Understanding the Folded Dipole: Structure, Impedance, and Simulation

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Explore the fundamentals of folded dipole antennas. Learn how accurate simulations using conformal modeling in AN-SOF reveal the true behavior of curved wire geometries and confirm the expected input impedance.

Basic Structure

A **folded dipole** is a variation of the classic **half-wave dipole antenna**, designed to offer a higher input impedance and broader bandwidth. It is commonly used in television antennas, FM broadcasting, and other VHF/UHF applications.

A folded dipole consists of **two parallel conductors** of equal length, spaced closely apart, and connected at both ends. One of these conductors is center-fed, while the other forms a closed loop. Both conductors are typically of equal diameter and length (**Fig. 1**).

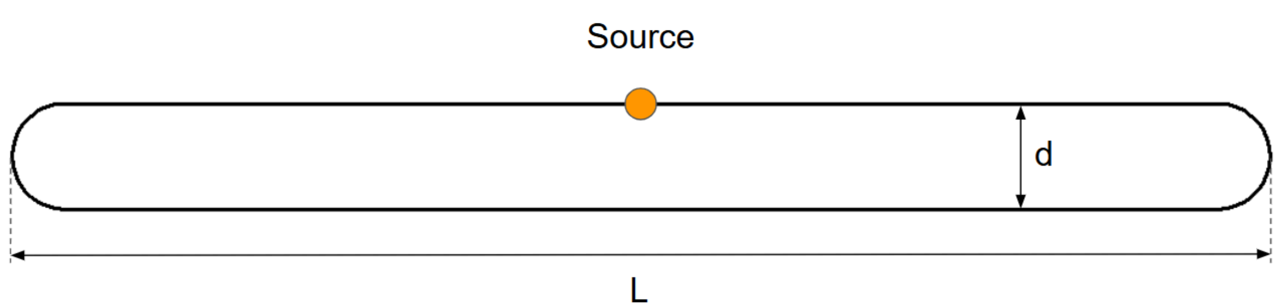

Fig. 1: Folded dipole with curved wire ends.

- **Length (L)**: Total length of the antenna is approximately **λ/2**.
- **Spacing (d)**: Relatively small compared to the wavelength (λ).

Operating Principle

The folded dipole operates on the same resonance principle as a standard half-wave dipole, but due to its geometry, it modifies the current distribution and input impedance. The presence of the second conductor "folds" the current path and causes a redistribution of voltage and current.

Impedance of a Folded Dipole

The main reason for using a folded dipole is its **higher input impedance** compared to a standard dipole.

If both conductors have equal diameter and are closely spaced, the input impedance of a folded dipole is:

$$Z_{in} = 4 \times Z_{dipole} \approx 4 \times 73\,\Omega = 292\,\Omega$$

This makes it a good match for **300 Ω** twin-lead transmission lines.

We must point out that **73 Ω is the real part of the input impedance (radiation resistance)** of an **infinitesimally thin, center-fed λ/2 dipole in free space**. In practice, **finite conductor thickness increases the radiation resistance**. To accurately account for this effect, it is important to run a simulation using a solver that implements the **Exact Kernel of the integral equation**—as is done in the **AN-SOF software**.

Radiation Pattern

- Similar to a standard dipole.
- Broadside pattern (maximum radiation perpendicular to the axis).
- Omnidirectional in the horizontal plane when mounted vertically.

Advantages

- Higher input impedance (easier matching to 300 Ω lines).
- Broader bandwidth compared to a simple dipole.
- More robust mechanical structure due to the loop design.

Considerations

- Needs to be properly matched if used with 50 Ω or 75 Ω coaxial cables (often a **balun** or **impedance matching transformer** is used).
- Performance depends on conductor spacing and diameter.

Simulation of a Folded Dipole with Curved Wires

This simulation models a folded dipole antenna using **curved wire segments at the ends**, accurately represented using **conformal segments** (**Fig. 2**). Unlike the traditional Method of Moments (MoM), which approximates curved wires with straight segments, **AN-SOF employs the Conformal Method of Moments (CMoM)** to precisely model the geometry.

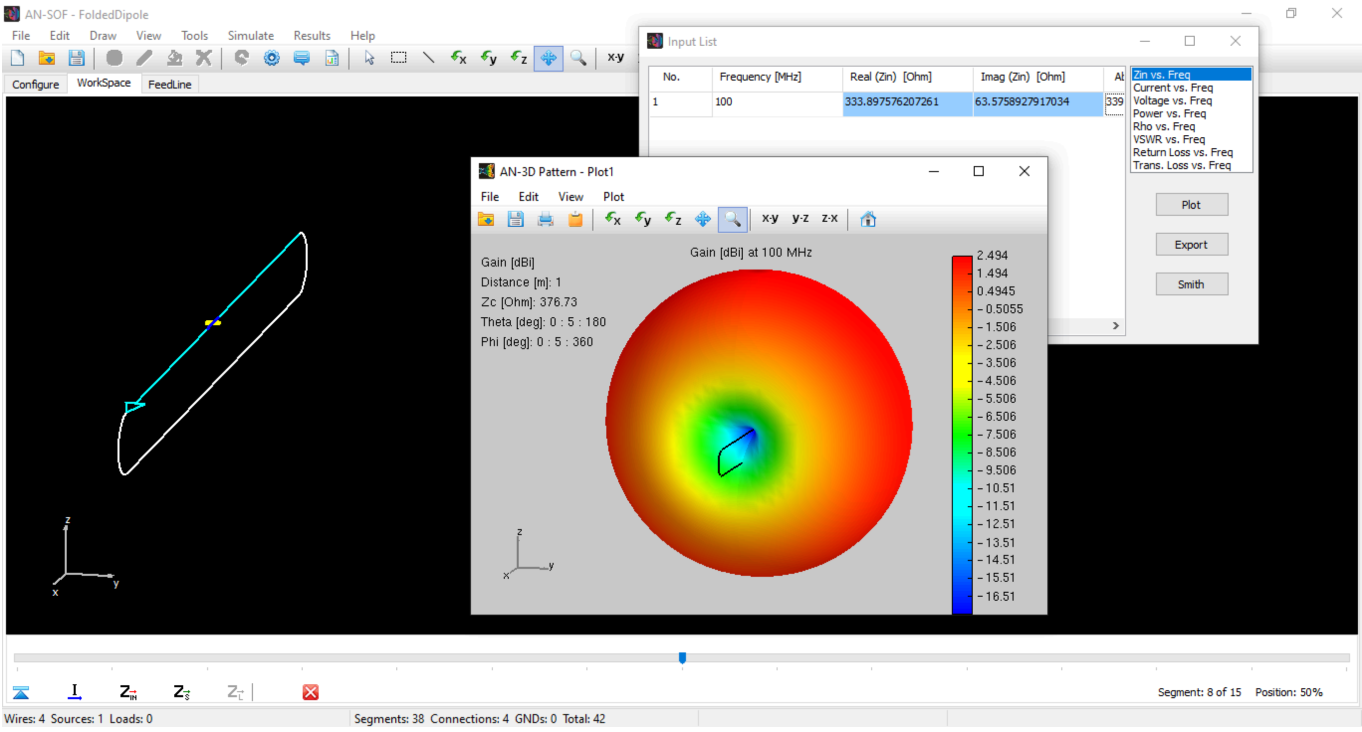

Fig. 2: Model of a half-wave folded dipole with curved wire ends in the AN-SOF workspace, showing the 3D gain pattern and input impedance results that account for conductor thickness.

Download Model

The resulting radiation pattern exhibits the standard **donut-shaped** form expected from a half-wave dipole, with only minimal distortion. Folded dipoles are commonly used to **increase the radiation resistance** of a standard half-wave dipole (typically around 75 Ω). In this simulation, the folded dipole shows an **input impedance with a real part close to 300 Ω**, consistent with theoretical expectations.

We encourage users to explore the **sensitivity of the folded dipole's input impedance** by experimenting with different conductor radii and adjusting the **radius of curvature at the wire ends**. The latter can be modified by changing the geometry of the arcs at the dipole ends.

See Also:

- **Complete Workflow: Modeling, Feeding, and Tuning a 20m Band Dipole Antenna**

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About the Author

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