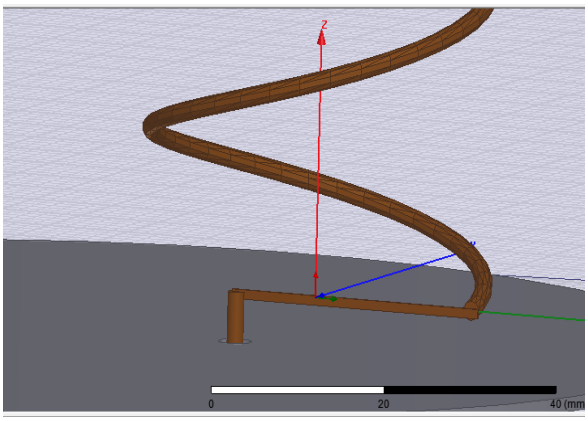

Fig2: balun between helix and coax

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4. COAXIAL FEED DESIGN

Coax is designed at 2.2GHz for 50 ohms.
Dielectric constant = 4.7
Inner diameter = 0.001m
Outer diameter=0.006 m.

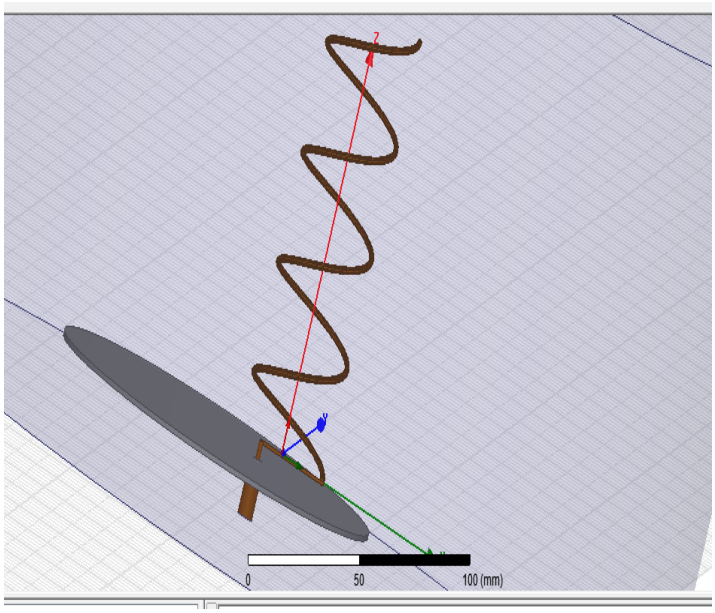

Fig3: Complete structure

5. SIMULATION RESULTS

5a. S_{11}

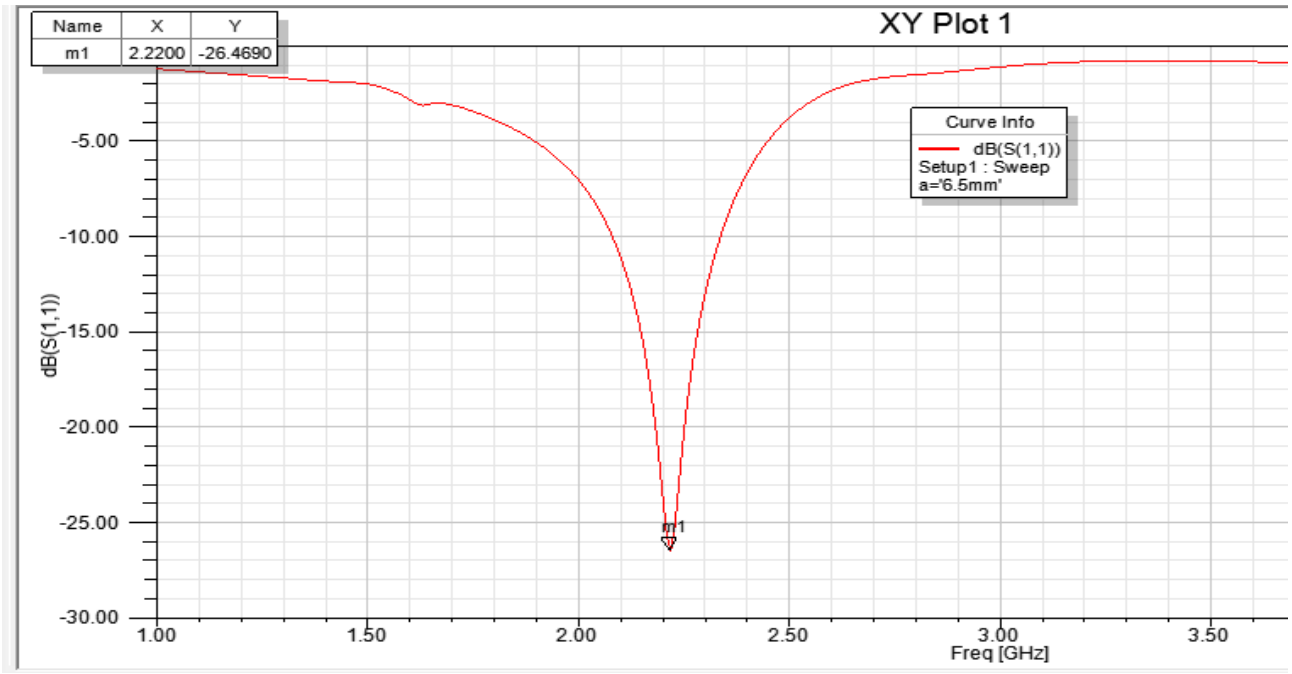

Fig4:S_{11}

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5b. Gain

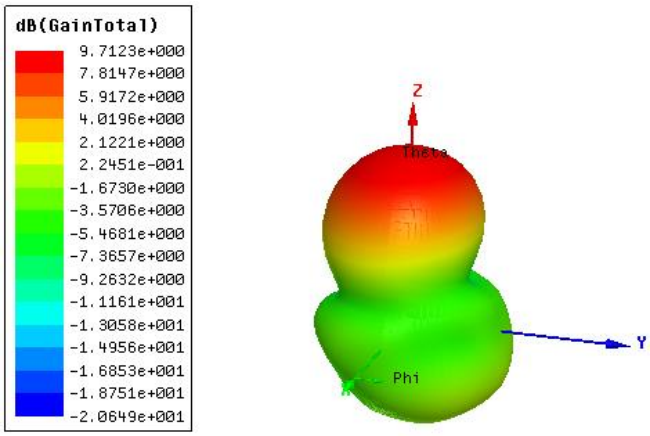

Fig4: gain

Gain obtained is around 9.7 dBi

5c.Polarization

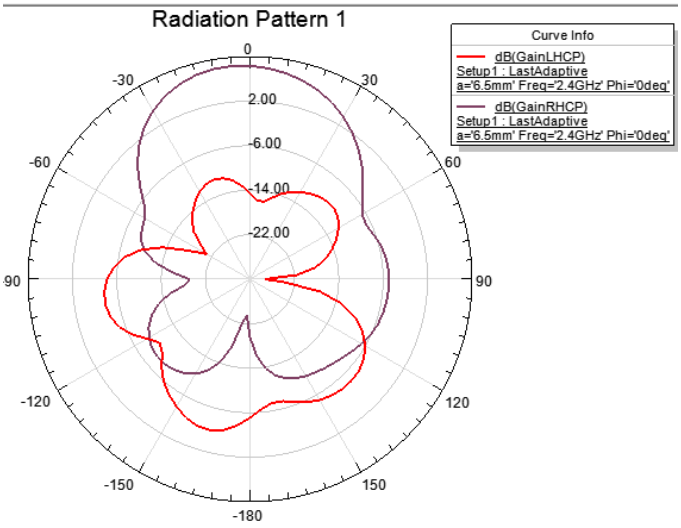

Fig5: polarization

Antenna is right circularly polarized

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