Xpower User's Guide

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Documentation Conventions

`Courier` typeface is used to illustrate command syntax, command names, and signal names.

`Courier bold` typeface illustrates user input, the names of buttons in dialog boxes, and the names of bar menu buttons.

Italic type is used to indicated keyword-fields in commands and file names.

<key> (angle brackets surrounding this typeface) identifies a function key or a special keyboard key.

[] right braces identify optional items in commands and description statements.

Xpower Users Guide

Overview

The Xpower program estimates the dynamic power consumption a CMOS circuit for a specific test stimulus sequence. It uses signal state history and loading information supplied by the SIMIC logic simulator. This information is scanned, and the energy consumed per test is calculated by summing the number of nodes that undergo state transitions, where each node is weighted by its capacitive loading.

Xpower displays dynamic power consumption utilizing X-window[1] graphics, and optionally generates a corresponding PostScript[2] description for subsequent printout. It displays this information in two ways, one showing the power distribution for the entire stimulus sequence, and the other showing the power dissipation for a selected set of test vectors. The latter display can be panned or zoomed to change the selected set of tests to be viewed. In each window, the average for the data in the display is indicated. A window can be summoned that reports the average power consumption and the test where maximum power consumption occurs.

In order to use Xpower, SIMIC History and Query Loading files must have been created in a prior SIMIC session.

Power Consumption

Xpower computes dynamic power consumption in **normalized** units of **mW/MHz**. This section describes the computed value, the scaling factors you should use to obtain actual dynamic power consumption, and other types of power consumption not addressed by Xpower.

Xpower Normalized Values

Dynamic power consumption is calculated from the capacitive energy stored and retrieved at each node whenever a signal transition occurs. This energy is calculated using the formula:

$$E = \frac{1}{2} \times C \times (\Delta V)^2 \qquad (1)$$

where C is the nodal capacitance, and ΔV is the high to low (or low to high) change in voltage, which is usually the supply voltage, Vdd. This formula is valid as long as the charging time is sufficiently greater than the effective RC time-constant for the node, which is generally the case.

Xpower assumes that capacitive loading is expressed in **farads** and that Vdd is **5 volts**. If this is not the case, the actual values can be entered (see *Modifying Calculation Parameters* on page 14).

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1. The X Window System is a trademark of Massachusetts Institute of Technology.
2. PostScript is a registered trademark of Adobe Systems Inc.

The normalized total power consumption computed by Xpower is:

$$P_n = \frac{\displaystyle\sum_{t=1}^{N} \sum_{\substack{i \in \text{ active} \\ \text{nodes in test } t}} E_i}{N} \times 10^9 \qquad (2)$$

where:

P_n is the normalized power consumption.

E_i is the energy stored or retrieved at the i-th active node in Test t (from Equation 1).

N is the total number of test stimuli.

The 10^9 factor scales power from watts to milliwatts (10^3) and normalizes time to μsec (10^6).

Obtaining Actual Power Consumption

To obtain the actual dynamic power consumption from the normalized value, use the formula:

$$P = P_n \times F_n \times \frac{\text{tests}}{\text{cycle}} \qquad (3)$$

where:

P   is the actual power consumption in milliwatts

P_n is the normalized power consumption reported by Xpower (from Equation 2)

F_n is the normalized master clock frequency in Mhz (e.g., if the master clock frequency is 7Mhz, then $F_n = 7$)

tests/cycle is the number of test stimuli corresponding to a single master clock cycle.

Equation 2 implicitly assumes a correspondence between test duration and master clock period. If the master clock is defined as a timing generator having RZ (return-to-zero) format, then each test period corresponds to a single clock cycle, and the *tests/cycle* multiplier should be 1. If the master clock is defined as a timing generator having NRZ (non-return-to-zero), then two test periods could correspond to a single master clock cycle, and *tests/cycle* should be 2.

If simulate-until-stable or waveform mode stimuli were used in the simulation, then *tests/cycle* would be at least 2, since this is the minimum number of tests required for each clock pulse's rising and falling edges. In general, as long as the master clock is periodic, this multiplier can be obtained from the formula:

$$\frac{\text{tests}}{\text{cycle}} = \frac{N}{N_{CL}} \qquad (4)$$

where:

N is the total number of test stimuli in the simulation

N_{CL} is the total number of clock cycles in the simulation.

If the clock signals are aperiodic, or if the circuit is asynchronous, Equation 5 should be used in place of Equation 3 (this equation is valid for all situations):

$$P \ = \ P_n \ \times \ \frac{N}{T_{sim}} \hspace{3cm} (5)$$

where:

    N   is the total number of test stimuli in the simulation

    T_{sim} is the total simulation time interval in μsec.

Other Sources Of Power Dissipation

Xpower filters out the energy dissipation contributions from external sources, i.e. primary inputs and bidirectional pads. In addition, through a command file, the user can indicate other signal transitions that need to be discounted. There are a few other contributions to power dissipation that Xpower does **not** take into account:

    (1)   Power consumption due to leakage current. In low frequency circuits, static leakage currents may cause a continuous power dissipation that is comparable in magnitude to the dynamic component. This leakage current is usually calculated by summing values found in the data sheets for each instantiated cell.

    (2)   Transient I^2R dissipation due to transistor switching times. When CMOS circuits undergo a state transition, there may be a time where pullup paths to Vdd and pulldown paths to ground connected to the same node are conducting simultaneously, allowing a low resistive path for current to flow. Except for heavily-loaded gate inputs with high slew rates, this current is normally of short duration compared to the capacitive dynamic currents.

    (3)   Spikes and other transient phenomena. The importance of glitches and narrow pulses grows with increasing operating frequency. These effects are very difficult to properly account for without precise analog simulation of the devices.

    (4) I^2R dissipation due to conduction paths through pullup and pulldown resistors.

Generating SIMIC History Information

SIMIC's `history` command controls the creation and content of the history files. Two files are created, with file extensions `hig` and `his`. This section contains a brief synopsis of the `history` command.

The `history` command must be issued to SIMIC prior to the `simulate` command. The format of the `history` command is:

        `history` *list* [*file*] [*prange*]

where:

    list is either:

    (a)   `LIST:` – specifying all signals are to be included in the history information, or

    (b)   `LIST=`*listofsignals* – *listofsignals* is a list of signals separated by commas or

whitespace, specifying which signals to include in the history information. Note that SIMIC wildcarding and Meta-signals (&INPUTS, &OUTPUTS, &BUSINS, &BUS-SES) for primary inputs, outputs, bus-inputs and bus-outputs respectively, are allowed.

file is an optional keyword field consisting of either:

(a) `FILE:` – indicating that the default file name is the name to use for the history files, or

(b) `FILE=`*filename* – *filename* is the name to use for the history files.

If *file* is omitted, `FILE:` is assumed.

prange is an optional keyword field consisting of the keyword `PRANGE=` followed by a list of stimulus ranges. This is used to suppress history information during portions of the simulation that are not of interest, thus reducing the size of the history files. If *prange* is omitted, then no history information will be suppressed during the simulation.

For example, the SIMIC command:

history list: file=mychip

causes all signal activity to be written to the files `mychip.hig` and `mychip.his` for the entire simulation.

Power consumption calculations will only be applied to the signals found in the history and loading files. In this way, sections of the chip can be analyzed independently.

For further information on the `history` command and its options, see the SIMIC User's Guide.

Generating The Query Loading File

The Query Loading file is an ascii file containing loading information in the following format:

node_name: Loading= *value*

where

node_name is the name of the node that the corresponding loading *value* is to be applied to.

value is any positive (or zero) real number.

For example:

ABEUR: Loading= 1.072

assigns the loading of 1.072 capacitive units to the node named `ABEUR`. The simplest method of generating this file is to let SIMIC do it for you. After loading in the circuit and backannotated loading (if required) with the SIMIC `GET` command, issue the Query loading command with the *file* option using the following format:

`?loading` *list file*

where:

list is either:

(a) `LIST:` – specifying all signals are to be included in the loading information, or

(b) `LIST=`*listofsignals* – *listofsignals* is a list of signals separated by commas or whitespace, specifying which signals to include in the loading information. Note that

SIMIC wildcarding and Meta-signals (&INPUTS, &OUTPUTS, &BUSINS, &BUS-SES) for primary inputs, outputs, bus-inputs and bus-outputs respectively, are allowed.

file is a keyword field consisting of either:

(a) FILE: – specifies that the loading file should have the default file name and the default extension qry, or

(b) FILE=*filename* – *filename* is the name to use for the query file (if this name does not specify a file extension, the default extension qry is implied).

The *list* keyword option should be identical to the one used in the companion history command.

For further information on the Query loading (?loading) command and its options, see the SIMIC User's Guide.

Details Of The Xpower Environment

Correcting Typographical Errors

Several options are specified to Xpower by typing them in dialog box windows. If you make a mistake while typing, the error can be corrected by using the left and right arrow keys to position the character cursor to the error (if necessary), the <Delete> key to delete the character *under* the cursor, and the <Backspace> key to delete the character *to the left of* the cursor. Also, typing with the cursor positioned inside the text overwrites the text to the right of the cursor. You may insert text instead by pressing the <Ins> (Insert) key. The dialog box window will remain in insert mode until the <Ins> is pressed again, or until the dialog box window is closed.

Case Sensitivity

All keyboard input in dialog box windows is case sensitive.

Mouse Buttons

Certain Xpower operations require use of the mouse. One of the buttons, called the SELECT button, performs special functions, such as setting input focus for user input. Typically, the SELECT button would be the left mouse button, but this is not always the case; thus, experimentation may be necessary for some systems.

Dialog Box Text Entry Windows

Some dialog boxes, such as the **Filename** dialog box illustrated in Figure 2, have multiple windows for entering text. One of the text entry windows will have input focus, that is, will be highlighted and ready to accept keyboard input. In order to set the input focus to a different text entry window, move the mouse cursor into the text entry window and press the mouse SELECT button.

Option Buttons

Option buttons are buttons that support multiple actions. For example, the **Signal Select Box** contains two option buttons, one of which is illustrated in Figure 1(see the Section *Selecting Signals For Analysis* for a description of this button's options). As shown in Figure 1(a), an option button's label displays the action that will be performed if the button is "pressed"; in this case, **Select Filtered**.

<div align="center">(a) An Option Button   (b) An Option Button Menu</div>
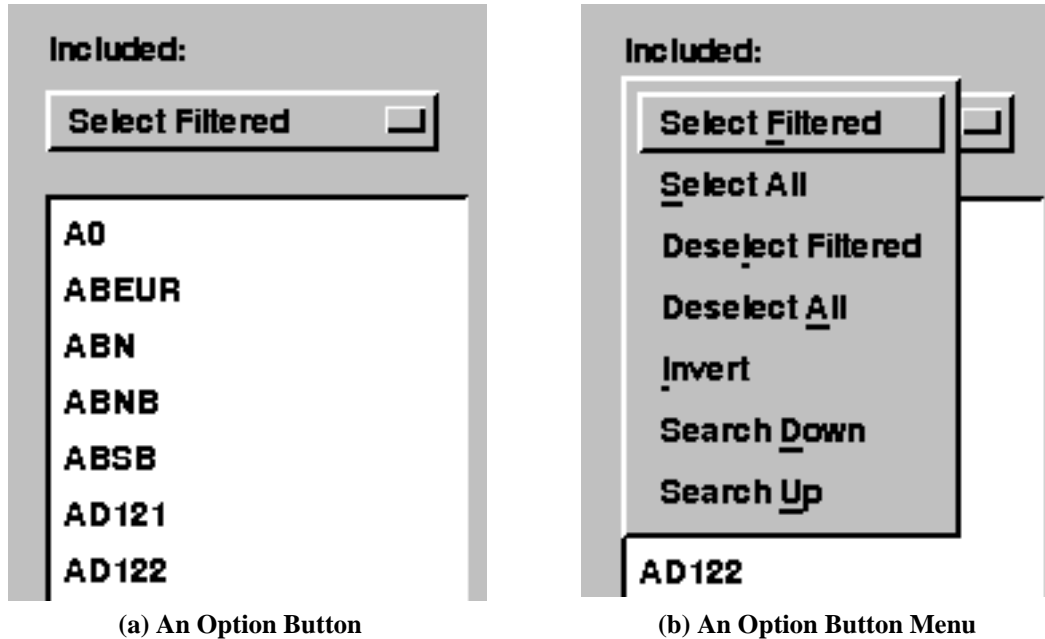
Figure 1 An Option Button and Its Menu

When the option button is "pressed", its menu of possible actions pops up over the button, with the action corresponding to the button's label selected, as shown in Figure 1(b). Releasing the mouse's SELECT button will cause the action to be performed (**Select Filtered** in this example). If, instead, the mouse cursor is dragged vertically through the pop up menu to another action before the SELECT button is released, this other action (e.g., **Invert**) will be performed, and subsequently will become the option button's label. If the mouse cursor is dragged outside the pop up menu before the SELECT button is released, then *no* action is performed. In all cases, the menu disappears when the SELECT button is released.

Alternatively, "pressing" the rectangular knob inside the option button causes the pop up menu to appear and remain on the screen. Selection can then be made either with the mouse, as above, or with the keyboard by (a) typing the single character underlined in each menu item (**f**, **s**, **l**, **d**. or **i** in this example) or (b) using the keypad up and down keys to move along the menu and pressing the <Return> key to perform the selected action. The pop up menu can be dismissed without making a selection by clicking the mouse SELECT button anywhere outside the menu.

Starting Xpower

Xpower is invoked with the system command:

> Xpower [*-c command*] [*history* [*loading*]]

where:

command is the full name of the command file.
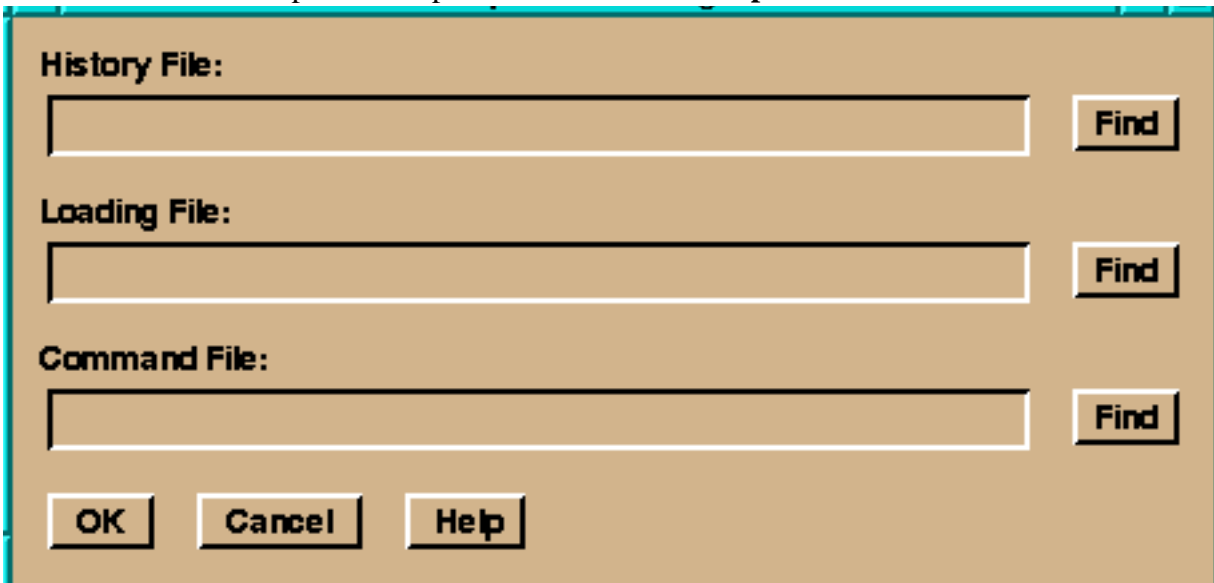
history   is the common name of the history files, possibly containing their path name if these files are not in the working directory.

loading   is the full name of the loading file.

If the loading file has the same name as the history files and its extension is qry, then the *loading* argument is optional. For example, if the names of these files are mychip.hig, mychip.his, and mychip.qry, then Xpower could be invoked with the command:

> **Xpower mychip**

If the history file name is not specified in the command line, Xpower will display the **Filename Dialog Box** shown in Figure 2, requesting the common name of the history files. Enter this name in the **History File** text entry window, as shown in the figure. If the loading file has the same name and its extension is qry, the loading file need not be specified; otherwise, specify its full name in the **Loading File** text entry window. Optionally, a command file can be specified in the **Command File** text entry window. Press the **OK** button to accept the entered filename(s), or the **Cancel** button to exit Xpower. Help is available via the **Help** button.

Figure 2 Filename Dialog Box

If Xpower cannot find the specified history files, it displays the **Correct History File Name** dialog box shown in Figure 3(a). If it cannot find the loading file (either explicitly specified or implied from the history files' filename), it displays the **Correct Loading File Name** dialog box shown in Figure 3(b). If it cannot find the command file, it displays the **Correct Command File Name** dialog box shown in Figure 3(c). Placing the cursor over the **OK** button and clicking the SELECT mouse button causes the **Filename Dialog Box** to appear for re-specifying the file names. Clicking the SELECT mouse button with the cursor over the **Cancel** button causes Xpower to exit.
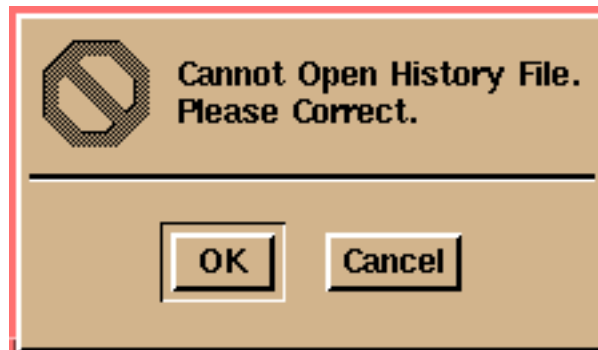
Figure 3(a) Correct History File Name Dialog Box
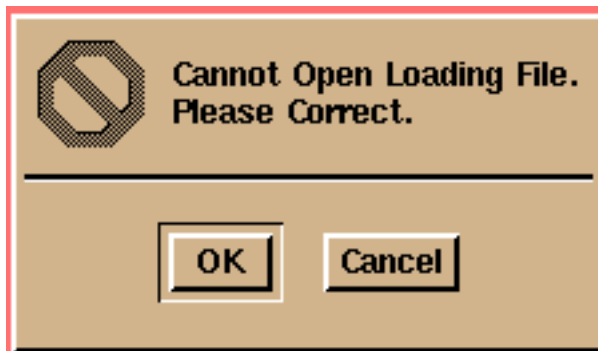
Figure 3(b) Correct Loading File Name Dialog Box
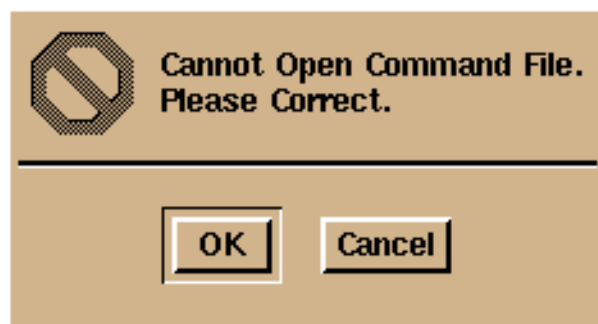
Figure 3(c) Correct Command File Name Dialog Box

To the right of each text entry field is a **Find** button. Pressing the **Find** button brings up a **File Selection Dialog Box** for the corresponding file type. This Dialog box allows you to browse for existing files, and optionally select the entry for the corresponding file in the **Filename Dialog Box**. The **History File Selection Dialog Box** is shown in Figure 4; the **Loading** and **Command File Selection Dialog Boxes** are similar. This Dialog box contains a number of panels.
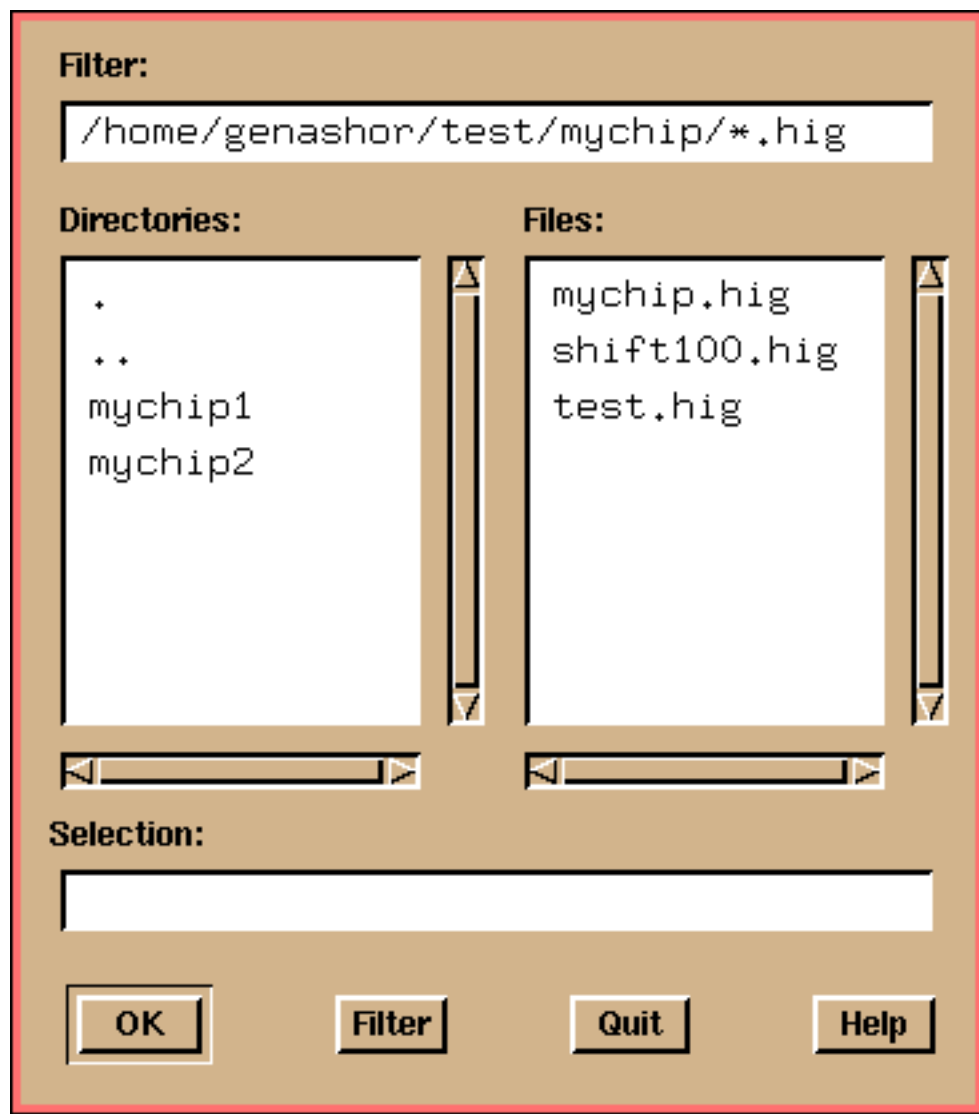
Figure 4 File Selection Dialog Box

The **Filter** panel displays the path to the directory and the search filter for the files in this directory. In this search filter, `*` and `?` are wildcards; an asterisk (*) specifies that *any* sequence of characters will match, and a question mark (?) specifies that any *single* character at the position of the question mark will match. For example, the path displayed in Figure 4 is `/home/gena-shor/test/mychip/` and the file search filter is `*.hig`, which specifies that all files in this directory whose names end with `.hig` should be included in the **Files** list. In general, only the directory portion of the **Filter** string should be modified (however, the file filter could be changed

to `*.his`, which would also create an acceptable list of history files for selection). In order to enable the modified filter, you must press the **Filter** button on the bottom of the Dialog box.

Below the **Filter** panel are two scrolling lists, labeled **Directories** and **Files**. The **Directories** list shows the directories found in the current **Filter** path. Note that ".", specifies the current directory, and ".." specifies the parent directory. Selecting one of the directories in this list causes that directory to become the current one. Selection can be made with the keyboard by positioning the cursor over the selection and pressing the <Return> key, or with the mouse by double clicking on the proper directory. The **Files** list displays the files in the current directory that match the filter. Note that in Figure 4, only the `.hig` files are displayed, since they are the only files that match the "`*.hig`" filter. Selecting an item from this list will cause it to be displayed in the **Selection** panel. The **Selection** panel contains the currently selected file. You may enter a filename directly here, rather than using the above method; entries of the form `filename`, `filename.hig`, and `filename.his` are all acceptable. Once this panel contains the file you want, pressing the **OK** button will select the history files, but they will not be read until the **OK** button of the **Filename Dialog Box** is pressed. Pressing **Quit** at any time will dismiss the **File Selection** Dialog box. Pressing **Help** provides some on-line help information about opening the history files.

Exiting Xpower

To exit Xpower, select **File** in the bar menu (see *Selecting Items In The Bar Menu Area* below). This causes the **File** item's pulldown menu to appear, as shown in Figure 5. Then, select **Exit** to quit the program.
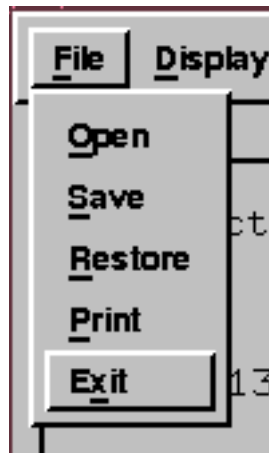
Figure 5 File Item's Pulldown Menu

The Xpower Display

As shown in Figure 6, the Xpower display contains three main areas:

    (1)   At the top is a **bar menu** with selections for: **File**, **Setup, View, Signals, Info**, and **Help**.

(2)   Directly below this menu is a **dissipation graph area**. This area is used by Xpower to display the dynamic power consumption for each test. A dotted reference line shows the average power consumption level; however this average is taken over the displayed area, not over the complete test stimulus set.

(3)   Below the **dissipation graph area** is a **scroll bar** used to scroll the graph horizontally.

The initial size of the Xpower display is the default size; it cannot be made any smaller. However, its size can be increased. To resize the display, move the mouse cursor to one of the resize handles, located at the outside corners of the display's border (the cursor changes shape when it is over the handle). Then, press the SELECT mouse button and drag the resize handle until the display attains the desired size. The initial size and placement and a variety of other display preferences can be set from the X-resource file (see *X-Resources Used By Xpower* on page 29).

At the start of the program, the full simulation history is analyzed and displayed in the graph area, as shown in Figure 6.
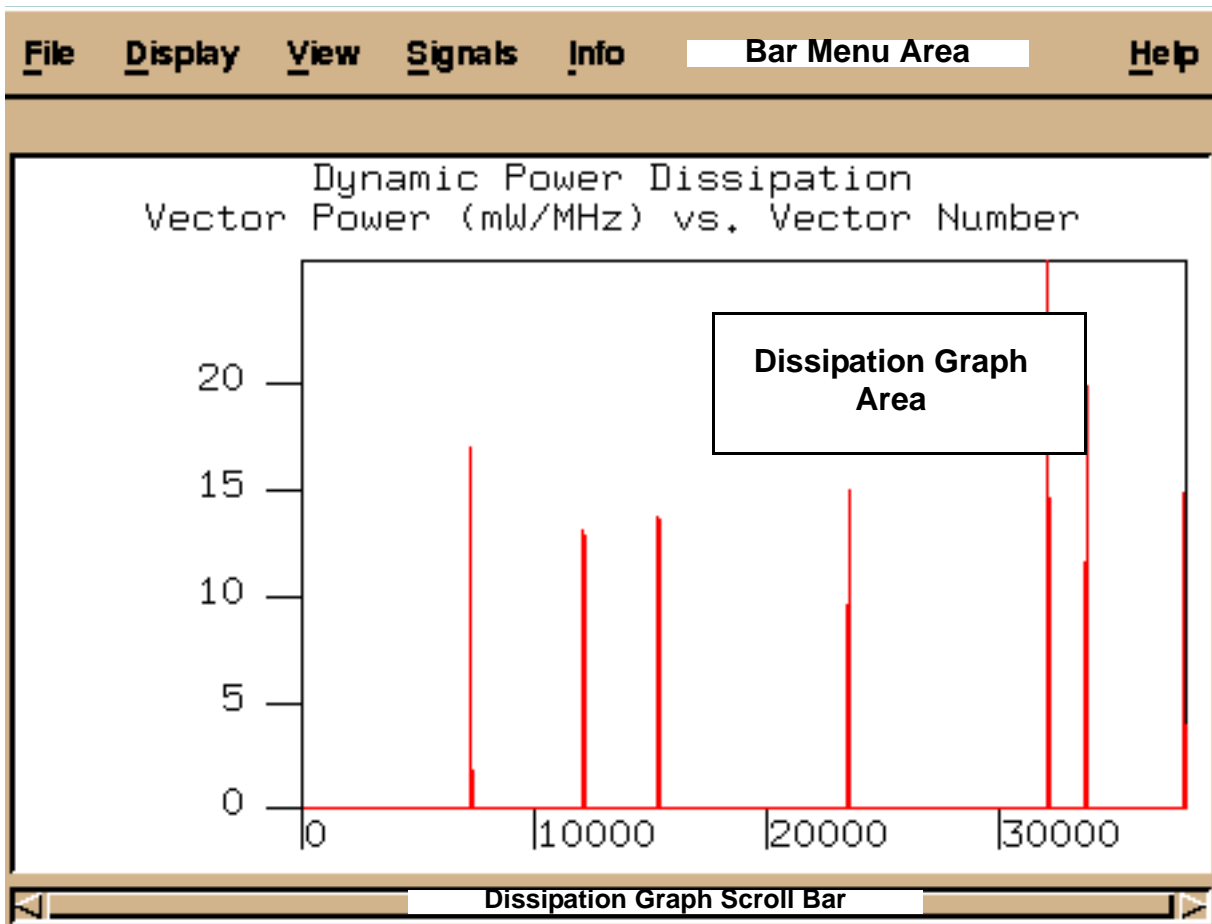
Figure 6 The Xpower Display

Selecting Items In The Bar Menu Area

The bar menu has five items for selection: **File, Display, View, Info**, and **Help**. Each item can be selected by pressing the SELECT mouse button while the mouse cursor is over the item. Alternatively, the <F10> key will select the bar menu. Items in the bar menu can then be selected either by pressing the key corresponding to the underlined letter of the item, or by using the left/right arrow keys. You may use the down arrow to display pulldown menus and then the up/down keys to walk the items in the pulldown menu. The menu items are selected by pressing the <Return> key. Pressing <F10> again will deselect the bar menu, as will clicking the SELECT mouse button anywhere outside the pulldown menu.

Panning And Zooming The Dissipation Display

Panning Using The Scrollbar

The scrollbar underneath the dissipation area can be used to pan through simulation tests. Referring to Figure 7:

(a)   Clicking any mouse button with the cursor over the left arrow causes the dissipation display to move backward one test.

(b)   Clicking any mouse button with the cursor over the right arrow causes the dissipation display to move forward one test.

(c)   Clicking any mouse button with the cursor between the left arrow and the slider causes the dissipation display to move backward one screen.

(d)   Clicking any mouse button with the cursor between the slider and the right arrow causes the dissipation display to move forward one screen.

(e)   Pressing any mouse button with the cursor over the slider, and then dragging the slider with the mouse button still pressed, causes the dissipation display to move in that direction.

Note: In (a) through (d) above, pressing the mouse button instead of clicking it causes continuous motion.

Figure 7 Scrollbar

Zooming Using The Mouse Or Zoom Menu

The mouse can be used to zoom into a range of tests and display power dissipation only for these tests. This is accomplished by moving the mouse cursor to the starting (first) test to be displayed, pressing and then holding the mouse SELECT button while dragging the mouse cursor to the ending (last) test to be displayed, and then releasing the button.

Zooming in or out can be done by pressing **View** in the bar menu and selecting one of the following options in the **View** menu:

    (a)   **Full** zooms out to encompass all tests.

    (b)   **Range** zooms into a specified range (see below); no less than two tests, and no more than all tests.

    (c)   **In** zooms in by a factor of two, but displays no less than two tests.

    (d)   **Out** zooms out by a factor of two, but displays no more than all tests.

If **Range** is chosen, a **Range Popup** window will be displayed, as shown in Figure 8. After making the desired entries in the **Starting Test** and **Ending Test** entry windows, pressing the **OK** button will update the display's test range. Pressing the **Cancel** button causes any changes in the entries to be ignored. If an entry is invalid for the starting or ending test when the **OK** button is pressed, then the appropriate warning panel will be displayed.
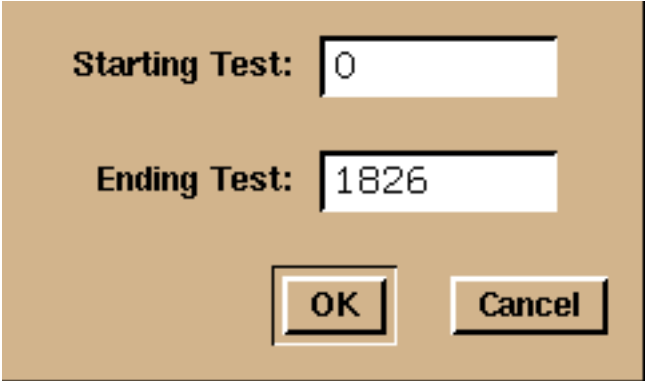
Figure 8 Range Popup

Panning And Zooming Using Action Keys

In addition to the methods described above, panning and zooming can be accomplished by the use of designated keys, pressed while the mouse cursor is focused in the dissipation graph area. These keys are listed in Table 1.

Table 1: List of Action Keys

Key	Description
f or F	Zooms display to full view.
l or ^\<Left\>	Pans display backward one test.
L or ^\<Left\>	Pans display backward one screen.
r or ^\<Right\>	Pans display forward one test.
R or \<Right\>	Pans display forward one screen.

In the table, "**^**" means "simultaneously hold down the **\<Control\>** key", **\<Left\>** is the left arrow keypad key, and \<Right\> is the right arrow keypad key.

Note: Holding any of these keys for an extended period will cause repeated action.

Modifying Calculation Parameters

You may modify the two global parameters that effect the computation of power by selecting **View** in the bar menu and then selecting **Setup** in the **View** menu. This will popup the **Display Entry Dialog Box** shown in Figure 9.

Figure 9 Display Entry Dialog Box

There are two value entries in this form: **Vdd** and **Capacitance Scale**. These parameters are used to calculating the energy saved and retrieved in capacitive nodes (see *Calculation of Normalized*

Power Consumption). By default, **Vdd** is 5 volts and **Capacitance Scale** is 1×farads. One of the two entry windows will have input focus, that is, its border will be highlighted and it will be ready to accept keyboard input. To modify the contents of the other entry window, move the cursor into the entry window and click the mouse SELECT button. After making the appropriate modifications, "press" **OK** to accept the entries, or **Cancel** to abort changing these parameters.

An alternative method of modifying these defaults is to use the appropriate commands into the command file. The **vdd** statement will override the default value, and the **capscale** statement will override the default capacitance scale. The format for these commands can be found in Table 4 on page 32.

The **Average Markers** check box below the text entry windows allows you to turn on or off the average line marker in the dissipation or distribution graph windows.

Selecting Signals For Analysis

You may decide to look at an isolated area of the design for more detailed analysis. Xpower offers a method for selecting which signals to include or exclude from the analysis. This mechanism is independent of the automatic suppression and command file suppression defined in later chapters. If the **Signal** button is pressed on the bar menu, the Signal Select Dialog is displayed as shown in Figure 10.
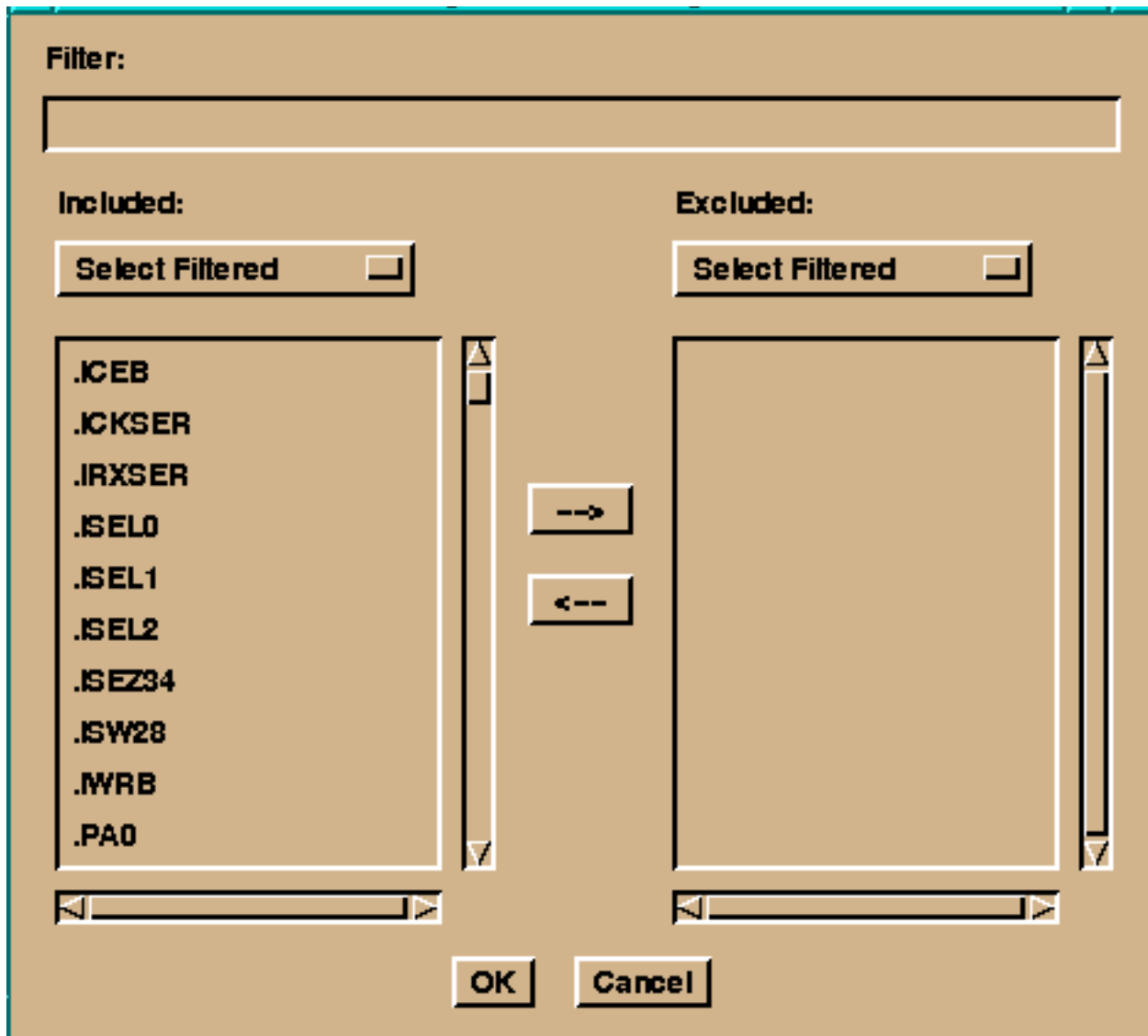
Figure 10 Signal Select Dialog

The **Filter** text entry section at the top of the form allows a regular expression to be entered to match entries in the scrolling lists below. Which scrolling list that the filter corresponds to depends on which options button (included or excluded) is used.

Regular expression is zero or more decision branches, which are separated by a '|'. A regular expression will match any signal that matches any one of the branches.

A branch is one or more pieces, concatenated together. A match is made if all the pieces match.

A piece is an atom, possibly followed by a '#', '+', or '@'. An atom is a regular expression within parenthesis, a range contained within '<' and '>' characters, a '$', or a '\' followed by any single character.

A range sequence is a sequence of characters enclosed in '>' and '>' characters, it normally matches a single character from this sequence. If the sequence begins with '^' then it will match a single character not from this sequence. If two characters are separated by a '-', then this specifies all characters from the first character, to the second, in ASCII sequence. For example, <0-9> will match any digit character.

Table 2 below lists all the meta characters allowed in regular expressions:

Table 2: Regular Expression Meta Characters

Character	Description
$	Matches any single character.
< >	Delimits a list of acceptable match characters. The list may include a range, such as a-z (to represent all lowercase letters). "ha<td>" will match the signals "hat" or "had".
*	Matches any sequence of characters. "a*b" will match any signal that starts with the character "a" and ends with the character "b", including a signal called "ab".
#	Matches zero or one occurrences of the previous character or expression group. "(ab)#d" will match "d", "abd", etc.
+	Matches one or more occurrences of the previous character expression grouping. "a+b" will match "ab", "aab", "aaab", etc.
@	Matches zero or more occurrences of the previous character."a#b" will match "b", "ab", "aab", etc.
( )	Delimits an expression grouping.
|	Logical Or of expression grouping. "(ab | cd)efg" will match the signals "abefg" and "cdefg".
\	Escape character causing the next character is to be used literally. The "\" must be used to specify any of the meta characters described in this table to represent themselves. "a\$b" will match the signal "a$b", but "a$b" will match "a0b", "a.b", etc.

Each option button has the options: **Select Filtered**, **Select All**, **Deselect Filtered**, **Deselect All**, **Invert**, **Search Down**, and **Search Up**.

Select Filtered selects all signals in the corresponding list that match the regular expression in the **Filter** text field.

Select All selects all signals in the list.

Deselect Filtered de-selects all signals that match the regular expression in the **Filter** text field.

Deselect All deselects all signals in the list.

Invert will make all selected signals deselected, and all deselected signals selected.

Search Down will look for a match for the regular expression in the **Filter** text field from the current cursor position, to the end of the list. If the match is not displayed, then the list will scroll to show the match.

Search Up will look for a match for the regular expression in the **Filter** text field from the current cursor position, to the start of the list. If the match is not displayed, then the list will scroll to show the match.

Once you have chosen which signals in the list to move, pressing the appropriate arrow box located between the lists, will move the selected signals to the appropriate list. When you have finished splitting the signals as needed, you need to press the **OK** or **Apply** button to update the analysis. Pressing **OK**, will dismiss the Signal Select Dialog box, whereas **Apply** will not. If you decide not to update the analysis, press the **Cancel** button, which reverts all selections since the last apply, and dismisses the Dialog box.

Signals that have been suppressed by the command file (discussed later), take precedence over the included/excluded attributes set in the Signal Select Dialog box. You may save the suppressed and excluded signals to a file by selecting the **Save** button in the **File** bar menu. This can later be restored by using the -c command line switch, or the **Restore** button in the **File** bar menu shown in Figure 11:
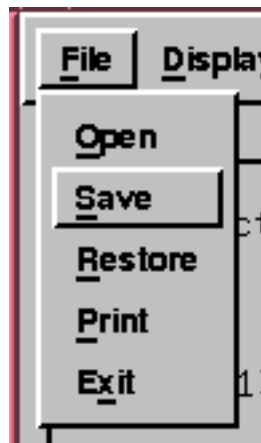
Figure 11 The Save and Restore Command Menu buttons.

Requesting Summary Statistics

A popup window can be summoned that displays the current parameter settings and summary information on the range of test stimuli currently being viewed in the **dissipation graph area**, the average power consumption, and the test at which maximum power consumption occurs. This popup window, the **Summary Statistics** window, is brought up by selecting the **Statistics** item in the **Display** menu. To dismiss the window, "press" the **Close** button in the window.

Figure 12 illustrates the **Summary Statistics** window for the display of Figure 6.


```
Capacitance is scaled by 1e-12
Vdd is 5 Volts
1148 Tests displayed
345140 Transitions analysed
Power Usage:
   Average is 6.45823 mW/MHz per test
   Maximum is 25.6588 mW/MHz at test 32039
```

Close
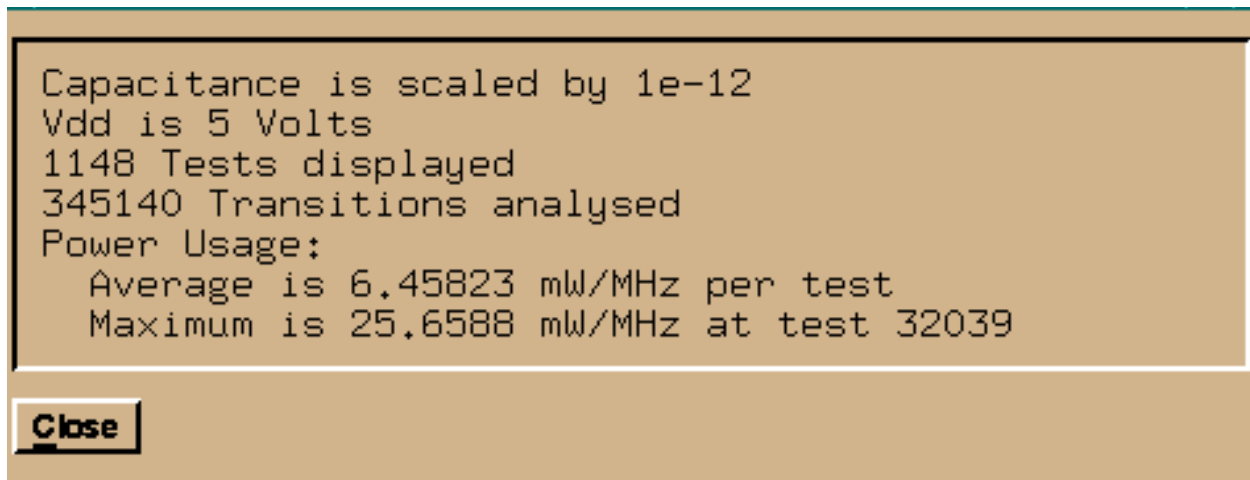
Figure 12 Summary Statistics Display

Displaying The Distribution Graph

The Distribution Graph displays the number of tests found at each power level within the range of tests viewed in the **dissipation graph area**. It can be brought up by selecting the **Distribution** item in the **Display** menu. To dismiss the window, "press" its **Close** button.

Figure 13 illustrates the **Distribution Graph** window for the display of Figure 6.

Figure 13 Distribution Graph Display

Generating A Report

A report in textual or PostScript format can be sent to a file or printer by selecting the **Print** item in the **File** menu, as shown in Figure 14 below.
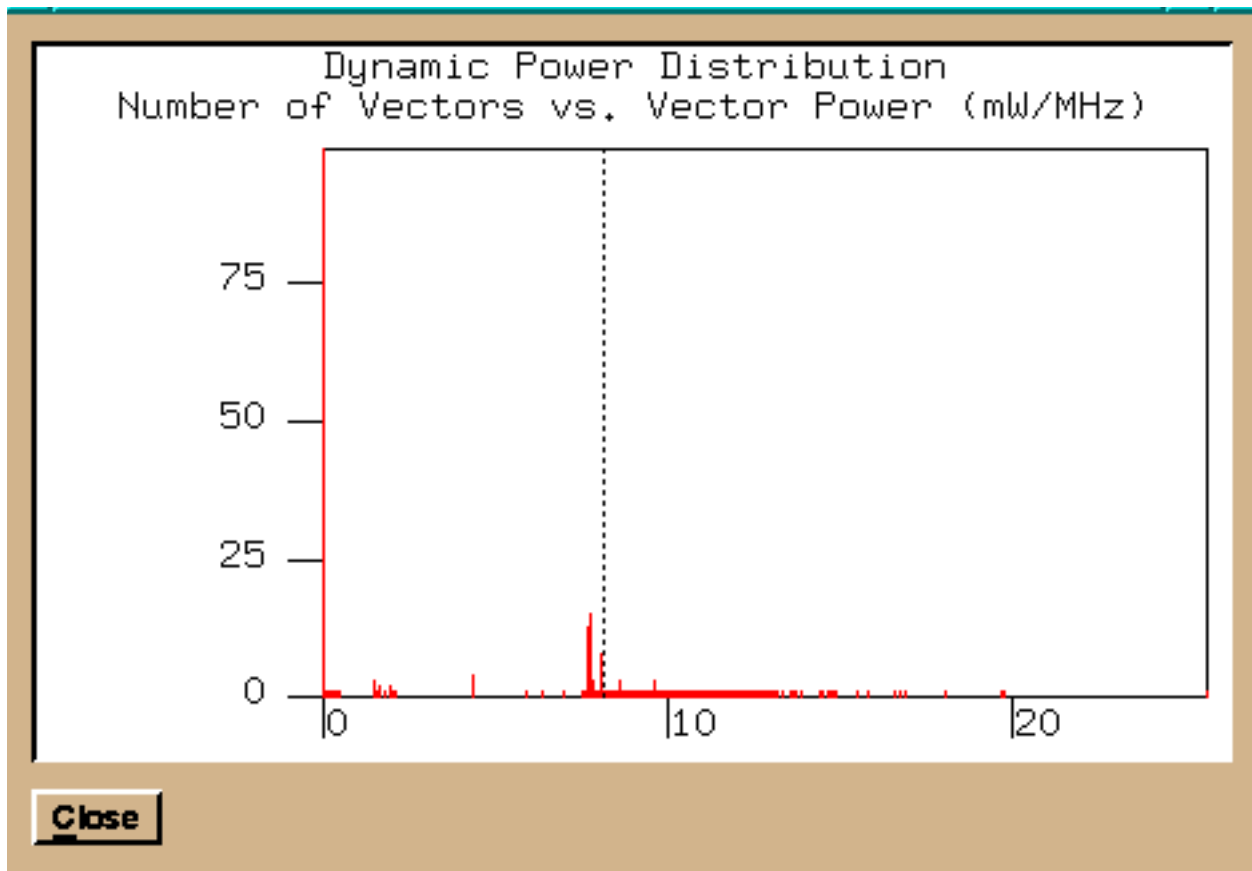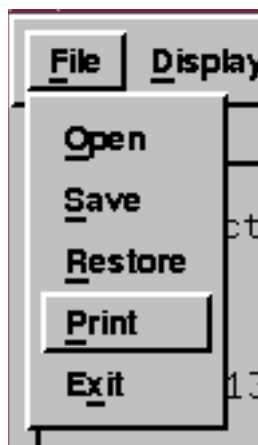

Figure 14 Print Item in File Menu

Xpower will then display the **Print Dialog Box** shown in Figure 15. Near the top of the dialog panel is a text entry window, which can be used to qualify the **Destination**. If the **Destination** selected is **Printer**, then you can use the text entry window to specify the name of the printer; if left blank, the default printer for your system is used. If the **Destination** selected is **File**, then you can use the text entry window to specify the name of the file; if left blank, the history file name, with the extension **.ps**, is used.

Selecting **PostScript** in the **Output Format** box will cause the output to be in the PostScript language, describing the dissipation and distribution data as graphs similar to the window displays. Selecting **Ascii** will choose output in standard Ascii text format with the dissipation and distribution data in tabular form.

Selecting **US Letter** in the **Output Size** box will size and offset the PostScript output for the US letter standard 8.5 X 11 inch paper. Selecting **A4** will size and offset the PostScript output for the A4 standard 210 X 297 mm paper.

The **Output Orientation** box orients the page for PostScript output. Selecting **Portrait** will orient the page so its vertical edge is along the paper's long dimension. Selecting **Landscape** will orient the page so its vertical edge is along the paper's short dimension.

If your PostScript Printer, or display, can handle color, then a color can be chosen for the graph displays. This is accomplished by selecting a color in the **Graph Color** box.

The **Output Contents** box allows you to select the information to be put into the report:

    (a)   Selecting **Header** causes header information to be included in the report. The header information includes the title, the type of stimuli, the number of tests per cycle, the range of tests analyzed, and the voltage used in the calculation.

    (b)   Selecting **Statistics** causes the statistical information to be included in the report in a tabular format and grouped by output-only nodes, internal-only nodes and total nodes. This information includes the number of nodes, the average node capacitance, the average power, and the maximum per-test power dissipation.

    (c)   Selecting **Distribution** causes the distribution data to be included in the report.

    (d)   Selecting **Dissipation** causes the dissipation data to be included in the report.

    (e)   Selecting **Average** causes the average power lines to be included in the PostScript dissipation and distribution graphs.

    (f)   Selecting **Logo** causes the Genashor Logo to be included in the PostScript Report

.
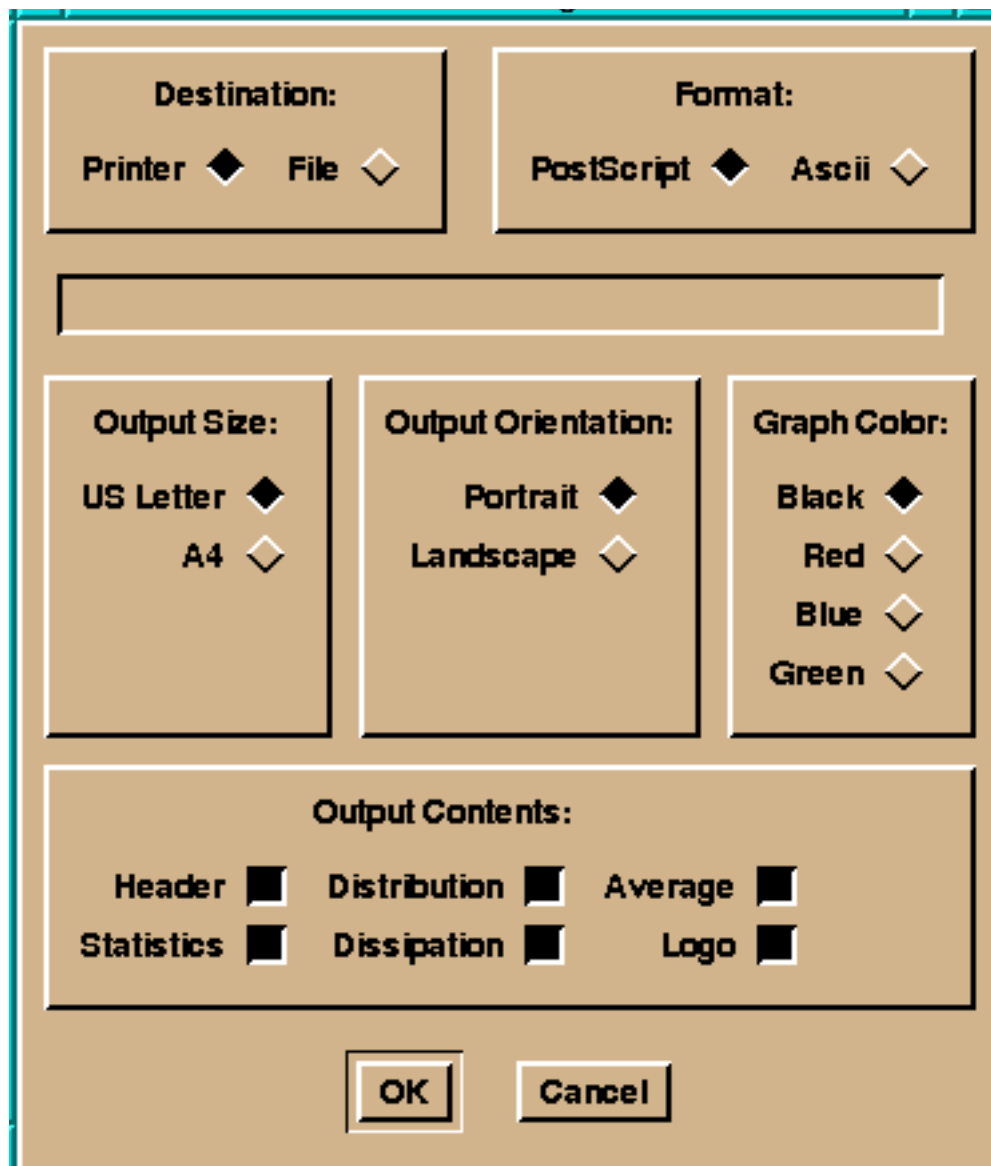
Figure 15 Print Dialog Box

If the file specified in the text entry window already exists, Xpower brings up the dialog box
shown in Figure 16, asking whether the existing file should be overwritten. "Press" **OK** to over-
write the file, or **Cancel** to subsequently specify a different file.
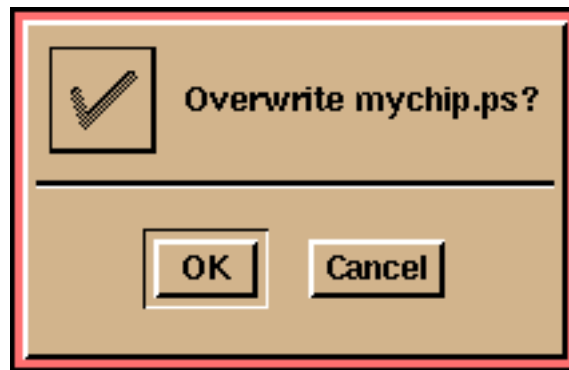
Figure 16 Dialog Box For Overwriting Existing File

If the file specified in the text entry window cannot be created (usually due to lack of write privilege or an attempt to overwrite a protected file), Xpower brings up the dialog box shown in Figure 17. "Press" **OK** to specify another file, or **Cancel** to abort creation of the file.
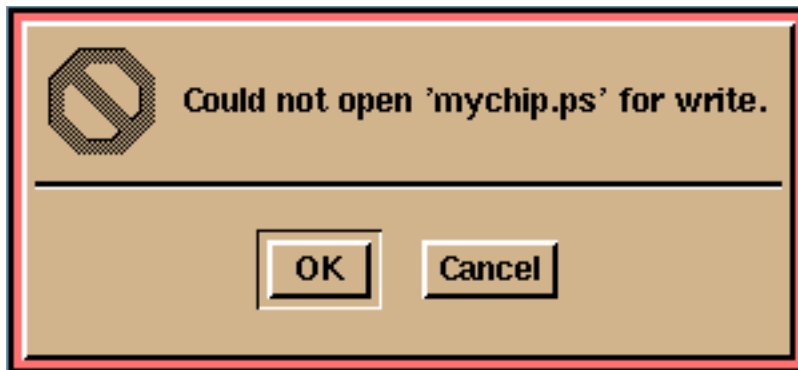
Figure 17 Dialog Box For Failed File Creation

Figure 18 illustrates the Postscript printout generated for a display similar to the one shown in Figure 6, reduced to 75% of its actual size.
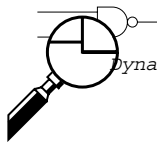
```
                              XPOWER (Version 2.00.02)

            Dynamic Power Consumption Report for, /home/gendel/gary/work/Xpower/chip,
                 using timing generator stimulus, with 1 test per cycle, 5V Vdd.
                              Analysed Test 1 to Test 37951

                              : OUTPUT INTERNAL TOTAL
                ------------------------------------------------------
                        Number of Nodes : 37 12586 12623
                Average Node Capacitance : 13.70 0.27 0.31 (pF)
                     Average Power : 0.38 8.78 9.16 (mW/MHz)
                    Maximum Power : 10.56 18.89 25.66 (mW/MHz)
                           at test : 7303 32039 32039
```

Graph of Dynamic Power Distribution
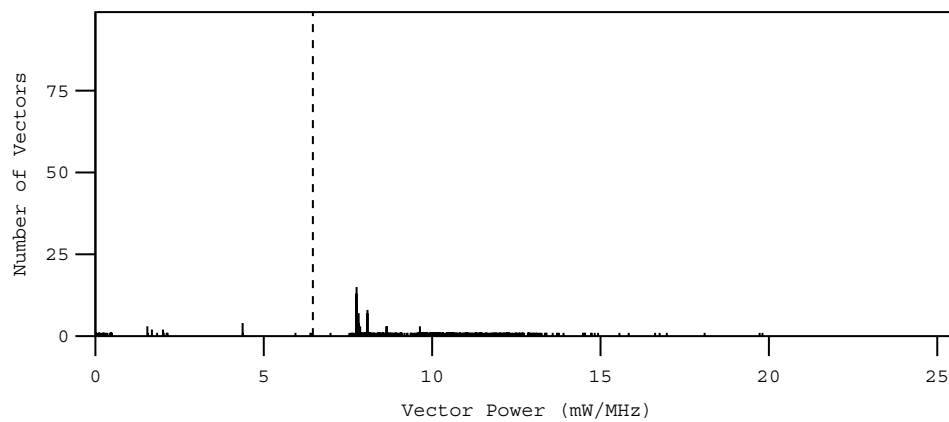
Graph of Dynamic Power Dissipation
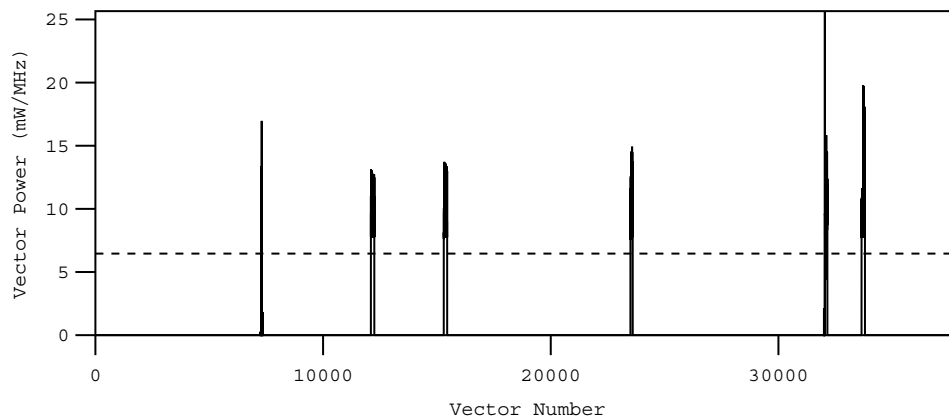
Figure 18 PostScript Printout Corresponding To The Display Of Figure 6

The Help Bar Menu Item

Selecting this item will cause a scrollable help window to display information on Xpower usage, as shown in Figure 19.

Figure 19 Help Information

The Info Bar Menu Item

Selecting this item will display an information box containing the current version of Xpower, as shown in Figure 20. "Pressing" **OK** will dismiss this window.

Figure 20 Xpower Info Display

Suppressing Transitions From The Power Consumption Total

There are a number of cases where a user may not want certain signals or signal transitions included in the power consumption statistics. Since a change in a primary input is really the result of energy expended by an external device, all energ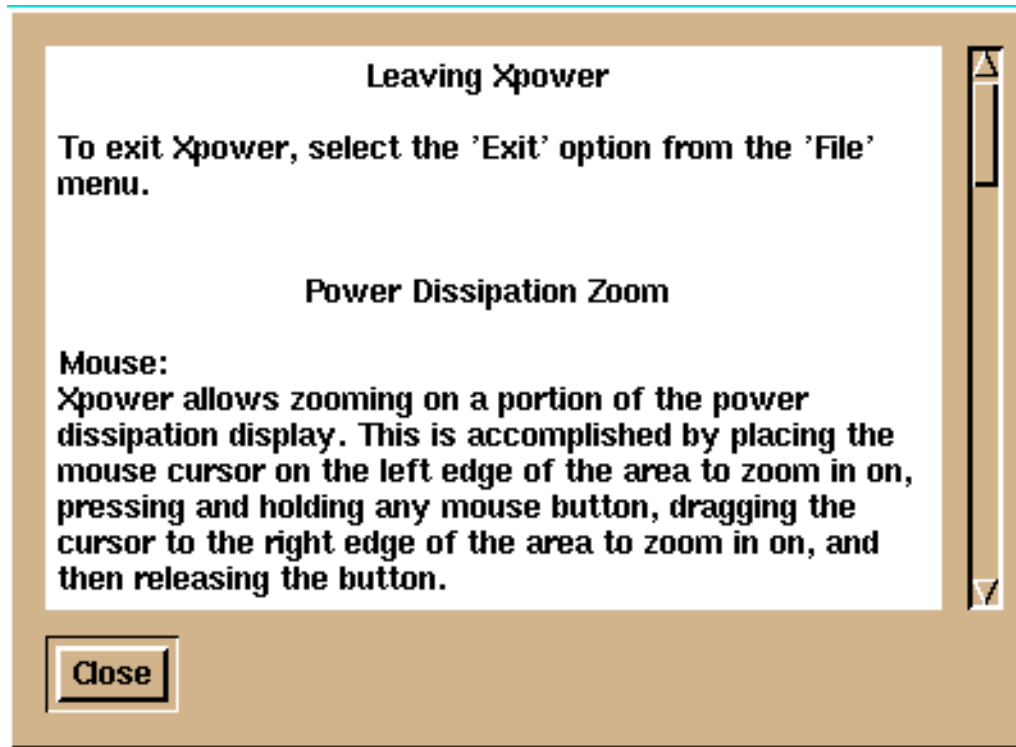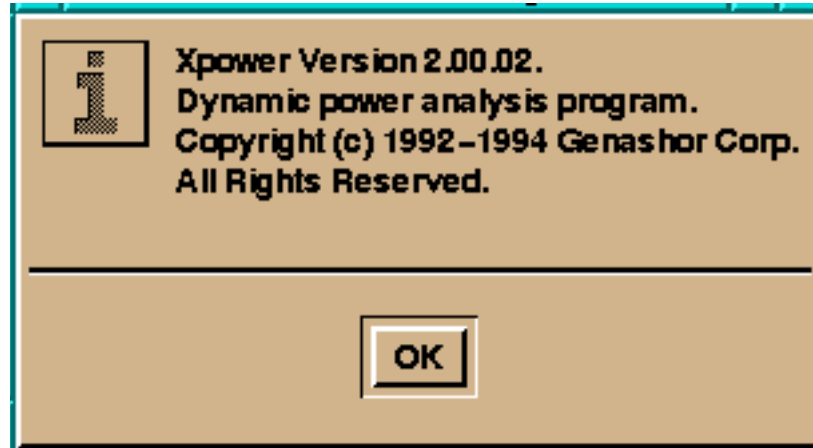y associated with these transitions is automatically discounted by Xpower. In addition, the primary wire-tied signal transitions are suppressed if the wire-tied result is the same as (was caused by) an external source (primary input or bus). Xpower uses the SIMIC naming convention to determine whether there is an external driver for a wire-tie. Simic convention is to use the signal's name, prefixed with a period (.) for the external driver. For example, if a primary bus is called `DATA1`, then the external driver for this bus is called `.DATA1`. In addition to the primary signals, the SIMIC constants `ONE` and `ZERO` are also discounted.

There are other topological situations that Xpower doesn't recognize, that may need to be identified for suppression, in order to produce accurate results. Xpower offers a simple mechanism for specifying these suppressions, via the command file:

(a) suppress <signal>
Where <signal> is the name of the signal to suppress. In this form, the suppress command will cause the removal of all transitions from the power consumption analysis.

(b) suppress <signal1> <signal2>
Where <signal1> is the name of the signal to suppress if it matches the current value of the signal specified in <signal2>

(c) nosuppress <signal>
This command is used to remove a signal from Xpower's automatic suppression, if desired. <signal> is the name of the signal to include without suppression.

    (d)   ignoreup <signal>
           Will suppress low to high transitions of the signal <signal>. This command is useful for indicating the presence of external pullup resistors.

    (e)   ignoredown <signal>
           Will suppress high to low transitions of the signal <signal>. This command is useful for indicating the presence of external pulldown resistors.

    (f)   exclude <signal>
           Performs the same functionality as the suppress command, except these can be included interactively via the Signal Select Dialog.

    (g)   reset
           removes all suppressions and exclusions from signals.

A signal is only allowed to have one suppression specification. If more than one specification is issued, the subsequent specifications will be ignored and an appropriate error message displayed at the terminal. However, the same signals may have a suppression and exclusion concurrently assigned.

Changing Files For Analysis

You may run as many Xpower processes as your operating system will allow. Once a process has started, you may, at any time, select new files for analysis. In this event, the old analysis will be discarded and the requested analysis performed.

Selecting New Files In Xpower

To choose new files to be analyzed, select the **Open** item from the **File** menu as shown in Figure 21. Xpower will ask for confirmation as shown in Figure 22. If you choose **Cancel**, the displays will continue to show the results of the current analysis. If you choose **OK**, Xpower will display the **Filename Dialog Box**, as shown in Figure 2. Update the entry fields with the correct information, following the procedure outlined in *Starting Xpower* on page 7.
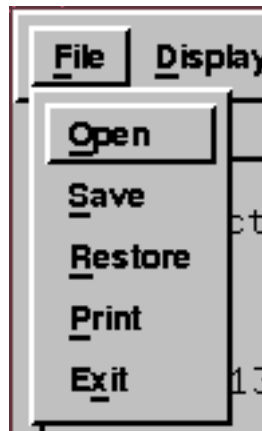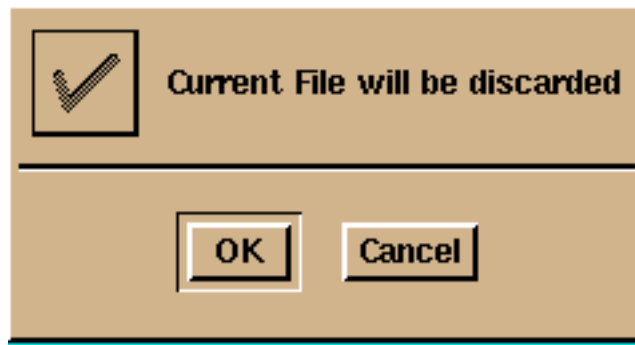
Figure 21 Open Item In File Menu

Figure 22 Confirmation Box For Open Selection.

Selecting New Files Outside Of Xpower

A simple mechanism exists that allows another process to instruct a running Xpower process to open new input files for analysis. This can be used to maintain an open Xpower window in a CAE framework, and automatically update the displays after a new simulation run. The **gcommand** program provides this interface. The format for invoking **gcommand** is:

gcommand *<window title> <arg list>*

where *<window title>* is the Xpower main window title name (Xpower by default), and *<arg list>* is a list of arguments to be sent to this window. The window title can be changed by the -title X-resource option. The X-resource options accepted by Xpower are described in *X-Resources Used By Xpower* below. The arguments are the same as if Xpower were invoked with a command line.

For example, if the title of main Xpower window is Xpower@chaos, then you can make this Xpower process analyze the history files named mycpu, with the following command:

gcommand Xpower@chaos mycpu

The effect is the same as if you started Xpower with the equivalent argument list.

If there is more than one window with the specified title, then the first window encountered will be updated.

Important: **gcommand** arguments must **not** contain X-resource options.

X-Resources Used By Xpower

The user may specify X-resources by using the command line switches (long or short), or by entering the resource assignment into an X-resource file. Xpower searches for user-set resources in the following order (highest precedence last):

(a) If $XFILESEARCHPATH exists, search along this path, otherwise use /usr/lib/X11 as a path prefix with the following search string:
"/%L/%T/%N%C:/%l/%T/%N%C:/%L/%T/%N:/%l/%T/%N:/%T/%N"

(b) If $XUSERFILESEARCHPATH exists, search along this path. Otherwise, if $XAPPLRESDIR exists, use this (otherwise $HOME) as a path prefix with the following search string:
"/%L/%N%C:/%l/%N%C:/%L/%N:/%l/%N:/%N".

(c) If RESOURCE_MANAGER property exists, read it, otherwise read $HOME/.Xdefaults.

(d) If $XENVIRONMENT exists, read it, otherwise read $HOME/.Xdefaults-hostname. Where hostname is the name of the current host.

(e) Read the command line switches.

Notes: The words beginning with a dollar sign ($) (for example $LANG and $HOME), are system environment variables. Search string substitutions can be found in the Xt reference documentation. Currently, the %C substitution string is not supported, and an empty string will be used if found.

For example, if you wanted the background color to be blue, you could either use the command line switch:

```
Xpower -bg blue
```

or insert the following line in one of the X-resource files mentioned above.

```
Xpower.Background:  Blue
```

Table 3 lists the X-resources that Xpower recognizes.

.

Table 3: List of Xpower X-resources

Short Command Line Switch	Long Command Line Switch	X-resource Name	Description
-bc	-baseColor	BaseColor	Specifies the color to use for all window backgrounds. The default is "Tan".
-bg	-background	BackGround	Specifies the color to use for the graph backgrounds. The default is "White".

Table 3: List of Xpower X-resources

Short Command Line Switch	Long Command Line Switch	X-resource Name	Description
	-display	display	Specifies the display device for Xpower output. The default is the DISPLAY environment variable.
-dsc	-darkShadeColor	DarkShadeColor	Specifies the color for dark shading used for 3-Dimensional appearance. Default is "Black".
-ff	-fixedFont	FixedFont	Specifies the font to use for all text displays that require fixed spaced fonts. Default is "6x9".
-fg	-foreground	Foreground	Specifies the color to use for all window foregrounds. Default is "Black".
	-geometry	geometry	Specifies the size and/or the location of the main Xpower window. The size is defined by the format: WxH, where W is the width and H is the height. The location is in the format {+-}X{+-}Y, where X is the x position relative to the right, if positive, or left, if negative, and Y is the y position relative to the top, if positive, or bottom, if negative. If the width or height is smaller than the minimum, Xpower will force the window to the minimum value.
-gac	-graphAxisColor	GraphAxisColor	Specifies the color to use for the graph axis and labels. Default is "Black".
-gc	-graphColor	GraphColor	Specifies the color to use for the graphs. Default is "Red".
-hl	-highlight	Highlight	Specifies the color to use to highlight the currently selected entry widget. Default is "Red".

Table 3: List of Xpower X-resources

Short Command Line Switch	Long Command Line Switch	X-resource Name	Description
-lsc	-lightShadeColor	LightShadeColor	Specifies the color for light shading used for 3-Dimensional appearance. Default is "White".
-mka	-menuKeyAccelerator	MenuKeyAccelerator	Specifies whether underlining and accelerator keys are used for menu selection. Default is "On".
-os	-outputSize	OutputSize	Specifies the default paper size for report. Valid values are "A4" and "USletter". Default is "USletter".
-sbc	-scrollBarColor	ScrollBarColor	Specifies the color for the scrollbar buttons and slider. Default is to use BaseColor.
-tfc	-textFieldColor	TextFieldColor	Specifies the background color for all text display fields. Default is "White".
	-title	title	Sets the Xpower window title. Default is "Xpower".
-vf	-variableFont	VariableFont	Specifies the font to use for all text displays that use proportionally spaced fonts. Default is "variable".

The Command File

The command file is read just prior to performing the power consumption analysis. Comments are allowed in the command file by prefixing the comment with a number sign (#). Commands are case insensitive, however the arguments are case sensitive. Table 4 lists all valid commands.

Table 4: List of Commands

Command	Description
capscale <scale>	Sets capacitance scale value to <scale>. This can be changed interactively in the Setup Dialog.
exclude <signal>	Suppresses specified signal in analysis. These may be changed interactively in the Signal Select Dialog Box.
ignoredown <signal>	Ignores high to low transitions for signal <signal>.
ignoreup <signal>	Ignores low to high transitions for signal <signal>.
nosuppress <signal>	Removes suppression of signal <signal>.
reset	Removes all suppressions and exclusions from signals.
suppress <signal>	Ignores all transitions for signal <signal>
suppress <signal1> <signal2>	Ignores transitions for signal <signal1>, if it's final value is the same as signal <signal2>.
vdd <voltage>	Sets vdd value to <voltage>. This can be changed interactively in the Setup Dialog.