# AN-SOF Modeling Guidelines

Additional information to the user manual on tips and tools for modeling antennas.

The equivalent circuit of a balun

A balun can be implicitly modeled in AN-SOF using an equivalent generator, as this figure shows. Since voltage sources admit an internal impedance, we can adjust its resistance value to match the antenna input resistance. Of course, we must previously cancel out the antenna reactance using an opposite lumped reactance.

To calculate the true generator side VSWR, go to the Configure tab > Settings panel > VSWR Ref. Impedance and set the same value as the resistance of the equivalent circuit of the balun.

For example, if you have a 4:1 balun (K = 4 being the impedance transformation factor), put a voltage source at the antenna terminals having 2 x the voltage of the true source and an internal resistance of 4 x the true internal resistance. Also, set "4 x the true internal resistance" as the reference impedance for VSWR in the Settings panel.
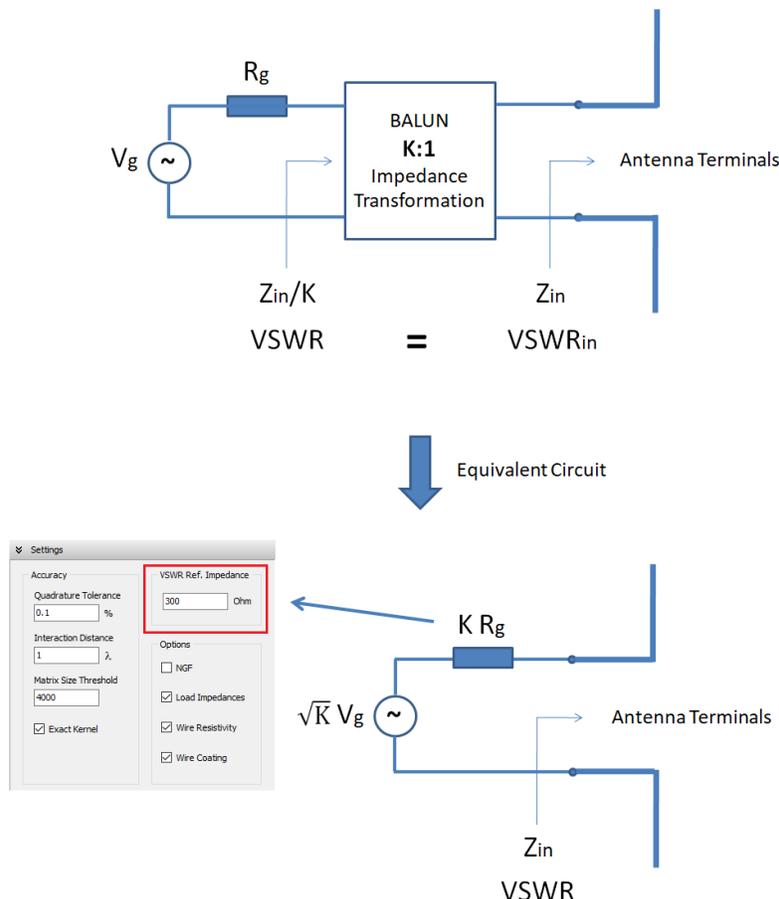
On the modeling of radio masts

Radiating towers or radio masts can be modeled in AN-SOF with a high degree of detail, as shown in this figure. Since we already know the omnidirectional shape of the radiation pattern, what interests us is to calculate electric field values at ground level for a given input power. Go to Configure tab > Near Field panel and set the desired coordinate system (Cartesian or Cylindrical: Z = 0, Spherical: theta = 90°). Go to the Excitation panel to set the input power (it is customary to set 1,000 W). To increase the conductivity of the soil and therefore the radiation efficiency, we can use a radial wire ground screen.

Regarding the feeding point, we can put a source at the position of the base insulator if the feedline will be connected there in the real life antenna. In this way, we will obtain the input impedance of the antenna, which we can then post-process (e.g. tuning house + transmission line coming from the transmitter).

To speed up the simulation, we could use a simplified model, which consists of a single vertical wire with a triangular cross section. The radiation pattern will be the same as before, but we must be careful at the feeding point.

The base of the tower in the detailed model forms a short transmission line to the source position at the tower center. In the simplified model, we can offset the source from the center a distance equal to the half width of the tower to simulate the short transmission line effect.
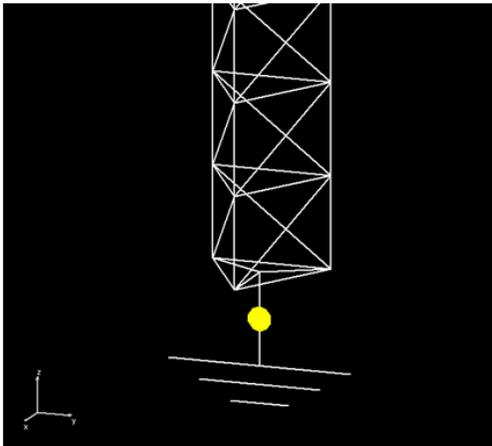
Both models can be downloaded from:

https://antennasimulator.com/.../BroadcastTowerRadials.zip
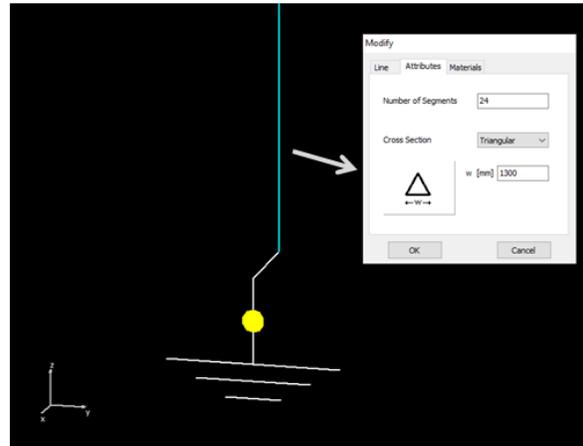
2

¼ λ Radiating Tower @ 3 MHz
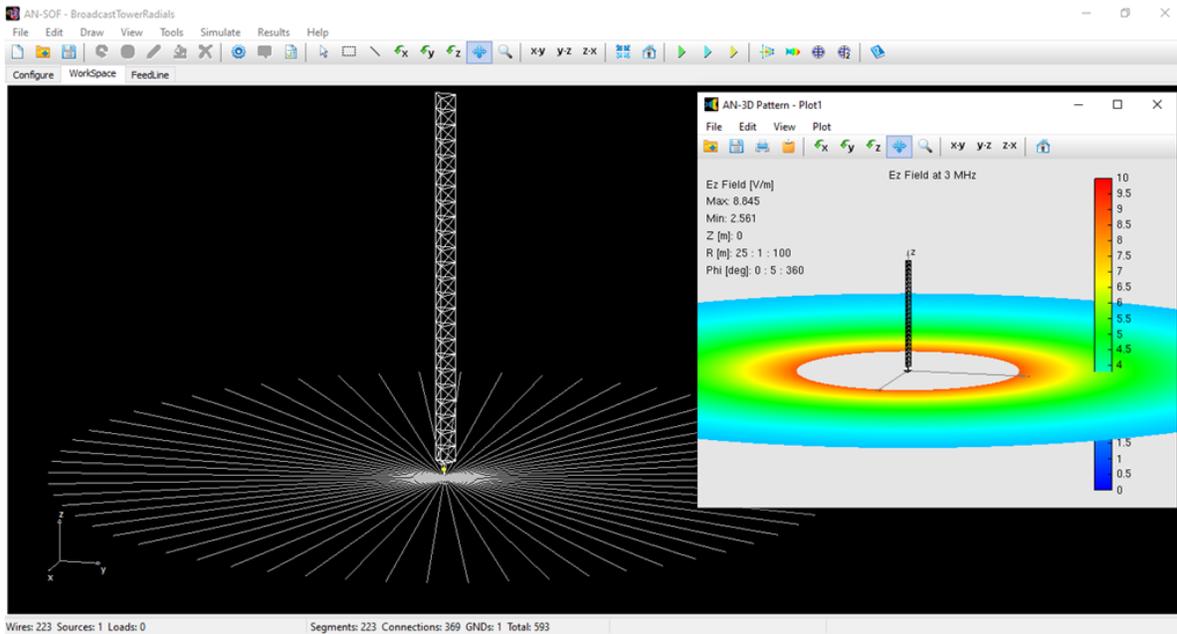
Detailed model

$Z_{in} = 53 + j\ 65\ \Omega$

593 segments

Simplified model

$Z_{in} = 52 + j\ 61\ \Omega$

29 segments

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How to import AN-SOF wires into AN-SOF

Wires can be imported into AN-SOF from another AN-SOF project, so wire structures of different projects can be combined in a single project.

When a project is saved, a file having extension .wre will also be saved. This file contains the geometrical description of the wires. To import wires to a project, go to File menu > Import Wires > AN-SOF Format and just find and select the .wre file that you want to import.

For instance, this feature allows us to analyze the electromagnetic response of an antenna and its supporting structure separately, and then to combine them in a new project to analyze the response of the whole structure.

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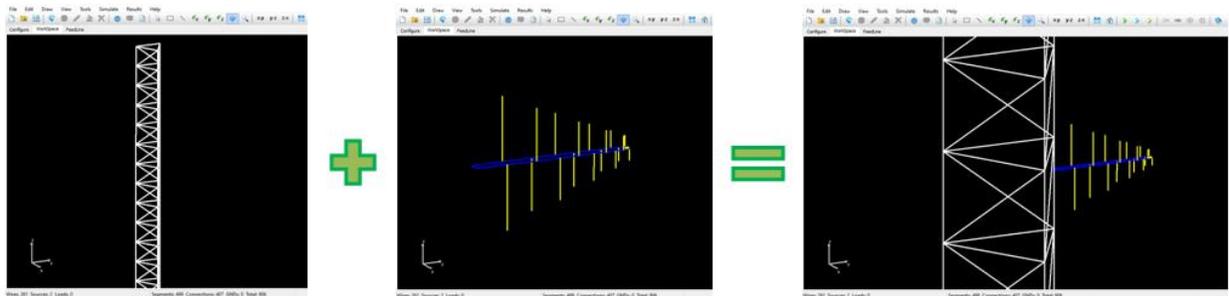
How to detect errors in the geometry of a model

To discover errors in the wire structure we can use the following functions in the **AN-SOF main menu > Tools** option:

- **Check Individual Wires:** It will be checked that the length of each segment and its radius are short compared to the wavelength. If the Exact Kernel is not set in Configure tab > Settings, then the segment diameter/length ratio will also be checked (the so-called thin-wire ratio).
- **Check Wire Spacing:** It will be checked that each wire does not overlap with the others. Two wires can be as close as their radii allow, without overlapping.
- **Delete Duplicate Wires:** It will be checked that each wire is unique, in other words, that an identical wire has not been superimposed on it. Duplicate wires will be automatically deleted.

Those wires in error will be highlighted in red and those in warning in yellow.

Keep in mind that we can still run a simulation with wires in warning if we check the validity of the model using an **Average Gain Test (AGT)**. On the other hand, at a point where several wires are connected, slight overlaps may occur that do not generate errors in the results since Kirchhoff's current law is fulfilled there.