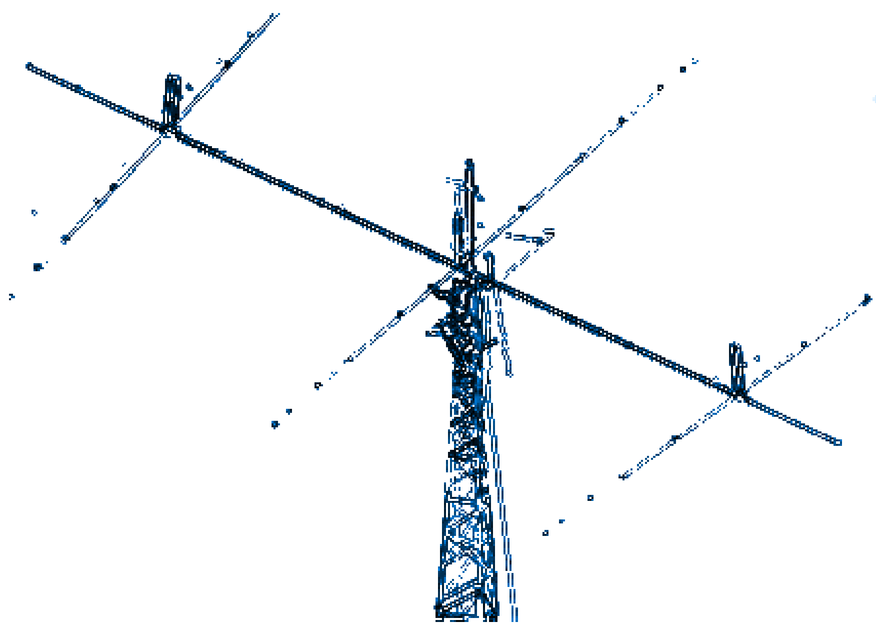
ORION Microsystems

NEC4WIN95 /NEC4WIN95VM user manual



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1 Welcome to NEC4WIN95

NEC4WIN95 is a very user friendly antenna simulation program. With NEC4WIN95 you have a true 32 bits windows program for Win95/98® and WinNT®.

Most commands are accessible in one click via a toolbar and the program was designed with the antenna modeler in mind. Text and graphic outputs contain most of the information needed without having to type extra commands.

A number of options and personal preferences are saved and the program will restore your preferred setup of windows size and positions, predefined options when you start it.

A true context sensitive help using the F1 key will always guide you when you don t know what to do. Keywords search and full text search are also available in the help file and help you locate information by keywords or just plain text.

NEC4WIN95 is not a static product. We continuously improve and add important features requested by users. The readme file contains last minute information that it was not possible to put in this manual or in the help file and you should read that file before anything else.

1.1 NEC4WIN95VM vs. NEC4WIN95

NEC4WIN95VM is the Virtual Memory version of NEC4WIN95 and has exactly the same user interface plus some additional functions not found in the standard NEC4WIN95. In this manual NEC4WIN95 may be used in place of NEC4WIN95VM, the reverse is not true.

Commands specific to NEC4WIN95VM will be highlighted.

1.2 Installation

1. From Windows Explorer (File manager) select the diskette.
2. Click on SETUP.EXE.
3. The installation program displays a Welcome dialog. Click **Next**
4. Read the licence agreement and click **Yes** to agree.
5. You are prompted for a destination directory. The default is **Program_Files\NEC4WIN95** and you can modify that if you want or just type **Next** to begin installation.
6. SETUP copies files, creates a folder in Start>Programs and installs NEC4WIN95.EXE, help and readme files.

1.3 Installation from CD (VM version)

If the autostart CD feature is enabled on your system, the CD startup displays a general information file when you insert the CD. Click on the NEC4WIN95VM to start installation.

You can also use Explorer to start SETUP from the NEC4WIN95VM directory.

The CD contains additional files like the PDF manual, an Acrobat Reader, HTML FAQ and library.

1.4 Troubleshooting installation problems

If the program installed correctly but does not run you can have one of these problems:

DLL or OCX missing or not registered

Number representation not US

1.4.1 DLL or OCX Missing

Most DLLs and OCX are registered. This means that a special key is entered in the registry with a path pointing on this DLL. Most DLLs and OCX are in the Windows system directory. Check that you have the latest Windows upgrade. Check our Web site for Service Pack updates and links to Microsoft.

1.4.2 DLL and OCX registration problems

Registry problems are generally caused by links in the registry to missing DLLs or OCX, incompatible DLLs or errors in the registry. The error codes that you can get are:

Error 339 DLL missing or not registered correctly.

Error 50003 signals also DLL or OCX problems.

This problem is often corrected by running REGSVR32.EXE to register the DLL/OCX. The REGSVR32 program should be in your system directory. Click on **Start > Run** and type:

REGSVR32 dllname (or ocxname)

This will register the corresponding DLL or OCX and you should get a message: "DLL/OCX correctly registered".

In some extreme cases you will have to cleanup your registry to remove bad links and unused entries.

You will find these utilities at: http://www.windows95.com, ZDNet and www.shareware.com.

Note: Some DLLs and OCX work together and must be updated in group.

1.4.3 Number representation not US

NEC4WIN95 use the US number representation with "." as a decimal separator and "," as thousand separator.

To set up go to **Control Panel > Regional Settings > Number** and set **Decimal Symbol** to "." and **Digit Grouping Symbo**l to ",". Some Windows versions (Germany) may require also that you change the Decimal Symbol and Digit Grouping in **Currency**.

1.5 OCX installed by NEC4WIN95

The following list show the OCX installed or updated by the installation program. A copy of the old ones is made before installation in **Windows\system\n4w95**. If you experience problems with the new OCX you can restore from the backup files.

1. Threed32.ocx
2. grid32.ocx
3. comctl32.ocx
4. comct232.ocx
5. comdlg32.ocx
6. MSChart.ocx (VM3)

Note: The fact that you have a backup for these OCX doesn t mean that they were replaced. They are all copied the first time you install NEC4WIN95

2 Quick tour of NEC4WIN95

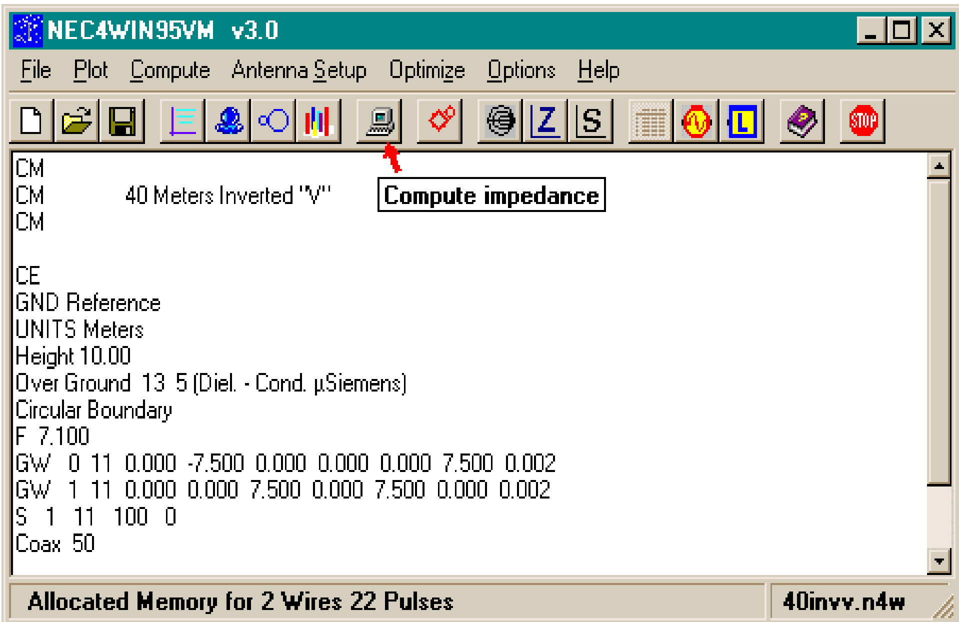
NEC4WIN95 contains a set of demo files that you can use as examples and can modify to create your own projects. You can also create your own projects from scratch.

NEC4WIN95 has a **context sensitive help activated by F1.** If you don t remember what to do anywhere in the program press F1. You will get help for the current window or dialog.

2.1 Starting NEC4WIN95, Main window

Click on **Start > Programs > NEC4WIN95 > NEC4WIN95** to start the program. A Splash Screen with the Copyright is displayed for 5 seconds. You can click on it to go directly to the program and bypass the 5 seconds delay.

The main window is displayed (see picture below). A standard windows menu and button bar at the top of the window allow you to open files, save, run simulations (computer button), display patterns etc. If you leave the mouse on a button, a tip pops up.



This partial view of the main window show the standard Windows menu and the NEC4WIN95 toolbar[1].

The white window below is the main output window. It is used to display loaded projects and simulation results. This area can be edited before printing to add personal comments.

It is not however an area where the project is modified or wires edited. You must use the Geometry window to create or delete wires or menu items in Antenna Setup to change frequency, Ground etc.

1. This is a VM3 version Main window view. The Near Field and Smith Chart buttons do not exist in all versions

2.2 Opening a project

Click on the **open** button (small folder), and select in the file dialog the **40invv.n4w** project. The project is listed in the main window.

Note: If the font is too small in the main Window, you can change the screen fonts by going to **Options > Screen Font** and selecting a different font or font size.

2.2.1 Compute antenna impedance

Click on the Compute Impedance button (small computer). The results of the simulation is displayed in the main window and you get an output that looks like this:

```
Antenna Height is: 10 m  (32.8ft)
Ground Diel. =  13  Cond. =  5
Frequency   : 7.100 Mhz
Wave Length : 42.225 m  (138.535 ft)
IMPEDANCE  =  58.78 -  j 9.34 Ohms at Source  1
SWR       =  1.27
Voltage    =  100.00 +  j 0.00 at Pulse 11
Current    =  1.66 +  j 0.26 Amps
Power      =  82.97 WATTS
```

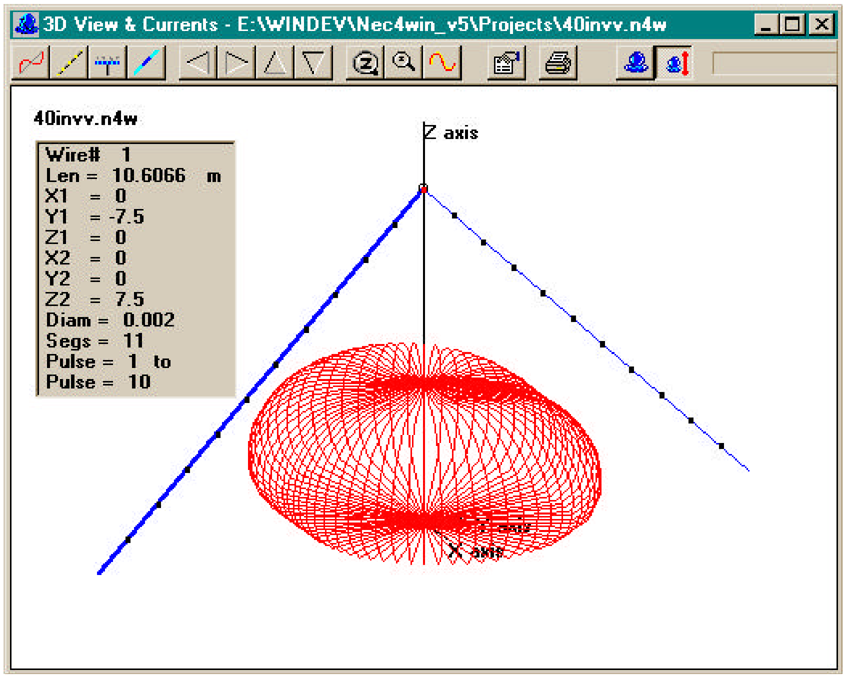
2.2.2 3D view and 3D pattern

To view the antenna in 3D, click on the fifth button (View antenna and pattern in 3D). A new window is opened and you can see that the antenna is an inverted V with a source at the top.

The picture above show also the 3D pattern and the wire info window. These can be turned on or OFF using the buttons on the toolbar. The whole graphic view can be rotated with the mouse. The Wire Info Window on the left provides all data about the highlighted wire (here wire #1) and you can use Space Bar (Shift Space) to look at all the wires.

Press on F1 for help, the 3D view help is displayed and you have a description of all the buttons and special keys.

Note: Due to the intensive calculations needed to display a 3D view that rotates smoothly, the 3D view is refreshed only when the mouse is moved and may be blanked when other windows pop-up on top of it.



Type Alt-Tab to return to the program and experiment with the colors using the B, F, W, P etc. keys. You can choose the combination of colors you like. This setup is saved in the .INI and will be restored next time. Now try the following steps:

1. Click the *left button* and move the mouse, you can rotate the view in all directions.
2. Click the right button and move slowly the mouse to move (pan) the antenna in the window.
3. Click on the first button (wave) to display the current.
4. Click on the big magnifier to increase the size of the antenna.
5. Click on the *current zoom* button (next to small magnifier). This button has two states and will stay pressed until you click again.
6. With the *zoom current* pushed in, click on the magnifiers. The current is zoomed/unzoomed and the antenna says the same.
7. Click on the *current* button to hide the current.
8. Click now on the blue 3D Field pattern button. The program runs and a progress bar is displayed at the top right, then a 3D pattern is superimposed on the antenna. You can rotate the whole set to look at the pattern.
9. Zoom/Unzoom the pattern with the magnifiers after clicking on the *Ant/Pattern ratio* button (right of 3D). The pattern is zoomed or unzoomed and the antenna stays the same.
10. Click now on the 4rth button, the Wire info button. A small window pops up on the left side of the 3D view showing data about the first wire. Notice also that in the view, the wire is highlighted and that a small circle is displayed at the top. This small circle show that the two wires are connected (Figure 2 3D view with wire info)
11. Click on the left mouse button in the wire info windows to increment the wire number (left mouse will decrease) and see the dimensions and coordinates of wire 2.
12. Close the wire info button by clicking on the wire info button on the button bar.

Click on the different buttons to see how they work. Most buttons are click only, two of them are on/off buttons to zoom current or patterns without changing the antenna.

Remember that you can at any time press on F1 for a context sensitive help if you forgot what the buttons do or special command keys.

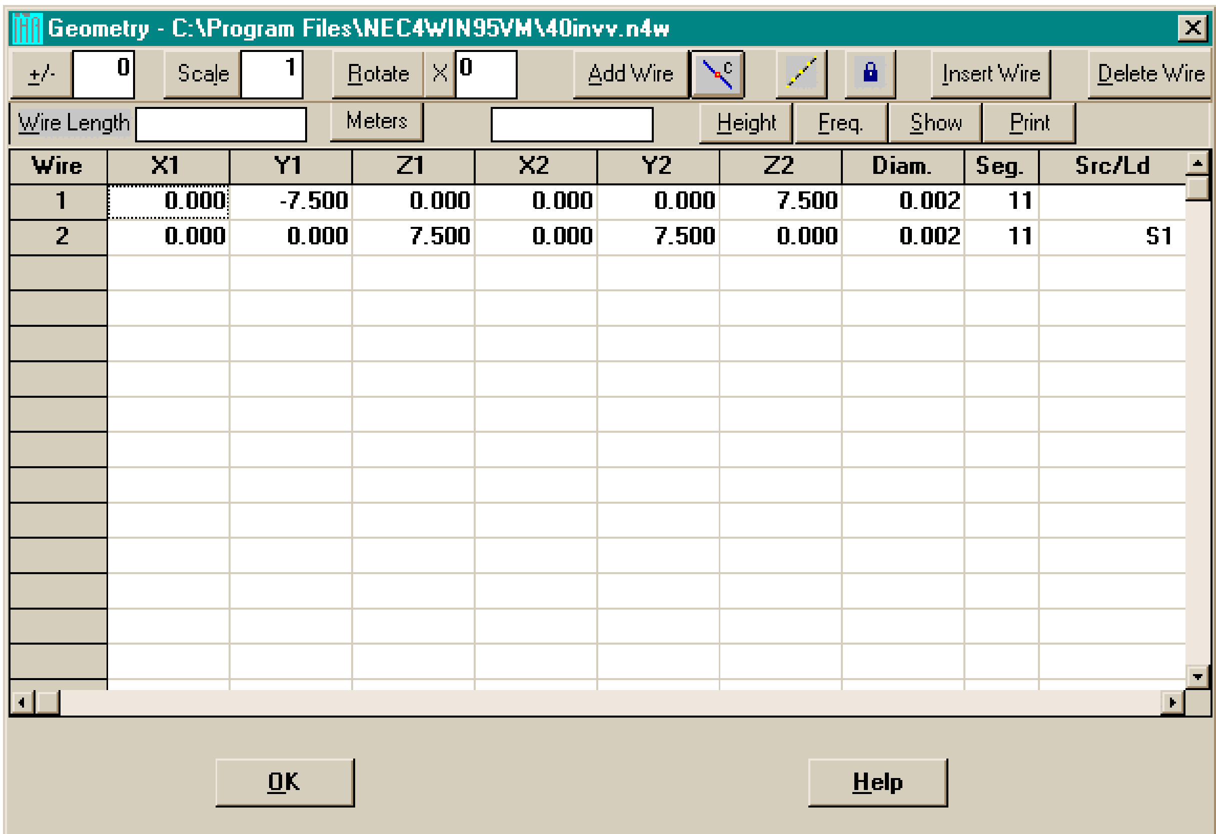
Close the 3D View by clicking on the top right close button.

2.3 Editing and creating wires -The Geometry grid

Click on the **Geometry Wire Grid** button right of the "Z" "S" buttons. A window like the one in the picture below is displayed. This is the window where you can edit, create and modify your antenna wires. Each wire is defined by its start and end X, Y and Z coordinates in space.

The additional information for each wire is the wire diameter and the number of segments used in the simulation. Each wire is numbered and takes one line in the spreadsheet like entry form.

To add a new wire click on **Add Wire**, a new blank wire is added with a default diameter and segments. Click on a cell and type a new value then type **Enter**, or **cursor right/left** to go to the next cell.



Press F1 to get Help on the Geometry grid. There is a picture of the Geometry grid in the Help and you can click in the picture to see what a specific button or column does. There is also additional information on spreadsheet editing and advanced commands like Scale and Rotate.

You can also delete individual wires or a block of wires by highlighting a wire or a block with the mouse in the left column (wire numbers) and clicking on **Delete Wire**.

Warning: There is no Undo and if you make a mistake. The only way to restore the original is to restore by reloading the project. So **SAVE** your projects before doing any editing.

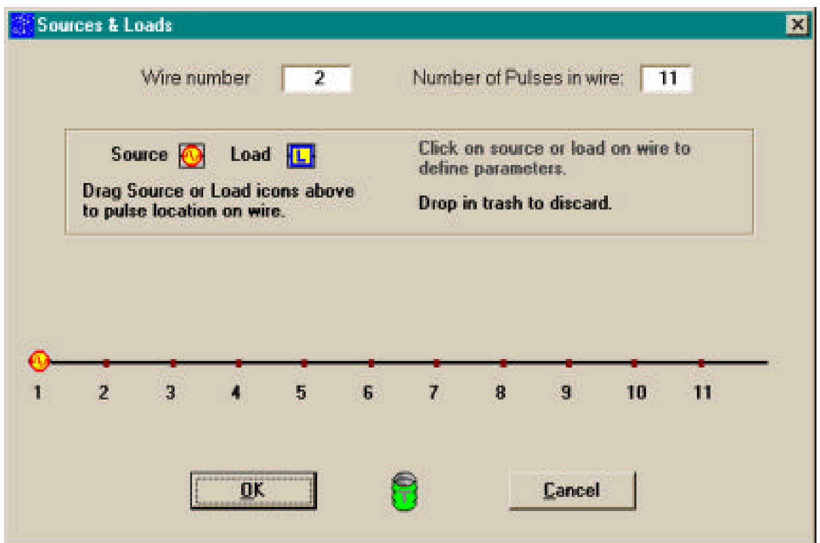
2.4 The Sources & Loads window

In the **Src/Ld** column on the right you see an S1 symbol. Double Click on that cell. A new window is displayed like the one below. It is the Sources & Loads window used to create or modify sources and loads used in the antenna project. It shows a graphic representation of the wire with pulses and segments, and sources or loads that are on that wire. In our case, we have a source placed on **Pulse 1** of the second wire. Pulse 1 is the apex of the inverted V dipole.

2.4.1 Pulses and Segments

To simulate an antenna, wires are divided in sections called **Segments**. These segments are equivalent to elementary dipoles used by the internal simulation algorithms. This segmentation is the base of what specialists call the MOM or Method Of Moment simulation algorithms (see Crash Course on Modeling in the Help file). There are limitations on the maximum size of segments in wavelengths. The average is lambda/20 or 10 segments per half wavelength.

Pulses are the junction of segments. Notice that there is no pulse at the end of the wire where #12 should be. This is because that extremity of the wire is free. We have a pulse 1 because our wire is connected to wire 1 at this location.



If you click on **Wire number** in the Sources/Loads dialog (or window), the wire number is incremented and you can see now Wire #1. You can see that on Wire 1, *pulses are missing at each extremity*. How come? We just said that wire 1 was connected to wire 2 at the apex and we should have a pulse on the right extremity.

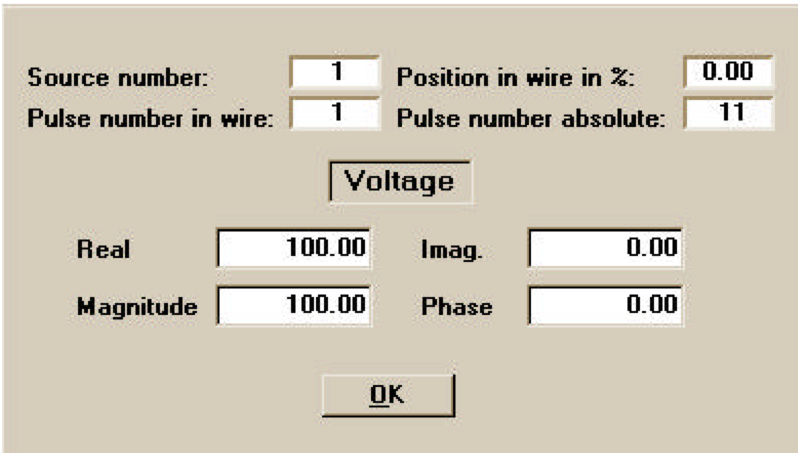
This is caused by the fact that internal algorithms scan wires in sequential order and allocate pulses as they go. When they scan wire #1 they have no way of knowing that this wire is connected to something else, so they don t generate a pulse at that location. When the algorithm scans wire #2, they find that its starting coordinate is the same as end coordinate of wire #1 and a pulse is created at the beginning of wire #2, etc. This is an idiosyncrasy of Mininec and you will find these *false missing pulse* in all antennas with loops and wires connected in series. Reordering wires can create new pulses and delete other pulses. **Sources and Loads are attached to an absolute pulse number (Pulse 11 in case above) and will move when you shuffle wires around**.

Click on the Source on Wire #2 pulse 1. A small window opens.

Note: *Grounded extremities will have a pulse created at the ground connection. Verticals antennas are generally simulated with the lower extremity on the ground and the source placed on that pulse. If you raise the antenna above the ground just a bit, that pulse will disappear and the source will move up to the new pulse #1.*

2.4.2 Sources and Loads parameters

You should have on your screen a small dialog displayed on top of the Sources/Loads window exactly like the one below.

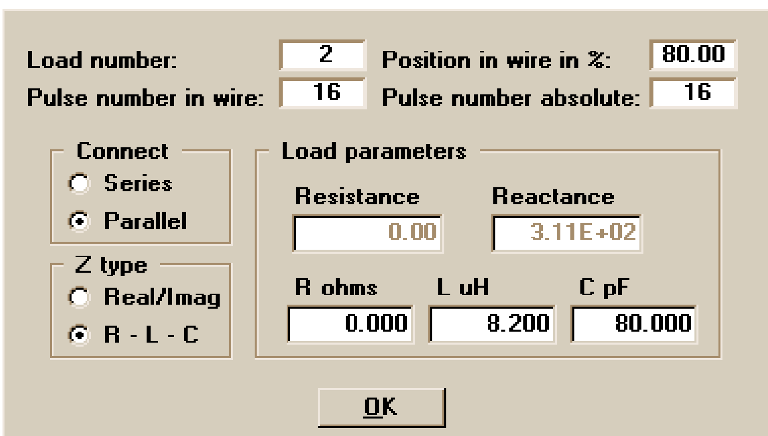


This dialog is used to customize sources. Only the type of source and the Magnitude and Phase can be modified. The first two rows display information about the source: Source number, Position in percent in the current wire, Pulse position relative to the wire and Absolute Pulse position in the antenna.

Most of the time you don t have to change anything. Normal antennas use a standard voltage source, and changing the voltage will just change nothing in the antenna impedance or patterns, only the power.

With phased arrays on the other side you have to change the phase and eventually the magnitude for the different sources. In addition, many phased arrays are fed in **Current** and **you can select a Current/Voltage source by clicking on Voltage** the recessed button in the center of the dialog (see 4square demo project for current sources example).

There is an equivalent dialog for Loads.



This allows you to enter a complex impedance as series R, X or R, L and C or Parallel RX, RLC. L are in microHenries and C in PicoFarads.

2.4.3 Placing Sources and Loads, Stacking Loads

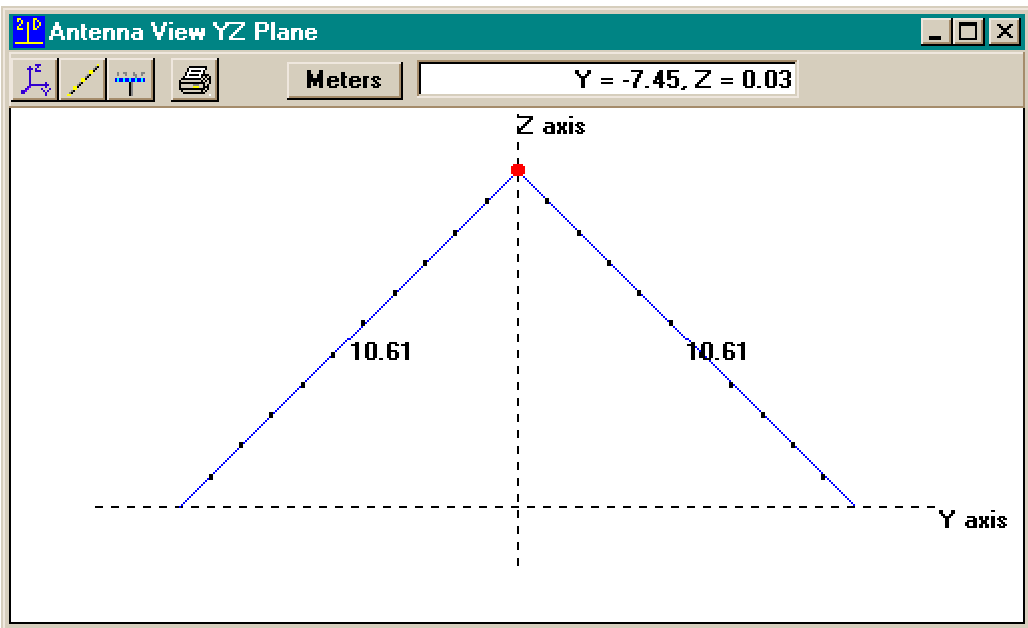
Return to the **Sources & Load** window and try to add a new source anywhere on the wire. You do that by clicking on the Source Icon in the box at the top and dragging the icon with the mouse to a pulse wire (keep the Left mouse button down while dragging). Release the Left button and drop it on a pulse, a new Load is created. Same thing for Loads. You will have to click on the Load to set the RX/RLC parameters. You can drag a source from a Pulse to another Pulse on the same wire.

If you need to move a source/load to another wire you have to delete it first by dropping it in the trash, then click on Wire Number (Left will increment, Right will decrement) and create a new source or load on the selected wire.

You can stack Loads on the same pulse position. You should be aware however that stacked Loads are not placed in parallel in the model but in series. If you need to enter parallel components you must do it in the same Load.

2.4.4 2D View

Click on OK to close the Sources & Loads dialog and return to the Geometry spreadsheet. **Click on Show** to look at a 2D orthogonal view of the antenna. Sources and Loads are visible as colored dots.The first button on the left allows you to look at the antenna from each side and top. The second one displays pulses, the third one Absolute Pulse numbers when pulses are on.



You can print or use **Ctrl-C to copy graphics** to the clipboard, and paste into any Windows compatible graphic program or Word Processor. This Copy graphics command is valid for all graphics displayed by NEC4WIN95.

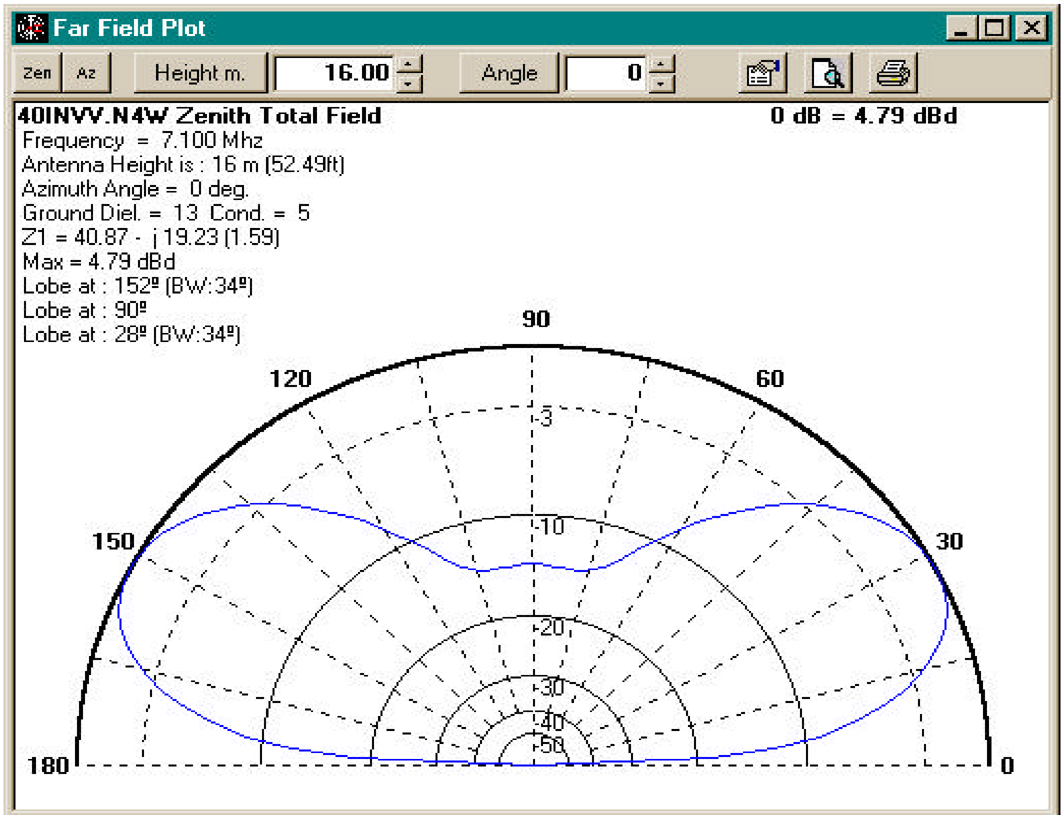
Note:You can customize the look of 2D and 3D windows and select different colors with special keys. Press F1 for context sensitive Help explaining the special keys.

2.5 Radiation patterns

To see the radiation patterns click on the *Far Field* button. The Far Field Plot window is displayed. Verify that the angle in the angle edit box is zero and click on the *Zen button*. This displays the elevation pattern for an azimuth equal to the value in the angle box, zero here, and the window looks like the picture below.

Look at the pattern and the data printed on the left. Height, ground type, impedance, max gain and lobes are displayed.

You see that there are two lobes. One at 140° and one at 40°. The value in parenthesis BW:68° is the lobe width at -3dB.



2.5.1 Zenith Azimuth Take Off Angle, TOAZ

Zenith or **Elevation** angles are measured from the horizontal +X direction, then go up to 90 degrees at the zenith and 180 degrees in our back (-X direction). When using Free Space the pattern is plotted on a 360 degrees circle instead of 180 degrees.

Azimuth refers to a 360 degrees horizontal angle from a reference which is in NEC4WIN95 the +X axis with angles increasing in the clockwise direction.This means that

Azimuth 90 degrees is on the right side when we look in the +X direction.

This may seem complicated but you must remember that Azimuth and Zenith patterns are a two dimensional view of a 3D object. You can visualize Azimuth patterns as horizontal slices and Zenith or Elevation patterns as vertical slices of that 3D pattern. Each slice is cut at a certain Elevation angle for Azimuth or horizontal patterns and Zenith or Vertical patterns are sliced at a particular Azimuth angle.

When you plot the Zenith or Elevation, the angle where the field is maximum in the vertical plane is saved in an internal variable we called TOA.

When you plot the Azimuth pattern, the angle where the field is maximum in the Azimuth (horizontal plane) is also saved in an internal variable called TOAz. These values are available by **Left and Right Click on the Angle Button** (left of the Angle box).

This means that if you Left click on **Angle** the last saved **TOA** is loaded in the *Angle Box* and you are ready to plot the Azimuth pattern at the elevation angle where the field is maximum.

If you Right click on **Angle**, the last azimuth lobe angle **TOAz** will be loaded, and you are ready to plot the Elevation pattern in the Azimuth plane where the Field is maximum.

2.5.2 Finding the lobe where field is maximum

By default NEC4WIN95 will start with a 20 degrees angle in Zenith an 0 degrees in Azimuth. Even if you followed the layout guidelines (see Coordinates and Far Field Patterns on page 16) the main lobe could be on an Azimuth different from zero in the horizontal plane. In addition if you are using ground, the Take Off angle will be different from zero.

We will use the 4square project as an example. **Load the 4square example** and **Click on Far Field Patterns**.

To find the main lobe, **Click on Zenith** with a 0 Azimuth in the Angle box. This will plot the vertical pattern in the 0 Azimuth direction (+X -X). You can see a lobe on the right at 24 degrees elevation. **Left Click on Angle**, the value 24 is loaded in the Angle box. Note that the maximum Gain printed on the top is 3.35 dBi.

Click on Azimuth now. This plots the Horizontal Field at an elevation of 24 degrees and you can see a lobe at around 315 degrees (top left quarter). Note that the max gain is now at 5.77 dBi higher than found in the Elevation at Zero Azimuth. Why? Because the first Zenith pattern plotted the field in the vertical axis on your screen and you can see that the field there is just above the -3dB line. This is the 3.35 dBi we found earlier.

Right Click on Angle now. The value 315 is loaded in Angle. This is our main lobe in the horizontal plane at 24 degrees elevation. **Click on Zenith** and now you can see a 5.77 dBi lobe at 24 degrees elevation.

If you repeat the operation of Left Click, Azimuth, Right Click, Zenith you still get the same values. You found your major lobe. It is a 315 degrees Azimuth, 24 degrees elevation.

In most cases you will not have to make that exercise, but this is how you can find the maximum maximorum field for antennas with lobes that are not aligned on the +X -X axis.

2.6 Help, Tutorials and Step by Step

The help file contains a small tutorial with step by step instructions showing show you can create from scratch a simple basic dipole, then a three elements inverted V wire beam, and a 3 element quad.

Other sections in the tutorial explain some basic principle of modeling, basic operations in the program like editing wires, block editing etc...

You can print a single topic in the Help file or complete sections by clicking on the item to print then on Print in the Contents view.

Help also contain an Index with keywords, and a full text search tab where you can enter any string and find it in the Help file.

3 Modeling antenna basics

3.1 Introduction to modeling

A computer model is a mathematical representation of a physical problem. It is used to simulate complex physical phenomenons without having to make any physical experiment. It is difficult to run experiments on things like weather, an airplane crash, a nuclear reactor close to melt down or galaxies colliding. The only way we can analyze these phenomenons and understand their behavior, is to use computer models.

3.1.1 Segments, Pulses and Sources

Antennas can be modeled too. There are equations describing the fields generated by simple antennas like dipoles. In the real world, antennas are a lot more complicated and we do not have precise formulas for complex antennas. The only solution is to simplify the antenna and reduce it to a set of elementary dipoles for which we have precise math formulas. This explains why each wire or tube in the antenna is split in **Segments**. Each segment is equivalent to an elementary dipole and the program will now integrate (sum) the electromagnetic fields generated by all these small dipoles at a certain distance and angle to simulate the antenna as a whole.

In reality the model is a bit more complex because each segment is also affected by all other segments. The model impedance matrix contains also the mutual impedance of each segment relative to the others. When the antenna is over ground, a reflected image antenna is added to that basic model.

This segmentation is the basic principle behind all antenna modeling programs like MININEC3 and NEC. All wires are split in **Segments**.

Pulses are the interconnection points of these segments. In NEC4WIN95 they are visible in the 2D and 3D antenna view as dots.

1. There are no pulses at unconnected segment extremities.
2. Grounded extremities in wires have a pulse placed at the ground connection.
3. The first segment of the first wire is always considered to be disconnected. No pulse is found there even if a wire is connected there later in the wire sequence (loops, elevated radials).

Sources in the model represent the source of energy, usually feed line connections. **They are placed only on pulses** and referenced by their pulse number. **Loads** (resistors, inductance, capacitors or complex impedances) are also inserted at pulse position and referenced by their pulse number. In NEC4WIN95 you do not have to compute pulse number and can place sources and loads on a graphic representation of the antenna wires.

3.1.2 Computation complexity

If an antenna has N segments, the internal model is centered around a square array called impedance matrix with N rows and N columns.

To compute the impedance computation complexity is of the order of N^3. This means that the more segments we use the more accurate the results, but time will increase proportionally to the power 3 of the number of segments. We must therefore use a number of segments that will produce good results without taking hours to run.

3.1.3 NEC4WIN95 limitations

NEC4WIN95 is based on the original Mininec3 algorithms from NOSC and has all Mininec3 limitations:

1. Impedance is calculated using a *Perfect Ground*.
2. Close Parallel wires and wires close to the ground do not simulate well (below lambda/10).
3. Antennas with sharp corners should use segment tapering due to the corner problem .

These special cases are limit cases and can require additional segmentation and segment tapering.

3.2 Antenna description

Antennas are described as a set of wires. These wires must be STRAIGHT. Bent or curved wires are described as a set of consecutive straight connected wires. The term wire here, describes a conductor representing a real wire, a tube or even a metallic structure like a tower.

Wires are represented by two sets of X, Y and Z rectangular coordinates: the start and end coordinates, wire diameter and the number of segments used to model that wire.

3.3 Interconnection of wires

Wires are connected when they have the same start/end coordinates. If you want to define a T antenna, you must define 2 wires for the top and one for the vertical section. If you enter two wires placed like a T the program can t recognize that they are connected and results will be incorrect. You must enter a wire for the top left branch of the T, one for the right branch, and one for the vertical section. In the example below the three wires are interconnected at 0, 0, 30.

Wire#	X1	Y1	Z1	X2	Y2	Z2	Diam.
1	0	-5	30	0	0	30	.02
2	0	0	30	0	5	30	.02
3	0	0	0	0	0	30	.02

The program is able to accept wires in any order, but to improve speed, it is recommended to enter wires in their logical order of connection.

If you use different diameters for wires, interconnected wires should have a diameter ratio at the connection smaller than 5 and never bigger than 10.

3.3.1 X, Y Z wires coordinates

Antenna coordinates are defined in the X, Y and Z rectangular coordinates systems with Z representing the vertical axis, and the XY plane representing the horizontal plane.

If you assume that you are standing at coordinate 0, 0, 0 (in X, Y, Z order) and looking toward the +X direction, +Y is on your left, -Y is on your right, +Z is above your head, -Z under your feet.

The entries for a two element beam at 30 feet will look like this:

Wire#	X1	Y1	Z1	X2	Y2	Z2	Diam.
1	0	-15	30	0	15	30	.02
2	10	-14	30	10	14	30	.02

The reflector is 30 feet, the active element 28 feet. spacing on the boom is 10 feet.

You can center the active element on zero. In that case, you enter the X coordinates for the reflector as negative, and the X coordinates of the active element as zero. As you can see in the example below, the distance on the boom between elements is still the same. The only difference is that the antenna is now centered on the active element and this could be useful when you look at the antenna in 2D or 3D. This does not change the results or patterns plots in any way, it is just cosmetic .

Wire#	X1	Y1	Z1	X2	Y2	Z2	Diam.
1	0	-15	30	0	15	30	.02
2	10	-14	30	10	14	30	.02

3.3.2 Coordinates and Far Field Patterns

You can in theory define wires any way you want. There is however an interaction between how wires are defined and how patterns, particularly Azimuth, are plotted.

NEC4WIN95 plots Azimuth patterns in a 360 circle with zero degrees at the top of your screen and angles increasing in the **clockwise direction**.

In NEC4WIN95 zero Azimuth is aligned with the +X axis

This means that if you define dipoles or beam elements aligned on the -Y +Y axis, and for directive antennas pointing toward +X, the main Azimuth lobe will be at zero azimuth (top of your screen.)

If you enter your dipole along the -X +X axis, the only thing that will happen is that the main lobe will be in the -X +X direction. The Azimuth pattern will have lobes aligned horizontally toward +90 and 180 degrees on the screen.

Use the 3D pattern button in the 3D view on some examples to see how antenna, pattern and coordinates. You will find that most examples have the main lobe aligned with the +X axis. Azimuth pattern main lobe for most dipoles and beams will be at zero azimuth pointing at the top. If you look at the wires you will find that all wires are aligned parallel to the -X +X.

3.3.3 General guidelines for defining wires

1. Antennas are modeled as a set of straight wires.
2. Wire diameter should not be larger than lambda/15.
3. Wires can be connected only at their extremities when the end coordinates of one wire are equal to the coordinates of another wire.
4. Z equal to zero means that the wire is connected to ground.
5. Segments should not be smaller than lambda/20 or 10 segments per half wave.
6. It is better to enter elements parallel to the YZ plane as -Y, +Y and spaced along the X axis.
7. Interconnected wires of different diameter should have a diameter ratio at the connection inferior to 5.

3.3.4 Tapered Elements

You must define a separate wire for each diameter tubing and specify the corresponding diameter in the diam. column. The example below is for a 30 feet dipole using three tube diameters.

Wire	X1	Y1	Z1	X2	Y2	Z2	Diam.
1	0	-15	30	0	-12	30	.042
2	0	-12	30	0	-8	30	.0625
3	0	-8	30	0	8	30	.125
4	0	8	30	0	12	30	.0625
5	0	12	30	0	15	30	.042

3.3.5 Segment Size

It is not necessary to have the same number of segments for all wires in an antenna. As a rule of thumb, **segments should be smaller or equal to lambda/10.** This is equivalent to 5 segments for a dipole, but to be on the safe side, you should use a minimum of 5 segments for each lambda/4 or half dipole.

Segment size is also related to wire diameter. For an accurate solution the segment length must be bigger than four diameters (**Segment Length > 4 Diameters**)

Note: On new projects the program will automatically compute the necessary segments and insert the calculated segment number in the grid.

Segment Tapering - The Corner Problem

We already signaled in the Limitations section that NEC4WIN95 has a problem with corners and acute angles. This is a well know problem in all Mininec3 based programs.

This is an oversimplification but you can consider that the current in segments is calculated at the center of the segment. This means that at a corner or sharp angle connection between to wires, the centers are half a segment away from the corner and *the algorithms will literally cut corners round, making the antenna a little bit shorter than it is in reality*. This means:

1. Resonance will be higher than normal.
2. The larger the segments worse the shortening effect.
3. Impedance will vary because of this effect.

The solution is to have shorter segments near corners and sharp angles. This is done by splitting the original wire in sections of decreasing length, with smaller segment toward the corner. This technique is called **Segment Tapering**. There is an example of segment tapering in the Quad tutorial showing how this is done in NEC4WIN95 using the Taper button in the geometry grid.

This however creates additional wires, multiplies segments and slows down the program. New NEC4WIN95 versions will have a Loop Correction switch Options that makes segment tapering obsolete (check the Quad Tutorial.)

3.3.6 Convergence, Model Validity

A mathematical model has limitations. You must always check that your model is accurate. Any of the following symptoms signals a problem in the model

1. You get results that seems to be inaccurate: too much gain; impedance lower than expected. Large reactance and sometimes negative resistance is symptoms of problems in the model.
2. If when checking currents (3DView or log) you see abrupt and sudden changes in current without any Load present.
3. Sudden change in antenna impedance for very small frequency variations.
4. When increasing the number of segments, impedance and gain show big differences.

In most cases standard segmentation will give good results. If you think that you get incorrect results when running a model:

1. Increase the number of segments on close parallel wires, wires close to the ground, wires carrying sources, loads, or wires where currents are maximum (in that order).
2. Add segment tapering near corners and connections.

3.3.7 Common mistakes

The most common mistakes we found in users models are:

1. **Incorrect wiring, disconnected wires**. Wires are crossed but not connected. Remember that a T need three wires not just two. Use the 3D view, Wire Info button which displays small circles at points that are connected. If you don t see a circle check your coordinates.
2. **Bad segmentation**. Many users forget that segment ratio at connection points should be equal or smaller than 2 and will have large segments on a wire, then very small segments on the next one. This sometimes can make models unstable.
3. **Bad units**. Dimensions were entered in the wrong units. You can edit the ASCII file and put the correct one on the Units line. On small project copy the block of wires, change units and paste the old values.
4. **Source not on correct pulse**. When you add or delete wires above a wire that contains a source you modify the number of pulses and sources/Loads will shift position.
5. **Incorrect type of source**. Phased arrays described in antenna books use Current Sources in general. Check that you use the correct type of source.
6. **Grounded wire disconnected**. A vertical has generally the base grounded with a source placed at that ground pulse. Raising the antenna above ground will disconnect the bottom part of the vertical from the ground and move the source up one pulse.

Note: NEC4WIN95 will signal wires of zero length, wires buried under the ground, similar wires, missing source.

4 User Interface, Menu

4.1 Main Window, Toolbar

Area where most results are printed. Can be edited to add personal comments, copied using cut and paste, erased using Select All then Delete. Use the Right Mouse to display the edit menu.

Most frequently used commands are on the toolbar, from left to right:

New Project
Open Project
Save Current Project
2D View
3D View & Current
Far Field Patterns (Zenith & Azimuth plots)
3D Near Field Plot
Compute Impedance
Optimize
Smith Chart (VM3 only)
Plot Impedance
Plot SWR
Geometry Spreadsheet
Source View - Create
Load View- Create
Help Contents
Stop any running calculations (Also double click main window)

Note: The toolbar can be reset, reorganized or customized by double clicking on the toolbar itself.

4.2 Main Menu

The main menu at top of the Main window contains seven items:

File, Plot, Compute, Antenna Setup, Optimize, Options, Help.

Important thing to know: If you put the cursor on any of the submenu and press F1, a specific Help will be displayed for that item. Same thing if you are in a window or dialog.

Most commands are explained in the Help file. We will clarify only some here, use F1 for the others. The notation used in the Help and this manual for menu commands is to list the cascade of menu items with a **>** sign to indicate submenus.

Example: **File > Log File** means click on File then Log File.

4.2.1 File

Used for basic File commands to create a new project, open an existing one, save under the same name or Save As to change the name.

4.2.1.1 Log File

When Checked all important data including data printed in the Main Window is recorded in the Log File which name is displayed. A default log is created at startup but you can Click on Log File to close this log then click again to create a new log and select a new filename.

4.2.1.2 View Log

Displays the log file using Notepad. When this file becomes too large you will have to close it to use WordPad which is unable to read a file in use by another program.

4.2.1.3 Printer Setup

Standard Windows interface.

4.2.1.4 Print Main Window

This will print the Main Window and Clean the window.

4.2.2 Plot

This item regroups all graphic outputs: Far Field patterns, 3D and 2D views, Impedance, SWR, Gain and Front to Back plot. *All graphics can be copied to the ClipBoard with Ctrl-C*.

3D Near Field view and Smith Chart (VM3 only)

4.2.2.1 Impedance Plot

The Plot Impedance command also available on the toolbar will prompt you for a frequency range, a frequency step and will start plotting the antenna impedance in real time on a rectangular graph with Resistance on the horizontal, and Reactance X on the vertical axis.

Left Click on the graph to rescale the R and X by entering new Maximum and Minimum.

Right Click on the graph to change the Frequency Range or Step.

4.2.2.2 SWR Plot

Almost the same except that you are prompted for a Max F, Min F, Step and Max SWR.

Left Click will redisplay this dialog. Right Click is not used.

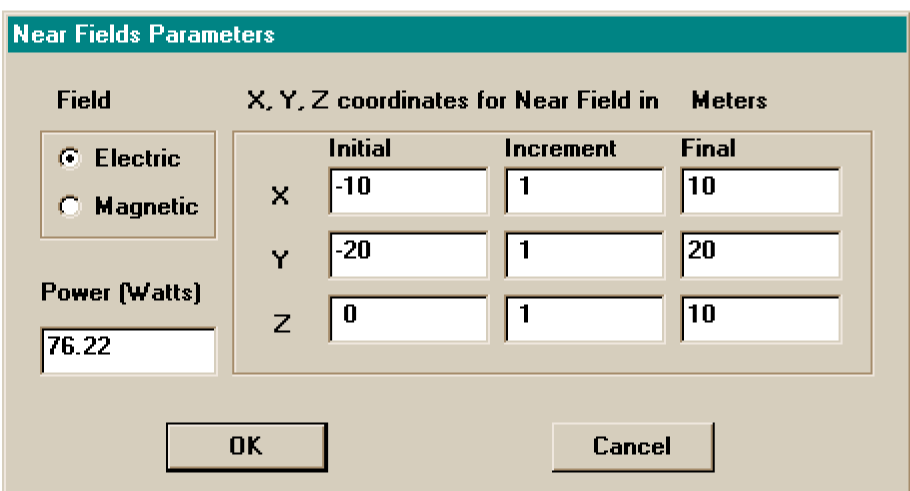
4.2.2.3 Gain and F/B Plot

Gain and F/B are plotted at a specific Azimuth and Elevation angle. *These values are the last values used as TOA and TOAz in the Far Field Pattern window*. This means that you should first plot Azimuth and Zenith pattern, find the maximum lobe as explained in the Quick Tour and then go to plot Gain and Front to Back.

Gain and Front To Back Plot are similar. Left Click will redisplay the dialog for Frequency Range, Step, and Maximum, Minimum to plot.

4.2.2.4 Near Fields (VM only)

The Near Field Parameters dialog (picture below) is displayed.



Select Electric or Magnetic field, then the 3D volume in which you want to compute and display the Near Field data.

You must define an X and Y rectangle by its coordinates, -10 to -10 for X and -20 to +20 for Y, and a vertical range for Z.

You also define the **Increment** used for each of the three coordinates.

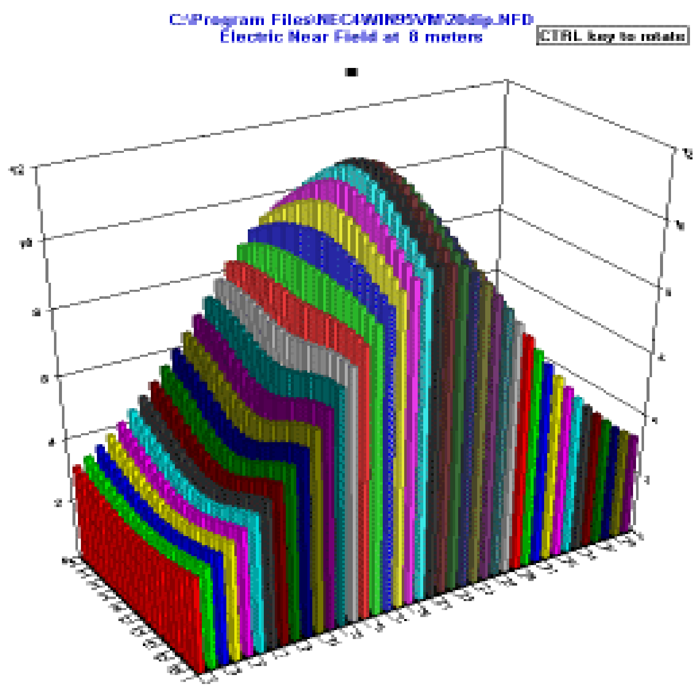
When you click on OK, **the program will compute the E or H Near Field for every point** from Xmin to Xmax, Ymin to Ymax and Zmin to Zmax using steps equal to the increments you specified for each coordinate. This means that the model will run

(Xmax-Xmin).(Ymax-Ymin).(Zmax-Zmin)/Xstep.Ystep.Zstep

passes on your model and this could take an enormous time if the model is complex.

The example above for example will generate 20.40.10 or 8000 points. This is OK with a simple dipole, but on a multielement beam that could take hours. It is therefore recommended to start with large steps then refine more and more.

When NEC4WIN95VM finished generating the data, the 3D Near Field view is displayed. Each view is a horizontal slice of the 3D volume at different heights. You can change the height by clicking on an Up/Down control.



You can rotate the view by pressing on CTRL plus Left mouse button and moving the mouse. The data can be displayed in **Linear**, **Logarithmic** or **percentage**.

When you click on one of the vertical bars, the value of the field and the coordinates are displayed in the box on the tool bar.

4.2.2.5 Smith Chart Impedance Plot (VM only)

NEC4WIN95VM allows you to plot impedance on a frequency range in a Smith Chart format.

When you click on the Smith Chart button on the toolbar or Plot menu, you are prompted for a Frequency range and Step. The program then computes all impedances in the specified range using Step as an increment and displays the results on a Smith Chart.

The reference impedance Z0 is by default your "Coax" impedance, but you can change this value by a Right Click on the chart. Select **Change Z0**, and enter a new reference impedance. The new chart is redisplayed instantly without recalculations.

The Chart is printed by Right Click then selecting Print.

The Smith Chart is copied to the clipboard by CTRL-C. You can then go to your editor or graphic program and type CTRL-V (or Paste) to paste the graphic.

4.2.3 Compute

Numerical calculations only. Results are printed in Main Window or saved in the Log.

4.2.3.1 Compute Impedance

Same function as toolbar. Will perform a simulation and compute the impedance of the loaded model at the specified frequency, Height and Ground mode and Type.

4.2.3.2 Compute Resonance

This displays a dialog where you can enter a frequency range, frequency step in MHz, and perform a compute impedance for each frequency at the specified step. Results are printed in the Main Window.

4.2.3.3 Compute Far Field, Near Field

Using old Mininec3 interface with scientific angles. Output is logged.

4.2.3.4 Compute Currents

This will compute the currents in the antenna and save in the Log File. If there is no Log active you are prompted to create one.

4.2.4 Antenna Setup

All data relative to the antenna is under that menu.

4.2.4.1 Free Space - Use Ground

Click to use one of the two modes. In **Free Space** the antenna does not use the ground at all. When **Use Ground** is displayed you should define ground parameters using Antenna Setup > Ground.

4.2.4.2 Geometry

Opens the Geometry Grid (spreadsheet) which allows creation of wires, edition, shift, rotations and tapering of wires. Press F1 to get more information on Spreadsheet editing. See the Tutorial for examples using advanced functions like rotations.

4.2.4.3 Height

Used to specify a **global Height**. This value is added to the Z coordinates and allows you to enter antenna coordinates around a zero reference, then raise the antenna at any height by changing the **Height** value.

In the Far Field Pattern plot you can vary this height dynamically and plot patterns at different heights without having to re-edit your project.

4.2.4.4 Frequency

Operating Frequency in MegaHertz. Can be changed in Geometry.

4.2.4.5 Ground

Opens a special Ground Selection dialog where you can select the type of ground from a list of preselected ground types:

Perfect		
Excellent	20	30 mS/m
Good	14	6
Average	13	5
Poor	12	2
Bad	4	1

You can also type your own values in the corresponding boxes for the Dielectric constant and Conductivity in milliSiemens per meters.

The boundary type is not used.

You can define how many radials are **on the ground**, and how long they are **in meters**. This is used to simulate a counter poise or radial screen placed on the ground.

4.2.4.6 Sources

This open the Sources/Loads dialog as seen in the Quick Tour section.

Create a source or Load by dragging the corresponding icon from the top to the schematic representation of the wire, and dropping it on a pulse.

Click on a Source/Load to adjust or set its parameters.

Drag a Source or Load to another pulse on the same wire.

To move to another wire you have to delete by dropping into the trash then create a new Source or Load on the new wire.

Click on the Source to display the Source dialog. You can then specify the source parameters: pulse position, magnitude, and phase. The pulse position comes from its placement on the wire and you cannot change it unless you move the source to another pulse. You can change the magnitude and phase.

Voltage or Current source

You can simulate most antennas using voltage sources. In some specific cases like phased arrays you have to use current sources. To select current sources click on the pseudo button found above the source parameters (magnitude/phase) to display Voltage or Current.

Magnitude

It is by default 100 (volts or amps). If you are modeling a single source antenna you do not have to change it. If you are modeling a multiple source antenna, like a W8JK or a phased array, you may have to modify this value to reflect the percentage of energy sent to a specific element. A good example is the binomial array where elements receive energy according to the binomial pattern (1, 1 2 1, 1 3 3 1, etc.). If we have three elements in our binomial array the first voltage is 100, the second 200 the third one 100.

Even then, the absolute values are not important, it is the relative ratio between the different sources that is important and you could enter 1, 2, 1 instead.

Phase

The phase is normally left at zero in single source antennas. If you have multiple sources you have to enter the phase. In a W8JK for example you could have one source at phase zero, and the second one as phase 180 degrees.

4.2.4.7 Loads

Loads are inserted exactly like sources by dragging the Load icon and dropping it on the wire. Then click on that load to define its elements.

You can insert 2 types of loads:

Series	All elements (R, L, C or R, X) are in series
Parallel	All elements (R, L, C or R, X) are in parallel

Elements can be entered as

Resistance and Reactance R, X

Impedance elements as R, L and C (L in microHenries, C in picoFarads)

Note: When you enter R, L, C elements the R, X boxes displays the resulting impedance at the working frequency. You can use this feature to adjust L, C in traps for maximum impedance. A zero value is ignored and interpreted as a missing component.

Note: Empty entries in Loads are ignored in parallel loads as if that element was missing.

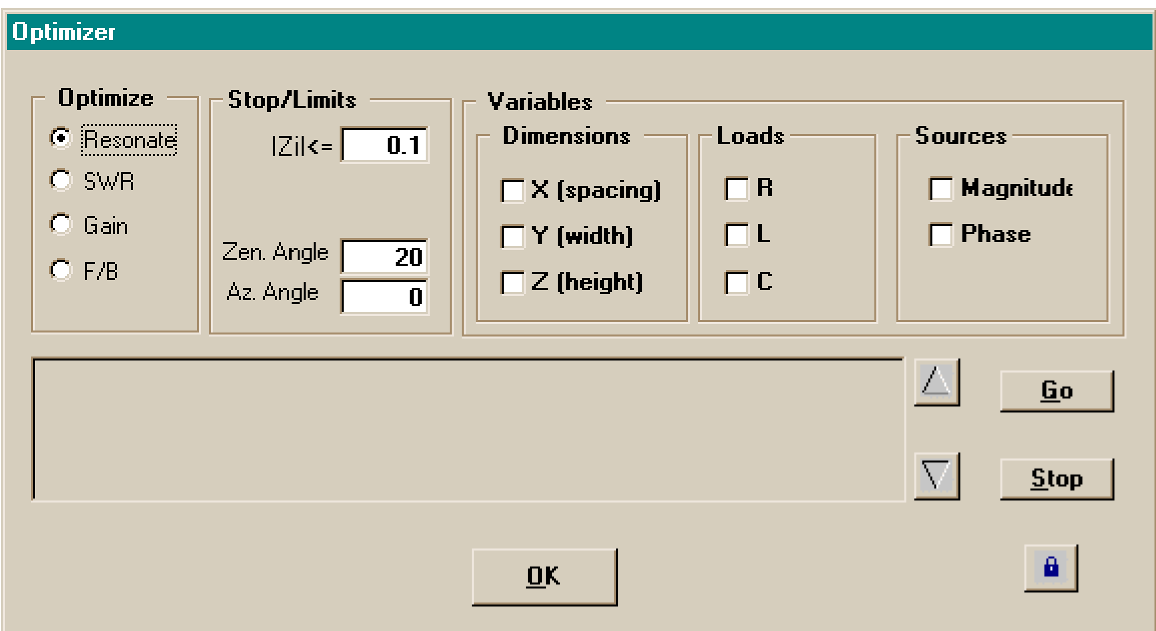
4.2.4.8 Project File

You can edit the project directly in ASCII and make quick changes. The syntax for NEC4WIN95 commands is documented in **Help > Project Commands**.

You can edit or add comments lines to your project using this function.

4.2.5 Optimize

This will open the Optimizer window when a project is loaded. The Optimizer window looks like this:



The optimizer allows you to optimize your antennas for **Resonance**, **SWR**, **Gain** and/or **Front to Back**. The user interface has been designed for maximum user friendliness and is entirely mouse driven. There is no symbolic variables or programming of any kind.

Just **select Resonance, SWR, Gain or Front to Back**.

Select Elevation and Azimuth Angles at which you want to optimize (Gain, F/B)

Click on the Variables that the optimizer should vary to reach that goal: X, Y, Z; R, L or C in Loads, etc.

Click on Go. That s all.

Note: The angles are loaded from the maximum lobe values saved in Far Field Pattern when you plot the Elevation and Azimuth pattern. Plot Patterns first before optimizing to set these angles

4.2.5.1 Wire locking

Just under the **Stop Button** you can see a small button with a Lock similar to the one in the geometry grid. This allows you to Lock wires, sources and loads. **The optimizer will not modify locked wires, sources or Loads**. In addition, **any wire connected to a locked wire will have the connection point also locked**.

To lock a wire you Click on the corresponding checkbox in the list to lock the variable. The optimizer will ignore locked wires, and all wires connected to it will have the connection frozen. This will prevent accidental disconnection of wires, and keep loops and closed antennas closed.

4.2.5.2 Optimizer stop, Trigger values

The optimizer will stop when one of the following condition occurs:

No change detected with applied delta

Maximum Delta reached (10% by default, user definable in options)

Trigger values reached (*from below for main trigger, from above for secondary trigger*)

User clicked on Stop

4.2.5.3 Main trigger, secondary trigger

When optimizing for Gain or Front to Back we have two triggers. The main trigger is on the first line and will stop optimization *when the result becomes higher than the trigger value*. This allows you to put a max gain or F/B that you want to reach. If the optimizer can t reach that maximum it will stop when results stop changing.

The secondary trigger will stop optimization when crossing the trigger value from above. This allows the secondary result (gain or F/B) to grow, eventually go over the desired value, but will stop optimization when decreasing below the specified value.

A good way to stop optimization in Gain - Front to Back optimizations is to make a first run with approximate values. Then consult the log file for the best Gain-F/B and use them as triggers. Reload the original file and restart optimization.

4.2.6 Optimization tips

NEC4WIN95 does not use symbolic variables: it is too complicated for the average user and trigonometry is not for the non-mathematically inclined. You should remember that:

Everything selected is "Optimized".

If you click on X, all X dimensions will be varied. If you add Y to that, all Y dimensions will be also modified, etc. This could create a heavy increase of calculations and time to reach a result. A step by step approach will produce better results. In a beam for example you can optimize the Y dimension first (elements width), then optimize X (spacing), etc.

You can limit optimization to selected wires by Locking the other wires.

Use the wire lock feature to limit optimizations. In a beam you can for example optimize the radiator, then director then reflectors one by one on width (Y), then spacing, until you reach the target gain or front to back.

Use the Optimizer log as a fine tuning tool

When you start an optimization by clicking on Optimize a special log called NEC4WIN95.OPT is created. This text file will log all operations performed on the initial antenna, delta, results, etc... By consulting the log, you can find combinations of Gain - F/B that you like. Use these values as triggers to stop optimization.

Resonance and SWR are not always the same thing

Resonance is calculated by reducing the reactive part to a minimum. SWR is calculated using the coax impedance used in the model. **Select a correct coax impedance before running an SWR optimization**.

Returning to a middle point in the optimization using Total Delta from the log

Total delta is a scaling factor to apply on the initial dimensions to reproduce results found in the log. This delta should be applied only on the dimension(s) that were optimized and only on unlocked wires so be careful when you want to backtrack in the optimization. Use the same original dimensions you used when you started optimization, and rescale only the dimensions you changed using X, Y or Z and on unlocked wires only. You can use the Scale box in the geometry grid to do that rescaling.

Example: You are optimizing the width of all 3 elements in a 3 element beam. After running an optimization pass you find in NEC4WIN95.OPT that for a total delta of 1.002 you get maximum gain and F/B ratio:

Reload the original project

Go to geometry, enter 1.002 in the Scale edit box

Highlight the Y1 column, click on Scale

Highlight the Y2 column, click on Scale

Check that you get the desired Gain and F/B

4.2.6.1 File Management

You can use this not only when you optimize but any time you work on a project.

Save your project frequently.

Use **Save As** to save modified versions when you modify something.

Use meaningful filenames.

When *you start an optimization, the current file is renamed WORKOPT.N4W to prevent the destruction of the original data*. Use Save As to save intermediate results that you like so you can come back and fine tune eventually.

Keep backups of your important projects. Some are the result of hours of work and you don t want to loose that by mistake.

4.2.7 Options

This regroups all options and switches used by the program. As explained earlier, use the context sensitive help by highlighting the menu item and press F1. The special menu which need more explanation are:

4.2.7.1 Fixed Float Format

This will switch the Geometry display from a Fixed format to Scientific notation. In Float Format you can enter values as ±X.XXXE±ee. This could increase precision when using small dimensions and prevent truncation.

4.2.7.2 NEC Frequency Offset

MININEC3 exhibit an offset in frequency on the Reactance. This is particularly visible in VHF/UHF antenna with thick elements. When simulating such antennas turn the NEC switch on for better precision. Gain is also affected by this switch.

4.2.7.3 Loop Correction

This switch will apply a correction on closed antennas like loops and quads to compensate the MININEC3 "Corner Problem". You do not need to taper segments when using this switch. Segmentation should be kept at around 20 to 25 segments per wave, which means that a quad should have 6 segments per side. Increasing segmentation could reduce accuracy.

4.2.7.4 Zero Height Warning

NEC4WIN95 signals antennas that are touching the ground. This can become annoying with time, especially when you are working on grounded verticals. This switch will cut warnings.

4.2.7.5 ICEPAC

This option generates ICEPAC model 13 files for use with the NTIS HF Propagation software. ICEPAC, the Ionospheric Communications Enhanced Profile Analysis and Circuit Prediction Program predicts the expected performance of high frequency (HF) broadcast systems for the four seasons, different sunspot activities, hours of the day, and geographic location. It is a high level propagation analysis software derived from IONCAP, designed by the ITS Institute for Telecommunication Sciences and distributed freely on Internet on a US Dept. of Commerce site maintained by Gregory R. Hand. You can download from there a version of ICEPAC for Windows 95/98 and NT called HFWIN32.

http://elbert.its.bldrdoc.gov/hf.html

5 Technical Support, Web Sites

We urge you to check the Help file first, use the F1 key to get help. Use the Index and Full Text Search in the help to locate more information. If you are a novice, do the tutorials.

We maintain a FAQ page on our Web site in the Support area.

If you still have problems and can t find a solution, you can contact us via Email, which is our preferred way of communications. Describe your problem, the type of computer and operating system you use and attach eventually a project causing problems and any other pertinent information. We answer Email in less than 24 hours.

Electronic mail: **support@orionmicro.com**

Our main Web site is at: **http://www.orionmicro.com**

Our Phone number is: (514) 626 5002

Address:

ORION Microsystems
197 JONCAIRE, Ile Bizard, Quebec
H9C 2P7 CANADA

We remind you that we are not Antenna consultants, and that support is on NEC4WIN95 and NEC4WIN95VM issues and not on modeling problems at large.