Antenna-Simulation of a Helix antenna

1. Description

A Helical Antenna is formed of a helix shaped conductor wire. Normally a ground plane holds the helical antenna vertically and the antenna is technically fed like a monopole. Helical antennas can operate in one of two principal modes: normal mode or axial mode.

In the normal mode the dimensions of the helix are small compared to the wavelength and the antenna acts as an omni-directional monopole while in the axial mode the dimensions of the helix are comparable to a wavelength and the antenna operates directional along the antenna's axis. The following helical antenna is designed using the multi-configuration feature of HFWorks and operates at 2.45 GHz on its axial mode. A helix antenna consists of more than three turns of alumina or copper wire of a constant pitch. This gives a circular polarized (either LHCP or RHCP: i.e. left hand or right hand circular polarization) radiation in direction of the antenna axis and an antenna gain of more than 8dBi.

This sort of radiation is found in television and satellite communications as it has a higher capacity to struggle against losses caused by the atmosphere. Such an antenna emitting in a circular polarization has always a 3 dB power loss factor (PLF) with another linear polarized antenna. Within this HFWorks tutorial, we introduce the key features of simulating a helix antenna.

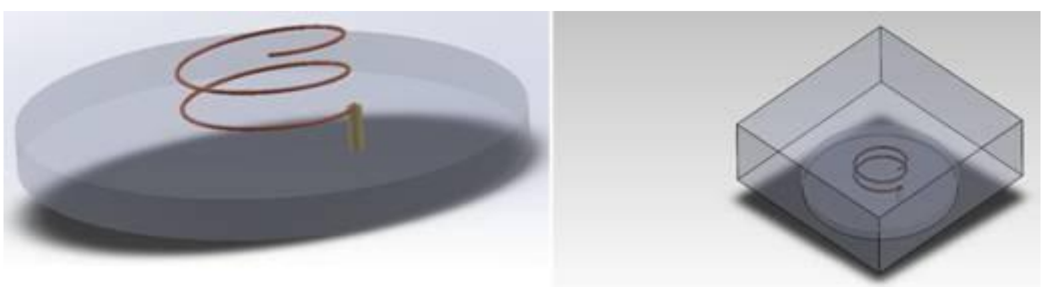

Figure 1: Helical antenna model (3D SolidWorks view)

2. Simulation

To simulate the behavior of this helix antenna (we are more interested in radiation patterns and antenna parameters like gain, directivity...), we will create an Antenna study, and specify the relevant frequency range at which the antenna operates (in our case 10 frequencies uniformly distributed from 1.9 GHz to 2.3 GHz). In an antenna simulation, radiation boundaries which are peculiar features of such a simulation have to be assigned to the radiation surfaces. These surfaces truncate the air surrounding the antenna and simulate and anechoic chamber.

3. Solids and Materials

The helix which is the most important and special part of the antenna assembly is usually made of copper or aluminum. The conductivity of this metal imposes a certain direction to the electric field. The latter is in this way polarized in circularly like pattern inheriting the form of the helix. The solid beneath the helix should be assigned a PEC (Perfect Electric Conductor) boundary condition to play the role of the ground metal. This can be automatically done realized by assigning the solid a PEC material from the material browser.

As mentioned earlier, we have to define the radiation boundaries to truncate the open air space surrounding the antenna. The locations of these boundaries define the truncations for the air surrounding the antenna.

The port definition for this antenna is located on a round surface beneath the ground metal, similarly to a connector for a coaxial cable. The helix goes through the cylinder until the port surface. Therefore, a PEC is assigned only to the outer faces of swept cylinder, while the th inner part which is filled by the helix wire is assigned a +Signal boundary condition. The + Signal and PEC materials are then separated by a Teflon material at the body of the cylinder..

5. Meshing

The most important part of the antenna lies in the form of the helical conductor, the latter has to be meshed in a convenient rate to ensure reliable Maxwell's equations solution: The more you mesh a round shape, the more the solver realizes it is; nevertheless this shouldn't exceed a certain limit. On the other hand the Teflon cylinder which has the wire signal going through its round cut should also be meshed in a fine rate. We obtain a mesh similar to this figure's:

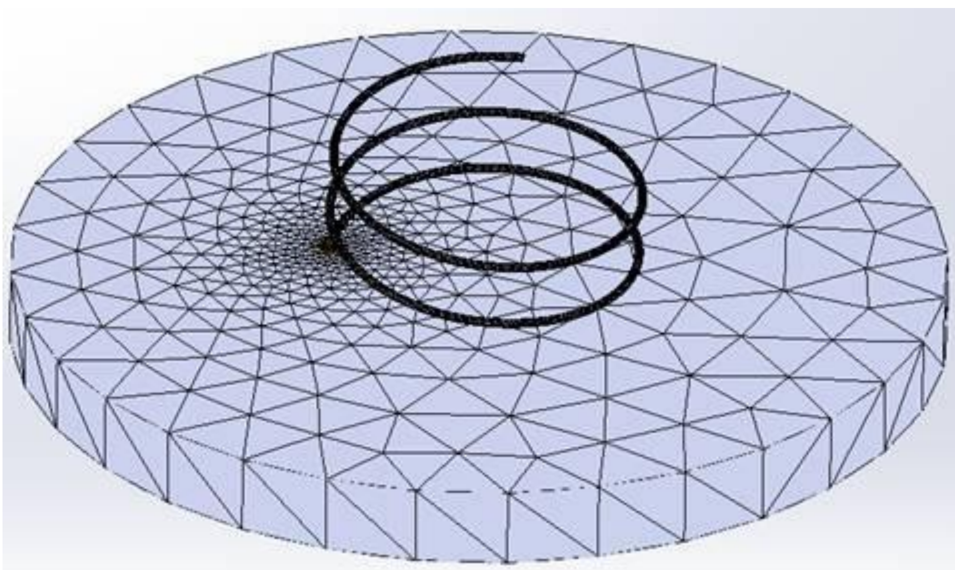

Figure 2: Mesh of the helix antenna

6. Results

Various 3D and 2D plots are available to exploit, depending on the nature of the task and on which feature the user is interested in. As we are dealing with an antenna simulation, plotting the radiation diagram seems like an intuitive task. The following figure shows the radiation pattern of the considered antenna:

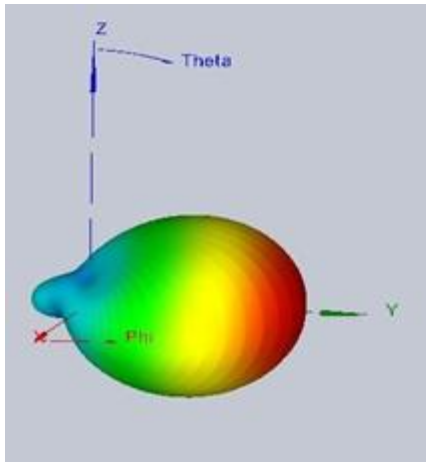

Figure 3: 3D radiation patterns of an helix antenna

This figure shows conformal views (2D and 3D) of the variation of the power radiation pattern of the antenna in terms of the Theta angle.

As mentioned within the beginning of this report, HFWorks computes Scattering Parameters within antenna studies as well; this is mostly relevant to antennas' matching optimization tasks. In this example, the antenna is best matched at 2.47 GHz:

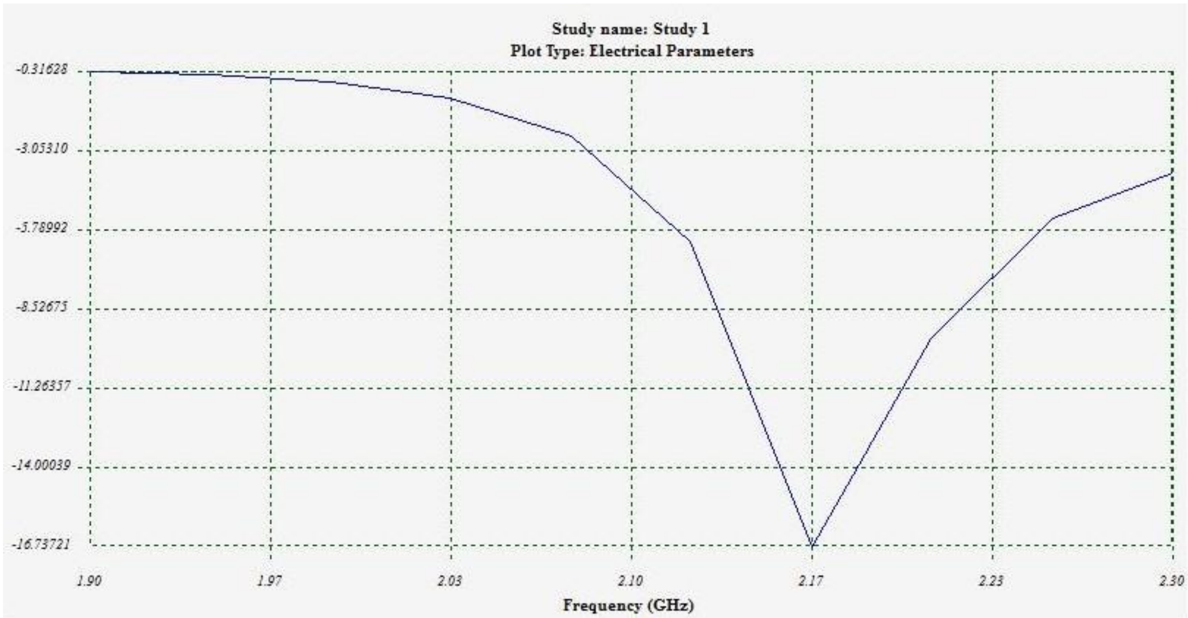

Figure 4: Variations of reflection coefficient at the antenna's port

The polar plots for the antenna parameters cover a wide range of parameters: radiated electric field, radiation intensity, directivity, gain pattern, axial ratio... etc. As mentioned earlier, we can simulate, plot and animate the electric field distribution on the antenna wire; the animation being realized by the variation of omega-t angle from 0 to 360°. This is a vector plot of the electric field at 2.47 GHz:

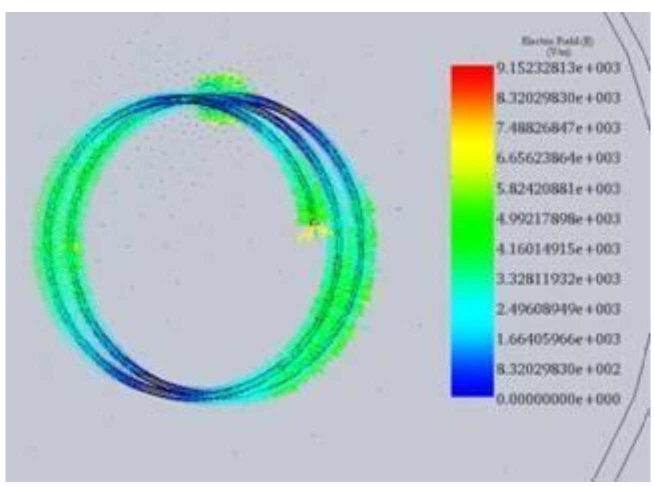

Figure 5: Electric field vector distribution