SEIBERSDORF LABORATORIES

MANUAL

Antenna Simulation Software Version 1.4

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Antenna Simulation Software

Version 1.4

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1. INTRODUCTION

The program **Antenna** can be used for automatic calculations of transmission loss between pairs of dipole antennas or antenna factors in horizontal or vertical polarisation in free-space or above groundplane. It is based on NEC2D, a dual precision version of the Numerical Electromagnetic Code NEC2 [1].

The dipoles are modelled as uniformly segmented straight wires. The length of the dipoles is optimised to achieve an input reactance less than 1 Ω at the resonance frequency under free-space conditions.

NEC can be used both in the far-field and in the radiating near-field. Therefore, the transmission loss can be reliably calculated for closely spaced dipoles and low frequencies [2,5].

2. INSTALLATION

2.1. Supported Platforms

Antenna is running on following platforms:

- Microsoft Windows version 3.1. or higher
- Windows 98
- Windows NT
- Windows 2000
- Windows XP
- Windows Vista

We can not guarantee that the software will work on all these platforms without any problems because of individual configuration of your PC. If there are any problems, please contact us.

For comfortable handling we recommend the ensuing hardware:

- A Pentium (or equivalent) based IBM or compatible computer.

2.2. Installing Antenna

Contents of Disk:
The **Antenna** measurement software comes on a compact disk, type CD-R.
The ensuing table contains a list of the software components of the **Antenna** installation CD.

antenna.exe	calculation software
nec2d.exe	dual precision version of the Numerical Electromagnetic Code NEC2
setup.exe	installation program for **Antenna**
models	directory with dipole model files PRD0030.NMF - PRD1000.NMF.
donec.pif	program information file for starting the NEC batch job
donec.bat	NEC batch job file
in.txt	file used by donec.bat

A packed version or additional files could be on the CD e.g. to support different SW-platforms.

 To install Antenna:

- Start Windows.

- Place the **Antenna** installation CD in the disk drive.

- Select the disc drive folder, e.g. "D:\ " and double-click to the "Setup.exe" file to start the installation process.

- Fill in the paths where you have put in the installation CD ("Source Path:") and where you like to install **Antenna** ("Target Path:"), e.g. "C:\programs\Antenna". Please take care if a path name has more than 8 characters, a new folder is generated by the operating system using only the first 8 characters of the folder you wrote. To install **Antenna** in a folder whose name has more than 8 characters use the first 6 characters added by "**~1**"longer respectively "**~2**", if it is the second folder (alphabetically sorted) you like to install the **Antenna** with the same first 6 characters like "C:\Progra~1\Antenna" instead of "C:\Programme\Antenna".

- Click the Install-button.

- Now the installation program copies the files to your hard disk and creates a new window for **Antenna.**

2.3. Starting Antenna

To run the software, simply double-click on the **Antenna** icon.

> **Remark:** After starting your first calculation, you have to specify the destination of the file "notepad.exe". The file "notepad.exe" is a program in your "...\windows" directory.

3. QUICK START

In this chapter a typical transmission loss calculation is described step by step.

After starting **Antenna**, an application window with a menu bar and two radio buttons opens.
Click on the **Site attenuation** radio-button in the bottom of the application window to ensure calculations of transmission loss between pairs of dipole antennas.
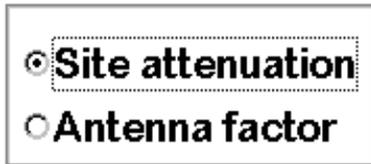
Start a new calculation with the "**File/New**" command in the menu bar. A new main computation window opens for the selection of all parameters needed for the transmission loss calculations.
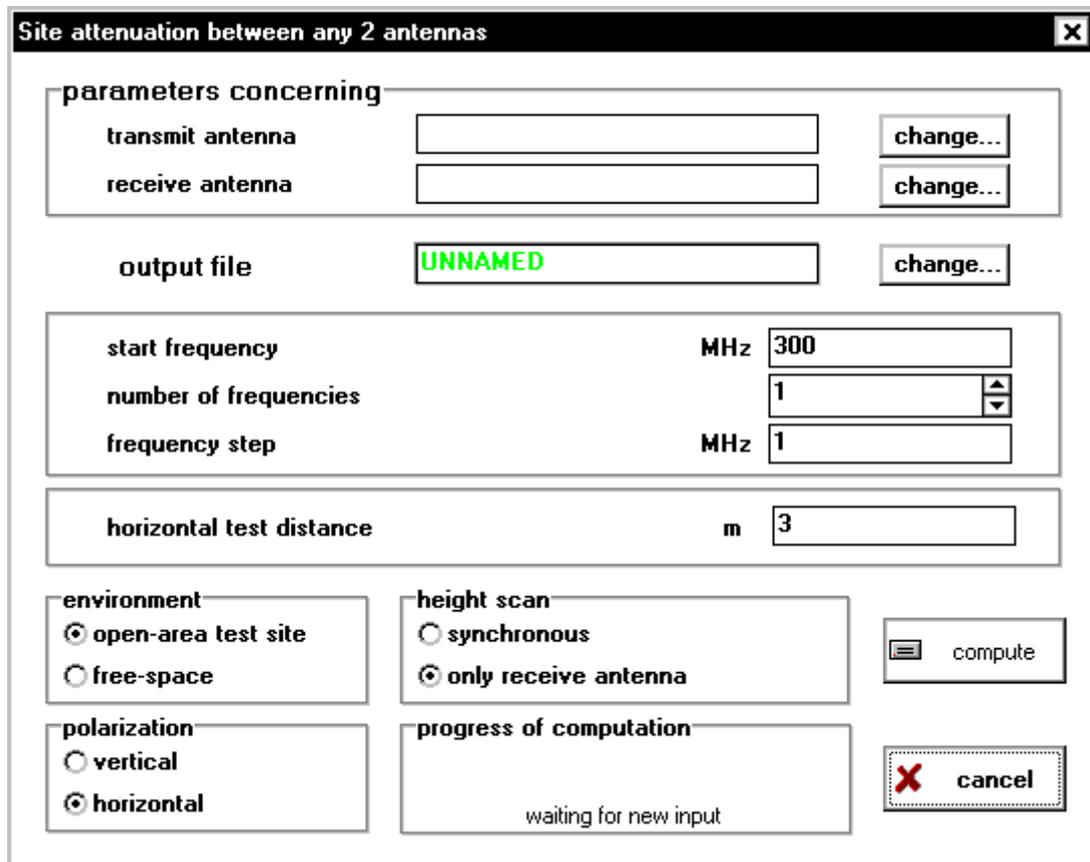
Your fist input should be a new name for the **output file**. Click on the "**change...**" button in the main computation window.

A standard Window dialogbox will appear and you can make your filename selection.

Hint: Store all transmission loss results in the **...antenna\fdh** subdirectory.

After that, press the "**change...**" button in the **parameters concerning transmit antenna** section of the computation window,

parameters concerning

| transmit antenna | | change... |
| receive antenna | | change... |

and the **transmit antenna parameters** window will appear. To prepare for calculations specify the following parameters in the **transmit antenna** window:

- file name of antenna model
- height above groundplane (XY-plane)
- load impedance
- element diameter

transmit antenna ☒

parameters - transmit antenna

| sub/directory | C:\ANTENNA\models |
| file name | | change... |

height above XY-plane	m	1
load impedance	Ohm	100
element diameter	mm	3

✔ OK ✗ Cancel

To load or change the transmit antenna model click on the "**change...**" button. Now you can select an antenna model file in a Windows dialogbox. You will find the models in the **...antenna\models** directory on your local disk. For example please choose the **PRD1000.NMF** model file. This file is the model of the 1000 MHz tuned dipole antenna.

Specify the height above groundplane and the load impedance of the antenna in the corresponding text-edit field. The load impedance of Seibersdorf *Precision Reference Dipoles* is always 100 Ω.

height above XY-plane	m	1
load impedance	Ohm	100
element diameter	mm	3

For example, choose **2 m** height and **100 Ω** load impedance. After finishing your selection, press the **OK** button to close the window.

Back in the main computation window, press the "**change...**" button on the right side of the **parameters concerning receive antenna** text-field. The window is very similar to the transmit antenna window. The only difference is the possibility to perform a height scan of the receive antenna model. If you set a **starting height** of **1 m**, a **step size** of **0.2 m** and the **number of steps** to **16**, the result will be a 1 m to 4 m discrete step height scan of the receive antenna model.

Press the "**OK**" button to finish the input of the receive antenna parameters.

Back in the main computation window, continue your parameter selection by setting the test frequency to **1000 MHz** . It can be done in the **start frequency** edit-field.

Finally, set the distance between the antennas to **10m.** You can make this selection in the **horizontal test distance** edit-field.

Start the calculation by pressing the "**compute**" button. Depending on your hardware, the **results** window will appear after a few seconds or minutes (On a 100 MHz Pentium system the calculation time is around 45 seconds). In this example, the result will be a minimum site attenuation of **42.72 dB** at **1.20 m** height above groundplane.
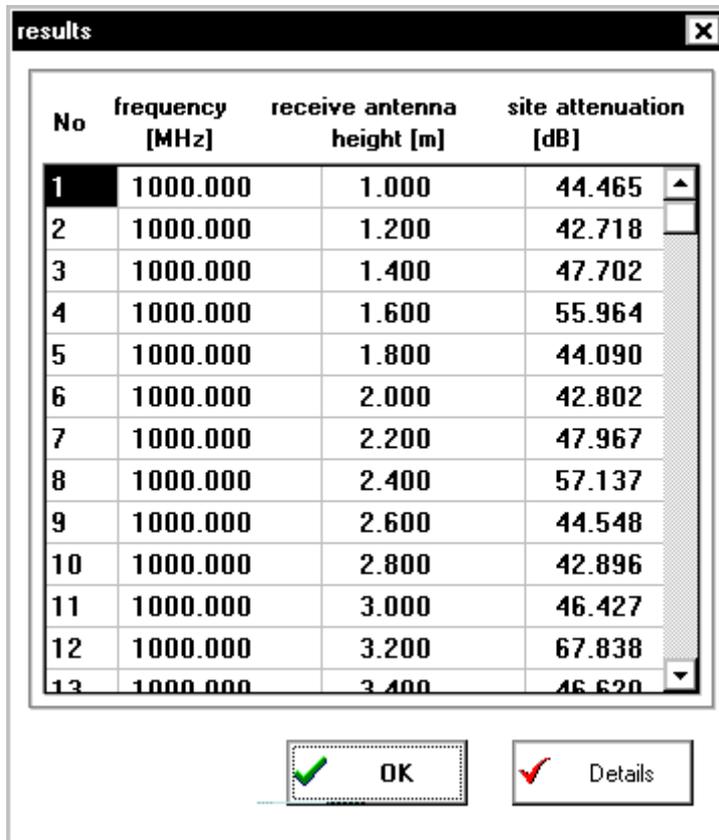
No	frequency [MHz]	receive antenna height [m]	site attenuation [dB]
1	1000.000	1.000	44.465
2	1000.000	1.200	42.718
3	1000.000	1.400	47.702
4	1000.000	1.600	55.964
5	1000.000	1.800	44.090
6	1000.000	2.000	42.802
7	1000.000	2.200	47.967
8	1000.000	2.400	57.137
9	1000.000	2.600	44.548
10	1000.000	2.800	42.896
11	1000.000	3.000	46.427
12	1000.000	3.200	67.838
13	1000.000	3.400	46.620

OK   Details

4. ANTENNA CALCULATIONS

This chapter describes the menus and types of calculations you can select after starting the Antenna program.
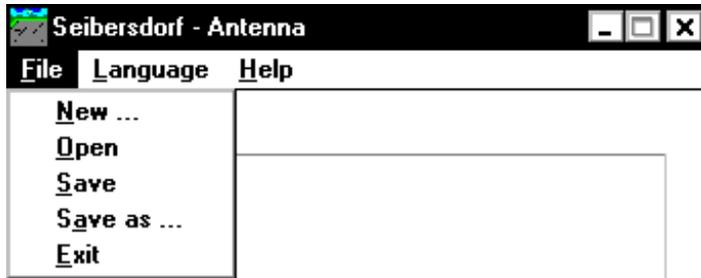
4.1. Create a New Result File

With the "**File/New**" command in the menu bar, you can create a new and empty result file with the default name "**unnamed**". The **main computation window** will open for the parameter selection.

4.2. Loading a Result File

The "**File/Open**" command is used to load previously calculated data in order to display the results again or to perform a calculation with a similar configuration. Just choose the desired file and confirm your choice with the **OK-button**.

Hint: You can find the results of previous transmission loss calculations in the **...\fdh** subdirectory. Antenna factor result files can be found in the **...\afk** subdirectory. **...** is used here instead of the target path specified in the installation program (i.e. c:\antenna\fdh is the full pathname). To each result file with "**fdh**" extension, there exists a second textfile with a "**.txt**" extension, which contains a tabulator separated table of the result values. You can load this file into Windows *Excel* program for further computation.

## 4.3. Site Attenuation Calculations

Click on the **Site attenuation** radio-button in the bottom of the application window to ensure calculations of transmission loss between pairs of dipole antennas.
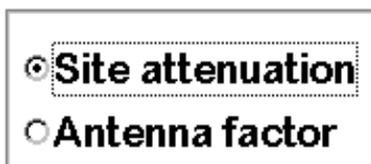
Hint: To avoid numerical difficulties with NEC2, we recommend a maximum test distance of 30 m for site attenuation calculations between pairs of identical antennas.

4.4. Antenna Factor Calculations

Click on the **Antenna factor** radio-button to calculate antenna factors.
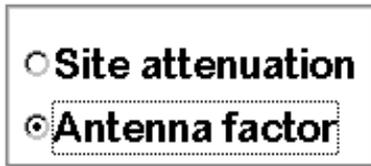
With this part of the program you can calculate the antenna factor of the receive antenna. A transmit antenna is needed to generate a field. With different transmit antenna models and variations in the test distances, you can simulate coupling effects between transmit device and receive antenna and effects of spherical-wave illumination

Hint: To reduce coupling effects in the antenna factor calculation and to achieve an uniform illumination, please select at least a test distance of 30 m for free space calculations. To avoid numerical difficulties in antenna factor calculations above ground-plane caused by destructive interference in the generated field, the test distance must be at least 80 m at a transmit antenna height of 1 m. Please select also a small transmit antenna .You can choose model PRD0250 for calculations below 300 MHz and model PRD1000 for calculations above 300 MHz.

Remark: Select 100 Ω for the receive antenna load impedance. For the complete real PRD antenna factor, you have to add the balun attenuation which includes the additional 3 dB attenuation caused by the 100 Ω to 50 Ω impedance transformation.

5. PARAMETER SELECTION

Start a new calculation with the "**File/New**" command in the menu bar. A new main computation window opens for the selection of all parameters needed for the transmission loss calculations or antenna factor calculation.

This chapter describes all functions of the main computation window and its subwindows.

Remark: For all inputs of real numbers, you have to use a point for decimal separation. Finish your data input with a mouse-click on the "**OK**" button of the window. If the input values are not valid, they will be replaced by the previous ones.

5.1. Environment Conditions

You may choose between an **ideal** open-area test site with infinite conductive groundplane and an **ideal** free-space environment.

Remark: For free-space calculations you cannot select an antenna polarisation. To ensure, that the distance between the antennas is equal to the test distance you have to set both antennas on the same height above XY-plane (e.g. 1 m).

5.2. Polarisation

Only under open-area test site environment you can select the polarisation of the antennas.

```
┌polarization──────────┐
│ ○ vertical            │
│ ⊙ horizontal          │
└───────────────────────┘
```

Caution: There would be an error message when the tips of the antennas touch the ground.

5.3. Changing Antenna Model and Parameters

By pressing one of the "**change...**" buttons in the main computation window

```
┌parameters concerning─────────────────────────────────┐
│                                                        │
│  transmit antenna  [                    ]  [ change... ]│
│                                                        │
│  receive antenna   [                    ]  [ change... ]│
│                                                        │
└────────────────────────────────────────────────────────┘
```

you can select the antenna model and set the parameters of the transmit or receive antenna.

5.3.1. Transmit Antenna Parameters

Following transmit antenna parameters can be specified:

- **File name of transmit antenna model**

You can select one of the following model files.

PRD0030.NMF	corresponding to	30 MHz PRD
	up to	
PRD1000.NMF	corresponding to	1000 MHz PRD

- **Height above ground plane (XY-plane)**

Only positive real numbers greater than zero are allowed.

- **Element Diameter**

The *Seibersdorf Precision Reference Dipoles* element diameters are **18 mm** for the models PRD0030 to PRD0250 and **3 mm** for the models PRD0300 to PRD1000.

Remark: The free space resonance frequency is tuned only for the specified element diameters.

- **Load impedance**

This parameter is available only during site attenuation calculations

Remark: The load impedance of *Seibersdorf Precision Reference Dipoles* is 100 Ω.

5.3.2. Receive Antenna Parameters

Following receive antenna parameters can be specified:

- **File name of receive antenna model** (similar to transmit antenna parameters)
- **Height above ground plane with optional height scan**
- **Element diameter** (similar to transmit antenna parameters)
- **Load impedance** (similar to transmit antenna parameters)

You can perform a height scan of the receive antenna model by setting a **starting height**, a **step size** and the **number of steps.** If you want calculations only at a single height , set the **number of steps** to **1**.

Remark: The maximum number of steps is **5000** for transmission loss and antenna factor calculations. You have to multiply the number of heights with the number of frequencies.

5.4. Frequency

You can perform a discrete frequency scan by setting a **starting frequency**, a **step size** and the **number of steps.** Set the **number of steps** to **1,** if you want calculations at a single frequency only.
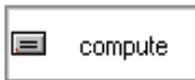
5.5. Type of Height Scan

There is an option to carry out a height scan by simultaneously move both antennas. If you want to do such a height scan, please press the synchronous radio-button before starting the calculation.
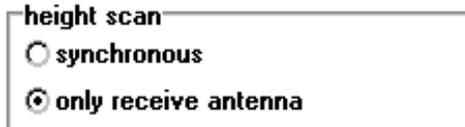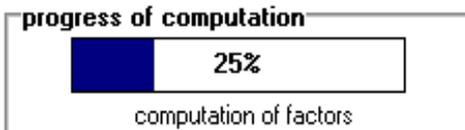

5.6. Start and Stop of a Computation

After finishing the input parameter selection you can start the computation by pressing the


button. The program will check your input parameter. If the input parameters have not changed, the results are displayed immediately. If a new computation is necessary, the **progress of computation** gauge will appear.

You have to wait until the computation has finished and the results will appear on your display.

Remark: You are not allowed to change the input parameters during a running computation. The change would affect your results.

If you want to stop the computation, you can press the
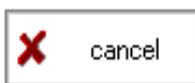
button. This will stop your computation immediately and the available results are displayed.

6. LITERATURE

[1]   J.C.Logan, A.J.Burke, "Numerical Electromagnetic Code", Naval Oceans Systems Centre, CA, USA, 1981

[2]   H.Garn, M.Buchmayr, W.Müllner, J.Rasinger: "Primary standards for antenna factor calibration in the frequency range of 30 to 1000 MHz", IEEE Trans.Instrumentation Measurem., vol. 46, no. 2, April 1997

[3]   H.Garn, M.Buchmayr, W.Müllner: "Tracing antenna factors in the range of 30 - 1000 MHz to basic quantities", OEFZS-4799, April 1997

[4]   CISPR 16-1-5 2003, "Antenna calibration test sites for 30 MHz to 1 000 MHz"

[5]   H.Garn, M.Buchmayr and W.Müllner: "Tracing antenna factors of precision dipoles to basic quantities", IEEE Transactions on Electromagnetic Compatibility, vol. 40, no. 4, November 1998

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