This file corresponds to section 1.2 of the provided Users Manual.

Page references correspond to locations in the Users Manual.

(If the text appears to wide for the screen, choose Print|Setup and choose portrait).

1.2 Getting Started

To start SimWindows just double click on the SimWindows icon from the Program Manager. This starts the simwin16.exe file (simwin32.exe for SimWindows32). Two auxiliary files must be in the same directory as SimWindows. One of those files is the bwcc.dll (bwcc32.dll for SimWindows32). Borland International supplies this file with their compiler. The second file that must be present is material.prm. This file is the default material parameters file for Si and AlGaAs which SimWindows loads when it starts. See section 8.3.2 for more information on material parameters files. SimWindows will generate error messages if neither of these files is present. Both of these files should be present if the installation was successful. SimWindows will now display an introductory screen followed by the desktop window.

The following sections comprise a simple tutorial for SimWindows. It begins by outlining the basic interface of SimWindows. It will then explain how to load a device file, perform simulations, and generate output.

1.2.1 The SimWindows Desktop

The SimWindows desktop is the main window that will open files, perform simulations, and examine results. There are four major components to the desktop: the menu, tool bar, window area, and status bar. This section only describes these components in general and gives a brief tutorial on SimWindows.

Table 1 - List of SimWindows menu items

Pull-down menu	Purpose
File	File operation commands
Edit	Edit and search commands for device files
Environment	Modify environment parameters
Device	Modify device and simulation parameters
Plot	Produce and output plots
Data	Input and output misc. data
Window	Control layout of windows
Help	Display general information about SimWindows

With the desktop running, there are three items to observe. First, most of the menu items are disabled, since no devices are loaded. Once a device is loaded, SimWindows will enable most of the menu items. The menu is updated dynamically meaning that depending on which window is active or which options are selected, only valid menu options will be enabled. However, the File, Environment, and Help menu options are enabled because these do not depend on devices. Table 1 describes the menu items and their basic function. The second item to notice is that moving the mouse pointer over menu options with the left mouse button pressed, will cause SimWindows to display in the status bar at the bottom a hint associated with each menu item. The status bar not only displays help hints, but it also displays the current state of the Num Lock and Cap Lock keys on the keyboard. While editing files, the status bar also displays the line number of your cursor. The last item to notice is the tool bar. The tool bar contains buttons that will perform the same function as a particular menu item. Just like the menu, SimWindows updates the tool bar dynamically. When a menu option is enabled, its associated tool button (if any) will be enabled. SimWindows also displays help hints when mouse pointer moves over the various tool buttons.

1.2.2 Loading a Device

The first step in using SimWindows is to either load or create a “device file.” There are a number of example device files that come with SimWindows. The device file for this tutorial is comalgpn.dev which is a simple AlGaAs p-n diode. The examples\comments subdirectory for SimWindows contains this file. To load the device file, choose File|Open. This will display the Open File dialog box. The default extension for device files is DEV. Move to the examples\comments subdirectory and open the comalgpn.dev file. SimWindows will create a window which contains the text in the device file. The window itself is called the device window and is one of three kinds of windows that SimWindows uses. The first part of the window caption is “DEVICE FILE” which indicates that this window creates and edits device files. Device files are just ASCII files that contain a description of the device. They contain parameters such as the material, dimensions, and doping. SimWindows can edit many device files simultaneously and the options under the Edit menu can cut and paste selections from one device file to another. When SimWindows opens a file, it determines what type of file it is. There is only one kind of file, called a “state file,” that only SimWindows can read. This tutorial and section 8.3.4 will discuss more about state files. If the file is not a state file, then SimWindows will assume it is a text file and load it into a device window. Therefore, SimWindows can edit any kind of text file.

With a device file loaded into SimWindows, the Device|Generate menu option becomes enabled. To start simulating the comalgpn device, choose Device|Generate. If several device files are open, select the window containing the comalgpn device, then choose Device|Generate. When SimWindows generates a device, a number of things happen. First, SimWindows saves the device file to disk. If the file is a new file and untitled, SimWindows will ask for a new file name. If the file already has a file name, then it saves the file using the current file name. Note that this will overwrite the previous file. Second, SimWindows reads the device file, allocates memory and performs initial calculations. If there is a syntax error in the device file, SimWindows will display the line number of the error and the cause of the error. Third, SimWindows will iconify the device window and create a second window. The new window is a state window and is the second of the three important kinds of windows that SimWindows uses. The state window represents the state of the device. Lastly, SimWindows will enable most menu items. If everything was successful, the state window will display the message “Device successfully created.” The state window displays information during device simulations. Simulations are now ready to begin. The iconified device window serves no purpose from here on.

1.2.3 Performing Simulations

An important item to remember is that SimWindows always completely stores the present state of the device. Each new simulation begins from where the last simulation ended. SimWindows can simulate only one device at a time. It can also save the state of the device on disk. This is done by clicking on the state window and then choosing the File|Save As option. If the state has not been previously saved, then SimWindows will ask for a file name. The default extension for state files is STA. State files store all of the simulation results to let the user examine them later without performing the simulations over again. To open a state file, choose the File|Open option and choose the name of the state file.

The initial state of the comalgpn device is charge neutral. This is a non-physical state that SimWindows uses as the initial state for performing device simulations. To return to the initial state, select the Device|Reset option. The first physical state that SimWindows calculates is thermal equilibrium. Choose Device|Start Simulation and SimWindows will begin iterating. The state window shows the present operating conditions and then the iteration number as well as the corresponding numerical error for the iteration. Since solving for equilibrium requires only one variable (potential), the state window displays only one error value. By default the numerical error must be less than 10-8 before the iterations stop. The iterations will also stop if the iteration

number reaches the default value of 15. The error, maximum iteration number as well as other parameters are set using Environment|Preferences. When the iterations stop, the state window will display the result of the iteration (converged or not converged), the present device state, and the elapsed time. When the calculation is completed, various parameters are available by choosing Device|Device Information. To plot any position dependent parameter, select any of the options under the Plot menu. The next section gives more information on obtaining output.

To control the operating conditions (applied bias, optical input etc.) there are a number of menu options to choose. The simplest operating condition is an applied bias. To apply a 0.5 V forward bias, choose the Device|Contacts menu option. Since this is a pn diode (and not an np diode), a positive voltage on the left contact will forward bias the device. Enter 0.5 in the edit box label “Applied Bias (V)” and then press the OK button. Simulate the device by choosing Device|Start Simulation. SimWindows will begin iterating, but this time the state window will display three error values for the potential, the electron quasi-fermi level, and the hole quasi-fermi level.

One aspect of the fact that SimWindows always stores the present state of the device is that if it does not achieve convergence before it reaches the maximum number of iterations, just start the simulation again. SimWindows will continue from where it left off.

1.2.4 Generating Output

Plot windows are the third kind of window in SimWindows. The plot menu lists the various options associated with plots. Most of the options from this menu are only available when a device is loaded. The exception to this is the External Optical Spectra plot which SimWindows enables when the environment includes external optical generation.

Choose Plot|Band Diagram to see a band diagram of the comalgpn device. To change the scale for the x and y axes, either double click on the plot or choose the Plot|Scale menu option. This will activate the Scale dialog box for the selected plot. This dialog box accepts input for the minimum and maximum x and y values, and gives options for either a linear or logarithmic y axis. Three operations are also available for the y axis. The operations are either none, negative, or absolute value. These operations help to view values that can vary by many orders of magnitude but can also be positive and negative. The best example of this is the recombination rate. It is often desirable to view the recombination on a log plot, but this is problematic since the recombination rate can be both positive a negative. By default plots do not display zero and negative values on a log plot, but selecting either -y or abs(y) in the scale dialog box will display these values. An easier way to set the scale is to use the zoom feature. Click and hold the left mouse button on a plot, then drag a rectangle over the plot. The plot will zoom to the portion within the rectangle and display it in the entire plot area. To return to the automatic scale, choose the Plot|Auto-Scale menu item or press the ESC key.

The plot window can also yield actual numerical data in two ways. The first method is the trace window. Select a plot and then choose the Plot|Show Trace Window option. This will display a dialog box associated with the selected plot. When the mouse pointer moves across the plot, the trace window displays the x and y values for the closest data point. Note that each plot has its own trace window. If two plot windows are open, there is a separate trace window for each plot. The second way to obtain data from a plot is to select the plot and choose the File|Save option. SimWindows will ask for a file name and then write the x and y values to the file. The format of the file is comma delimited columns that any typical spreadsheet program can load for further analysis.

When plots are visible and SimWindows simulates a device, it also updates the data in the plots automatically to reflect the new results. To prevent this, choose Plot|Freeze Plot. The plot is now frozen with the current data. This feature is useful for displaying two plots of the same quantity for different states of the device - different voltages for example. To update a frozen plot, click on the plot window and choose Plot|Melt Plot.

1.2.5 Summary

This section has presented a basic look at the functionality of SimWindows. There are a number of items to keep in mind while using SimWindows:

1. Use SimWindows intelligently. It is a software tool just like any other program. If there are problems obtaining convergence, then there may be a problem with the program. The problem may also be related to the nature of the device. For example using too few grid points can cause convergence problems. Play around with your device and submit a bug report if nothing seems to help.

2. Play with SimWindows: There are many subtleties about the user interface that will appear with experience. Submit a bug report if there are suggestions on improving the interface.

3. Be careful when saving: Remember that there are three kinds of windows (device, state, and plot). The File|Save and File|Save As work differently for each one. For a device window, SimWindows saves the device file. Likewise, SimWindows saves the state file when the state window is active. It will save the plot data when a plot window is active.

4. SimWindows always stores the present state of the device: Any time it performs a simulation, it starts from the end of the last simulation. To start from the beginning, choose the Device|Reset option.