NEC-WIN SYNTH

User's Manual

Antenna Analysis Software
Version 1.0

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Special thanks to our Beta Users for their ongoing suggestions and support.

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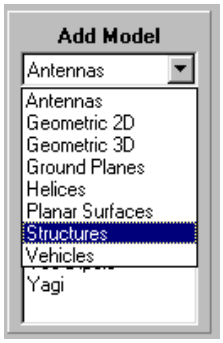
Quick Example

This is a really fast example to show you how easy it is to build models with NEC-Win Synth. Features will not be discussed in this example so please be sure to attempt the other examples.

Objectives

- Build a tower
- Add a pole to the top
- Add a Log Periodic Antenna

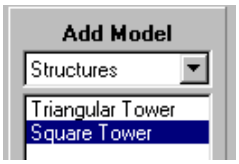
Open NEC-Win Synth



Build a tower

1. Under the Add Models section of the Display window change the type to structures.

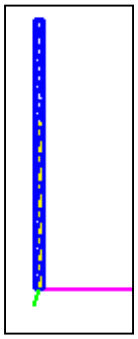
2. From the list choose Square Tower.

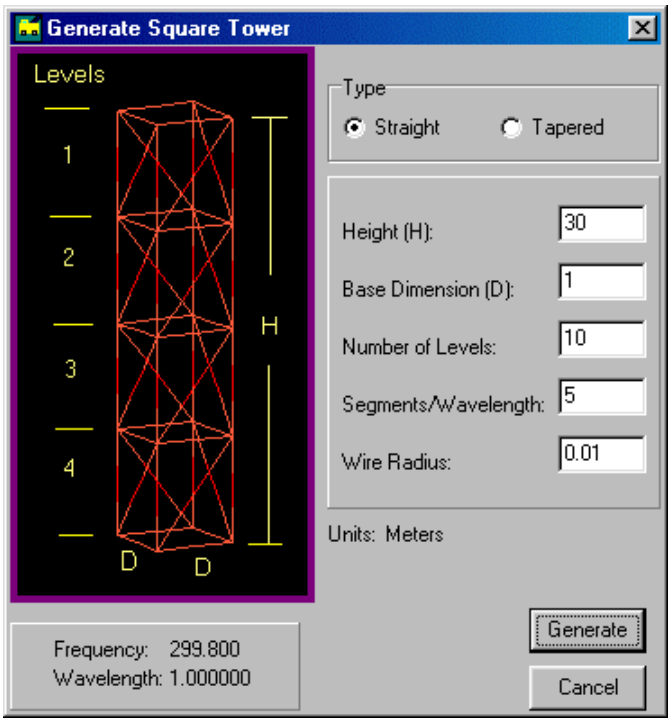


3. The Generate Square Tower dialog will appear.

Change the Height to 30 and the number of levels to 10. Click on Generate.

The tower will be built and shown in the Display window.





4. Click on the Zoom Area button. 

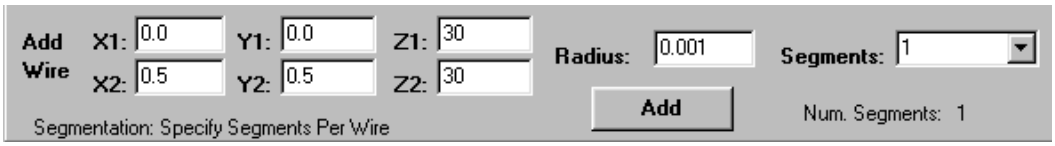
Move the mouse over to the top left of the tower, click on the left button and then put a box around the top of the tower. Let go of the left mouse button and the top of the tower will be zoomed into the window.

Rotate the tower so that you can view the top of it. Click on the Rotate button and then hold down the left mouse button while moving it over the display area.

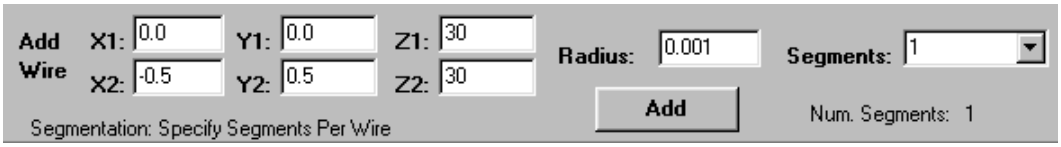
Add a pole to the top

5. Place 4 wires at the top of the tower. This will enable you to connect a bar to the tower for placement of the Log Periodic antenna. Using the Add Wires panel add the following four wires:

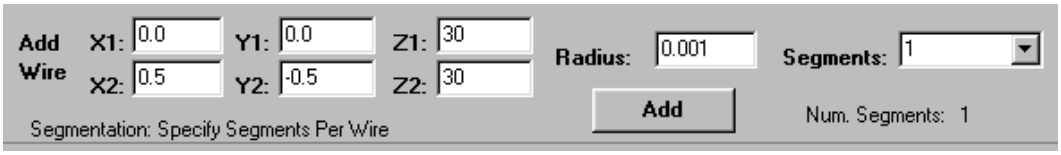
X2 = 0.5 Y2 = 0.5



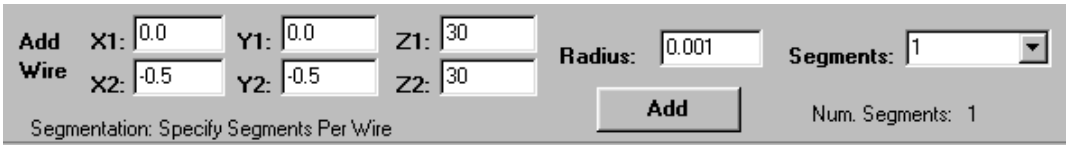
X2 = -0.5 Y2 = 0.5



X2 = 0.5 Y2 = -0.5

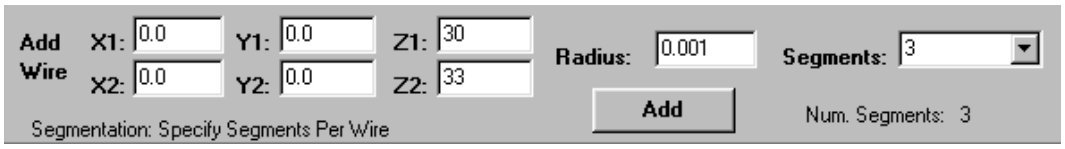


X2 = -0.5 Y2 = -0.5



You should now have a cross at the top of the Tower.

6. Place a bar at the center of the cross in the vertical direction.



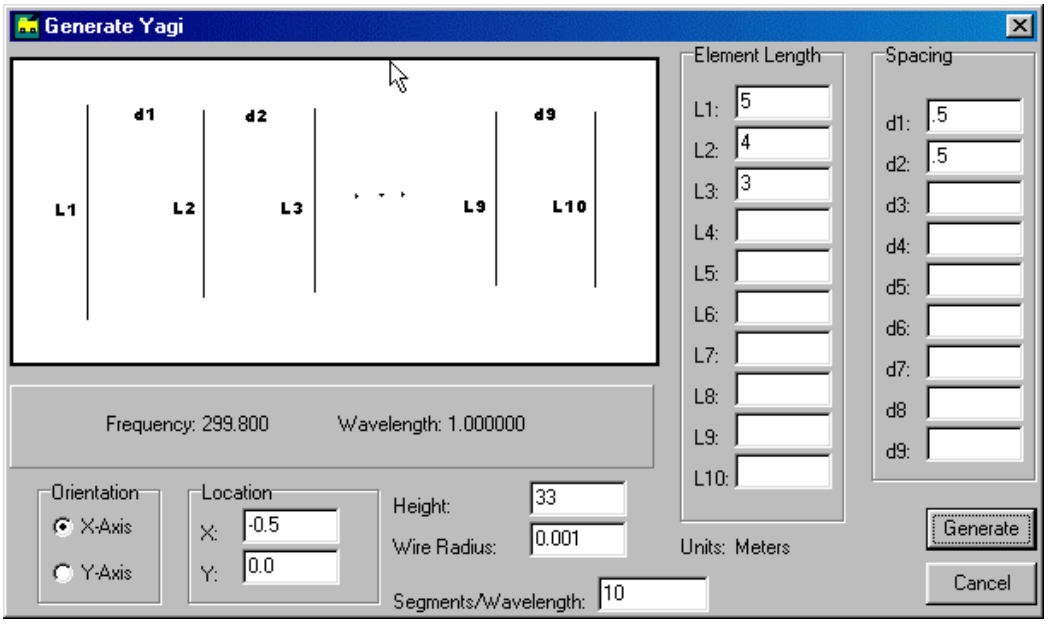
Since the bar increases the overall size of the model the complete model will be rescaled to fit back into the display window.

Add a Log Periodic Antenna

7. Add the Log Period antenna by changing the model type, under Add Model, to Antennas. Click on Yagi.

When the Generate Yagi dialog appears enter the following parameters:

L1 : 5 L2 : 4 L3 : 3 d1 : 0.5 d2 : 0.5
Orientation: X-Axis Location: X : -0.5 Y : 0.0 Height : 33



Click on the Generate button.

Note: This is not an accurate model but allows you to see how the program works.

Take the time to zoom in on the antenna and tower. Rotate, Pan, and Zoom the model. When you feel comfortable please continue to the other examples.

Example 1

In order to gain familiarity with all of the NEC-Win Synth features it is essential that all of the examples be completed.

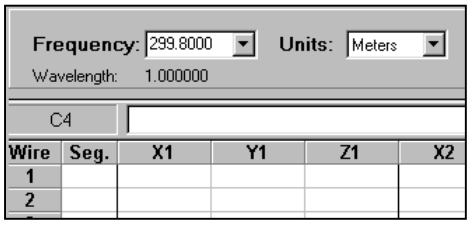
Objectives

- Selecting the Frequency, Units, and Wire Thickness
- Adding Predefined Models
- Zooming an Area
- Using the Modify Geometry Commands
- Using Variables

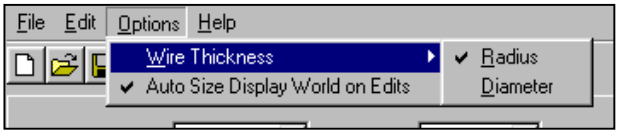
Open NEC-Win Synth

Selecting the Frequency, Units, and Wire Thickness

1. The Units and Frequency are used throughout the complete program. The first step is to go to the Spreadsheet window and choose the Frequency and Units. These can also be can be changed in the Display window.



2. Choose whether the Wire Thickness should be input as Diameter or Radius



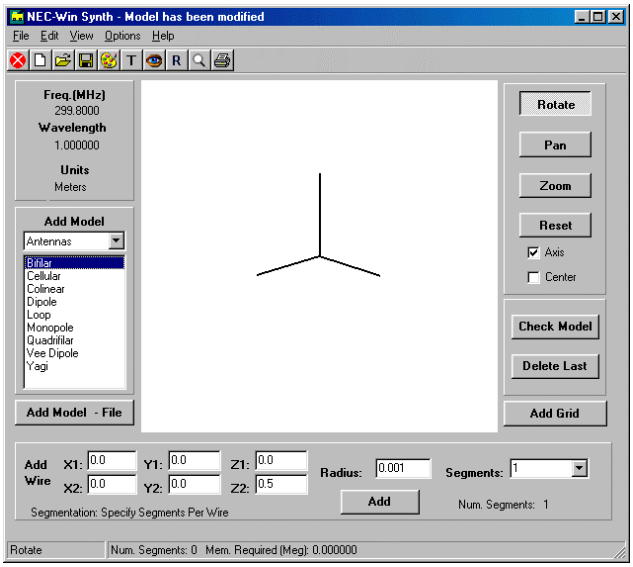
3. Switch to the Display window

The Display Window allows you to:

- View the model
- Add Single Wires
- Add Predefined Models
- Import Models from a File
- Add a Grid
- Delete the Last Model or Wire entered

The status bar displays the current viewing mode: Rotate, Pan, or Zoom

To use these functions hold down the left mouse button while moving the mouse over the Display.



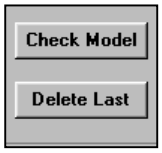
Note: Double clicking the left mouse button over the image will cycle through Rotate, Pan, and Zoom.

The status bar also displays how many segments are in the model and the approximate memory that will be required by NEC to run the model.

Adding Predefined Models

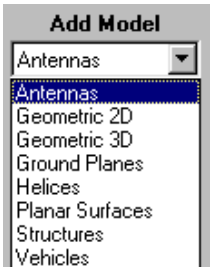
4. Adding a Model

Note: The last model or wire entered can be deleted by clicking on the Delete Last button.



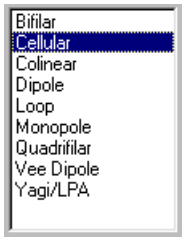
Click on the Add Model combo box

Click on Antennas



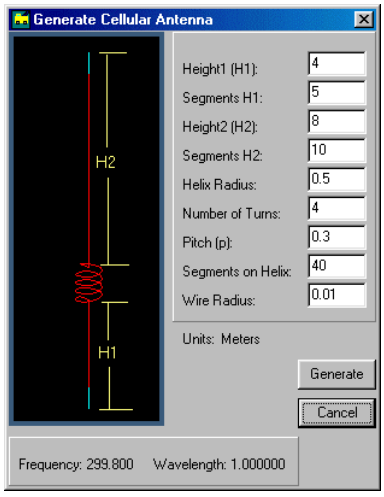
The list of available Antenna Models will be displayed.

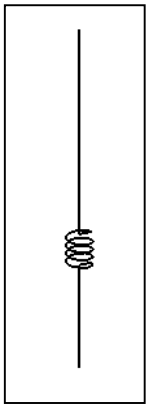
Click on Cellular.



The Generate Cellular Antenna dialog box will be displayed.

Click on the Generate button to accept the defaults. The Cellular Antenna model should now be displayed in the Display window.



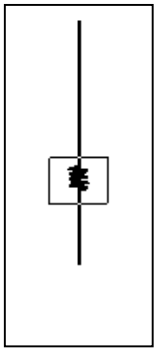


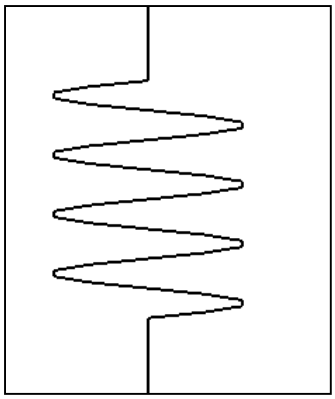
Zooming an Area

5. Zooming an Area of the Model

Click on the Zoom Area button on the toolbar 

Move the mouse over to the Display window and the cursor will turn into a crosshair. Click the left mouse button and then drag the mouse to encompass the center of the cellular antenna.

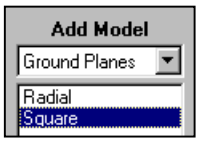




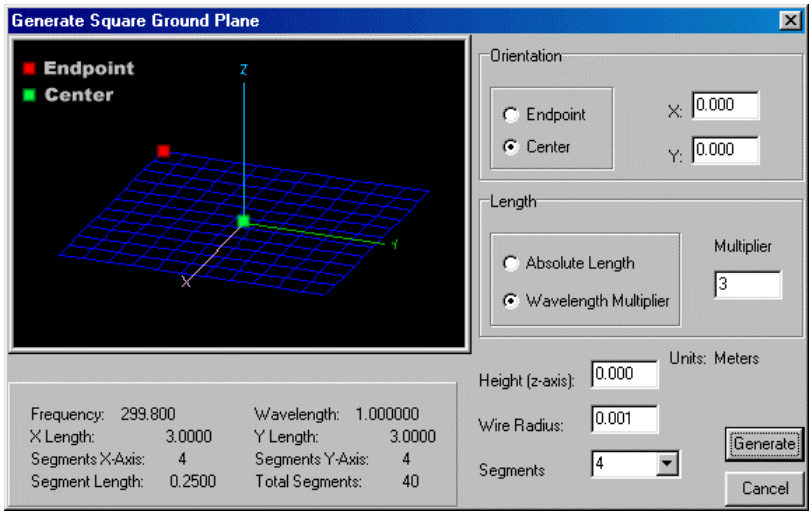
You can Zoom back out by clicking on the zoom out button, choosing Zoom Out from the options menu or typing ctrl-z.

6. Add a Ground Plane to the model

Go back to the Add Model combo box and choose Ground Planes. From the available selections in the listbox choose Square.



The Generate Square Ground Plane dialog will appear.



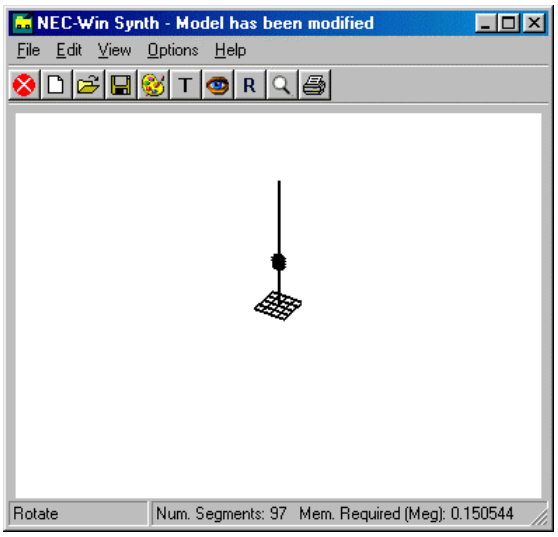
Under Length click on Wavelength Multiplier and enter **3** as the multiplier. In the Segments combo box enter **4**. Leave the rest of the selections at their defaults.

Note: Since the Segments are specified via a combo box remember that you can choose Auto and then double click on the combo box to select the segments/wavelength.

Click on Generate.

The Display window should now contain the cellular model with a ground plane underneath it.

7. Resize the Display window



Resizing the Display window allows easier access to the Spreadsheet window.

Click on the lower right corner of the Display window and shrink the window. As the window gets smaller the buttons around the border will disappear.

Adjust the Display window and the Spreadsheet window so that both can be viewed at once. A typical configuration would be to make the Display window small and move it to the upper left corner of the screen with the Spreadsheet left at its default size placed in the lower right corner.

Optimal viewing of both windows occurs if the resolution is set to Small Font with a resolution greater than or equal to 1024 x 768.

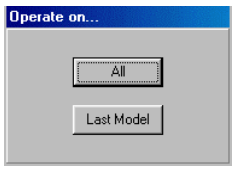
Note: When you resize the display window the status bar may disappear. To bring it back, make the window a little larger.

Using the Modify Geometry Commands

8. Moving the Ground plane

In the Spreadsheet toolbar click on the Select All button.

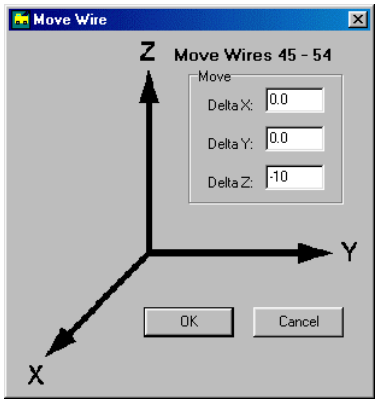
Since two models were entered (cellular and square ground) the Select All button will prompt whether you wish to Select All wires or the Last Model. The Ground Plane was the last model entered so select Last Model.



The Wires for the Ground Plane will now be highlighted.

To display the Move Geometry dialog box click on the Move button (the center button under the Geometry panel).

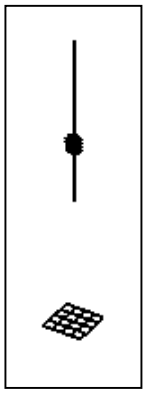
The Move Dialog will appear.



Enter **–10** in the DeltaZ edit box. This will move the height of the ground plane down 10 units.

Click on the OK button.

Looking at the Display window you will see that the ground plane has moved down.



Using Variables

9. Moving the Height of the Ground Plane using Variables

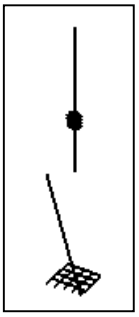
Unless you have clicked on a cell in the Spreadsheet the Ground Plane wires will still be highlighted. Note that the Ground Plane occupies wires 45 – 54.

Wire	Seg.	X1	Y1	Z1
42	1	0.4045084	-0.293893	5.17
43	1	0	0	5.2
44	10	0	0	5.2
45	4	-1.5	-1.5	=a
46	4	-1.5	-0.75	-10

Go to Wire #45 and enter =a into the Z1 column. Hit <enter>.

The cell will now contain the value “0”. This value is the default for all variables that have not been assigned a value.

The display window will now show wire #45 going up to the origin (Z = 0).



While wire #45 cell Z1 is still selected hit ctrl-c to copy the cell contents into the clipboard. Copy and Paste can also be accessed via the right menu button or the Edit menu.

Now highlight the Z1 column for wires #46 – 54. Type ctrl-v to copy the clipboard contents into these cells.

46	4	-1.5	-0.75	-10
47	4	-1.5	0	-10
48	4	-1.5	0.75	-10
49	4	-1.5	1.5	-10
50	4	-1.5	-1.5	-10
51	4	-0.75	-1.5	-10
52	4	0	-1.5	-10
53	4	0.75	-1.5	-10
54	4	1.5	-1.5	-10

46	4	-1.5	-0.75	0
47	4	-1.5	0	0
48	4	-1.5	0.75	0
49	4	-1.5	1.5	0
50	4	-1.5	-1.5	0
51	4	-0.75	-1.5	0
52	4	0	-1.5	0
53	4	0.75	-1.5	0
54	4	1.5	-1.5	0

Note: While doing all of these operations you should see the ground plane continuously change in the Display window.

Highlight Column Z1 for Wires #45 – 54 (note that wire 45 should be included since Z2 for wire 45 still contains –10). Type ctrl-v to copy the clipboard contents into these cells. When finished you should have the following:

45	4	-1.5	-1.5	0	1.5	-1.5	0
46	4	-1.5	-0.75	0	1.5	-0.75	0
47	4	-1.5	0	0	1.5	0	0
48	4	-1.5	0.75	0	1.5	0.75	0
49	4	-1.5	1.5	0	1.5	1.5	0
50	4	-1.5	-1.5	0	-1.5	1.5	0
51	4	-0.75	-1.5	0	-0.75	1.5	0
52	4	0	-1.5	0	0	1.5	0
53	4	0.75	-1.5	0	0.75	1.5	0
54	4	1.5	-1.5	0	1.5	1.5	0

Click on the Fn button to view variables or equations in each cell.

45	4	-1.5	-1.5	=A	1.5	-1.5	=A
46	4	-1.5	-0.75	=A	1.5	-0.75	=A
47	4	-1.5	0	=A	1.5	0	=A
48	4	-1.5	0.75	=A	1.5	0.75	=A
49	4	-1.5	1.5	=A	1.5	1.5	=A
50	4	-1.5	-1.5	=A	-1.5	1.5	=A
51	4	-0.75	-1.5	=A	-0.75	1.5	=A
52	4	0	-1.5	=A	0	1.5	=A
53	4	0.75	-1.5	=A	0.75	1.5	=A
54	4	1.5	-1.5	=A	1.5	1.5	=A

Since the "A" variable is equal to zero the ground plane is located at the origin.

	A	B
1	Var.	Value
2	F =	299.8
3	W =	1
4	A =	
5	B =	
6	C =	
7	D =	
8	E =	
9	G =	
10	H =	
11	I =	
12	J =	
13	K =	
14	L =	
15	M =	
16	N =	
17	O =	

Wires | Equations

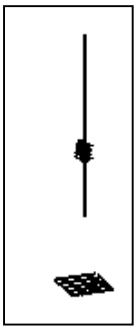
10. Changing Variable values

Click on the Equations tab at the bottom of the Spreadsheet window.

Type **–5** for the value of A.

	Var.	Value	Comment
2	F =	299.8	Primary Frequency (MHz)
3	W =	1	Wavelength = c/f
4	A =	-5	
5	B =		

Hit <Enter>. The Display will change and you will see that the Ground Plane has moved.



For more information about using equations and variables, please refer to the section Using Variables and Equations.

Take some time to change the variable values as well as rotate, pan, or zoom the model in the Display window. Remember that since the Display window has been resized, the buttons to rotate, pan, or zoom are no longer available but by double clicking the left mouse button in the Display window you can cycle through these options.

Congratulations! You have just finished your first example. Please be sure to complete the rest of the examples to learn more about the features in NEC-Win Synth.

Example 2

This example will cover more of the features included in NEC-Win Synth. The model consists of a 3-wire dipole.

Objectives

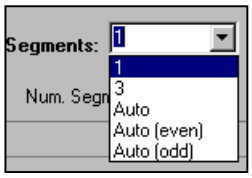
- Adding Wires
- Selection Feature
- Highlight Feature
- Wire Information
- Deleting Wires ****Must Read****

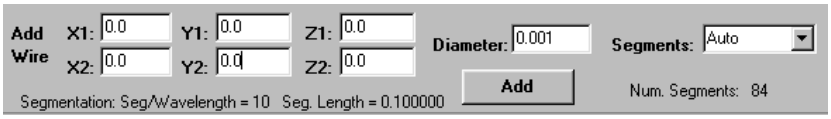
Open NEC-Win Synth

1. In the Spreadsheet window set the Units to Feet, the Frequency to 28.5, and the wire thickness to Diameter. (Refer to Example 1 if help is needed)

Adding Wires

2. Go to the Add Wires panel in the Display Window. Before adding a wire choose how to segment the wire. Click on the Segments combo box. Select Auto.



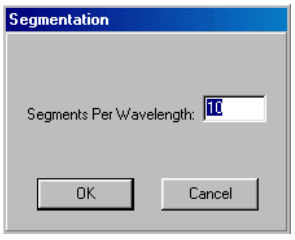


The text at the bottom of the panel will inform you what the settings are for the Segments/Wavelength and the Segment Length based on the current Frequency.

Auto will automatically calculate how many segments each wire should have based on segments/wavelength. Auto (even) and Auto (odd) will ensure that the number of segments are either even or odd. 1 and 3 are included because they are typical choices with three (3) typically used for a wire that will contain a source.

Note: You can enter how many segments are on each wire by typing the value directly into the combo box.

Double click the left mouse button on the Segments combo box. The Segments/Wavelength dialog will appear. Choose how many segments per wavelength should be used for Auto, Auto (odd), or Auto (even).

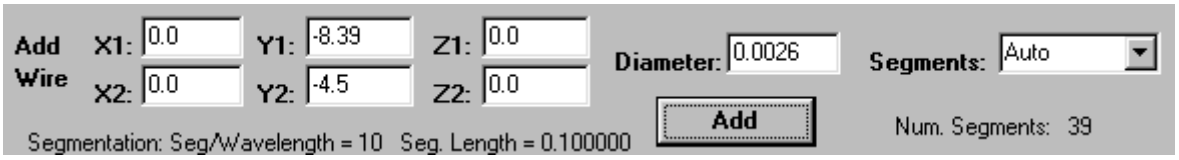


Note: Any model that contains a Segment combo box can be double clicked to set this parameter.

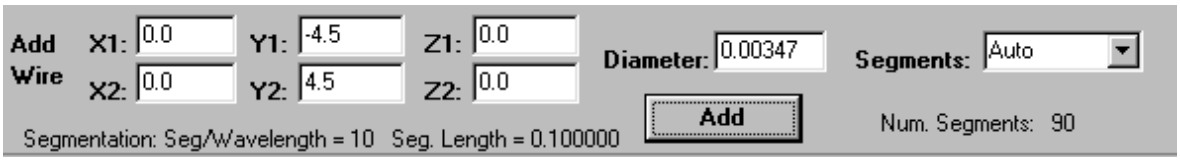
3. Add the following wires by entering the appropriate coordinates and wire diameter in the edit boxes. Click on the Add button after you enter each set of coordinates.

Note: If you make a mistake you can delete the wire by clicking on the Delete Last button.

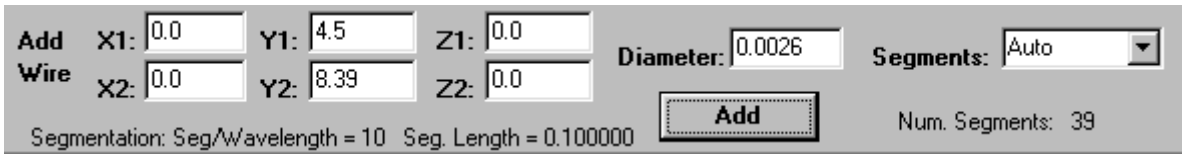
Wire #1



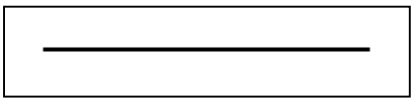
Wire #2



Wire #3



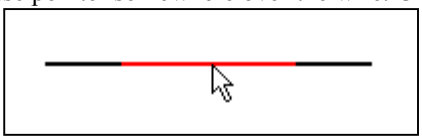
The Display window should now contain a picture of the dipole. Since it is along the axis, to get a better view turn off the axis by unchecking the Axis checkbox



Selection Feature

4. Using the Selection Feature

Since the Dipole consists of three individual wires we will use the Select Feature to determine which wire is which. Move the **TIP** of the mouse pointer somewhere over the wire. Click on the **Right** mouse button.



The wire that was clicked on will change color. Also, back in the Spreadsheet window the row, which created that wire, will be highlighted.

Wire	Seg.	X1	Y1	Z1	X2	Y2	Z2	Dia.
2	90	0	-4.5	0	0	4.5	0	0.00347
3	39	0	4.5	0	0	8.39	0	0.0026

Using the Select Feature automatically turns on the Highlight Feature back in the Spreadsheet window. 

Highlight Feature

5. Using the Highlight Feature

The Highlight Feature is the reverse of the Select Feature. When the Highlight button is depressed clicking on any wire in the Spreadsheet will highlight the wire back in the Display window.

Note: If you leave the Highlight Feature turned on any new wires added will be the color selected for Highlight. This makes it easy to distinguish new wires when building complex models.

Wire Information

6. Wire Information

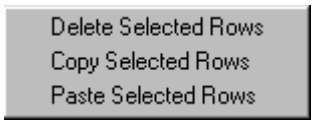
As you click on each row for a particular wire, the status bar in the Spreadsheet will display the Wire Number, Wire Length, Segment Lengths for the wire, the Diameter, and the Radius.

As you enter each wire it will be checked to see if it meets the segments/wavelength criteria (specified in the Spreadsheet – Geometry Checker menu). It will also be checked to ensure that the segment length is not less than the radius. If either of these conditions occurs the word VIOLATION will be at the end of the line.

Deleting Wires ***Must Read***

7. Deleting Wires

Wire **MUST** be deleted by first highlighting them and then clicking on the right mouse button to access the quick menu. Within the quick menu choose Delete Selected Rows.



Warning: Wires should not be deleted by clearing spreadsheet cells.

This was a short example but it exposed powerful features. Please continue to the next example.

Graphically Adding Wires /Modifying Coordinates

NEC-Win Synth allows you to get coordinate information from the Display window as well as place wires or modify coordinates graphically.

Objectives

- Getting Coordinate Information for a Wire
- Placing a wire graphically
- Getting the Distance between points in order to Move a Model
- Adding / Modifying spreadsheet coordinates graphically

This chapter covers the Get Coordinate and Get Pair of Coordinates option. It is essential to understand the difference between the two.

The Get Coordinate option is intended to modify existing wires. You select a set of coordinates from the spreadsheet (X1, Y1, Z1 or X2, Y2, Z2) then you click on a point in the Display and the new coordinates will replace the old coordinates. Get Coordinates may also be used to enter a new wire. The new wire will run from the origin to the point selected on the Display.

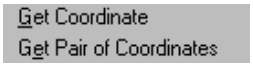
The Get Pair of Coordinates option is used to add wires to the model graphically or get coordinate information. When used for coordinate information the X, Y, and Z values for any wire or segment end may be obtained as well as the distance between a set of coordinates. The distance information may be used to determine where to move a model. The following examples should help clarify the difference between the two options.

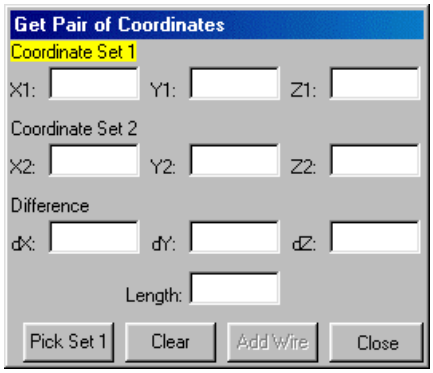
Open NEC-Win Synth

Getting Coordinate Information for a Wire

1. Click on Add Model and from the Antenna category choose Bifilar. Click on generate to build a bifilar based on the defaults. After the model appears, zoom in on it by clicking on the Zoom button and boxing an area of the model.

2. In the **Spreadsheet** window click the right mouse button. The quick menu will appear. Select Get Pair of Coordinates. Get Pair of Coordinates can also be selected from the Display – Edit menu.





The Get Pair of Coordinates dialog will appear. The Display window toolbar will now contain text stating that the interface has been placed into Get Coordinate Mode.

In the **Display** window, use the **Right** mouse button to click on different wires in the model. As you click on a wire it will be highlighted and the segment endpoints will have boxes.

Note: The size of the boxes in Coordinate identification can be modified via the View menu in the Display window. If the boxes are not visible you should either zoom the model or change the box size.

3. When you are ready to identify a coordinate hit the F1 key (function key 1). The text in the Display window toolbar should change to Select Point Now.

4. Move the mouse over one of the boxes and click on the **Right** mouse button. If the mouse was within a box, the coordinates for that endpoint will now be displayed in the Get Pair of Coordinates dialog.

5. As long as you want information from the same wire you can repeatedly click on any of the boxes. If you want to switch wires you need to hit the F1 key then click on a different wire. Hitting the F1 key will return the program to Get Coordinate mode. Go to step 3 to get coordinate information for the new wire.

Placing a Wire Graphically

6. Placing a wire graphically is easy. In the last steps you found coordinate information and it was placed in the Coordinate Set 1 edit boxes in the Get Pair of Coordinates dialog. Now, all you need to do is get coordinate information for Coordinate Set 2. To switch to Coordinate Set 2 either click on the Pick Set 1 button in the dialog box (the button will change to Pick Set 2) or hit the F3 key (function key 3). Then click the right mouse button on the appropriate wire to highlight it. Once the wire is highlighted click on the F1 key to put the interface into selection mode and click on the appropriate box. After Coordinate Sets 1 and 2 are filled in, click on Add Wire and a wire will be generated between the coordinate sets. The number of segments for the new wire will be based on the current setting of the Geometry Checker. For instance, if the Geometry checker is set to check for 10 segments/wavelength then the new wire will contain 10 segments/wavelength.

In a nutshell this is the procedure:

- Click on Get Pair of Coordinates in the Spreadsheet quick menu
- Using the Right mouse button click on the appropriate wire
- Hit the F1 key – click on the correct box with the Right mouse button
- Hit the F3 key to switch to coordinate set 2
- Highlight the appropriate wire using the Right mouse button
- Hit the F1 key – click on the correct box with the Right mouse button
- Click on the Add Wire button in the Show Coordinates dialog

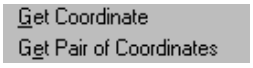
Note: The F2 key (function key 2) is reserved for editing of spreadsheet cells.

Getting the Distance between points in order to Move a Model

Getting the distance between two points is achieved using the same method described in the above procedure. The dx, dy, and dz edit boxes show the distance between each coordinate. The Length is the absolute length between the points. When only one set of coordinates is identified in the Get Pair of Coordinates dialog the X1, Y1, and Z1 values themselves are the distance from the origin. . At this time there is no automated way to copy the data from the Get Pair of Coordinates dialog into the Move dialog

Adding / Modifying Spreadsheet Coordinates Graphically

7. This procedure uses the Get Coordinate option available in the Spreadsheet quick menu (accessible with the right mouse button).



Note: You should read the first part of this chapter for a better understanding of how this feature works.

In the Spreadsheet window, move the cursor to the set of coordinates you would like to modify. This would be X1, Y1, Z1 or X2, Y2, Z2. You do not need to highlight all three coordinates. As long as the cursor is in column 2, 3 or 4 for the first coordinate set or column 5, 6, or 7 for the second coordinate set the program will recognize which coordinate set you would like to modify. You may also place the cursor on the first blank line if you would like to add a new wire. If you do place the cursor on a blank line the above rules still apply depending on which coordinate you wish to automatically obtain.

8. After selecting the coordinates to modify, click on the Right mouse button and choose Get Coordinate from the quick menu. The Display window will highlight the current wire with boxes at the segment endpoints.

9. Using the Right mouse button click on the appropriate wire. Once the appropriate wire is highlighted, hit the F1 key (function key 1) then click on the desired box to get the coordinate information and place it into the spreadsheet. The number of segments for the wire will be modified based on the current setting of the Geometry Checker. If this option is used to generate a new wire the new wire will only contain one segment since the other endpoint will be the origin.

Note: The Get Coordinate operation may be canceled by hitting the Escape key.

Combining Shapes

This example will cover how to combine shapes to create models.

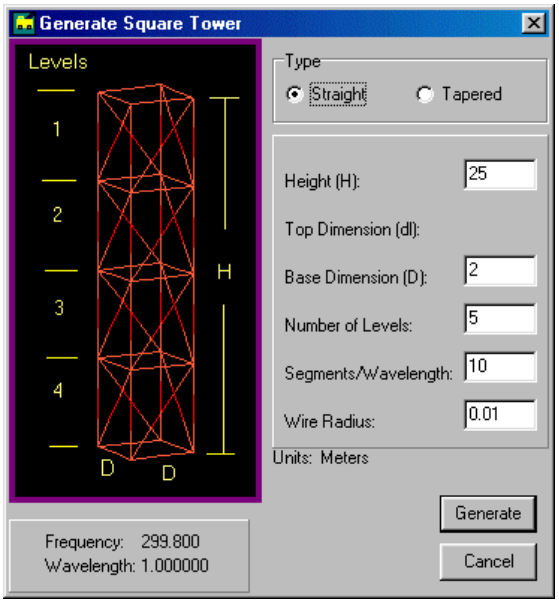
Objectives

- Adding a Parabola to the top of a Tower
- How to Modify a Model that was not the Last Entered
- Saving or Exporting Files
- Adding a Grid
- Miscellaneous Button and Menu Options

Open NEC-Win Synth

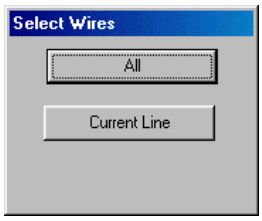
Adding a Parabola to the top of a Tower

1. Go to the Display window and choose Structures in the Add Model listbox. Click on Square Tower and enter the following parameters shown in the dialog box to the right.

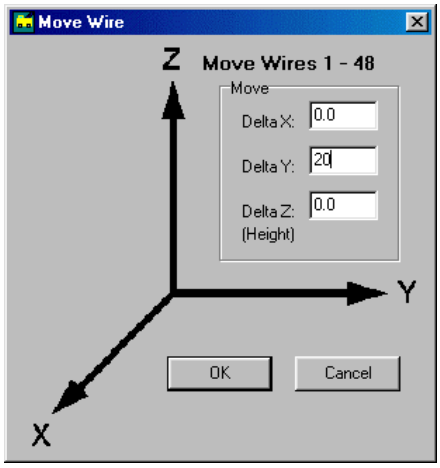


2. Now move the tower 20 meters out the y-axis. Click on the Move button in the Spreadsheet window.

3. You will be prompted whether you want to move All the wires or the currently selected wire (in the Spreadsheet). Click on All.

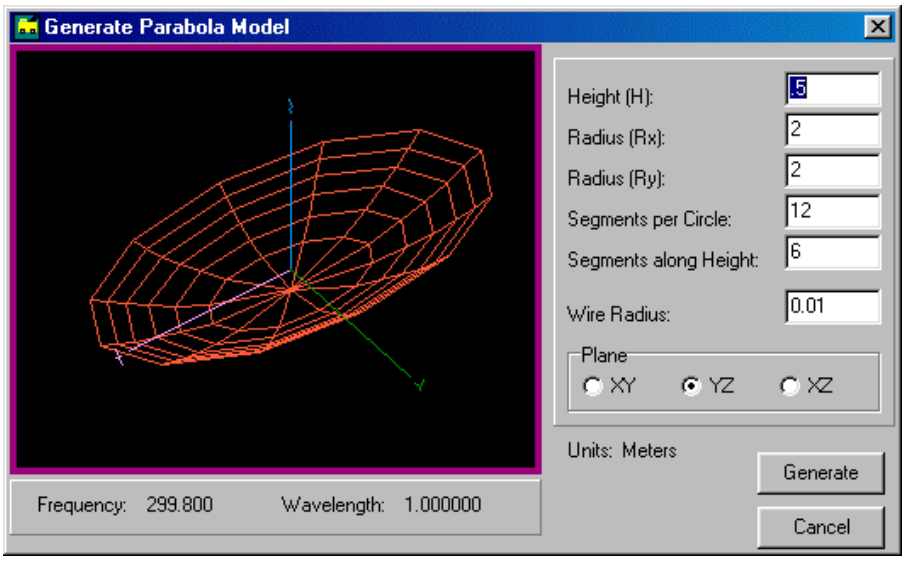


4. The Move Wires dialog will appear. Enter 20 in the Y parameter and click OK.

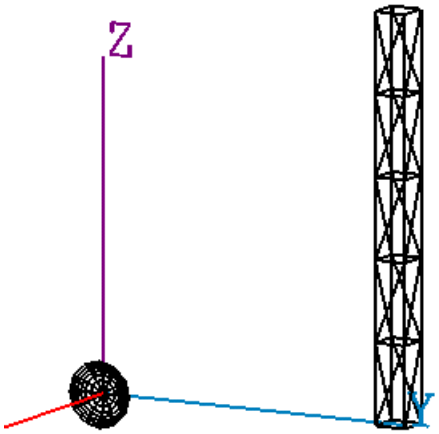


Viewing the Tower in the Display window you should now see that it is located 20 meters out the y-axis.

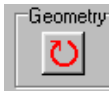
5. Now add a Parabola to the top of the tower. The parabola will be tilted 45 degrees. In the Display window change the Add Model listbox to Microwave. Click on Parabola. Enter the following parameters.



At this point you should have the following in the Display window.



6. Tilt the Parabola 45 degrees. Click on the Rotate button in the Spreadsheet window. In the dialog that appears choose Last Model. Enter –45 for the Y parameter in order to rotate the parabola around the y-axis 45 degrees.



Note: Rotations follow the right hand rule.

Warning: Rotations should be done at the origin before moving the model. If you were to move the parabola to the top of the tower and then do the rotation the parabola would be rotated around the y-axis ending up somewhere off in space.

7. Move the parabola to the top of the tower. Click on the Move button. The tower has a height of 25 meters and a location at the y-axis of 20. Move the parabola to two meters above the tower. In the Move Wires dialog enter 20 for the Y parameter and 27 for the Z parameter (height).

The parabola should now be sitting two meters above the tower at a 45-degree tilt.

At this point you would want to physically connect the parabola to the tower. In this exercise we are going to skip that part but offer a hint. To find the connection point to the center of the parabola use Wire Identify. Zoom in the parabola and click the right mouse button on the wires converging at the center. Viewing the coordinates for each wire in the Spreadsheet window you will see that the common coordinate (the center coordinate) is (0, 20, 27).

How to Modify a Model that was not the Last Entered

8. NEC-Win Synth tracks the last model entered be it through Add Model, Add Grid, Add Wire, or Add Models – File. Tracking the last model entered makes it easy to rotate, move, or delete the model. At times you may want to perform operations on a model that was not the last entered. For instance, in the previous example you may have wanted to move the tower after you had already added the parabola. Clicking on the Select button on the Spreadsheet toolbar only gives you the option to select the entire structure or the last model entered so that won't help. What you need to do is highlight the appropriate rows in the spreadsheet. Once the appropriate rows are highlighted you can perform move or rotate operations on them.

The following is the easiest way to find the wires contained in a particular model.

Within the Display window, click the right mouse button on one of the wires in the model. This will highlight the appropriate row in the Spreadsheet window. Then within the spreadsheet move the cursor up with the arrow keys. As you do this watch the Display window to see when the highlighted wire switches to a different model. Once this occurs you have found the beginning of the model. Repeat this procedure moving the cursor down to find the last wire in the model.

Once you have located the starting and ending rows in the Spreadsheet highlight the appropriate wires. Clicking on rotate or move will allow you to modify the model. This technique is also useful if you wish to copy a model into the clipboard.

If the model is large, you can zero in on the beginning and ending wires by clicking the mouse around on Spreadsheet rows to get a better idea of where one model ends and the other begins. Once you get in the general area you can move the cursor with the arrow keys to find the exact row.

By first clicking on a wire in the Display window, the Highlight function on the Spreadsheet is turned on. If you only want to click on the Spreadsheet then you should turn on the Highlight function by clicking on the Highlight button on the Spreadsheet toolbar.

Miscellaneous Functions

In this example a model will not be built but various features will be discussed.

Objectives

- Using NEC-Win Synth with NEC-Win Plus
- Adding Models from a File
- Saving or Exporting Files
- Adding a Grid
- Miscellaneous Button and Menu Options

Using NEC-Win Synth with NEC-Win Plus

If NEC-Win Synth was installed in the NEC-Win Plus directory then using the program from within NEC-Win Plus is trivial.

To open NEC-Win Synth while working in NEC-Win Plus, move the cursor in the NEC-Win Plus spreadsheet to the row where you would like to add the NEC-Win Synth model. After placing the cursor, click on the right mouse button to access the NEC-Win Plus quick menu. Choose Insert Synthesizer Output. This will cause NEC-Win Synth to start up. NEC-Win Synth will automatically have the Frequency and Units set according to the NEC-Win Plus settings. The Start Frequency in NEC-Win Plus will be the one used by NEC-Win Synth.

Warning: If you change the Frequency or Units in NEC-Win Synth NEC-Win Plus will not be aware of the change.

When NEC-Win Synth is started from within NEC-Win Plus there will be a new button added to the NEC-Win Synth Display and Spreadsheet toolbars. This button is known as the close and exit button.

After building your model click on the Close and Exit button and the model will be automatically loaded into NEC-Win Plus.

Adding Models from a File

Open NEC-Win Synth

1. Go to the Display window and click on the Add Model – File button or choose Add Model File from the File menu.

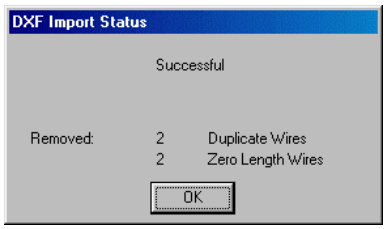
When the Open File dialog box appears browse to the nec-synth\examples directory and select “tank.nec”.

The file will be read in and the tank will be displayed in the Display window.

Supported File Formats include: NEC input files, AutoCAD© DXF files, and ASCII text files.

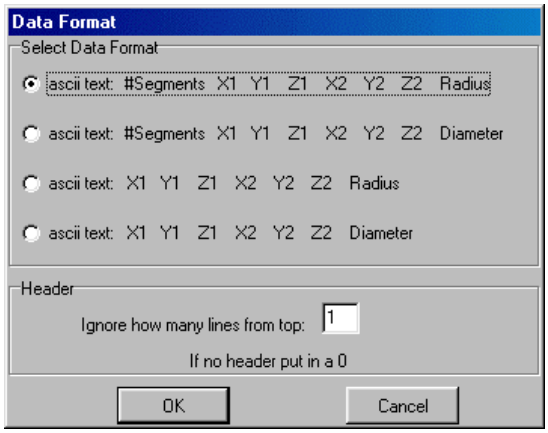
NEC input file commands supported are: CM, CE, GW, GS, GE, and FR. If the input parser finds any other commands you will be warned but the supported commands will still be read in. If the NEC file contains a GS command then the coordinates in the NEC file will be converted to the units chosen in the main interface. If no GS is present meters are assumed.

DXF input files are expected to have the "LINE" type. When a DXF file is read into the program it will be checked for duplicate and zero length wires. These wires will be automatically removed.



Several formats are supported for ASCII input files. When you select to import a file of this type you will be prompted to choose the format. If the file contains a header the number of lines in the header should be entered.

If you choose Radius or Diameter and the program is set to the opposite the values will automatically be converted.



Saving or Exporting Files

2. Saving or Exporting a File

NEC-Win Synth can save the file in its native format, *.nws, or as a NEC input file, ASCII text file or EZNEC geometry file. When saved as an *.nws file everything is saved including variables and equations. If saved as a NEC input file, ASCII text file or EZNEC geometry file variable and equation information is lost.

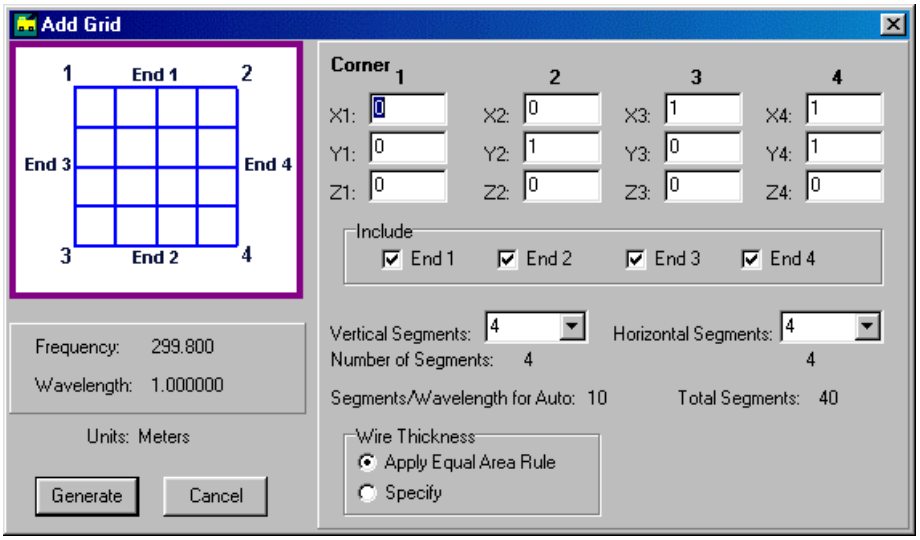
Adding a Grid

3. Adding a Grid

Click on the New button or choose New from the File menu.

Go to the Display window and click on the Add Grid button.

The Add Grid dialog box will appear.



The Add Grid feature is unique from the Add Models section because placement and size of the grid is totally user controlled.

- The grid is specified by entering all four endpoints
- Ability to omit wires at any of the four sides is possible
- Number of segments for the Vertical or Horizontal wires can be specified or calculated automatically
- Wire thickness can be specified or the Equal Area Rule can be applied

If Auto is chosen for segmentation then double clicking on either the combo box for Vertical or Horizontal will bring up the Choose Segments/Wavelength dialog box.

The Equal Area Rule is used to determine the wire radius or diameter to approximate a metal sheet. The formula applied is:

$2\pi a = d$, a = wire radius d = separation of wires in the mesh

Connecting two grids should be done by lining up two of the endpoints on each grid (or segment endpoints on the existing grid if a full match is not desired) and **ensuring** that the number of segments or the segment length between the two sets of endpoints is the same. Also, make sure to **omit** the **end wire** (under the Include panel) on the side that will be connected so duplicate wires are not generated.

Choose some endpoints and click on Generate to build the grid.

Miscellaneous Button and Menu Options

4. Miscellaneous Features

Buttons:

Top Button – this button is available on both the Spreadsheet and Display windows. When enabled the chosen window will remain on top of the other window. This is a nice feature when the windows overlap each other and you wish to see certain parts of both windows at the same time.

Close Button – this button is only on the Display window and closes it. This button DOES NOT exit the program.

Display Button – this button is only on the Spreadsheet window and opens the Display window.

Color Button – this button is only available from the Display toolbar and brings up the Color Selection dialog box to assign the colors used in the Display window.

Menu Functions:

This menu item is available from the Spreadsheet - Options menu. When the menu item is checked, any edits to existing wires will be checked to determine if the Display window should be resized to show wires that may go outside the window. Since a resize causes the model to be reset a typical use for turning off (unchecking) this option would be if the model is zoomed and a resize is not desired.

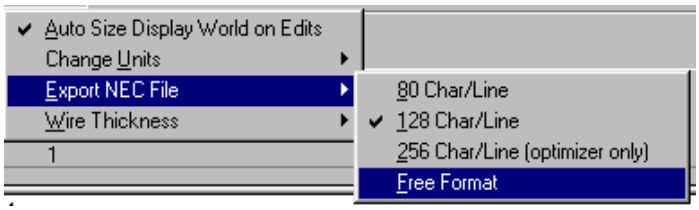
This menu item is available from the Display - Edit menu. When it is selected the entire model will be examined and new world coordinates will be generated to ensure the model fits in the Display window.

When a wire is added that is beyond the current display, new world coordinates will be generated so that the entire model fits in the display window. If the same wire which caused the new world coordinates is deleted the world coordinates will not be regenerated. In other words, adding wires may cause the world coordinates to be recalculated but deleting wires will not. This is the situation where this menu option is useful. Since the world coordinates are always made larger if needed there may be times after wires are deleted that the world window should be made smaller so that the model gets larger in the window.

The past three examples have covered the features available in NEC-Win Synth. Other sections in this manual cover some of these items in more detail.

This menu item is available from the Display - Options menu. When this option is turned on every time a new model is added you will be prompted whether or not you wish to start a new file.

This menu item is available from the Display – Options menu. All of the predefined models have default values. As you use the program it will store your values as the default for each model. When you select this menu option ALL of the models will be restored to their default values.



The Export NEC option is available from the Spreadsheet – Options menu. This option allows you to choose how many characters per line should be used when you save the model as a NEC file.

Geometry Checker

This chapter will discuss the use of the Geometry Checker.

Objectives

- Setting the Segments/Wavelength Parameter
- Running the Geometry Checker
- Identifying the Geometry Warning or Error
- Automatically Fixing Violations
- Supported Geometry Violations

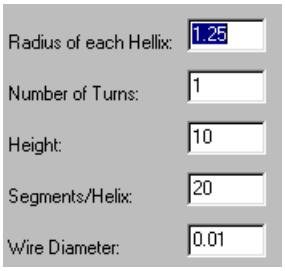
Open NEC-Win Synth

Setting the Segments/Wavelength Parameter

1. Before using the geometry checker you need to decide how many segments/wavelength should be used on each wire. Once you start the geometry checker, every wire will be examined to determine if it meets the requested criteria. Common values used for the segments/wavelength are 5, 10, and 20. 10 is the typical choice with 20 being used in critical areas and 5 in less critical areas. For instance, if you model a car with the antenna on the roof a feasible solution would be to have 20 segments/wavelength on the roof and 10 segments/wavelength on the sides. Segmentation is one of the most important aspects of any model. A bad choice of segment lengths may generate invalid results. It is assumed that the analysis package used to analyze the generated models will cover the topic in more detail.

To set the Segments/Wavelength go to the Geometry Checker menu option on the main menu of the spreadsheet. For the following example set it to Typical (10 seg/lambda). This means that every wire, which does not contain 10 segments/lambda, will get flagged as a violation.

Running the Geometry Checker



2. Lets start with a trivial example. Set the frequency to 299.8 MHz and the units to Meters. Change the Add Model category to Antenna and choose Bifilar. Enter the following parameters:

After the model is built start the geometry checker. This is done in a variety of ways. The toolbar on each window (display and spreadsheet) contains a geometry check button. 

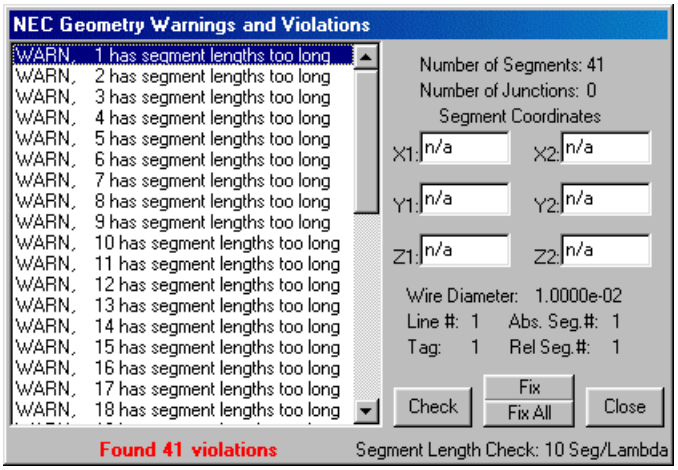
On the right side of the Display Window there is a button to call the geometry checker. 

Click on one of the above choices. The geometry checker will open and validation of the model will begin.

After the checking is complete, the Geometry Checker dialog box will contain any violations that were found. At the bottom of the dialog is listed how many violations were found. The checker will list as many as 1500 violations at a time.

If no violations were found, the listbox will remain empty and the text "No Violations Found" will be shown at the bottom of the dialog.

Segment lengths too long generate a warning. This implies that the model can still be simulated but the results may be questionable.



The dialog contains information about each warning or error. The number of segments is listed as well as the number of junctions (a point where three or more wires connect). The edit boxes for X1, Y1, Z1, X2, Y2, and Z2 contain n/a because "Segment lengths too long" refers to the complete wire not individual segments on the wire. If the warning/error referred to a segment then the segment coordinates would be listed in the edit boxes. The coordinates are displayed in edit boxes so that they can be copied to the clipboard for use in the spreadsheet to help connect wires.

There are two warning that refer to the complete wire. "Segment lengths too long" is one and the other is "Segment length is smaller than the radius". All other errors/warnings refer to individual segments.

The rest of the dialog contains the wire diameter (or radius), the line number of the offending wire or segment, the tag (also referred to as the wire number), the absolute segment number and the relative segment number. When the warning/error is for a complete wire only the values for the first segment in the wire will be listed.

Identifying the Geometry Warning or Error

3. The wire, which caused the warning or error, can be easily found. Click the left mouse button on any of the listed violations and the wire will be highlighted in the Display window and the appropriate line will also be highlighted in the Spreadsheet window. If the violation references two segments then one click will highlight the first segment and a double click will highlight the second segment.

Automatically Fixing Violations

Warning: Attempting to automatically fix wire grids can destroy the grid.

4. The program can attempt to automatically fix two of the nine reported violations. The two supported violations are: Segment lengths too long and Segment length is less than the radius of the wire. To fix the bifilar model that was created above, click on the "Fix All" button in the Geometry Checker dialog box. Since this operation will affect every wire you will be prompted to save the model first. The model should always be saved so that it can be reloaded in case the fix destroys connection points. This is especially important when working with grids.

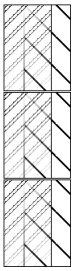
After saving the file, the number of segments for each wire will be modified and the checker will analyze the model to check if the fix worked correctly. In the case of the bifilar, every wire should be successfully fixed.

If working with complex models you may not want to run "Fix All". In this case the "Fix" button is provided. The fix button **only** operates on the wire highlighted in the listbox.

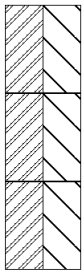
Supported Geometry Violations

5. The following is a list of the violations reported by the geometry checker.

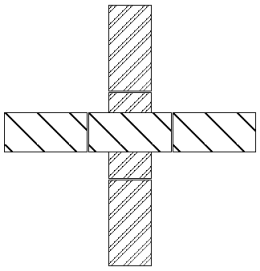
Warnings:



Segments within volume of each other



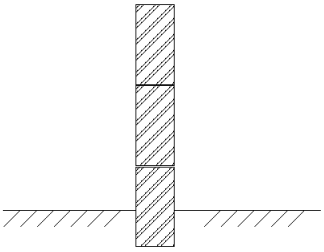
Parallel and Close



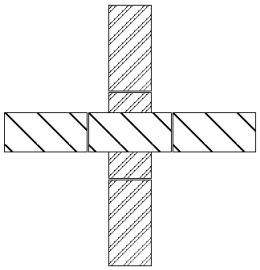
Segments Cross at Midpoint

Errors:

Parallel and Overlapping



Extend Below Ground



Segments Intersect at Midpoint

In addition to the above are three more violations: zero length wire, Segment lengths are too long, and Segment length is less than the radius of the wire.

Warnings – Warnings should be fixed. Although a model with warnings can still be analyzed, the results may be incorrect.

Segments within volume of each other – the **center** of a segment is enclosed by another segments radius.

Parallel and close – two parallel segments are separated by less than the sum of their radii.

Segments cross at midpoint – two segments that cross each other are separated by less than the sum of their radii.

Errors – Errors must be fixed before the analysis can be completed.

Parallel and overlapping – the centers of two segments are on top of each other. This condition is usually caused when wires are actually on top of each other. AutoCAD® DXF files are known for having duplicate wires.

Extend below ground – a preset ground has been used and a segment extends below it.

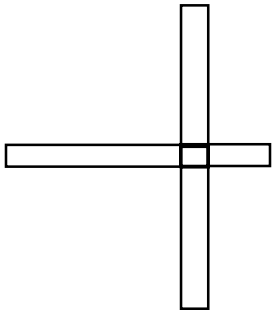
Segments intersect at midpoint – the centers of two segments intersect within the NEC tolerance for a connection. Please refer to the explanation below on junctions.

Segment is of Length Zero – this occurs when both sets of endpoints for the wire are the same.

Not a Valid Junction – NEC connects segments at a junction based on a set of rules. One-rule tests to ensure that all coordinate endpoints are within a certain distance from each other. If the endpoints meet the test, then the segments are considered connected and a junction is formed. This error is usually caused when a segment with a small length is connected to segments with much larger lengths. At junctions, all segments should be approximately the same length.

The rule for junctions is that all endpoints must be within 0.001 x Shortest Segment of each other.

The figure demonstrates the typical cause of a "Not a Valid Junction" error. If all of the endpoints are not exactly the same (i.e. 1.0040, 1.0039), when the above rule is applied the coordinate endpoints must be within 0.001 x the length of the smallest segment. If not, the error will be generated.



Using Variables and Equations

Using equations in NEC-Win Synth is very easy. The purpose of this section is to explain how to use variables and equations. At the end of this section you will build a Quad Loop antenna using variables.

Objectives

- Using Variables
- Using Equations
- Referencing Other Cells
- Using the Scratch Pad
- Referencing Cells on the Equations Page and Wire Page
- Copying and Pasting Formulas
- Quad Loop Antenna built with Variables

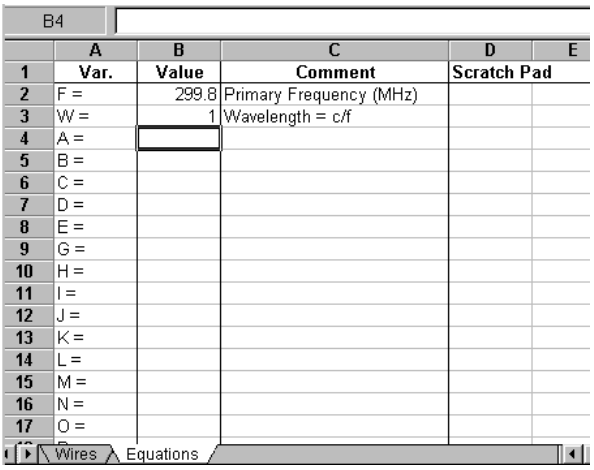
Note: To toggle between equations/variables and their values click on the Fn button.

Warning: When entering a variable or an equation, begin the entry with the equal (=) sign.

Using Variables

Start a new file.

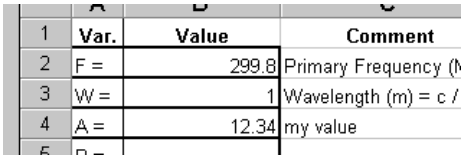
Variable values are specified on the Equations page. Switch to the Equations page.



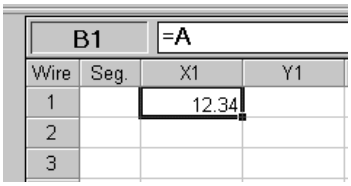
The frequency and wavelength variables track the start frequency entered in the frequency box.

The other variables are user controlled.

Enter a value and comment in the **A=** variable row.



Switch to the Wires page, click on a cell, type **=A,** and hit <Enter>. The cell will contain the value you specified on the Equations page for Variable **A**.



The edit box, at the top, displays the symbolic value. The edit box will be explained in Step 2. To toggle the spreadsheet between symbolic and numerical values click on the Fn button.

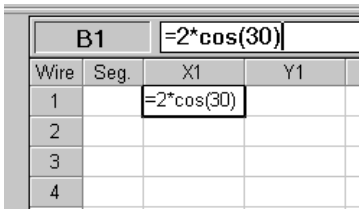
Switch to the Equations page and change the value of A. Click back to the Wires page and you will see that the cell has been automatically updated to reflect the new value.

NEC-Win Synth includes fifty user-defined variables, A through ZZ, plus variables for the start frequency and its associated wavelength.

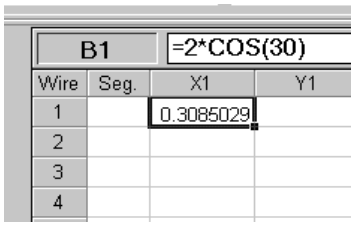
Using Equations

Start a new file. When prompted to save the old file click on No.

Equations can be typed directly into a geometry cell.



Type **=2*cos(30)** into X1 Wire 1. As you type the equation into the cell, notice that the edit box at the top also displays what is being typed. To the left of the edit box is the label **B1**. **B1** is the actual cell index for X1 Wire 1. B is the column and 1 is the row. Hit the <Enter> key.



Warning: trigonometric functions expect radians not degrees.

The cell now contains the numeric value of the formula but the edit box at the top will still display the symbolic entry.

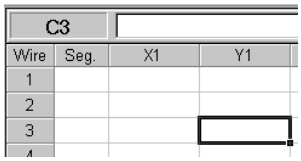
Note: To edit the formula, highlight the cell and hit the F2 key. **If you hit the F2 key twice a larger edit box will pop up to make entering long formulas easier**.

Cell Indexing

The cell index contains the column and row with the column specified first. The columns go in alphabetical order as shown in the table. The Wire number corresponds to the row number.

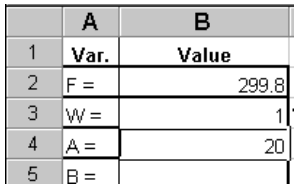
Header	**Seg**	**X1**	**Y1**	**Z1**	**X2**	**Y2**	**Z2**	**Radius**
Index	A	B	C	D	E	F	G	H

For instance, Y1 for Wire 3 would have a cell index of **C3** because Y1 corresponds to C and Wire 3 corresponds to the row number. Tab over to Y1 Wire 3 and you will see that the label next to the edit box displays **C3**.

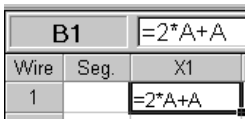


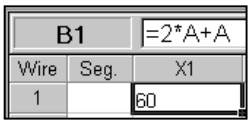
Equations can use predefined variables.

Type 20 into the **A** variable.

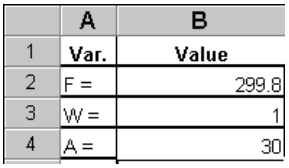


Flip back to the Wires page and type **=2*A+A** into a cell.
Hit <Enter>. As expected, the cell contains the value 60.



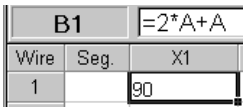


Switch to the Equations page and change the value of **A** to 30.



	A	B
1	**Var.**	**Value**
2	F =	299.8
3	W =	1
4	A =	30

Switch back to the Wires page and you will see that the cell now contains the value 90.

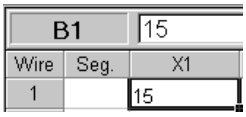


Any number of variables can be used in the equation plus most mathematical operators are available. Please see the on-line help for more information on the mathematical operators.

Referencing Other Cells

Start a new file. When prompted to save the old file click on No.

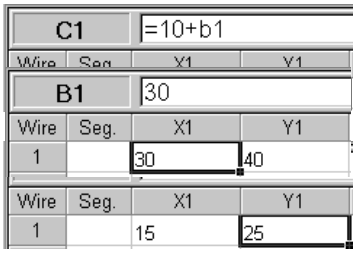
You can easily reference other cells on the same page. Type 15 into cell X1 Wire 1 then hit <Enter>. Note that the index for X1 Wire 1 is **B1**.



In the Y1 Wire 1 cell type **=10+b1** and hit <Enter>.

Note: Variables are case insensitive.

Y1 Wire 1 now holds the value 25.



Change the X1 value to 30 and hit <Enter>. Y1 will automatically recognize the change and switch to 40.

Using the Scratch Pad

The scratch pad, on the Equations page, is provided as a means of doing intermediate calculations.

Start a new file. When prompted to save the old file click on No.

Enter 5 for the **A** variable. Then in Column D Row 4 of the scratch pad type **=12+A** and hit <Enter>.

	A	B	C	D
1	Var.	Value	Comment	Scratch Pad
2	F =	299.8	Primary Frequency (MHz)	
3	W =	1	Wavelength(meters) = c / f	
4	A =	5		=12+a
5	B =			

The cell should hold the value 17.

	A	B	C	D
1	Var.	Value	Comment	Scratch Pad
2	F =	299.8	Primary Frequency (MHz)	
3	W =	1	Wavelength(meters) = c / f	
4	A =	5		17
5	B =	=D4		

Type **=D4** into the **B** variable.

B is now equal to the scratch pad value.

	A	B
1	Var.	Value
2	F =	299.8
3	W =	1
4	A =	5
5	B =	17

Note: Scratch Pad cells can reference other scratch pad cells just like the cells on the Wires page can reference other cells. (Refer to step 3)

Referencing Cells on the Equations Page and Wire Page

Cells on the Wires page can be referenced on the Equations page and vice-versa. Cells on different pages are referenced by using the page name.

Start a new file. When prompted to save the old file click on No.

Go to the scratch pad and type **=2*3** in the **D3** cell. Hit <Enter> and the cell will hold the value 6.

D3 =2*3

	A	B	C	D
1	Var.	Value	Comment	Scratch Pad
2	F =	299.8	Primary Frequency (MHz)	
3	W =	1	Wavelength(meters) = c / f	=2*3

Go to the Wires page and type **=Equations!D3** into a cell. This is how to reference cell **D3** on the Equations page.

Note the exclamation point (!) between the word **Equations** and the cell reference **D3**.

B1 =Equations!D3

Wire	Seg.	X1	Y1
1		quations!D3	

When you hit <Enter>, the cell will hold the scratch pad value for cell **D3**

B1 =Equations!D3

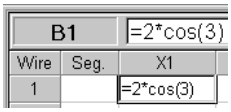
Wire	Seg.	X1	Y1
1		6	

This operation can be done in reverse. Within the Equations page you can refer to cells on the Wires page by using **=Wires!** plus a cell index. For example: **=Wires!B2**

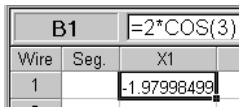
Copying and Pasting Formulas

Start a new file. When prompted to save the old file click on No.

Enter **=2*cos(3)** into X1 Wire 1.

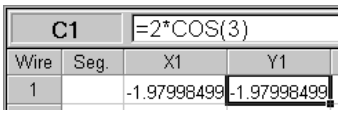


Hit <Enter>. The cell will now contain the numerical value for the formula.



While the cell is highlighted, type **ctrl-c** to put the formula into the clipboard.

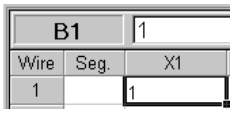
Now move over to Y1 Wire1 and hit **ctrl-v** to paste the clipboard data into the cell. The formula has been copied into the cell NOT the value.
The values are the same because the cell contained operations on constants.



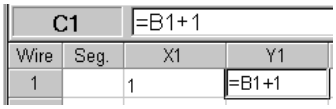
Copying Formulas that contain references to other cells.

Start a new file. When prompted to save the old file click on No.

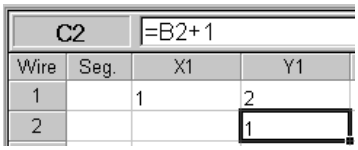
Type the value 1 into X1 Wire 1. Note that this cell is indexed as **B1**.



Type **=B1+1** into Y1 Wire 1 then hit <Enter>. The value two will appear in the cell. This value is obtained by adding 1 to the contents of **B1**. **B1** may contain constants, variables or equations. While cell **C1** is still highlighted copy the formula into the clipboard by typing **ctrl-c**.



Move down to Y1 Wire 2 and type **ctrl-v** to copy the formula into the cell.

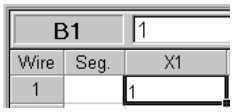


As you can see there is a problem! Y1 Wire 2 holds the value 1 not 2 as expected. If you look at the edit box you will see that the formula is **=B2+1**. What happened? The formula that you copied should be **=B1+1.** This is a typical spreadsheet function. When you copy the formula the **relative** cell references will change. In this example, all you did was copy the formula down one row from the original formula. Therefore, only the row reference changed (from B1 to B2). If you had copied the cell into another column the column reference also would have changed. For example, if you had copied the formula into Z1 Wire 2 the formula would be **=C2+1**. Give it a try!

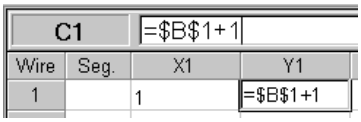
If you want to maintain an **absolute** reference to a cell you need to put dollar signs ($) before the column and row reference. Let's try our example again.

Start a new file. When prompted to save the old file click on No.

Type the value 1 into X1 Wire 1.

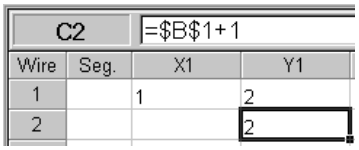


Type **=B1+1** into Y1 Wire 1and hit <Enter>**.**



Copy the cell contents by typing **ctrl-c**.

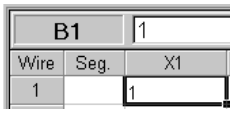
Paste the formula into Y1 Wire 2 by typing **ctrl-v**.



Now the formula has retained the value of X1 Wire 1 ($**B$1**) for use in the equation.

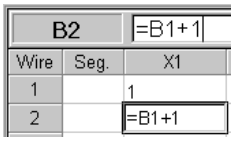
Formulas can be copied into more than one cell at a time.

Type the value 1 into X1 Wire 1 (the cell index is **B1**).

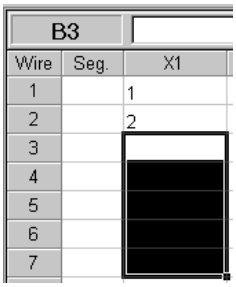


Type **=B1+1** into X1 Wire 2 and hit <Enter>. The cell should hold the value 2.

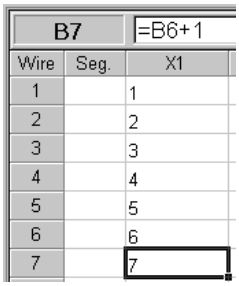
Type **ctrl-c** to copy this formula into the clipboard.



Highlight X1 Wires 3 – 7.



Type **ctrl-v** to copy the formula into the cells.



Because **relative** cell referencing was used, each cell will take the contents of the previous cell and add 1.

Quad Loop Antenna Built with Variables

You will now create a quad loop in free space with the loop center at X=0, Y=0, Z=0. In this example, we will make use of the variable **A** on the **Equations** page.

Enter the following data. Make sure to type **=A** or **=-A** in each cell with a variable. Since A has not been defined, the value of zero will appear in each cell.

Wire	Seg.	X1	Y1	Z1	X2	Y2	Z2
1	5	0	=-A	=A	0	=A	=A
2	5	0	=A	=A	0	=A	=-A
3	5	0	=A	=-A	0	=-A	=-A
4	5	0	=-A	=-A	0	=-A	=A

Assign the wire diameter of **0.001628** to each wire (if using radii enter 0.000814).

The **Start Frequency** can be left at its default value of 299.8 MHz.

Switch to the Equations page.

The Quad Loop geometry will be based on the wavelength. Enter **=0.125*W** into the cell for **Variable A** then hit <enter>.

B4 =0.125*W

	A	B	C
1	**Var.**	**Value**	**Comment**
2	F =	299.8	Primary Frequency (MHz)
3	W =	1	Wavelength(meters) = c / f
4	A =	=0.125*W	Quad Loop geometry variable

Switch back to the Wires page and you will see that all of the cells that contained zeros for the **A** variable are now defined.

Wire	Seg.	X1	Y1	Z1	X2	Y2	Z2
1	5	0	-0.125	0.125	0	0.125	0.125
2	5	0	0.125	0.125	0	0.125	-0.125
3	5	0	0.125	-0.125	0	-0.125	-0.125
4	5	0	-0.125	-0.125	0	-0.125	0.125

Switch the **Start Frequency** to 400 MHz.

Note: The Wavelength variable, W, tracks the Start Frequency.

As you type in the new Start Frequency, you should see the geometry coordinates change. The new coordinates should match the picture below. You can toggle between the equations and their values by clicking on the FN button. To verify the geometry, view the model in the Display window.

Wire	Seg.	X1	Y1	Z1	X2	Y2	Z2
1	5	0	-0.0936875	0.0936875	0	0.0936875	0.0936875
2	5	0	0.0936875	0.0936875	0	0.0936875	-0.0936875
3	5	0	0.0936875	-0.0936875	0	-0.0936875	-0.0936875
4	5	0	-0.0936875	-0.0936875	0	-0.0936875	0.0936875

Comments: Re-segmenting the model as you change the frequency is not needed since you have based the geometry on the wavelength variable. This means that as Frequency is scaled, the segments per wavelength will remain constant. To completely scale the model, the wire diameter would also require the use of an equation. Since that was not done in this example, the input impedance will vary as you change the frequency.

You should now have the fundamental skills to use Variables and Equations

General Program Notes and Modeling Guidelines

General Program Notes

- International Use and Decimal Separators
- Memory Requirements
- Rotate, Move, and Scale Wires
- Mirror Image Illusion (the model looks flipped or backwards)

International Use and Decimal Separators

International versions of windows may use the "comma" as a decimal separator. NEC-Win Synth expects the separator to be a "period".

To fix the problem go into the Windows control panel and under the **number option** for ***regional settings*** make sure the decimal symbol is a period (**.**) and the digit grouping symbol is a comma (**,**).

Memory Requirements

The memory required, to run a model, is calculated based on the number of segments.

$$memory = NumberofSegments^2 x16$$

The above formula is a rule of thumb. There will be additional memory required depending on how many sources and loads are in the model.

Rotate, Move, and Scale Wires

Model coordinates can be rotated, moved or scaled.

Rotate – rotates the selected entries button around the x, y, or z-axis.

Move – moves selected entries along the x, y, or z-axis.

Scale – scales each wire by a specified scaling factor.

To modify a single wire, place the cursor on the appropriate row.

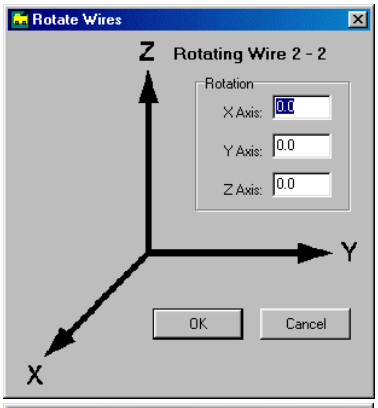
Wire	Seg.	X1	Y1	Z1	X2	Y2	Z2
1	5	0	-8.39	0	0	-4.5	0

To modify a group of wires, highlight the geometry for all wires.

Wire	Seg.	X1	Y1	Z1	X2	Y2	Z2
1	5	0	-8.39	0	0	-4.5	0
2	11	0	-4.5	0	0	4.5	0
3	5	0	4.5	0	0	8.39	0

Rotate:

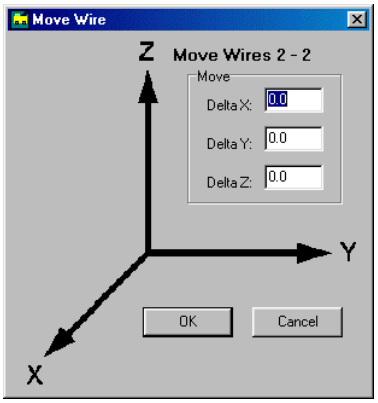
After highlighting a series of wires, click on the Rotate button. The Wire Rotate dialog will appear.



Choose which axis you would like to rotate the wires around and then enter the appropriate value in degrees. Values may be positive or negative.

Move:

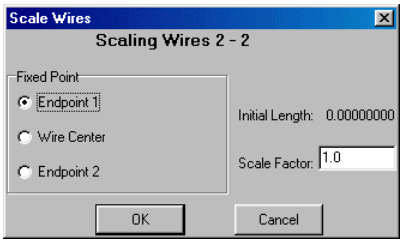
Clicking on the Move button brings up the Move Wires dialog box.



Determine where the selected wires want to be moved and enter the value into the appropriate edit box. Note: Z controls the height.

Scale:

Clicking on the Scale button brings up the Wire Scale dialog box.

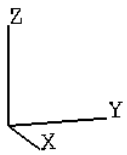


When scaling you have the ability to choose a fixed point and the scaling will be performed accordingly. If Wire Center is chosen, then **both** sets of endpoints will be modified. If Endpoint 1 or Endpoint 2 is chosen as the Fixed Point, then **only** the other endpoint will be modified.

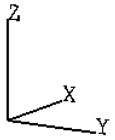
Mirror Image Illusion - the Model Looks Flipped or Backwards

This is an optical illusion!

Because NEC-Win Synth is a 2D viewer, it does not show perspective. Also, it does not include hidden line removal. The result of these two items is that at times the model may look flipped. The correct orientation can be obtained by rotating the model. Whether or not the model is flipped can be determined by viewing the axes.



Good



Bad

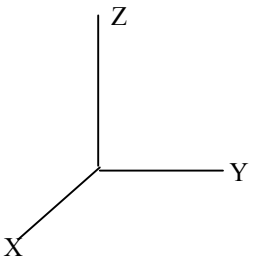
In the bad picture the x-axis is on the other side of the y-axis.

General Modeling Guidelines

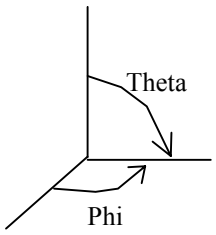
- NEC Coordinate System
- Wire Modeling Guidelines
- Wire versus Tag Numbers
- Current Direction
- Units
- Frequency Limitations
- Modeling Angles
- Equivalent Radius for Non-Circular Cross-Sections
- Wire Gridding – a method of building solid surfaces
- Loops

NEC Coordinate System

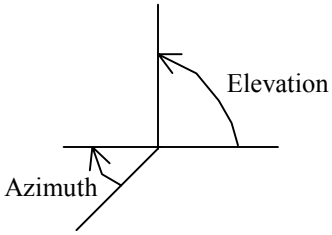
NEC uses the following coordinate systems:



NEC Coordinate System



NEC Polar Coordinates

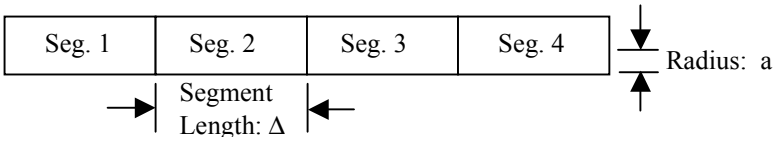


Not directly supported by NEC

Wire Modeling Guidelines

There are a few general rules that you should follow in order to obtain the most accurate model. The most important rules pertain to the wire radius and segmentation.

Each wire is broken into segments:



Segment length, Δ, relative to the wavelength, λ, should be:

$\Delta < 0.1\lambda$	accurate for most cases
$\Delta < 0.05\lambda$	used in critical regions
$\Delta < 0.2\lambda$	used on long, straight wires

Minimum segment length: $\Delta_{min} \sim 10^{-4}\lambda$

To verify segment length, after you run the simulation, click on the Tabular list box and choose Segmentation Data. The segment lengths and **radius** will be listed. **Note: These values are in meters.**

The radius, **a,** must take into account both segment length, Δ, and wavelength, λ. The following guidelines should be followed.

$$a < 0.5\,\Delta$$
$$2\pi a/\lambda << 1$$

The wavelength, λ, is equal to:

$$wavelength(\lambda) = \frac{SpeedofLight}{Frequency} = \frac{299.8x10^6}{Frequency}$$

General Rules:

Wires that connect must connect at segment end points. (Refer to the wire gridding guidelines)

Segments may not overlap since the division of current between two overlapping segments is indeterminate.

When wires are parallel and very close together, the segments should be aligned to avoid incorrect current perturbations from offset match points and segment junctions.

When possible, wires should be several radii apart.

A segment is required at each point where a network connection or voltage source will be located.

Avoid large changes in radius. (Refer to the stepped diameter fix towards the end of this section)

Avoid sharp bends on thick wires.

Wire versus Tag Numbers

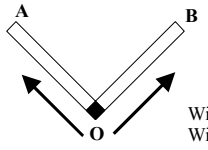
Wire and tag numbers in NEC-Win Synth are essentially the same thing. NEC uses the term TAG to identify a wire. The TAG number, what NEC-Win Synth refers to as the Wire number, is the field immediately following the "GW".

GW **1** 9 0.0 0.0 0.0 0.0 0.0 0.5 0.0001

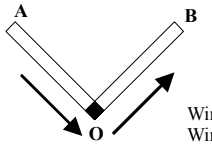
Tags do not have to be unique and the same tag number can reference more than one wire. Since NEC-Win Synth controls the wire number, and each wire is labeled separately, the user is ensured that the tag and wire numbers are the same.

Current Direction

For each wire, positive current flows from the first set of coordinates to the second set of coordinates.



Wire #1: X0,Y0, Z0, XA, YA, ZA
Wire #2: X0, Y0, Z0, XB, YB, ZB



Wire #1: XA, YA, ZA, X0,Y0, Z0
Wire #2: X0, Y0, Z0, XB, YB, ZB

Units

Far field gain is in dBi.

NEC uses meters. Therefore, all geometric units are converted to meters when a NEC file is output.

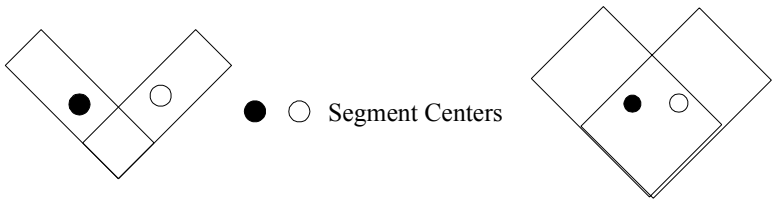
NEC uses radius for wire width. Therefore, the wire diameter is converted to radius before NEC is run.

Frequency Limitation

There is no limit on the frequency range, although NEC is usually not used for frequencies above 2 gHz. NEC is dependent on the structure geometry not the frequency. If the structure can be modeled, following the NEC guidelines, then the appropriate frequency can be used.

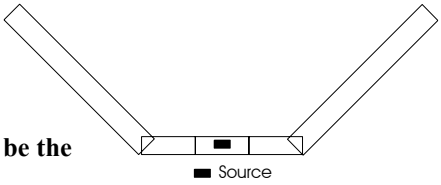
Modeling Angles

Angular wires can be modeled with NEC but care must be taken to ensure that the wire radius does not overlap the center of the segment on the other wire.



Correct **Incorrect**

A common technique to model angles is to add three short segments, of **equal length**, with the appropriate source in the center segment.



Note: Segments on each side of a source should always be the same length as the Source Segment.

Equivalent Radius for Non-Circular Cross- Sections

It is sometimes necessary to model a wire that is not circular. When this occurs, the equivalent radius for the model needs to be determined by using the equations below. This information was taken from the ACES Short Course given by Jerry Burke, Dick Adler, and James Breakall.

Equivalent radius must lie between inscribed and circumscribed circles which geometrically bound the noncircular cross-section.

Tighter bounds can be formed by circles formed with the same area and perimeter as that of the noncircular cross-section.

For the inner circle bound:

$$a_{in} = \sqrt{\frac{A}{\pi}}$$

A = area

For the outer circle bound:

$$a_{out} = \frac{P}{2\pi}$$

P = perimeter

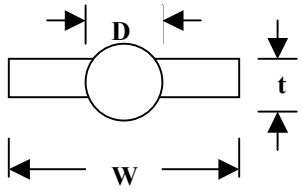
Therefore:

$$\sqrt{\frac{A}{\pi}} \le a_e \le \frac{P}{2\pi}$$

Choose the mean:

$$a_e \approx \frac{\left(\sqrt{\frac{A}{\pi}} + \frac{P}{2\pi}\right)}{2}$$

Example: YAGI element-to-boom clamp



D = 1.5 in.
W = 3.25 in.
t = 0.25 in.

$$A = \frac{\pi D^2}{4} + t(W - D) = 2.21$$

$$P = \pi D + 2(W - D) = 8.21$$

$$a_e = \frac{\sqrt{\frac{A}{\pi}} + \frac{D}{2\pi}}{2} = 1.07"$$

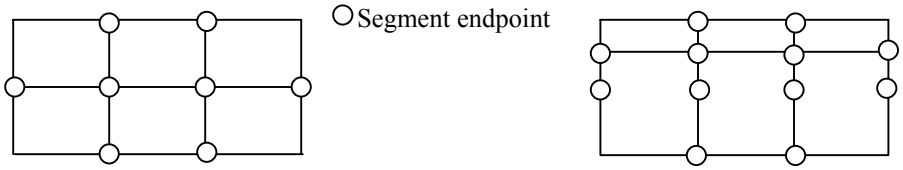
The equivalent radius (a_e) is equal to 1.07" therefore the diameter is 2.14".

Wire Gridding – a method of building solid surfaces

Wire gridding is a popular way to model surfaces. Here are some general guidelines when wire gridding:

Wires should be placed within 1/10 of a wavelength of each other near critical areas. The grid should consist of a mesh of orthogonal wires with nearly equal spacing. Segments should connect at **ALL** points where the wires overlap and segment lengths should be approximately the same throughout the grid. You should verify the grid with the geometry checker and adjust segmentation accordingly.

Example:



Correct Incorrect

For the wire radius, the "equal area rule" seems to work in many cases:

$2\pi a = d,$

where a = wire radius and d = separation of wires in the mesh.

To model a patch antenna, you can use a wire grid to obtain far field patterns. Since the dielectric is not modeled, the impedance will be incorrect but the data obtained can be used in conjunction with microwave theory to determine the impedance.

Note: Use equal radii and segmentation at junctions.

Loops

NEC2 **should not** be used to model loops that have a circumference less than 0.1 wavelength. Far field gain values of –99.99 or negative input impedance values are a sign that the model is exceeding the capabilities of NEC2.

In free space and over perfect ground, the size is not as restrictive as it is over Sommerfeld ground. The transmit case is the worst. A receive loop solution depends on the total input impedance so you can have small loops close to Sommerfeld ground and still survive with a useable solution. The transmit loop needs an accurate real part of the source impedance so this may cause problems. Near to ground, the transmit case suffers faster. For example, if you calculate the source impedance for a loop that is larger than the free space minimum limit, it works fine (good average power gain) but if that same "small but good" loop is placed as high as a wavelength over finite ground, it starts to degrade the Average Power Gain and it gets worse as the antenna gets closer.

Known Problems and Bugs

Model does not show up – Display window behavior seems erratic

NEC-Win Synth uses OpenGL. It is possible that your video adapter may not fully support OpenGL. By default, Windows has full hardware acceleration enabled. You may need to turn this off or lower the setting in order for NEC-Win Synth to function correctly. To adjust this parameter, go to the Control Panel. Choose the System icon. In the dialog that appears choose Performance. Click on Graphics at the bottom of the dialog. The Advanced Graphics dialog will appear. Move the scrollbar to None. In some cases you may be able to set the scrollbar at a midway point. Trial and error is the only way to verify if some hardware acceleration can be turned on.

Status bar on display window disappears

When the Display window is resized the status bar at the bottom may disappear. To get it back use the mouse to make the window a little larger.

Axis labels disappear

At times the "X, Y, or Z" axis labels may disappear. The only way to fix this problem is to restart the program.

