# Enhancing RF Performance: Wideband Dipole Antenna with Integrated Balun

## A Dipole Antenna

Dipole antennas find various RF applications. However, feeding them with a coaxial unbalanced line can pose challenges due to the dipole's balanced nature. Using coaxial cables can lead to common mode currents and radiation issues. To address this, a BALUN is typically employed. In this printed dipole antenna operating at 2.4 GHz, a BALUN integrated with a tapered line allows direct coaxial connection. The butterfly shape technique enhances bandwidth.

***Figure 1*** *- Helical antenna model (3D SolidWorks view)*

### Simulation

To analyze the behavior of this dipole antenna, including radiation patterns, gain, and other antenna parameters, we will conduct an Antenna study covering a frequency range from 1.8 GHz to 3.8 GHz. In antenna simulations, radiation boundaries are crucial and are assigned to the outer air surfaces to mimic an anechoic chamber.

HFWorks' Antenna studies provide various output results, including electrical parameters like insertion and return losses.

## Solids and Materials

The antenna consists of a Duroid 5880 substrate and two Perfect Electric Conductor surfaces perpendicular to the port face. The entire structure is placed within an air box.

## Load/ Restraint

The port is applied to the lateral faces of both the substrate (on the upper face of the PEC) and the air box. This setup allows the simulation to consider the electric field's radiation in the air. Radiation Boundaries (RB) truncate the outer air box to create the effect of an anechoic chamber.

## Meshing

Meshing the surfaces of the port and the printed patch ensures accurate representation in the simulation. To achieve better results, the mesh element length should not exceed one-tenth of the wavelength.

***Figure 2*** *- Mesh of the dipole antenna*

# Results

Various 3D and 2D plots are available for analysis. The following figure illustrates the radiation pattern of the antenna at 2.3 GHz:

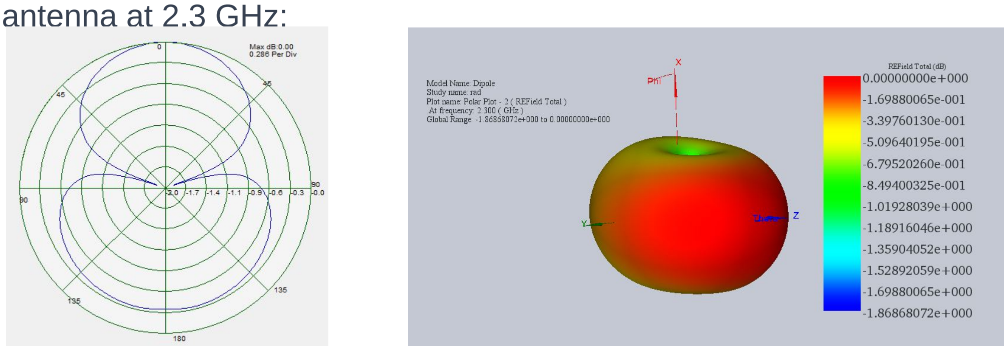


***Figure 3 -*** *2D and 3D radiation patterns of the dipole antenna at 2.3 GHz*

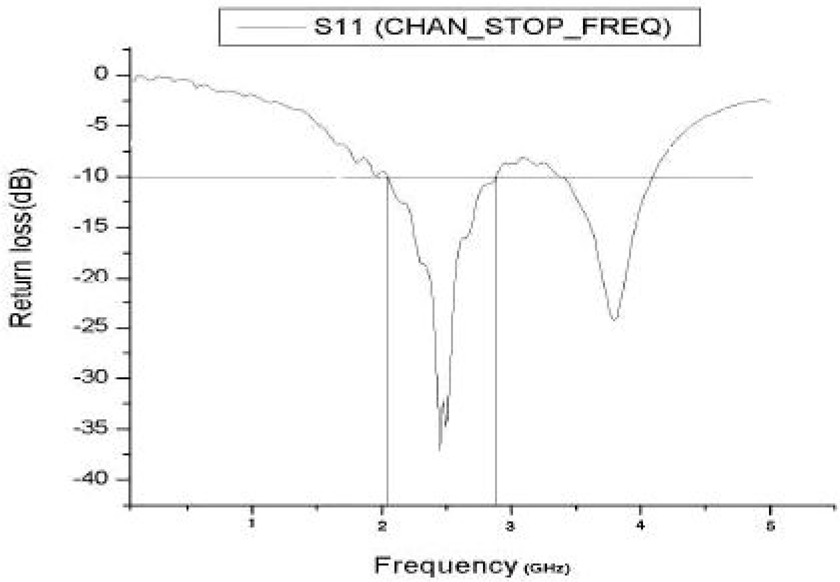


***Figure 5 -*** *Variations of the measured reflection coefficient at the antenna's port*

HFWorks provides a range of antenna parameters including radiated electric field, radiation intensity, directivity, gain pattern, axial ratio, and more. Additionally, it allows for the simulation, plotting, and animation of the electric field distribution on the antenna patch. The animation is achieved by varying the omega-t angle from 0 to 360°. Here is a plot of the electric field at 2.3 GHz:

***Figure 6*** *- Near Electric field vector distribution*

# Conclusion

The application note explores a printed dipole antenna operating at 2.4 GHz, addressing challenges associated with coaxial feeding due to the dipole's balanced nature. By integrating a BALUN with a tapered line, a direct coaxial connection becomes feasible, enhancing bandwidth through a butterfly-shaped technique. Simulation via HFWorks involves an Antenna study spanning 1.8 GHz to 3.8 GHz, considering radiation patterns, gain, and antenna parameters. Key elements include a Duroid 5880 substrate, Perfect Electric Conductor surfaces, and radiation boundaries to emulate an anechoic chamber. Precise meshing and analysis yield insights into radiation patterns and reflection coefficients. HFWorks facilitates visualization of electric field distribution and offers parameters like radiated electric field and gain pattern for comprehensive analysis, demonstrating the effectiveness of the printed dipole antenna in RF applications.