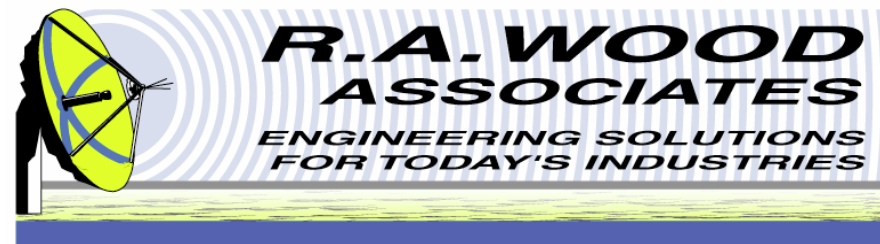


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# PathLossSolver User Manual

Version 1.3



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# Overview

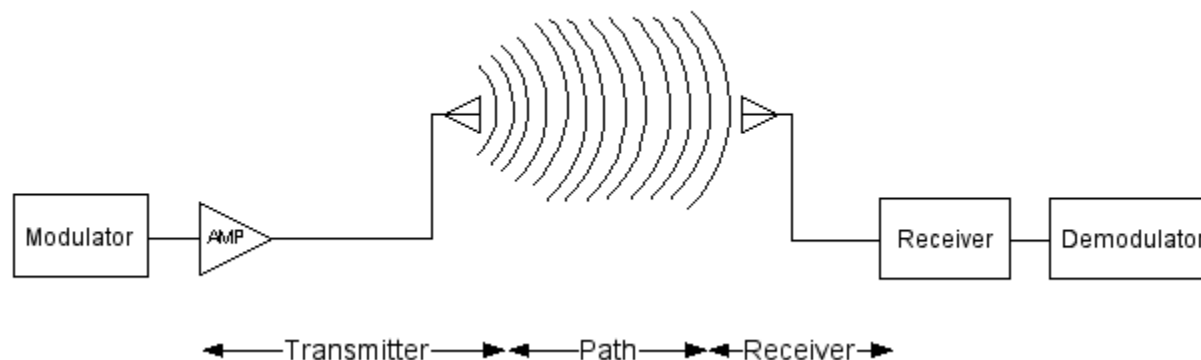
PathLossSolver calculates the one way RF path loss. This program provides a simple, easy to use interface to determine the Radio Frequency (RF) signal levels at a receiver at a given distance from an RF transmitter.

## Key Features:

- Calculates RF signal level at a range of distances from the transmitter.
- Antenna gains, transmitter losses and receiver losses can be incorporated into the calculations.
- Displays variables and calculations in a simple, intuitive, and easy to use interface.
- Different units (km, miles, feet, etc) may be selected for distance and transmitter power.
- A list of additional losses may be created and included in the calculations.
- A graph and table of receiver power level vs. range is plotted.
- Parameters may be loaded from and saved to text files.

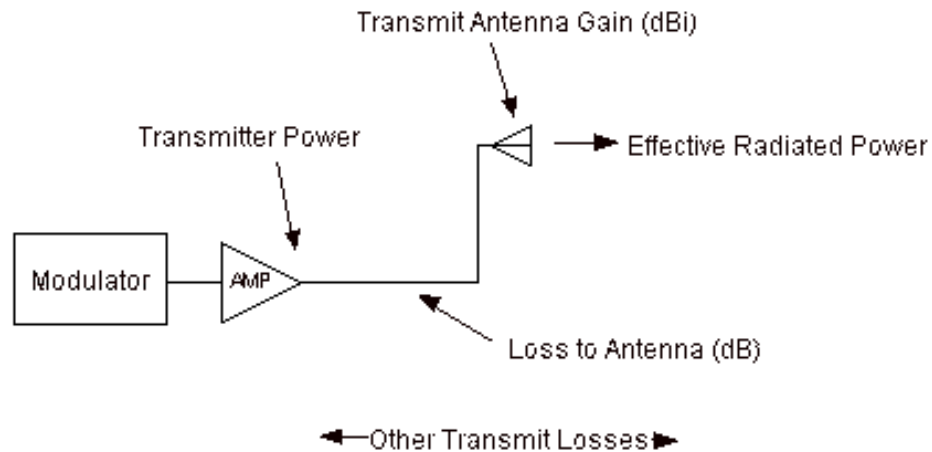
The program has three parts: Transmitter Characteristics, Path Characteristics, and Receiver Characteristics (Figure 1). Parameters can be modified in each of these parts to determine the RF signal level at the receiver input.

**Figure 1 PathLossSolver Components**



# The Transmitter

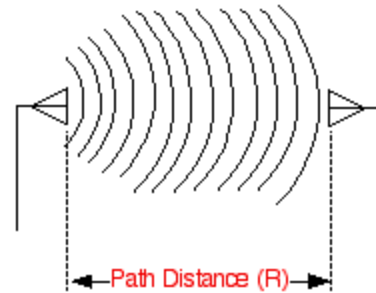
In this section the user can select the transmitter power, the losses from the transmitter to the transmitter antenna, and the antenna gain. The Effective Radiated Power is calculated (See Figure 2). The Loss to the antenna may include coaxial cable, transmission line losses, and component losses (eg. duplexers, switches, ect.) between the amplifier and the antenna. Other Transmitter Losses may be added (eg. random losses, polarization losses, antenna pointing losses, ect.).



**Figure 2 Transmitter Characteristics**

# The Path

The Path section calculates the loss in the RF signal as it travels a certain distance through the atmosphere (Figure 3). Items that may be included in the Path Attenuation (dB/Distance Unit) include but are not limited to water vapor loss, rain loss, and oxygen absorption. Items that may be included in the Other Path Attenuation include fixed losses, and simplified multi-path losses.



Path Loss Exponent:

$$\frac{\lambda^2}{(4\pi)^2 R^2}, \frac{\lambda^2}{(4\pi)^2 R^3}, \frac{\lambda^2}{(4\pi)^2 R^4}, \frac{\lambda^2}{(4\pi)^2 R^5}$$

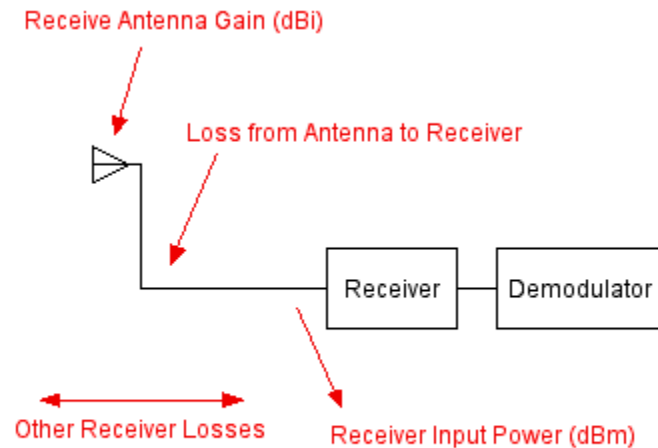
Path Attenuation (dB/Distance Unit)

Other Path Attenuation (dB)

**Figure 3 Path Characteristics**

# The Receiver

The receiver captures the RF energy with the receiver antenna and translates it to a receiver power at the receiver front end. Figure 4 shows the components of the Receiver. The Receiver Input Power is calculated at the receiver input. The Loss from the Antenna to the Receiver may include coaxial cable, transmission line losses, and component losses between the antenna and the receiver. Other Receiver Losses may also be added (eg. antenna random loss, polarization losses, antenna pointing losses, ect).



**Figure 4 Receiver Characteristics**



# Trial Version Limitations and System Requirements

- Trial Version
  - The trial version of PathLossSolver has all the features of the full version with the following limitation:
    - The frequency is fixed at 915 MHz or 915 GHz.
  - The full version is available for purchase for \$59.99 (US Dollars). Buy now to unlock all program features.
  
- System Requirements
  - PathLossSolver was designed to operate in the Windows NT, 2000, and XP environment.



# Changes by Version

Thank you for choosing PathLossSolver Version 1.3!

We are continually improving this program to meet your needs. Please let us know if you have any comments or suggestions.

Latest Version: 1.3

Changes in Version 1.3

- Enhanced the registration process.

Changes in Version 1.2

- Enhanced the registration process.

Changes in Version 1.1

- Improved the registration process. You can now send payment by PayPal, WWW form, or E-mail. The user name and registration key are sent to us electronically, thereby making the registration process easier and less prone to error.

Changes in version 1.01

- Fixed Edit Losses Panels to prevent Interface problems.
- Updated to 6.1 Runtime Engine.



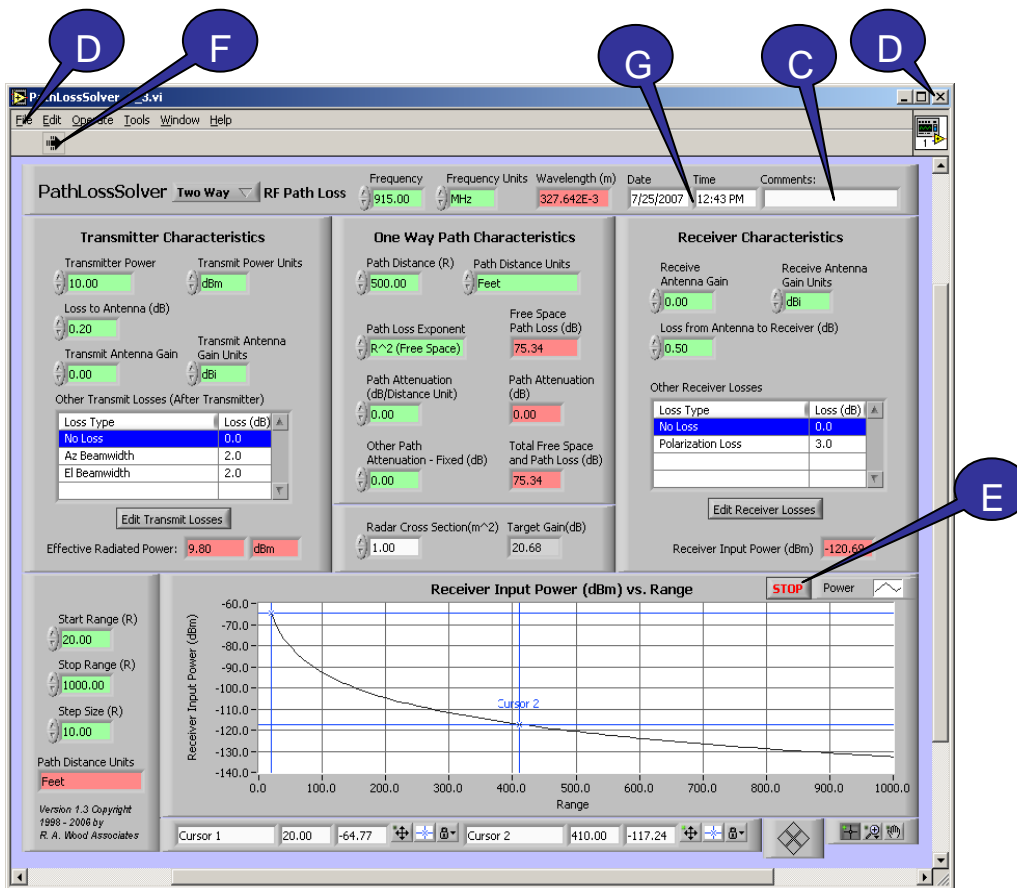


# Installing PathLossSolver

- To check out PathLossSolver for yourself, visit the R.A. Wood software download page at:  
[http://rawood.com/software\\_products/download\\_software\\_page.html#path\\_loss\\_solver\\_anchor](http://rawood.com/software_products/download_software_page.html#path_loss_solver_anchor)
- Select Download Now! next to the Path Loss Solver \_ 1 \_ 3 \_ Installer.exe
- Click Save File to save the installer.
- After the installer download is complete, double click on the PathLossSolver Installer icon to start the installation process.
- Work through the user prompts to install PathLossSolver.
  - Select a folder to save the PathLossSolver setup files to and select OK.
  - Select Next> on the Installation Wizard
  - Browse to select a location to save the PathLossSolver program files to, and Select Next>.
  - Select Next> again to continue with the installation process.
  - Select Finish to exit and complete the installation.
- Once the installation is complete, go to Start>>All Programs>> Path Loss Solver to load the program.
- An Electronic End User License Agreement will appear. Read the agreement and select Agree to continue.
- The Change Log will appear next. This document describes the software changes and improvements by version. Click Continue to start the program.
- On the start up screen, create a user name. This name will only be used for registration purposes.
  - Select Register to pay for the full version of PathLossSolver. You may pay through paypal or contact us with other arrangements.
  - Select Continue to use the trial version. Each time you open the trial version you will have the opportunity to register for the full version. In the trial version you are unable to change the frequency.
- Click Continue again to use the trial version of PathLossSolver or enter the Registration number and click Unlock Software to access the full version.
- For detailed screen shots of the installation process visit:  
<http://helprawoodsoftware.rawood.com/tiki-editpage.php?page=PathLossSolver%20Downloading%20and%20Installing%20the%20Program>

# Program Operation

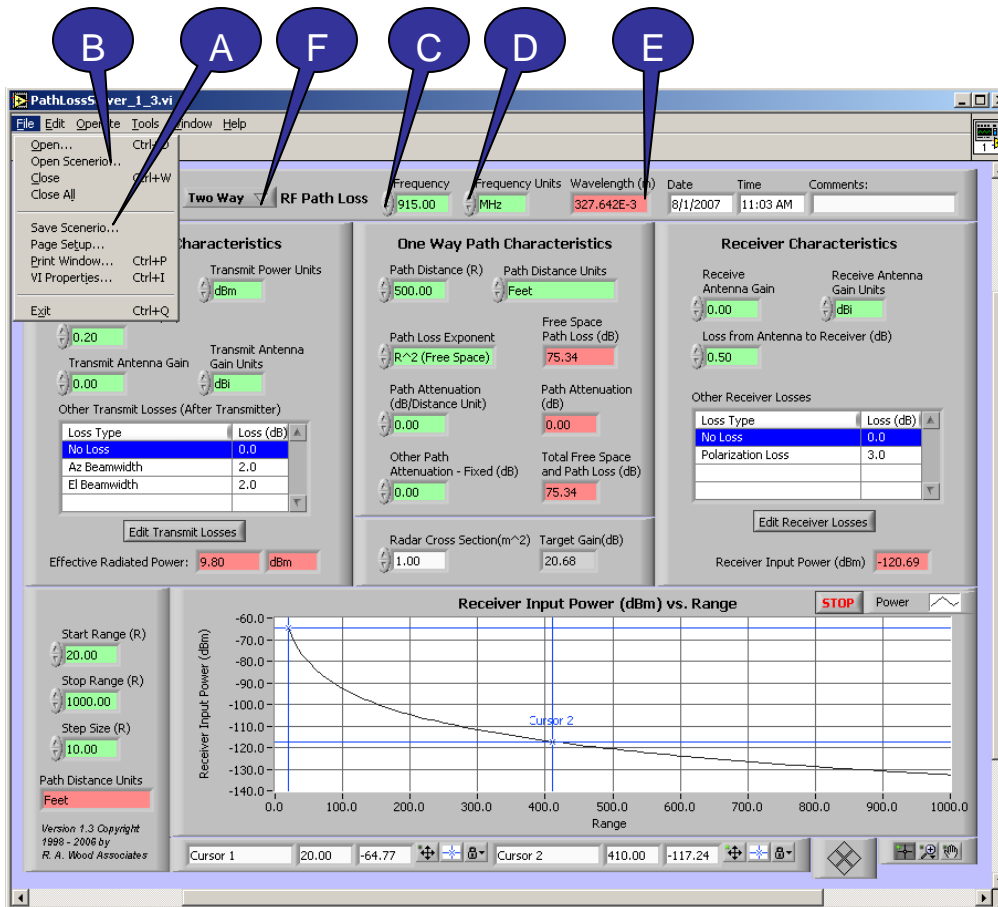
The screen shot below is of the main panel in PathLossSolver. Edit the parameters on this panel to your specifications to determine the RF path loss.



- The **green** controls are user inputs.
- The **pink** indicators are program outputs.
- The **Comments** field allows the user to document the current setup.
- To **exit** the program click the **X** in the upper right corner of the panel or go to **File>>Exit**.
- Click the **STOP** button to terminate the program operation. PathLossSolver will remain open but all controls will be inactive.
- To **restart** PathLossSolver, click the white arrow in the upper left corner. A black arrow indicates the program is already operating.
- The real **Date** and **Time** are displayed at the top of the screen.

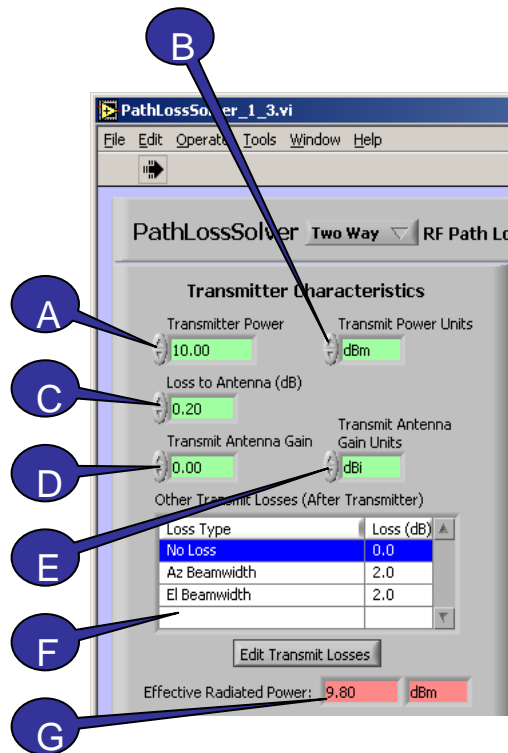


# Program Operation Cont.



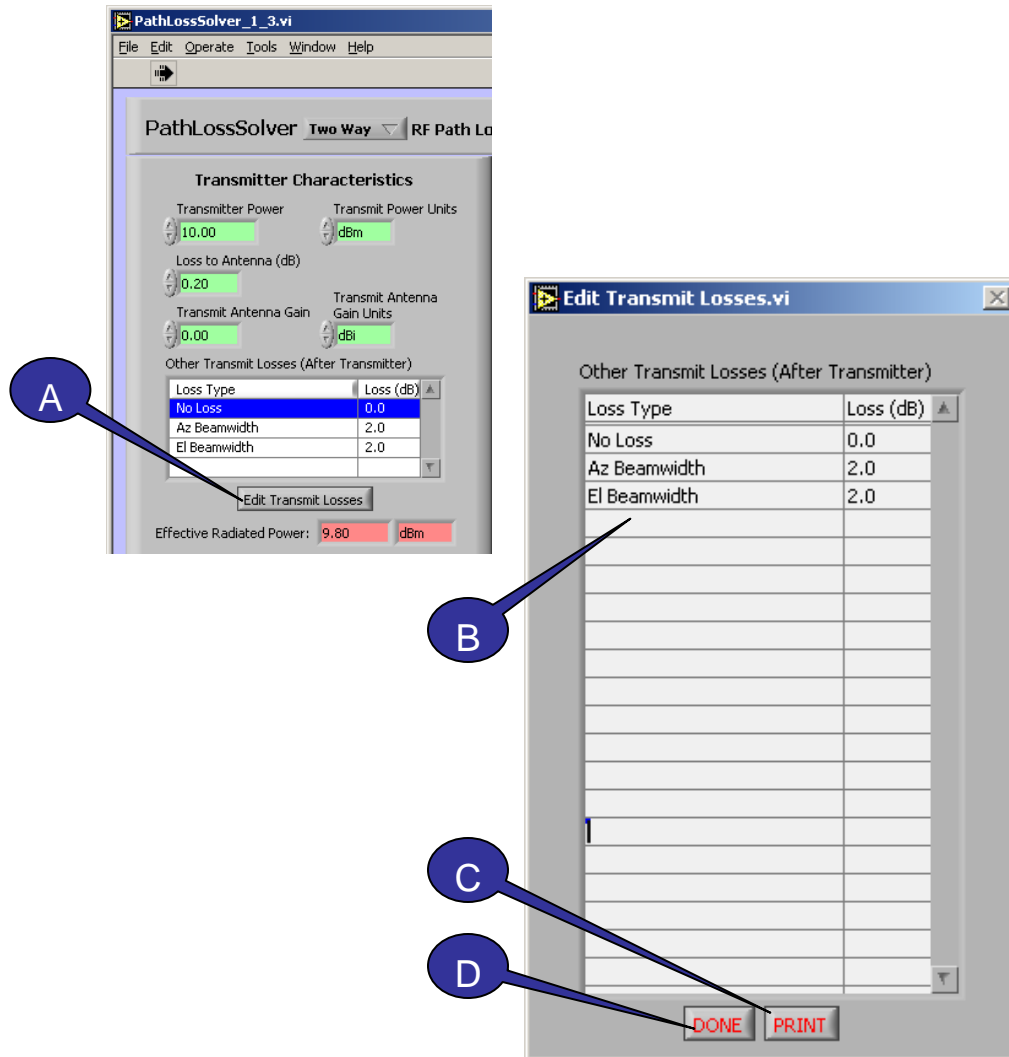
- A. **Save Scenario** – To save the input parameters to a tab delineated text file go to **File>>Save Scenario...** This will save all green fields as well as the transmitter losses table and the receiver losses table for future recall.
- B. **Open Scenario** – To open an existing setup file go to **File>>Open Scenario...**
- C. **Frequency** – Enter the desired frequency noting the units displayed to the right.
- D. **Frequency Units** – Click on the arrow next to the frequency units field to select MHz or GHz.
- E. **Wavelength** – The calculated wavelength in meters is displayed in exponential notation.
- F. **Two Way** – Select between Two Way or One Way RF Path Loss. The graph and pertinent calculations will automatically update.

# Transmitter Parameters



- A. **Transmitter Power** – Enter the transmitter power in the units displayed to the right.
- B. **Transmitter Power Units** – Select dBm, dBW, mWatts, Watts, kWatts, or MWatts for the transmitter Power Units.
- C. **Loss to Antenna** – Insert the loss from the transmitter to the antenna.
- D. **Transmit Antenna Gain** – Enter the transmitter antenna gain in the units displayed to the right.
- E. **Transmit Antenna Gain Units** – Select the units for the Transmit Antenna Gain.
- F. **Other Transmit Losses** – User entered losses are displayed in this table. To edit or add additional losses click on the **Edit Transmit Losses** button. See the next page for details.
- G. **Effective Radiated Power** - The calculated ERP is displayed here in the same units as the **Transmitter Power**. To convert this value to different units change the **Transmitter Power Units** above.

## Transmitter Parameters Cont.



The image shows two windows from the PathLossSolver software. The main window, titled 'PathLossSolver\_1\_3.vi', displays 'Transmitter Characteristics' with the following values:

- Transmitter Power: 10.00 dBm
- Loss to Antenna (dB): 0.20
- Transmit Antenna Gain: 0.00 dBi
- Effective Radiated Power: 9.80 dBm

Below these values is a table for 'Other Transmit Losses (After Transmitter)':

Loss Type	Loss (dB)
No Loss	0.0
Az Beamwidth	2.0
El Beamwidth	2.0

An 'Edit Transmit Losses' button is located below the table. A callout 'A' points to this button.

The 'Edit Transmit Losses.vi' pop-up window is also shown, containing a table with the same data as the main window:

Loss Type	Loss (dB)
No Loss	0.0
Az Beamwidth	2.0
El Beamwidth	2.0

At the bottom of this window are 'DONE' and 'PRINT' buttons. Callouts 'B', 'C', and 'D' point to the table area and the buttons respectively.

- A. **Edit Transmit Losses** – To edit or add other transmitter losses to the calculations, click on the **Edit Transmit Losses** button. This will open a pop up window.
- B. To add a transmitter loss to the list simply click on the list and type the desired addition.
- C. **Print** – Click this button to print the list of transmitter losses. The list will automatically print on the default printer.
- D. **Done** – After you are finished updating the list, click Done to exit the window. This will bring you back to the PathLossSolver main panel.



# Background on Wireless Propagation Loss

Excerpt from: Wireless Communications, Principles and Practice by Theodore S. Rappaport  
 pages 102-104  
 Copyright 1996 by Prentice Hall PTR  
 Prentice-Hall Inc.  
 Upper Saddle River, NJ 07458

“Most radio propagation models are derived using a combination of analytical and empirical methods. The empirical approach is based on fitting curves or analytical expressions that recreate a set of measured data. This has the advantage of implicitly taking into account all propagation factors, both known and unknown, through actual field measurements. However, the validity of an empirical model at transmission frequencies or environments other than those used to derive the model can only be established by additional measured data in the new environment at the required transmission frequency. Over time, some classical propagation models have emerged which are now used to predict large-scale coverage for mobile communication systems designs. By using path loss models to estimate the received signal level as a function of distance, it becomes possible to predict the SNR for a mobile communication system.”

“Both theoretical and measurement-based propagation models indicate that average received signal power decreases logarithmically with distance, whether in outdoor or indoor radio channels. ... The average large-scale path loss for an arbitrary T-R separation is expressed as a function of distance by using a path loss exponent, n.

$$PL(d) = (d/d_0)^n$$

$$PL(dB) = PL(d_0) + 10\log(d/d_0)$$

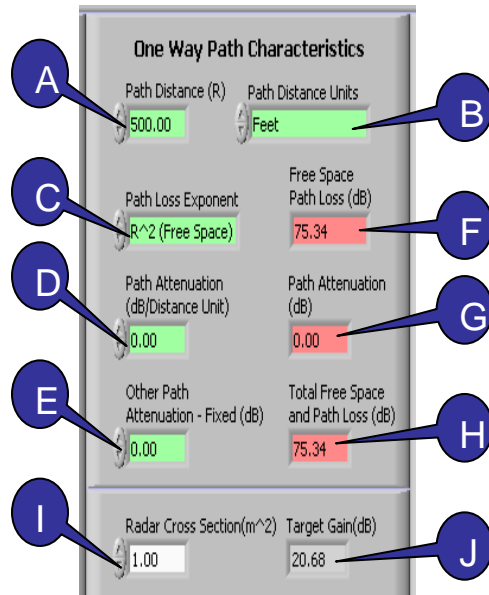
n is the path loss exponent which indicates the rate at which the path loss increases with distance,  $d_0$  is the close-in reference distance which is determined from measurements close to the transmitter, and d is the T-R separation distance. ... The value of n depends on the specific propagation environment. For example, in free space, n is equal to 2, and when obstructions are present, n will have a larger value.

It is important to select a free space reference distance that is appropriate for the propagation environment. In large coverage cellular systems, 1km reference distances are commonly used [Lee85], whereas in microcellular systems, much smaller distances (such as 100m or 1m) are used. The reference distance should always be in the far field of the antenna so that near-field effects do not alter the reference path loss. The reference path loss is calculated using the free space path loss formula...or through field measurements at distance  $d_0$ . Table 3.2 lists typical path loss exponents obtained in various mobile radio environments.”

Table 3.2 Path Loss Exponents for Different Environments

Environment	Path Loss Exponent, n
Free space	2
Urban area cellular radio	2.7 to 3.5
Shadowed urban cellular radio	3 to 5
In building line-of-sight	1.6 to 1.8
Obstructed in building	4 to 6
Obstructed in factories	2 to 3

# Path Parameters

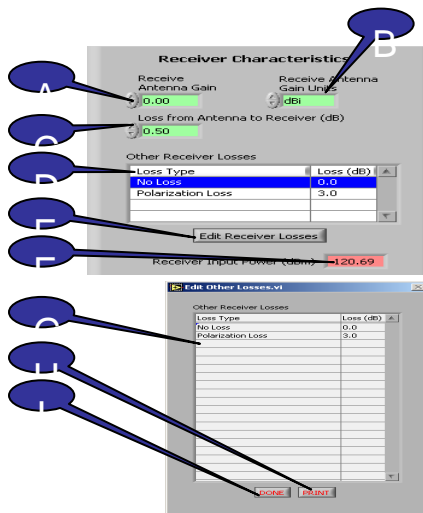


One Way Path Characteristics			
<b>A</b> Path Distance (R)	500.00	Path Distance Units	<b>B</b> Feet
Path Loss Exponent	<b>C</b> R <sup>2</sup> (Free Space)	Free Space Path Loss (dB)	<b>F</b> 75.34
Path Attenuation (dB/Distance Unit)	<b>D</b> 0.00	Path Attenuation (dB)	<b>G</b> 0.00
Other Path Attenuation - Fixed (dB)	<b>E</b> 0.00	Total Free Space and Path Loss (dB)	<b>H</b> 75.34
Radar Cross Section(m <sup>2</sup> )	<b>I</b> 1.00	Target Gain(dB)	<b>J</b> 20.68

- A. Path Distance** – Enter distance,  $d$  between the Tx and Rx antennas.
- B. Path Distance Units** – Select km, meters, feet, miles, or nautical miles for the path distance units. These units will also be used for the graph.
- C. Path Loss Exponent** – Select  $n$ , the range exponent (from 2-5). The path loss exponent affects the type of environment that is modeled.  $n = 2$  represents a free space model. Larger  $n$  values indicate obstructions.
- D. Path Attenuation** – Enter additional losses per unit length.
- E. Other Path Attenuation** – Fixed losses, multi-path losses, and other effects are added here.
- F. Free Space Path Loss** – The calculated free space path loss in dB is displayed here. This is the path loss caused by the path distance at the path loss exponent.
- G. Path Attenuation** – The calculated path attenuation in dB is displayed here.
- H. Total Free Space and Path Loss** – The total path attenuation loss is displayed here. This is the sum of the Free Space Path Loss and the Path Attenuation.
- I. Radar Cross Section** – Enter the desired radar cross section to edit the graph and calculate the target gain.
- J. Target Gain** - The calculated target gain in dB is displayed here.



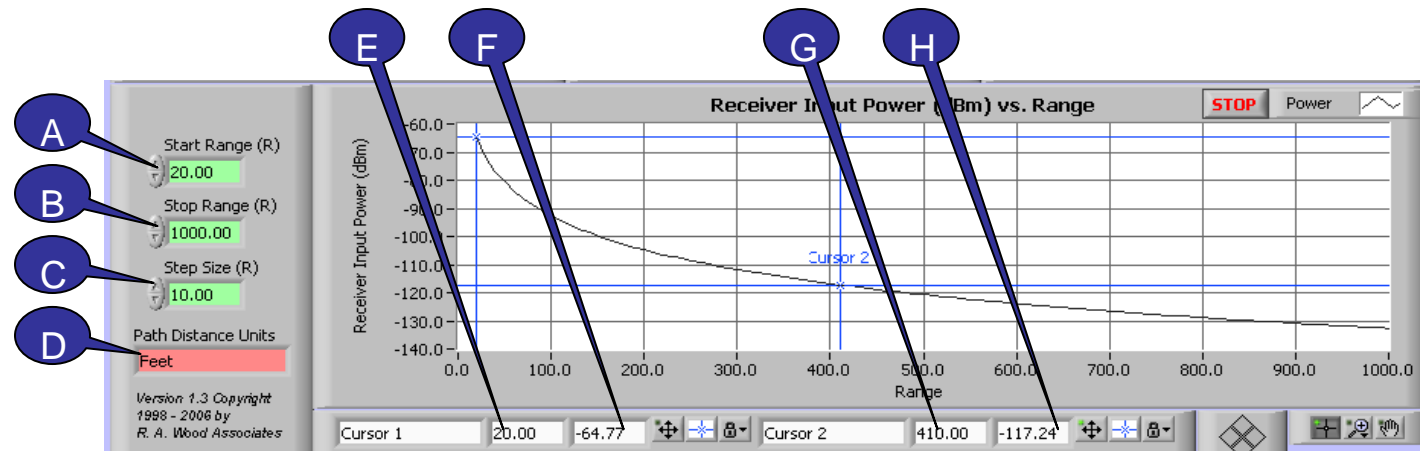
# Receiver Parameters



- A. **Receive Antenna Gain** – Enter the desired receiver antenna gain in dBi (dB relative to an Isotropic source)
- B. **Receive Antenna Gain Units** – Select the units for the receiver antenna gain.
- C. **Loss from Antenna to Receiver** – Enter the loss from the antenna to the receiver in db.
- D. **Other Receiver Losses** – Other user entered losses are displayed in this list. These losses are used in the calculations.
- E. **Edit Receiver Losses** – To edit or add receiver losses to the list above click this button. A pop up window will open.
- F. **Receiver Input Power** – The calculated receiver input power is displayed in dBm.
- G. To add other receiver losses to the list simply click on the list and type the desired addition.
- H. **Print** – Click this button to print the list of receiver losses. The list will automatically print on the default printer.
- I. **Done** - After you are finished updating the list, click Done to exit the window. This will bring you back to the PathLossSolver main panel.



# Graph Setup

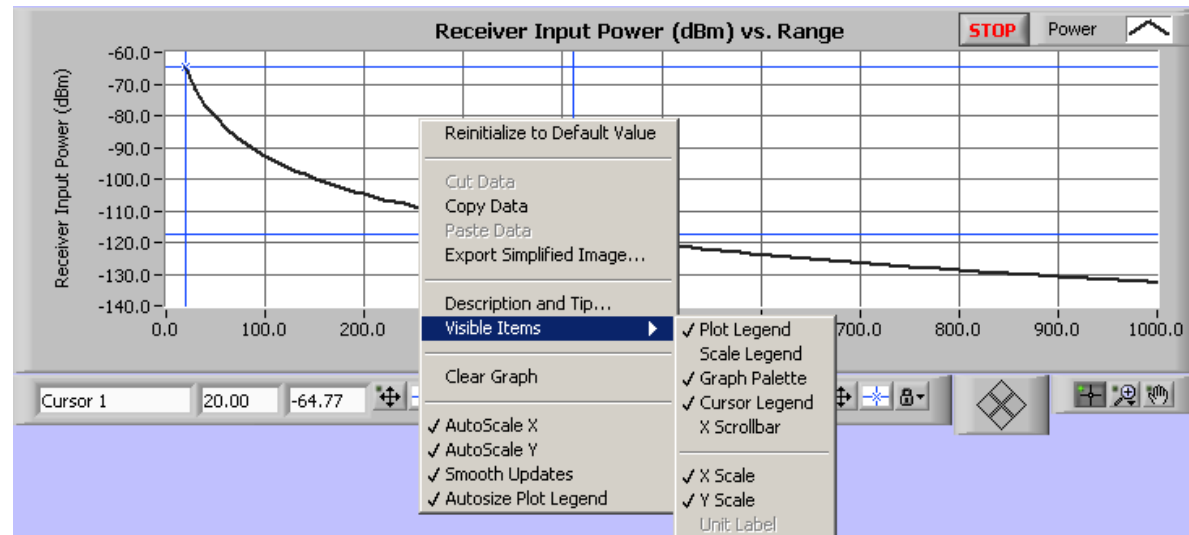


- A. Start Range** – Enter the starting value for the graphical display.
- B. Stop Range** – Enter the stop value for the graphical display.
- C. Step Size** – Enter the distance between data points. The stop value will be included as a data point even if it does not match the step size.
- D. Path Distance Units** – This is a display of the Path Distance Units. To change the units for the graph use the Path Distance Units filed under the Path Parameters above.
- E. Cursor 1 Distance** – This field indicates the current distance marked by cursor 1 in the Path Distance Units.
- F. Cursor 1 Signal Level** – This field indicates the Signal Level in dBm at cursor 1.
- G. Cursor 2 Distance** – This field indicates the current distance marked by cursor 2 in the Path Distance Units.
- H. Cursor 2 Signal Level** – This field indicates the Signal Level in dBm at cursor 2.

# Graph Display Options

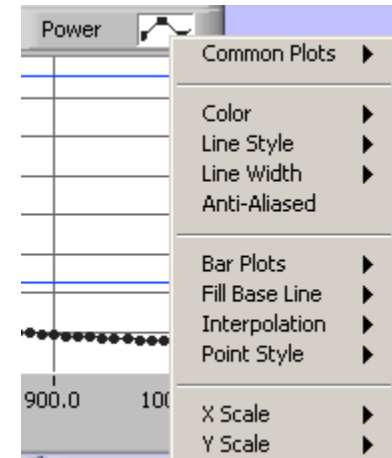
To change the display options or visible items on the graph, right click any where in the graphical display window to view a pop up menu.

- **Reinitialize to Default Value:** This option will return the graphical display back to its original settings. This includes clearing the data line. Using this option will make it appear as though the data was erased. To retrieve the data, change the Start / Stop Range.
- **Copy Data:** Copy Data will make a copy of the entire graphical display in its original form. Use this feature to create presentations of the results.
- **Export Simplified Image...:** This option will copy the graphical display in a simplified black and white version.
- **Visible Items:** Use the Visible Items menu to hide parts of the graphical display. Although this will simplify the display, it will also hide valuable information.
- **Clear Graph:** Clear Graph is similar to Reinitialize to Default Value. This option clears the power line from the graph. To retrieve the data, change the Start / Stop Range.
- **Other:** The remaining options (Autoscale X, Autoscale Y, Smooth Updates, and Autosize Plot Legend) should be left on their default settings.



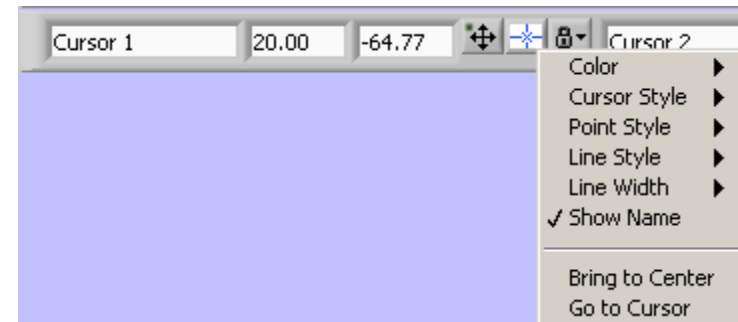
# Line Display Options

- The color and style of the Power line on the graph may be customized. Left click on the Power line field to view an options menu.
- **Common Plots:** The common plots menu may be used to change the data display options. These options change the way in which the data points are connected and delineated. By default the standard line without individual data points is selected.
- **Color:** Select a custom color for the data line to make a bold presentation. By default the Power line is black.
- **Line Style:** Use the Line Style menu to select between dashed and solid lines. By default the Power line is solid.
- **Line width:** The Line width may be adjusted to accentuate the data.
- **Point Size:** Use the Point Size menu to visually define the individual data points. Selecting any of the options in this menu will create bullets at each of the points on the graph.
- **Other:** The remaining options (Anti-Aliased, Bar Plots, Fill Baseline, Interpolation, X Scale, and Y Scale) should be left on their default values. Although no harm will come in changing these options, they do not apply to the tests and presentation realm of PathLossSolver.



# Cursor Line Properties

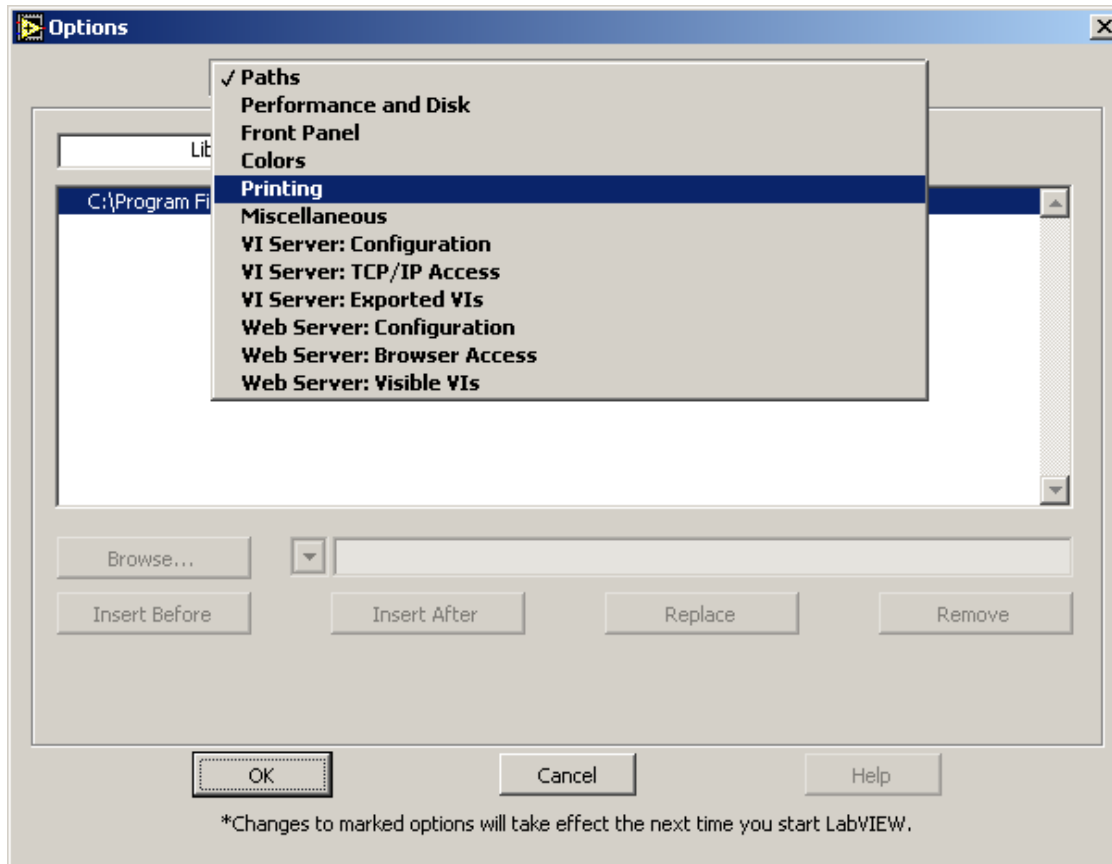
On the graph there are two blue cursor lines. These lines may be used to specify a region of focus on the graph. You may move these lines to any location by clicking and dragging them to a position or by entering a coordinate (Distance, Signal Level) in the appropriate field. You may change the color and style of the cursor lines by left clicking on the blue star shaped button next to the desired cursor line.



- **Color:** Select a custom color for the cursor lines to make them stand out or allow them to hide in the background.
- **Cursor Style:** The cursor style option changes the look of the cursor lines. You may choose between a single vertical line, cross hairs, or a single horizontal line.
- **Point Style:** Use the Point Size menu to visually define the point at which the cursor line crosses the data line.
- **Line Style:** Use the Line Style menu to select between dashed and solid lines. By default the cursor lines are solid.
- **Line width:** The Line width may be adjusted to accentuate or deemphasize the cursor lines.
- **Show Name:** The Show Name option will display the name of the cursor line on the graph.
- **Bring to Center:** Bring to Center moves the cursor line to the center of the graph.
- **Go to Cursor:** Go to Cursor shifts the graph to be centered around the current location of the cursor line.
- **Lock Position:** To lock the cursor lines to a fixed location, left click on the button with the lock next to the appropriate cursor line.

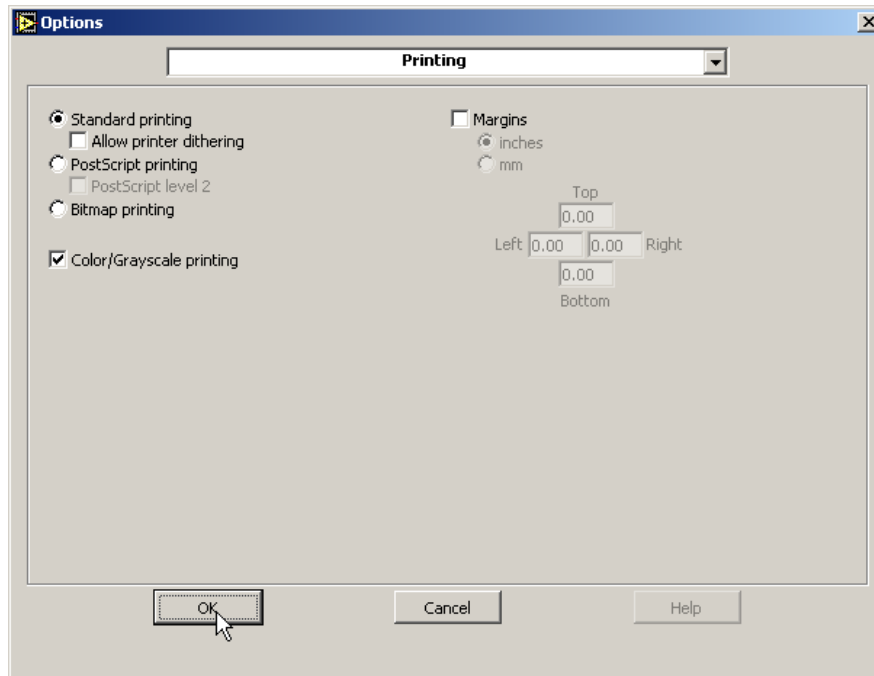
# Printing

- The default printer is set for a postscript type printer.
- To print on an ink jet printer go to **Tools>>Options**. In the pop up window, click on the arrow next to Paths and select **Printing**.

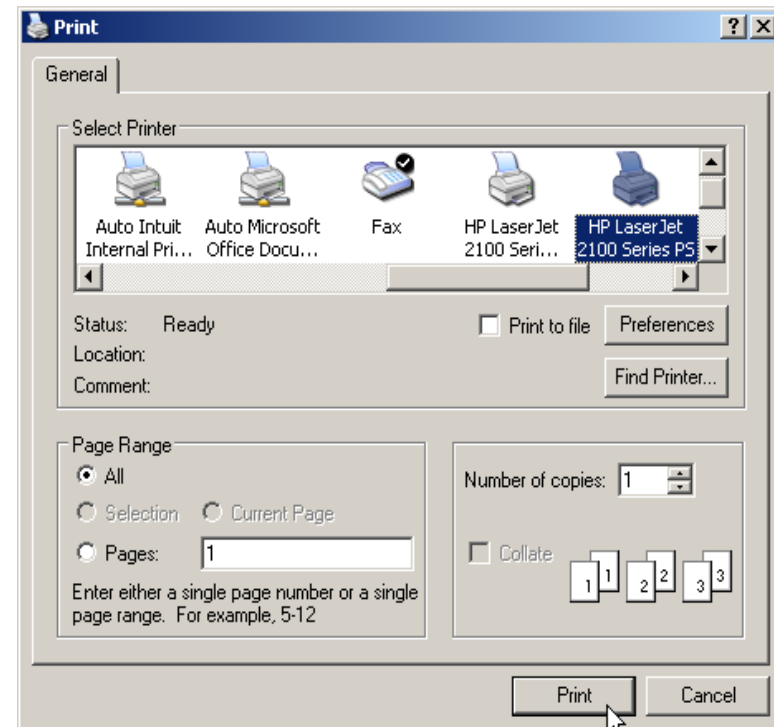


# Printing Cont.

- Set the printing options to **Standard Printing** and click **OK**.



- On the panel that you want to print, go to **File>>Print Window....** In the dialog box select the ink jet printer and click **Print**



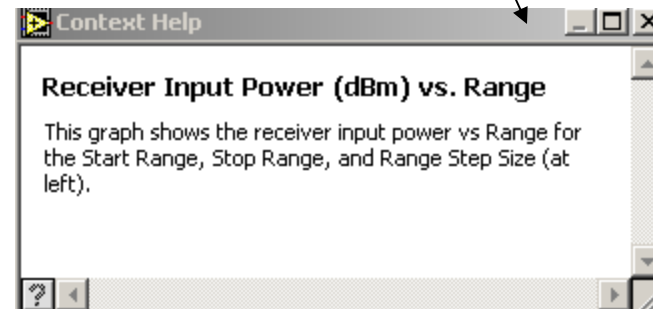
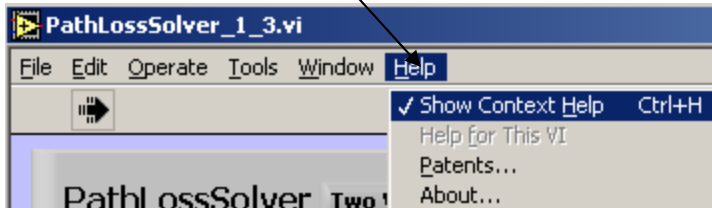


# Help Menu

- For help on functions while PathLossSolver is running, go to Help >> Show Context Help. This will bring up a window with helpful tips that change according to the location of your mouse. Drag your mouse over buttons, graphs, or tables to view detailed descriptions of their functions (see example below). As always, if you run into problems, don't hesitate to contact us at any time.
- For additional Help resources please visit our Software Support Forum at: <http://rawood.com/support3/index.php>
- As always, if you run into problems, don't hesitate contact us any time at 315-735-4217 or [rawood@rawood.com](mailto:rawood@rawood.com)

Click on Show Context Help to bring up Help window.

This is an example Context Help Window that is displayed when the mouse button hovers over The Receiver Input Power Vs. Range graph. Move the mouse to hover over different buttons or tables to view help on other functions.





# Purchasing Information

- We currently offer several methods for purchasing our software products:
  1. Select the desired method from within the program itself (recommended for single purchases)
  2. Use the PayPal Forms on our software download page :  
[http://rawood.com/software\\_products/purchase\\_software.html](http://rawood.com/software_products/purchase_software.html) (useful for purchasing multiple programs)
  3. Fill out the WWW form
  4. Contact us directly so we can contact you for payment arrangements
- When purchasing, please double check that both your User Name and Registration Key are correct.

