MININEC Pro

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http://www.blackcatsystems.com/software/mininec.html

Introduction

MININEC Pro is an antenna analysis program. The antenna geometry is entered as a set descriptions of the wires that make up the antenna. Then the antenna is analyzed, either for a specific frequency or a range of frequencies. The feedpoint impedance is calculated and displayed, and radiation patterns for the antenna may also be displayed.

A Quick Tutorial To Get Started

As an example, let's analyze the standard half wave dipole antenna. Our antenna will be designed for 7.15 MHz in the 40 meter ham radio band.

The dipole is analyzed as a single wire, 20.4 meters long, with a feedpoint in the center.

We'll first analyze the antenna in free space (not taking into account the ground). Go to the Environment tab, and make sure Free Space is checked. The other parameters can be ignored for now.

Next select the Wires tab, and go to the bottom, where we enter in our single wire. We must first decide how many pulses the wire should be divided into, we'll choose 10 for now. The larger the number of pulses, the more accurate (in general) the results. But this is a good starting point. So enter in 10. Next enter 20.4 into the Length input. We can ignore the Position input, that is used to more easily enter in information for antenna with several wires, such as when analyzing a yagi. Enter in a radius of 0.001 (1 mm) and select m (meters) from the popup menu, as all of our values have been entered in meters. Click on the Add button. A entry has been added to the list of wires.

Next we want to set the height of the wire. Click on the 0 value under Z1 (the height of the starting end of the wire), and change it to 8 (for 8 meters, or about 25 feet). Do likewise for the 0 under Z2 (the height of the second end of the wire).

Next we need to enter in an excitation, this is where power is applied to the antenna (ie: where the transmission line to the radio is connected). Click on the Excitation tab, and then the Add button. There are three values we need to deal with here, the Pulse number, the Voltage, and the Phase:

Each wire is divided into pulses, as explained above. In our case, we divided it into 10 pulses. The dipole is center fed, so we need to apply our excitation to the center pulse in the wire, number 5. This happens to be the default value for an excitation, so we don't need to change it. If you wanted to change the value, you would click on the value twice to turn it into an edit field, and type in the new value. Likewise, we can use the default voltage and phase values, which represent the magnitude and phase of the applied RF.

Next we need to set the frequency to 7.15 MHz. After doing this, click on the Calculate button. The Feedpoint impedance is calculated, about 70 ohms resistive and -2 ohms reactive in our case - our antenna not exactly resonant at 7.15 MHz, but is very close.

Next we'd like to take a look at the radiation pattern for the antenna. Click on the Plot tab.

We'll use the default values of Total (vertical and horizontal radiation) and do an Azimuth plot at an elevation of 90 degrees, that is looking at the radiation towards the horizon (0 degrees orientation is straight up, 90 degrees is towards the horizon with MININEC). Click on the Plot button, and you get the standard figure eight type pattern that you expect. Our results seem to agree well with theory!

Next we can look at an Elevation plot, that is, how the radiation field varies with the takeoff angle. Change the Type to Elevation, and keep the angle at 90, we want to look at the pattern at one of the main lobes. Click plot. We see a perfect circle, which makes sense since we're ignoring the ground. The dipole radiates equally well at all elevations.

Next we want to see the effects of ground. Go back to the Environment tab, and change from Free Space to Ground. For simplicity we will assume a perfect conductor, so click that box as well. Go back to the Excitation tab, and click Calculate to run the analysis again. Notice that the impedance has changed, due to the effects of ground. Note: If you get invalid results, go back and make sure you correctly entered all the information, including the height of the antenna. It is very easy to accidentally leave it as zero, which will work with an antenna in free space, but not one over a ground!

Go back to the Plot tab, and without changing anything, click on the Plot button. Now we see that there is no radiation directed downwards (due to the ground) and the peak radiation is straight up, again as expected from theory.

Change to type back to Azimuth, and change the angle from 90 degrees to something slightly smaller (since in theory there is zero radiation exactly towards the horizon). We'll try 80 degrees. We have our figure eight again, but not quite as sharp as the free space example.

Next let's see what happens when we use the antenna at the third harmonic, as a 3/2 wave dipole on 15 meters. Change the frequency to 21.2 MHz and click on Calculate. The feedpoint impedance goes up, as expected. If we calculate the plot at 80 degrees altitude, we see the additional lobes, as expected for a 3/2 wavelength dipole. Changing to an Elevation plot at 0 degrees shows us that there is a narrow lobe directed upwards, and two other lobes at an elevation of about 30 degrees. We can go back and look at a plot for 30 degrees, and see a clover shaped radiation pattern.

Now let's see how the feedpoint impedance varies over all of HF. Go to the FreqPlot tab. Enter starting and ending frequencies of 2 and 30 MHz. If you have a fast computer, or want to wait a while, enter in a step of 0.1 MHz. Then click on Plot. The yellow line represents resistance, the blue line represents reactance. Note that for antennas with a lot of segments, these calculations can take a long time. A progress bar shows how much time is left.

Other features and Useful information

Sometimes it is necessary to include a resistance in an antenna model, such as with a rhombic or T2FD. The Load tab can be used to add a resistance (and optional reactance). The pulse number of the segment is specified, along with the resistance and reactance (leave zero if none).

After an analysis is run, the Output tab has a table showing all of the pulses in the design. For each pulse, the coordinates (X,Y,Z) are given, along with the wire radius, connection information, as well as the real and imaginary current, as well as the magnitude and phase of the current.

In addition to a perfect conductor, more realistic grounds can be used. Uncheck the Perfect Conductor checkbox, and enter in values for the dielectric constant (13 is a typical value, it could be lower such as 5 for very poor ground, and 20 for good ground) and conductivity (which can range from 0.001 for poor ground to 0.03 for good ground, 0.005 is an average value).

You can enter in dimensions in a variety of units. By default, all numbers are treated as meters. You can put a suffix after a number to specify another unit: putting a ft indicates feet, in indicates inches, and mm indicates millimeters. Putting a # in front of a number treats it as a wire gauge (AWG).