Synopsys®
PrimeTime PX Tutorials

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Contents

Introduction

PrimeTime PX supports two modes of power analysis: the averaged and the time-based power analysis mode. The tool installation directory contains tutorials for both modes of power analysis. To use the tutorial, copy the tutorial file to your own directory and follow the instructions in this chapter. The design used in the tutorials consists of a multiplier, an adder, and logic to connect them. The design example, the activity data files, the scripts, and the steps you complete to run the examples are described in the following sections:

- Averaged Power Analysis Mode Tutorial
- Vector-Free Power Analysis Mode Tutorial
- Time-Based Power Analysis Mode Tutorial

Averaged Power Analysis Mode Tutorial

The *install_dir*/doc/pt/tutpx/averaged directory contains the examples for averaged power analysis. The averaged power analysis mode is selected when you set the `power_analysis_mode` variable to `averaged`. This variable must be set before specifying any power analysis command.

The following sections describe the various files used in the tutorial, the commands used in the PrimeTime PX scripts, how you run the examples in the tool and how to view the generated report.

Related Files

In the tutorial directory, the files listed in Table 1 are related to averaged power analysis.

Table 1 Files for the Averaged Power Analysis Tutorial

File name	Description
`./sim/vcd.dump.gz`	Value Change Dump (VCD) file
`./src/hdl/gate/mac.vg`	Gate-level netlist of the design
`./src/lib/snps/core_typ.db`	Technology library file
`./src/hdl/gate/mac.sdc`	Synopsys Design Constraints (SDC) file
`./src/annotate/mac.spef.gz`	Parasitic file
`./src/annotate/mac.spef.gz`	VCD file
`./sim/mac.saif`	SAIF file with switching activity
`./averaged/ave_saif.tcl`	Averaged power analysis using switching activity from the Switching Activity Interchange Format (SAIF) file
`./averaged/ave_vcd.tcl`	Averaged power analysis using switching activity

	from the VCD file
`./averaged/ave_vf.tcl`	Averaged power analysis using the default switching activity

PrimeTime PX Script File

The tutorial contains three examples of Tcl scripts for the averaged power analysis mode. Example 1 shows one such script.

Example 1 PrimeTime PX Script in the Tutorial For Averaged Power Analysis

```
#######################################################
#     Set the Power Analysis Mode
#######################################################
set power_enable_analysis TRUE
set power_analysis_mode averaged
#######################################################
#     Read and link the Gate Level Netlist
#######################################################
set search_path  "../src/hdl/gate ../src/lib/snps . "
set link_library " * core_typ.db"
read_verilog   mac.vg
current_design mac
link
#######################################################
# Read SDC and set transition time or annotate parasitics
#######################################################
read_sdc   ../src/hdl/gate/mac.sdc
set_disable_timing [get_lib_pins ssc_core_typ/*/G]
read_parasitics ../src/annotate/mac.spef.gz
#######################################################
#       check, update, or report the timing
#######################################################
check_timing
update_timing
report_timing
#######################################################
#       read switching activity file
#######################################################
read_vcd -strip_path tb/macinst ../sim/vcd.dump.gz
report_switching_activity -list_not_annotated
#######################################################
#       check or update or report power
#######################################################
check_power
update_power
report_power -hierarchy
quit
```

For more information about each command, review the remaining sections of this chapter or check the man pages.

The commands in the script are grouped into different sections, which represent the basic steps of power analysis. These steps are common for all types of power analysis:

1. Set the power analysis mode.
2. Read and link the design.
3. Set input transition and annotate parasitics.
4. Read the switching activity file.
5. Perform power analysis.

Gate-Level Netlist

PrimeTime PX supports a gate-level netlist only. The mag.vg file is a gate-level Verilog netlist. This netlist contains leaf-level cells that are the instantiation of the library cells. The valid formats are Verilog, VHDL, EDIF, .db, .ddc, or Milkyway. Verilog is used for this tutorial. The netlist can be either flat or hierarchical.

Technology Library

The technology library file contains library cells. Each cell has timing, power, and characterization information. Internal power and leakage power are in the library.

SDC File

The SDC file contains the design constraints. The driver cell information is used to calculate the transition time on the primary inputs.

Parasitic File

The parasitic file contains the capacitance of the nets. Capacitance is one of the factors in determining the dynamic power. You can unzip and view the file.

Switching Activity

In the averaged power analysis, you use either SAIF or VCD file formats to read the switching activity.

A SAIF file is generated either from gate-level or RTL simulation. RTL SAIF captures switching activity for only part of the design. PrimeTime PX propagates the partial switching activity throughout the whole design.

You can also use the VCD file to specify the switching activity information. If you do not specify switching activity information, the tool assumes certain defaults for the switching activity.

Steps for Analyzing Power

For this tutorial, the working directory is **./tutpx/averaged**. The search path is set based on that directory. It should be your current directory. Before running the tutorial, verify that PrimeTime PX has been installed.

Changing Your Working Directory

Change your current directory to **./tutpx/averaged**. The search path setting is based on this directory.

Running PrimeTime PX

You can run any of the example scripts, ave_saif.tcl, ave_vcd.tcl or ave_vf.tcl for the averaged power analysis flow. For instance, to run the ave_saif.tcl script, enter the following command:

```
% pt_shell -f ave_saif.tcl
```

PrimeTime PX runs in batch mode. The tool stops when all the commands in the Tcl script have been executed.

Perform timing analysis before running the `update_power` command. This improves performance and avoids additional timing updates triggered by the switching activity annotation commands.

Viewing the Power Report

In the averaged power analysis mode, using the SAIF file format for activity information, the `report_power` command generates the power report as shown in Example 2.

Example 2 Report Generated by the report_power Command

```
****************************************
Report : Averaged Power
         -hierarchy
Design : mac
...
****************************************
                                    Switch   Int      Leak      Total
Hierarchy                           Power    Power    Power     Power    %
------------------------------------------------------------------------------
mac                                 1.55e-03 2.10e-03 2.59e-07  3.65e-03 100.0
 mult_21 (mac_DW02_mult_16_16_0)    7.28e-04 5.54e-04 1.49e-07  1.28e-03  35.2
   U1/U9720 (mac_DW01_add_25_0)     2.12e-04 1.27e-04 1.60e-08  3.39e-04   9.3
 add_23 (mac_DW01_add_33_0)         3.31e-04 2.40e-04 2.36e-08  5.72e-04  15.7
1
```

Vector-Free Power Analysis Mode Tutorial

When you select the averaged power analysis mode and do not specify any activity information, the tool performs vector-free power analysis. In this mode, PrimeTime PX applies the default toggle rate on the primary inputs and black box outputs and then propagates them. If required, you can change the default toggle rate. This usage model is useful for quick power estimation.

Related Files

In the tutorial directory, the files listed in Table 2 are related to the vector-free analysis tutorial.

Table 2 Files for Vector-Free Tutorial

File Name	Description
`./averaged/ave_vf.tcl`	PrimeTime PX script for vector-free analysis
`./src/hdl/gate/mac.vg`	Gate-level netlist of the design
`./src/lib/snps/core_typ.db`	Technology library file
`./src/hdl/gate/mac.sdc`	Synopsys Design Constraints (SDC) file
`./src/annotate/mac.spef.gz`	Parasitic file

PrimeTime PX Script

This is a Tcl script. You specify the search path, the link and the target library, the PrimeTime PX variables and commands for power analysis, in this script.

Example 3 PrimeTime PX Script in the Tutorial For Vector-Free Power Analysis

```
#######################################################
Link the Design
#######################################################
set search_path         "../src/hdl/gate ../src/lib/snps . "
set link_library    " * core_typ.db"

set power_enable_analysis true
set power_analysis_mode averaged
set read_verilog mac.vg
current_design      mac
link
#######################################################
#       set transition time / annotate parasitics
#######################################################
read_sdc             ../src/hdl/gate/mac.sdc
read_parasitics      ../src/annotate/mac.spef.gz
#######################################################
#       power analysis
#######################################################
check_timing
update_timing
```

```
report_timing
update_power
report_power -hierarchy
```

Steps for Analyzing Power

The current working directory should be **./tutpx/averaged**.

Running PrimeTime PX

To run the ave_vf.tcl script in PrimeTime PX, enter the following command:

```
%>pt_shell -f ave_vf.tcl
```

PrimeTime PX runs in batch mode and stops when all the commands in the script have been executed.

Perform timing analysis before running the `update_power` command. This improves performance and avoids additional timing updates triggered by the switching activity annotation commands.

Viewing the Power Report

The power report from vector-free power analysis has the same format as the SAIF-based report. The report shows only averaged power but not peak power.

Time-Based Power Analysis Mode Tutorial

The *install_dir/doc/pt/tutpx/time_based* contains the examples for time-based power analysis. The time-based power analysis mode is selected when you set the `power_analysis_mode` variable to `time_based`. This variable must be set before specifying any power analysis command.

The following sections describe the various files used in the tutorial, the commands used in the PrimeTime PX scripts, how you run the examples in the tool and how to view the generated report.

Related Files

In the tutorial directory, the files listed in Table 3 are related to the time-based power analysis tutorial.

Table 3 Files for the Time-Based Power Analysis Tutorial

File name	Description
`./time_based/tim_gatevcd.tcl`	Script for gate-level time-based power analysis
`./time_based/tim_rtlvcd.tcl`	Script for RTL VCD time-based power analysis
`./src/hdl/gate/mac.vg`	Gate-level netlist of the design
`./src/lib/snps/core_typ.db`	Technology library file
`./src/hdl/gate/mac.sdc`	Synopsys Design Constraints (SDC) file
`./src/annotate/mac.spef.gz`	Parasitic file
`./sim/rtlvcd.dump`	RTL VCD file
`./sim/vcd.dump.gz`	Gate-level VCD file

PrimeTime PX Script

The tutorial contains two Tcl script examples for the time-based power analysis mode. Example 4 shows the various steps in time-based power analysis:

Example 4 Script Example for Time-Based Power Analysis

```
#####################################################
#    Set the Power Analysis Mode
#####################################################
set power_enable_analysis TRUE
set power_analysis_mode time_based
#####################################################
#       link design
#############################################
set search_path   "../src/hdl/gate ../src/lib/snps . "
set link_library    " * core_typ.db"
read_verilog   mac.vg
current_design mac
link
```

```
#######################################################
#       set transition time / annotate parasitics
#######################################################
read_sdc                  ../src//hdl/gate/mac.sdc
set_disable_timing [get_lib_pins ssc_core_typ/*/G]
read_parasitics           ../src/annotate/mac.spef.gz
#######################################################
check_timing
update_timing
report_timing
#######################################################
#       read switching activity file
#######################################################
read_vcd ../sim/vcd.dump.gz -strip_path tb/macinst
#######################################################
#       analyze power
#######################################################
check_power
set_power_analysis_options -waveform_format out -waveform_output vcd
update_power
report_power
quit
```

The commands in the script are grouped into different sections, which represent the basic steps of power analysis. These steps are common for all types of power analysis:

1. Set the power analysis mode.
2. Read and link the design.
3. Set input transition and annotate parasitics.
4. Read the switching activity file.
5. Perform power analysis.

Steps for Analyzing Power

Set the current working directory to **./tutpx/time_based**.

Running PrimeTime PX

The tutorial contains two example scripts for time-based power analysis using PrimeTime PX. You use the tim_gatevcd.tcl to run the gate-level time-based analysis and tim_rtlvcd.tcl to run the RTL VCD time-based analysis.

To run the tim_gatevcd.tcl script, use the following command:

```
%> pt_shell -f tim_gatevcd.tcl
```

PrimeTime PX runs in batch mode. The tool halts when all the commands in the script have been executed.

Perform timing analysis before running the `update_power` command. This improves performance and avoids additional timing updates triggered by the switching activity annotation commands.

Reviewing the Power Report and Waveforms

At the end of the run, PrimeTime PX prints out the power report. Example 5 shows the report which itemizes the power consumption on each hierarchical instance.

Example 5 Power Report Showing Itemized Power Consumption on Each Hierarchical Instance

```
                        Switch   Int      Leak     Total
 Hierarchy                      Power    Power    Power    Power     %
------------------------------------------------------------------------------
mac                            1.53e-03 2.13e-03 2.59e-07  3.65e-03 100.0
 mult_21 (mac_DW02_mult_16)    7.16e-04 5.57e-04 1.49e-07  1.27e-03  34.8
 U1/U9720 (mac_DW01_add_25)    2.02e-04 1.28e-04 1.60e-08  3.30e-04   9.0
 add_23 (mac_DW01_add_33_0)    3.24e-04 2.49e-04 2.36e-08  5.74e-04v 15.7


                              Peak     Peak              Glitch    X-tran
Hierarchy                     Power    Time              Power     Power
------------------------------------------------------------------------------
mac                           0.197    180.000-180.010   5.43e-05  4.68e-07
 mult_21 (mac_DW02_mult_16) 4.74e-02 546.650-546.660   3.36e-05  0.000
 U1/U9720 (mac_DW01_add_25) 1.59e-02 3116.120-3116.130 2.28e-05  0.000
 add_23 (mac_DW01_add_33_0) 2.01e-02 6744.580-6744.590 1.63e-05  0.000
```

Viewing Power Waveforms Using nWave Waveform Viewer

After the power analysis, a power .fsdb waveform file is saved in the current directory. To view the file, use the waveform viewer called nWave. In the UNIX shell, enter `nWave &` to start the viewer. Specify `nWave -h` to view the usage options and their descriptions. This viewer requires a snps_fs_nwave license.

Alternatively, in the GUI, choose Power > View Waveforms to open nWave. Figure 1 shows the waveforms for peak power analysis.

Figure 1 Peak Power Analysis Waveform

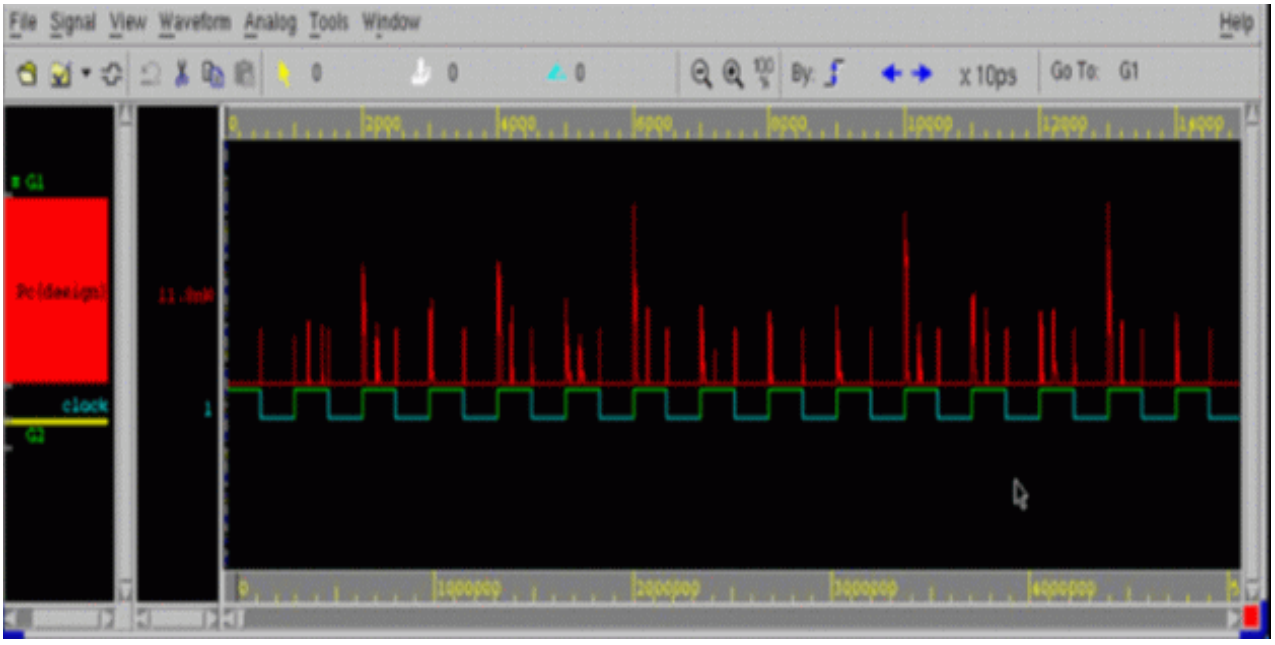
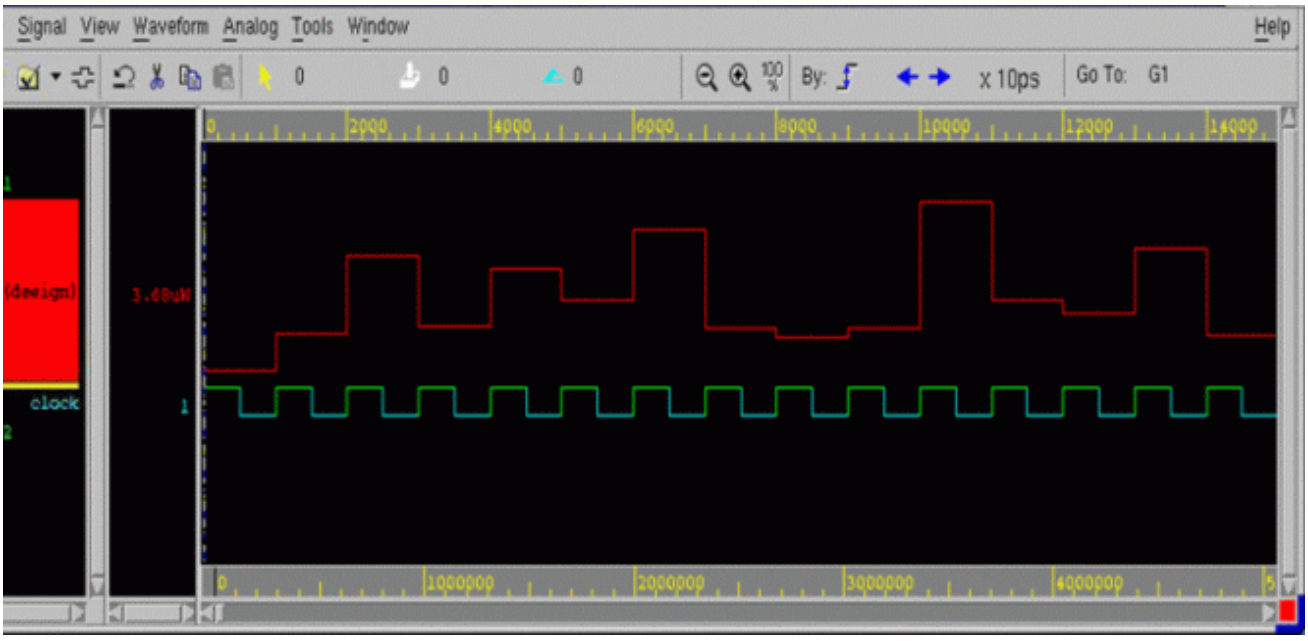


Figure 2 show the waveforms for and cycle accurate peak power analysis respectively.

Figure 2 Cycle Accurate Peak Power Analysis Waveform



Software Compatibility

The nWave waveform viewer version 2012.01p2 supports the latest FSDB library and the fsdb2vcd utility. The FSDB library is used to output the power waveform file in the .fsdb format, while the fsdb2vcd utility converts the .fsdb format to the VCD format.

The nWave version 2012.01p2 is backward compatible and supports previous releases of PrimeTime PX.
