

Verification Continuum™

**Synopsys**

# Synplify Pro for Microsemi Edition Reference Manual

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December 2019

**SYNOPSYS®**

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Synopsys, Inc.  
690 East Middlefield Road  
Mountain View, CA 94043  
[www.synopsys.com](http://www.synopsys.com)

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## CHAPTER 1

# Product Overview

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This document is part of a set that includes reference and procedural information for the Synopsys® FPGA synthesis tool. The reference manual provides additional details about the synthesis tool user interface, commands, and features. Use this information to supplement the user guide tasks, procedures, design flows, and result analysis.

The following sections include an introduction to the synthesis tool.

- [Overview of the Synthesis Tool](#), on page 12
- [Synopsys FPGA Tool Features](#), on page 14
- [Graphic User Interface](#), on page 17
- [Getting Help](#), on page 19

# Overview of the Synthesis Tool

This section introduces the technology, main features, and user interface of the FPGA synthesis tool. See the following for details:

- [Common Features](#), on page 12
- [Graphic User Interface](#), on page 17

## Common Features

The Synopsys FPGA synthesis tool includes the following built-in features:

- The HDL Analyst<sup>®</sup> analysis and debugging environment, a graphical tool for analysis and crossprobing. See [Analyzing With the HDL Analyst Tool, on page 272](#) and [Analyzing With the Standard HDL Analyst Tool, on page 336](#) in the *User Guide*.
- The Text Editor window, with a language-sensitive editor for writing and editing HDL code. See [Text Editor View, on page 45](#).
- The SCOPE<sup>®</sup> (Synthesis Constraint Optimization Environment<sup>®</sup>) tool, which provides a spreadsheet-like interface for managing timing constraints and design attributes. See [SCOPE Constraints Editor, on page 212](#).
- FSM Compiler, a symbolic compiler that performs advanced finite state machine (FSM) optimizations. See [Running the FSM Compiler, on page 425](#).
- Integration with the Identify Debugger.

The following features are specific to the Synplify Pro tool. For a comparison of the features in the tools, see [Synopsys FPGA Tool Features, on page 14](#).

- FSM Explorer, which tries different state machine optimizations before picking the best implementation. See [Running the FSM Explorer, on page 429](#).
- The FSM Viewer, for viewing state transitions in detail. See [Using the FSM Viewer, on page 291](#).
- The Tcl window, a command line interface for running TCL scripts. See [Tcl Script Window, on page 41](#).

- The Timing Analyst window, which allows you to generate timing schematics and reports for specified paths for point-to-point timing analysis.
- Other special windows, or *views*, for analyzing your design, including the Watch Window and Message Viewer (see [The Project View, on page 22](#)).
- Certain optimizations available, like retiming.
- Advanced analysis features like crossprobing and probe point insertion.
- Place-and-Route implementation(s) to automatically run placement and routing after synthesis. You can run place-and-route from within the tool or in batch mode. This feature is supported for certain technologies (see [Running P&R Automatically after Synthesis, on page 558](#) in the *User Guide*).

# Synopsys FPGA Tool Features

This table distinguishes between major functionality for the Synopsys FPGA products.

	Synplify	Synplify Pro	Synplify Premier	Synplify Premier DP
<b>Performance</b>				
Behavior Extracting Synthesis Technology® (BEST™)	x	x	x	x
Vendor-Generated Core/IP Support (certain technologies)		x	x	x
FSM Compiler	x	x	x	x
FSM Explorer		x	x	x
Gated Clock Conversion		x	x	x
Register Pipelining		x	x	x
Register Retiming		x	x	x
SCOPE® Constraint Entry	x	x	x	x
High Reliability Features		Limited	x	x
Integrated Place-and-Route	x	x	x	x
<b>Analysis</b>				
HDL Analyst®	Option	x	x	x
Timing Analyzer - Point-to-point		x	x	x
Timing Report View			x	x
FSM Viewer		x	x	x
Crossprobing		x	x	x
Probe Point Creation		x	x	x
Identify® Instrumentor	x	x	x	x
Identify Debugger	x	x	x	x

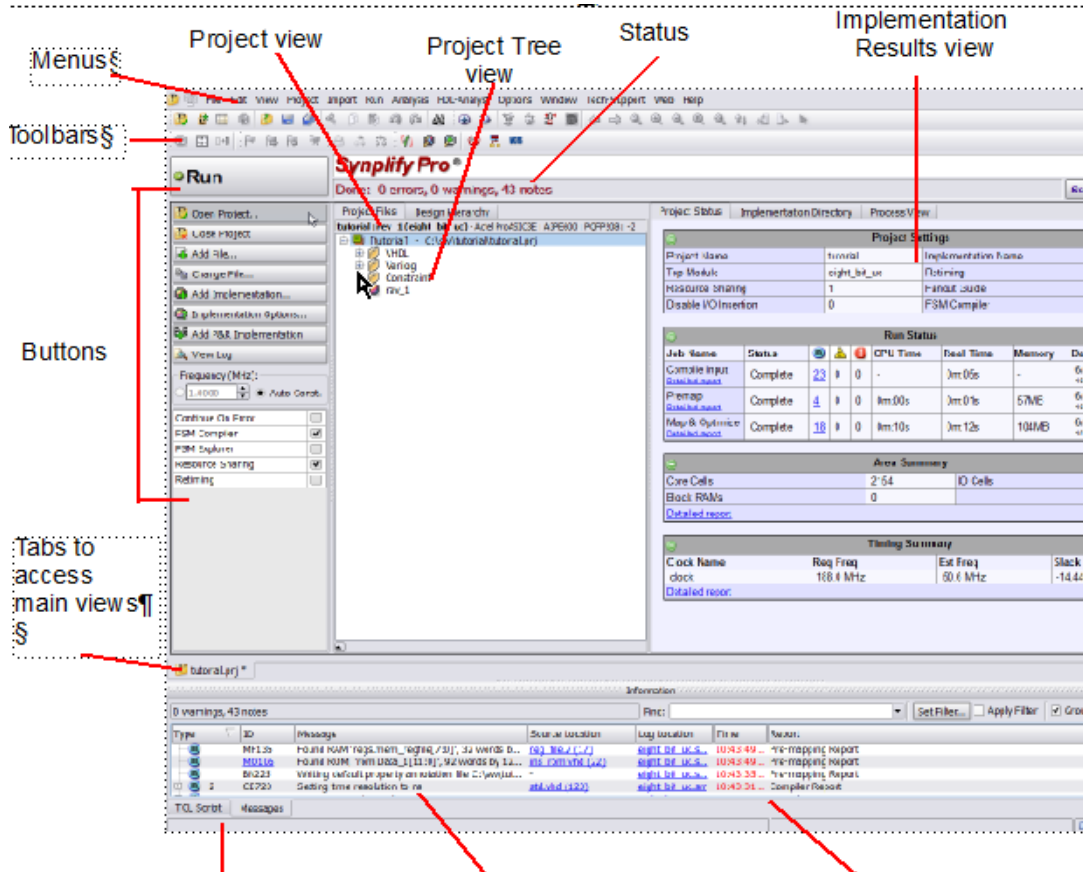
	Synplify	Synplify Pro	Synplify Premier	Synplify Premier DP
<b>Physical Design</b>				
Design Planner				x
Logic Assignment to Regions				x
Area Estimation and Region Capacity				x
Pin Assignment				x
Physical Optimizations			x	x
Physical Analyst			x	x
Synopsys DesignWare® Foundation Library			x	x
<b>Runtime</b>				
Hierarchical Design		x	x	x
Multiprocessing /Distributed Processing			x	x
Compile on Error			x	x
<b>Team Design</b>				
Mixed Language Design		x	x	x
Compile Points		x	x	x
Hierarchical Design		x	x	x
True Batch Mode (Floating licenses only)		x	x	x
GUI Batch Mode (Floating licenses)	x	x	x	x
Batch Mode P&R	-	x	x	x
Back Annotation of P&R Data	-	-	x	x
Identify Integration	Limited	x	x	x
<b>Design Environment</b>				
Text Editor View	x	x	x	x

	Synplify	Synplify Pro	Synplify Premier	Synplify Premier DP
Watch Window		x	x	x
Message Window		x	x	x
Tcl Window		x	x	x
Multiple Implementations		x	x	x
Vendor Technology Support	x	x	Selected	Selected
<b>Prototyping Features</b>				
Runtime Features			x	x
Compile Points		x	x	x
Gated Clock Conversion			x	x
Compile on Error			x	x
Unified Power Format (UPF)			x	x



# Graphic User Interface

The Synopsys FPGA family of products share a common graphical user interface (GUI) in order to ensure a cohesive look and feel across the different products.



The following table shows where you can find information about different parts of the GUI, some of which are not shown in the above figure. For more information, see the *User Guide*.

For information about ...	See ...
Project window	<a href="#">The Project View</a> , on page 22
HDL Analyst view	<a href="#">Chapter 7, Analyzing with HDL Analyst</a>
Text Editor view	<a href="#">Text Editor View</a> , on page 45
Tcl window	<a href="#">Tcl Script Window</a> , on page 41
Watch Window	<a href="#">Watch Window</a> , on page 37
SCOPE spreadsheet	<a href="#">SCOPE Constraints Editor</a> , on page 212
Other views and windows	<a href="#">The Project View</a> , on page 22
Menu commands and their dialog boxes	<a href="#">Chapter 5, User Interface Commands</a>
Toolbars	<a href="#">Toolbars</a> , on page 57
Buttons	<a href="#">Buttons and Options</a> , on page 72
Context-sensitive popup menus and their dialog boxes	<a href="#">Chapter 6, GUI Popup Menu Commands</a>
Online help	Use the F1 keyboard shortcut or click the Help button in a dialog box. See <a href="#">Help Menu</a> , on <a href="#">page 451</a> , for more information.

# Getting Help

Look through the documentation for information. You can access the information online from the Help menu, or refer to the corresponding manual. The following table shows you how the information is organized.

## Finding Information

For help with ...	Refer to the ...
How to...	<i>User Guide</i>
Flow information	<i>User Guide</i>
FPGA Implementation Tool	Synopsys Web Page (Web->FPGA Implementation Tools menu command from within the software)
Synthesis features	<i>User Guide</i> and <i>Reference Manual</i>
Language and syntax	<i>Language Support Reference Manual</i>
Attributes and directives	<i>Attribute Reference Manual</i>
Tcl language	Online help (Help->Tcl Help)
Synthesis Tcl commands	<i>Command Reference Manual</i> or type <b>help</b> followed by the command name in the Tcl window
Using tool-specific features and attributes	<i>User Guide</i>
Error and warning messages	Click the message ID code

## Document Set

This document is part of a series of books included with the Synopsys FPGA synthesis software tool. The set consists of the following books that are packaged with the tool:

- *FPGA Synthesis User Guide*
- *FPGA Synthesis Reference*
- *FPGA Synthesis Command Reference*
- *FPGA Synthesis Attributes and Directives Reference*

- *FPGA Synthesis Language Support Reference*
- *Identify Instrumentor User Guide*
- *Identify Debugger User Guide*
- *Identify Debugging Environment Reference Manual*

## CHAPTER 2

# User Interface Overview

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This chapter presents tools and technologies that are built into the Synopsys FPGA synthesis software to enhance your productivity.

This chapter describes the following aspects of the graphical user interface (GUI):

- [The Project View](#), on page 22
- [The Project Results View](#), on page 26
- [Other Windows and Views](#), on page 36
- [Using the Mouse](#), on page 52
- [Toolbars](#), on page 57
- [Keyboard Shortcuts](#), on page 64
- [Buttons and Options](#), on page 72

# The Project View

The Project View is the main interface to the tool. The Project View consists of a Project Management View on the left and a Project Results View on the right. The interface and available functionality vary for your tool. See the following for an overview:

- [Multiple Pane Project View](#), on page 22

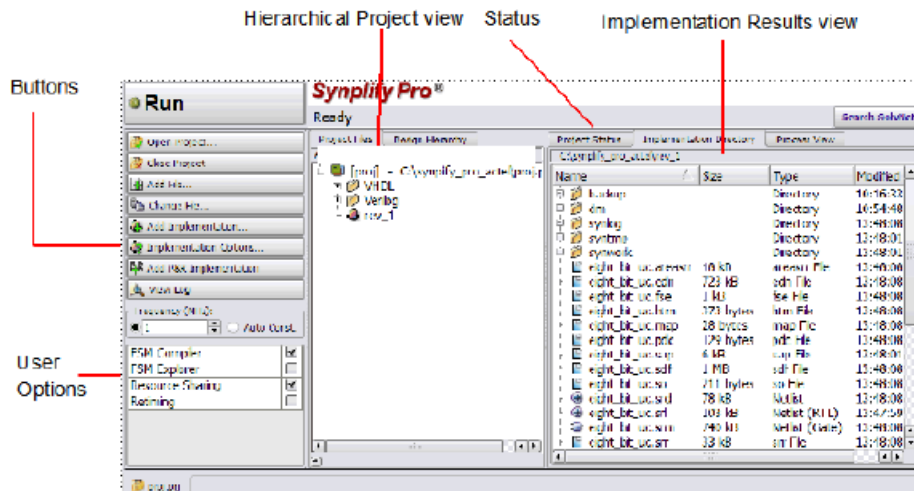
## Multiple Pane Project View

The Project Management view is on the left side of the window, and is used to create or open projects, create new implementations, set device options, and initiate design synthesis. The Project Results view is on the right.

You can also use the Project Management view to manage and synthesize hierarchical designs.

The following figure shows the main parts of the interface. Additional details about the project view are described here:

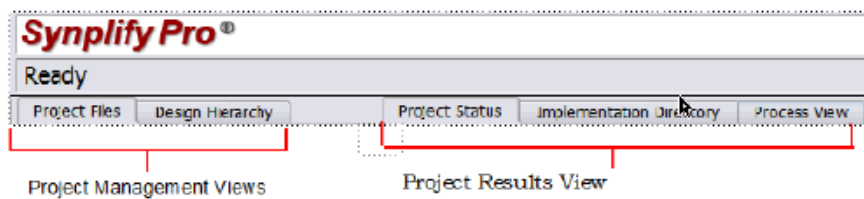
- [Project Management View](#), on page 24
- [The Project Results View](#)



The Project view has the following main parts:

Project View Interface	Description
Status	Displays the tool name or the current status of the synthesis job that is running. Clicking in this area displays additional information about the current job.
Buttons and options	Allow immediate access to some of the more common commands. See <a href="#">Buttons and Options, on page 72</a> for details.
Implementation Results view	<p>Lists the result of the synthesis runs for the implementations of your design. You can only view one set of implementation results at a time. Click an implementation in the Project view to make it active and view its result files.</p> <p>The Project Results view includes the following:</p> <ul style="list-style-type: none"> <li>• <a href="#">Project Status Tab</a>—provides an overview of the project settings and at-a-glance summary of synthesis messages and reports.</li> <li>• <a href="#">Implementation Directory</a>—lists the names and types of the result files, and the dates they were last modified.</li> <li>• <a href="#">Process View</a>—gives you instant visibility to the synthesis and place-and-route job flows.</li> </ul> <p>See <a href="#">The Project Results View, on page 26</a> for more information.</p>

## Project Management View



The Project Management view is on the left side of the window, and is used to create or open projects, create new implementations, set device options, and initiate design synthesis. The graphical user interface (GUI) lets you manage



hierarchical designs that can be synthesized independently and imported back to the top-level project in a team design flow. The following figure shows the Project view as it appears in the interface.

# The Project Results View

The Project Results view appears on the right side of the Project view and contains the results of the synthesis runs for the implementations of your design. The Project Results view includes the following:

- [Project Status Tab](#)
- [Implementation Directory](#)
- [Process View](#)
- [Report Tab](#)

## Project Status Tab

The Project Status view provides an overview of the project settings and at-a-glance summary of synthesis messages and reports such as an area or optimization summary for the active implementation. You can track the status and settings for your design and easily navigate to reports and messages in the Project view.

To display this window, click the Project Status tab in the Project view. An overview for the project is displayed in a spreadsheet format for each of the following sections:

- [Project Settings](#)
- [Run Status](#)
- [Reports](#)

For details about how to access synthesis results, see [Accessing Specific Reports Quickly, on page 193](#).

Project Status

Implementation Directory

Process View

Project Settings

Project Name	tutorial	Implementation Name	rev_3
Top Module	alu	Retiming	0
Resource Sharing	1	Fanout Guide	10000
Disable I/O Insertion	0	Disable Sequential Optimizations	0

Run Status

Job Name	Status	<div><div></div><div></div><div></div></div>	CPU Time	Real Time	Memory	Date/Time
Compile Input (compiler) <a href="#">Detailed report</a>	Complete	<div><div>10</div><div>0</div><div>0</div></div>	-	0m:02s	-	8/11/2016 11:20:30 AM
Pre-mapping (premap) <a href="#">Detailed report</a>	Complete	<div><div>3</div><div>1</div><div>0</div></div>	0m:00s	0m:00s	79MB	8/11/2016 11:20:33 AM
Map & Optimize (fpga_mapper) <a href="#">Detailed report</a>	Complete	<div><div>11</div><div>2</div><div>0</div></div>	0m:01s	0m:00s	80MB	8/11/2016 11:28:34 AM

Area Summary

Carry Cells	59	Sequential Cells	10
DSP Blocks (MACC) (dsp_used)	1	I/O Cells	40
Global Clock Buffers	1	LUTs (total_luts)	108
<a href="#">Detailed report</a>		<a href="#">Hierarchical Area report</a>	

Timing Summary

<a href="#">Detailed report</a>	<a href="#">Timing Report View</a>
---------------------------------	------------------------------------

You can expand or collapse each section of the Project Status view by clicking on the + or - icon in the upper left-corner of each section.

Project Status Implementation Directory Process View

Project Settings

Project Name	physical_synthesis	Implementation Name	logical_synthesis
--------------	--------------------	---------------------	-------------------

## Project Settings

Project Settings is populated with the project settings from the run\_options.txt file after a synthesis run. This section displays information, like the following:

- Project name, top-level module, and implementation name
- Project options currently specified, such as Resource Sharing, Fanout Guide, and Disable I/O Insertion

## Run Status

The Run Status table gets updated during and after a synthesis run. This section displays job status information for the compiler, premap job, mapper, and place-and-route runs, as needed. This section displays information about the synthesis run:

- Job name - Jobs include Compiler Input, Premap, and Map & Optimize. The job might have a Detailed Report link. When you click on this link, it takes you to the corresponding report in the log file.

The screenshot shows the 'Run Status' table with three jobs: 'Compile Input', 'Premap', and 'Map & Optimize'. The 'Map & Optimize' job is selected, and its detailed report is displayed in a pop-up window. A red arrow points from the 'Detailed report' link in the table to the report window.

Job Name	Status	22	0	0	CPU Time	Real Time	Memory	Date/Time
Compile Input <a href="#">Detailed report</a>	Complete	22	0	0	-	0m:02s	-	8/8/2013 1:29:29 PM
Premap <a href="#">Detailed report</a>	Complete	4	1	0	0m:00s	0m:00s	78MB	8/8/2013 1:29:30 PM
Map & Optimize <a href="#">Detailed report</a>	Complete	15	1	0	0m:16s	0m:17s	102MB	8/8/2013

**Report: tutorial (rev\_3)**

- Synthesis
  - Compiler Report
  - Pre-mapping Report**
    - Clock Summary
  - Mapper Report
    - Clock Conversion
    - Timing Report
      - Performance Summary
      - Clock Relationships
      - Interface Information
      - Detailed Report for Clocks
      - Resource Utilization
      - Hierarchical Area Report(eight bit
- Place and Route
  - Backannotation Report (13:29 08-Aug)
  - Session Log (13:29 08-Aug)

Synopsys Xilinx Technology Pre-mapping. Version map Copyright (C) 1991-2013, Synopsys, Inc. This software Product Version I-2013.03 beta

Mapper Startup Complete (Real Time elapsed 0h:00m:0s)

Linked File: eight\_bit\_uc\_scck.rpt

Printing clock summary report in "C:\sw\tutorial\

0N:MF144 : | Running in 32-bit mode.

0N:MF556 : | Clock conversion enabled

Design Input Complete (Real Time elapsed 0h:00m:00s)

Mapper Initialization Complete (Real Time elapsed 0h:00m:00s)

Start loading timing files (Real Time elapsed 0h:00m:00s)

routerable is 1.6,1.5999994618778267,1.871713156657

- Status - Reports whether the job is running or completed.

- | Type | ID    | Message   | Source Location | Log Location     | Time        | Report             |
|------|-------|---|-----------------|------------------|-------------|--------------------|
| 2    | MF206 | Auto Constraint mode is enabled                       |                 | slight bit up... | 13:28:46... | Pre-mapping Report |
| 2    | MF206 | Clock conversion enabled                              |                 | slight bit up... | 16:18:24... | Pre-mapping Report |
|      | FX104 | Found address in view work_slight_bit_up(verilog) ... | ahv_005         | slight bit up... | 13:28:48... | Pre-mapping Report |
|      |       | Found counter in view work_prgn_cnt(verilog) ...      | prc_033         | slight bit up... | 13:28:48... | Pre-mapping Report |

- Real and CPU times, peak memory, and a timestamp

The mapper summary table generates various reports such as an

- Click the Detailed Report link when applicable, to go to the log file and information about the selected report. These reports are written to the synlog folder for the active implementation.

For example, the Area Summary contains a resource usage count for components such as registers, LUTs, and I/O ports in the design. Click the Detailed report link to display the usage count information in the design for this report.

**Run Status**

Job Name	Status	Icon 1	Icon 2	Icon 3	CPU Time	Real Time	Memory	Date/Time
Compile Input <a href="#">Data feed report</a>	Complete	64	60	0	-	0m:18s	-	11/4/2011 8:12:36 AM
Promap <a href="#">Data feed report</a>	Complete	5	1	0	0m:13s	0m:13s	1/6MB	11/4/2011 9:12:30 AM
Map & Optimize <a href="#">Data feed report</a>	Complete	334	1143	0	06m:11s	15m:33s	1383MB	11/4/2011 8:28:23 AM

**Area Summary**

I/O ports	54	Non I/O Register bits	44412 (361%)
I/O Register bits	0	Block Rams	48 (43)
DSP40s	72		

**Report: tutorial (rev\_3)**

- Synthesis
  - Compiler Report
  - Pre-mapping Report
    - Clock Summary
    - Clock Conversion
  - Mapper Report
  - Timing Report
    - Performance Summary
    - Clock Relationships
    - Interface Information
  - Detailed Report for Clocks
  - Resource Utilization**
- Hierarchical Area Report(eight\_bit)
- Place and Route
  - Backannotation Report (13:29 08-Aug)
  - Session Log (13:29 08-Aug)

**Resource Usage Report for eight\_bit\_uc**

Mapping to part: xc7vx230cxf1157-1i

Cell usage:

DSP40E1	1 use
ED	8 uses
EDC	103 uses
EDCE	124 uses
EDC	5 uses
FDD	2 uses
EDPE	24 uses
GND	10 uses
MUXCY_T	13 uses
MUXCY	2 uses
RAM32X25	4 uses
VCC	10 uses
MORCY	20 uses
LUT1	20 uses
LUT2	23 uses
LUT3	9 uses
LUT4	77 uses
LUT6	73 uses
LUT6	154 uses
LUT6_2	2 uses

## Report Tab

Some reporting such as the Hierarchical Area Report are written to the Report tab of the Project Results view. These reports are typically not included in the log file; therefore, they are displayed separately.

### Hierarchical Area Report

The hierarchical area report is supported for the following technology families.

**Vendors****Technologies**

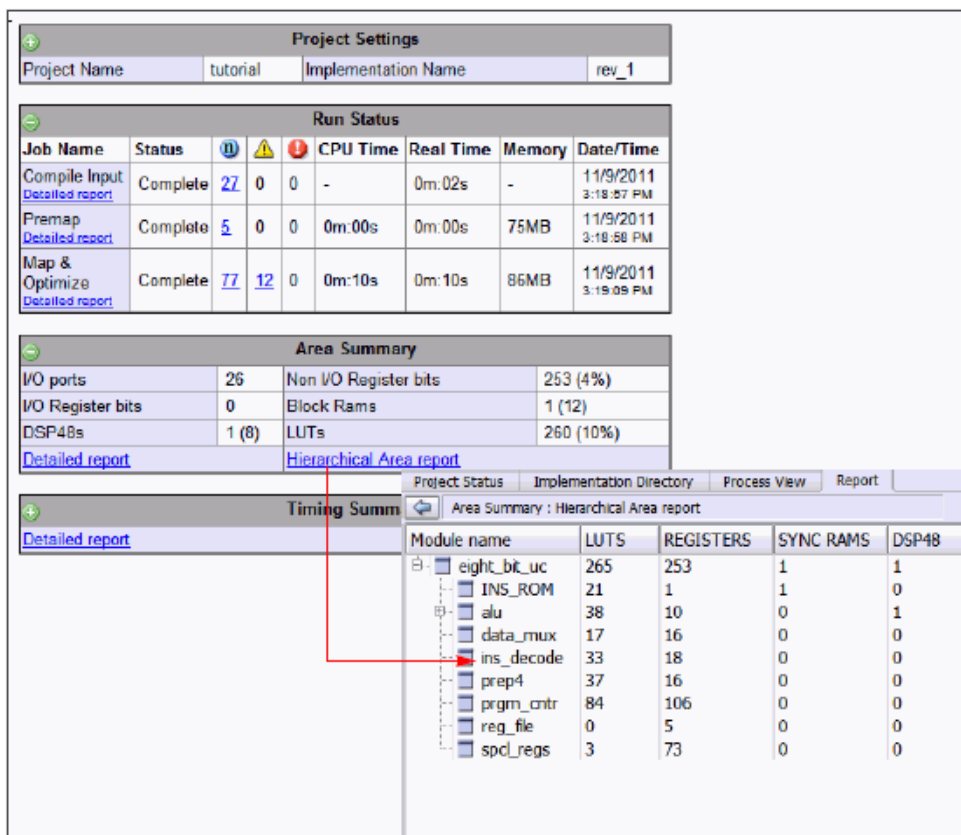
Microsemi

- IGLOO2 family
- RTG4 family
- Smartfusion2 family

A Hierarchical Area report is generated in a Report tab that you can access from the Project Status view. This report generates area usage for components such as sequential and combinational logic, RAM, and DSP blocks.

You can locate the Hierarchical Area report file in the following Implementation Directory: /synlog/report.

Use the arrow icon (  ) to get back to the main Project Status view.



**Project Settings**

Project Name	tutorial	Implementation Name	rev_1
--------------	----------	---------------------	-------

**Run Status**

Job Name	Status	U	W	!	CPU Time	Real Time	Memory	Date/Time
Compile Input <a href="#">Detailed report</a>	Complete	27	0	0	-	0m:02s	-	11/9/2011 3:18:57 PM
Premap <a href="#">Detailed report</a>	Complete	5	0	0	0m:00s	0m:00s	75MB	11/9/2011 3:18:58 PM
Map & Optimize <a href="#">Detailed report</a>	Complete	77	12	0	0m:10s	0m:10s	86MB	11/9/2011 3:19:09 PM

**Area Summary**

I/O ports	26	Non I/O Register bits	253 (4%)
I/O Register bits	0	Block Rams	1 (12)
DSP4Bs	1 (8)	LUTs	260 (10%)

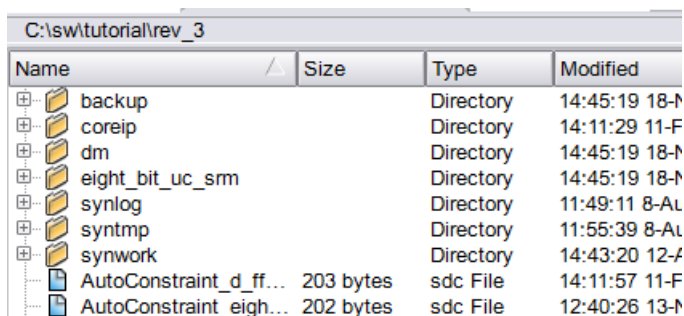
[Detailed report](#) [Hierarchical Area report](#)

**Timing Summary** [Area Summary : Hierarchical Area report](#)

Module name	LUTs	REGISTERS	SYNC RAMS	DSP4B
eight_bit_uc	265	253	1	1
INS_ROM	21	1	1	0
alu	38	10	0	1
data_mux	17	16	0	0
ins_decode	33	18	0	0
prep4	37	16	0	0
prgm_cntr	84	106	0	0
reg_file	0	5	0	0
spcl_regs	3	73	0	0

## Implementation Directory

An implementation is one version of a project, run with certain parameter or option settings. You can synthesize again, with a different set of options, to get a different implementation. In the Project view, an implementation is shown in the folder of its project; the active implementation is highlighted. You can display multiple implementations in the same Project view. The output files generated for the active implementation are displayed in the Implementation Directory.



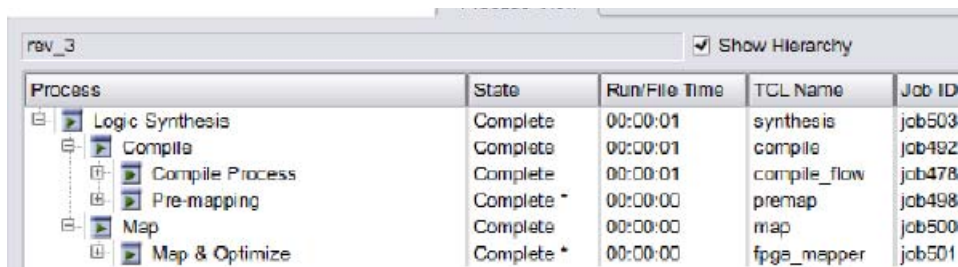
Name	Size	Type	Modified
backup		Directory	14:45:19 18-11
coreip		Directory	14:11:29 11-F
dm		Directory	14:45:19 18-11
eight_bit_uc_srm		Directory	14:45:19 18-11
synlog		Directory	11:49:11 8-A1
syntmp		Directory	11:55:39 8-A1
synwork		Directory	14:43:20 12-F
AutoConstraint_d_ff...	203 bytes	sdc File	14:11:57 11-F
AutoConstraint_eigh...	202 bytes	sdc File	12:40:26 13-11



## Process View

As process flow jobs become more complex, the benefits of exposing the underlying job flow is extremely valuable. The Process View gives you this visibility to track the design progress for the synthesis and place-and-route job flows.

Click the Process View tab on the right side of the Project Results view. This displays the job flow hierarchy run on the active implementation and is a function of this current implementation and its project settings.



The screenshot shows a window titled "rev\_3" with a "Show Hierarchy" checkbox checked. It displays a tree view of the process flow on the left and a corresponding table of job details on the right.

Process	State	Run/File Time	TCL Name	Job ID
Logic Synthesis	Complete	00:00:01	synthesis	job503
Compile	Complete	00:00:01	compile	job492
Compile Process	Complete	00:00:01	compile_flow	job478
Pre-mapping	Complete *	00:00:00	premap	job498
Map	Complete	00:00:00	map	job500
Map & Optimize	Complete *	00:00:00	fpga_mapper	job501

## Process View Displays and Controls

The Process View shows the current state of a job and allows you to control the run. You can see various aspects of the synthesis process flow, such as logical synthesis, premap, and map. If you run place and route, you can see its job processes as well.

Appropriate jobs of the process flow contains the following information:

- Job Input and Output Files
- Completion State

Displays if the job generated an error, warning, or was canceled.

- Job State
  - Out-of-date - Job needs to be run.
  - Running - Job is active.
  - Complete - Job has completed and is up-to-date.
  - Complete \* - Job is up-to-date, so the job is skipped.
- Run/File Time - Job process flow runtime in real time or file creation date timestamp.
- Job TCL Command - Job process name.

Each job has the following control commands that allows you to run jobs at any stage of the design process, for example map. Right-click on any job icon and select one of the following commands from the popup menu:

- Cancel *jobProcess* that is running
- Disable *jobProcess* that you do not want to run
- Run this *jobProcess* only
- Run to this *jobProcess* from the beginning of run
- Run from this *jobProcess* to the end of run




## Hierarchical Job Flows

A hierarchical job flow runs two or more subordinate jobs. Primitive jobs launch an executable, but have no subordinate jobs. The Logical Synthesis flow is a hierarchical job that runs the Compile and Map flows.

The state of a hierarchical job depends on the state of its subordinate jobs.

- If a subordinate job is out-of-date, then its parent job is out-of-date.
- If a subordinate job has an error, then its parent job terminates with this error.
- If a subordinate job has been canceled, then its parent job is canceled as well.
- If a subordinate job is running, then its parent job is also running.

The Process View is a hierarchical tree view. To collapse or expand the main hierarchical tree, enable or disable the Show Hierarchy option. Use the plus or minus icon to expand or collapse each process flow to show the details of the jobs. The icons below are used to show the information for the state of each process:

- Red arrow () - Job is out-of-date and needs to be rerun.
- Green arrow () - Job is up-to-date.
- Red Circle with! () - Job encountered an error.

## Other Windows and Views

Besides the Project view, the tool provides other windows and views that help you manage input and output files, direct the synthesis process, and analyze your design and its results. The following windows and views are described here:

- [Dockable GUI Entities](#), on page 37
- [Watch Window](#), on page 37
- [Tcl Script and Messages Windows](#), on page 40
- [Tcl Script Window](#), on page 41
- [Message Viewer](#), on page 41
- [Output Windows \(Tcl Script and Watch Windows\)](#), on page 45
- [Text Editor View](#), on page 45
- [Context Help Editor Window](#), on page 48
- [Interactive Attribute Examples](#), on page 50

See the following for descriptions of other views and windows that are not covered here:

Project View	<a href="#">The Project View</a> , on page 22
SCOPE Interface	<a href="#">SCOPE Tabs</a> , on page 213
HDL Analyst Schematic	<a href="#">Chapter 7, Analyzing with HDL Analyst</a>

## Dockable GUI Entities

Some of the main GUI entities can appear as either independent windows or docked elements of the main application window. These entities include the menu bar, Watch window, Tcl window, and various toolbars (see the description of each entity for details). Docked elements function effectively as *panes* of the application window; you can drag the border between two such panes to adjust their relative areas.

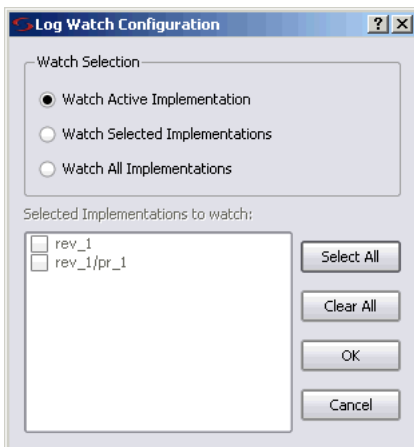
## Watch Window

The Watch window displays selected information from the log file (see [Log File, on page 157](#)) as a spreadsheet of parameters that you select to monitor. The values are updated when synthesis finishes.

### Watch Window Display

Display of the Watch window is controlled by the View ->Watch Window command. By default, the Watch window is below the Project view in the lower right corner of the main application window.

To access the Watch window configuration menu, right-click in any cell. Select Configure Watch to display the Log Watch Configuration dialog box.



In the Watch window, indicate which implementations to watch under Watch Selection. The selected implementation(s) will display in the Watch window.

You can move the Watch window anywhere on the screen; you can make it float in its own window (named Watch Window) or dock it at a docking area (an edge) of the application window. Double-click in the banner to toggle between docked and floating.

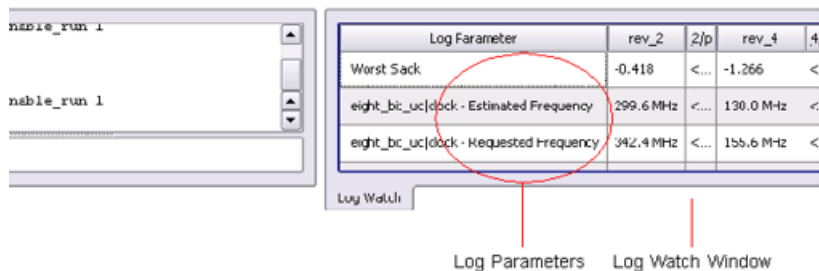
The Watch window has a special positioning popup menu that you access by right-clicking the window border. The following commands are in the menu:

Command	Description
Allow Docking	A toggle: when enabled, the window can be docked.
Hide	Hides the window; use View -> Watch Window to show it again.
Float in Main Window	A toggle: when enabled, the window is floated (undocked).

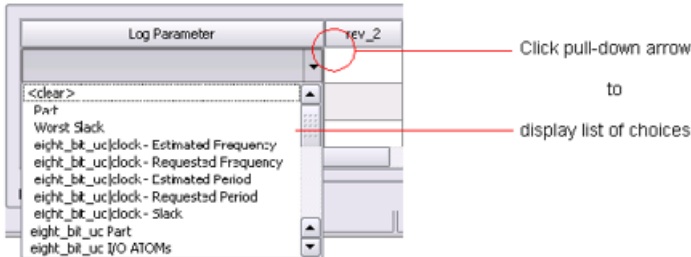
Right-clicking the window *title bar* when the Watch window is floating displays an alternative popup menu with commands Hide and Move; Move lets you position the window using either the arrow keys or the mouse.

## Using the Watch Window

You can view and compare the results of multiple implementations in the Watch window.



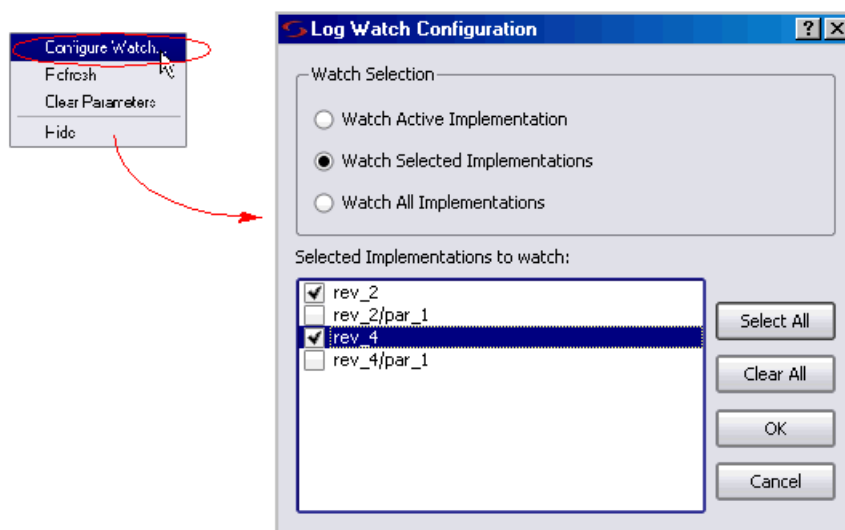
To choose log parameters from a pull-down menu, click in the Log Parameter section of the window. Click the pull-down arrow that appears to display the parameter list choices:



The Watch window creates an entry for each implementation of a project:

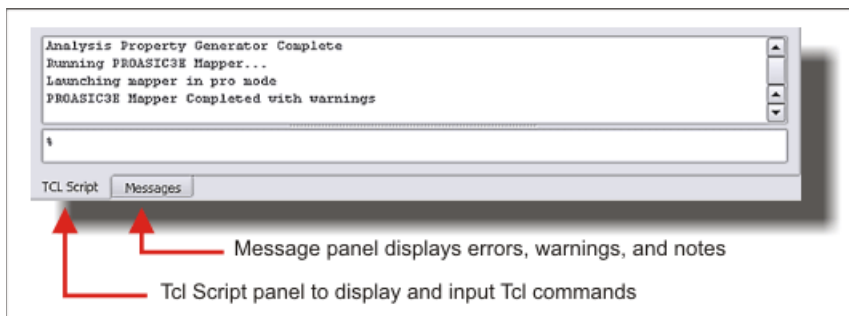
Log Parameter	rev_2	rev_4
Worst Slack	-0.418	-1.266
eight_bit_uc clock - Estimated Frequency	299.6 MHz	130.0 MHz
eight_bit_uc clock - Requested Frequency	342.4 MHz	155.6 MHz

To choose the implementations to watch, use the Log Watch Configuration dialog box. To display this box, right-click in the Watch window, then choose Configure Watch in the popup menu. Enable Watch Selected Implementations, then choose the implementations you want to watch in the list Selected Implementations to watch. The other buttons let you watch only the active implementation or all implementations.



## Tcl Script and Messages Windows

The Tcl window has tabs for the Tcl Script and Messages windows. By default, the Tcl windows are located below the Project Tree view in the lower left corner of the main application window.



You can float the Tcl windows by clicking on a window edge while holding the Ctrl or Shift key. You can then drag the window to float it anywhere on the screen or dock it at an edge of the application window. Double-click in the banner to toggle between docked and floating.



Right-clicking the Tcl windows *title bar* when the window is floating displays a popup menu with commands Hide and Move. Hide removes the window (use View ->Tcl Window to redisplay the window). Move lets you position the window using either the arrow keys or the mouse.

For more information about the Tcl windows, see [Tcl Script Window, on page 41](#) and [Message Viewer, on page 41](#).

## Tcl Script Window

The Tcl Script window is an interactive command shell that implements the Tcl command-line interface. You can type or paste Tcl commands at the prompt (“% ”). For a list of the available commands, type “help \*” (without the quotes) at the prompt. For general information about Tcl syntax, choose Help ->TCL.

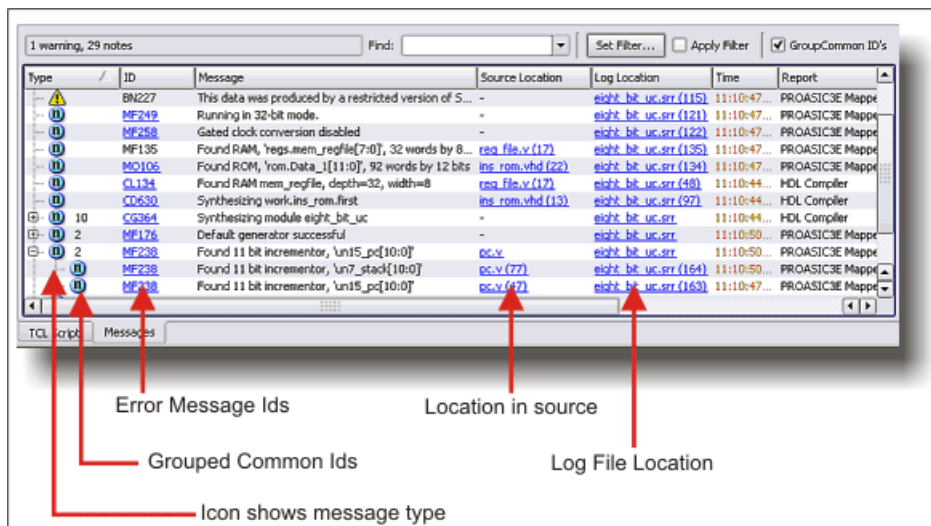
The Tcl script window also displays each command executed in the course of running the synthesis tool, regardless of whether it was initiated from a menu, button, or keyboard shortcut. Right-clicking inside the Tcl window displays a popup menu with the Copy, Paste, Hide, and Help commands.

*See also*

- [Chapter 2, Tcl Synthesis Commands](#), for information about the Tcl synthesis commands.
- [Generating a Job Script, on page 513](#) in the *User Guide*.

## Message Viewer

To display errors, warnings, and notes after running the synthesis tool, click the Messages tab in the Tcl Window. A spreadsheet-style interactive interface appears.







Interactive tasks in the Messages panel include:

- Drag the pane divider with the mouse to change the relative column size.
- Click on the ID entry to open online help for the error, warning, or note.
- Click on a Source Location entry to go to the section of code in the source HDL file that is causing the message.
- Click on a Log Location entry to go to its location in the log file.

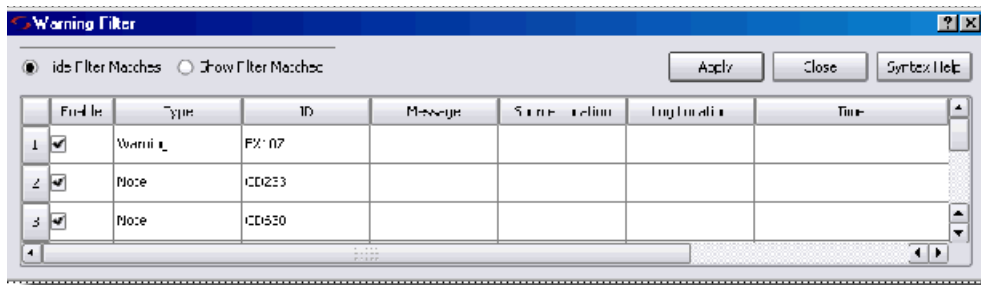
The following table describes the contents of the Messages panel. You can sort the messages by clicking the column headers. For further sorting, use Find and Filter. For details about using this window, see [Checking Results in the Message Viewer, on page 205](#) in the *User Guide*.

Item	Description
Find	Type into this field to find errors, warnings, or notes.
Filter	Opens the Warning Filter dialog box. See <a href="#">Messages Filter, on page 44</a> .
Apply Filter	Enable/disable the last saved filter.

Item	Description
Group Common ID's	<p>Enable/disable grouping of repeated messages. Groups are indicated by a number next to the type icon. There are two types of groups:</p> <ul style="list-style-type: none"> <li>• The same warning or note ID appears in multiple source files indicated by a dash in the source files column.</li> <li>• Multiple warnings or notes in the same line of source code indicated by a bracketed number.</li> </ul>
Type	<p>The icons indicate the type of message:</p> <p> Error</p> <p> Warning</p> <p> Note</p> <p> Advisory</p> <p>A plus sign next to an icon indicates that repeated messages are grouped together. Click the plus sign to expand and view the various occurrences of the message.</p>
ID	This is the message ID. You can select an underlined ID to launch help on the message.
Message	The error, warning, or note message text.
Source Location	The HDL source file that generated the error, warning, or note message.
Log Location	The location of the error, warning, or note message in the log file.
Time	<p>The time that the error, warning, or note message was recorded in the log file for the various stages of synthesis (for example: compiler, premap, and map). If you rerun synthesis, only new messages generate a new timestamp for this session.</p> <p><b>Note:</b> Once synthesis has run to completion, all the .srr files for the different stages of synthesis are merged into one unified .srr file. If you exit the GUI, these timestamps remain the same when you re-open the same project in the GUI again.</p>
Report	Indicates which section of the Log File report the error appears, for example Compiler or Mapper.

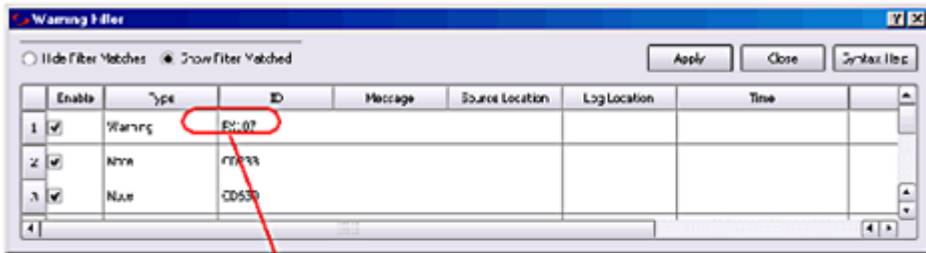
## Messages Filter

You filter which errors, warnings, and notes appear in the Messages panel of the Tcl Window using match criteria for each field. The selections are combined to produce the result. You can elect to hide or show the warnings that match the criteria you set. See [Checking Results in the Message Viewer, on page 205](#) in the *User Guide*.

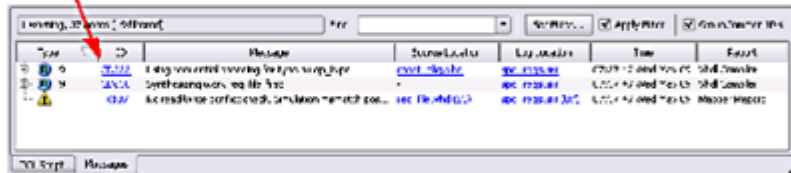


Item	Description
Hide Filter Matches	Hides matched criteria in the Messages Panel.
Show Filter Matches	Shows matched criteria in the Messages Panel.
Syntax Help	Gives quick syntax descriptions.
Apply	Applies the filter criteria to the Messages Panel report, without closing the window.
Type, ID, Message, Source Location, Log Location, Time, Report	Log file report criteria to use when filtering.

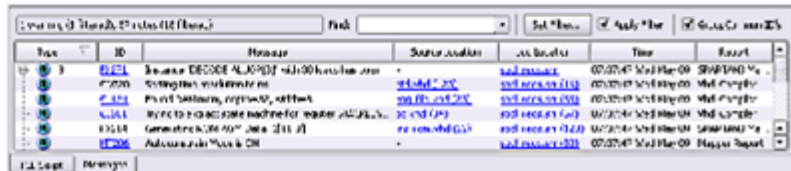
The following is a filtering example.



Show Filter  
Matches



Hide Filter  
Matches



## Output Windows (Tcl Script and Watch Windows)

The Output windows are the Tcl Script and Log Watch windows. To display or hide them, use View->Output Windows from the main menu. Refer to [Watch Window, on page 37](#) and [Tcl Script and Messages Windows, on page 40](#) for more information.

## Text Editor View

The Text Editor view displays text files. These can be constraint files, source code files, or other informational or report files. You can enter and edit text in the window. You use this window to update source code and fix syntax or synthesis errors. You can also use it to crossprobe the design. For information about using the Text Editor, see [Editing HDL Source Files with the Built-in Text Editor, on page 39](#) in the *User Guide*.

```

C:/tutorial/tutorial/tutorial/rtl/ins_decode.vhd
12  CLK : in std_logic;
13  RESET: in std_logic;
14  INST : in std_logic_vector(11 downto 0);
15  LONGK :out std_logic_vector(8 downto 0);
16  ALUOP  : out ALUOP_TYPE;
17  FWE    : out std_logic;
18  W_Reg_Write : out std_logic;
19  ALUA_SEL : out ALU_SEL_TYPE;
20  ALUB_SEL : out ALU_SEL_TYPE;
21  STATUS_Z_WRITE : out std_logic;
22  STATUS_C_WRITE : out std_logic;
23  TRIS_WE : out std_logic;
24  TWO_CYC_INST : out std_logic;
25  SKIP_INST : out std_logic;
26  OPCODE_GOTO : out std_logic;
27  OPCODE_CALL : out std_logic;
28  OPCODE_RETLOW : out std_logic
29 );
30 end INS_Decode;
31
32 Architecture RTL of Ins_Decode is
33

```

Ln 3 Col 14 Total 331 Ovr Block


## Opening the Text Editor

To open the Text Editor to edit an existing file, do one of the following:

- Double-click a source code file (.v or .vhd) in the Project view.
- Choose File ->Open. In the dialog box displayed, double-click a file to open it.

With the Microsoft® Windows® operating system, you can instead drag and drop a source file from a Windows folder into the gray background area of the GUI (*not* into any particular view).




To open the Text Editor on a new file, do one of the following:

- Choose File ->New, then specify the kind of text file you want to create.
- Click the HDL icon () to create and edit an HDL source file.

The Text Editor colors HDL source code keywords such as module and output blue and comments green.

## Text Editor Features

The Text Editor has the features listed in the following table.

Feature	Description
Color coding	Keywords are blue, comments green, and strings red. All other text is black.
Editing text	You can use the Edit menu or keyboard shortcuts for basic editing operations like Cut, Copy, Paste, Find, Replace, and Goto.
Completing keywords	To complete a keyword, type enough characters to make the string unique and then press the Esc key.
Indenting a block of text	The Tab key indents a selected block of text to the right. Shift-Tab indents text to the left.
Inserting a bookmark	Click the line you want to bookmark. Choose Edit ->Toggle Bookmark, type Ctrl-F2, or click the Toggle Bookmark icon (  ) on the Edit toolbar. The line number is highlighted to indicate that there is a bookmark at the beginning of the line.
Deleting a bookmark	Click the line with the bookmark. Choose Edit ->Toggle Bookmark, type Ctrl-F2, or click the Toggle Bookmark icon (  ) on the Edit toolbar.
Deleting all bookmarks	Choose Edit ->Delete all Bookmarks, type Ctrl-Shift-F2, or click the Clear All Bookmarks icon (  ) on the Edit toolbar.
Editing columns	Press and hold Alt, then drag the mouse down a column of text to select it.
Commenting out code	Choose Edit ->Advanced ->Comment Code. The rest of the current line is commented out: the appropriate comment prefix is inserted at the current text cursor position.
Checking syntax	Use Run ->Syntax Check to highlight syntax errors, such as incorrect keywords and punctuation, in source code. If the active window shows an HDL file, then only that file is checked. Otherwise, the entire project is checked.
Checking synthesis	Use Run ->Synthesis Check to highlight hardware-related errors in source code, like incorrectly coded flip-flops. If the active window shows an HDL file, then only that file is checked. Otherwise, the entire project is checked.

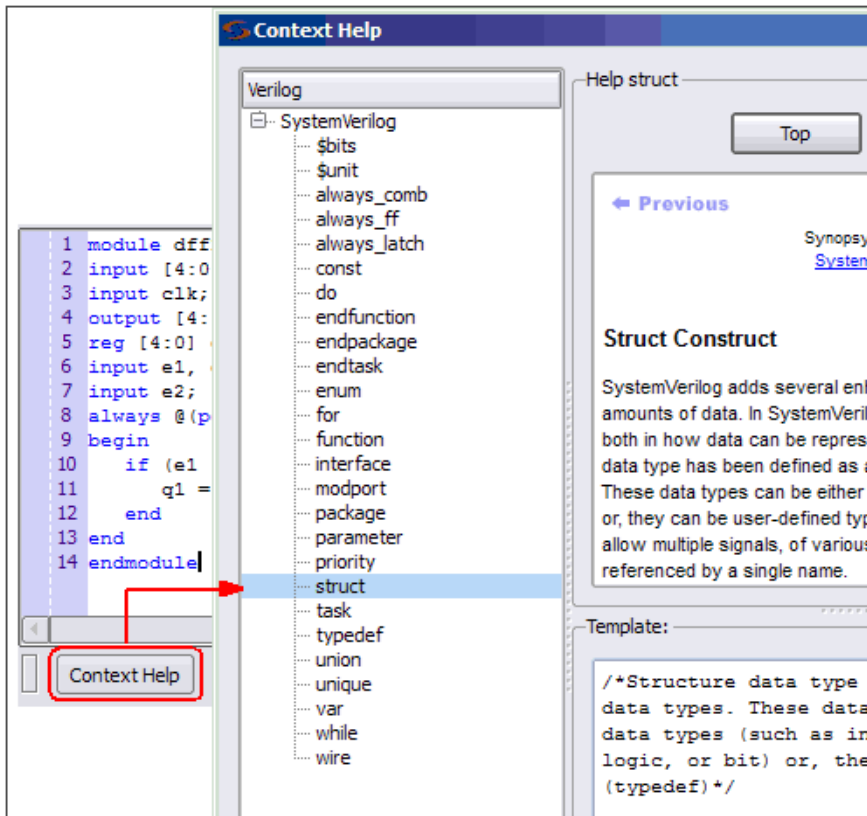
*See also:*

- [Editor Options Command, on page 432](#), for information on setting Text Editor preferences.
- [File Menu, on page 302](#), for information on printing setup operations.
- [Edit Menu Commands for the Text Editor, on page 308](#), for information on Text Editor editing commands.
- [Text Editor Popup Menu, on page 457](#), for information on the Text Editor popup menu.
- [Text Editor Toolbar, on page 61](#), for information on bookmark icons of the Edit toolbar.
- [Keyboard Shortcuts, on page 64](#), for information on keyboard shortcuts that can be used in the Text Editor.

## Context Help Editor Window

Use the Context Help button to copy Verilog, SystemVerilog, or VHDL constructs into your source file or Tcl constraint commands into your Tcl file. When you load a Verilog/SystemVerilog/VHDL file or Tcl file into the UI, the Context Help button displays at the bottom of the window. Click on this button to display the Context Help Editor.





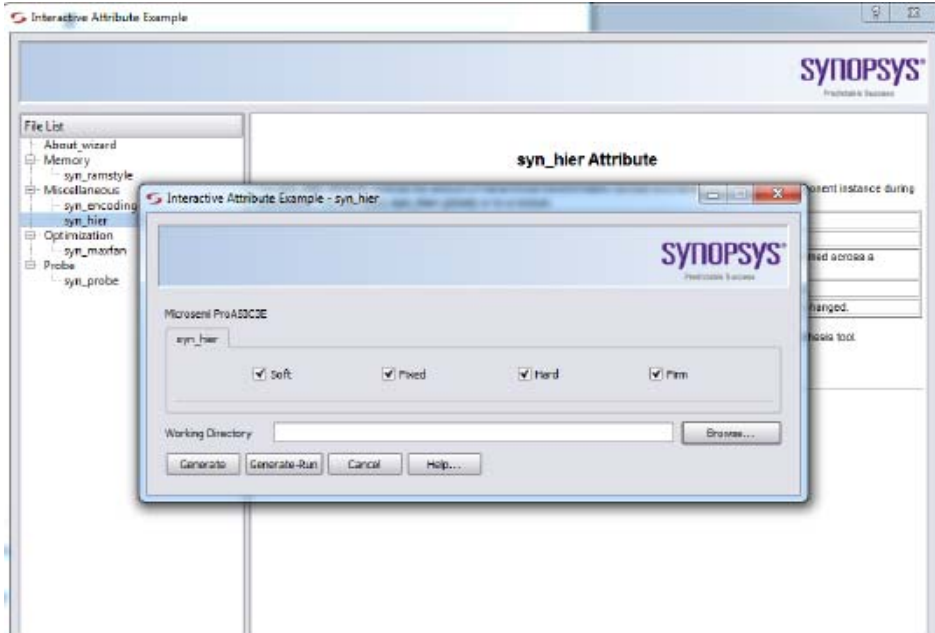
When you select a construct in the left-side of the window, the online help description for the construct is displayed. If the selected construct has this feature enabled, the online help topic is displayed on the top of the window and a generic code or command template for that construct is displayed at the bottom. The Insert Template button is also enabled. When you click the Insert Template button, the code or command shown in the template window is inserted into your file at the location of the cursor. This allows you to easily insert the code or constraint command and modify it for the design that you are going to synthesize. If you want to copy only parts of the template, select the code or constraint command you want to insert and click Copy. You can then paste it into your file.

Field/Option	Description
Top	Takes you to the top of the context help page for the selected construct.
Back	Takes you back to the last context help page previously viewed.
Forward	Once you have gone back to a context help page, use Forward to return to the original context help page from where you started.
Online Help	Brings up the interactive online help for the synthesis tool.
Copy	Allows you to copy selected code from the Template file and paste it into the editor file.
Insert Template	Automatically copies the code description in its entirety from the Template file to the editor file.

## Interactive Attribute Examples

The Interactive Attribute Examples wizard lets you select pre-defined attributes to run in a project. To use this tool:

1. Launch the wizard from Help->Demos & Examples.
2. Click the Examples button. Then click on Interactive Attribute Examples and the Launch Interactive Attributes Wizard links.



3. Double-click on an attribute to start the wizard.
4. Specify the Working Directory location to write your project.
5. Click Generate to generate a project for your attribute.

A project will be created with an implementation for each attribute value selected.

6. Click Generate Run to run synthesis for all the implementations. When synthesis completes:
  - The Technology view opens to show how the selected attribute impacts synthesis.
  - You can compare resource utilization and timing information between implementations in the Log Watch window.

# Using the Mouse

The mouse button operations in Synopsys FPGA product is standard; refer to [Mouse Operation Terminology](#) for a summary of supported functions. The tool provides support for:

- [Using Mouse Strokes](#), on page 53
- [Using the Mouse Buttons](#), on page 54
- [Using the Mouse Wheel](#), on page 56

## Mouse Operation Terminology

The following terminology is used to refer to mouse operations:

Term	Meaning
Click	Click with the <i>left</i> mouse button: press then release it without moving the mouse.
Double-click	Click the left mouse button twice rapidly, without moving the mouse.
Right-click	Click with the right mouse button.
Drag	Press the left mouse button, hold it down while moving the mouse, then release it. Dragging an object moves the object to where the mouse is released; then, releasing is sometimes called “ <i>dropping</i> ”. Dragging initiated when the mouse is not over an object often traces a selection rectangle, whose diagonal corners are at the press and release positions.
Press	Depress a mouse button; unless otherwise indicated, the left button is implied. It is sometimes used as an abbreviation for “press and hold”.
Hold	Keep a mouse button depressed. It is sometimes used as an abbreviation for “press and hold”.
Release	Stop holding a mouse button depressed.

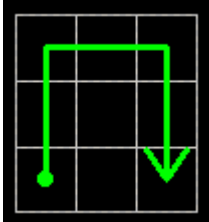
## Using Mouse Strokes

Mouse strokes are used to quickly perform simple repetitive commands. Mouse strokes are drawn by pressing and holding the right mouse button as you draw the pattern. The stroke must be at least 16 pixels in width or height to be recognized. You will see a green mouse trail as you draw the stroke (the actual color depends on the window background color).

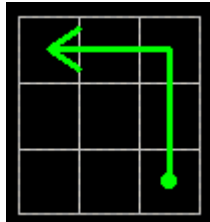
Some strokes are context sensitive. That is, the interpretation of the stroke depends upon the window in which the stroke is started. For example, in an HDL Analyst view, the right stroke means “Next Sheet.” In a dialog box, the right stroke means “OK.”

For information on each of the available mouse strokes, consult the Mouse Stroke Tutor.

The strokes you draw are interpreted on a grid of one to three rows. Some strokes are similar, differing only in the number of columns or rows, so it may take a little practice to draw them correctly. For example, the strokes for Redo and Back differ in that the Redo stroke is back and forth horizontally, within a single-row grid, while the Back stroke involves vertical movement as well.



Redo Last Operation

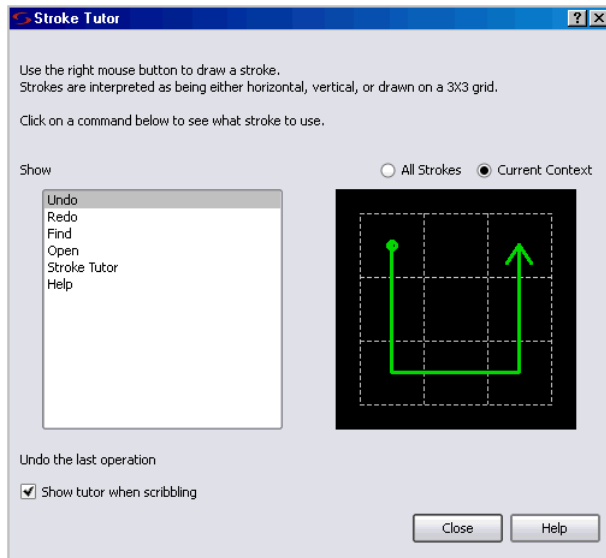


Back to Previous View

## The Mouse Stroke Tutor

Do one of the following to access the Mouse Stroke Tutor:

- Help->Stroke Tutor
- Draw a question mark stroke ("?")
- Scribble (Show tutor when scribbling must be enabled on the Stroke Help dialog box)



The tutor displays the available strokes along with a description and a diagram of the stroke. You can draw strokes while the tutor is displayed.

Mouse strokes are context sensitive. When viewing the Stroke Tutor, you can choose **All Strokes** or **Current Context** to view just the strokes that apply to the context of where you invoked the tutor. For example, if you draw the "?" stroke in an HDL Analyst window, the **Current Context** option in the tutor shows only those strokes recognized in the HDL Analyst window.

You can display the tutor while working in a window such as the HDL Analyst view. However you cannot display the tutor while a modal dialog is displayed, as input is restricted to the modal dialog.

## Using the Mouse Buttons

The operations you can perform using mouse buttons include the following:

- You select an object by clicking it. You deselect a selected object by clicking it. Selecting an object by clicking it deselects all previously selected objects.
- You can select and deselect multiple objects by pressing and holding the Control key (Ctrl) while clicking each of the objects.

- You can select a range of objects in a Hierarchy Browser, as follows:
  - select the first object in the range
  - scroll the tree of objects, if necessary, to display the last object in the range
  - press and hold the Shift key while clicking the last object in the range


Selecting a range of objects in a Hierarchy Browser crossprobes to the corresponding schematic, where the same objects are automatically selected.

- You can select all of the objects in a region by tracing a selection rectangle around them (lassoing).
- You can select text by dragging the mouse over it. You can alternatively select text containing no white space (such as spaces) by double-clicking it.
- Double-clicking sometimes selects an object and immediately initiates a default action associated with it. For example, double-clicking a source file in the Project view opens the file in a Text Editor window.
- You can access a contextual popup menu by clicking the right mouse button. The menu displayed is specific to the current context, including the object or window under the mouse.

For example, right-clicking a project name in the Project view displays a popup menu with operations appropriate to the project file.

Right-clicking a source (HDL) file in the Project view displays a popup menu with operations applicable to source files.

Right-clicking a selectable object in an HDL Analyst schematic also *selects* it, and deselects anything that was selected. The resulting popup menu applies only to the selected object. See [Working in the Schematic, on page 224](#) of the *FPGA Synthesis User Guide*, for information on HDL Analyst views.

Most of the mouse button operations involve selecting and deselecting objects. To use the mouse in this way in an HDL Analyst schematic, the mouse pointer must be the cross-hairs symbol: . If the cross-hairs pointer is not displayed, right-click the schematic background to display it.

## Using the Mouse Wheel

If your mouse has a wheel and you are using a Microsoft Windows platform, you can use the wheel to scroll and zoom, as follows:

- Whenever only a horizontal scroll bar is visible, rotating the wheel scrolls the window horizontally.
- Whenever a vertical scroll bar is visible, rotating the wheel scrolls the window vertically.
- Whenever both horizontal and vertical scroll bars are visible, rotating the wheel while pressing and holding the Shift key scrolls the window horizontally.
- In a window that can be zoomed, such as a graphics window, rotating the wheel while pressing and holding the Ctrl key zooms the window.



# Toolbars

Toolbars provide a quick way to access common menu commands by clicking their icons. The following standard toolbars are available:

- [Project Toolbar](#) — Project control and file manipulation.
- [Analyst Toolbar](#) — Manipulation of compiled and mapped schematic views.
- [Text Editor Toolbar](#) — Text editor bookmark commands.
- [FSM Viewer Toolbar](#) — Display of finite state machine (FSM) information.
- [Tools Toolbar](#) — Opens supporting tool.

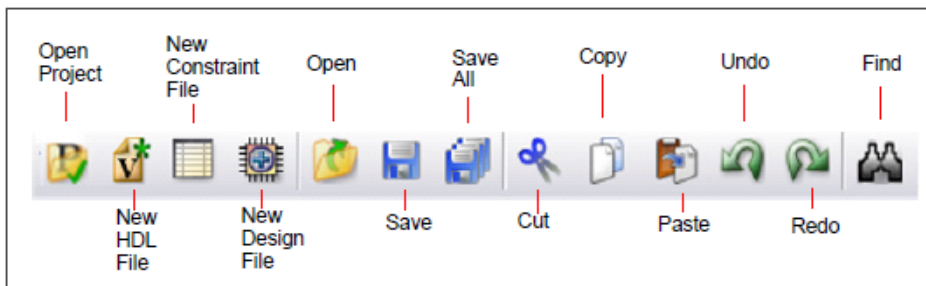
You can enable or disable the display of individual toolbars - see [Toolbar Command, on page 324](#).

By dragging a toolbar, you can move it anywhere on the screen: you can make it float in its own window or dock it at a docking area (an edge) of the application window. To move the menu bar to a docking area without docking it there (that is, to leave it floating), press and hold the Ctrl or Shift key while dragging it.

Right-clicking the window *title bar* when a toolbar is floating displays a popup menu with commands Hide and Move. Hide removes the window. Move lets you position the window using either the arrow keys or the mouse.









## Project Toolbar




The Project toolbar provides the following icons, by default:



The following table describes the default Project icons. Each is equivalent to a File or Edit menu command; for more information, see the following:

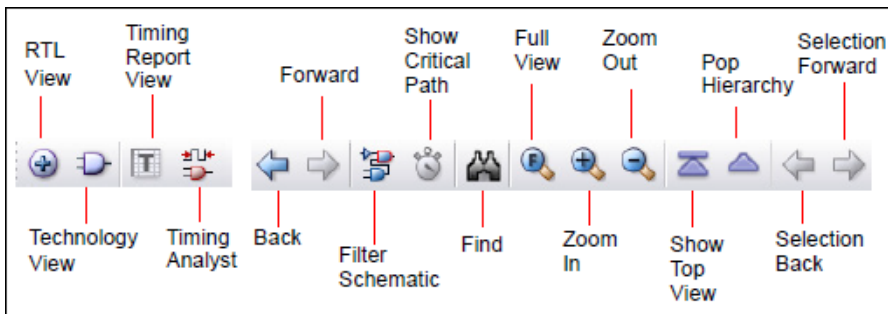
- [File Menu, on page 302](#)
- [Edit Menu, on page 307](#)

Icon	Description
 Open Project	Displays the Open Project dialog box to create a new project or to open an existing project. Same as File ->Open Project.
 New HDL file	Opens the Text Editor window with a new, empty source file. Same as File ->New, Verilog File or VHDL File.
 New Constraint File (SCOPE)	Opens the SCOPE spreadsheet with a new, empty constraint file. Same as File ->New, Constraint File (SCOPE).
 Open	Displays the Open dialog box, to open a file. Same as File ->Open.
 Save	Saves the current file. If the file has not yet been saved, this displays the Save As dialog box, where you specify the filename. The kind of file depends on the active view. Same as File ->Save.
 Save All	Saves all files associated with the current design. Same as File ->Save All.
 Cut	Cuts text or graphics from the active view, making it available to Paste. Same as Edit ->Cut.
 Paste	Pastes previously cut or copied text or graphics to the active view. Same as Edit ->Paste.

Icon	Description
 Undo	Undoes the last action taken. Same as Edit ->Undo.
 Redo	Performs the action undone by Undo. Same as Edit ->Redo.
 Find	Finds text in the Text Editor or objects in an RTL view or Technology view. Same as Edit ->Find.






## Analyst Toolbar

The Analyst toolbar becomes active after a design has been compiled. The toolbar provides the following icons, by default:



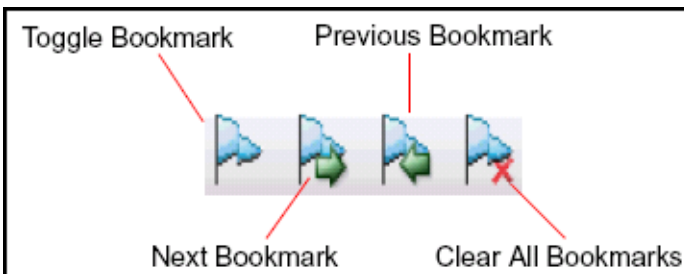
The following table describes the default Analyst icons. Each is equivalent to an HDL Analyst menu command - see [HDL Analyst Menu, on page 408](#), for more information.

Icon	Description
 RTL View	<p>Opens a new, hierarchical RTL view: a register transfer-level schematic of the compiled design, together with the associated Hierarchy Browser.</p> <p>Same as HDL Analyst -&gt;RTL -&gt;Hierarchical View.</p>
 Technology View	<p>Opens a new, hierarchical Technology view: a technology-level schematic of the mapped (synthesized) design, together with the associated Hierarchy Browser.</p> <p>Same as HDL Analyst -&gt;Technology -&gt;Hierarchical View.</p>
 Timing Analyst	<p>Generates and displays a custom timing report and view. The timing report provides more information than the default report (specific paths or more than five paths) or one that provides timing based on additional analysis constraint files. See <a href="#">Analysis Menu, on page 396</a>.</p> <p>Only available for certain device technologies.</p> <p>Same as Analysis -&gt;Timing Analyst.</p>
 Filter Schematic	<p>Filters your entire design to show only the selected objects. The result is a <i>filtered</i> schematic.</p> <p>Same as HDL Analyst -&gt;Filter Schematic.</p>
 Show Critical Path	<p>Filters your design to show only the instances (and their paths) whose slack times are within the slack margin of the worst slack time of the design (see HDL Analyst -&gt;Set Slack Margin). The result is flat if the entire design was already flat.</p> <p>Available only in a Technology view.</p>
 Back	<p>Goes backward in displaying schematics of the current HDL Analyst view.</p> <p>Same as View -&gt;Back.</p>
 Forward	<p>Goes forward in displaying schematics of the current HDL Analyst view.</p> <p>Same as View -&gt;Forward.</p>
 Zoom In	<p>Zooms the view in or out. Buttons stay active until deselected.</p>
 Zoom Out	<p>Same as View -&gt;Zoom In or View -&gt;Zoom Out.</p>





Icon	Description
 Zoom Full	Zoom that reduces the active view to display the entire design. Same as View ->Full View.
 Show Top Level	Displays the schematic for the top-level view.
 Pop Hierarchy	Traverses the schematic hierarchy using pop mode.
 Selection Back	Displays the previous schematic that was selected.
 Selection Forward	Toggles back to the original schematic that was previously selected.

## Text Editor Toolbar

The Edit toolbar is active whenever the Text Editor is active. You use it to edit *bookmarks* in the file. (Other editing operations are located on the Project toolbar - see [Project Toolbar, on page 57](#).) The Edit toolbar provides the following icons, by default:

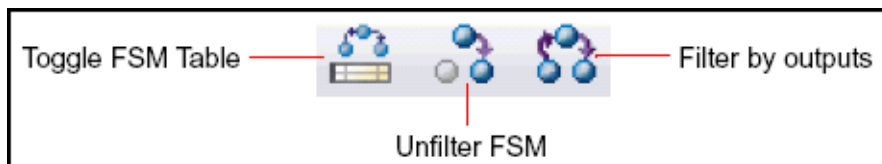


The following table describes the default Edit icons. Each is available in the Text Editor, and each is equivalent to an Edit menu command there - see [Edit Menu Commands for the Text Editor, on page 308](#), for more information.




Icon	Description
 Toggle Bookmark	Alternately inserts and removes a bookmark at the line that contains the text cursor. Same as Edit ->Toggle bookmark.
 Next Bookmark	Takes you to the next bookmark. Same as Edit ->Next bookmark.
 Previous Bookmark	Takes you to the previous bookmark. Same as Edit ->Previous bookmark.
 Clear All Bookmarks	Removes all bookmarks from the Text Editor window. Same as Edit ->Delete all bookmarks.

## FSM Viewer Toolbar

When you push down into a state machine primitive in an RTL view, the FSM Viewer displays and enables the FSM toolbar. The FSM Viewer graphically displays the states and transitions. It also lists them in table form. By default, the FSM toolbar provides the following icons, providing access to common FSM Viewer commands.








The following table describes the default FSM icons. Each is available in the FSM viewer, and each is equivalent to a View menu command available there - see [View Menu, on page 321](#), for more information.

Icon	Description
 Toggle FSM Table	Toggles the display of state-and-transition tables. Same as View->FSM Table.
 Unfilter FSM	Restores a filtered FSM diagram so that all the states and transitions are showing. Same as View->Unfilter.
 Filter by outputs	Hides all but the selected state(s), their output transitions, and the destination states of those transitions. Same as View->Filter->By output transitions.

## Tools Toolbar

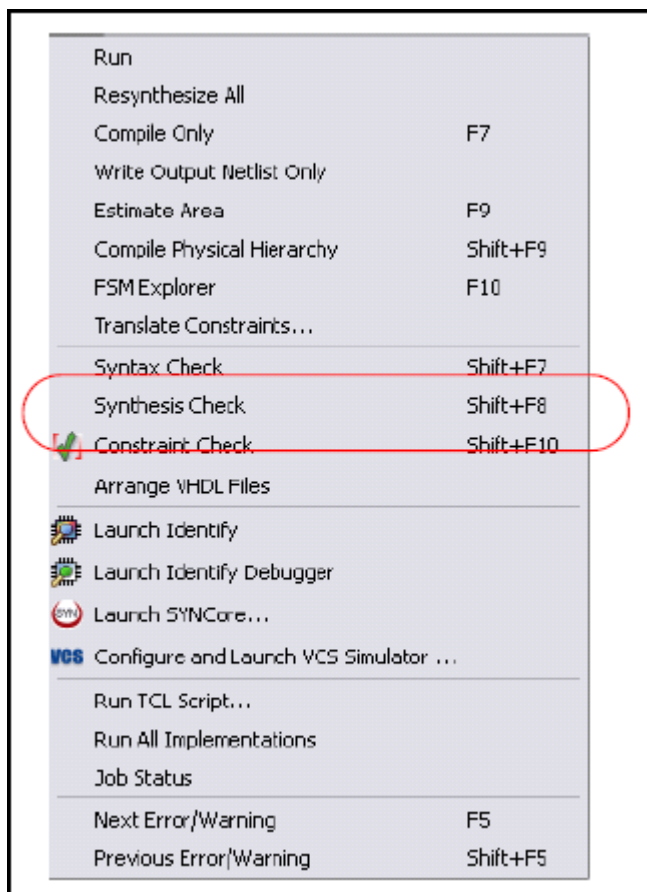
The Tools Toolbar opens supporting tool.

Icon	Description
 Constraint Check	Checks the syntax and applicability of the timing constraints in the constraint file for your project and generates a report ( <i>project_name_cck.rpt</i> ). Same as Run->Constraint Check.
 Identify Instrumentor	Brings up the Synopsys Identify Instrumentor product. For more information, see <a href="#">Working with the Identify Tools, on page 560</a> of the User Guide.
 Launch Identify Debugger	Launches the Synopsys Identify Debugger product. For more information, see <a href="#">Working with the Identify Tools, on page 560</a> of the User Guide.
 Launch SYNCore	Launches the SYNCore IP wizard. This tool helps you build IP blocks such as memory models for your design. For more information, see <a href="#">Launch SYNCore Command, on page 385</a> .
 VCS Simulator	Configures and launches the VCS simulator.

# Keyboard Shortcuts

Keyboard shortcuts are key sequences that you type in order to run a command. Menu list keyboard shortcuts next to the corresponding commands.

For example, to check syntax, you can press and hold the Shift key while you type the F7 key, instead of using the menu command Run ->Syntax Check.



The following table describes the keyboard shortcuts.



Keyboard Shortcut	Description
b	<p>In an RTL or Technology view, shows all logic between two or more selected objects (instances, pins, ports). The result is a <i>filtered</i> schematic. Limited to the current schematic.</p> <p>Same as HDL Analyst -&gt;Current Level -&gt;Expand Paths (see <a href="#">HDL Analyst Menu: Filtering and Flattening Commands, on page 411</a>).</p>
Ctrl-++ (number pad)	<p>In the FSM Viewer, hides all but the selected state(s), their output transitions, and the destination states of those transitions.</p> <p>Same as View -&gt;Filter -&gt;By output transitions.</p>
Ctrl+- (number pad)	<p>In the FSM Viewer, hides all but the selected state(s), their input transitions, and the origin states of those transitions.</p> <p>Same as View -&gt;Filter -&gt;By input transitions.</p>
Ctrl-+* (number pad)	<p>In the FSM Viewer, hides all but the selected state(s), their input and output transitions, and their predecessor and successor states.</p> <p>Same as View -&gt;Filter -&gt;By any transition.</p>
Ctrl-1	<p>In an RTL or Technology view, zooms the active view, when you click, to full (normal) size. Same as View -&gt;Normal View.</p>
Ctrl-a	<p>Centers the window on the design. Same as View -&gt;Pan Center.</p>
Ctrl-b	<p>In an RTL or Technology view, shows all logic between two or more selected objects (instances, pins, ports). The result is a <i>filtered</i> schematic. Operates hierarchically, on lower levels as well as the current schematic.</p> <p>Same as HDL Analyst -&gt;Hierarchical -&gt;Expand Paths (see <a href="#">HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409</a>).</p>
Ctrl-c	<p>Copies the selected object. Same as Edit -&gt;Copy. This shortcut is sometimes available even when Edit -&gt;Copy is not. See, for instance, <a href="#">Find Command (HDL Analyst), on page 313</a>.)</p>
Ctrl-d	<p>In an RTL or Technology view, selects the driver for the selected net. Operates hierarchically, on lower levels as well as the current schematic.</p> <p>Same as HDL Analyst -&gt;Hierarchical -&gt;Select Net Driver (see <a href="#">HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409</a>).</p>

Keyboard Shortcut	Description
Ctrl-e	<p>In an RTL or Technology view, expands along the paths from selected pins or ports, according to their directions, to the nearest objects (no farther). The result is a <i>filtered</i> schematic. Operates hierarchically, on lower levels as well as the current schematic.</p> <p>Same as HDL Analyst-&gt;Hierarchical -&gt;Expand (see <a href="#">HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409</a>).</p>
Ctrl-Enter (Return)	<p>In the FSM Viewer, hides all but the selected state(s).</p> <p>Same as View-&gt;Filter-&gt;Selected (see <a href="#">View Menu, on page 321</a>).</p>
Ctrl-f	Finds the selected object. Same as Edit->Find.
Ctrl-F2	<p>Alternately inserts and removes a bookmark to the line that contains the text cursor.</p> <p>Same as Edit-&gt;Toggle bookmark (see <a href="#">Edit Menu Commands for the Text Editor, on page 308</a>).</p>
Ctrl-F4	Closes the current window. Same as File ->Close.
Ctrl-F6	Toggles between active windows.
Ctrl-g	<p>In the Text Editor, jumps to the specified line. Same as Edit-&gt;Goto (see <a href="#">Edit Menu Commands for the Text Editor, on page 308</a>).</p> <p>In an RTL or Technology view, selects the sheet number in a multiple-page schematic. Same as View-&gt;View Sheets (see <a href="#">View Menu: RTL and Technology Views Commands, on page 322</a>).</p>
Ctrl-h	In the Text Editor, replaces text. Same as Edit->Replace (see <a href="#">Edit Menu Commands for the Text Editor, on page 308</a> ).
Ctrl-i	In an RTL or Technology view, selects instances connected to the selected net. Operates hierarchically, on lower levels as well as the current schematic. Same as HDL Analyst->Hierarchical->Select Net Instances (see <a href="#">HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409</a> ).
Ctrl-j	<p>In an RTL or Technology view, displays the unfiltered schematic sheet that contains the net driver for the selected net. Operates hierarchically, on lower levels as well as the current schematic.</p> <p>Same as HDL Analyst-&gt;Hierarchical-&gt;Goto Net Driver (see <a href="#">HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409</a>).</p>

Keyboard Shortcut	Description
Ctrl-l	<p>In the FSM Viewer, or an RTL or Technology view, toggles zoom locking. When locking is enabled, if you resize the window the displayed schematic is resized proportionately, so that it occupies the same portion of the window.</p> <p>Same as View-&gt;Zoom Lock (see <a href="#">View Menu Commands: All Views, on page 321</a>).</p>
Ctrl-m	<p>In an RTL or Technology view, expands inside the subdesign, from the lower-level port that corresponds to the selected pin, to the nearest objects (no farther). Same as HDL Analyst-&gt;Hierarchical-&gt;Expand Inwards (see <a href="#">HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409</a>).</p>
Ctrl-n	Creates a new file or project. Same as File->New.
Ctrl-o	Opens an existing file or project. Same as File->Open.
Ctrl-p	Prints the current view. Same as File->Print.
Ctrl-q	In an RTL or Technology view, toggles the display of visual properties of instances, pins, nets, and ports in a design.
Ctrl-r	<p>In an RTL or Technology view, expands along the paths from selected pins or ports, according to their directions, until registers, ports, or black boxes are reached. The result is a <i>filtered</i> schematic. Operates hierarchically, on lower levels as well as the current schematic.</p> <p>Same as HDL Analyst-&gt;Hierarchical-&gt;Expand to Register/Port (see <a href="#">HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409</a>).</p>
Ctrl-s	In the Project View, saves the file. Same as File ->Save.
Ctrl-t	<p>Toggles display of the Tcl window.</p> <p>Same as View -&gt;Tcl Window (see <a href="#">View Menu, on page 321</a>).</p>
Ctrl-u	<p>In the Text Editor, changes the selected text to lower case. Same as Edit-&gt;Advanced-&gt;Lowercase (see <a href="#">Edit Menu Commands for the Text Editor, on page 308</a>).</p> <p>In the FSM Viewer, restores a filtered FSM diagram so that all the states and transitions are showing. Same as View-&gt;Unfilter (see <a href="#">View Menu: FSM Viewer Commands, on page 323</a>).</p>
Ctrl-v	Pastes the last object copied or cut. Same as Edit ->Paste.

Keyboard Shortcut	Description
Ctrl-x	Cuts the selected object(s), making it available to Paste. Same as Edit ->Cut.
Ctrl-y	In an RTL or Technology view, goes forward in the history of displayed sheets for the current HDL Analyst view. Same as View->Forward (see <a href="#">View Menu: RTL and Technology Views Commands, on page 322</a> ). In other contexts, performs the action undone by Undo. Same as Edit->Redo.
Ctrl-z	In an RTL or Technology view, goes backward in the history of displayed sheets for the current HDL Analyst view. Same as View->Back (see <a href="#">View Menu: RTL and Technology Views Commands, on page 322</a> ). In other contexts, undoes the last action. Same as Edit ->Undo.
Ctrl-Shift-F2	Removes all bookmarks from the Text Editor window. Same as Edit ->Delete all bookmarks (see <a href="#">Edit Menu Commands for the Text Editor, on page 308</a> ).
Ctrl-Shift-h	In an RTL or Technology view, shows all pins on selected <i>transparent</i> hierarchical (non-primitive) instances. Pins on primitives are always shown. Available only in a filtered schematic. Same as HDL Analyst ->Show All Hier Pins (see <a href="#">HDL Analyst Menu: Analysis Commands, on page 415</a> ).
Ctrl-Shift-i	In an RTL or Technology view, selects all instances on the current schematic level (all sheets). This does <i>not</i> select instances on other levels. Same as HDL Analyst->Select All Schematic->Instances (see <a href="#">HDL Analyst Menu, on page 408</a> ).
Ctrl-Shift-p	In an RTL or Technology view, selects all ports on the current schematic level (all sheets). This does <i>not</i> select ports on other levels. Same as HDL Analyst->Select All Schematic->Ports (see <a href="#">HDL Analyst Menu, on page 408</a> ).
Ctrl-Shift-u	In the Text Editor, changes the selected text to lower case. Same as Edit->Advanced->Uppercase (see <a href="#">Edit Menu Commands for the Text Editor, on page 308</a> ).

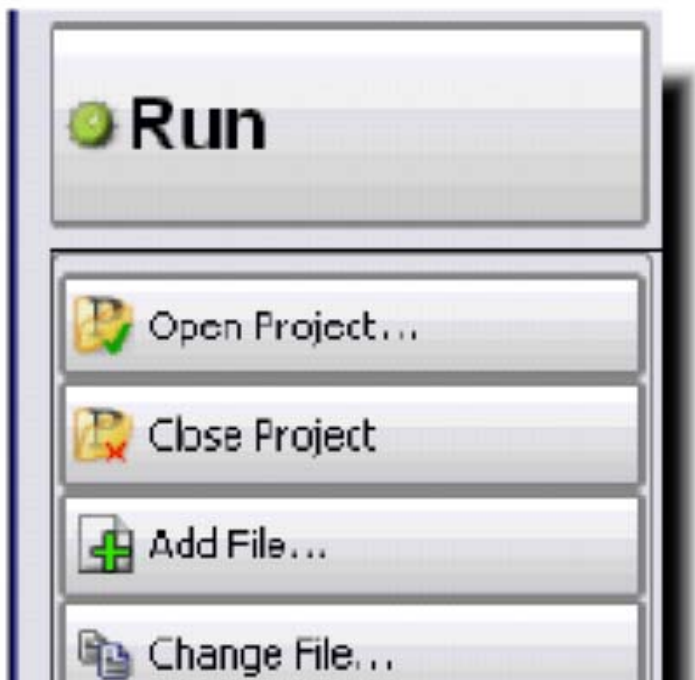
Keyboard Shortcut	Description
d	In an RTL or Technology view, selects the driver for the selected net. Limited to the current schematic. Same as HDL Analyst ->Current Level ->Select Net Driver (see <a href="#">HDL Analyst Menu, on page 408</a> ).
Delete (DEL)	Removes the selected files from the project. Same as Project->Remove Files From Project.
e	In an RTL or Technology view, expands along the paths from selected pins or ports, according to their directions, to the nearest objects (no farther). Limited to the current schematic. Same as HDL Analyst->Current Level->Expand (see <a href="#">HDL Analyst Menu, on page 408</a> ).
F1	Provides context-sensitive help. Same as Help->Help.
F2	In an RTL or Technology view, toggles traversing the hierarchy using the push/pop mode. Same as View->Push/Pop Hierarchy (see <a href="#">View Menu: RTL and Technology Views Commands, on page 322</a> ). In the Text Editor, takes you to the next bookmark. Same as Edit->Next bookmark (see <a href="#">Edit Menu Commands for the Text Editor, on page 308</a> ).
F4	In the Project view, adds a file to the project. Same as Project->Add Source File (see <a href="#">Build Project Command, on page 306</a> ). In an RTL or Technology view, zooms the view so that it shows the entire design. Same as View->Full View (see <a href="#">View Menu: RTL and Technology Views Commands, on page 322</a> ).
F5	Displays the next source file error. Same as Run->Next Error/Warning (see <a href="#">Run Menu, on page 377</a> ).
F7	Compiles your design, without mapping it. Same as Run->Compile Only (see <a href="#">Run Menu, on page 377</a> ).
F8	Synthesizes (compiles and maps) your design. Same as Run->Synthesize (see <a href="#">Run Menu, on page 377</a> ).
F11	Toggles zooming in. Same as View->Zoom In (see <a href="#">View Menu: RTL and Technology Views Commands, on page 322</a> ).

Keyboard Shortcut	Description
F12	In an RTL or Technology view, filters your entire design to show only the selected objects. Same as HDL Analyst->Filter Schematic - see <a href="#">HDL Analyst Menu: Filtering and Flattening Commands, on page 411</a> .
i	In an RTL or Technology view, selects instances connected to the selected net. Limited to the current schematic. Same as HDL Analyst->Current Level->Select Net Instances (see <a href="#">HDL Analyst Menu, on page 408</a> ).
j	In an RTL or Technology view, displays the unfiltered schematic sheet that contains the net driver for the selected net. Same as HDL Analyst->Current Level->Goto Net Driver (see <a href="#">HDL Analyst Menu, on page 408</a> ).
r	In an RTL or Technology view, expands along the paths from selected pins or ports, according to their directions, until registers, ports, or black boxes are reached. The result is a <i>filtered</i> schematic. Limited to the current schematic. Same as HDL Analyst ->Current Level->Expand to Register/Port (see <a href="#">HDL Analyst Menu, on page 408</a> ).
Shift-F2	In the Text Editor, takes you to the previous bookmark.
Shift-F4	Allows you to add source files to your project (Project->Add Source Files).
Shift-F5	Displays the previous source file error. Same as Run->Previous Error/Warning (see <a href="#">Run Menu, on page 377</a> ).
Shift-F7	Checks source file syntax. Same as Run->Syntax Check (see <a href="#">Run Menu, on page 377</a> ).
Shift-F8	Checks synthesis. Same as Run->Synthesis Check (see <a href="#">Run Menu, on page 377</a> ).
Shift-F10	Checks the timing constraints in the constraint files in your project and generates a report ( <i>project_name_cck.rpt</i> ). Same as Run->Constraint Check (see <a href="#">Run Menu, on page 377</a> ). In an RTL or Technology view, lets you pan (scroll) the schematic by dragging it with the mouse. Same as View ->Pan (see <a href="#">View Menu: RTL and Technology Views Commands, on page 322</a> ).

Keyboard Shortcut	Description
Shift-F11	Toggles zooming out. Same as View->Zoom Out (see <a href="#">View Menu, on page 321</a> ).
Shift-Left Arrow	Displays the previous sheet of a multiple-sheet schematic.
Shift-Right Arrow	Displays the next sheet of a multiple-sheet schematic.
Shift-s	<p>Dissolves the selected instances, showing their lower-level details. Dissolving an instance one level replaces it, in the current sheet, by what you would see if you pushed into it using the push/pop mode. The rest of the sheet (not selected) remains unchanged.</p> <p>The number of levels dissolved is the Dissolve Levels value in the Schematic Options dialog box. The type (filtered or unfiltered) of the resulting schematic is unchanged from that of the current schematic. However, the effect of the command is different in filtered and unfiltered schematics.</p> <p>Same as HDL Analyst -&gt;Dissolve Instances - see <a href="#">Dissolve Instances, on page 417</a>.</p>

## Buttons and Options

The Project view contains several buttons and a few additional features that give you immediate access to some of the more common commands and user options.



The following table describes the Project View buttons and options.



Button/Option	Action
Open Project...	Opens a new or existing project. Same as File->Open Project (see <a href="#">Open Project Command, on page 307</a> ).
Close Project	Closes the current project. Same as File->Close Project (see <a href="#">Run Menu, on page 377</a> ).
Add File...	Adds a source file to the project. Same as Project->Add Source File (see <a href="#">Build Project Command, on page 306</a> ).
Change File...	Replaces one source file with another. Same as Project ->Change File (see <a href="#">Change File Command, on page 333</a> ).
Add Implementation	Creates a new implementation.
Implementation Options	Displays the Implementation Options dialog box, where you can set various options for synthesis. Same as Project->Implementation Options (see <a href="#">in the User GuideImplementation Options Command, on page 342</a> ).
Add P&R Implementation	Creates a place-and-route implementation to control and run place and route from within the synthesis tool. See <a href="#">Add P&amp;R Implementation Popup Menu Command, on page 474</a> for a description of the dialog box, and <a href="#">Running P&amp;R Automatically after Synthesis, on page 558</a> in the <i>User Guide</i> for information about using this feature.
View Log	Displays the log file. Same as View->View Log File (see <a href="#">View Menu, on page 321</a> ).
Frequency (MHz)	Sets the global frequency, which you can override locally with attributes. Same as enabling the Frequency (MHz) option on the Constraints panel of the Implementation Options dialog box.

Button/Option	Action
Auto Constrain	<p>When Auto Constrain is enabled and no clocks are defined, the software automatically constrains the design to achieve best possible timing by reducing periods of individual clock and the timing of any timed I/O paths in successive steps.</p> <p>See <a href="#">Using Auto Constraints, on page 376</a> in the <i>User Guide</i> for detailed information about using this option.</p> <p>You can also set this option on the Constraints panel of the Implementation Options dialog box.</p>
FSM Compiler	<p>Turning on this option enables special FSM optimizations. Same as enabling the FSM Compiler option on the Options panel of the Implementation Options dialog box (see <a href="#">Optimizing State Machines, on page 424</a> in the <i>User Guide</i>).</p>
FSM Explorer	<p>When enabled, the FSM Explorer selects an encoding style for the finite state machines in your design.</p> <p>Same as enabling the FSM Explorer option on the Options panel of the Implementation Options dialog box. For more information, see <a href="#">Running the FSM Compiler, on page 425</a> in the <i>User Guide</i>.</p>

Button/Option	Action
Resource Sharing	<p>When enabled, makes the compiler use resource sharing techniques. This option does not affect resource sharing by the mapper.</p> <p>The option is the same as the Resource Sharing option on the Options panel of the Implementation Options dialog box. See <a href="#">Sharing Resources, on page 422</a> in the <i>User Guide</i> for usage details.</p>
Retiming	<p>When enabled, improves the timing performance of sequential circuits. The retiming process moves storage devices (flip-flops) across computational elements with no memory (gates/LUTs) to improve the performance of the circuit. This option also adds a retiming report to the log file.</p> <p>Same as enabling the Retiming option on the Options panel of the Implementation Options dialog box. Use the <code>syn_allow_retiming</code> attribute to enable or disable retiming for individual flip-flops. See <a href="#">syn_allow_retiming, on page 59</a> for syntax details.</p>
Run	<p>Runs synthesis (compilation and mapping).</p> <p>Same as the Run-&gt;Run command (see <a href="#">Run Menu, on page 377</a>).</p>



## CHAPTER 3

# HDL Analyst Tool

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The HDL Analyst tool helps you examine your design and synthesis results, and analyze how you can improve design performance and area.

The following describe the HDL Analyst tool and the operations you can perform with it.

- [HDL Analyst Views and Commands](#), on page 78
- [Schematic Objects and Their Display](#), on page 88
- [Basic Operations on Schematic Objects](#), on page 97
- [Multiple-sheet Schematics](#), on page 102
- [Exploring Design Hierarchy](#), on page 105
- [Filtering and Flattening Schematics](#), on page 113
- [Timing Information and Critical Paths](#), on page 119

# HDL Analyst Views and Commands


The HDL Analyst tool graphically displays information in two schematic views: the RTL and Technology views (see [RTL View, on page 78](#) and [Technology View, on page 80](#) for information). The graphic representation is useful for analyzing and debugging your design, because you can visualize where coding changes or timing constraints might reduce area or increase performance.

This section gives you information about the following:

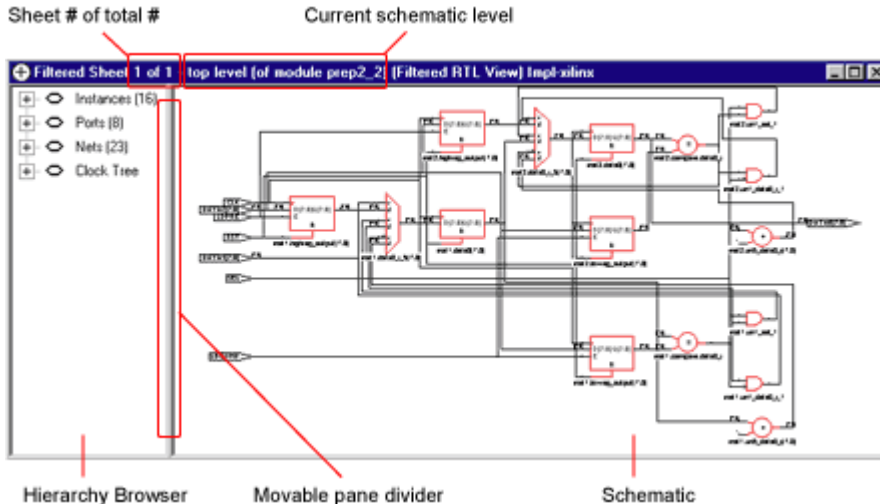
- [Hierarchy Browser](#), on page 82
- [FSM Viewer Window](#), on page 83
- [Filtered and Unfiltered Schematic Views](#), on page 85
- [Accessing HDL Analyst Commands](#), on page 86

## RTL View

The RTL view provides a high-level, technology-independent, graphic representation of your design after compilation, using technology-independent components like variable-width adders, registers, large multiplexers, and state machines. RTL views correspond to the srs netlist files generated during compilation. RTL views are only available after your design has been successfully compiled. For information about the other HDL Analyst view (the Technology view generated after mapping), see [Technology View, on page 80](#).

To display an RTL view, first compile or synthesize your design, then select HDL Analyst->RTL and choose Hierarchical View or Flattened View, or click the RTL icon (.

An RTL view has two panes: a Hierarchy Browser on the left and an RTL schematic on the right. You can drag the pane divider with the mouse to change the relative pane sizes. For more information about the Hierarchy Browser, see [Hierarchy Browser, on page 82](#). Your design is drawn as a set of schematics. The schematic for a design module (or the top level) consists of one or more sheets, only one of which is visible in a given view at any time. The title bar of the window indicates the current hierarchical schematic level, the current sheet, and the total number of sheets for that level.



The design in the RTL schematic can be hierarchical or flattened. Further, the view can consist of the entire design or part of it. Different commands apply, depending on the kind of RTL view.

The following table lists where to find further information about the RTL view:

**For information about ... See ...**

Hierarchy Browser	<a href="#">Hierarchy Browser</a> , on page 82
Procedures for RTL view operations like crossprobing, searching, pushing/popping, filtering, flattening, etc.	<a href="#">Working in the Standard Schematic</a> , on page 295 of the <i>User Guide</i> .
Explanations or descriptions of features like object display, filtering, flattening, etc.	<a href="#">HDL Analyst Tool</a> , on page 77
Commands for RTL view operations like filtering, flattening, etc.	<a href="#">Accessing HDL Analyst Commands</a> , on page 86 <a href="#">HDL Analyst Menu</a> , on page 408

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**For information about ...    See ...**



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Viewing commands like zooming, panning, etc.	<a href="#">View Menu: RTL and Technology Views Commands</a> , on page 322
History commands: Back and Forward	<a href="#">View Menu: RTL and Technology Views Commands</a> , on page 322
Search command	<a href="#">Find Command (HDL Analyst)</a> , on page 313

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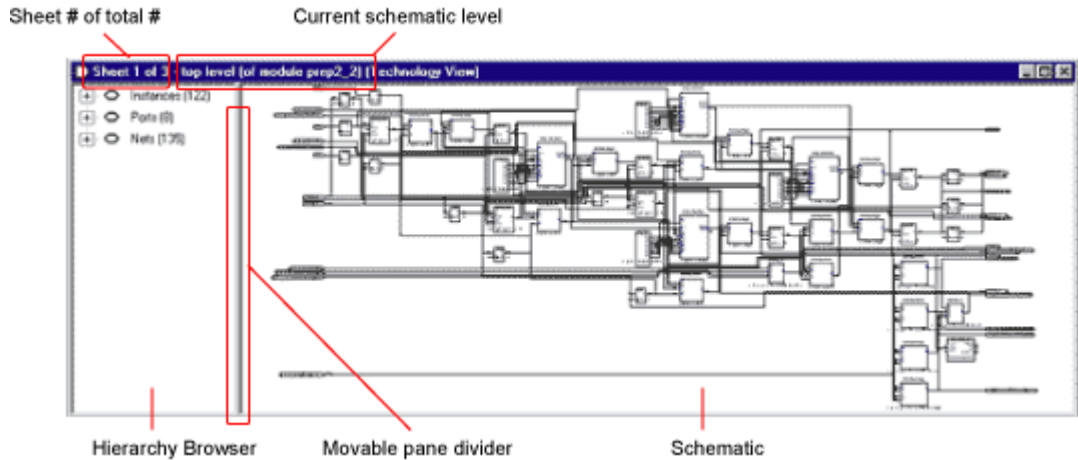
## Technology View

A Technology view provides a low-level, technology-specific view of your design after mapping, using components such as look-up tables, cascade and carry chains, multiplexers, and flip-flops. Technology views are only available after your design has been synthesized (compiled and mapped). For information about the other HDL Analyst view (the RTL view generated after compilation), see [RTL View, on page 78](#).

To display a Technology view, first synthesize your design, and then either select a view from the HDL Analyst->Technology menu (Hierarchical View, Flattened View, Flattened to Gates View, Hierarchical Critical Path, or Flattened Critical Path) or select the Technology view icon (.

A Technology view has two panes: a Hierarchy Browser on the left and an RTL schematic on the right. You can drag the pane divider with the mouse to change the relative pane sizes. For more information about the Hierarchy Browser, see [Hierarchy Browser, on page 82](#). Your design is drawn as a set of schematics at different design levels. The schematic for a design module (or the top level) consists of one or more sheets, only one of which is visible in a given view at any time. The title bar of the window indicates the current schematic level, the current sheet, and the total number of sheets for that level.





The schematic design can be hierarchical or flattened. Further, the view can consist of the entire design or a part of it. Different commands apply, depending on the kind of view. In addition to all the features available in RTL views, Technology views have two additional features: critical path filtering and flattening to gates.

The following table lists where to find further information about the Technology view:

**For information about ... See ...**

Hierarchy Browser	<a href="#">Hierarchy Browser</a> , on page 82
Procedures for Technology view operations like crossprobing, searching, pushing/popping, filtering, flattening, etc.	<a href="#">Working in the Standard Schematic</a> , on page 295 of the <i>User Guide</i>
Explanations or descriptions of features like object display, filtering, flattening, etc.	<a href="#">HDL Analyst Tool</a> , on page 77
Commands for Technology view operations like filtering, flattening, etc.	<a href="#">Accessing HDL Analyst Commands</a> , on page 86 <a href="#">HDL Analyst Menu</a> , on page 408

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**For information about ...    See ...**


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Viewing commands like zooming, panning, etc.	<a href="#">View Menu: RTL and Technology Views Commands</a> , on page 322
History commands: Back and Forward	<a href="#">View Menu: RTL and Technology Views Commands</a> , on page 322
Search command	<a href="#">Find Command (HDL Analyst)</a> , on page 313



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## Hierarchy Browser

The Hierarchy Browser is the left pane in the RTL and Technology views. (See [RTL View, on page 78](#) and [Technology View, on page 80](#).) The Hierarchy Browser categorizes the design objects in a series of trees, and lets you browse the design hierarchy or select objects. Selecting an object in the Browser selects that object in the schematic. The objects are organized as shown in the following table, with a symbol that indicates the object type. See [Hierarchy Browser Symbols, on page 83](#) for common symbols.

Instances	Lists all the instances and primitives in the design. In a Technology view, it includes all technology-specific primitives.
Ports	Lists all the ports in the design.
Nets	Lists all the nets in the design.
Clock Tree	Lists all the instances and ports that drive clock pins in an RTL view. If you select everything listed under Clock Tree and then use the Filter Schematic command, you see a filtered view of all clock pin drivers in your design. Registers are not shown in the resulting schematic, unless they drive clocks. This view can help you determine what to define as clocks.

























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A tree node can be expanded or collapsed by clicking the associated icons: the square plus () or minus () icons, respectively. You can also expand or collapse all trees at the same time by right-clicking in the Hierarchy Browser and choosing Expand All or Collapse All.

You can use the keyboard arrow keys (left, right, up, down) to move between objects in the Hierarchy Browser, or you can use the scroll bar. Use the Shift or Ctrl keys to select multiple objects. See [Navigating With a Hierarchy Browser, on page 109](#) for more information about using the Hierarchy Browser for navigation and crossprobing.

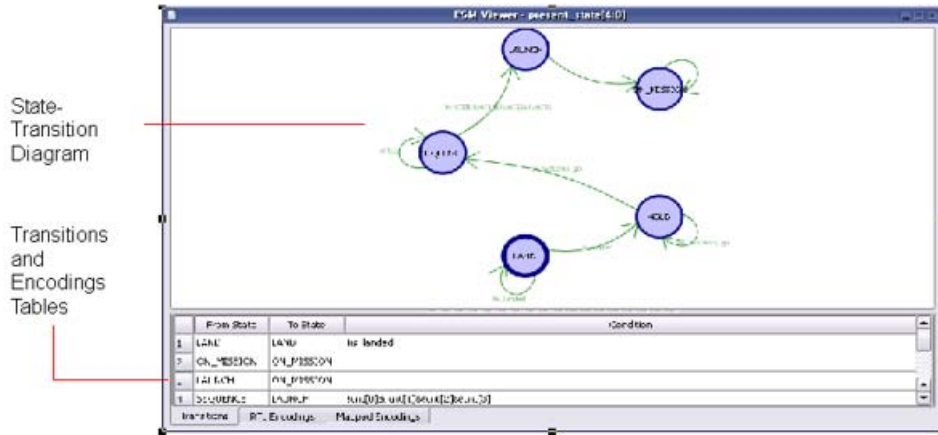
## Hierarchy Browser Symbols

Common symbols used in Hierarchy Browsers are listed in the following table.


Symbol	Description	Symbol	Description
	Folder		Buffer
	Input port		AND gate
	Output port		NAND gate
	Bidirectional port		OR gate
	Net		NOR gate
	Other primitive instance		XOR gate
	Hierarchical instance		XNOR gate
	Technology-specific primitive or inferred ROM		Adder
	Register or inferred state machine		Multiplier
	Multiplexer		Equal comparator
	Tristate		Less-than comparator
	Inverter		Less-than-or-equal comparator

## FSM Viewer Window

Pushing down into a state machine primitive in the RTL view displays the FSM Viewer and enables the FSM toolbar. The FSM Viewer contains graphical information about the finite state machines (FSMs) in your design. The window has a state-transition diagram and tables of transitions and state encodings.



For the FSM Viewer to display state machine names for a Verilog design, you must use the Verilog parameter keyword. If you specify state machine names using the define keyword, the FSM Viewer displays the binary values for the state machines, rather than their names.

You can toggle display of the FSM tables on and off with the Toggle FSM Table icon () on the FSM toolbar. The FSM tables are in the following panels:

- The Transitions panel describes, for each transition, the From State, To State, and Condition of transition.
- The RTL Encodings panel describes the correlation, in the RTL view, between the states (State) and the outputs (Register) of the FSM cell.
- The Mapped Encodings panel describes the correlation, in the Technology view, between the states (State) and their encodings into technology-specific registers. The information in this panel is available only after the design has been synthesized.

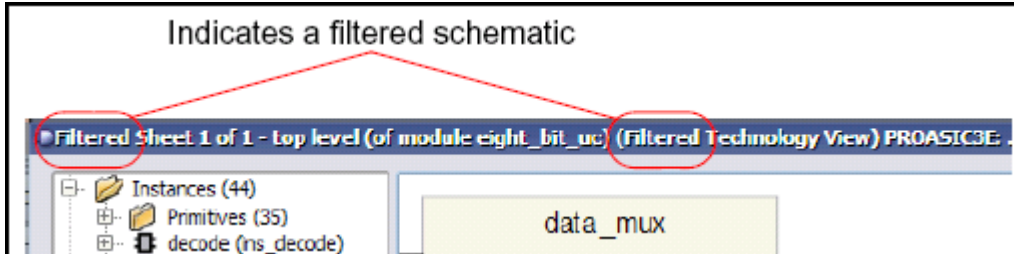
The following table describes FSM Viewer operations.

To accomplish this ...	Do this ...
Open the FSM Viewer	Run the FSM Compiler or the FSM Explorer. Use the push/pop mode in the RTL view to push down into the FSM and open the FSM Viewer window.
Hide/display the table	Use the FSM icons.
Filter selected states and their transitions	Select the states. Right-click and choose the filter criteria from the popup, or use the FSM icons.
Display the encoding properties of a state	Select a state. Right-click to display its encoding properties (RTL or Mapped).
Display properties for the state machine	Right-click the window, outside the state-transition diagram. The property sheet shows the selected encoding method, the number of states, and the total number of transitions among states.
Crossprobe	Double-click a register in an RTL or Technology view to see the corresponding code. Select a state in the FSM view to highlight the corresponding code or register in other open views.

## Filtered and Unfiltered Schematic Views

HDL Analyst views ([RTL View, on page 78](#) and [Technology View, on page 80](#)) consist of schematics that let you analyze your design graphically. The schematics can be filtered or unfiltered. The distinction is important because the kind of view determines how objects are displayed for certain commands.

- Unfiltered schematics display all the objects in your design, at appropriate hierarchical levels.
- Filtered schematics show only a subset of the objects in your design, because the other objects have been filtered out by some operation. The Hierarchy Browser in the filtered view always list all the objects in the design, not just the filtered objects. Some commands, such as HDL Analyst -> Show Context, are only available in filtered schematics. Views with a filtered schematic have the word Filtered in the title bar.



Filtering commands affect only the displayed schematic, not the underlying design. See the following topics:

- For a detailed description of filtering, see [Filtering and Flattening Schematics, on page 113](#).
- For procedures on using filtering, see [Filtering Schematics, on page 340](#) in the *User Guide*.

## Accessing HDL Analyst Commands

You can access HDL Analyst commands in many ways, depending on the active view, the currently selected objects, and other design context factors. The software offers these alternatives to access the commands:

- HDL Analyst and View menus
- HDL Analyst popup menus appear when you right-click in an HDL Analyst view. The popup menu is context-sensitive, and includes commonly used commands from the HDL Analyst and View menus, as well as some additional commands.
- HDL Analyst toolbar icons provide shortcuts to commonly used commands

For brevity, this document primarily refers to the menu method of accessing the commands and does not list alternative access methods.

*See also:*

- [HDL Analyst Menu](#), on page 408
- [View Menu](#), on page 321
- [RTL and Technology Views Popup Menus](#), on page 479

- [Analyst Toolbar](#), on page 59

# Schematic Objects and Their Display

Schematic objects are the objects that you manipulate in an HDL Analyst schematic: instances, ports, and nets. Instances can be categorized in different ways, depending on the operation: hidden/unhidden, transparent/opaque, or primitive/hierarchical. The following topics describe schematic objects and the display of associated information in more detail:

- [Object Information](#), on page 88
- [Sheet Connectors](#), on page 89
- [Primitive and Hierarchical Instances](#), on page 90
- [Hidden Hierarchical Instances](#), on page 93
- [Transparent and Opaque Display of Hierarchical Instances](#), on page 91
- [Schematic Display](#), on page 93

For most objects, you select them to perform an operation. For some objects like sheet connectors, you do not select them but right-click on them and select from the popup menu commands.

## Object Information

To obtain information about specific objects, you can view object properties with the Properties command from the right-click popup menu, or place the pointer over the object and view the object information displayed. With the latter method, information about the object displays in these two places until you move the pointer away:

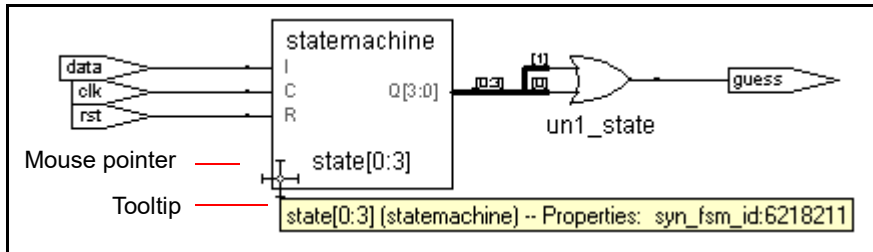
- The status bar at the bottom of the synthesis window displays the name of the instance, net, port, or sheet connector and other relevant information. If HDL Analyst->Show Timing Information is enabled, the status bar also displays timing information for the object. Here is an example of the status bar information for a net:

```
Net clock (local net clock) Fanout=4
```

You can enable and disable the display of status bar information by toggling the command View -> Status Bar.



- In a tooltip at the mouse pointer  
Displays the name of the object and any attached attributes. The following figure shows tooltip information for a state machine:



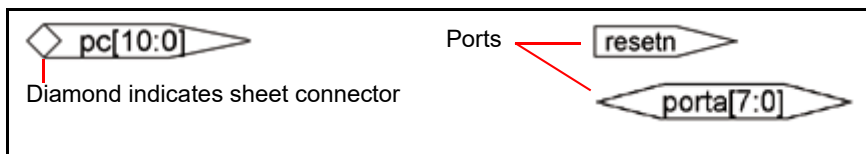
To disable tooltip display, select View -> Toolbars and disable the Show Tooltips option. Do this if you want to reduce clutter.

See also

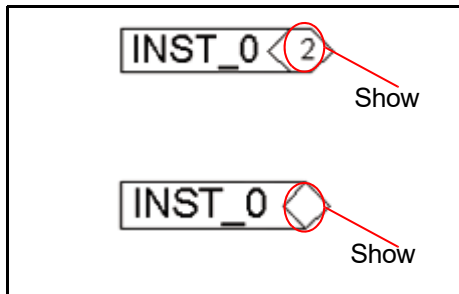
- [Pin and Pin Name Display for Opaque Objects](#), on page 94
- [Standard HDL Analyst Options Command](#), on page 440

## Sheet Connectors

When the HDL Analyst tool divides a schematic into multiple sheets, sheet connector symbols indicate how sheets are related. A sheet connector symbol is like a port symbol, but it has an empty diamond with sheet numbers at one end. Use the Options->HDL Analyst Options command (see [Sheet Size Panel](#), on page 446) to control how the schematic is divided into multiple sheets.



If you enable the Show Sheet Connector Index option in the (Options->HDL Analyst Options), the empty diamond becomes a hexagon with a list of the connected sheets. You go to a connecting sheet by right-clicking a sheet connector and choosing the sheet number from the popup menu. The menu has as many sheet numbers as there are sheets connected to the net at that point.



See also

- [Multiple-sheet Schematics](#), on page 102
- [Standard HDL Analyst Options Command](#), on page 440
- [RTL and Technology Views Popup Menus](#), on page 479

## Primitive and Hierarchical Instances

HDL Analyst instances are either primitive or hierarchical, and sorted into these categories in the Hierarchy Browser. Under Instances, the browser first lists hierarchical instances, and then lists primitive instances under Instances->Primitives.

### Primitive Instances


Although some primitive objects have hierarchy, the term is used here to distinguish these objects from *user-defined* hierarchies. Primitive instances include the following:

RTL View	Technology View
High-level logic primitives, like XOR gates or priority-encoded multiplexers	Black boxes
Inferred ROMs, RAMs, and state machines	Technology-specific primitives, like LUTs or FPGA block RAMs
Black boxes	
Technology-specific primitives, like LUTs or FPGA block RAMs	

In a schematic, logic gate primitives are represented with standard schematic symbols, and technology-specific primitives with various symbols (see [Hierarchy Browser, on page 82](#)). You can push into primitives like technology-specific primitives, inferred ROMs, and inferred state machines to view internal details. You cannot push into logic primitives.

## Hierarchical Instances

*Hierarchical* instances are user-defined hierarchies; all other instances are considered to be primitives. Hierarchical instances correspond to Verilog modules and VHDL entities.

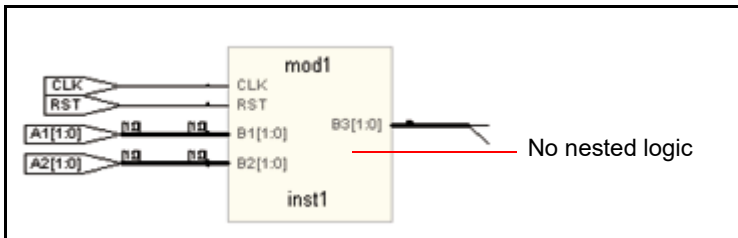
The Hierarchy Browser lists hierarchical instances under *Instances*, and uses this symbol: . In a schematic, the display of hierarchical instances depends on the combination of the following:

- Whether the instance is transparent or opaque. Transparent instances show their internal details nested inside them; opaque instances do not. You cannot directly control whether an object is transparent or opaque; the views are automatically generated by certain commands. See [Transparent and Opaque Display of Hierarchical Instances, on page 91](#) for details.
- Whether the instance is hidden or not. This is user-controlled, and you can hide instances so that they are ignored by certain commands. See [Hidden Hierarchical Instances, on page 93](#) for more information.

## Transparent and Opaque Display of Hierarchical Instances

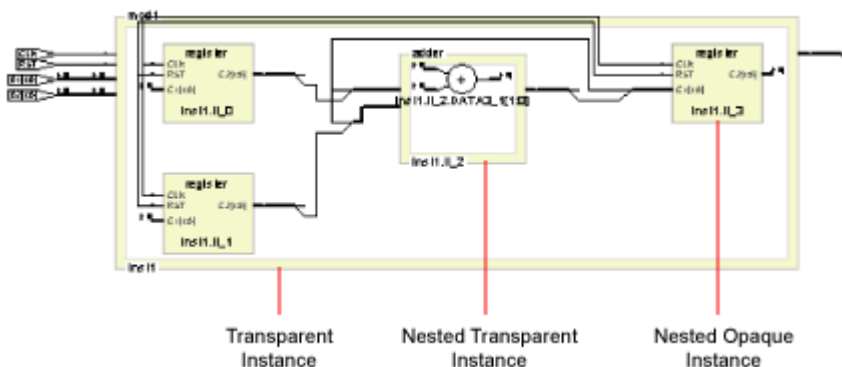
A hierarchical instance can be displayed transparently or opaquely. You cannot directly control the display; certain commands cause instances to be transparent. The distinction between transparent and opaque is important because some commands operate differently on transparent and opaque instances. For example, in a filtered schematic Flatten Current Schematic flattens only transparent hierarchical instances.

- Opaque instances are pale yellow boxes, and do not display their internal hierarchy. This is the default display.



- Transparent instances display some or all their lower-level hierarchy nested inside a hollow box with a pale yellow border. Transparent instances are only displayed in filtered schematics, and are a result of certain commands. See [Looking Inside Hierarchical Instances](#), on page 110 for information about commands that generate transparent instances.

A transparent instance can contain other opaque or transparent instances nested inside. The details inside a transparent instance are independent schematic objects and you can operate on them independently: select, push into, hide, and so on. Performing an operation on a transparent object does not automatically perform it on any of the objects nested inside it, and conversely.



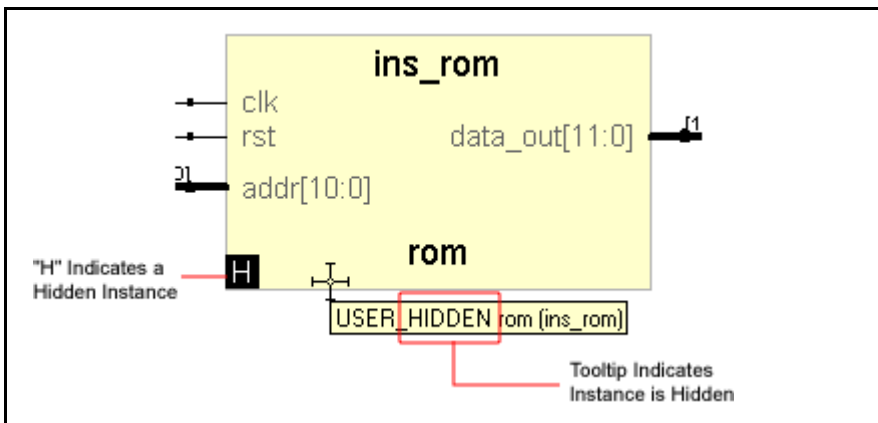
See also

- [Looking Inside Hierarchical Instances](#), on page 110
- [Multiple Sheets for Transparent Instance Details](#), on page 104
- [Filtered and Unfiltered Schematic Views](#), on page 85

## Hidden Hierarchical Instances

Certain commands do not operate on the lower-level hierarchy of hidden instances, so you can hide instances to focus the operation of a command and improve performance. You hide opaque or transparent hierarchical instances with the Hide Instances command (described in [RTL and Technology Views Popup Menus, on page 479](#)). Hiding and unhiding only affects the current HDL Analyst view, and does not affect the Hierarchy Browser. You can hide and unhide instances as needed. The hierarchical logic of a hidden instance is not removed from the design; it is only excluded from certain operations.

The schematics indicate hidden hierarchical instances with a small H in the lower left corner. When the mouse pointer is over a hidden instance, the status bar and the tooltip indicate that the instance is hidden.



## Schematic Display

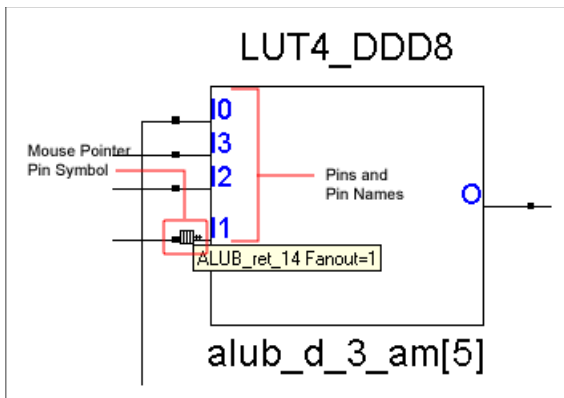
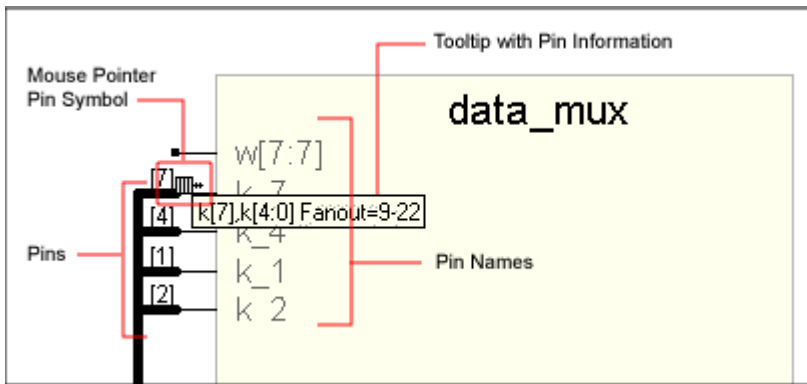
The HDL Analyst Options dialog box controls general properties for all HDL Analyst views, and can determine the display of schematic object information. Setting a display option affects all objects of the given type in all views. Some schematic options only take effect in schematic windows opened after the setting change; others affect existing schematic windows as well.

The following are some commonly used settings that affect the display of schematic objects. See [Standard HDL Analyst Options Command, on page 440](#) for a complete list of display options.

Option	Controls the display of ...
Show Cell Interior	Internal logic of technology-specific primitives
Compress Buses	Buses as bundles
Dissolve Levels	Hierarchical levels in a view flattened with HDL Analyst -> Dissolve Instances or Dissolve to Gates, by setting the number of levels to dissolve.
Instances Filtered Instances Instances added for expansion	Instances on a schematic by setting limits to the number of instances displayed
Instance Name Show Conn Name Show Symbol Name Show Port Name	Object labels
Show Pin Name HDL Analyst->Show All Hier Pins	Pin names. See <a href="#">Pin and Pin Name Display for Opaque Objects, on page 94</a> and <a href="#">Pin and Pin Name Display for Transparent Objects, on page 95</a> for details.

## Pin and Pin Name Display for Opaque Objects

Although it always displays the pins, the software does not automatically display pin names for opaque hierarchical instances, technology-specific primitives, RAMS, ROMs, and state machines. To display pin names for these objects, enable Options-> HDL Analyst Options->Text->Show Pin Name. The following figures illustrate this display. The first figure shows pins and pin names of an opaque hierarchical instance, and the second figure shows the pins of a technology-specific primitive with its cell contents not displayed.



## Pin and Pin Name Display for Transparent Objects

This section discusses pin name display for transparent hierarchical instances in filtered views and technology-specific primitives.

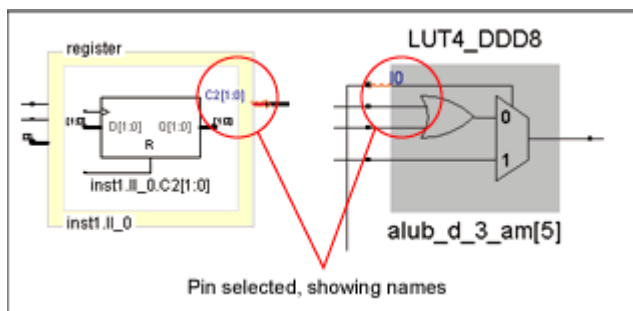
### Transparent Hierarchical Instances

In a filtered schematic, some of the pins on a transparent hierarchical instance might not be displayed because of filtering. To display all the pins, select the instance and select HDL Analyst -> Show All Hier Pins.

To display pin names for the instance, enable Options->HDL Analyst Options->Text->Show Pin Name. The software temporarily displays the pin name when you move the cursor over a pin. To keep the pin name displayed even after you move the cursor away, select the pin. The name remains until you select something else.

## Primitives

To display pin names for technology primitives in the Technology view, enable Options-> HDL Analyst Options->Text->Show Pin Name. The software displays the pin names until the option is disabled. If Show Pin Name is enabled when Options-> HDL Analyst Options->General->Show Cell Interior is also enabled, the primitive is treated like a transparent hierarchical instance, and primitive pin names are only displayed when the cursor moves over the pins. To keep a pin name displayed even after you move the cursor away, select the pin. The name remains until you select something else.



See also:

- [Standard HDL Analyst Options Command](#), on page 440
- [Controlling the Amount of Logic on a Sheet](#), on page 102
- [Analyzing Timing in Schematic Views](#), on page 358 in the *User Guide*



# Basic Operations on Schematic Objects

Basic operations on schematic objects include the following:

- [Finding Schematic Objects](#), on page 97
- [Selecting and Unselecting Schematic Objects](#), on page 98
- [Crossprobing Objects](#), on page 99
- [Dragging and Dropping Objects](#), on page 101

For information about other operations on schematics and schematic objects, see the following:

- [Filtering and Flattening Schematics](#), on page 113
- [Timing Information and Critical Paths](#), on page 119
- [Multiple-sheet Schematics](#), on page 102
- [Exploring Design Hierarchy](#), on page 105

## Finding Schematic Objects

You can use the following techniques to find objects in the schematic. For step-by-step procedures using these techniques, see [Finding Objects \(Standard\)](#), on page 316 in the *User Guide*.

- Zooming and panning
- HDL Analyst Hierarchy Browser

You can use the Hierarchy Browser to browse and find schematic objects. This can be a quick way to locate an object by name if you are familiar with the design hierarchy. See [Browsing With the Hierarchy Browser](#), on page 316 in the *User Guide* for details.

- Edit -> Find command

The Edit -> Find command is described in [Find Command \(HDL Analyst\)](#), on page 313. It displays the Object Query dialog box, which lists schematic objects by type (Instances, Symbols, Nets, or Ports) and lets you use wildcards to find objects by name. You can also fine-tune your search by setting a range for the search.

This command selects all found objects, whether or not they are displayed in the current schematic. Although you can search for hidden instances, you cannot find objects that are inside hidden instances at a lower level. Temporarily hiding an instance thus further refines the search range by excluding the internals of a given instance. This can be very useful when working with transparent instances, because the lower-level details appear at the current level, and cannot be excluded by choosing Current Level Only. See [Using Find for Hierarchical and Restricted Searches, on page 318](#) in the *User Guide*.

- Edit -> Find command combined with filtering

Edit->Find enhances filtering. Use Find to select by name and hierarchical level, and then filter the design to limit the display to the current selection. Unselected objects are removed. Because Find only adds to the current selection (it never deselects anything already selected), you can use successive searches to build up exactly the selection you need, before filtering.

- Filtering before searching with Edit->Find

Filtering helps you to fine-tune the range of a search. You can search for objects just within a filtered schematic by limiting the search range to the Current Level Only.

Filtering adds to the expressive power of displaying search results. You can find objects on different sheets and filter them to see them all together at once. Filtering collapses the hierarchy visually, showing lower-level details nested inside transparent higher-level instances. The resulting display combines the advantage of a high-level, abstract view with detail-rich information from lower levels.


See [Filtering and Flattening Schematics, on page 113](#) for further information.

## Selecting and Unselecting Schematic Objects

Whenever an object is selected in one place it is selected and highlighted everywhere else in the synthesis tool, including all Hierarchy Browsers, all schematics, and the Text Editor. Many commands operate on the currently selected objects, whether or not those objects are visible.

The following briefly list selection methods; for a concise table of selection procedures, see [Selecting Objects in the RTL/Technology Views, on page 302](#) in the *User Guide*.

## Using the Mouse to Select a Range of Schematic Objects

In a Hierarchy Browser, you can select a *range* of schematic objects by clicking the name of an object at one end of the range, then holding the Shift key while clicking the name of an object at the other end of the range. To use the mouse for selecting and unselecting objects in a schematic, the cross-hairs symbol (  ) must appear as the mouse pointer. If this is not currently the case, right-click the schematic background.

## Using Commands to Select Schematic Objects

You can select and deselect schematic objects using the commands in the HDL Analyst menu, or use Edit->Find to find and select objects by name.

The HDL Analyst menu commands that affect selection include the following:

- Expansion commands like Expand, Expand to Register/Port, Expand Paths, and Expand Inwards select the objects that result from the expansion. This means that (except for Expand to Register/Port) you can perform successive expansions and expand the set of objects selected.
- The Select All Schematic and Select All Sheet commands select all instances or ports on the current schematic or sheet, respectively.
- The Select Net Driver and Select Net Instances commands select the appropriate objects according to the hierarchical level you have chosen.
- Deselect All deselects all objects in *all* HDL Analyst views.

*See also*

- [Finding Schematic Objects](#), on page 97
- [HDL Analyst Menu](#), on page 408

## Crossprobing Objects

Crossprobing helps you diagnose where coding changes or timing constraints might reduce area or increase performance. When you crossprobe, you select an object in one place and it or its equivalent is automatically selected and

highlighted in other places. For example, selecting text in the Text Editor automatically selects the corresponding logic in all HDL Analyst views. Whenever a net is selected, it is highlighted through all the hierarchical instances it traverses, at all schematic levels.

## Crossprobing Between Different Views

You can crossprobe objects (including logic inside hidden instances) between RTL views, Technology views, the FSM Viewer, HDL source code files, and other text files. Some RTL and source code objects are optimized away during synthesis, so they cannot be crossprobed to certain views.

The following table summarizes crossprobing to and from HDL Analyst (RTL and Technology) views. For information about crossprobing procedures, see [Crossprobing \(Standard\)](#), on page 329 in the *User Guide*.

From ...	To ...	Do this ...
Text Editor: log file	Text Editor: HDL source file	Double-click a log file note, error, or warning. The corresponding HDL source code appears in the Text Editor.
Text Editor: HDL code	Analyst view FSM Viewer	<p>The RTL view or Technology view must be open. Select the code in the Text Editor that corresponds to the object(s) you want to crossprobe.</p> <p>The object corresponding to the selected code is automatically selected in the target view, if an HDL source file is in the Text Editor. Otherwise, right-click and choose the Select in Analyst command.</p> <p>To cross-probe from text other than source code, first select Options-&gt;HDL Analyst Options and then enable Enhanced Text Crossprobing.</p>
FSM Viewer	Analyst view	<p>The target view must be open. The state machine must be encoded with the onehot style to crossprobe from the transition table.</p> <p>Select a state anywhere in the FSM Viewer (bubble diagram or transition table). The corresponding object is automatically selected in the HDL Analyst view.</p>

From ...	To ...	Do this ...
Analyst view FSM Viewer	Text Editor	<p>Double-click an object. The source code corresponding to the object is automatically selected in the Text Editor, which is opened to show the selection.</p> <p>If you just select an object, without double-clicking it, the corresponding source code is still selected and displayed in the editor (provided it is open), but the editor window is not raised to the front.</p>
Analyst view	Another open view	<p>Select an object in an HDL Analyst view. The object is automatically selected in all open views.</p> <p>If the target view is the FSM Viewer, then the state machine must be encoded as onehot.</p>
Tcl window	Text Editor	Double-click an error or warning message (available in the Tcl window errors or warnings panel, respectively). The corresponding source code is automatically selected in the Text Editor, which is opened to show the selection.
Text Editor: any text containing instance names, like a timing report	Corresponding instance	Highlight the text, then right-click & choose Select or Filter. Use this to filter critical paths reported in a text file by the FPGA timing analysis tool.

## Dragging and Dropping Objects

You can drag and drop objects like instances, nets and pins from the HDL Analyst schematic views to other windows to help you analyze your design or set constraints. You can drag and drop objects from an RTL or Technology views to the following other windows:

- SCOPE editor
- Text editor window
- Tcl window

## Multiple-sheet Schematics

When there is too much logic to display on a single sheet, the HDL Analyst tool uses additional schematic sheets. Large designs can take several sheets. In a hierarchical schematic, each module consists of one or more sheets. Sheet connector symbols ([Sheet Connectors, on page 89](#)) mark logic connections from one sheet to the next.

For more information, see

- [Controlling the Amount of Logic on a Sheet](#), on page 102
- [Navigating Among Schematic Sheets](#), on page 102
- [Multiple Sheets for Transparent Instance Details](#), on page 104

### Controlling the Amount of Logic on a Sheet

You can control the amount of logic on a schematic sheet using the options in Options->HDL Analyst Options->Sheet Size. The Maximum Instances option sets the maximum number of instances on an unfiltered schematic sheet. The Maximum Filtered Instances option sets the maximum number of instances displayed at any given hierarchical level on a filtered schematic sheet.

*See also:*

- [Standard HDL Analyst Options Command](#), on page 440
- [Setting Schematic Preferences, on page 305](#) of the *User Guide*.

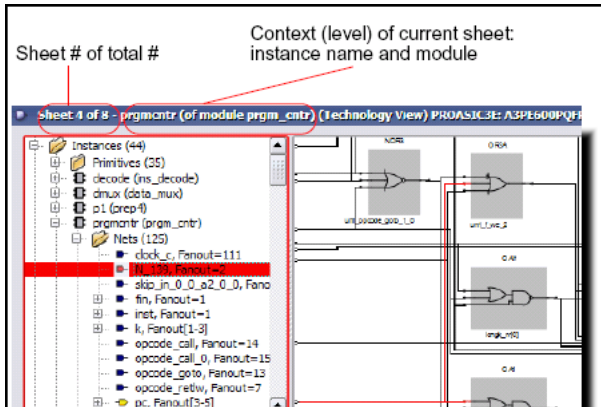
### Navigating Among Schematic Sheets

This section describes how to navigate among the sheets in a given schematic. The window title bar lets you know where you are at any time.

#### Multisheet Orientation in the Title Bar

The window title bar of an RTL view or Technology view indicates the current context. For example, uc\_alu (of module alu) in the title indicates that the current schematic level displays the instance uc\_alu (which is of module alu). The objects shown are those comprising that instance.

The title bar also indicates, for the current schematic, the number of the displayed sheet, and the total number of sheets — for example, sheet 2 of 4. A schematic is initially opened to its first sheet.



## Navigating Among Sheets

You can navigate among different sheets of a schematic in these ways:

- Follow a sheet connector, by right-clicking it and choosing a connecting sheet from the popup menu
- Use the sheet navigation commands of the View menu: Next Sheet, Previous Sheet, and View Sheets, or their keyboard shortcut or icon equivalents
- Use the history navigation commands of the View menu (Back and Forward), or their keyboard shortcuts or icon equivalents to navigate to sheets stored in the display history

For details, see [Working with Multisheet Schematics](#), on page 303 in the *User Guide*.

You can navigate among different design levels by pushing and popping the design hierarchy. Doing so adds to the display history of the View menu, so you can retrace your push/pop steps using View->Back and View->Forward. After pushing down, you can either pop back up or use View->Back.

See also:

- [Filtering and Flattening Schematics](#), on page 113

- [View Menu: RTL and Technology Views Commands](#), on page 322
- [Pushing and Popping Hierarchical Levels](#), on page 105

## Multiple Sheets for Transparent Instance Details

The details of a transparent instance in a filtered view are drawn in two ways:

- Generally, these interior details are spread out over multiple sheets at the same schematic level (module) as the instance that contains them. You navigate these sheets as usual, using the methods described in [Navigating Among Schematic Sheets, on page 102](#).
- If the number of nested contents exceeds the limit set with the Filtered Instances option (Options->HDL Analyst Options), the nested contents are drawn on separate sheets. The parent hierarchical instance is empty, with a notation (for example, Go to sheets 4-16) inside it, indicating which sheets contain its lower-level details. You access the sheets containing the lower-level details using the sheet navigation commands of the View menu, such as Next Sheet.

*See also:*

- [Controlling the Amount of Logic on a Sheet](#), on page 102
- [View Menu: RTL and Technology Views Commands](#), on page 322



# Exploring Design Hierarchy

The hierarchy in your design can be explored in different ways. The following sections explain how to move between hierarchical levels:

- [Pushing and Popping Hierarchical Levels](#), on page 105
- [Navigating With a Hierarchy Browser](#), on page 109
- [Looking Inside Hierarchical Instances](#), on page 110

## Pushing and Popping Hierarchical Levels

You can navigate your design hierarchy by pushing down into a high-level schematic object or popping back up. Pushing down into an object takes you to a lower-level schematic that shows the internal logic of the object. Popping up from a lower level brings you back to the parent higher-level object.

Pushing and popping is best suited for traversing the hierarchy of a specific object. If you want a more general view of your design hierarchy, use the Hierarchy Browser instead. See [Navigating With a Hierarchy Browser, on page 109](#) and [Looking Inside Hierarchical Instances, on page 110](#) for other ways of viewing design hierarchy.

## Pushable Schematic Objects






To push into an instance, it must have hierarchy. You can push into the object regardless of its position in the design hierarchy; for example, you can push into the object if it is shown nested inside a transparent instance. You can push down into the following kinds of schematic objects:

- Non-hidden hierarchical instances. To push into a hidden instance, unhide it first.
- Technology-specific primitives (not logic primitives)
- Inferred ROMs and state machines in RTL views. Inferred ROMs, RAMs, and state machines do not appear in Technology views, because they are resolved into technology-specific primitives.

When you push/pop, the HDL Analyst window displays the appropriate level of design hierarchy, except in the following cases:

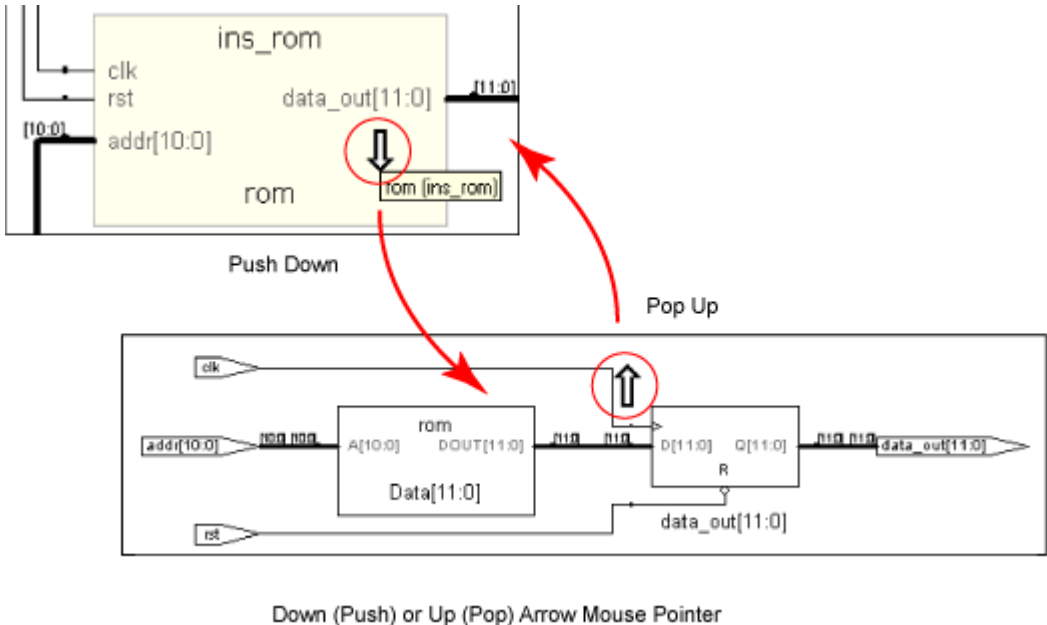
- In the Synplify Pro tool, the FSM Viewer opens, with graphical information about the FSM. See the [FSM Viewer Window, on page 83](#), for more information.
- When you push into an inferred ROM in an RTL view, the Text Editor window opens and displays the ROM data table (rom.info file).

You can use the following indicators to determine whether you can push into an object:

- The mouse pointer shape when Push/Pop mode is enabled. See [How to Push and Pop Hierarchical Levels, on page 106](#) for details.
- A small H symbol (  ) in the lower left corner indicates a hidden instance, and you cannot push into it.
- The Hierarchy Browser symbols indicates the type of instance and you can use that to determine whether you can push into an object. For example, hierarchical instance (  ), technology-specific primitive (  ), logic primitive such as XOR (  ), or other primitive instance (  ). The browser symbol does not indicate whether or not an instance is hidden.
- The *status bar* at the bottom of the main synthesis tool window reports information about the object under the pointer, including whether or not it is a hidden instance or a primitive.

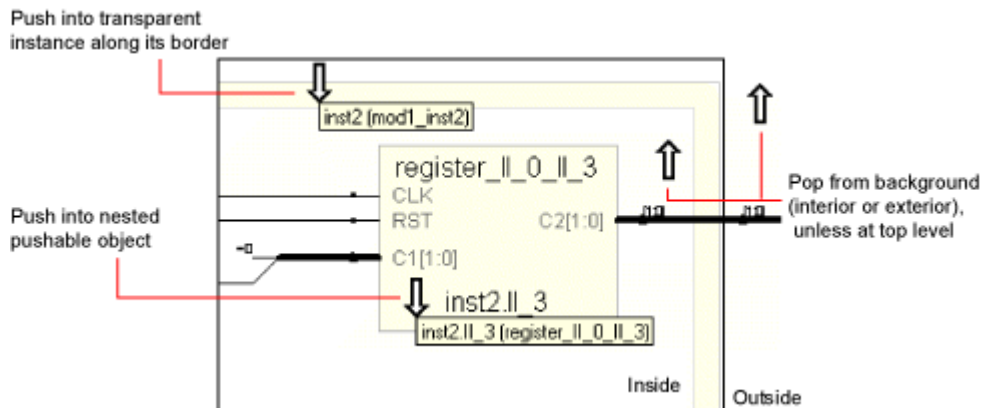
## How to Push and Pop Hierarchical Levels

You push/pop design levels with the HDL Analyst Push/Pop mode. To enable or disable this mode, toggle View->Push/Pop Hierarchy, use the icon, or use the appropriate mouse strokes.






Once Push/Pop mode is enabled, you push or pop as follows:

- To *pop*, place the pointer in an empty area of the schematic background, then click or use the appropriate mouse stroke. The background area inside a transparent instance acts just like the background area outside the instance.
- To *push* into an object, place the mouse pointer over the object and click or use the appropriate mouse stroke. To push into a transparent instance, place the pointer over its pale yellow border, not its hollow (white) interior. Pushing into an object nested inside a transparent hierarchical instance descends to a lower level than pushing into the enclosing transparent instance. In the following figure, pushing into transparent instance inst2 descends one level; pushing into nested instance inst2.ll\_3 descends two levels.



The following arrow mouse pointers indicate status in Push/Pop mode. For other indicators, see [Pushable Schematic Objects](#), on page 105.

A down arrow 	Indicates that you can push (descend) into the object under the pointer and view its details at the next lower level.
An up arrow 	Indicates that there is a hierarchical level above the current sheet.
A crossed-out double arrow 	Indicates that there is no accessible hierarchy above or below the current pointer position. If the pointer is over the schematic background it indicates that the current level is the top and you cannot pop higher. If the pointer is over an object, the object is an object you cannot push into: a non-hierarchical instance, a hidden hierarchical instance, or a black box.

See also:

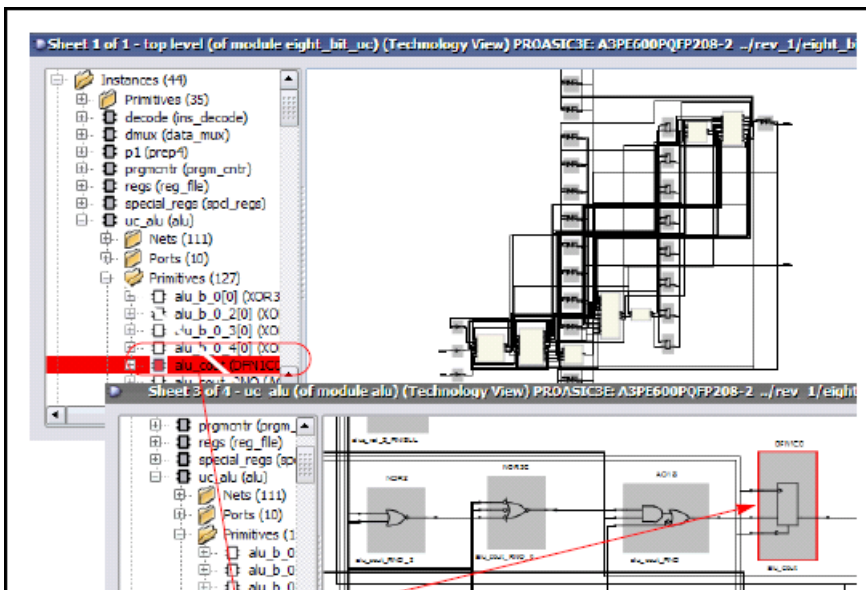
- [Hidden Hierarchical Instances](#), on page 93
- [Transparent and Opaque Display of Hierarchical Instances](#), on page 91
- [Using Mouse Strokes](#), on page 53
- [Navigating With a Hierarchy Browser](#), on page 109

## Navigating With a Hierarchy Browser

Hierarchy Browsers are designed for locating objects by browsing your design. To move between design levels of a particular object, use Push/Pop mode (see [Pushing and Popping Hierarchical Levels, on page 105](#) and [Looking Inside Hierarchical Instances, on page 110](#) for other ways of viewing design hierarchy).

The browser in the RTL view displays the hierarchy specified in the RTL design description. The browser in the Technology view displays the hierarchy of your design after technology mapping.

Selecting an object in the browser displays it in the schematic, because the two are linked. Use the Hierarchy Browser to traverse your hierarchy and select ports, nets, components, and submodules. The browser categorizes the objects, and accompanies each with a symbol that indicates the object type. The following figure shows crossprobing between a schematic and the hierarchy browser.



Explore the browser hierarchy by expanding or collapsing the categories in the browser. You can also use the arrow keys (left, right, up, down) to move up and down the hierarchy and select objects. To select more than one object,

press Ctrl and select the objects in the browser. To select a range of schematic objects, click an object at one end of the range, then hold the Shift key while clicking the name of an object at the other end of the range.

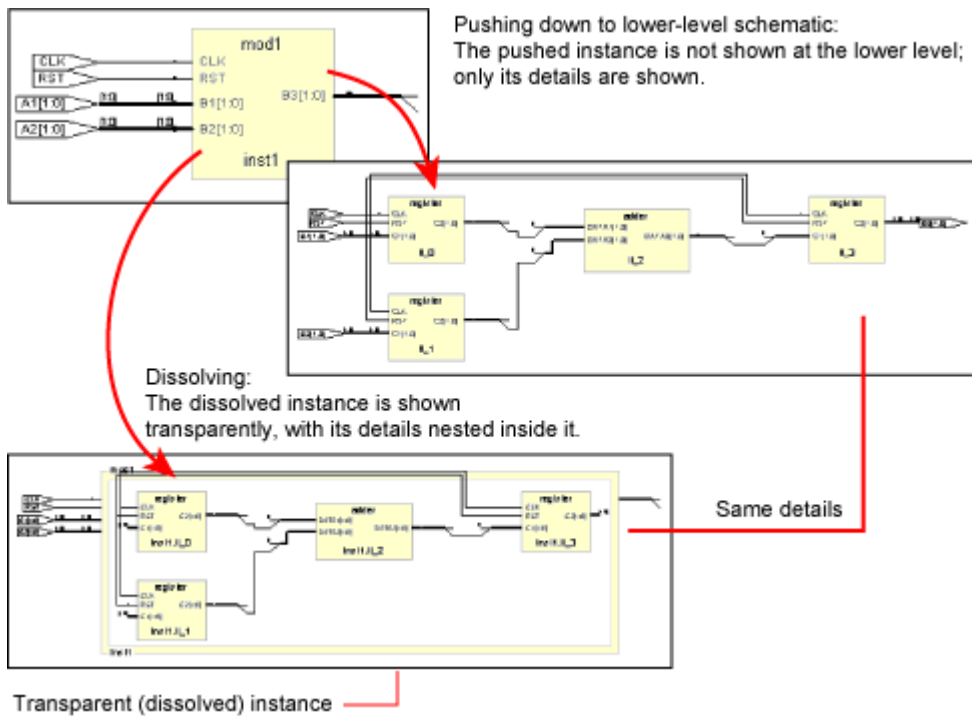
*See also:*

- [Crossprobing Objects](#), on page 99
- [Pushing and Popping Hierarchical Levels](#), on page 105
- [Hierarchy Browser Popup Menu Commands](#), on page 479

## Looking Inside Hierarchical Instances

An alternative method of viewing design hierarchy is to examine transparent hierarchical instances (see [Navigating With a Hierarchy Browser, on page 109](#) and [Navigating With a Hierarchy Browser, on page 109](#) for other ways of viewing design hierarchy). A transparent instance appears as a hollow box with a pale yellow border. Inside this border are transparent and opaque objects from lower design levels.

Transparent instances provide design context. They show the lower-level logic nested within the transparent instance at the current design level, while pushing shows the same logic a level down. The following figure compares the same lower-level logic viewed in a transparent instance and a push operation:



You cannot control the display of transparent instances directly. However, you can perform the following operations, which result in the display of transparent instances:

- Hierarchically expand an object (using the expansion commands in the HDL Analyst menu).
- Dissolve selected hierarchical instances in a *filtered* schematic (HDL Analyst -> Dissolve Instances).
- Filter a schematic, after selecting multiple objects at more than one level. See [Commands That Result in Filtered Schematics](#), on page 113 for additional information.

These operations only make *non-hidden hierarchical* instances transparent. You cannot dissolve hidden or primitive instances (including technology-specific primitives). However, you can do the following:

- Unhide hidden instances, then dissolve them.
- Push down into technology-specific primitives to see their lower-level details, and you can show the interiors of all technology-specific primitives.

*See also:*

- [Pushing and Popping Hierarchical Levels](#), on page 105
- [Navigating With a Hierarchy Browser](#), on page 109
- [HDL Analyst Command](#), on page 409
- [Transparent and Opaque Display of Hierarchical Instances](#), on page 91
- [Hidden Hierarchical Instances](#), on page 93



# Filtering and Flattening Schematics

This section describes the HDL Analyst commands that result in filtered and flattened schematics. It describes

- [Commands That Result in Filtered Schematics](#), on page 113
- [Combined Filtering Operations](#), on page 114
- [Returning to The Unfiltered Schematic](#), on page 114
- [Commands That Flatten Schematics](#), on page 115
- [Selective Flattening](#), on page 116
- [Filtering Compared to Flattening](#), on page 117

## Commands That Result in Filtered Schematics

A filtered schematic shows a subset of your design. Any command that *results in a filtered schematic* is a filtering command. Some commands, like the Expand commands, increase the amount of logic displayed, but they are still considered filtering commands because they result in a filtered view of the design. Other commands like Filter Schematic and Isolate Paths remove objects from the current display.

Filtering commands include the following:

- Filter Schematic, Isolate Paths - reduce the displayed logic.
- Dissolve Instances (in a filtered schematic) - makes selected instances transparent.
- Expand, Expand to Register/Port, Expand Paths, Expand Inwards, Select Net Driver, Select Net Instances - display logic connected to the current selection.
- Show Critical Path, Flattened Critical Path, Hierarchical Critical Path - show critical paths.

All the filtering commands, except those that display critical paths, operate on the currently selected schematic object(s). The critical path commands operate on your entire design, regardless of what is currently selected.

All the filtering commands except Isolate Paths are accessible from the HDL Analyst menu; Isolate Paths is in the RTL view and Technology view popup menus (along with most of the other commands above).

For information about filtering procedures, see [Filtering Schematics, on page 340](#) in the *User Guide*.

See also:

- [Filtered and Unfiltered Schematic Views](#), on page 85
- [HDL Analyst Menu](#), on page 408 and [RTL and Technology Views Popup Menus](#), on page 479

## Combined Filtering Operations

Filtering operations are designed to be used in combination, successively. You can perform a sequence of operations like the following:

1. Use Filter Schematic to filter your design to examine a particular instance. See [HDL Analyst Menu: Filtering and Flattening Commands, on page 411](#) for a description of the command.
2. Select Expand to expand from one of the output pins of the instance to add its immediate successor cells to the display. See [HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409](#) for a description of the command.
3. Use Select Net Driver to add the net driver of a net connected to one of the successors. See [HDL Analyst Menu: Hierarchical and Current Level Submenus, on page 409](#) for a description of the command.
4. Use Isolate Paths to isolate the net driver instance, along with any of its connecting paths that were already displayed. See [HDL Analyst Menu: Analysis Commands, on page 415](#) for a description of the command.

Filtering operations add their resulting filtered schematics to the history of schematic displays, so you can use the View menu Forward and Back commands to switch between the filtered views. You can also combine filtering with the search operation. See [Finding Schematic Objects, on page 97](#) for more information.

## Returning to The Unfiltered Schematic

A filtered schematic often loses the design context, as it is removed from the display by filtering. After a series of multiple or complex filtering operations, you might want to view the context of a selected object. You can do this by

- Selecting a higher level object in the Hierarchy Browser; doing so always crossprobes to the corresponding object in the original schematic.
- Using Show Context to take you directly from a selected instance to the corresponding context in the original, unfiltered schematic.
- Using Goto Net Driver to go from a selected net to the corresponding context in the original, unfiltered schematic.

There is no Unfilter command. Use Show Context to see the unfiltered schematic containing a given instance. Use View->Back to return to the previous, unfiltered display after filtering an unfiltered schematic. You can go back and forth between the original, unfiltered design and the filtered schematics, using the commands View->Back and Forward.

See also:

- [RTL and Technology Views Popup Menus](#), on page 479
- [View Menu: RTL and Technology Views Commands](#), on page 322

## Commands That Flatten Schematics

A flattened schematic contains no hierarchical objects. Any command that results in a flattened schematic is a flattening command. This includes the following.

Command	Unfiltered Schematic	Filtered Schematic
Dissolve Instances	Flattens selected instances	--
Flatten Current Schematic (Flatten Schematic)	Flattens at the current level and all lower levels. RTL view: flattens to generic logic level Technology view: flattens to technology-cell level	Flattens only non-hidden transparent hierarchical instances; opaque and hidden hierarchical instances are not flattened.
RTL->Flattened View	Creates a new, unfiltered RTL schematic of the entire design, flattened to the level of generic logic cells.	
Technology->Flattened View	Creates a new, unfiltered Technology schematic of the entire design, flattened to the level of technology cells.	

Command	Unfiltered Schematic	Filtered Schematic
Technology-> Flattened to Gates View	Creates a new, unfiltered Technology schematic of the entire design, flattened to the level of Boolean logic gates.	
Technology-> Flattened Critical Path	Creates a filtered, flattened Technology view schematic that shows only the instances with the worst slack times and their path.	
Unflatten Schematic	Undoes any flattening done by Dissolve Instances and Flatten Current Schematic at the current schematic level. Returns to the original schematic, as it was before flattening (and any filtering).	

All the commands are on the HDL Analyst menu except Unflatten Schematic, which is available in a schematic popup menu.

The most versatile commands, are Dissolve Instances and Flatten Current Schematic, which you can also use for selective flattening ([Selective Flattening, on page 116](#)).

See also:

- [Filtering Compared to Flattening](#), on page 117
- [Selective Flattening](#), on page 116

## Selective Flattening

By default, flattening operations are not very selective. However, you can selectively flatten particular instances with these command (see [RTL and Technology Views Popup Menus, on page 479](#) for descriptions):

- Use Hide Instances to hide instances that you do *not* want to flatten, then flatten the others (flattening operations do not recognize hidden instances). After flattening, you can Unhide Instances that are hidden.
- Flatten selected hierarchical instances using one of these commands:
  - If the current schematic is unfiltered, use Dissolve Instances.
  - If the schematic is filtered, use Dissolve Instances, followed by Flatten Current Schematic. In a filtered schematic, Dissolve Instances makes the selected instances transparent and Flatten Current Schematic flattens only transparent instances.

The Dissolve Instances and Flatten Current Schematic (or Flatten Schematic) commands behave differently in filtered and unfiltered schematics as outlined in the following table:

Command	Unfiltered Schematic	Filtered Schematic
Dissolve Instances	Flattens selected instances	Provides virtual flattening: makes selected instances transparent, displaying their lower-level details.
Flatten Current Schematic Flatten Schematic	Flattens <i>everything</i> at the current level and below	Flattens only the non-hidden, <i>transparent</i> hierarchical instances: does not flatten opaque or hidden instances. See below for details of the process.

In a filtered schematic, flattening with Flatten Current Schematic is actually a two-step process:

1. The transparent instances of the schematic are flattened in the context of the entire design. The result of this step is the entire hierarchical design, with the transparent instances of the filtered schematic replaced by their internal logic.
2. The original filtering is then restored: the design is refiltered to show only the logic that was displayed before flattening.

Although the result displayed is that of Step 2, you can view the intermediate result of Step 1 with View->Back. This is because the display history is erased before flattening (Step 1), and the result of Step 1 is added to the history as if you had viewed it.

## Filtering Compared to Flattening

As a general rule, use filtering to examine your design, and flatten it only if you really need it. Here are some reasons to use filtering instead of flattening:

- Filtering before flattening is a more efficient use of computer time and memory. Creating a new view where everything is flattened can take considerable time and memory for a large design. You then filter anyway to remove the flattened logic you do not need.
- Filtering is selective. On the other hand, the default flattening operations are global: the entire design is flattened from the current level down.

Similarly, the inverse operation (UnFlatten Schematic) unflattens everything on the current schematic level.

- Flattening operations eliminate the *history* for the current view: You can not use View->Back after flattening. (You can, however, use UnFlatten Schematic to regenerate the unflattened schematic.).

*See also:*

- [RTL and Technology Views Popup Menus](#), on page 479
- [Selective Flattening](#), on page 116

# Timing Information and Critical Paths

The HDL Analyst tool provides several ways of examining critical paths and timing information, to help you analyze problem areas. The different ways are described in the following sections.

- [Timing Reports](#), on page 119
- [Critical Paths and the Slack Margin Parameter](#), on page 120
- [Examining Critical Path Schematics](#), on page 121

See the following for more information about timing and result analysis:

- [Watch Window](#), on page 37
- [Log File](#), on page 157
- [Chapter 13, \*Optimizing Processes for Productivity\*](#) in the *User Guide*

## Timing Reports

When you synthesize a design, a default timing report is automatically written to the log file, which you can view using View->View Log File. This report provides a clock summary, I/O timing summary, and detailed timing information for your design.

For certain device technologies, you can use the Analysis->Timing Analyst command to generate a custom timing report. Use this command to specify start and end points of paths whose timing interests you, and set a limit for the number of paths to analyze between these points. By default, the sequential instances, input ports, and output ports that are currently selected in the Technology views of the design are the candidates for choosing start and end points. In addition, the start and end points of the previous Timing Analyst run become the default start and end points for the next run. When analyzing timing, any latches in the path are treated as level-sensitive registers.

The custom timing report is stored in a text file named *resultsfile.ta*, where *resultsfile* is the name of the results file (see [Implementation Results Panel, on page 349](#)). In addition, a corresponding output netlist file is generated, named *resultsfile\_ta.srm*. Both files are in the implementation results directory.

The Timing Analyst dialog box provides check boxes for viewing the text report (Open Report) in the Text Editor and the corresponding netlist (Open Schematic) in a Technology view. This Technology view of the timing path, labeled Timing View in the title bar, is special in two ways:

- The Timing View shows only the paths you specify in the Timing Analyst dialog box. It corresponds to a special design netlist that contains critical timing data.
- The Timing Analyst and Show Critical Path commands (and equivalent icons and shortcuts) are unavailable whenever the Timing View is active.

*See also:*

- [Analysis Menu](#), on page 396
- [Timing Reports](#), on page 162
- [Log File](#), on page 157

## Critical Paths and the Slack Margin Parameter

The HDL Analyst tool can isolate critical paths in your design, so that you can analyze problem areas, add timing constraints where appropriate, and resynthesize for better results.

After you successfully run synthesis, you can display just the critical paths of your design using any of the following commands from the HDL Analyst menu:

- Hierarchical Critical Path
- Flattened Critical Path
- Show Critical Path

The first two commands create a new Technology view, hierarchical or flattened, respectively. The Show Critical Path command reuses the current Technology view. Neither the current selection nor the current sheet display have any effect on the result. The result is flat if the entire design was already flat; otherwise it is hierarchical. Use Show Critical Path if you want to maintain the existing display history.

All these commands filter your design to show only the instances (and their paths) with the worst slack times. They also enable HDL Analyst -> Show Timing Information, displaying timing information.



Negative slack times indicate that your design has not met its timing requirements. The worst (most negative) slack time indicates the amount by which delays in the critical path cause the timing of the design to fail. You can also obtain a *range* of worst slack times by setting the *slack margin* parameter to control the sensitivity of the critical-path display. Instances are displayed only if their slack times are within the slack margin of the (absolutely) worst slack time of the design.

The slack margin is the criterion for distinguishing worst slack times. The larger the margin, the more relaxed the measure of worst, so the greater the number of critical-path instances displayed. If the slack margin is zero (the default value), then only instances with the worst slack time of the design are shown. You use HDL Analyst->Set Slack Margin to change the slack margin.

The critical-path commands do not calculate a single critical path. They filter out instances whose slack times are not too bad (as determined by the slack margin), then display the remaining, worst-slack instances, together with their connecting paths.

For example, if the worst slack time of your design is -10 ns and you set a slack margin of 4 ns, then the critical path commands display all instances with slack times between -6 ns and -10 ns.

*See also:*

- [HDL Analyst Menu](#), on page 408
- [HDL Analyst Command](#), on page 409
- [Handling Negative Slack](#), on page 364 of the *User Guide*
- [Analyzing Timing in Schematic Views](#), on page 358 of the *User Guide*

## Examining Critical Path Schematics

Use successive filtering operations to examine different aspects of the critical path. After filtering, use View -> Back to return to the previous point, then filter differently. For example, you could use the command Isolate Paths to examine the cone of logic from a particular pin, then use the Back command to return to the previous display, then use Isolate Paths on a different pin to examine a different logic cone, and so on.

Also, the Show Context and Goto Net Driver commands are particularly useful after you have done some filtering. They let you get back to the original, unfiltered design, putting selected objects in context.

*See also:*

- [Returning to The Unfiltered Schematic](#), on page 114
- [Filtering and Flattening Schematics](#), on page 113

## CHAPTER 4

# Constraint Guidelines

---

Constraints are used in the FPGA synthesis environment to achieve optimal design results. Timing constraints set performance goals, non-timing constraints (design constraints) guide the tool through optimizations that further enhance performance.

This chapter provides an overview of how constraints are handled in the FPGA synthesis environment.

- [Constraint Types](#), on page 124
- [Constraint Files](#), on page 125
- [Timing Constraints](#), on page 127
- [FDC Constraints](#), on page 130
- [Methods for Creating Constraints](#), on page 131
- [Constraint Translation](#), on page 133
- [Constraint Checking](#), on page 138
- [Database Object Search](#), on page 140
- [Forward Annotation](#), on page 141
- [Auto Constraints](#), on page 141

# Constraint Types

One way to ensure the FPGA synthesis tool achieves the best quality of results for your design is to define proper constraints. In the FPGA environment, constraints can be categorized by the following types:

Type	Description
Timing	Performance constraints that guide the synthesis tools to achieve optimal results. Examples: clocks ( <code>create_clock</code> ), clock groups ( <code>set_clock_groups</code> ), and timing exceptions like multicycle and false paths ( <code>set_multicycle_path...</code> ) See <a href="#">Timing Constraints, on page 127</a> for information on defining these constraints.
Design	Additional design goals that enhance or guide tool optimizations. Examples: Attributes and directives ( <code>define_attribute</code> , <code>define_global_attribute</code> ), I/O standards ( <code>define_io_standard</code> ), and compile points ( <code>define_compile_point</code> ).

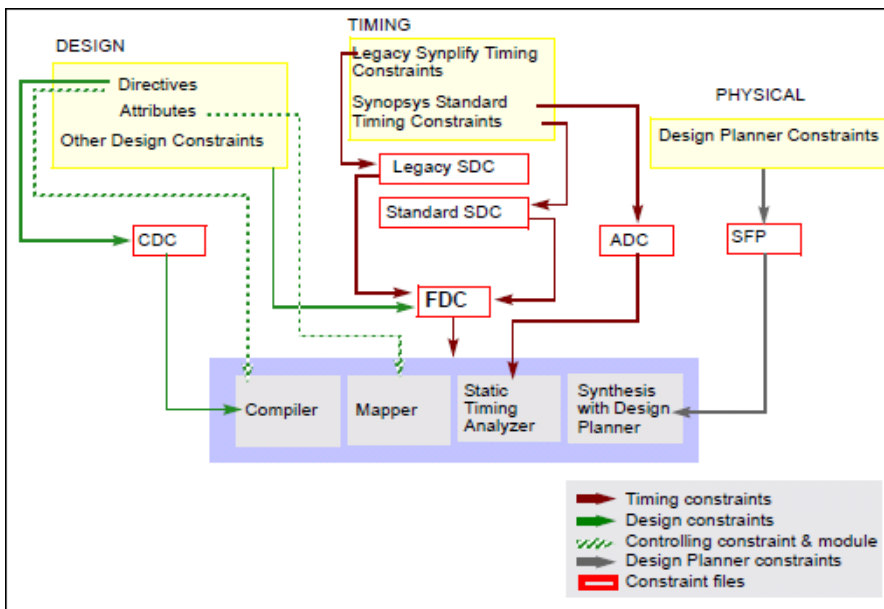
The easiest way to specify constraints is through the SCOPE interface. The tool saves timing and design constraints to an FDC file that you add to your project.

## See Also

<a href="#">Constraint Files, on page 125</a>	Overview of constraint files
<a href="#">Timing Constraints, on page 127</a>	Overview of timing constraint definitions and FDC file generation.
<a href="#">SCOPE Constraints Editor, on page 212</a>	Information about automatic generation of timing and design constraints.
<a href="#">Timing Constraints, on page 258</a>	Timing constraint syntax
<a href="#">Design Constraints, on page 297</a>	Design constraint syntax

# Constraint Files

The figure below shows the files used for specifying various types of constraints. The FDC file is the most important one and is the primary file for both timing and non-timing design constraints. The other constraint files are used for specific features or as input files to generate the FDC file, as described in [Timing Constraints, on page 127](#). The figure also indicates the specific processes controlled by attributes and directives.



The table is a summary of the various kinds of constraint files.

<b>File</b>	<b>Type</b>	<b>Common Commands</b>	<b>Comments</b>
FDC	Timing constraints	<code>create_clock,</code> <code>set_multicycle_delay ...</code>	Used for synthesis. Includes timing constraints that follow the Synopsys standard format as well as design constraints.
	Design constraints	<code>define_attribute,</code> <code>define_io_standard ...</code>	
ADC	Timing constraints for timing analysis	<code>create_clock,</code> <code>set_multicycle_delay ...</code>	Used with the stand-alone timing analyzer.
SDC (Synopsys Standard)	FPGA timing constraints	<code>create_clock,</code> <code>set_clock_latency,</code> <code>set_false_path ...</code>	Use <code>sd2fdc</code> to convert constraints to an FDC file so that they can be passed to the synthesis tools.
SDC (Legacy)	Legacy timing constraints and non-timing (or design) constraints	<code>define_clock,</code> <code>define_false_path</code> <code>define_attribute,</code> <code>define_collection ...</code>	Use <code>sd2fdc</code> to convert the constraints to an FDC file so that they can be passed to the synthesis tools.

# Timing Constraints

The synthesis tool has supported different timing formats in the past, and this section describes some of the details of standardization:

- [Legacy SDC and Synopsys Standard SDC](#), on page 127
- [FDC File Generation](#), on page 128
- [Timing Constraint Precedence in Mixed Constraint Designs](#), on page 128

## Legacy SDC and Synopsys Standard SDC

Releases prior to G-2012.09 had two types of constraint files that could be used in a design project:

- Legacy “Synplify-style” timing constraints (`define_clock`, `define_false_path...`) saved to an `sdc` file. This file also included non-timing design constraints, like attributes and compile points.
- Synopsys standard timing constraints (`create_clock`, `set_false_path...`). These constraints were also saved to an `sdc` file, which only contained timing constraints. Non-timing constraints were in a separate `sdc` file. The tool used the two files together, drawing timing constraints from one and non-timing constraints from the other.

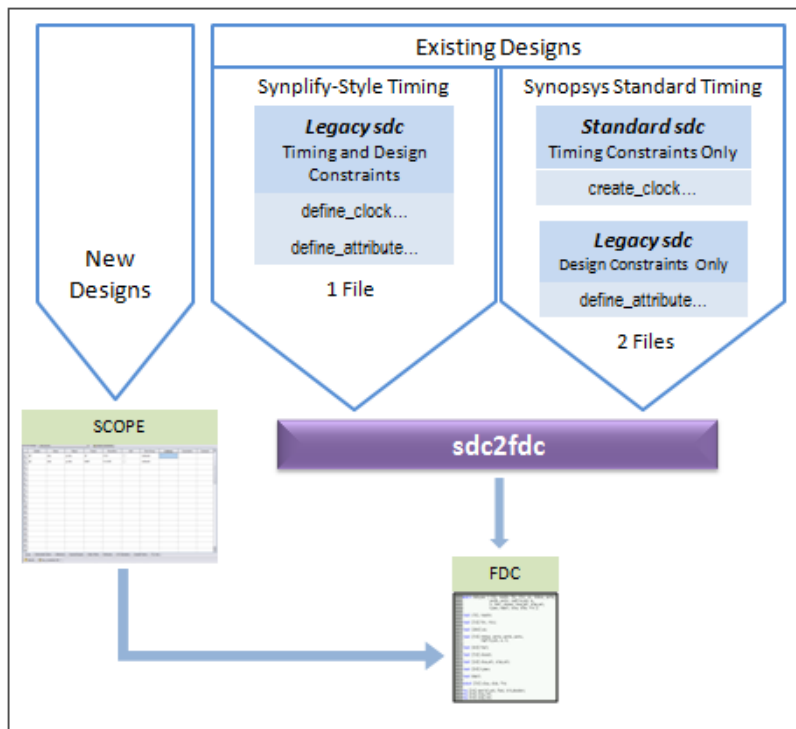
Starting with the G-2012.09 release, Synopsys standard timing constraint format has replaced the legacy-style constraint format, and a new FDC (FPGA design constraint) file consolidates both timing and design formats. As a result of these updates, there are some changes in the use model:

- Timing constraints in the legacy format are converted and included in an FDC file, which includes both timing and non-timing constraints. The file uses the Synopsys standard syntax for timing constraints (`create_clock`, `set_multicycle_path...`). The syntax for non-timing design constraints is unchanged (`define_attribute`, `define_io_standard...`).
- The SCOPE editor has been enhanced to support the timing constraint changes, so that new constraints can be entered correctly.
- For older designs, use the `sd2fdc` command to do a one-time conversion.

## FDC File Generation

The following figure is a simplified summary of constraint-file handling and the generation of fdc.

It is not required that you convert Synopsys standard sdc constraints as the figure implies, because they are already in the correct format. You could have a design with mixed constraints, with separate Synopsys standard sdc and fdc files. The disadvantage to keeping them in the standard sdc format is that you cannot view or edit the constraints through the SCOPE interface.



## Timing Constraint Precedence in Mixed Constraint Designs

Your design could include timing constraints in a Synopsys standard sdc file and others in an fdc file. With mixed timing constraints in the same design, the following order of precedence applies:



The tool reads the file order listed in the project file and any conflicting constraint overwrites a previous constraint. This means that constraint priority is determined by the constraint that is read last.

With the legacy timing constraints, it is strongly recommended that you convert them to the `fdc` format. However, even if you retain the old format in an existing design, they must be used alone and cannot be mixed in the same design as `fdc` or Synopsys standard timing `sdc` constraints. Specifically, do not specify timing constraints using mixed formats. For example, do not define clocks with `define_clock` and `create_clock` together in the same constraint file or multiple SDC/FDC files.

For the list of FPGA timing constraints (FDC) and their syntax, see [Timing Constraints, on page 258](#).

# FDC Constraints

The FPGA design constraints (FDC) file contains constraints that the tool uses during synthesis. This FDC file includes both timing constraints and non-timing constraints in a single file.

- Timing constraints define performance targets to achieve optimal results. The constraints follow the Synopsys standard format, such as `create_clock`, `set_input_delay`, and `set_false_path`.
- Non-timing (or design constraints) define additional goals that help the tool optimize results. These constraints are unique to the FPGA synthesis tools and include constraints such as `define_attribute`, `define_io_standard`, and `define_compile_point`.

The recommended method to define constraints is to enter them in the SCOPE editor, and the tool automatically generates the appropriate syntax. If you define constraints manually, use the appropriate syntax for each type of constraint (timing or non-timing), as described above. See [Methods for Creating Constraints, on page 131](#) for details on generating constraint files.

Prior to release G-2012.09, designs used timing constraints in either legacy Synplify-style format or Synopsys standard format. You must do a one-time conversion on any existing SDC files to convert them to FDC files using the following command:

```
% sdc2fdc
```

`sdc2fdc` converts constraints as follows:

For legacy Synplify-style timing constraints	Converts timing constraints to Synopsys standard format and saves them to an FDC file.
For Synopsys standard timing constraints	Preserves Synopsys standard format timing constraints and saves them to an FDC file.
For non-timing or design constraints	Preserves the syntax for these constraints and saves them to an FDC file.

Once defined, the FDC file can be added to your project. Double-click this file from the Project view to launch the SCOPE editor to view and/or modify your constraints. See [Converting SDC to FDC, on page 164](#) for details on how to run `sdc2fdc`.

# Methods for Creating Constraints

Constraints are passed to the synthesis environment in FDC files using Tcl command syntax.

## New Designs

For new designs, you can specify constraints using any of the following methods:

Definition Method	Description
SCOPE Editor (fdc file)– Recommended	<p>Use this method to specify constraints wherever possible. The SCOPE editor automatically generates fdc constraints with the right syntax. You can use it for most constraints. See <a href="#">Chapter 4, Constraint Commands</a>, for information how to use SCOPE to automatically generate constraint syntax.</p> <p>Access: File-&gt;New-&gt;FPGA Design Constraints ...</p>
Manually-Entered Text Editor (fdc File, all other constraint files)	<p>You can manually enter constraints in a text file. Make sure to use the correct syntax for the timing and design commands.</p> <p>The SCOPE GUI includes a TCL View with an advanced text editor, where you can manually generate the constraint syntax. For a description of this view, see <a href="#">TCL View, on page 236</a>.</p> <p>You can also open any constraint file in a text editor to modify it.</p>
Source Code Attributes/Directives (HDL files)	<p>Directives must be entered in the source code because they affect the compiler. Do not include any other constraints in the source code, as this makes the source code less portable. In addition, you must recompile the design for the constraints to take effect.</p> <p>Attributes can be entered through the SCOPE interface, as they affect the mapper, not the compiler</p>
Automatic— First Pass	<p>Enable the Auto Constrain button in the Project view to have the tool automatically generate constraints based on inferred clocks. See <a href="#">Using Auto Constraints, on page 376</a> in the <i>User Guide</i> for details.</p> <p>Use this method as a quick first pass to get an idea of what constraints can be set.</p>

If there are multiple timing exception constraints on the same object, the software uses the guidelines described in [Conflict Resolution for Timing Exceptions, on page 254](#) to determine the constraint that takes precedence.

## See Also

To specify the correct syntax for the timing and design commands, see:

- [Chapter 4, Constraint Commands](#)
- *Attribute Reference Manual*

## Existing Designs

The SCOPE editor in this release does not save constraints to SDC files. For designs prior to G-2012.09, it is recommended that you migrate your timing constraints to FDC format to take advantage of the tool's enhanced handling of these types of constraints. To migrate constraints, use the `sd2fdc` command (see [Converting SDC to FDC, on page 164](#)) on your sdc files.

---

**Note:** If you need to edit an SDC file, either use a text editor, or double-click the file to open the legacy SCOPE editor. For information on editing older SDC files, see [Using the SCOPE Editor \(Legacy\), on page 165](#).

---

## See Also

To use the current SCOPE editor, see:

- [Chapter 4, Constraint Commands](#)
- [Chapter 5, Specifying Constraints](#)

# Constraint Translation

The tool includes standalone scripts to convert specific vendor constraints, as well as functionality that includes constraint translation as part of the larger task of generating a synthesis project from vendor files.

## sdc2fdc Conversion

The `sdc2fdc` Tcl shell command translates legacy FPGA timing constraints to Synopsys FPGA timing constraints. This command scans the input SDC files and attempts to convert constraints for the implementation.

For details, see the following:

- [Troubleshooting Conversion Error Messages](#), on page 133
- [sdc2fdc FPGA Design Constraint \(FDC\) File](#), on page 135
- [sdc2fdc](#), on page 108 in the *Command Reference* manual (syntax)

## Troubleshooting Conversion Error Messages

The following table contains common error messages you might encounter when running the `sdc2fdc` Tcl shell command, and descriptions of how to resolve these problems. In addition to these messages, you must also ensure that your files have read/write permissions set properly and that there is sufficient disk space.

Message Example	Underlying Problem
Remove/disable D:FDC_constraints/rev_FDC/top_translated.fdc from the current implementation.	Cannot translate a *_translated.fdc file
Add/enable one or more SDC constraint files.	No active constraint files
Add clock object qualifier (p: n: ...) for "define_clock -name {clka} -period 10 -clockgroup {default_clkgroup_0}" Synplicity_SDC source file: D:.../clk_prior/scratch/top.sdc. Line number: 32	Clock not translated

Message Example	Underlying Problem
Specify -name for "define_clock {p:clkb} -period 20 -clockgroup {default_clkgroup_1}" Synplicity SDC source file: D:.../clk_prior/scratch/top.sdc. Line number: 33	Clock not translated
Missing qualifier(s) (i: p: n: ...) "define_multicycle_path 4 -from {a* b*} -to \$fdc_cmd_0 -start" Synplicity SDC source file: D:.../clk_prior/scratch/top.sdc. Line number: 76	Bad -from list for define_multicycle_path {a* b*}
Mixing of object types not permitted "define_multicycle_path -to {i:*y*.q[*] p:ena} 3" Synplicity SDC source file: D:.../clk_prior/scratch/top.sdc. Line number: 77	Bad -to list for define_multicycle_path {i: *y* .q[*] p:ena}
Mixing of object types and missing qualifiers not permitted "define_multicycle_path -from {i:*y*.q[*] p:ena enab} 3" Synplicity SDC source file: D:.../clk_prior/scratch/top.sdc. Line number: 77	Bad -from list for define_multicycle_path {i:*y* .q[*] p:ena enab}
Default 1000. "create_clock -name {clkb} {p:clkb} -period 1000 -waveform {0 500.0}" Synplicity SDC source file: D:.../clk_prior/scratch/top.sdc. Line number: 33	No period or frequency found
"create_clock -name {clka} {p:clka} -period 10 -rise 5 -clockgroup {default_clkgroup_0}" Synplicity SDC source file: D:.../clk_prior/scratch/top.sdc. Line number: 32	Must specify both -rise and -fall, or neither

Fix any issues in the SDC source file and rerun the `sdc2fdc` command.

## Batch Mode

If you run `sdc2fdc -batch`, then the following occurs:

- The two `Clock not translated` messages in the table above are not generated.
- When the translation is successful, the SDC file is disabled and the FDC file is enabled and saved automatically in the project file.

However, if the `-batch` option is *not* used and the translation is successful, then the SDC file is disabled and the FDC file is enabled but

*not* automatically saved in the Project file. A message to this effect displays in the Tcl shell window.

## sdc2fdc FPGA Design Constraint (FDC) File

The FDC constraint file generated after running `sdc2fdc` contains translated legacy FPGA timing constraints (SDC), which are now in the FDC format. This file is divided into two sections:

- 1 Contains this information:
  - Valid FPGA design constraints (e.g. `define_scope_collection` and `define_attribute`)
  - Legacy timing constraints that were not translated because they were specified with `-disable`.
- 2 Contains the legacy timing constraints that were translated.

This file also provides the following:

- Each source `sdc` file has its separate subhead.
- Each compile point is treated as a top level, so its `sdc` file has its own `_translated.fdc` file.
- The translator adds the naming rule, `set_rtl_ff_names`, so that the synthesis tool knows these constraints are not from the Synopsys Design Compiler.

The following example shows the contents of the FDC file.

```
#####
####This file contains constraints from Synplicity SDC files that have been
####translated into Synopsys FPGA Design Constraints (FDC.
####Translated FDC output file:
####D:/bugs/timing_88/clk_prior/scratch/FDC_constraints/rev_2/top_translated.fdc
####Source SDC files to the translation:
####D:/bugs/timing_88/clk_prior/scratch/top.sdc
#####

#####
####Source SDC file to the translation:
####D:/bugs/timing_88/clk_prior/scratch/top.sdc
#####

#Legacy constraint file
#C:\Clean_Demos\Constraints_Training\top.sdc
#Written on Mon May 21 15:58:35 2012
#by Synplify Pro, Synplify Pro Scope Editor
#
#Collections
#
define_scope_collection all_grp {define_collection \
```

```

[find -inst {i:FirstStbcPhase}] \
[find -inst {i:NormDenom[6:0]}] \
[find -inst {i:NormNum[7:0]}] \
[find -inst {i:PhaseOut[9:0]}] \
[find -inst {i:PhaseOutOld[9:0]}] \
[find -inst {i:PhaseValidOut}] \
[find -inst {i:ProcessData}] \
[find -inst {i:Quadrant[1:0]}] \
[find -inst {i:State[2:0]}] \
}

#
#Clocks

#define_clock -disable -name {clkc} -virtual -freq 150 -clockgroup default_clkgroup_1

#Clock to Clock
#
#
#Inputs/Outputs
#
define_input_delay -disable {b[7:0]} 2.00 -ref clka:r
define_input_delay -disable {c[7:0]} 0.20 -ref clkbr:r
define_input_delay -disable {d[7:0]} 0.30 -ref clkbr:r
define_output_delay -disable {x[7:0]} -improve 0.00 -route 0.00
define_output_delay -disable {y[7:0]} -improve 0.00 -route 0.00
#
#Registers
#
#
#Multicycle Path
#
#
#False Path
#
#
define_false_path -disable -from {i:x[1]}
#

#Path Delay
#
#
#Attributes
#
define_io_standard -default_input -delay_type input syn_pad_type {LVCMOS_33}#

#I/O standards
#
#
#Compile Points
#
#
#Other Constraints

#####
#SDC compliant constraints translated from Legacy Timing Constraints
#####
#
set_rtl_ff_names {#}

create_clock -name {clka} [get_ports {clka}] -period 10 -waveform {0 5.0}
create_clock -name {clkb} [get_ports {clkb}] -period 6.666666666666667
-waveform {0 3.3333333333333335}
set_input_delay -clock [get_clocks {clka}] -clock_fall -add_delay 0.000 [all_
inputs]

```



```

set_output_delay -clock [get_clocks {clka}] -add_delay 0.000 [all_outputs]
set_input_delay -clock [get_clocks {clka}] -add_delay 2.00 [get_ports {a[7:0]}]
set_input_delay -clock [get_clocks {clka}] -add_delay 0 [get_ports {rst}]
set_mcp 4
set_multicycle_path $mcp -start \
    -from \
        [get_ports \
            {a* \
                b*} \
            ] \
    -to \
        [find -seq -hier {q?[*]} ]

set_multicycle_path 3 -end \
    -from \
        [find -seq {*y*.q[*]} ]

set_clock_groups -name default_clkgroup_0 -asynchronous \
    -group [get_clocks {clka dcm|clk0_derived_clock dcm|
        clk2x_derived_clock dcm|clk0fx_derived_clock}]
set_clock_groups -name default_clkgroup_1 -asynchronous \
    -group [get_clocks {clkb}]

```

# Constraint Checking

The synthesis tool has several features to help you debug and analyze design constraints. Use the constraint checker to check the syntax and applicability of the timing constraints in the project. The synthesis log file includes a timing report as well as detailed reports on the compiler, mapper, and resource usage information for the design. A standalone timing analyzer (STA) generates a customized timing report when you need more details about specific paths or want to modify constraints and analyze, without resynthesizing the design. The following sections provide more information about these features.

## Constraint Checker

Check syntax and other pertinent information on your constraint files using Run->Constraint Check or the Check Constraints button in the SCOPE editor. This command generates a report that checks the syntax and applicability of the timing constraints that includes the following information:

- Constraints that are not applied
- Constraints that are valid and applicable to the design
- Wildcard expansion on the constraints
- Constraints on objects that do not exist

---

**Note:** Using collections with Tcl control constructs (such as if, for, foreach, and while) can produce unexpected synthesis results. Avoid defining constraints for collections with control constructs, especially since the constraint checker does not recognize these built-in Tcl commands.

---

See [Constraint Checking Report](#), on page 173 for details.

## Timing Constraint Report Files

The results of running constraint checking, synthesis, and standalone timing analysis are provided in reports that help you analyze constraints.

Use these files for additional timing constraint analysis:

File	Description
<code>_cck.rpt</code>	Lists the results of running the constraint checker (see <a href="#">Constraint Checking Report, on page 173</a> ).
<code>_cck_fdc_rpt</code>	Lists the wildcard expansion results of running the constraint checker for collections with the <code>get_*</code> and <code>all_*</code> object query commands using the <code>check_fdc_query</code> Tcl command. See <a href="#">check_fdc_query, on page 29</a> for more information.
<code>_scck.rpt</code>	Lists the results of running the constraint checker for collections with the <code>get_*</code> and <code>all_*</code> object query commands.
<code>.ta</code>	Reports timing analysis results (see <a href="#">Generating Custom Timing Reports with STA, on page 366</a> ).
<code>.srr</code> or <code>.htm</code>	Reports post-synthesis timing results as part of the text or HTML log file (see <a href="#">Timing Reports, on page 162</a> and <a href="#">Log File, on page 157</a> ).

# Database Object Search

To apply constraints, you have to search the database to find the appropriate objects. Sometimes you might want to search for and apply the same constraint to multiple objects. The FPGA tool provides some Tcl commands to facilitate the search for database objects:

Commands	Common Commands	Description
Find	Tcl Find, open_design...	Lets you search for design objects to form collections that can apply constraints to the group. See <a href="#">Using Collections, on page 154</a> and <a href="#">find, on page 149</a> .
Collections	define_collection, c_union...	Create, copy, evaluate, traverse, and filter collections. See <a href="#">Using Collections, on page 154</a> and <a href="#">Collection Commands, on page 166</a> for more information.

# Forward Annotation

The tool can automatically generate vendor-specific constraint files for forward annotation to the place-and-route tools when you enable the Write Vendor Constraints switch (on the Implementation Results tab) or use the `-write_apr_-constraint` option of the `set_option` command.

Vendor	File Extension
Microsemi PolarFire	_VM.SDC
Microsemi SmartFusion2	_SDC.SDC _VM.SDC
Microsemi All devices except PolarFire and SmartFusion2	_SDC.SDC

For information about how forward annotation is handled for your target technology, refer to the appropriate vendor chapter of the *FPGA Synthesis Reference Manual*.

## Auto Constraints

Auto constraints are automatically generated by the synthesis tool, however, these do not replace regular timing constraints in the normal synthesis flow. Auto constraints are intended as a quick first pass to evaluate the kind of timing constraints you need to set in your design.

To enable this feature and automatically generate register-to-register constraints, use the Auto Constrain option. For details, see [Using Auto Constraints](#), on page 376 in the *User Guide*.



## CHAPTER 5

# Input and Result Files

---

This chapter describes the input and output files used by the tool.

- [Input Files](#), on page 144
- [Libraries](#), on page 148
- [Output Files](#), on page 152
- [Log File](#), on page 157
- [Timing Reports](#), on page 162
- [Hierarchical Area Report](#), on page 172
- [Constraint Checking Report](#), on page 173

# Input Files

The following table describes the input files used by the synthesis tool.

Extension	File	Description
.adc	Analysis Design Constraint	<p>Contains timing constraints to use for stand-alone timing analysis. Constraints in this file are used only for timing analysis and do not change the result files from synthesis. Constraints in the adc file are applied in addition to sdc constraints used during synthesis. Therefore, adc constraints affect timing results only if there are no conflicts with sdc constraints.</p> <p>You can forward annotate adc constraints to your vendor constraint file without rerunning synthesis. See <a href="#">Using Analysis Design Constraints, on page 369</a> of the <i>User Guide</i> for details.</p>
.fdc	Synopsys FPGA Design Constraint	<p>Create FPGA timing and design constraints with SCOPE. You can run the sdc2fdc utility to translate legacy FPGA timing constraints (SDC) to Synopsys FPGA timing constraints (FDC). For details, see the <a href="#">sdc2fdc, on page 108</a>.</p>
.ini	Configuration and Initialization	<p>Governs the behavior of the synthesis tool. You normally do <i>not</i> need to edit this file. For example, use the HDL Analyst Options dialog box, instead, to customize behavior. See <a href="#">HDL Analyst Options Command, on page 439</a>.</p> <p>On the Windows 7 platforms, the ini file is in the C:\Users\userName\AppData\Roaming\Synplicity directory.</p> <p>On Linux workstations, the ini file is in the following directory: (~/.Synplicity, where ~ is your home directory, which can be set with the environment variable \$HOME).</p>
.prj	Project	<p>Contains all the information required to complete a design. It is in Tcl format, and contains references to source files, compilation, mapping, and optimization switches, specifications for target technology and other runtime options.</p>
.sdc	Constraint	<p>Contains the timing constraints (clock parameters, I/O delays, and timing exceptions) in Tcl format. You can either create this file manually or generate it by entering constraints in the SCOPE window.</p>



Extension	File	Description
.sv	Source files (Verilog)	Design source files in SystemVerilog format. The sv source file is added to the Verilog directory in the Project view. For more information about the Verilog and SystemVerilog languages, and the synthesis commands and attributes you can include, see <a href="#">Verilog, on page 146, Chapter 1, Verilog Language Support</a> , and <a href="#">Chapter 2, SystemVerilog Language Support</a> . For information about using VHDL and Verilog files together in a design, see <a href="#">Using Mixed Language Source Files, on page 48 of the User Guide</a> .
.vhd	Source files (VHDL)	Design source files in VHDL format. See <a href="#">VHDL, on page 146, Chapter 3, VHDL Language Support</a> , and <a href="#">Chapter 4, VHDL 2008 Language Support</a> for details. For information about using VHDL and Verilog files together in a design, see <a href="#">Using Mixed Language Source Files, on page 48 of the User Guide</a> .
.v	Source files (Verilog)	Design source files in Verilog format. For more information about the Verilog language, and the synthesis commands and attributes you can include, see <a href="#">Verilog, on page 146, Chapter 1, Verilog Language Support</a> , and <a href="#">Chapter 2, SystemVerilog Language Support</a> . For information about using VHDL and Verilog files together in a design, see <a href="#">Using Mixed Language Source Files, on page 48 of the User Guide</a> .

## HDL Source Files

The HDL source files for a project can be in either VHDL (.vhd), Verilog (.v), or SystemVerilog (.sv) format.

The Synopsys FPGA synthesis tool contains built-in macro libraries for vendor macros like gates, counters, flip-flops, and I/Os. If you use the built-in macro libraries, you can easily instantiate vendor macros directly into the VHDL designs, and forward-annotate them to the output netlist. Refer to the appropriate vendor support documentation for more information.

## VHDL

The Synopsys FPGA synthesis tool supports a synthesizable subset of VHDL93 (IEEE 1076), and the following IEEE library packages:

- `numeric_bit`
- `numeric_std`
- `std_logic_1164`

The synthesis tool also supports the following industry standards in the IEEE libraries:

- `std_logic_arith`
- `std_logic_signed`
- `std_logic_unsigned`

The Synopsys FPGA synthesis tool library contains an attributes package (*installDirectory/lib/vhd/synattr.vhd*) of built-in attributes and timing constraints that you can use with VHDL designs. The package includes declarations for timing constraints (including black-box timing constraints), vendor-specific attributes, and synthesis attributes. To access these built-in attributes, add the following two lines to the beginning of each of the VHDL design units that uses them:

```
library synplify;  
use synplify.attributes.all;
```

For more information about the VHDL language, and the synthesis commands and attributes you can include, see [Chapter 3, VHDL Language Support](#) and [Chapter 4, VHDL 2008 Language Support](#).

## Verilog

The Synopsys FPGA synthesis tool supports a synthesizable subset of Verilog 2001 and Verilog 95 (IEEE 1364) and SystemVerilog extensions. For more information about the Verilog language, and the synthesis commands and attributes you can include, see [Chapter 1, Verilog Language Support](#) and [Chapter 2, SystemVerilog Language Support](#).

The Synopsys FPGA synthesis tool contains built-in macro libraries for vendor macros like gates, counters, flip-flops, and I/Os. If you use the built-in macro libraries, you can instantiate vendor macros directly into Verilog designs and forward-annotate them to the output netlist. Refer to the *User Guide* for more information.

# Libraries

You can instantiate components from a library, which can be either in Verilog or VHDL. For example, you might have technology-specific or custom IP components in a library, or you might have generic library components. The *installDirectory/lib* directory included with the software contains some component libraries you can use for instantiation.

There are several kinds of libraries you can use:

- Technology-specific libraries that contain I/O pad, macro, or other component descriptions. The *lib* directory lists these kinds of libraries under vendor sub-directories. The libraries are named for the technology family, and in some cases also include a version number for the version of the place-and-route tool with which they are intended to be used.

For information about using vendor-specific libraries to instantiate LPMs, PLLs, macros, I/O pads, and other components, refer to the appropriate sections in the *Appendices* of the *Reference Manual*.

- The open verification library is automatically included in the FPGA product installation. When using your own open verification library, follow the recommendation described in [Open Verification Library \(Verilog\)](#), on page 149.
- Technology-independent libraries that contain common components. You can have your own library or use the one Synopsys provides. This library is a Verilog library of common logic elements, much like the Synopsys® GTECH component library. See [The Generic Technology Library](#), on page 149 for a description of this library.
- An ASIC Library Data Format file (.lib) is the technology library file that contains information about the functionality of each standard cell, its input capacitance, fanout, and timing information. For the synthesis flow to understand the instantiated or mapped ASIC primitives in the HDL, you would need to translate the functionality of the standard cell to equivalent synthesizable Verilog/VHDL definitions. To do this, you can use the *lib2syn* executable. For details, see [ASIC Library Files](#), on page 150.

## Open Verification Library (Verilog)

The open verification library is automatically included in the FPGA product installation. If you use your own version of the open verification library, then it is recommended that you disable loading the default synovl library to avoid any conflicts between the two libraries. To do this, set the `-disable_synovl` environment variable to 1. For example:

```
#in bash
export disable_synovl=1

#in csh
setenv disable_synovl 1
```

When the default synovl library is disabled, the following message is generated in the log file: @N::Open Verification Library which is part of tool installation, is being disabled by option "disable\_synovl".

## The Generic Technology Library

The synthesis software includes this Verilog library for generic components under the *installDirectory/lib/generic\_technology* directory. Currently, the library is only available in Verilog format. The library consists of technology-independent common logic elements, which help the designer to develop technology-independent parts. The library models extract the functionality of the component, but not its implementation. During synthesis, the mappers implement these generic components in implementations that are appropriate to the technology being used.

To use components from this directory, add the library to the project by doing either of the following:

- Add `add_file -verilog "$LIB/generic_technology/gtech.v` to your .prj file or type it in the Tcl window.
- In the tool window, click the Add file button, navigate to the *installDirectory/lib/generic\_technology* directory and select the gtech.v file.

When you synthesize the design, the tool uses components from this library.

You cannot use the generic technology library together with other generic libraries, as this could result in a conflict. If you have your own GTECH library that you intend to use, do not use the generic technology library.

## ASIC Library Files

An ASIC Library Data Format file (.lib) is the technology library file that contains information about the functionality of each standard cell, its input capacitance, fanout, and timing information.

For the synthesis flow to understand the instantiated or mapped ASIC primitives in the HDL, you would need to manually translate the functionality of the standard cell to equivalent synthesizable Verilog/VHDL definitions. This .lib file conversion is not automated in the synthesis flow. This means that the tool will not automatically translate .lib files into corresponding and equivalent synthesizable Verilog/VHDL definitions.

However, you can use the lib2syn executable to facilitate this conversion process. The lib2syn.exe executable generates equivalent synthesizable Verilog/VHDL definitions for the cells defined in the input .lib file. You can find this executable at these locations:

- Windows: *installDirectory/bin/lib2syn.exe*
- Linux: *installDirectory/bin/lib2syn*

The executable can be run as shown in these examples:

- For Verilog output: `lib2syn.exe test.lib -ovm a.vm -logfile test_lib2syn.log`
- For VHDL output: `lib2syn.exe test.lib -ovhm a.vhm -logfile test_lib2syn.log`

The tool supports the Synopsys GTECH library flow by default, so you do not need the .lib file equivalent synthesizable Verilog/VHDL definitions for a NETLIST mapped to a GTECH library.

Note that for the synthesis flow, the lib2syn executable does not translate cells with state table definitions.

The synthesis tools do not read Synopsys Liberty format (.syn) files directly. However, there are workarounds.

- If your design has instantiated ASIC cells, do the following:
  - Get the Verilog functional files for the instantiated components.
  - Add the functional files to your project as libraries.
- If you have an ASIC library in the Liberty (.lib) or .sel format, do the following:

- Convert the ASIC library into a Verilog functional file with the lib2syn utility. The lib2syn command syntax is shown below:

*installDirectory/bin/lib2syn.exe library.lib -ovm VerilogFunctionalFile*

or

*installDirectory/bin/lib2syn.exe library.sel -ovm VerilogFunctionalFile*

- Add the functional file to your project as a library.

# Output Files

The synthesis tool generates reports about the synthesis run and files that you can use for simulation or placement and routing. The following table describes the output files, categorizing them as either synthesis result and report files, or output files generated as input for other tools.

Extension	File	Description
.areasrr	Hierarchical Area Report	Reports area-specific information such as sequential and combinational RAMs, DSPs, and Black Boxes on each module in the design. See <a href="#">Hierarchical Area Report</a> , on page 172.
_cck.rpt	Constraint Checker Report	Checks the syntax and applicability of the timing constraints in the .fdc file for your project and generates a report ( <i>projectName_cck.rpt</i> ). See <a href="#">Constraint Checking Report</a> , on page 173 for more information.
_compiler.linkerlog	Compiler log file for HDL source file linking	Provides details for why the VHDL and/or Verilog components in the source files were not properly linked. This file is located in the synwork directory for the implementation.
.fse	FSM information file	Design-dependent. Contains information about encoding types and transition states for all state machines in the design.
.info	Design component files	Design-dependent. Contains detailed information about design components like state machines or ROMs.



Extension	File	Description
.linkerlog	Mixed language ports/generics differences	Provides details of why the VHDL and/or Verilog components in the source files were not properly linked. This file is located in the synwork directory for the implementation. The same information is also reported in the log file.
.pfl	Message Filter criteria	Output file created after filtering messages in the Messages window. See <a href="#">Updating the <i>projectName.pfl</i> file, on page 215</a> in the <i>User Guide</i> .
Results file: • .edn • .vm	Vendor-specific results file	Results file that contains the synthesized netlist, written out in a format appropriate to the technology and the place-and-route tool you are using. The vendor-specific formats include the following: • .edn or .vm for Microsemi Specify this file on the Implementation Results panel of the Implementation Options dialog box ( <a href="#">Implementation Results Panel, on page 349</a> ).
run_options.txt	Project settings for implementations	This file is created when a design is synthesized and contains the project settings and options used with the implementations. These settings and options are also processed for displaying the Project Status view after synthesis is run. For details, see <a href="#">Project Status Tab, on page 26</a> .

Extension	File	Description
.sap	Synplify Annotated Properties	This file is generated after the Annotated Properties for Analyst option is selected in the Device panel of the Implementation Options dialog box. After the compile stage, the tool annotates the design with properties like clock pins. You can find objects based on these annotated properties using Tcl Find. For more information, see <a href="#">find</a> , on <a href="#">page 149</a> and <a href="#">Using the Tcl Find Command to Define Collections</a> , on <a href="#">page 149</a> .
.sar	Archive file	Output of the Synopsys FPGA Archive utility in which design project files are stored into a single archive file. Archive files use Synopsys Proprietary Format. See <a href="#">Archive Project Command</a> , on <a href="#">page 335</a> for details on archiving, unarchiving and copying projects.
_scck.rpt	Constraint Checker Report (Syntax Only)	Generates a report that contains an overview of the design information, such as, the top-level view, name of the constraints file, if there were any constraint syntax issues, and a summary of clock specifications.
.srd	Intermediate mapping files	Used to save mapping information between synthesis runs. You do not need to use these files.
.srm	Mapping output files	Output file after mapping. It contains the actual technology-specific mapped design. This is the representation that appears graphically in a Technology view.
.srr	Synthesis log file	Provides information on the synthesis run, as well as area and timing reports. See <a href="#">Log File</a> , on <a href="#">page 157</a> , for more information.

Extension	File	Description
.srs	Compiler output file	Output file after the compiler stage of the synthesis process. It contains an HDL-level representation of a design. This is the representation that appears graphically in an RTL view.
synlog folder	Intermediate technology mapping files	This folder contains intermediate netlists and log files after technology mapping has been run. Timestamp information is contained in these netlist files to manage jobs with up-to-date checks. For more information, see <a href="#">Using Up-to-date Checking for Job Management, on page 184</a> .
synwork folder	Intermediate pre-mapping files	This folder contains intermediate netlists and log files after pre-mapping has been run. Timestamp information is contained in these netlist files to manage jobs with up-to-date checks. For more information, see <a href="#">Using Up-to-date Checking for Job Management, on page 184</a> .
.ta	Customized Timing Report	Contains the custom timing information that you specify through Analysis->Timing Analyst. See <a href="#">Analysis Menu, on page 396</a> , for more information.
_ta.srm	Customized mapping output file	Creates a customized output netlist when you generate a custom timing report with HDL Analyst->Timing Analyst. It contains the representation that appears graphically in a Technology view. See <a href="#">Analysis Menu, on page 396</a> for more information.

Extension	File	Description
.tap	Timing Annotated Properties	This file is generated after the Annotated Properties for Analyst option is selected in the Device panel of the Implementation Options dialog box. After the compile stage, the tool annotates the design with timing properties and the information can be analyzed in the RTL view and Design Planner. You can also find objects based on these annotated properties using Tcl Find. For more information, see <a href="#">Using the Tcl Find Command to Define Collections, on page 149</a> in the <i>User Guide</i> .
.tlg	Log file	This log file contains a list of all the modules compiled in the design.
<i>vendor constraint file</i>	Constraints file for forward annotation	Contains synthesis constraints to be forward-annotated to the place-and-route tool. The constraint file type varies with the vendor and the technology. Refer to the vendor chapters for specific information about the constraints you can forward-annotate. Check the Implementation Results dialog (Implementation Options) for supported files. See <a href="#">Implementation Results Panel, on page 349</a> .

Extension	File	Description
.vm .vhm	Mapped Verilog or VHDL netlist	<p>Optional post-synthesis netlist file in Verilog (.vm) or VHDL (.vhm) format. This is a structural netlist of the synthesized design, and differs from the original HDL used as input for synthesis. Specify these files on the Implementation Results dialog box (Implementation Options). See <a href="#">Implementation Results Panel, on page 349</a>.</p> <p>Typically, you use this netlist for gate-level simulation, to verify your synthesis results. Some designers prefer to simulate before and after synthesis, and also after place and route. This approach helps them to isolate the stage of the design process where a problem occurred. The Verilog and VHDL output files are for functional simulation only. When you input stimulus into a simulator for functional simulation, use a cycle time for the stimulus of 1000 time ticks.</p>

## Log File

The log file report, located in the implementation directory, is written out in two file formats: text (*projectName.srr*) and HTML with an interactive table of contents (*projectName.htm* and *projectName\_srr.htm*) where *projectName* is the name of your project. Select View Log File in HTML in the Options->Project View Options dialog box to enable viewing the log file in HTML. Select the View Log button in the Project view ([Buttons and Options, on page 72](#)) to see the log file report.

The log file is written each time you compile or synthesize (compile and map) the design. When you compile a design without mapping it, the log file contains only compiler information. As a precaution, a backup copy of the log file (.srr) is written to the backup sub-directory in the Implementation Results directory. Only one backup log file is updated for subsequent synthesis runs.

The log file contains detailed reports on the compiler, mapper, timing, and resource usage information for your design. Errors, notes, warnings, and messages appear in both the log file and on the Messages tab in the Tcl window.

For further details about different sections of the log file, see the following:

For information about ...	See ...
Compiled files, messages (warnings, errors, and notes), user options set for synthesis, state machine extraction information, including a list of reachable states.	<a href="#">Compiler Report, on page 158</a>
Buffers added to clocks in certain supported technologies.	<a href="#">Clock Buffering Report, on page 159</a>
Buffers added to nets.	<a href="#">Net Buffering Report, on page 159</a>
Compile point remapping.	<a href="#">Compile Point Information, on page 160</a>
Timing results. This section of the log file begins with “START TIMING REPORT” section. If you use the Timing Analyst to generate a custom timing report, its format is the same as the timing report in the log file, but the customized timing report is in a .ta file.	<a href="#">Timing Reports, on page 162</a>
Resources used by synthesis mapping.	<a href="#">Resource Usage Report, on page 160</a>
Design changes made as a result of retiming.	<a href="#">Retiming Report, on page 161</a>
Design changes made as a result of gated clock conversion.	<a href="#">, on page 180</a>

## Compiler Report

This report starts with the compiler version and date, and includes the following:

- Project information: the top-level module.
- Design information: HDL syntax and synthesis checks, black box instantiations, FSM extractions and inferred RAMs/ROMs.

- Netlist filter information: constant propagation.

## Premap Report

This report begins with the pre-mapper version and date, and reports the following:

- File loading times and memory usage
- Clock summary - For details, see [Clock Pre-map Reports, on page 165](#).

## Mapper Report

This report begins with the mapper version and date, and reports the following:

- Project information: the names of the constraint files, target technology, and attributes set in the design.
- Design information such as flattened instances, extraction of counters, FSM implementations, clock nets, buffered nets, replicated logic, HDL optimizations, and informational or warning messages.

## Clock Buffering Report

This section of the log file reports any clocks that were buffered. For example:

```
Clock Buffers:  
Inserting Clock buffer for port clock0,TNM=clock0
```

## Net Buffering Report

Net buffering reports are generated for most all of the supported FPGAs and CPLDs. This information is written in the log file, and includes the following information:

- The nets that were buffered or had their source replicated
- The number of segments created for that net
- The total number of buffers added during buffering
- The number of registers and look-up tables (or other cells) added during replication

## Example: Net Buffering Report

```
Net buffering Report:
Badd_c[2] - loads: 24, segments 2, buffering source
Badd_c[1] - loads: 32, segments 2, buffering source
Badd_c[0] - loads: 48, segments 3, buffering source
Aadd_c[0] - loads: 32, segments 3, buffering source
Added 10 Buffers
Added 0 Registers via replication
Added 0 LUTs via replication
```

## Compile Point Information

The Summary of Compile Points section of the log file (*projectName.srr*) lists each compile point, together with an indication of whether it was remapped, and, if so, why. Also, a timing report is generated for each compile point located in its respective results directories in the Implementation Directory. The compile point is the top-level design for this report file.

For more information on compile points and the compile-point synthesis flow, see [Synthesizing Compile Points, on page 455](#) of the *User Guide*.

## Timing Section

A default timing report is written to the log file (*projectName.srr*) in the “START OF TIMING REPORT” section. See [Timing Reports, on page 162](#), for details.

For certain device technologies in the Synplify Pro tool, you can use the Timing Analyst to generate additional timing reports for point-to-point analysis (see [Analysis Menu, on page 396](#)). Their format is the same as the timing report.

## Resource Usage Report

A resource usage report is added to the log file each time you compile or synthesize. The format of the report varies, depending on the architecture you are using. The report provides the following information:

- The total number of cells, and the number of combinational and sequential cells in the design
- The number of clock buffers and I/O cells
- Details of how many of each type of cell in the design



See [Checking Resource Usage, on page 201](#) in the *User Guide* for a brief procedure on using the report to check for overutilization.

## Retiming Report

Whenever retiming is enabled, a retiming report is added to the log file (*projectName.srr*). It includes information about the design changes made as a result of retiming, such as the following:

- The number of flip-flops added, removed, or modified because of retiming. Flip-flops modified by retiming have a `_ret` suffix added to their names.
- Names of the flip-flops that were *moved* by retiming and no longer exist in the Technology view.
- Names of the flip-flops *created* as result of the retiming moves, that did not exist in the RTL view.
- Names of the flip-flops *modified* by retiming; for example, flip-flops that are in the RTL and Technology views, but have different fanouts because of retiming.

# Timing Reports

Timing results can be written to one or more of the following files:

<code>.srr</code> or <code>.htm</code>	Log file that contains a default timing report. To find this information, after synthesis completes, open the log file (View -> Log File), and search for START OF TIMING REPORT.
<code>.ta</code>	Timing analysis file that contains timing information based on the parameters you specify in the stand-alone Timing Analyst (Analysis->Timing Analyst).
<code>designName_async_clk.rpt.scv</code>	Asynchronous clock report file that is generated when you enable the related option in the stand-alone Timing Analyzer (Analysis->Timing Analyst). This report can be displayed in a spreadsheet tool and contains information for paths that cross between multiple clock groups. See <a href="#">Asynchronous Clock Report, on page 170</a> for details on this report.

The timing reports in the `.srr/.htm` and `.ta` files have the following sections:

- [Timing Report Header](#), on page 163
- [Performance Summary](#), on page 163
- [Clock Pre-map Reports](#), on page 165
- [Clock Relationships](#), on page 168
- [Interface Information](#), on page 169
- [Asynchronous Clock Report](#), on page 170

## Timing Report Header

The timing report header lists the date and time, the name of the top-level module, the number of paths requested for the timing report, and the constraint files used.

```

00055
00056 ##### START TIMING REPORT #####
00057 # Timing Report written on Fri Sep 06 13:38:15 2002
00058 #
00059
00060
00061 Top view:                mod2
00062 Paths requested:         5
00063 Constraint File(s):
00064 @N| This timing report estimates place and route data. Please look i
00065 @N| Clock constraints cover all FF-to-FF, FF-to-output, input-to-FF
00066

```

You can control the size of the timing report by choosing Project -> Implementation Options, clicking the Timing Report tab of the panel, and specifying the number of start/end points and the number of critical paths to report. See [Timing Report Panel](#), on page 351, for details.

## Performance Summary

The Performance Summary section of the timing report lists estimated and requested frequencies for the clocks, with the clocks sorted by negative slack. The timing report has a different section for detailed clock information.

```

Performance Summary
*****

Worst slack in design: 8.479

Starting Clock      Requested      Estimated      Requested      Estimated      Slack      Clock      Clock
Frequency           Frequency      Period         Period         Type          Group
-----
clk1                100.0 MHz      NA             10.000         NA             NA         declared   default_clkgroup
clk2                111.1 MHz      1920.5 MHz     9.000          0.521         8.479      declared   default_clkgroup
clk3                125.0 MHz      NA             8.000          NA             NA         declared   default_clkgroup
comb1|gclk_inferred_clock  1.0 MHz      NA             1000.000       NA             NA         inferred   Inferred_clkgroup_0
en3_0              66.7 MHz      NA             15.000         NA             NA         declared   default_clkgroup
ff_clk1|clk_out_derived_clock  111.1 MHz     1920.5 MHz     9.000          0.521         17.479     derived (from clk2)  default_clkgroup
*****
Estimated period and frequency reported as NA means no slack depends directly on the clock waveform

```

The Performance Summary lists the following information for each clock in the design:

Performance Summary Column	Description
Starting Clock	Clock at the start point of the path. If the clock name is system, the clock is a collection of clocks with an undefined clock event. Rising and falling edge clocks are reported as one clock domain.
Requested/Estimated Frequency	Target frequency goal /estimated value after synthesis. See <a href="#">Cross-Clock Path Timing Analysis, on page 168</a> for information on how cross-clock path slack is reported.
Requested/Estimated Period	Target clock period/estimated value after synthesis.
Slack	Difference between estimated and requested period. See <a href="#">Cross-Clock Path Timing Analysis, on page 168</a> for information on how cross-clock path slack is reported.
Clock Type	The type of clock: inferred, declared, derived or system. For more information, see <a href="#">Clock Types, on page 164</a> .
Clock Group	Name of the clock group that a clock belongs.

The synthesis tool does not report inferred clocks that have an unreasonable slack time. Also, a real clock might have a negative period. For example, suppose you have a clock going to a single flip-flop, which has a single path going to an output. If you specify an output delay of -1000 on this output, then the synthesis tool cannot calculate the clock frequency. It reports a negative period and no clock.

## Clock Types

The synthesis timing reports include the following types of clocks:

- Declared Clocks

User-defined clocks specified in the constraint file.

- Inferred Clocks

These are clocks that the synthesis timing engine finds during synthesis, but which have not been constrained by the user. The tool

assigns the default global frequency specified for the project to these clocks.

- **Derived Clocks**

These are clocks that the synthesis tool identifies from a clock divider/multiplier such as DCM.

- **System Clock**

The system clock is the delay for the combinational path. Additionally, a system clock can be reported if there are sequential elements in the design for a clock network that cannot be traced back to a clock. Also, the system clock can occur for unconstrained I/O ports. You must investigate these conditions.

Paths to/from black boxes are timed by the system clock. Add the black-box timing constraints. See [syn\\_black\\_box](#), on page 63 for the black box source code directives.

## Clock Pre-map Reports

The following clock reports are generated during pre-map.

- [Clock Summary](#), on page 166
- [Clock Load Summary](#), on page 166
- [Clock Optimization Report](#), on page 167

## Clock Summary

Here is an example of the pre-map Clock Summary report.

```
Clock Summary
*****
```

Level	Start Clock	Requested Frequency	Requested Period	Clock Type	Clock Group	Clock Load
0 -	clk	10.0 MHz	100.000	declared	default_clkgroup	20
0 -	clk_comb	10.0 MHz	100.000	declared	default_clkgroup	5
0 -	clk_pin0	10.0 MHz	100.000	declared	default_clkgroup	1
0 -	clk_pin1	10.0 MHz	100.000	declared	default_clkgroup	1
0 -	clk_pin2	10.0 MHz	100.000	declared	default_clkgroup	1
0 -	clk_pin3	10.0 MHz	100.000	declared	default_clkgroup	1
0 -	clk_pin4	10.0 MHz	100.000	declared	default_clkgroup	1

## Clock Load Summary

The pre-map Clock Load Summary table contains the following:

- Clock name
- Number of clock loads
- Clock source pin
- Clock load on clock pin sequential example
- Clock load on non-clock pin sequential example
- Clock load on combinatorial example

## Clock Load Summary

\*\*\*\*\*

Clock	Clock Load	Source Pin	Clock Pin Seq Example	Non-clock Pin Seq Example	Non-clock Pin Comb Example
clk	20	clk.clk(i)	i0.in1_share_reg.C	i1.i0.out.D[0]	i2.and_out0.I[1] (and)
clk_comb	5	clk_comb.clk_comb(i)	-	-	i2.and_out0.I[2] (and)
clk_pin0	1	clk_pin0.clk_pin0(i)	i1.i0.out.C	-	-
clk_pin1	1	clk_pin1.clk_pin1(i)	i1.i1.out.C	-	-
clk_pin2	1	clk_pin2.clk_pin2(i)	i1.i2.out.C	-	-
clk_pin3	1	clk_pin3.clk_pin3(i)	i1.i3.out.C	-	-
clk_pin4	1	clk_pin4.clk_pin4(i)	i1.i4.out.C	-	-

## Clock Optimization Report

This is an example of the pre-map Clock Optimization report. A table is provided with information for both the Non-Gated/Non-Generated Clocks and Gated/Generated Clocks.

#### START OF INTERNAL CLOCK OPTIMIZATION REPORT ####

5 non-gated/non-generated clock tree(s) driving 15 clock pin(s) of sequential element(s)  
 5 gated/generated clock tree(s) driving 5 clock pin(s) of sequential element(s)  
 0 instances converted, 5 sequential instances remain driven by gated/generated clocks

Non-Gated/Non-Generated Clocks				
Clock Tree ID	Driving Element	Drive Element Type	Fanout	Sample Instance
<a href="#">ClockId_0_5</a>	clk_pin4	port	1	i1.i4.out
<a href="#">ClockId_0_6</a>	clk_pin3	port	1	i1.i3.out
<a href="#">ClockId_0_7</a>	clk_pin2	port	1	i1.i2.out
<a href="#">ClockId_0_8</a>	clk_pin1	port	1	i1.i1.out
<a href="#">ClockId_0_9</a>	clk_pin0	port	1	i1.i0.out
<a href="#">ClockId_0_10</a>	clk	port	10	i0.outb

Gated/Generated Clocks					
Clock Tree ID	Driving Element	Drive Element Type	Unconverted Fanout	Sample Instance	Explanation
<a href="#">ClockId_0_0</a>	i2.and_out4.00T	and	1	reg4.out	Multiple clocks on instance
<a href="#">ClockId_0_1</a>	i2.and_out3.00T	and	1	reg3.out	Multiple clocks on instance
<a href="#">ClockId_0_2</a>	i2.and_out2.00T	and	1	reg2.out	Multiple clocks on instance
<a href="#">ClockId_0_3</a>	i2.and_out1.00T	and	1	reg1.out	Multiple clocks on instance
<a href="#">ClockId_0_4</a>	i2.and_out0.00T	and	1	reg0.out	Multiple clocks on instance

## Clock Relationships

For each pair of clocks in the design, the Clock Relationships section of the timing report lists both the required time (constraint) and the worst slack time for each of the intervals rise to rise, fall to fall, rise to fall, and fall to rise. See [Cross-Clock Path Timing Analysis, on page 168](#) for details about cross-clock paths.

This information is provided for the paths between related clocks (that is, clocks in the same clock group). If there is no path at all between two clocks, then that pair is not reported. If there is no path for a given pair of edges between two clocks, then an entry of No paths appears.

For information about how these relationships are calculated, see [Clock Groups, on page 215](#). For tips on using clock groups, see [Defining Other Clock Requirements, on page 177](#) in the *User Guide*.

Clock Relationships									
*****									
Clocks		rise to rise		fall to fall		rise to fall		fall to rise	
Starting	Ending	constraint	slack	constraint	slack	constraint	slack	constraint	slack
clk1	clk1	25.000	15.943	25.000	17.764	No paths	-	No paths	-
clk1	clk2	1.000	-9.430	No paths	-	No paths	-	1.000	-1.531
clk2	clk1	No paths	-	1.000	-0.811	1.000	-1.531	No paths	-
clk2	clk2	8.000	0.764	8.000	-1.057	No paths	-	6.000	2.814
clk3	clk3	No paths	-	10.000	0.943	No paths	-	No paths	-

## Cross-Clock Path Timing Analysis

The following describe how the timing analyst calculates cross-clock path frequency and slack.

### Cross-Clock Path Frequency

For each data path, the tool estimates the highest frequency that can be set for the clock(s) without a setup violation. It finds the largest scaling factor that can be applied to the clock(s) without causing a setup violation. If the start clock is not the same as the end clock, it scales both by the same factor.

$$\text{scale} = (\text{minimum time period} - (-\text{current slack})) / \text{minimum time period}$$

It assumes all other delays in the setup calculation (e.g., uncertainty) are fixed.



It applies relevant multicycle constraints to the setup calculation.

The estimated frequency for a clock is the minimum frequency over all paths that start or end on that clock, with the following exceptions:

- The tool does not consider paths between the system clock and another clock to estimate frequency.
- It considers paths with a path delay constraint to be asynchronous, and does not use them to estimate frequency.
- It considers paths between clocks in different domains to be asynchronous, and does not use them to estimate frequency.

### Slack for Cross-Clock Paths

The slack reported for a cross-clock path is the worst slack for any path that starts on that clock. Note that this differs from the estimated frequency calculation, which is based on the worst slack for any path starting or ending on that clock.

## Interface Information

The interface section of the timing report contains information on arrival times, required times, and slack for the top-level ports. It is divided into two subsections, one each for Input Ports and Output Ports. Bidirectional ports are listed under both. For each port, the interface report contains the following information.

Port parameter	Description
Port Name	Port name.
Starting Reference Clock	The reference clock.
User Constraint	The input/output delay. If a port has multiple delay records, the report contains the values for the record with the worst slack. The reference clock corresponds to the worst slack delay record.

Port parameter	Description
Arrival Time	Input ports: define_input_delay, or default value of 0. Output ports: path delay (including clock-to-out delay of source register). For purely combinational paths, the propagation delay is calculated from the driving input port.
Required Time	Input ports: clock period - (path delay + setup time of receiving register + define_reg_input_delay value). Output ports: clock period - define_output_delay. Default value of define_output_delay is 0.
Slack	Required Time - Arrival Time

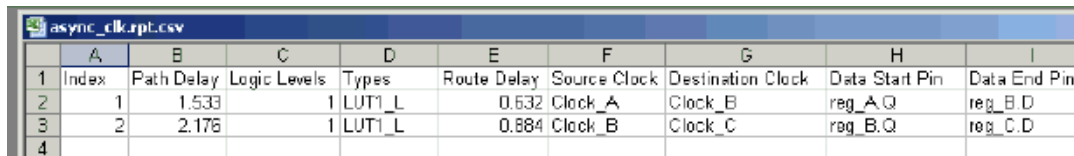
## Asynchronous Clock Report

You can generate a report for paths that cross between clock groups using the stand-alone Timing Analyst (Analysis->Timing Analyst, Generate Asynchronous Clock Report check box). Generally, paths in different clock groups are automatically handled as false paths. This option provides a file that contains information on each of the paths and can be viewed in a spreadsheet tool. To display the CSV-format report:

1. Locate the file in your results directory *projectName\_async\_clk.rpt.csv*.
2. Open the file in your spreadsheet tool.

Column	Description
Index	Path number.
Path Delay	Delay value as reported in standard timing (ta) file.
Logic Levels	Number of logic levels in the path (such as LUTs, cells, and so on) that are between the start and end points.
Types	Cell types, such as LUT, logic cell, and so on.
Route Delay	As reported for each path in ta
Source Clock	Start clock.
Destination Clock	End clock.

Column	Description
Data Start Pin	Sequential device output pin at start of path.
Data End Pin	Setup check pin at destination.



	A	B	C	D	E	F	G	H	I
1	Index	Path Delay	Logic Levels	Types	Route Delay	Source Clock	Destination Clock	Data Start Pin	Data End Pin
2	1	1.533	1	LUT1_L	0.632	Clock_A	Clock_B	reg_A.Q	reg_B.D
3	2	2.176	1	LUT1_L	0.684	Clock_B	Clock_C	reg_B.Q	reg_C.D
4									

# Hierarchical Area Report

An area report is created during synthesis which contains the percentage utilization for elements in the design, as well as, total sequential utilization for elements of specific modules. For instance, elements can include sequential, combinational, or memory elements. They can also include the following types of technology-specific elements for ROMs, I/O pads, or DSPs.

This report generates technology-specific area information that is reflected in the output depending upon the specified device. The report is written to the *projectName*.areasr file. You can view the file with the log viewer or any text editor.

# Constraint Checking Report

Use the Run->Constraint Check command to generate a report on the constraint files in your project. The *projectName\_cck.rpt* file provides information such as invalid constraint syntax, constraint applicability, and any warnings or errors. For details about running Constraint Check, see [Tcl Syntax Guidelines for Constraint Files](#), on page 55 in the *User Guide*.

This section describes the following topics:

- [Reporting Details](#), on page 173
- [Inapplicable Constraints](#), on page 174
- [Applicable Constraints With Warnings](#), on page 175
- [Sample Constraint Check Report](#), on page 176

## Reporting Details

This constraint checking file reports the following:

- Constraints that are not applied
- Constraints that are valid and applicable to the design
- Wildcard expansion on the constraints
- Constraints on objects that do not exist

It contains the following sections:

Summary	Statement which summarizes the total number of issues defined as an error or warning (x) out of the total number of constraints with issues (y) for the total number of constraints (z) in the .fdc file. Found <x> issues in <y> out of <z> constraints
Clock Relationship	Standard timing report clock table, without slack.
Unconstrained Start/End Points	Lists I/O ports that are missing input/output delays.

Unapplied constraints	Constraints that cannot be applied because objects do not exist or the object type check is not valid. See <a href="#">Inapplicable Constraints, on page 174</a> for more information.
Applicable constraints with issues	Constraints will be applied either fully or partially, but there might be issues that generate warnings which should be investigated, such as some objects/collections not existing. Also, whenever at least one object in a list of objects is not specified with a valid object type a warning is displayed. See <a href="#">Applicable Constraints With Warnings, on page 175</a> for more information.
Constraints with matching wildcard expressions	Lists constraints or collections using wildcard expressions up to the first 1000, respectively.

## Inapplicable Constraints

Refer to the following table for constraints that were not applied because objects do not exist or the object type check was not valid:

For these constraints ...	Objects must be ...
Attributes	Valid definitions
create_clock	<ul style="list-style-type: none"> <li>• Ports</li> <li>• Nets</li> <li>• Pins</li> <li>• Registers</li> <li>• Instantiated buffers</li> </ul>
create_generated_clock	Clocks
define_compile_point	<ul style="list-style-type: none"> <li>• Region</li> <li>• View</li> </ul>
define_current_design	v: <i>view</i>

For these constraints ...	Objects must be ...
set_false_path set_multicycle_path set_max_delay	For -to or -from objects: <ul style="list-style-type: none"> <li>• i:sequential instances</li> <li>• p:ports</li> <li>• i:black boxes</li> </ul> For -through objects <ul style="list-style-type: none"> <li>• n:nets</li> <li>• t:hierarchical ports</li> <li>• t:pins</li> </ul>
set_multicycle_path	Specified as a positive integer
set_input_delay	<ul style="list-style-type: none"> <li>• Input ports</li> <li>• bidir ports</li> </ul>
set_output_delay	<ul style="list-style-type: none"> <li>• Output ports</li> <li>• Bidir ports</li> </ul>
set_reg_input_delay set_reg_output_delay	Sequential instances

## Applicable Constraints With Warnings

The following table lists reasons for warnings in the report file:

For these constraints ...	Objects must be ...
create_clock	<ul style="list-style-type: none"> <li>• Ports</li> <li>• Nets</li> <li>• Pins</li> <li>• Registers</li> <li>• Instantiated buffers</li> </ul>
set_clock_uncertainty	A single object. Multiple objects are not supported.
define_compile_point	A single object. Multiple objects are not supported.
define_current_design	v:view

**For these constraints ...****Objects must be ...**

set\_false\_path  
 set\_multicycle\_path  
 set\_path\_delay

For -to or -from objects:

- i:sequential instances
- p:ports
- i:black boxes

For -through objects:

- n:nets
- t:hierarchical ports
- t:pins

set\_input\_delay

A single object. Multiple objects are not supported.

set\_output\_delay

A single object. Multiple objects are not supported.

set\_reg\_input\_delay  
 set\_reg\_output\_delay

A single object. Multiple objects are not supported.

**Sample Constraint Check Report**

The following is a sample report generated by constraint checking:

```
# Synopsys Constraint Checker, version maprc, Build 1138R, built Jun 7 2016
# Copyright (C) 1994-2016, Synopsys, Inc.
```

```
# Written on Fri Jun 7 09:42:22 2016
```

```
##### DESIGN INFO #####
```

```
Top View:                "decode_top"
```

```
Constraint File(s):       "C:\timing_88\FPGA_decode_top.sdc"
```

```
##### SUMMARY #####
```

```
Found 3 issues in 2 out of 27 constraints
```



##### DETAILS #####

#### Clock Relationships

\*\*\*\*\*

Starting	Ending	rise to rise	fall to fall	rise to fall	fall to rise
clk2x	clk2x	24.000	24.000	12.000	12.000
clk2x	clk	24.000	No paths	No paths	12.000
clk	clk2x	24.000	No paths	12.000	No paths
clk	clk	48.000	No paths	No paths	No paths

#### Note:

'No paths' indicates there are no paths in the design for that pair of clock edges.  
 'Diff grp' indicates that paths exist but the starting clock and ending clock are in different clock groups

#### Unconstrained Start/End Points

\*\*\*\*\*

p:test\_mode

#### Inapplicable constraints

\*\*\*\*\*

```
set_false_path -from p:next_synd -through i:core.tabl.ram_loader
@E:|object "i:core.tabl.ram_loader" does not exist
@E:|object "i:core.tabl.ram_loader" is incorrect type; "-through" objects must be of
type net (n:), or pin (t:)
```

#### Applicable constraints with issues

\*\*\*\*\*

```
set_false_path -from {core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.omega_inst.omega_tmp_d_lch[7:0]}
@W:|object "core.decoder.root_mult*.root_prod_pre[*]" is missing qualifier which may
result in undesired results; "-from" objects must be of type clock (c:), inst (i:), port
(p:), or pin (t:)
```

#### Constraints with matching wildcard expressions

\*\*\*\*\*

```
set_false_path -from {core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.omega_inst.omega_tmp_d_lch[7:0]}
@N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]
```

```
set_false_path -from {i:core.decoder.*.root_prod_pre[*]} -to {i:core.decoder.t_*_[*]}
@N:|expression "core.decoder.*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]
@N:|expression "core.decoder.t_*_[*]" applies to objects:
core.decoder.t_20_[7:0]
core.decoder.t_19_[7:0]
core.decoder.t_18_[7:0]
core.decoder.t_17_[7:0]
core.decoder.t_16_[7:0]
core.decoder.t_15_[7:0]
core.decoder.t_14_[7:0]
core.decoder.t_13_[7:0]
core.decoder.t_12_[7:0]
core.decoder.t_11_[7:0]
core.decoder.t_10_[7:0]
core.decoder.t_9_[7:0]
core.decoder.t_8_[7:0]
core.decoder.t_7_[7:0]
core.decoder.t_6_[7:0]
core.decoder.t_5_[7:0]
core.decoder.t_4_[7:0]
core.decoder.t_3_[7:0]
core.decoder.t_2_[7:0]
core.decoder.t_1_[7:0]
core.decoder.t_0_[7:0]

set_false_path -from {i:core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.err[7:0]}
@N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.omega_inst.deg_omega[4:0]}
@N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.omega_inst.omega_tmp[0:7]}
@N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.root[7:0]}
@N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]
```

```
set_false_path -from {i:core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.root_inst.count[3:0]}
N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.root_inst.q_reg[7:0]}
@N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.root_mult*.root_prod_pre[*]} -to
{i:core.decoder.root_inst.q_reg_d_lch[7:0]}
@N:|expression "core.decoder.root_mult*.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]
core.decoder.root_mult.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.root_mult.root_prod_pre[*]} -to
{i:core.decoder.error_inst.den[7:0]}
@N:|expression "core.decoder.root_mult.root_prod_pre[*]" applies to objects:
core.decoder.root_mult.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.root_mult1.root_prod_pre[*]} -to
{i:core.decoder.error_inst.num1[7:0]}
@N:|expression "core.decoder.root_mult1.root_prod_pre[*]" applies to objects:
core.decoder.root_mult1.root_prod_pre[14:0]

set_false_path -from {i:core.decoder.synd_reg_*_[7:0]} -to {i:core.decoder.b_*_[7:0]}
@N:|expression "core.decoder.synd_reg_*_[7:0]" applies to objects:
core.decoder.un1_synd_reg_0_[7:0]
core.decoder.synd_reg_20_[7:0]
core.decoder.synd_reg_19_[7:0]
core.decoder.synd_reg_18_[7:0]
core.decoder.synd_reg_17_[7:0]
core.decoder.synd_reg_16_[7:0]
core.decoder.synd_reg_15_[7:0]
core.decoder.synd_reg_14_[7:0]
core.decoder.synd_reg_13_[7:0]
core.decoder.synd_reg_12_[7:0]
core.decoder.synd_reg_11_[7:0]
core.decoder.synd_reg_10_[7:0]
core.decoder.synd_reg_9_[7:0]
core.decoder.synd_reg_8_[7:0]
core.decoder.synd_reg_7_[7:0]
core.decoder.synd_reg_6_[7:0]
core.decoder.synd_reg_5_[7:0]
core.decoder.synd_reg_4_[7:0]
core.decoder.synd_reg_3_[7:0]
core.decoder.synd_reg_2_[7:0]
core.decoder.synd_reg_1_[7:0]
```

@N: |expression "core.decoder.b\_\*\_[7:0]" applies to objects:

```
core.decoder.unl_b_0_[7:0]
core.decoder.b_calc.unl_lambda_0_[7:0]
core.decoder.b_20_[7:0]
core.decoder.b_19_[7:0]
core.decoder.b_18_[7:0]
core.decoder.b_17_[7:0]
core.decoder.b_16_[7:0]
core.decoder.b_15_[7:0]
core.decoder.b_14_[7:0]
core.decoder.b_13_[7:0]
core.decoder.b_12_[7:0]
core.decoder.b_11_[7:0]
core.decoder.b_10_[7:0]
core.decoder.b_9_[7:0]
core.decoder.b_8_[7:0]
core.decoder.b_7_[7:0]
core.decoder.b_6_[7:0]
core.decoder.b_5_[7:0]
core.decoder.b_4_[7:0]
core.decoder.b_3_[7:0]
core.decoder.b_2_[7:0]
core.decoder.b_1_[7:0]
core.decoder.b_0_[7:0]
```

Library Report

\*\*\*\*\*

# End of Constraint Checker Report

## CHAPTER 6

# RAM and ROM Inference

---

This chapter provides guidelines and Verilog or VHDL examples for coding RAMs for synthesis. It covers the following topics:

- [Guidelines and Support for RAM Inference](#), on page 182
- [Automatic RAM Inference](#), on page 183
- [Block RAM Inference](#), on page 187
- [Initial Values for RAMs](#), on page 229
- [RAM Instantiation with SYNCORE](#), on page 242
- [ROM Inference](#), on page 243

# Guidelines and Support for RAM Inference

There are two methods to handle RAMs: instantiation and inference. Many FPGA families provide technology-specific RAMs that you can instantiate in your HDL source code. The software supports instantiation, but you can also set up your source code so that it infers the RAMs. The following table sums up the pros and cons of the two approaches.

## Inference in Synthesis

### Advantages

- Portable coding style
- Automatic timing-driven synthesis
- No additional tool dependencies

### Limitations

- Glue logic to implement the RAM might result in a sub-optimal implementation
- Can only infer synchronous RAMs
- No support for address wrapping
- Pin name limitations means some pins are always active or inactive

## Instantiation

### Advantages

- Most efficient use of the RAM primitives of a specific technology
- Supports all kinds of RAMs

### Limitations

- Source code is not portable because it is technology-dependent
- Limited or no access to timing and area data if the RAM is a black box
- Inter-tool access issues, if the RAM is a black box created with another tool

You must structure your source code correctly for the type of RAM you want to infer. The following table lists the supported technology-specific RAMs that can be generated by the synthesis tool.

RAM Type	Microsemi
Single Port	x
Dual Port	x
True Dual Port	x

# Automatic RAM Inference

Instead of instantiating synchronous RAMs, you can let the synthesis tools automatically infer them directly from the HDL source code and map them to the appropriate technology-specific RAM resources on the FPGA. This approach lets you maintain portability.

Here are some of the advantages offered by the inference approach:

- The tool automatically infers the RAM from the HDL code, which is technology-independent. This means that the design is portable from one technology to another without rework.
- RAM inference is the best method for prototyping.
- The tool automatically adds the extra glue logic needed to ensure that the logic is correct.
- The software automatically runs timing-driven synthesis for inferred RAMs.

## Block RAM

The synthesis software can implement the block RAM it infers using different types of block RAM and different block RAM modes.

### Types of Block RAM

The synthesis software can infer different kinds of block RAM, according to how the code is set up. For details about block RAM inference, see [Block RAM Inference, on page 187](#) and [RAM Attributes, on page 184](#). For inference examples, and see [Block RAM Examples, on page 193](#).

The synthesis tool can infer the following kinds of block RAM:

- Single-port RAM
- Dual-port RAM

Based on how the read and write ports are used, dual-port RAM can be further classified as follows:

- Simple dual-port
- Dual-port

- True dual-port

## Supported Block RAM Modes

Block RAM supports three operating modes, which determine the output of the RAM when write enable is active. The synthesis tools infer the mode from the RTL you provide. It is best to explicitly describe the RAM behavior in the code, so as to correctly infer the operating mode you want. Refer to the examples for recommended coding styles.

The block RAM operating modes are described in the following table:

Mode	When write enable (WE) is active ...
WRITE_FIRST	This is a transparent mode, and the input data is simultaneously written into memory and stored in the RAM data output (DO). DO uses the value of the RAM data input (DI). See <a href="#">WRITE_FIRST Mode Example, on page 194</a> for an example.
READ_FIRST	This mode is read before write. The data previously stored at the write address appears at the RAM data output (DO) first, and then the RAM input data is stored in memory. DO uses the value of the memory content. See <a href="#">READ_FIRST Mode Example, on page 195</a> for an example.
NO_CHANGE	RAM data output (DO) remains the same during a write operation, with DO containing the last read data. See <a href="#">NO_CHANGE Mode Example, on page 196</a> for an example.

## RAM Attributes

In addition to the automatic inference by the tool, you can specify RAM inference with the `syn_ramstyle` and `syn_rw_conflict_logic` attributes. The `syn_ramstyle` attribute explicitly specifies the kind of RAM you want, while the `syn_rw_conflict_logic` attribute specifies that you want to infer a RAM, but leave it to the synthesis tools to select the kind of RAM, as appropriate.

### Attribute-Based Inference of Block RAM

For block RAM, the `syn_ramstyle` attribute has a number of valid values, all of which are extensively described in the documentation. This section confines itself to the following values, which are most relevant to the discussion:



<b>syn_ramstyle Value</b>	<b>Description</b>
block_ram	Enforces the inference and implementation of a technology-specific RAM.
registers	Prevents inference of a RAM, and maps the RAM to flip-flops and logic.
no_rw_check	Does not create overhead logic to account for read-write conflicts.

If you specify the `syn_rw_conflict_logic` attribute, the synthesis tools can infer block RAM, depending on the design. If the tool does infer block RAM, it does not insert bypass logic around the block RAM to account for read-write conflicts and prevent simulation mismatches. In this way its functionality is the same as `syn_ramstyle` with `no_rw_check`, which does not insert bypass logic either.

## Specifying the Attributes

You set the attribute in the HDL source code, through the SCOPE interface or in an FPGA constraint file.

### HDL Source Code

Set the attribute on the Verilog register or VHDL signal that holds the output values of the RAM. The following syntax shows how to specify the attribute in Verilog and VHDL code:

```
Verilog  reg [7:0] ram_dout [127:0]
         /*synthesis syn_ramstyle = "block_ram"*/;
         reg [d_width-1:0] mem [mem_depth-1:0]
         /*synthesis syn_rw_conflict_logic = 0*/;
```

```
VHDL    attribute syn_ramstyle of ram_dout : signal is "block_ram";
```

## SCOPE

For the `syn_ramstyle` attribute, set the attribute on the RAM register memory signal, `mem`, as shown below. For the `syn_rw_conflict_logic` attribute, set it on the instance or set it globally. The attributes are written out to a constraints file using the syntax described in the next section.

	Enabled	Object Type	Object	Attribute	Value	Val Type
1	<input checked="" type="checkbox"/>	<any>	i:mem[7:0]	syn_ramstyle	block_ram	string

## Constraints File

In the fdc Tcl constraints file written out from the SCOPE interface, the `syn_ramstyle` attribute is attached to the register `mem` signal of the RAM, and the `syn_rw_conflict_logic` attribute is attached to the view, as shown below:

```
define_attribute {i:mem[7:0]} {syn_ramstyle} {block_ram}
define_attribute {v:mem[0:7]} syn_rw_conflict_logic {0}
```

For the `syn_rw_conflict_logic` attribute, you can also specify it globally, as well as on individual modules and instances:

```
define_global_attribute syn_rw_conflict_logic {0}
```

# Block RAM Inference

Based on the design and how you code it, the tool can infer the following kinds of block RAM: single-port, simple dual-port, dual-port, and true dual-port. The details about RAM inference and setup guidelines are described here:

- [Setting up the RTL and Inferring Block RAM](#), on page 187
- [Simple Dual-Port Block RAM Inference](#), on page 189
- [Dual-Port RAM Inference](#), on page 191
- [True Dual-Port RAM Inference](#), on page 191
- [True Dual-Port Byte-Enabled RAM Inference](#), on page 192

## Setting up the RTL and Inferring Block RAM

To ensure that the tool infers the kind of block RAM you want, do the following:

1. Set up the RAM HDL code in accordance with the following guidelines:
  - The RAM must be synchronous. It must not have any asynchronous control signals connected. The synthesis tools do not infer asynchronous block RAM.
  - You must register either the read address or the output.
  - The RAMs must not be too small, as the tool does not infer block RAM for small-sized RAMs. The size threshold varies with the target technology.

- Set up the clocks and read and write ports to infer the kind of RAM you want. The following table summarizes how to set up the RAM in the RTL:

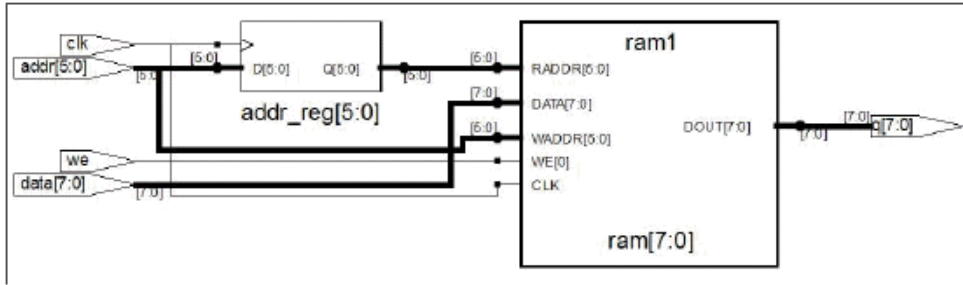
RAM	Clock	Read Ports	Write Ports
Single-port	Single clock	One; same as write	One; same as read
Simple dual-port	Single or dual clock	One dedicated read	One dedicated write
Dual-port	Single or dual clock	Two independent reads	One dedicated write
True dual-port	Single or dual clock	Two independent reads	Two independent writes

See [Dual-Port RAM Inference, on page 191](#) and [True Dual-Port RAM Inference, on page 191](#) for additional information.

For illustrative code examples, see the single-port and dual-port examples listed in [Block RAM Examples, on page 193](#).

- If needed, guide automatic inference with the `syn_ramstyle` attribute:
  - To force the inference of block RAM, specify `syn_ramstyle=blockram`.
  - To prevent a block RAM from being inferred or if your resources are limited, use `syn_ramstyle=registers`.
  - If you know your design does not read and write to the same address simultaneously, specify `syn_ramstyle=no_rw_check` to ensure that the synthesis tool does not unnecessarily create bypass logic for resolving conflicts.
- Synthesize the design.

The tool first compiles the design and infers the RAMs, which it represents as abstract technology-independent primitives like RAM1 and RAM2. You can view these RAMs in the RTL view, which is a graphic, technology-independent representation of your design after compilation:



It is important that the compiler first infers the RAM, because the tool only maps the inferred RAM primitives to technology-specific block RAM. Any RAM that is not inferred is mapped to registers. You can view the mapped RAMs in the Technology view, which is a graphic representation of your design after synthesis, and shows the design mapped to technology-specific resources.

## Simple Dual-Port Block RAM Inference

Simple dual-port RAMs (SDP) are block RAMs with one port dedicated to read operations and one port dedicated to write operations. SDP RAMs offer the unique advantage of combining ports and using them to pack double the data width and address width.

The synthesis tools map SDP RAMs to RAM primitives in the architecture. A unique set of addresses, clocks, and enable signals are used for each port. The synthesis tool might also set the `RAM_MODE` property on the RAM to indicate the RAM mode.

The inference of simple dual-port RAM is dependent on the size of the address and data. The RAM must follow the coding guidelines listed below to be inferred.

- The read and write addresses must be different
- The read and write clocks can be different
- The enable signals can be different

Here is an example where the tool infers SDP RAM:

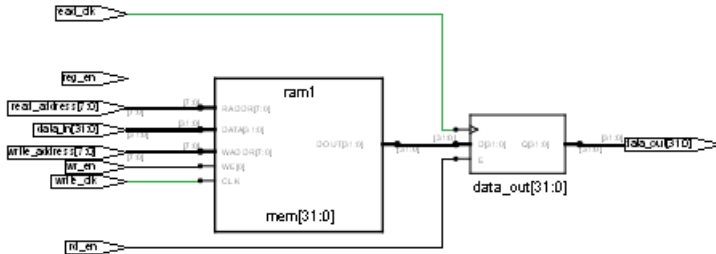
```
module Read_First_RAM (
    read_clk,
    read_address,
    data_in,
    write_clk,
    rd_en,
    wr_en,
    reg_en,
    write_address,
    data_out);

parameter address_width = 8;
parameter data_width = 32;
parameter depth = 256;
input read_clk, write_clk;
input rd_en;
input wr_en;
input reg_en;
input [address_width-1:0] read_address, write_address;
input [data_width-1:0] data_in;
output [data_width-1:0] data_out;
//wire [data_width-1:0] data_out;
reg [data_width-1:0] mem [depth -1 : 0]/* synthesis
    syn_ramstyle="no_rw_check"
    */;
reg [data_width-1:0] data_out;

always @(posedge write_clk)
if(wr_en)
    mem[write_address] <= data_in;

always @(posedge read_clk)
if(rd_en)
    data_out <= mem[read_address];

endmodule
```



## Dual-Port RAM Inference

Dual-port RAM is configured to have read and/or write operations from both ports of the RAM. One such configuration is a RAM with one port for both read and write operations and another dedicated read-only port. A unique set of addresses, clocks, and enable signals are used for each port. The synthesis tool sets properties on the RAM to indicate the RAM mode.

To infer dual-port block RAM, the RAM must follow the coding rules described below.

- The read and write addresses must be different
- The read and write clocks can be different
- The enable signals can be different

## True Dual-Port RAM Inference

True dual-port RAMs (TDP) are block RAMs with two write ports and two read ports. The compiler extracts a RAM2 primitive for RAMs with two write ports or two read ports and the tool maps this primitive to TDP RAM. The ports operate independently, with different clocks, addresses and enables.

The synthesis tool also sets the RAM\_MODE property on the RAM to indicate the RAM mode.

The compiler infers TDP block RAM based on the write processes. The implementation depends on whether the write enables use one process or multiple processes:

- When all the writes are made in one process, there are no address conflicts, and the compiler generates an nram that is later mapped to either true dual-port block RAM. The following coding results in an nram

with two write ports, one with write address `waddr0` and the other with write address `waddr1`:

```
always @(posedge clk)
begin
    if(we1) mem[waddr0] <= data1;
    if(we2) mem[waddr1] <= data2;
end
```

- When the writes are made in multiple processes, the software does not infer a multiport RAM unless you explicitly specify the `syn_ramstyle` attribute with a value that indicates the kind of RAM to implement, or with the `no_rw_check` value. If the attribute is not specified as such, the software does not infer an `nram`, but infers a RAM with multiple write ports. You get a warning about simulation mismatches when the two addresses are the same.

In the following case, the compiler infers an `nram` with two write ports because the `syn_ramstyle` attribute is specified. The writes associated with `waddr0` and `waddr1` are `we1` and `we2`, respectively.

```
reg [1:0] mem [7:0] /* synthesis syn_ramstyle="no_rw_check" */;
always @(posedge clk1)
begin
    if(we1) mem[waddr0] <= data1;
end

always @(posedge clk2)
begin
    if(we2) mem[waddr1] <= data2;
end
```

## True Dual-Port Byte-Enabled RAM Inference

The procedure below describes how to specify RAM where you can read/write each byte into a specific address location independently, and how to implement it as block RAM. See the article 2560210, *Verilog RTL Coding Style for True Dual-Port Byte-Enabled RAM* on the Synopsys website, for an example.

1. Instantiate the true dual-port RAM  $n$  number of times, where  $n$  is the number of bytes for a particular RAM address.

In the following example, `ram_dp` is instantiated twice because there are two bytes in the address:



```
ram_dp u1 (clk1, clk2, dia[7:0] , addra, wea[0], doa[7:0] , dib[7:0] , addrb, web[0],  
          dob[7:0]);  
ram_dp u2 (clk1, clk2, dia[15:8], addra, wea[1], doa[15:8], dib[15:8], addrb,  
          web[1], dob[15:8]);
```

2. To map the true dual-port RAM into a block RAM, add the `syn_ramstyle="block_ram"` attribute to the true dual-port RAM module.
3. Run compile.

The RTL schematic shows two instantiations, as specified.

4. Run map.

After synthesis, check the resource utilization report to make sure that two block RAMs were inferred, as specified.

## Block RAM Examples

The examples below show you how to define RAM in the HDL code so that the synthesis tools can infer block RAM. See the following for details:

- [Block RAM Mode Examples](#), on page 193
- [Single-Port Block RAM Examples](#), on page 197
- [Dual-Port Block RAM Examples](#), on page 200
- [True Dual-Port RAM Examples](#), on page 202

For details about inferring block RAM, see [Block RAM Inference, on page 187](#).

## Block RAM Mode Examples

The coding style supports the enable and reset pins of the block RAM primitive. The tool supports different write mode operations for single-port and dual-port RAM. This section contains examples of how to specify the supported block RAM output modes:

- [WRITE\\_FIRST Mode Example](#), on page 194
- [READ\\_FIRST Mode Example](#), on page 195
- [NO\\_CHANGE Mode Example](#), on page 196

## WRITE\_FIRST Mode Example

This example shows the WRITE\_FIRST mode operation with active enable.

```
module v_rams_02a (clk, we, en, addr, di, dou);
  input clk;
  input we;
  input en;
  input [5:0] addr;
  input [63:0] di;
  output [63:0] dou;
  reg [63:0] RAM [63:0];
  reg [63:0] dou;

  always @(posedge clk)
  begin
    if (en)
      begin
        if (we)
          begin
            RAM[addr] <= di;
            dou <= di;
          end
        else
          dou <= RAM[addr];
        end
      end
  end

  always @(posedge clk)
  if (en & we) RAM[addr] <= di;
endmodule
```

The following figure shows the RTL view of a WRITE\_FIRST mode RAM with output registered. Select the Technology view to see that the RAM is mapped to a block RAM.



```

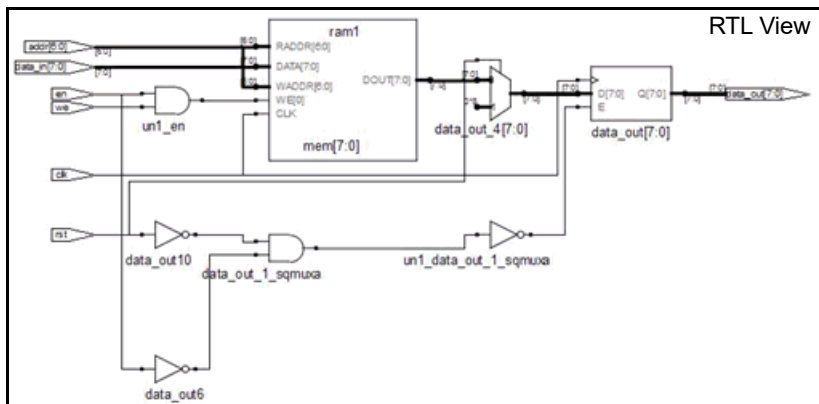
module ram_test(data_out, data_in, addr, clk, rst, en, we);
output [7:0]data_out;
input [7:0]data_in;
input [6:0]addr;
input clk, en, rst, we;
reg [7:0] mem [127:0] /* synthesis syn_ramstyle = "block_ram" */;
reg [7:0] data_out;

always@(posedge clk)
if(rst == 1)
    data_out <= 0;
else begin
    if(en) begin
        data_out <= mem[addr];
    end
end

always @(posedge clk)
if (en & we) mem[addr] <= data_in;
endmodule

```

The following figure shows the RTL view of a READ\_FIRST RAM with inferred enable and reset, with reset taking precedence. Select the Technology view to see that the inferred RAM is mapped to a block RAM.



## NO CHANGE Mode Example

This NO\_CHANGE mode example has neither enable nor reset. If you register the read address and the output address, the software infers block RAM.

```

module ram_test(data_out, data_in, addr, clk, we);
output [7:0]data_out;
input [7:0]data_in;
input [6:0]addr;
input clk,we;
reg [7:0] mem [127:0] /* synthesis syn_ramstyle = "block_ram" */;
reg [7:0] data_out;

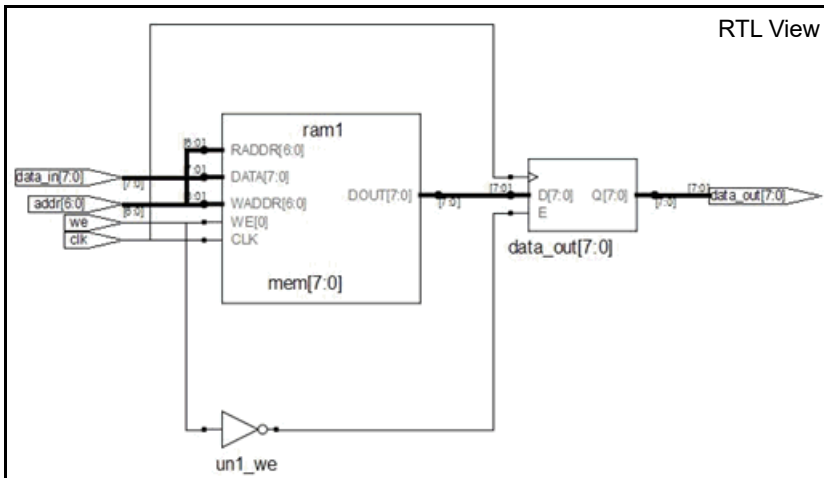
always@(posedge clk)
if(we == 1)
    data_out <= data_out;
else
    data_out <= mem[addr];

always @(posedge clk)
if (we) mem[addr] <= data_in;

endmodule

```

The next figure shows the RTL view of a NO\_CHANGE RAM. Select the Technology view to see that the RAM is mapped to block RAM.



## Single-Port Block RAM Examples

This section describes the coding style required to infer single-port block RAMs. For single-port RAM, the same address is used to index the write-to and read-from RAM. See the following examples:

- [Single-Port Block RAM Examples](#), on page 197
- [Single-Port RAM with RAM Output Registered Examples](#), on page 199
- [Dual-Port Block RAM Examples](#), on page 200

## Single-Port RAM with Read Address Registered Example

In these examples, the read address is registered, but the write address (which is the same as the read address) is not registered. There is one clock for the read address and the RAM.

### Verilog Example: Read Address Registered

```
module ram_test(q, a, d, we, clk);
  output [7:0] q;
  input [7:0] d;
  input [6:0] a;
  input clk, we;
```

```

reg [6:0] read_add;
/* The array of an array register ("mem") from which the RAM is
inferred*/
reg [7:0] mem [127:0] ;
assign q = mem[read_add];

always @(posedge clk) begin
read_add <= a;
if(we)
    /* Register RAM Data */
    mem[a] <= d;
end

endmodule

```

## VHDL Example: READ Address Registered

```

library ieee;
use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;

entity ram_test is
    port (d : in std_logic_vector(7 downto 0);
          a : in std_logic_vector(6 downto 0);
          we : in std_logic;
          clk : in std_logic;
          q : out std_logic_vector(7 downto 0) );
end ram_test;

architecture rtl of ram_test is
    type mem_type is array (127 downto 0) of
        std_logic_vector (7 downto 0);
    signal mem: mem_type;
    signal read_add : std_logic_vector(6 downto 0);
begin
    process (clk)
    begin
        if rising_edge(clk) then
            if (we = '1') then
                mem(conv_integer(a)) <= d;
            end if;
            read_add <= a;
        end if;
    end process;

    q <= mem(conv_integer(read_add));
end rtl ;

```

## Single-Port RAM with RAM Output Registered Examples

In this example, the RAM output is registered, but the read and write addresses are unregistered. The write address is the same as the read address. There is one clock for the RAM and the output.

### Verilog Example: Data Output Registered

```
module ram_test(q, a, d, we, clk);
  output [7:0] q;
  input [7:0] d;
  input [6:0] a;
  input clk, we;
  /* The array of an array register ("mem") from which the RAM is
  inferred */
  reg [7:0] mem [127:0] ;
  reg [7:0] q;

  always @(posedge clk) begin
    q = mem[a];
    if(we)
      /* Register RAM Data */
      mem[a] <= d;
    end

endmodule
```

### VHDL Example: Data Output Registered

```
library ieee;
use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;

entity ram_test is
  port (d: in std_logic_vector(7 downto 0);
        a: in integer range 127 downto 0;
        we: in std_logic;
        clk: in std_logic;
        q: out std_logic_vector(7 downto 0) );
end ram_test;

architecture rtl of ram_test is
  type mem_type is array (127 downto 0) of
    std_logic_vector (7 downto 0);
  signal mem: mem_type;
begin
```

```

    process(clk)
    begin
        if (clk'event and clk='1') then
            q <= mem(a);
            if (we='1') then
                mem(a) <= d;
            end if;
        end if;
    end process;
end rtl;

```

## Dual-Port Block RAM Examples

The following example or HDL code results in simple dual-port block RAMs being implemented in supported technologies.

### Verilog Example: Dual-Port RAM

This Verilog example has two read addresses, both of which are registered, and one address for write (same as a read address), which is unregistered. It has two outputs for the RAM, which are unregistered. There is one clock for the RAM and the addresses.

```

module dualportram ( q1,q2,a1,a2,d,we,clk1) ;
    output [7:0]q1,q2;
    input [7:0] d;
    input [6:0]a1,a2;
    input clk1,we;
    wire [7:0] q1;
    reg [6:0] read_addr1,read_addr2;
    reg[7:0] mem [127:0] /* synthesis syn_ramstyle = "no_rw_check" */;
    assign q1 = mem [read_addr1];
    assign q2 = mem[read_addr2];

    always @ ( posedge clk1) begin
        read_addr1 <= a1;
        read_addr2 <= a2;
        if (we)
            mem[a2] <= d;
    end

endmodule

```



## VHDL Example: Dual-Port RAM

The following VHDL example is of READ\_FIRST mode for a dual-port RAM:

```
Library IEEE ;
use IEEE.std_logic_1164.all ;
use IEEE.std_logic_arith.all ;
use IEEE.std_logic_unsigned.all ;

entity Dual_Port_ReadFirst is
    generic (data_width: integer :=4;
            address_width: integer :=10);

    port (write_enable: in std_logic;
          write_clk, read_clk: in std_logic;
          data_in: in std_logic_vector (data_width-1 downto 0);
          data_out: out std_logic_vector (data_width-1 downto 0);
          write_address: in std_logic_vector (address_width-1 downto 0);
          read_address: in std_logic_vector (address_width-1 downto 0)
        );
end Dual_Port_ReadFirst;

architecture behavioral of Dual_Port_ReadFirst is
    type memory is array (2**(address_width-1) downto 0) of
        std_logic_vector (data_width-1 downto 0);
    signal mem : memory;

    signal reg_write_address : std_logic_vector (address_width-1 downto 0);
    signal reg_write_enable: std_logic;

    attribute syn_ramstyle : string;
    attribute syn_ramstyle of mem : signal is "block_ram";

begin
    register_enable_and_write_address:
        process (write_clk,write_enable,write_address,data_in)
        begin
            if (rising_edge(write_clk)) then
                reg_write_address <= write_address;
                reg_write_enable <= write_enable;
            end if;
        end process;
```

```

write:
  process (read_clk,write_enable,write_address,data_in)
  begin
    if (rising_edge(write_clk)) then
      if (write_enable='1') then
        mem(conv_integer(write_address))<=data_in;
      end if;
    end if;
  end process;

read:
  process (read_clk,write_enable,read_address,write_address)
  begin
    if (rising_edge(read_clk)) then
      if (reg_write_enable='1') and (read_address =
        reg_write_address) then data_out <= "XXXX";
      else
        data_out<=mem(conv_integer(read_address));
      end if;
    end if;
  end process;

end behavioral;

```

## True Dual-Port RAM Examples

You must use a registered read address when you code the RAM or have writes to one process. If you have writes to multiple processes, you must use the `syn_ramstyle` attribute to infer the RAM.

There are two situations which can result in this error message:

```
"@E:MF216: ram.v(29)|Found NRAM mem_1[7:0] with multiple
processes"
```

- An nram with two clocks and two write addresses has `syn_ramstyle` set to a value of `registers`. The software cannot implement this, because there is a physical FPGA limitation that does not allow registers with multiple writes.
- You have a registered output for an nram with two clocks and two write addresses.

## Verilog Example: True Dual-Port RAM

The following HDL example shows the recommended coding style for true dual-port block RAM. It is a Verilog example where the tool infers true dual-port RAM from a design with multiple writes:

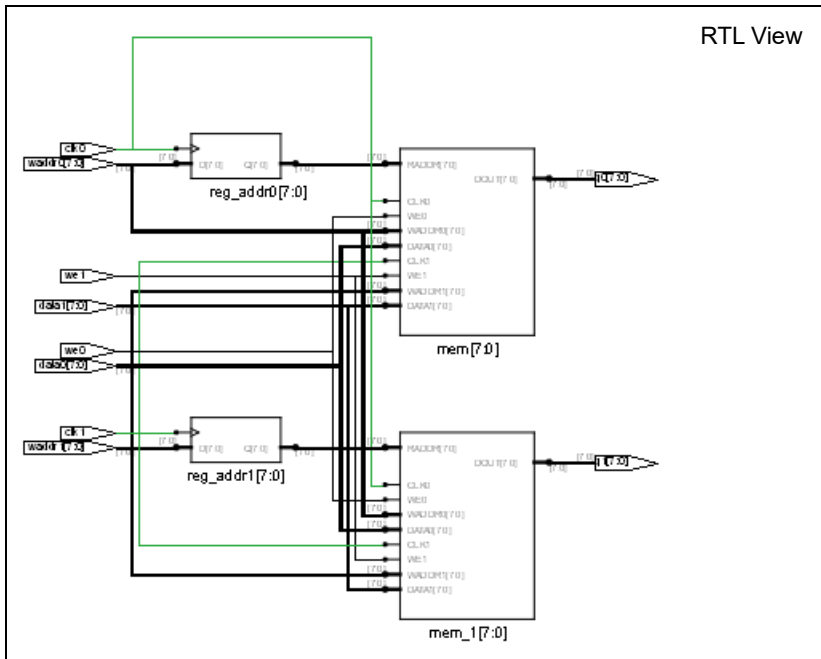
```

module ram(data0, data1, waddr0, waddr1, we0, we1,
           clk0, clk1, q0, q1);
  parameter d_width = 8;
  parameter addr_width = 8;
  parameter mem_depth = 256;
  input [d_width-1:0] data0, data1;
  input [addr_width-1:0] waddr0, waddr1;
  input we0, we1, clk0, clk1;
  output [d_width-1:0] q0, q1;
  reg [addr_width-1:0] reg_addr0, reg_addr1;
  reg [d_width-1:0] mem [mem_depth-1:0] /* synthesis
  syn_ramstyle="no_rw_check" */;
  assign q0 = mem[reg_addr0];
  assign q1 = mem[reg_addr1];

  always @(posedge clk0)
  begin
    reg_addr0 <= waddr0;
    if (we0)
      mem[waddr0] <= data0;
  end

  always @(posedge clk1)
  begin
    reg_addr1 <= waddr1;
    if (we1)
      mem[waddr1] <= data1;
  end
endmodule

```



## VHDL Example: True Dual-Port RAM

The following HDL example shows the recommended coding style for true dual-port block RAM. It is a VHDL example where the tool infers true dual-port RAM from a design with multiple writes:

```
library ieee;
use ieee.std_logic_1164.all;
use ieee.numeric_std.all;

entity one is
generic (data_width : integer := 4;
address_width :integer := 5 );
port (data_a:in std_logic_vector(data_width-1 downto 0);
data_b:in std_logic_vector(data_width-1 downto 0);
addr_a:in std_logic_vector(address_width-1 downto 0);
addr_b:in std_logic_vector(address_width-1 downto 0);
wren_a:in std_logic;
```

```

        wren_b:in std_logic;
        clk:in std_logic;
        q_a:out std_logic_vector(data_width-1 downto 0);
        q_b:out std_logic_vector(data_width-1 downto 0) );
end one;

architecture rtl of one is
type mem_array is array(0 to 2**(address_width) -1) of
std_logic_vector(data_width-1 downto 0);
signal mem : mem_array;
attribute syn_ramstyle : string;
attribute syn_ramstyle of mem : signal is "no_rw_check" ;
signal addr_a_reg : std_logic_vector(address_width-1 downto 0);
signal addr_b_reg : std_logic_vector(address_width-1 downto 0);
begin
    WRITE_RAM : process (clk)
    begin
        if rising_edge(clk) then
            if (wren_a = '1') then
                mem(to_integer(unsigned(addr_a))) <= data_a;
            end if;
            if (wren_b='1') then
                mem(to_integer(unsigned(addr_b))) <= data_b;
            end if;
            addr_a_reg <= addr_a;
            addr_b_reg <= addr_b;
        end if;
    end process WRITE_RAM;
    q_a <= mem(to_integer(unsigned(addr_a_reg)));
    q_b <= mem(to_integer(unsigned(addr_b_reg)));
end rtl;

```

## Limitations to RAM Inference

RAM inference is only supported for synchronous RAMs.

### // Example 1: Verilog Asymmetric RAM Coding Style 1

```

module asymmetric_ram (clkA, clkB, weA, enA, addrA, addrB, diA,
doB);

    parameter WIDTHA      = 2;

    parameter SIZEA       = 16384;

```

```

parameter ADDRWIDTHA = 14;
parameter WIDTHB      = 4;
parameter SIZEB       = 8192;
parameter ADDRWIDTHB  = 13;

input                clkA;
input                clkB;
input                weA;
input                enA;
input                [ADDRWIDTHA-1:0] addrA;
input                [ADDRWIDTHB-1:0] addrB;
input                [WIDTHA-1:0]    diA;
output reg [WIDTHB-1:0] doB;

`define max(a,b) {(a) > (b) ? (a) : (b)}
`define min(a,b) {(a) < (b) ? (a) : (b)}

function integer log2;
    input integer value;
    reg [31:0] shifted;
    integer res;
begin
    if (value < 2)
        log2 = value;
    else
        begin
            shifted = value-1;

```

```

        for (res=0; shifted>0; res=res+1)
            shifted = shifted>>1;
        log2 = res;
    end
end
endfunction

localparam maxSize    = `max(SIZEA, SIZEB);
localparam maxWIDTH   = `max(WIDTHA, WIDTHB);
localparam minWIDTH   = `min(WIDTHA, WIDTHB);
localparam RATIO      = maxWIDTH / minWIDTH;
localparam log2RATIO  = log2(RATIO);

reg      [minWIDTH-1:0]  RAM [0:maxSIZE-1];
reg      [ADDRWIDTHB-1:0]  addrB_reg;
genvar i;

always @(posedge clkA)
begin
    if ( enA & weA)
        RAM[addrA] <= diA;
    end

always @(posedge clkB)
begin
    addrB_reg <= addrB;
end

```

```

generate for (i = 0; i < RATIO; i = i+1)
begin: ramread
    localparam [log2RATIO-1:0] lsbaddr = i;
    always @(posedge clkB)
    begin
        doB[(i+1)*minWIDTH-1:i*minWIDTH] <= RAM[
            {addrB_reg, lsbaddr}];
    end
end
endgenerate

endmodule

```

## // Example 1: VHDL Asymmetric RAM Coding Style 1

```

library ieee;
use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;
use ieee.std_logic_arith.all;

entity asymmetric_ram is
    generic (
        WIDTHA      : integer := 2;
        SIZEA       : integer := 16384;
        ADDRWIDTHA  : integer := 14;
        WIDTHB      : integer := 4;
        SIZEB       : integer := 8192;
    )

```



```

        ADDRWIDTHB : integer := 13
    );

    port (
        clkA   : in  std_logic;
        clkB   : in  std_logic;
        weA    : in  std_logic;
        enA    : in  std_logic;
        addrA   : in  std_logic_vector(ADDRWIDTHA-1 downto 0);
        addrB   : in  std_logic_vector(ADDRWIDTHB-1 downto 0);
        diA     : in  std_logic_vector(WIDTHA-1 downto 0);
        doB     : out std_logic_vector(WIDTHB-1 downto 0)
    );
end asymmetric_ram;

```

architecture behavioral of asymmetric\_ram is

```

function max(L, R: INTEGER) return INTEGER is
begin
    if L > R then
        return L;
    else
        return R;
    end if;
end;

```

```

function min(L, R: INTEGER) return INTEGER is

```

```
begin
    if L < R then
        return L;
    else
        return R;
    end if;
end;

function log2 (val: INTEGER) return natural is
    variable res : natural;
begin
    for i in 0 to 31 loop
        if (val <= (2**i)) then
            res := i;
            exit;
        end if;
    end loop;
    return res;
end function Log2;

constant minWIDTH : integer := min(WIDTHA,WIDTHB);
constant maxWIDTH : integer := max(WIDTHA,WIDTHB);
constant maxSIZE   : integer := max(SIZEA,SIZEB);
constant RATIO : integer := maxWIDTH / minWIDTH;

type ramType is array (0 to maxSIZE-1) of
    std_logic_vector(minWIDTH-1 downto 0);
```

```
signal ram : ramType := (others => (others => '0'));
signal addrB_reg : std_logic_vector(ADDRWIDTHB-1 downto 0);

begin
  process (clkA)
  begin
    if rising_edge(clkA) then
      if enA = '1' then
        if weA = '1' then
          ram(conv_integer(addrA)) <= diA;
        end if;
      end if;
    end if;
  end process;

  process (clkB)
  begin
    if rising_edge(clkB) then
      for i in 0 to RATIO-1 loop
        doB((i+1)*minWIDTH-1 downto i*minWIDTH) <=
          ram(conv_integer(addrB_reg &
            conv_std_logic_vector(i,log2(RATIO))));
        addrB_reg <= addrB;
      end loop;
    end if;
  end process;
```

```
end behavioral;
```

## // Example 1: Verilog Asymmetric RAM Coding Style 2

```
module asymmetric_ram (clkA, clkB, weA, enA, addrA, addrB, diA,
    doB);

    parameter WIDTHA      = 2;
    parameter SIZEA       = 1024;
    parameter ADDRWIDTHA  = 10;
    parameter WIDTHB      = 8;
    parameter SIZEB       = 256;
    parameter ADDRWIDTHB  = 8;

    input                  clkA;
    input                  clkB;
    input                  weA;
    input                  enA;
    input      [ADDRWIDTHA-1:0]  addrA;
    input      [ADDRWIDTHB-1:0]  addrB;
    input      [WIDTHA-1:0]      diA;
    output reg  [WIDTHB-1:0]      doB;

    `define max(a,b) {(a) > (b) ? (a) : (b)}
    `define min(a,b) {(a) < (b) ? (a) : (b)}

    localparam maxSize  = `max(SIZEA, SIZEB);
    localparam maxWIDTH = `max(WIDTHA, WIDTHB);
```

```

    localparam minWIDTH = `min(WIDTHA, WIDTHB);
    localparam RATIO     = maxWIDTH / minWIDTH;

    reg      [minWIDTH-1:0]  RAM [0:maxSIZE-1];
    reg      [ADDRWIDTHB-1:0] addrB_reg;

always @(posedge clkA)
begin
    if (weA)
    begin
        RAM[addrA] <= diA;
    end
end

always @(posedge clkB)
begin
    addrB_reg <= addrB;

    doB[4*minWIDTH-1:3*minWIDTH] <= RAM[{addrB_reg, 2'd3}];
    doB[3*minWIDTH-1:2*minWIDTH] <= RAM[{addrB_reg, 2'd2}];
    doB[2*minWIDTH-1:minWIDTH]    <= RAM[{addrB_reg, 2'd1}];
    doB[minWIDTH-1:0]              <= RAM[{addrB_reg, 2'd0}];
end

endmodule

```

## // Example 1: VHDL Asymmetric RAM Coding Style 2

```
library ieee;

use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;
use ieee.std_logic_arith.all;

entity asymmetric_ram is

    generic (

        WIDTHA      : integer := 2;
        SIZEA       : integer := 1024;
        ADDRWIDTHA  : integer := 10;
        WIDTHB      : integer := 8;
        SIZEB       : integer := 256;
        ADDRWIDTHB  : integer := 8
    );

    port (

        clkA   : in  std_logic;
        clkB   : in  std_logic;
        weA    : in  std_logic;
        enA    : in  std_logic;
        addrA  : in  std_logic_vector(ADDRWIDTHA-1 downto 0);
        addrB  : in  std_logic_vector(ADDRWIDTHB-1 downto 0);
        diA    : in  std_logic_vector(WIDTHA-1 downto 0);
        doB    : out std_logic_vector(WIDTHB-1 downto 0)
    );
```

```
end asymmetric_ram;
```

architecture behavioral of asymmetric\_ram is

```
function max(L, R: INTEGER) return INTEGER is
begin
    if L > R then
        return L;
    else
        return R;
    end if;
end;
```

```
function min(L, R: INTEGER) return INTEGER is
begin
    if L < R then
        return L;
    else
        return R;
    end if;
end;
```

```
constant minWIDTH : integer := min(WIDTHA,WIDTHB);
constant maxWIDTH : integer := max(WIDTHA,WIDTHB);
constant maxSize   : integer := max(SIZEA,SIZEB);
constant RATIO : integer := maxWIDTH / minWIDTH;
```

```

type ramType is array (0 to maxSIZE-1) of
    std_logic_vector(minWIDTH-1 downto 0);
signal ram : ramType := (others => (others => '0'));
signal addrB_reg : std_logic_vector(ADDRWIDTHB-1 downto 0);

begin

    process (clkA)
    begin
        if rising_edge(clkA) then
            if enA = '1' then
                if weA = '1' then
                    ram(conv_integer(addrA)) <= diA;
                end if;
            end if;
        end if;
    end process;

    process (clkB)
    begin
        if rising_edge(clkB) then
            addrB_reg <= addrB;
            doB(minWIDTH-1 downto 0) <=
                ram(conv_integer(addrB_reg&conv_std_logic_vector(0,2)));
            doB(2*minWIDTH-1 downto minWIDTH) <=
                ram(conv_integer(addrB_reg&conv_std_logic_vector(1,2)));
            doB(3*minWIDTH-1 downto 2*minWIDTH) <=

```



```

        ram(conv_integer(addrB_reg&conv_std_logic_vector(2,2)));
    doB(4*minWIDTH-1 downto 3*minWIDTH) <=
        ram(conv_integer(addrB_reg&conv_std_logic_vector(3,2)));
    end if;
end process;

end behavioral;

```

## // Example 2: Verilog Asymmetric RAM Coding Style 1

```

module v_asymmetric_ram (clkA, clkB, weB, addrA, addrB, doA, diB);

    parameter WIDTHA      = 8;
    parameter SIZEA       = 256;
    parameter ADDRWIDTHA  = 8;
    parameter WIDTHB      = 32;
    parameter SIZEB       = 64;
    parameter ADDRWIDTHB  = 6;

    input  clkA;
    input  clkB;
    input  weB;

    input  [ADDRWIDTHA-1:0]  addrA;
    input  [ADDRWIDTHB-1:0]  addrB;

    output [WIDTHA-1:0]      doA;

    input  [WIDTHB-1:0]      diB;

    reg    [ADDRWIDTHA-1:0]  addrA_reg;

```

```

`define max(a,b) {(a) > (b) ? (a) : (b)}
`define min(a,b) {(a) < (b) ? (a) : (b)}

function integer log2;
input integer value;
reg [31:0] shifted;
integer res;

begin
    if (value < 2)
        log2 = value;
    else
        begin
            shifted = value-1;
            for (res=0; shifted>0; res=res+1)
                shifted = shifted>>1;
            log2 = res;
        end
    end
endfunction

localparam maxSize    = `max(SIZEA, SIZEB);
localparam maxWIDTH   = `max(WIDTHA, WIDTHB);
localparam minWIDTH   = `min(WIDTHA, WIDTHB);
localparam RATIO      = maxWIDTH / minWIDTH;
localparam log2RATIO = log2(RATIO);

reg    [minWIDTH-1:0] RAM [0:maxSize-1];
reg    [WIDTHB-1:0] readB;

genvar i;

always @(posedge clkA)

```

```

begin
    addrA_reg <= addrA;
end

assign doA = RAM[addrA_reg];

generate for (i = 0; i < RATIO; i = i+1)
    begin: ramread
        localparam [log2RATIO-1:0] lsbaddr = i;
        always @(posedge clkB)
            begin
                if (weB)
                    RAM[{addrB, lsbaddr}] <= diB[(i+1)
                        *minWIDTH-1:i*minWIDTH];
                end
            end
        end
    endgenerate

endmodule

```

## // Example 2: VHDL Asymmetric RAM Coding Style 1

```

library ieee;

use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;
use ieee.std_logic_arith.all;

entity asymmetric_ram is
    generic (

```

```

WIDTHA      : integer := 8;
SIZEA       : integer := 256;
ADDRWIDTHA  : integer := 8;
WIDTHB      : integer := 32;
SIZEB       : integer := 64;
ADDRWIDTHB  : integer := 6 );

port (clkA   : in  std_logic;
      clkB   : in  std_logic;
      weB    : in  std_logic;
      addrA  : in  std_logic_vector(ADDRWIDTHA-1 downto 0);
      addrB  : in  std_logic_vector(ADDRWIDTHB-1 downto 0);
      diB    : in  std_logic_vector(WIDTHB-1 downto 0);
      doA    : out std_logic_vector(WIDTHA-1 downto 0) );

end asymmetric_ram;

architecture behavioral of asymmetric_ram is
function max(L, R: INTEGER) return INTEGER is
begin
    if L > R then
        return L;
    else
        return R;
    end if;
end;

function min(L, R: INTEGER) return INTEGER is
begin
    if L < R then

```

```

        return L;
    else
        return R;
    end if;
end;

function log2 (val: INTEGER) return natural is
    variable res : natural;
begin
    for i in 0 to 31 loop
        if (val <= (2**i)) then
            res := i;
            exit;
        end if;
    end loop;
    return res;
end function Log2;

constant minWIDTH : integer := min(WIDTHA,WIDTHB);
constant maxWIDTH : integer := max(WIDTHA,WIDTHB);
constant maxSize  : integer := max(SIZEA,SIZEB);
constant RATIO : integer := maxWIDTH / minWIDTH;
type ramType is array (0 to maxSize-1) of
    std_logic_vector(minWIDTH-1 downto 0);
shared variable ram : ramType := (others => (others => '0'));
signal addrA_reg : std_logic_vector(ADDRWIDTHA-1 downto 0);
begin
    process (clkA)

```

```

begin
    if rising_edge(clkA) then
        addrA_reg <= addrA;
    end if;
end process;
doA <= ram(conv_integer(addrA_reg));

process (clkB)
begin
    if rising_edge(clkB) then
        if weB = '1' then
            for i in 0 to RATIO-1 loop
                ram(conv_integer(
                    addrB & conv_std_logic_vector(i,log2(RATIO))))
                    := diB((i+1)*minWIDTH-1 downto i*minWIDTH);
            end loop;
        end if;
    end if;
end process;

end behavioral;

```

## // Example 2: Verilog Asymmetric RAM Coding Style 2

```

module asymmetric_ram (clkA, clkB, enA, enB, weA, addrA,
    addrB, diA, doB );
parameter WIDTHA = 32;
parameter SIZEA = 256;

```

```
parameter ADDRWIDTHA = 8;
parameter WIDTHB= 16;
parameter SIZEB = 512;
parameter ADDRWIDTHB = 9;

input clkA, clkB, enA, enB, weA;
input [ADDRWIDTHA-1:0] addrA;
input [ADDRWIDTHB-1:0] addrB;
input [WIDTHA-1:0]    diA ;
output reg [WIDTHB-1:0] doB;
reg [WIDTHA-1:0] mux;
reg [WIDTHA-1:0] RAM [SIZEA-1:0];
always @(posedge clkA)
begin
    if(enA & weA)
        RAM[addrA] <= diA;
end

always @(posedge clkB)
begin
    mux = RAM[addrB[ADDRWIDTHB-1:1]];
    if(enB)
        if (addrB[0])
            begin
                doB <= mux[WIDTHA-1:WIDTHB];
            end
        else
```

```

        begin
            doB <= mux[WIDTHB-1:0];
        end
    end
end

endmodule

```

## // Example 2: VHDL Asymmetric RAM Coding Style 2

```

library ieee;
use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;
use ieee.std_logic_arith.all;

entity asymmetric_ram is
    generic (
        WIDTHA      : integer := 32;
        SIZEA       : integer := 256;
        ADDRWIDTHA  : integer := 8;
        WIDTHB      : integer := 16;
        SIZEB       : integer := 512;
        ADDRWIDTHB  : integer := 9
    );

    port (
        clkA  : in  std_logic;
        clkB  : in  std_logic;
        rst   : in  std_logic;

```



```

        weA      : in  std_logic;
        enA      : in  std_logic;
        enB      : in  std_logic;
        addrA     : in  std_logic_vector(ADDRWIDTHA-1 downto 0);
        addrB     : in  std_logic_vector(ADDRWIDTHB-1 downto 0);
        diA       : in  std_logic_vector(WIDTHA-1 downto 0);
        doB       : out std_logic_vector(WIDTHB-1 downto 0)
    );
end asymmetric_ram;

architecture behavioral of asymmetric_ram is
    type ramType is array (0 to SIZEA-1)
        of std_logic_vector (WIDTHA-1 downto 0);
    SHARED VARIABLE ram : ramType;

begin
    process (clkA)
    begin
        if rising_edge(clkA) then
            if enA = '1' then
                if weA = '1' then
                    ram(conv_integer(addrA)) := diA;
                end if;
            end if;
        end if;
    end process;
end process;
```

```

process (clkB)
variable mux  : std_logic_vector(WIDTHA-1 downto 0);
begin
  if rising_edge(clkB) then
    if enB = '1' then
      if addrB(0) = '0' then
        mux := ram(conv_integer
                    (addrB(ADDRWIDTHB-1 downto 1)));
        doB <= mux (WIDTHB-1 downto 0);
      else
        mux := ram(conv_integer(
                    addrB(ADDRWIDTHB-1 downto 1)));
        doB <= mux(WIDTHA-1 downto WIDTHB);
      end if;
    end if;
  end if;
end process;

end behavioral;

```

## // Example - UltraRAM Inference

```

// simple dual port, no_change ram, single uram

//synthesis translate_off
`define SIMULATION 1
//synthesis translate_on

```

```
`define ADDRSIZE 12

`define DATASIZE 72


`ifdef SIMULATION
`timescale 1 ps/1 ps
module rtl_ram(din, clk, we, waddr, raddr, dout);
    `else
module synth_ram(din, clk, we, waddr, raddr, dout);
    `endif


    input [`DATASIZE-1:0] din;
    input [`ADDRSIZE-1:0] waddr;
    input [`ADDRSIZE-1:0] raddr;
    input clk, we;
    output [`DATASIZE-1:0] dout;


    reg [`ADDRSIZE-1:0] raddr_reg;
    reg [`DATASIZE-1:0] reg2;
    reg [`DATASIZE-1:0] reg3;
    reg [`DATASIZE-1:0]      mem [(2**`ADDRSIZE)-1:0];


    always @ (posedge clk)
    begin
        if (we)
            begin
                mem[waddr] <= din;
            end
        end
    end
```

```
        end
        raddr_reg <= raddr;
        end

        assign dout = mem[raddr_reg];

    endmodule // top
```

# Initial Values for RAMs

You can specify initial values for a RAM in a data file and then include the appropriate task enable statement, `$readmemb` or `$readmemh`, in the initial statement of the HDL code for the module. The inferred logic can be different due to the initial statement. The syntax for these two statements is as follows:

```
$readmemh ("fileName", memoryName [, startAddress [, stopAddress]]);
```

```
$readmemb ("fileName", memoryName [, startAddress [, stopAddress]]);
```

<code>\$readmemb</code>	Use this with a binary data file.
<code>\$readmemh</code>	Use this with a hexadecimal data file.
<i>fileName</i>	Name of the data file that contains initial values. See <a href="#">Initialization Data File, on page 232</a> for format examples.
<i>memoryName</i>	The name of the memory.
<i>startAddress</i>	Optional starting address for RAM initialization; if omitted, defaults to first available memory location.
<i>stopAddress</i>	Optional stopping address for RAM initialization; <i>startAddress</i> must be specified

Also, see the following topics:

- [Example 1: RAM Initialization](#), on page 229
- [Example 2: Cross-Module Referencing for RAM Initialization](#), on page 230
- [Initialization Data File](#), on page 232
- [Forward Annotation of Initial Values](#), on page 235

## Example 1: RAM Initialization

This example shows a single-port RAM that is initialized using the `$readmemb` binary task enable statement which reads the values specified in the binary `mem.ini` file. See [Initialization Data File, on page 232](#) for details of the binary and hexadecimal file formats.

```

module ram_inference (data, clk, addr, we, data_out);
input [27:0] data;
input clk, we;
input [10:0] addr;
output [27:0] data_out;
reg [27:0] mem [0:2000] /* synthesis syn_ramstyle = "no_rw_check" */;
reg [10:0] addr_reg;

initial
begin
    $readmemb ("mem.ini", mem, 2, 1900) /* Initialize RAM with contents */
    /* from locations 2 thru 1900*/;
end

always @(posedge clk)
begin
    addr_reg <= addr;
end

always @(posedge clk)
begin
    if(we)
    begin
        mem[addr] <= data;
    end
end

assign data_out = mem[addr_reg];
endmodule

```

## Example 2: Cross-Module Referencing for RAM Initialization

The following example shows how a RAM using cross-module referencing (XMR) can be accessed hierarchically and initialized with the \$readmemb/\$readmemh statement which reads the values specified in the mem.txt file from the top-level design.

### Example2A: XMR for RAM Initialization (Top-Level Module)

```

// Example 2A: XMR for RAM Initialization
// (Top-Level Module)

//Top

```

```

module top (input[27:0] data, input clk, we, input[10:0] addr,
            output[27:0] data_out);
    ram_inference ram_inst (.*);
    initial
    begin
        $readmemb ("mem.txt", top.ram_inst.mem, 0, 10);
    end
endmodule

```

This code example implements cross-module referencing of the RAM block and is initialized with the \$readmemb statement in the top-level module.

### Example2B: XMR for RAM Initialization (RAM)

```

// Example 2B: XMR for RAM Initialization (RAM)

//RAM
module ram_inference (input[27:0] data, input clk, input[10:0]
    addr, output[27:0] data_out);
    reg[27:0] mem[0:2000] /*synthesis syn_ramstyle = "no_rw_check"*/;
    reg [10:0] addr_reg;
    always @(posedge clk)
    begin
        addr_reg <= addr;
    end
    always @(posedge clk)
    begin
        if(we)
        begin
            mem[addr] <= data;
        end
    end
endmodule

```

```

        end

    end

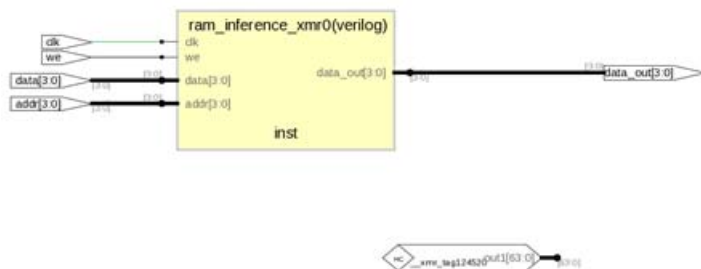
    assign data_out = mem[addr_reg];

endmodule

```

Here is the code example of the RAM block to be implemented for cross-module referencing and initialized.

The following shows the HDL Analyst view of a RAM module that must be accessed hierarchically to be initialized.



## RAM Initialization Limitations with XMR

XMR for RAM initialization requires that the following conditions be met:

- Variables must be recognized as inferred memories.
- Cross-module referencing of memory variables cannot occur between HDL languages.
- Cross-module referencing paths must be static and cannot include an index with a dynamic value.

## Initialization Data File

The initialization data file, read by the `$readmemb` and `$readmemh` system tasks, contains the initial values to be loaded into the memory array. This initialization file can reside in the project directory or can be referenced by an include path relative to the project directory. The system `$readmemb` or



\$readmemh task first looks in the project directory for the named file and, if not found, searches for the file in the list of directories on the Verilog tab in include-path order.

If the initialization data file does not contain initial values for every memory address, the unaddressed memory locations are initialized to 0. Also, if a width mismatch exists between an initialization value and the memory width, loading of the memory array is terminated; any values initialized before the mismatch is encountered are retained.

Unless an internal address is specified (see [Internal Address Format, on page 234](#)), each value encountered is assigned to a successive word element of the memory. If no addressing information is specified either with the \$readmem task statement or within the initialization file itself, the default starting address is the lowest available address in the memory. Consecutive words are loaded until either the highest address in the memory is reached or the data file is completely read.

If a start address is specified without a finish address, loading starts at the specified start address and continues upward toward the highest address in the memory. In either case, loading continues upward. If both a start address and a finish address are specified, loading begins at the start address and continues until the finish address is reached (or until all initialization data is read).

For example:

```
initial
begin
  //$readmemh ("mem.ini", ram_bank1)
  /* Initialize RAM with contents from locations 0 thru 31*/;

  //$readmemh ("mem.ini", ram_bank1,0)
  /* Initialize RAM with contents from locations 0 thru 31*/;

  $readmemh ("mem.ini", ram_bank1, 0, 31)
  /* Initialize RAM with contents from locations 0 thru 31*/;

  $readmemh ("mem.ini", ram_bank2, 31, 0)
  /* Initialize RAM with contents from locations 31 thru 0*/;
```

The data initialization file can contain the following:

- White space (spaces, new lines, tabs, and form-feeds)
- Comments (both comment formats are allowed)

- In addition, the data initialization file can include any number of hexadecimal addresses (see [Internal Address Format, on page 234](#)).

The binary data file mem.ini that corresponds to the example in [Example 1: RAM Initialization](#), on page 229 looks like this:

If you use `$readmemh` instead of `$readmemb`, the hexadecimal data file for the example in [Example 1: RAM Initialization, on page 229](#) looks like this:

In addition to the binary and hex formats described above, the initialization file can include embedded hexadecimal addresses. These hexadecimal addresses must be prefaced with an at sign (@) as shown in the example below.

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```

...
@0A7      /* memory address 137
FFFFF77   /* data for address 137*/
FFFFF7A   /* data for address 138*/
...

```

Either uppercase or lowercase characters can be used in the address. No white space is allowed between the @ and the hex address. Any number of address specifications can be included in the file, and in any order. When the \$readmemb or \$readmemh system task encounters an embedded address specification, it begins loading subsequent data at that memory location.

When addressing information is specified both in the system task and in the data file, the addresses in the data file must be within the address range specified by the system task arguments; otherwise, an error message is issued, and the load operation is terminated.

## Forward Annotation of Initial Values

Initial values for RAMs and sequential shift components are forward annotated to the netlist. The compiler currently generates netlist (srs) files with seqshift, ram1, ram2, and nram components. If initial values are specified in the HDL code, the synthesis tool attaches an attribute to the component in the srs file.

### // Example: Verilog Initial Values for Asymmetric RAM

```

//
// Asymmetric port RAM
//   Port A is 256x8-bit read-only
//   Port B is 64x32-bit write-only
//   Write_First mode with no control signals on Address register.
//   Different clocks.
//

module v_asymmetric_ram_4 (clkA, clkB, weB, addrA, addrB, doA,
diB);

```

```

parameter WIDTHA      = 8;
parameter SIZEA       = 256;
parameter ADDRWIDTHA  = 8;
parameter WIDTHB      = 32;
parameter SIZEB       = 64;
parameter ADDRWIDTHB  = 6;

input                  clkA;
input                  clkB;
input                  weB;
input    [ADDRWIDTHA-1:0]  addrA;
input    [ADDRWIDTHB-1:0]  addrB;
output    [WIDTHA-1:0]     doA;
input    [WIDTHB-1:0]     diB;
reg      [ADDRWIDTHA-1:0]  addrA_reg;

`define max(a,b) {(a) > (b) ? (a) : (b)}
`define min(a,b) {(a) < (b) ? (a) : (b)}

function integer log2;
    input integer value;
    reg [31:0] shifted;
    integer res;
begin
    if (value < 2)
        log2 = value;
    else

```

```

begin
    shifted = value-1;
    for (res=0; shifted>0; res=res+1)
        shifted = shifted>>1;
    log2 = res;
end
end
endfunction

localparam maxSize    = `max(SIZEA, SIZEB);
localparam maxWIDTH   = `max(WIDTHA, WIDTHB);
localparam minWIDTH   = `min(WIDTHA, WIDTHB);
localparam RATIO      = maxWIDTH / minWIDTH;
localparam log2RATIO = log2(RATIO);

reg      [WIDTHB-1:0]  readB;

genvar i;

reg      [minWIDTH-1:0] RAM [0:maxSize-1];
// RAM initialization
initial
$readmemb ("mem_init_256x8.dat", RAM);

always @(posedge clkA)
begin

```

```

    addrA_reg <= addrA;
end
assign doA = RAM[addrA_reg];

generate for (i = 0; i < RATIO; i = i+1)
    begin: ramread
        localparam [log2RATIO-1:0] lsbaddr = i;
        always @(posedge clkB)
            begin
                if (weB)
                    RAM[{addrB, lsbaddr}] <= diB[(i+1)*minWIDTH-1:i*minWIDTH];
            end
        end
    endgenerate

endmodule

```

### // Example: VHDL Initial Values for Asymmetric RAM

```

library ieee;
use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;
use ieee.std_logic_arith.all;

entity asymmetric_ram_4 is
    generic (

```

```

WIDTHA      : integer := 8;
SIZEA       : integer := 256;
ADDRWIDTHA  : integer := 8;
WIDTHB      : integer := 32;
SIZEB       : integer := 64;
ADDRWIDTHB  : integer := 6
);

port (
    clkA    : in  std_logic;
    clkB    : in  std_logic;
    reA     : in  std_logic;
    weB     : in  std_logic;
    addrA   : in  std_logic_vector(ADDRWIDTHA-1 downto 0);
    addrB   : in  std_logic_vector(ADDRWIDTHB-1 downto 0);
    diB     : in  std_logic_vector(WIDTHB-1 downto 0);
    doA     : out std_logic_vector(WIDTHA-1 downto 0)
);

end asymmetric_ram_4;

architecture behavioral of asymmetric_ram_4 is

    function max(L, R: INTEGER) return INTEGER is
    begin
        if L > R then
            return L;
        end if;
    end function;

```

```
        else
            return R;
        end if;
    end;

function min(L, R: INTEGER) return INTEGER is
begin
    if L < R then
        return L;
    else
        return R;
    end if;
end;

function log2 (val: INTEGER) return natural is
    variable res : natural;
begin
    for i in 0 to 31 loop
        if (val <= (2**i)) then
            res := i;
            exit;
        end if;
    end loop;
    return res;
end function Log2;

constant minWIDTH : integer := min(WIDTHA,WIDTHB);
```



```

constant maxWIDTH : integer := max(WIDTHA,WIDTHB);
constant maxSize   : integer := max(SIZEA,SIZEB);
constant RATIO : integer := maxWIDTH / minWIDTH;

type ramType is array (0 to maxSize-1) of
    std_logic_vector(minWIDTH-1 downto 0);
shared variable ram : ramType := (others => "11111111");

signal readA : std_logic_vector(WIDTHA-1 downto 0) := (
    others => '0');
signal regA   : std_logic_vector(WIDTHA-1 downto 0) :=
    (others => '0');

begin

    process (clkA)
    begin
        if rising_edge(clkA) then
            if reA = '1' then
                doA <= ram(conv_integer(addrA));
            end if;
        end if;
    end process;

    process (clkB)
    begin
        if rising_edge(clkB) then

```

```
    if weB = '1' then
        for i in 0 to RATIO-1 loop
            ram(conv_integer(addrB &
                conv_std_logic_vector(i,log2(RATIO))))
            := diB((i+1)*minWIDTH-1 downto i*minWIDTH);
        end loop;
    end if;
end if;
end process;

end behavioral;
```

## RAM Instantiation with SYNCORE

The SYNCORE Memory Compiler in the IP Wizard helps you generate HDL code for your specific RAM implementation requirements. For information on using the SYNCORE Memory Compiler, see [Chapter 7, \*SynCore IP Tool\*](#)

# ROM Inference

As part of BEST (Behavioral Extraction Synthesis Technology) feature, the synthesis tool infers ROMs (read-only memories) from your HDL source code, and generates block components for them in the RTL view.

The data contents of the ROMs are stored in a text file named `rom.info`. To quickly view `rom.info` in read-only mode, synthesize your HDL source code, open an RTL view, then push down into the ROM component.

Generally, the Synopsys FPGA synthesis tool infers ROMs from HDL source code that uses `case` statements, or equivalent `if` statements, to make 16 or more signal assignments using constant values (words). The constants must all be the same width.

Another requirement for ROM inference is that values must be specified for at least half of the address space. For example, if the ROM has 5 address bits, then the address space is 32 and at least 16 of the different addresses must be specified.

## Verilog Example

```
module rom(z,a);
  output [3:0] z;
  input [4:0] a;
  reg [3:0] z;

  always @(a) begin
    case (a)
      5'b00000 : z = 4'b0001;
      5'b00001 : z = 4'b0010;
      5'b00010 : z = 4'b0110;
      5'b00011 : z = 4'b1010;
      5'b00100 : z = 4'b1000;
      5'b00101 : z = 4'b1001;
      5'b00110 : z = 4'b0000;
      5'b00111 : z = 4'b1110;
      5'b01000 : z = 4'b1111;
      5'b01001 : z = 4'b1110;
      5'b01010 : z = 4'b0001;
      5'b01011 : z = 4'b1000;
      5'b01100 : z = 4'b1110;
      5'b01101 : z = 4'b0011;
      5'b01110 : z = 4'b1111;
```

```

        5'b01111 : z = 4'b1100;
        5'b10000 : z = 4'b1000;
        5'b10001 : z = 4'b0000;
        5'b10010 : z = 4'b0011;
        default : z = 4'b0111;
    endcase
end
endmodule

```

## VHDL Example

```

library ieee;
use ieee.std_logic_1164.all;

entity rom4 is
    port (a : in std_logic_vector(4 downto 0);
          z : out std_logic_vector(3 downto 0) );
end rom4;

architecture behave of rom4 is
begin
    process(a)
    begin
        if a = "00000" then
            z <= "0001";
        elsif a = "00001" then
            z <= "0010";
        elsif a = "00010" then
            z <= "0110";
        elsif a = "00011" then
            z <= "1010";
        elsif a = "00100" then
            z <= "1000";
        elsif a = "00101" then
            z <= "1001";
        elsif a = "00110" then
            z <= "0000";
        elsif a = "00111" then
            z <= "1110";
        elsif a = "01000" then
            z <= "1111";
        elsif a = "01001" then
            z <= "1110";
        elsif a = "01010" then
            z <= "0001";
        elsif a = "01011" then

```

```
        z <= "1000";
    elsif a = "01100" then
        z <= "1110";
    elsif a = "01101" then
        z <= "0011";
    elsif a = "01110" then
        z <= "1111";
    elsif a = "01111" then
        z <= "1100";
    elsif a = "10000" then
        z <= "1000";
    elsif a = "10001" then
        z <= "0000";
    elsif a = "10010" then
        z <= "0011";
    else
        z <= "0111";
    end if;
end process;
end behave;
```

## ROM Table Data (rom.info File)

**Note:** This data is for viewing only.

```
ROM work.rom4(behave)-z_1[3:0]
```

```
address width: 5
```

```
data width: 4
```

```
inputs:
```

```
0: a[0]
```

```
1: a[1]
```

```
2: a[2]
```

```
3: a[3]
```

```
4: a[4]
```

```
outputs:
```

```
0: z_1[0]
```

```
1: z_1[1]
```

```
2: z_1[2]
```

```
3: z_1[3]
```

```
data:
```

```
00000 -> 0001
```

```
00001 -> 0010
```

```
00010 -> 0110
```

```
00011 -> 1010
```

```
00100 -> 1000
```

```
00101 -> 1001
```

```
00110 -> 0000
```

```
00111 -> 1110
```

```
01000 -> 1111
```

```
01001 -> 1110
```

```
01010 -> 0001
```

```
01011 -> 1000
```

```
01100 -> 1110
```

```
01101 -> 0011
```

```
01110 -> 0010
```

```
01111 -> 0010
```

```
10000 -> 0010
```

```
10001 -> 0010
```

```
10010 -> 0010
```

```
default -> 0111
```

## ROM Initialization with Generate Block

The software supports conditional ROM initialization with the generate block, as shown in the following example:

```
generate
  if (INIT) begin
    initial
      begin
        $readmemb("init.hex",mem);
      end
  end
endgenerate
```





## CHAPTER 7

# SynCore IP Tool

---

This chapter describes the SYNCore IP functionality that is bundled with the synthesis tool.

- [SYNCore FIFO Compiler](#), on page 250
- [SYNCore RAM Compiler](#), on page 281
- [SYNCore Byte-Enable RAM Compiler](#), on page 303
- [SYNCore ROM Compiler](#), on page 319
- [SYNCore Adder/Subtractor Compiler](#), on page 334
- [SYNCore Counter Compiler](#), on page 358

# SYNCore FIFO Compiler

The SYNCore synchronous FIFO compiler offers an IP wizard that generates Verilog code for your FIFO implementation. This section describes the following:

- [Synchronous FIFO Overview](#), on page 250
- [Specifying FIFOs with SYNCore](#), on page 251
- [SYNCore FIFO Wizard](#), on page 256
- [FIFO Read and Write Operations](#), on page 265
- [FIFO Ports](#), on page 266
- [FIFO Parameters](#), on page 269
- [FIFO Status Flags](#), on page 271
- [FIFO Programmable Flags](#), on page 274

## Synchronous FIFO Overview

A FIFO is a First-In-First-Out memory queue. Different control logic manages the read and write operations. A FIFO also has various handshake signals for interfacing with external user modules.

The SYNCore FIFO compiler generates synchronous FIFOs with symmetric ports and one clock controlling both the read and write operations. The FIFO is symmetric because the read and write ports have the same width.

When the Write\_enable signal is active and the FIFO has empty locations, data is written into FIFO memory on the rising edge of the clock. A Full status flag indicates that the FIFO is full and that no more write operations can be performed. See [FIFO Write Operation, on page 265](#) for details.

When the FIFO has valid data and Read\_enable is active, data is read from the FIFO memory and presented at the outputs. The FIFO Empty status flag indicates that the FIFO is empty and that no more read operations can be performed. See [FIFO Read Operation, on page 266](#) for details.

The FIFO is not corrupted by an invalid request: for example, if a read request is made while the FIFO is empty or a write request is received when the FIFO is full. Invalid requests do not corrupt the data, but they cause the corre-

sponding read or write request to be ignored and the Overflow or Underflow flags to be asserted. You can monitor these status flags for invalid requests. These and other flags are described in [FIFO Status Flags, on page 271](#) and [FIFO Programmable Flags, on page 274](#).

At any point in time, Data count reflects the available data inside the FIFO. In addition, you can use the Programmable Full and Programmable Empty status flags for user-defined thresholds.

## Specifying FIFOs with SYNCore


The SYNCore IP Wizard helps you generate Verilog code for your FIFO implementations. The following procedure shows you how to generate Verilog code for a FIFO using the SYNCore IP wizard.

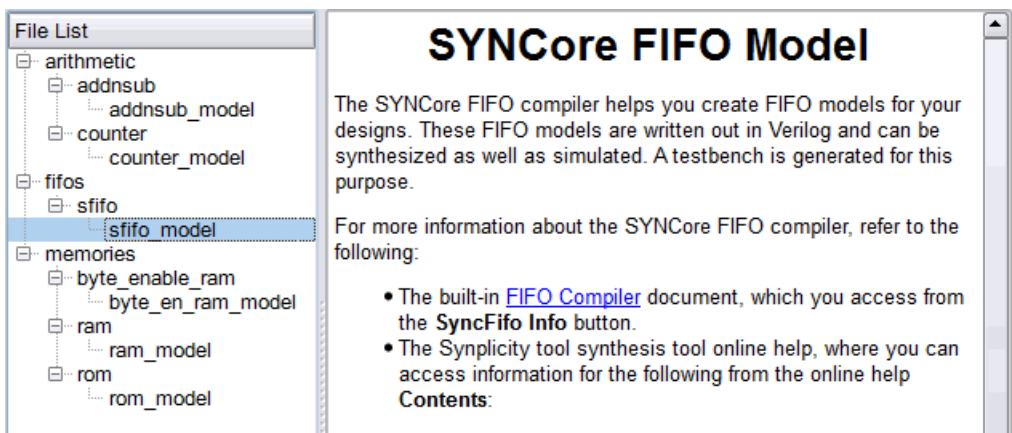
---

**Note:** The SYNCore FIFO model uses Verilog 2001. When adding a FIFO model to a Verilog-95 design, be sure to enable the Verilog 2001 check box on the Verilog tab of the Implementation Options dialog box or include a `set_option -vlog_std v2001` statement in your project file to prevent a syntax error.

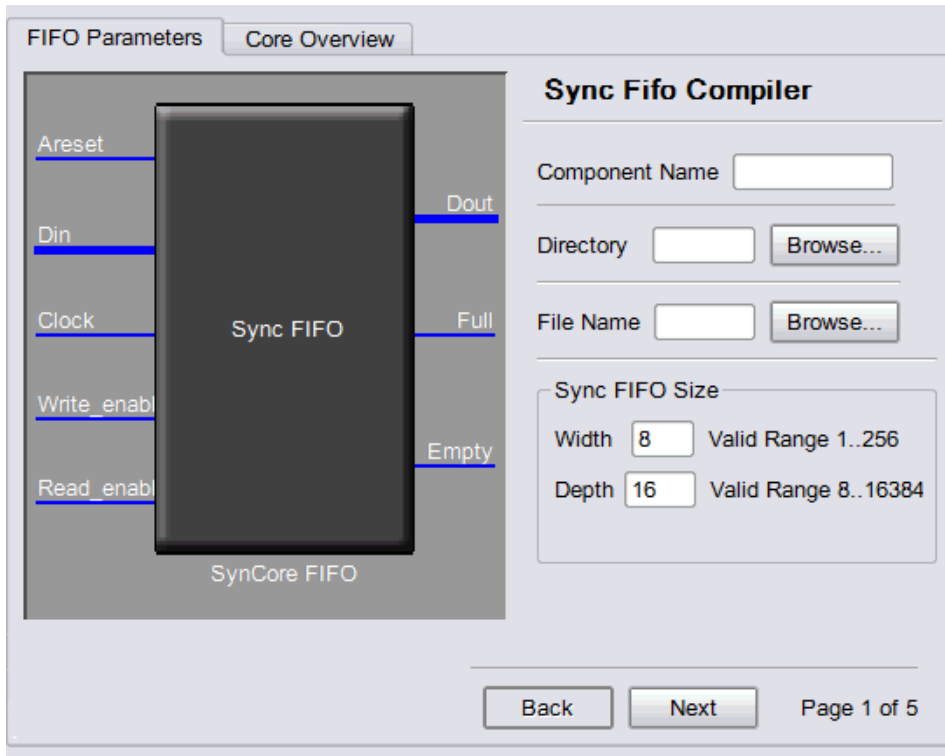
---

### 1. Start the wizard.

- From the synthesis tool GUI, select Run->Launch SYNCore or click the Launch SYNCore icon  to start the SYNCore IP wizard.



- In the window that opens, select `sffifo_model` and click Ok. This opens the first screen of the wizard.



2. Specify the parameters you need in the five pages of the wizard. For details, refer to [Specifying SYNCore FIFO Parameters, on page 254](#).

The FIFO symbol on the left reflects the parameters you set.

3. After you have specified all the parameters you need, click the Generate button (lower left).

The tool displays a confirmation message (TCL execution successfull!) and writes the required files to the directory you specified in the parameters. The HDL code is in Verilog.

The FIFO generated is a synchronous FIFO with symmetric ports and with the same clock controlling both the read and write operations. Data is written or read on the rising edge of the clock. All resets are synchro-

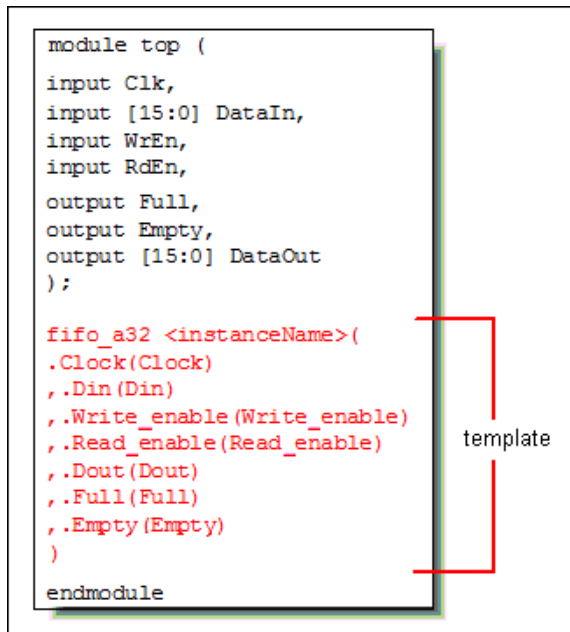
nous with the clock. All edges (clock, enable, and reset) are considered positive.

SYNCore also generates a testbench for the FIFO that you can use for simulation. The testbench covers a limited set of vectors for testing.

You can now close the SYNCore wizard.

#### 4. Add the FIFO you generated to your design.

- Use the Add File command to add the Verilog design file that was generated and the `syncore_sfifo.v` file to your project. These files are in the directory for output files that you specified on page 1 of the wizard.
- Use a text editor to open the `instantiation_file.vin` template file, which is located in the same directory. Copy the lines that define the memory, and paste them into your top-level module. The following shows a template file (in red text) inserted into a top-level module.



```

module top (
input Clk,
input [15:0] DataIn,
input WrEn,
input RdEn,
output Full,
output Empty,
output [15:0] DataOut
);

fifo_a32 <instanceName>(
.Clock(Clock)
,.Din(Din)
,.Write_enable(Write_enable)
,.Read_enable(Read_enable)
,.Dout(Dout)
,.Full(Full)
,.Empty(Empty)
)

endmodule

```

- #### 5. Edit the template port connections so that they agree with the port definitions in your top-level module as shown in the example below (the updated connection names are shown in red). You can also assign a unique name to each instantiation.

```
module top (  
    input Clk,  
    input [15:0] DataIn,  
    input WrEn,  
    input RdEn,  
  
    output Full,  
    output Empty,  
    output [15:0] DataOut  
);  
  
fifo_a32 busfifo(  
    .Clock(Clk)  
    ,.Din(DataIn)  
    ,.Write_enable(WrEn)  
    ,.Read_enable(RdEn)  
    ,.Dout(DataOut)  
    ,.Full(Full)  
    ,.Empty(Empty)  
)  
endmodule
```

Note that currently, the FIFO models will not be implemented with the dedicated FIFO blocks available in certain technologies.

## Specifying SYNCore FIFO Parameters

The following elaborates on the parameter settings for SYNCore FIFOs. The status, handshaking, and programmable flags are optional. For descriptions of the parameters, see [SYNCore FIFO Wizard, on page 256](#).

1. Start the SYNCore wizard, as described in [Specifying FIFOs with SYNCore, on page 251](#).
2. Do the following on page 1 of the FIFO wizard:
  - In Component Name, specify a name for the FIFO. Do not use spaces.
  - In Directory, specify a directory where you want the output files to be written. Do not use spaces.
  - In Filename, specify a name for the Verilog output file with the FIFO specifications. Do not use spaces.

- Click Next. The wizard opens another page where you can set parameters.
3. For a FIFO with no status, handshaking, or programmable flags, use the default settings. You can generate the FIFO, as described in [Specifying FIFOs with SYNCore, on page 251](#).
  4. To set an almost full status flag, do the following on page 2 of the FIFO wizard:
    - Enable Almost Full.
    - Set associated handshaking flags for the signal as desired, with the Overflow Flag and Write Acknowledge options.
    - Click Next when you are done.
  5. To set an almost empty status flag, do the following on page 3:
    - Enable Almost Empty.
    - Set associated handshaking flags for the signal as desired, with the Underflow Flag and Read Acknowledge options.
    - Click Next when you are done.
  6. To set a programmable full flag, do the following:
    - Make sure you have enabled Full on page 2 of the wizard and set any handshaking flags you require.
    - Go to page 4 and enable Programmable Full.
    - Select one of the four mutually exclusive configurations for Programmable Full on page 4. See [Programmable Full, on page 275](#) or details.
    - Click Next when you are done.
  7. To set a programmable empty flag, do the following:
    - Make sure you have enabled Empty on page 3 of the wizard and set any handshaking flags you require.
    - Go to page 5 and enable Programmable Empty.
    - Select one of the four mutually exclusive configurations for Programmable Empty on page 5. See [Programmable Empty, on page 277](#) or details.

You can now generate the FIFO and add it to the design, as described in [Specifying FIFOs with SYNCore, on page 251](#).

## SYNCore FIFO Wizard

The following describe the parameters you can set in the FIFO wizard, which opens when you select `sffifo_model`:

- [SYNCore FIFO Parameters Page 1](#), on page 256
- [SYNCore FIFO Parameters Page 2](#), on page 257
- [SYNCore FIFO Parameters Page 3](#), on page 259
- [SYNCore FIFO Parameters Page 4](#), on page 261
- [SYNCore FIFO Parameters Page 5](#), on page 263

### SYNCore FIFO Parameters Page 1

The page 1 parameters define the FIFO. Data is written/read on the rising edge of the clock.

Parameter	Function
Component Name	Specifies a name for the FIFO. This is the name that you instantiate in your design file to create an instance of the SYNCore FIFO in your design. Do not use spaces.
Directory	Indicates the directory where the generated files will be stored. Do not use spaces.



Parameter	Function
Filename	Specifies the name of the generated file containing the HDL description of the generated FIFO. Do not use spaces.
Width	Specifies the width of the FIFO data input and output. It must be within the valid range.
Depth	Specifies the depth of the FIFO. It must be within the valid range.

## SYNCore FIFO Parameters Page 2

**Sync Fifo Compiler**

---

Sync FIFO Optional Flags

Write Control Handshaking Options

Full Flags

☒ Full Flag

☒ Active High   ☐ Active Low

---

☐ Almost Full Flag

☒ Active High   ☐ Active Low

Overflow

☐ Overflow Flag

☒ Active High   ☐ Active Low

Write Acknowledge

☐ Write Acknowledge Flag

☒ Active High   ☐ Active Low

The page 2 parameters let you specify optional handshaking flags for FIFO write operations. When you specify a flag, the symbol on the left reflects your choice. Data is written/read on the rising edge of the clock.

Parameter	Function
Full Flag	<p>Specifies a Full signal, which is asserted when the FIFO memory queue is full and no more writes can be performed until data is read.</p> <p>Enabling this option makes the Active High and Active Low options (FULL_FLAG_SENSE parameter) available for the signal. See <a href="#">Full/Almost Full Flags, on page 271</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>
Almost Full Flag	<p>Specifies an Almost_full signal, which is asserted to indicate that there is one location left and the FIFO will be full after one more write operation.</p> <p>Enabling this option makes the Active High and Active Low options available for the signal (AFULL_FLAG_SENSE parameter). See <a href="#">Full/Almost Full Flags, on page 271</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>
Overflow Flag	<p>Specifies an Overflow signal, which is asserted to indicate that the write operation was unsuccessful because the FIFO was full.</p> <p>Enabling this option makes the Active High and Active Low options available for the signal (OVERFLOW_FLAG_SENSE parameter). See <a href="#">Handshaking Flags, on page 272</a> f and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>
Write Acknowledge Flag	<p>Specifies a Write_ack signal, which is asserted at the completion of a successful write operation.</p> <p>Enabling this option makes the Active High and Active Low options (WACK_FLAG_SENSE parameter) available for the signal. See <a href="#">Handshaking Flags, on page 272</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>
Active High	Sets the specified signal to active high (1).
Active Low	Sets the specified signal to active low (0).

## SYNCore FIFO Parameters Page 3

The page 3 parameters let you specify optional handshaking flags for FIFO read operations. Data is written/read on the rising edge of the clock.

The screenshot shows the 'Sync Fifo Compiler' window. Under the 'Sync FIFO Optional Flags' section, there are three main groups of options:

- Read Control Handshaking Options:**
  - Empty Flag:** A checked checkbox. Below it are two radio buttons: 'Active High' (selected) and 'Active Low'.
  - Almost Empty Flag:** An unchecked checkbox. Below it are two radio buttons: 'Active High' (selected) and 'Active Low'.
- Underflow:**
  - Underflow Flag:** An unchecked checkbox. Below it are two radio buttons: 'Active High' (selected) and 'Active Low'.
- Read Acknowledge:**
  - Read Acknowledge Flag:** An unchecked checkbox. Below it are two radio buttons: 'Active High' (selected) and 'Active Low'.

Parameter	Function
Empty Flag	<p>Specifies an Empty signal, which is asserted when the memory queue for the FIFO is empty and no more reads can be performed until data is written.</p> <p>Enabling this option makes the Active High and Active Low options (EMPTY_FLAG_SENSE parameter) available for the signal. See <a href="#">Empty/Almost Empty Flags, on page 272</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>

Parameter	Function
Almost Empty Flag	<p>Specifies an Almost_empty signal, which is asserted when there is only one location left to be read. The FIFO will be empty after one more read operation.</p> <p>Enabling this option makes the Active High and Active Low options (AEMPTY_FLAG_SENSE parameter) available for the signal. See <a href="#">Empty/Almost Empty Flags, on page 272</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>
Underflow Flag	<p>Specifies an Underflow signal, which is asserted to indicate that the read operation was unsuccessful because the FIFO was empty.</p> <p>Enabling this option makes the Active High and Active Low options (UNDRFLW_FLAG_SENSE parameter) available for the signal. See <a href="#">Handshaking Flags, on page 272</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>
Read Acknowledge Flag	<p>Specifies a Read_ack signal, which is asserted at the completion of a successful read operation.</p> <p>Enabling this option makes the Active High and Active Low options (RACK_FLAG_SENSE parameter) available for the signal. See <a href="#">Handshaking Flags, on page 272</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>
Active High	Sets the specified signal to active high (1).
Active Low	Sets the specified signal to active low (0).

## SYNCore FIFO Parameters Page 4

**Sync Fifo Compiler**

**Handshaking Options**

**Programmable Full Flag**

☐ Programmable Full Flag

☐ Single Programmable Full Threshold Constant

Full Threshold Assert Constant  Valid Range DEPTH/2..max of DEPTH

☐ Multiple Programmable Full Threshold Constant

Full Threshold Assert Constant  Valid Range DEPTH/2..max of DEPTH

Full Threshold Negate Constant  Valid Range DEPTH/2..max of DEPTH

☐ Single Programmable Full Threshold Input

☐ Multiple Programmable Full Threshold Input

☒ Active High ☐ Active Low

The page 4 parameters let you specify optional handshaking flags for FIFO programmable full operations. To use these options, you must have a Full signal specified. See [FIFO Programmable Flags, on page 274](#) for details and [FIFO Parameters, on page 269](#) for a list of the FIFO parameters. Data is written/read on the rising edge of the clock.

Parameter	Function
Programmable Full Flag	<p>Specifies a Prog_full signal, which indicates that the FIFO has reached a user-defined full threshold.</p> <p>You can only enable this option if you set Full Flag on page 2. When it is enabled, you can specify other options for the Prog_Full signal (PFULL_FLAG_SENSE parameter). See <a href="#">Programmable Full, on page 275</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p>

Parameter	Function
Single Programmable Full Threshold Constant	<p>Specifies a Prog_full signal with a single constant defining the assertion threshold (PGM_FULL_TYPE=1 parameter). See <a href="#">Programmable Full with Single Threshold Constant, on page 275</a> for details.</p> <p>Enabling this option makes Full Threshold Assert Constant available.</p>
Multiple Programmable Full Threshold Constant	<p>Specifies a Prog_full signal (PGM_FULL_TYPE=2 parameter), with multiple constants defining the assertion and de-assertion thresholds. See <a href="#">Programmable Full with Multiple Threshold Constants, on page 276</a> for details.</p> <p>Enabling this option makes Full Threshold Assert Constant and Full Threshold Negate Constant available.</p>
Full Threshold Assert Constant	<p>Specifies a constant that is used as a threshold value for asserting the Prog_full signal. It sets the PGM_FULL_THRESH parameter for PGM_FULL_TYPE=1 and the PGM_FULL_ATHRESH parameter for PGM_FULL_TYPE=2.</p>
Full Threshold Negate Constant	<p>Specifies a constant that is used as a threshold value for de-asserting the Prog_full signal (PGM_FULL_NTHRESH parameter).</p>
Single Programmable Full Threshold Input	<p>Specifies a Prog_full signal (PGM_FULL_TYPE=3 parameter), with a threshold value specified dynamically through a Prog_full_thresh input port during the reset state. See <a href="#">Programmable Full with Single Threshold Input, on page 276</a> for details.</p> <p>Enabling this option adds the Prog_full_thresh input port to the FIFO.</p>
Multiple Programmable Full Threshold Input	<p>Specifies a Prog_full signal (PGM_FULL_TYPE=4 parameter), with threshold assertion and deassertion values specified dynamically through input ports during the reset state. See <a href="#">Programmable Full with Multiple Threshold Inputs, on page 276</a> for details.</p> <p>Enabling this option adds the Prog_full_thresh_assert and Prog_full_thresh_negate input ports to the FIFO.</p>
Active High	Sets the specified signal to active high (1).
Active Low	Sets the specified signal to active low (0).

## SYNCore FIFO Parameters Page 5

These options specify optional handshaking flags for FIFO programmable empty operations. To use these options, you first specify an Empty signal on page 3. See [FIFO Programmable Flags, on page 274](#) for details and [FIFO Parameters, on page 269](#) for a list of the FIFO parameters. Data is written/read on the rising edge of the clock.

Parameter	Function
Programmable Empty Flag	<p>Specifies a Prog_empty signal (PEMPTY_FLAG_SENSE parameter), which indicates that the FIFO has reached a user-defined empty threshold. See <a href="#">Programmable Empty, on page 277</a> and <a href="#">FIFO Parameters, on page 269</a> for descriptions of the flag and parameter.</p> <p>Enabling this option makes the other options available to specify the threshold value, either as a constant or through input ports. You can also specify single or multiple thresholds for each of these options.</p>

Parameter	Function
Single Programmable Empty Threshold Constant	<p>Specifies a Prog_empty signal (PGM_EMPTY_TYPE=1 parameter), with a single constant defining the assertion threshold. See <a href="#">Programmable Empty with Single Threshold Input, on page 279</a> for details.</p> <p>Enabling this option makes Empty Threshold Assert Constant available.</p>
Multiple Programmable Empty Threshold Constant	<p>Specifies a Prog_empty signal (PGM_EMPTY_TYPE=2 parameter), with multiple constants defining the assertion and de-assertion thresholds. See <a href="#">Programmable Empty with Multiple Threshold Constants, on page 278</a> for details.</p> <p>Enabling this option makes Empty Threshold Assert Constant and Empty Threshold Negate Constant available.</p>
Empty Threshold Assert Constant	<p>Specifies a constant that is used as a threshold value for asserting the Prog_empty signal. It sets the PGM_EMPTY_THRESH parameter for PGM_EMPTY_TYPE=1 and the PGM_EMPTY_ATHRESH parameter for PGM_EMPTY_TYPE=2.</p>
Empty Threshold Negate Constant	<p>Specifies a constant that is used as a threshold value for de-asserting the Prog_empty signal (PGM_EMPTY_NTHRESH parameter).</p>
Single Programmable Empty Threshold Input	<p>Specifies a Prog_empty signal (PGM_EMPTY_TYPE=3 parameter), with a threshold value specified dynamically through a Prog_empty_thresh input port during the reset state. See <a href="#">Programmable Empty with Single Threshold Input, on page 279</a> for details.</p> <p>Enabling this option adds the Prog_full_thresh input port to the FIFO.</p>
Multiple Programmable Empty Threshold Input	<p>Specifies a Prog_empty signal (PGM_EMPTY_TYPE=4 parameter), with threshold assertion and deassertion values specified dynamically through Prog_empty_thresh_assert and Prog_empty_thresh_negate input ports during the reset state. See <a href="#">Programmable Empty with Multiple Threshold Inputs, on page 279</a> for details.</p> <p>Enabling this option adds the input ports to the FIFO.</p>
Active High	Sets the specified signal to active high (1).
Active Low	Sets the specified signal to active low (0).



Parameter	Function
Number of Valid Data in FIFO	Specifies the Data_cnt signal for the FIFO output. This signal contains the number of words in the FIFO in the read domain.

## FIFO Read and Write Operations

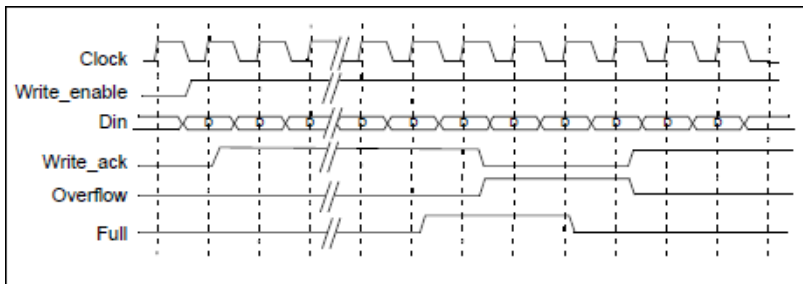
This section describes FIFO behavior with read and write operations.

### FIFO Write Operation

When write enable is asserted and the FIFO is not full, data is added to the FIFO from the input bus (Din) and write acknowledge (Write\_ack) is asserted. If the FIFO is continuously written without being read, it will fill with data. The status outputs are asserted when the number of entries in the FIFO is greater than or equal to the corresponding threshold, and should be monitored to avoid overflowing the FIFO.

When the FIFO is full, any attempted write operation fails and the overflow flag is asserted.

The following figure illustrates the write operation. Write acknowledge (Write\_ack) is asserted on the next rising clock edge after a valid write operation. When Full is asserted, there can be no more legal write operations. This example shows that asserting Write\_enable when Full is high causes the assertion of Overflow.

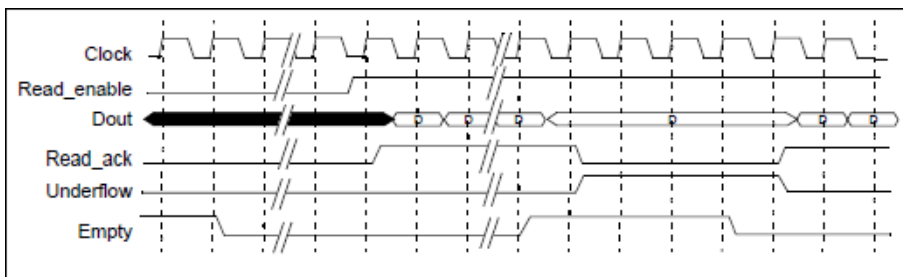


## FIFO Read Operation

When read enable is asserted and the FIFO is not empty, the next data word in the FIFO is driven on the output bus (Dout) and a read valid is asserted. If the FIFO is continuously read without being written, the FIFO will empty. The status outputs are asserted when the number of entries in the FIFO are less than or equal to the corresponding threshold, and should be monitored to avoid underflow of the FIFO. When the FIFO is empty, all read operations fail and the underflow flag is asserted.

If read and write operation occur simultaneously during the empty state, the write operation will be valid and empty, and is de-asserted at the next rising clock edge. There cannot be a legal read operation from an empty FIFO, so the underflow flag is asserted.

The following figure illustrates a typical read operation. If the FIFO is not empty, Read\_ack is asserted at the rising clock edge after Read\_enable is asserted and the data on Dout is valid. When Empty is asserted, no more read operations can be performed. In this case, initiating a read causes the assertion of Underflow on the next rising clock edge, as shown in this figure.



## FIFO Ports

The following figure shows the FIFO ports.



Port Name	Description
Almost_empty	Almost empty flag output (active high). Asserted when the FIFO is almost empty and only one more read can be performed. Can be active high or active low.
Almost_full	Almost full flag output (active high). Asserted when only one more write can be performed into the FIFO. Can be active high or active low.
AReset	Asynchronous reset input. Resets all internal counters and FIFO flag outputs.
Clock	Clock input for write and read. Data is written/read on the rising edge.
Data_cnt	Data word count output. Indicates the number of words in the FIFO in the read clock domain.
Din [width:0]	Data input word to the FIFO.
Dout [width:0]	Data output word from the FIFO.

Port Name	Description
Empty	FIFO empty output (active high). Asserted when the FIFO is empty and no additional reads can be performed. Can be active high or active low.
Full	FIFO full output (active high). Asserted when the FIFO is full and no additional writes can be performed. Can be active high or active low.
Overflow	FIFO overflow output flag (active high). Asserted when the FIFO is full and the previous write was rejected. Can be active high or active low.
Prog_empty	Programmable empty output flag (active high). Asserted when the words in the FIFO exceed or equal the programmable empty assert threshold. De-asserted when the number of words is more than the programmable full negate threshold. Can be active high or active low.
Prog_empty_thresh	Programmable FIFO empty threshold input. User-programmable threshold value for the assertion of the Prog_empty flag. Set during reset.
Prog_empty_thresh_assert	Programmable FIFO empty threshold assert input. User-programmable threshold value for the assertion of the Prog_empty flag. Set during reset.
Prog_empty_thresh_negate	Programmable FIFO empty threshold negate input. User programmable threshold value for the de-assertion of the Prog_full flag. Set during reset.
Prog_full	Programmable full output flag (active high). Asserted when the words in the FIFO exceed or equal the programmable full assert threshold. De-asserted when the number of words is less than the programmable full negate threshold. Can be active high or active low.
Prog_full_thresh	Programmable FIFO full threshold input. User-programmable threshold value for the assertion of the Prog_full flag. Set during reset.
Prog_full_thresh_assert	Programmable FIFO full threshold assert input. User-programmable threshold value for the assertion of the Prog_full flag. Set during reset.
Prog_full_thresh_negate	Programmable FIFO full threshold negate input. User-programmable threshold value for the de-assertion of the Prog_full flag. Set during reset.

Port Name	Description
Read_ack	Read acknowledge output (active high). Asserted when valid data is read from the FIFO. Can be active high or active low.
Read_enable	Read enable output (active high). If the FIFO is not empty, data is read from the FIFO on the next rising edge of the read clock.
Underflow	FIFO underflow output flag (active high). Asserted when the FIFO is empty and the previous read was rejected.
Write_ack	Write Acknowledge output (active high). Asserted when there is a valid write into the FIFO. Can be active high or active low.
Write_enable	Write enable input (active high). If the FIFO is not full, data is written into the FIFO on the next rising edge.

## FIFO Parameters

Parameter	Description
AEMPTY_FLAG_SENSE	FIFO almost empty flag sense 0 Active Low 1 Active High
AFULL_FLAG_SENSE	FIFO almost full flag sense 0 Active Low 1 Active High
DEPTH	FIFO depth
EMPTY_FLAG_SENSE	FIFO empty flag sense 0 Active Low 1 Active High
FULL_FLAG_SENSE	FIFO full flag sense 0 Active Low 1 Active High
OVERFLOW_FLAG_SENSE	FIFO overflow flag sense 0 Active Low 1 Active High

Parameter	Description
PEMPTY_FLAG_SENSE	FIFO programmable empty flag sense 0 Active Low 1 Active High
PFULL_FLAG_SENSE	FIFO programmable full flag sense 0 Active Low 1 Active High
PGM_EMPTY_ATHRESH	Programmable empty assert threshold for PGM_EMPTY_TYPE=2
PGM_EMPTY_NTHRESH	Programmable empty negate threshold for PGM_EMPTY_TYPE=2
PGM_EMPTY_THRESH	Programmable empty threshold for PGM_EMPTY_TYPE=1
PGM_EMPTY_TYPE	Programmable empty type. See <a href="#">Programmable Empty, on page 277</a> for details. 1 Programmable empty with single threshold constant. 2 Programmable empty with multiple threshold constant 3 Programmable empty with single threshold input 4 Programmable empty with multiple threshold input
PGM_FULL_ATHRESH	Programmable full assert threshold for PGM_FULL_TYPE=2
PGM_FULL_NTHRESH	Programmable full negate threshold for PGM_FULL_TYPE=2
PGM_FULL_THRESH	Programmable full threshold for PGM_FULL_TYPE=1
PGM_FULL_TYPE	Programmable full type. See <a href="#">Programmable Full, on page 275</a> for details. 1 Programmable full with single threshold constant 2 Programmable full with multiple threshold constant 3 Programmable full with single threshold input 4 Programmable full with multiple threshold input
RACK_FLAG_SENSE	FIFO read acknowledge flag sense 0 Active Low 1 Active High

Parameter	Description
UNDERFLOW_FLAG_SENSE	FIFO underflow flag sense 0 Active Low 1 Active High
WACK_FLAG_SENSE	FIFO write acknowledge flag sense 0 Active Low 1 Active High
WIDTH	FIFO data input and data output width

## FIFO Status Flags

You can set the following status flags for FIFO read and write operations.

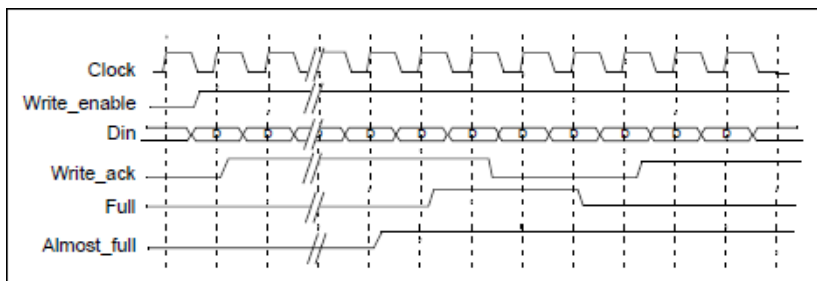
- [Full/Almost Full Flags](#), on page 271
- [Empty/Almost Empty Flags](#), on page 272
- [Handshaking Flags](#), on page 272
- Programmable full and empty flags, which are described in [Programmable Full](#), on page 275 and [Programmable Empty](#), on page 277.

### Full/Almost Full Flags

These flags indicate the status of the FIFO memory queue for write operations:

Full	Indicates that the FIFO memory queue is full and no more writes can be performed until data is read. Full is synchronous with the clock (Clock). If a write is initiated when Full is asserted, the write does not succeed and the overflow flag is asserted.
Almost_full	The almost full flag (Almost_full) indicates that there is one location left and the FIFO will be full after one more write operation. Almost full is synchronous to Clock. This flag is guaranteed to be asserted when the FIFO has one remaining location for a write operation.

The following figure displays the behavior of these flags. In this example, asserting Write\_enable when Almost\_full is high causes the assertion of Full on the next rising clock edge.



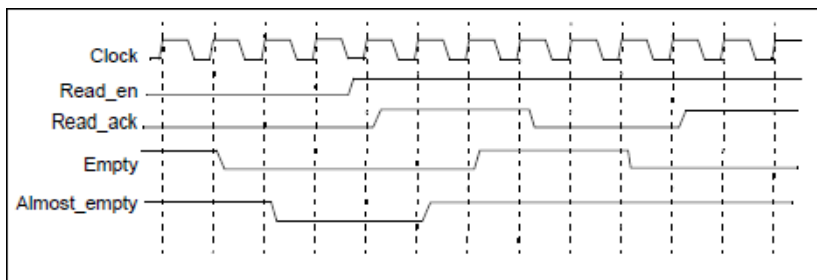
## Empty/Almost Empty Flags

These flags indicate the status of the FIFO memory queue for read operations:

**Empty** Indicates that the memory queue for the FIFO is empty and no more reads can be performed until data is written. The output is active high and is synchronous to the clock. If a read is initiated when the empty flag is true, the underflow flag is asserted.

**Almost\_empty** Indicates that the FIFO will be empty after one more read operation. Almost\_empty is active high and is synchronous to the clock. The flag is guaranteed to be asserted when the FIFO has one remaining location for a read operation.

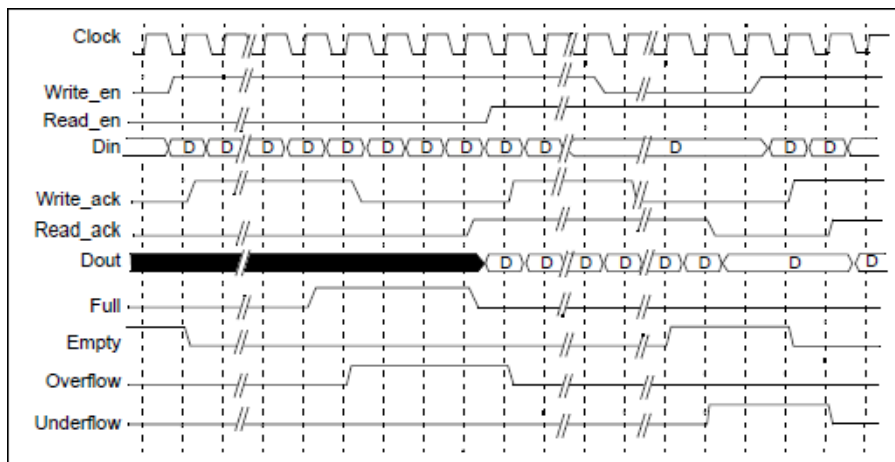
The following figure illustrates the behavior of the FIFO with one word remaining.



## Handshaking Flags

You can specify optional Read\_ack, Write\_ack, Overflow, and Underflow handshaking flags for the FIFO.





**Read\_ack** Asserted at the completion of each successful read operation. It indicates that the data on the Dout bus is valid. It is an optional port that is synchronous with Clock and can be configured as active high or active low.

Read\_ack is deasserted when the FIFO is underflowing, which indicates that the data on the Dout bus is invalid. Read\_ack is asserted at the next rising clock edge after read enable. Read\_enable is asserted when the FIFO is not empty.

Write_ack	<p>Asserted at the completion of each successful write operation. It indicates that the data on the Din port has been stored in the FIFO. It is synchronous with the clock, and can be configured as active high or active low.</p> <p>Write_ack is deasserted for a write to a full FIFO, as illustrated in the figure. Write_ack is deasserted one clock cycle after Full is asserted to indicate that the last write operation was valid and no other write operations can be performed.</p>
Overflow	<p>Indicates that a write operation was unsuccessful because the FIFO was full. In the figure, Full is asserted to indicate that no more writes can be performed. Because the write enable is still asserted and the FIFO is full, the next cycle causes Overflow to be asserted. Note that Write_ack is not asserted when FIFO is overflowing. When the write enable is deasserted, Overflow deasserts on the next clock cycle.</p>
Underflow	<p>Indicates that a read operation was unsuccessful, because the read was attempted on an empty FIFO. In the figure, Empty is asserted to indicate that no more reads can be performed. As the read enable is still asserted and the FIFO is empty, the next cycle causes Underflow to be asserted. Note that Read_ack is not asserted when FIFO is underflowing. When the read enable is deasserted, the Underflow flag deasserts on the next clock cycle.</p>

## FIFO Programmable Flags

The FIFO supports completely programmable full and empty flags to indicate when the FIFO reaches a predetermined user-defined fill level. See the following:

Prog_full	Indicates that the FIFO has reached a user-defined full threshold. See <a href="#">Programmable Full, on page 275</a> for more information.
Prog_empty	Indicates that the FIFO has reached a user-defined empty threshold. See <a href="#">Programmable Empty, on page 277</a> for more information.

Both flags support various implementation options. You can do the following:

- Set a constant value
- Set dedicated input ports so that the thresholds can change dynamically in the circuit
- Use hysteresis, so that each flag has different assert and negative values

## Programmable Full

The Prog\_full flag (programmable full) is asserted when the number of entries in the FIFO is greater than or equal to a user-defined assert threshold. If the number of words in the FIFO is less than the negate threshold, the flag is de-asserted. The following is the valid range of threshold values:

Assert threshold value	Depth/2 to Max of Depth For multiple threshold types, the assert value should always be larger than the negate value in multiple threshold types.
Negate threshold value	Depth/2 to Max of Depth

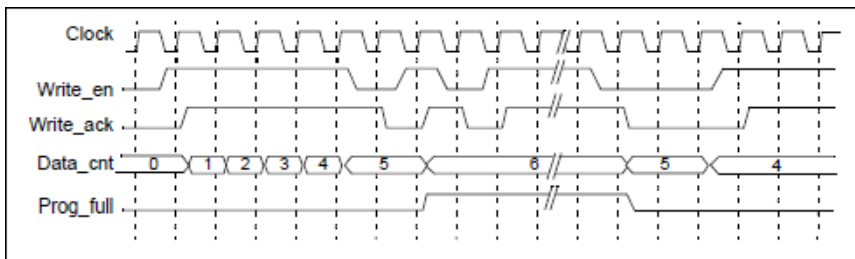
Prog\_full has four threshold types:

- [Programmable Full with Single Threshold Constant](#), on page 275
- [Programmable Full with Multiple Threshold Constants](#), on page 276
- [Programmable Full with Single Threshold Input](#), on page 276
- [Programmable Full with Multiple Threshold Inputs](#), on page 276

### Programmable Full with Single Threshold Constant

PGM\_FULL\_TYPE = 1

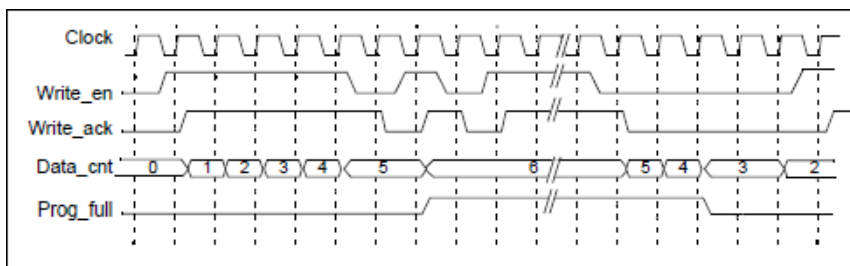
This option lets you set a single constant value for the threshold. It requires significantly fewer resources when the FIFO is generated. This figure illustrates the behavior of Prog\_full when configured as a single threshold constant with a value of 6.



## Programmable Full with Multiple Threshold Constants

PGM\_FULL\_TYPE = 2

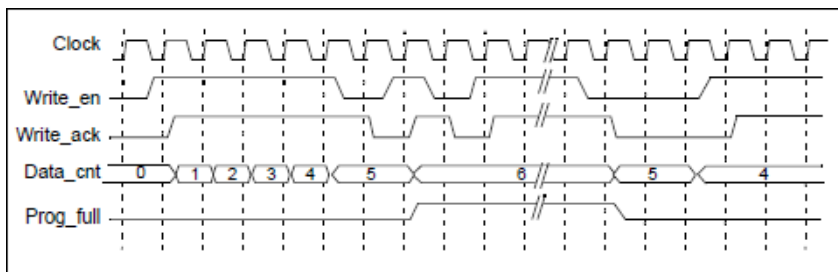
The programmable full flag is asserted when the number of words in the FIFO is greater than or equal to the full threshold assert value. If the number of FIFO words drops to less than the full threshold negate value, the programmable full flag is de-asserted. Note that the negate value must be set to a value less than the assert value. The following figure illustrates the behavior of Prog\_full configured as multiple threshold constants with an assert value of 6 and a negate value of 4.



## Programmable Full with Single Threshold Input

PGM\_FULL\_TYPE = 3

This option lets you specify the threshold value through an input port (Prog\_full\_thresh) during the reset state, instead of using constants. The following figure illustrates the behavior of Prog\_full configured as a single threshold input with a value of 6.

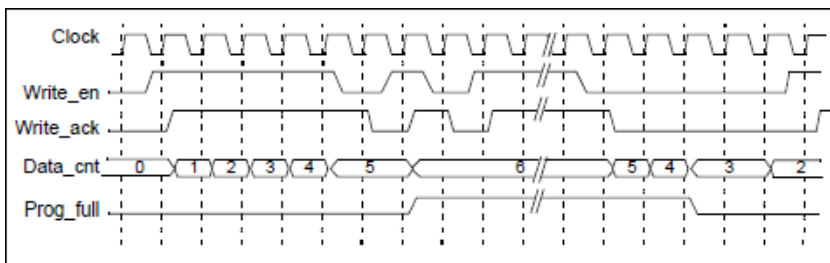


## Programmable Full with Multiple Threshold Inputs

PGM\_FULL\_TYPE = 4

This option lets you specify the assert and negate threshold values dynamically during the reset stage using the Prog\_full\_thresh\_assert and Prog\_full\_thresh\_negate input ports. You must set the negate value to a value less than the assert value.

The programmable full flag is asserted when the number of words in the FIFO is greater than or equal to the Prog\_full\_thresh\_assert value. If the number of FIFO words goes below Prog\_full\_thresh\_negate value, the programmable full flag is deasserted. The following figure illustrates the behavior of Prog\_full configured as multiple threshold inputs with an assert value of 6 and a negate value of 4.



## Programmable Empty

The programmable empty flag (Prog\_empty) is asserted when the number of entries in the FIFO is less than or equal to a user-defined assert threshold. If the number of words in the FIFO is greater than the negate threshold, the flag is deasserted. The following is the valid range of threshold values:

Assert threshold value	1 to Max of Depth/2 For multiple threshold types, the assert value should always be lower than the negate value in multiple threshold types.
Negate threshold value	1 to Max of Depth/2

There are four threshold types you can specify:

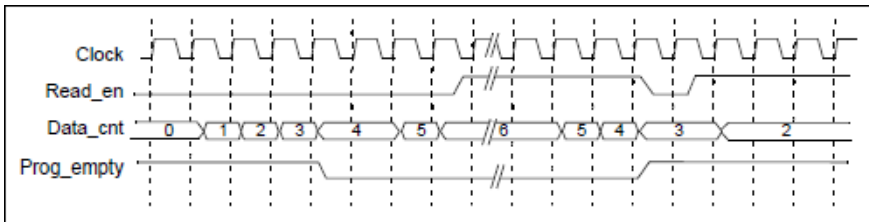
- [Programmable Empty with Single Threshold Constant](#), on page 278
- [Programmable Empty with Multiple Threshold Constants](#), on page 278
- [Programmable Empty with Single Threshold Input](#), on page 279

- [Programmable Empty with Multiple Threshold Inputs](#), on page 279

## Programmable Empty with Single Threshold Constant

PGM\_EMPTY\_TYPE = 1

This option lets you specify an empty threshold value with a single constant. This approach requires significantly fewer resources when the FIFO is generated. The following figure illustrates the behavior of Prog\_empty configured as a single threshold constant with a value of 3.

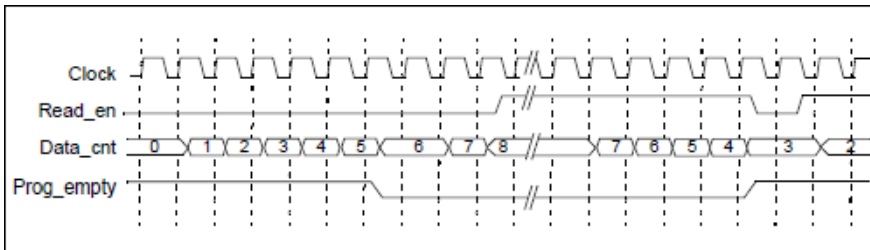


## Programmable Empty with Multiple Threshold Constants

PGM\_EMPTY\_TYPE = 2

This option lets you specify constants for the empty threshold assert value and empty threshold negate value. The programmable empty flag asserts and deasserts in the range set by the assert and negate values. The assert value must be set to a value less than the negate value. When the number of words in the FIFO is less than or equal to the empty threshold assert value, the Prog\_empty flag is asserted. When the number of words in FIFO is greater than the empty threshold negate value, Prog\_empty is deasserted.

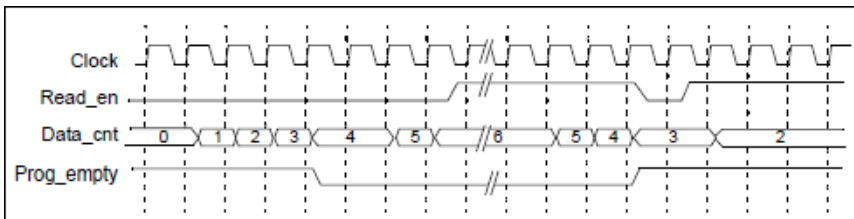
The following figure illustrates the behavior of Prog\_empty when configured as multiple threshold constants with an assert value of 3 and a negate value of 5.



### Programmable Empty with Single Threshold Input

PGM\_EMPTY\_TYPE = 3

This option lets you specify the threshold value dynamically during the reset state with the Prog\_empty\_thresh input port, instead of with a constant. The Prog\_empty flag asserts when the number of FIFO words is equal to or less than the Prog\_empty\_thresh value and deasserts when the number of FIFO words is more than the Prog\_empty\_thresh value. The following figure illustrates the behavior of Prog\_empty when configured as a single threshold input with a value of 3.

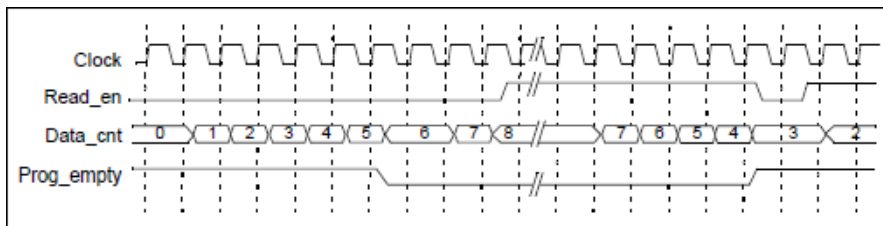


### Programmable Empty with Multiple Threshold Inputs

PGM\_EMPTY\_TYPE = 4

This option lets you specify the assert and negate threshold values dynamically during the reset stage using the Prog\_empty\_thresh\_assert and Prog\_empty\_thresh\_negate input ports instead of constants. The programmable empty flag asserts and deasserts according to the range set by the assert and negate values. The assert value must be set to a value less than the negate value.

When the number of FIFO words is less than or equal to the empty threshold assert value, `Prog_empty` is asserted. If the number of FIFO words is greater than the empty threshold negate value, the flag is deasserted. The following figure illustrates the behavior of `Prog_empty` configured as multiple threshold inputs, with an assert value of 3 and a negate value of 5.





# SYNCore RAM Compiler

The SYNCore RAM Compiler generates Verilog code for your RAM implementation. This section describes the following:

- [Specifying RAMs with SYNCore](#), on page 281
- [SYNCore RAM Wizard](#), on page 289
- [Single-Port Memories](#), on page 293
- [Dual-Port Memories](#), on page 295
- [Read/Write Timing Sequences](#), on page 299


## Specifying RAMs with SYNCore

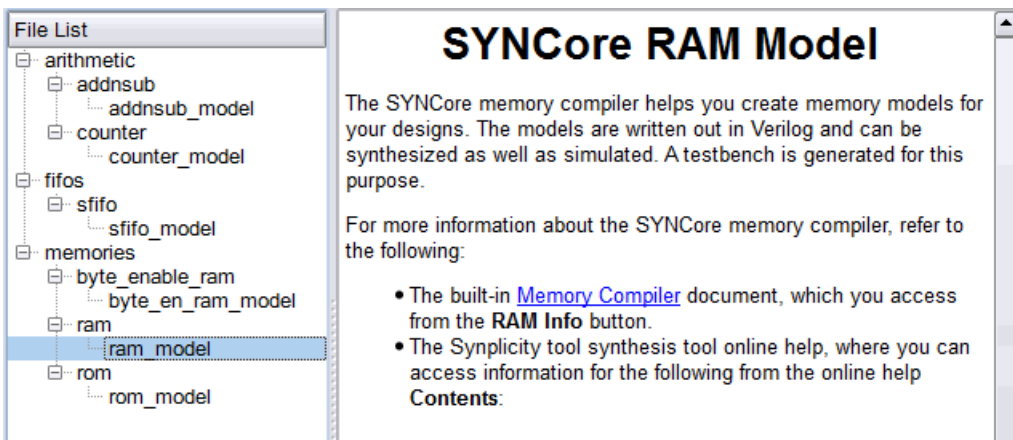
The SYNCore IP wizard helps you generate Verilog code for your RAM implementation requirements. The following procedure shows you how to generate Verilog code for a RAM using the SYNCore IP wizard.

---

**Note:** The SYNCore RAM model uses Verilog 2001. When adding a RAM model to a Verilog-95 design, be sure to enable the Verilog 2001 check box on the Verilog tab of the Implementation Options dialog box or include a `set_option -vlog_std v2001` statement in your project file to prevent a syntax error.

---

1. Start the wizard.
  - From the synthesis tool GUI, select Run->Launch SYNCore or click the Launch SYNCore icon  to start the SYNCore IP wizard.



- In the window that opens, select `ram_model` and click **Ok**. This opens the first screen of the wizard.

The screenshot displays the 'Memory Compiler' wizard interface. On the left, a block diagram shows a 'RAM' component with inputs 'Clk A', 'Wen A', 'Addr A', and 'Din A', and an output 'Dout A'. The component is labeled 'SynCore RAM'. On the right, the 'Memory Compiler' section contains the following fields and options:

- Component Name:** A text input field.
- Directory:** A text input field with a 'Browse...' button.
- File Name:** A text input field with a 'Browse...' button.
- Memory Size:**
  - Data Width:** 16 (Valid Range 1..256)
  - Address Width:** 8 (Valid Range 2..20)
- How will you be using the RAM?:**
  - ☒ Single Port
  - ☐ Dual Port
- Which clocking method do you want to use?:**
  - ☒ Single Clock
  - ☐ Separate Clocks For Each Port

At the bottom, there are 'Back' and 'Next' buttons, and a page indicator 'Page 1 of 3'.

## 2. Specify the parameters you need in the wizard.

- For details about the parameters for a single-port RAM, see [Specifying Parameters for Single-Port RAM, on page 286](#).
- For details about the parameters for a dual-port RAM, see [Specifying Parameters for Dual-Port RAM, on page 287](#). Note that dual-port implementations are only supported for some technologies.

The RAM symbol on the left reflects the parameters you set.

The default settings for the tool implement a block RAM with synchronous resets, and where all edges (clock, enable, and reset) are considered positive.

3. After you have specified all the parameters you need, click the **Generate** button in the lower left corner.

The tool displays a confirmation message is displayed (TCL execution successful!) and writes the required files to the directory you specified in the parameters. The HDL code is in Verilog.

SYNCore also generates a testbench for the RAM. The testbench covers a limited set of vectors.

You can now close the SYNCore Memory Compiler.

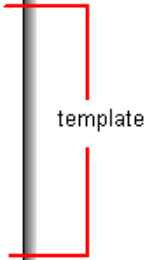
4. Edit the RAM files if necessary.

- The default RAM has a `no_rw_check` attribute enabled. If you do not want this, edit `syncore_ram.v` and comment out the ``define SYN_MULTI_PORT_RAM` statement, or use ``undef SYN_MULTI_PORT_RAM`.
- If you want to use the synchronous RAMs available in the target technology, make sure to register either the read address or the outputs.

5. Add the RAM you generated to your design.

- Use the **Add File** command to add the Verilog design file that was generated and the `syncore_ram.v` file to your project. These files are in the directory for output files that you specified on page 1 of the wizard.
- Use a text editor to open the `instantiation_file.vin` template file, which is located in the same directory. Copy the lines that define the memory, and paste them into your top-level module. The following figure shows a template file (in red text) inserted into a top-level module.

```
module top (  
  
    input ClkA,  
    input [7:0] AddrA,  
    input [15:0] DataInA,  
    input WrEnA,  
  
    output [15:0] DataOutA  
  
);  
  
myram2 <InstanceName> (  
    .PortAClk(PortAClk)  
    , .PortAAddr(PortAAddr)  
    , .PortADataIn(PortADataIn)  
    , .PortAWriteEnable(PortAWriteEnable)  
    , .PortADataOut(PortADataOut)  
);  
  
endmodule
```



6. Edit the template port connections so that they agree with the port definitions in your top-level module as shown in the example below (the updated connection names are shown in red). You can also assign a unique name to each instantiation.

```
module top (  
  
    input ClkA,  
    input [7:0] AddrA,  
    input [15:0] DataInA,  
    input WrEnA,  
  
    output [15:0] DataOutA  
  
);  
  
myram2 decoderram(  
    .PortAClk(ClkA)  
    , .PortAAddr(AddrA)  
    , .PortADataIn(DataInA)  
    , .PortAWriteEnable(WrEnA)  
    , .PortADataOut(DataOutA)  
);  
  
endmodule
```

## Specifying Parameters for Single-Port RAM

To create a single-port RAM with the SYNCore Memory Compiler, you need to specify a single read/write address (single port) and a single clock. You only need to configure Port A. The following procedure lists what you need to specify. For descriptions of each parameter, refer to [SYNCore RAM Wizard, on page 289](#).

1. Start the SYNCore RAM wizard, as described in [Specifying RAMs with SYNCore, on page 281](#).
2. Do the following on page 1 of the RAM wizard:
  - In Component Name, specify a name for the memory. Do not use spaces.
  - In Directory, specify a directory where you want the output files to be written. Do not use spaces.
  - In Filename, specify a name for the Verilog file that will be generated with the RAM specifications. Do not use spaces.

- Enter data and address widths.
- Enable Single Port, to specify that you want to generate a single-port RAM. This automatically enables Single Clock.
- Click Next. The wizard opens another page where you can set parameters for Port A.

The RAM symbol dynamically updates to reflect the parameters you set.

3. Do the following on page 2 of the RAM wizard:

- Set Use Write Enable to the setting you want.
- Set Register Read Address to the setting you want.
- Set Synchronous Reset to the setting you want. Register Outputs is always enabled
- Specify the read access you require for the RAM.

You can now generate the RAM by clicking Generate, as described in [Specifying RAMs with SYNCore, on page 281](#). You do not need to specify any parameters on page 3, as this is a single-port RAM and you do not need to specify Port B. All output files are in the directory you specified on the first page of the wizard.

For details about setting dual-port RAM parameters, see [Specifying Parameters for Dual-Port RAM, on page 287](#). For read/write timing diagrams, see [Read/Write Timing Sequences, on page 299](#).

## Specifying Parameters for Dual-Port RAM

The following procedure shows you how to set parameters for dual-port memory in the SYNCore wizard. Dual-port RAMs are only supported for some technologies. For information about generating single-port RAMs, see [Specifying Parameters for Single-Port RAM, on page 286](#). It shows you how to generate these common RAM configurations:

- One read access and one write access
- Two read accesses and one write access
- Two read accesses and two write accesses

For the corresponding read/write timing diagrams, see [Read/Write Timing Sequences, on page 299](#).

1. Start the SYNCore RAM wizard, as described in [Specifying RAMs with SYNCore, on page 281](#).
2. Do the following on page 1 of the RAM wizard:
  - In Component Name, specify a name for the memory. Do not use spaces.
  - In Directory, specify a directory where you want the output files to be written. Do not use spaces.
  - In Filename, specify a name for the Verilog file that will be generated with the RAM specifications. Do not use spaces.
  - Enter data and address widths.
  - Enable Dual Port, to specify that you want to generate a dual-port RAM.
  - Specify the clocks.
 

For a single clock ...	Enable Single Clock.
For separate clocks for each of the ports ...	Enable Separate Clocks For Each Port.
  - Click Next. The wizard opens another page where you can set parameters for Port A.
3. Do the following on page 2 of the RAM wizard to specify settings for Port A:
  - Set parameters according to the kind of memory you want to generate:
 

One read & one write	Enable Read Only Access.
Two reads & one write	Enable Read and Write Access. Specify a setting for Use Write Enable.
Two reads & two writes	Enable Read and Write Access. Specify a setting for Use Write Enable. Specify a read access option for Port A.
  - Specify a setting for Register Read Address.
  - Set Synchronous Reset to the setting you want. Register Outputs is always enabled.



- Click Next. The wizard opens another page where you can set parameters for Port B. The page and the parameters are identical to the previous page, except that the settings are for Port B instead of Port A.
4. Specify the settings for Port B on page 3 of the wizard according to the kind of memory you want to generate:

One read & one write	Enable Write Only Access. Set Use Write Enable to the setting you want.
Two reads & one write	Enable Read Only Access. Specify a setting for Register Read Address.
Two reads & two writes	Enable Read and Write Access. Specify a setting for Use Write Enable. Specify a setting for Register Read Address. Set Synchronous Reset to the setting you want. Note that Register Outputs is always enabled. Select a read access option for Port B.

The RAM symbol on the left reflects the parameters you set. All output files are written to the directory you specified on the first page of the wizard.

You can now generate the RAM by clicking Generate, as described in [Specifying RAMs with SYNCore, on page 281](#), and add it to your design.

## SYNCore RAM Wizard

The following describe the parameters you can set in the RAM wizard, which opens when you select ram\_model:

- [SYNCore RAM Parameters Page 1](#), on page 290
- [SYNCore RAM Parameters Pages 2 and 3](#), on page 292

## SYNCore RAM Parameters Page 1

**Memory Compiler**

Component Name

Directory

Browse...

Filename

Browse...

Memory Size

Data Width

16

Valid Range 1..256

Address Width

8

Valid Range 2..256

How will you be using the RAM?

☒ Single Port ☐ Dual Port

Which clocking method do you want to use?

☒ Single Clock ☐ Separate Clocks For Each Port

Component Name	<p>Specifies the name of the component. This is the name that you instantiate in your design file to create an instance of the SYNCore RAM in your design. Do not use spaces. For example:</p> <pre> raml01 &lt;ComponentName&gt; (     .PortAClk(PortAClk)     , .PortAAddr(PortAAddr)     , .PortADataIn(PortADataIn)     , .PortAWriteEnable(PortAWriteEnable)     , .PortBDataIn(PortBDataIn)     , .PortBAddr(PortBAddr)     , .PortBWriteEnable(PortBWriteEnable)     , .PortADataOut(PortADataOut)     , .PortBDataOut(PortBDataOut) ); </pre>
Directory	<p>Specifies the directory where the generated files are stored. Do not use spaces. The following files are created:</p> <ul style="list-style-type: none"> <li>• <code>filelist.txt</code> - lists files written out by SYNCore</li> <li>• <code>options.txt</code> - lists the options selected in SYNCore</li> <li>• <code>readme.txt</code> - contains a brief description and known issues</li> <li>• <code>syncore_ram.v</code> - Verilog library file required to generate RAM model</li> <li>• <code>testbench.v</code> - Verilog testbench file for testing the RAM model</li> <li>• <code>instantiation_file.vin</code> - describes how to instantiate the wrapper file</li> <li>• <code>component.v</code> - RAM model wrapper file generated by SYNCore</li> </ul> <p>Note that running the Memory Compiler wizard in the same directory overwrites the existing files.</p>
Filename	Specifies the name of the generated file containing the HDL description of the compiled RAM. Do not use spaces.
Data Width	Is the width of the data you need for the memory. The unit used is the number of bits.
Address Width	Is the address depth you need for the memory. The unit used is the number of bits.
Single Port	When enabled, generates a single-port RAM.

Dual Port	When enabled, generates a dual-port RAM.
Single Clock	When enabled, generates a RAM with a single clock for dual-port configurations.
Separate Clocks for Each Port	When enabled, generates separate clocks for each port in dual-port RAM configurations.

## SYNCore RAM Parameters Pages 2 and 3

The port implementation parameters on pages 2 and 3 are identical, but page 2 applies to Port A (single- and dual-port configurations), and page 3 applies to Port B (dual-port configurations only). The following figure shows the parameters on page 2 for Port A.

**Memory Compiler**

Configuring Port A

How do you want to configure Port A

☒ Read And Write Access ☐ Read Only Access ☐ Write Only Access

Design Options for Port A

☒ Use Write Enable

☒ Register Read Address

☒ Register Outputs

☐ Synchronous Reset

Read Access Options for Port A

☒ Read before Write ☐ Read after Write ☐ No Read on Write

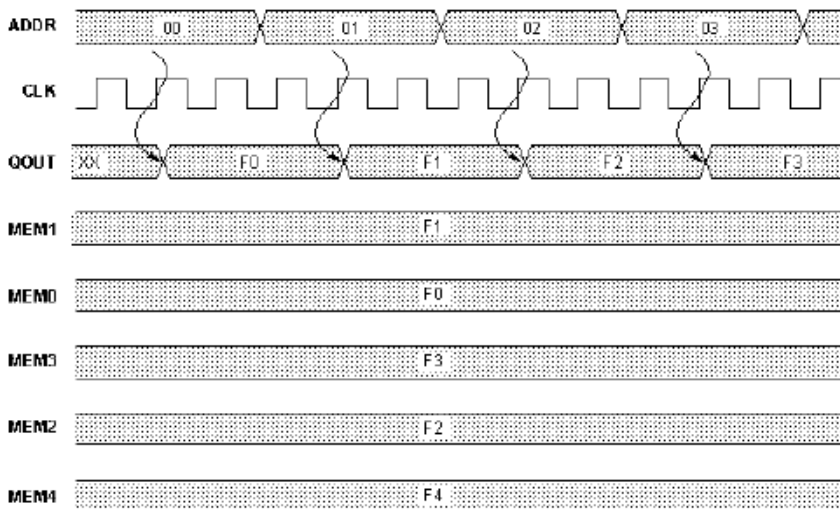
Read and Write Access	Specifies that the port can be accessed by both read and write operations.
Read Only Access	Specifies that the port can only be accessed by read operations.
Write Only Access	Specifies that the port can only be accessed by write operations.
Use Write Enable	Includes write-enable control. The RAM symbol on the left reflects the selections you make.

Register Read Address	Adds registers to the read address lines. The RAM symbol on the left reflects the selections you make.
Register Outputs	Adds registers to the write address lines when you specify separate read/write addressing. The register outputs are always enabled. The RAM symbol on the left reflects the selections you make.
Synchronous Reset	Individually synchronizes the reset signal with the clock when you enable Register Outputs. The RAM symbol on the left reflects the selections you make.
Read before Write	Specifies that the read operation takes place before the write operation for port configurations with both read and write access (Read And Write Access is enabled). For a timing diagram, see <a href="#">Read Before Write, on page 300</a> .
Read after Write	Specifies that the read operation takes place after the write operation for port configurations with both read and write access (Read And Write Access is enabled). For a timing diagram, see <a href="#">Write Before Read, on page 301</a> .
No Read on Write	Specifies that no read operation takes place when there is a write operation for port configurations with both read and write access (Read And Write Access is enabled). For a timing diagram, see <a href="#">No Read on Write, on page 302</a> .

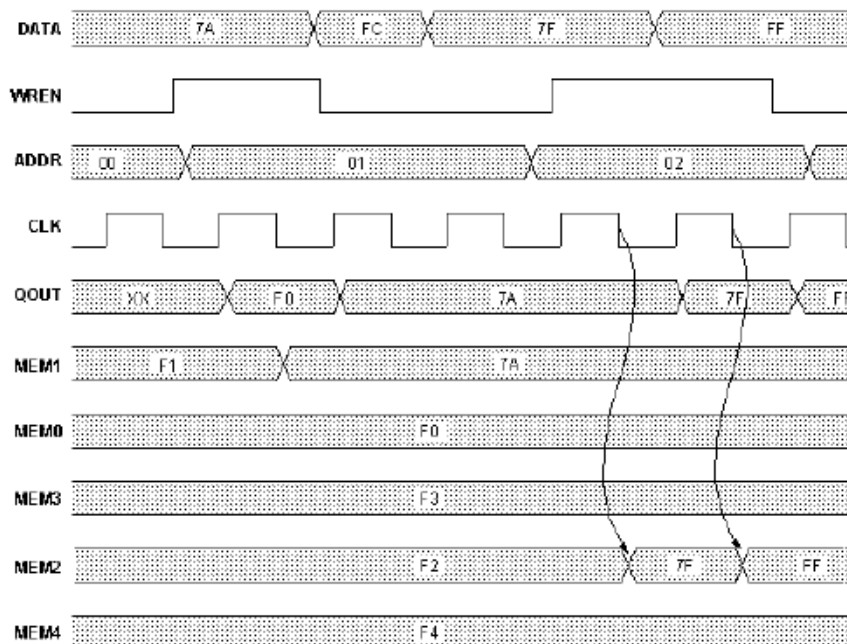
## Single-Port Memories

For single-port RAM, it is only necessary to configure Port A. The following diagrams show the read-write timing for single-port memories. See [Specifying RAMs with SYNCore, on page 281](#) for a procedure.

## Single-Port Read



## Single-Port Write



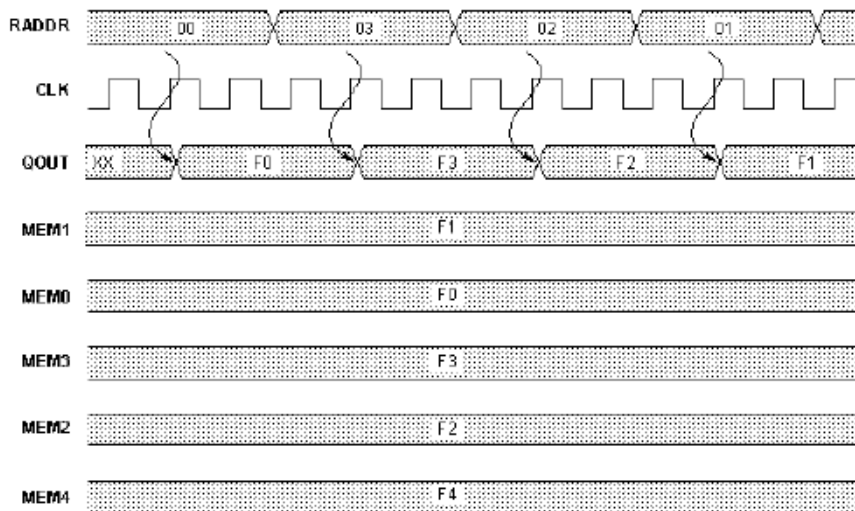
## Dual-Port Memories

SYNCore dual-port memory includes the following common configurations:

- One read access and one write access
- Two read accesses and one write access
- Two read accesses and two write accesses

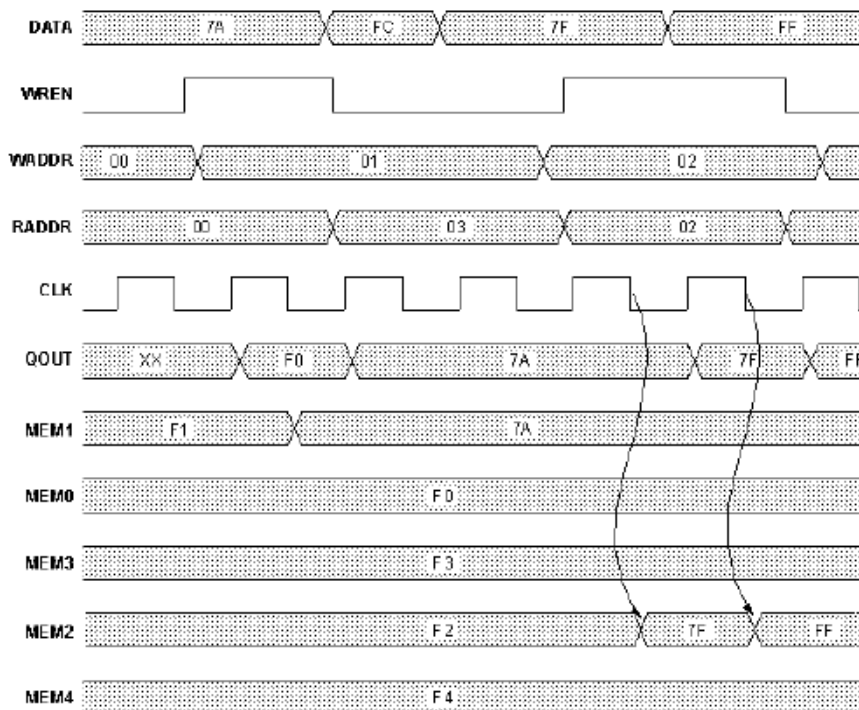
The following diagrams show the read-write timing for dual-port memories. See [Specifying RAMs with SYNCore, on page 281](#) for a procedure to specify a dual-port RAM with SYNCore.

## Dual-Port Single Read

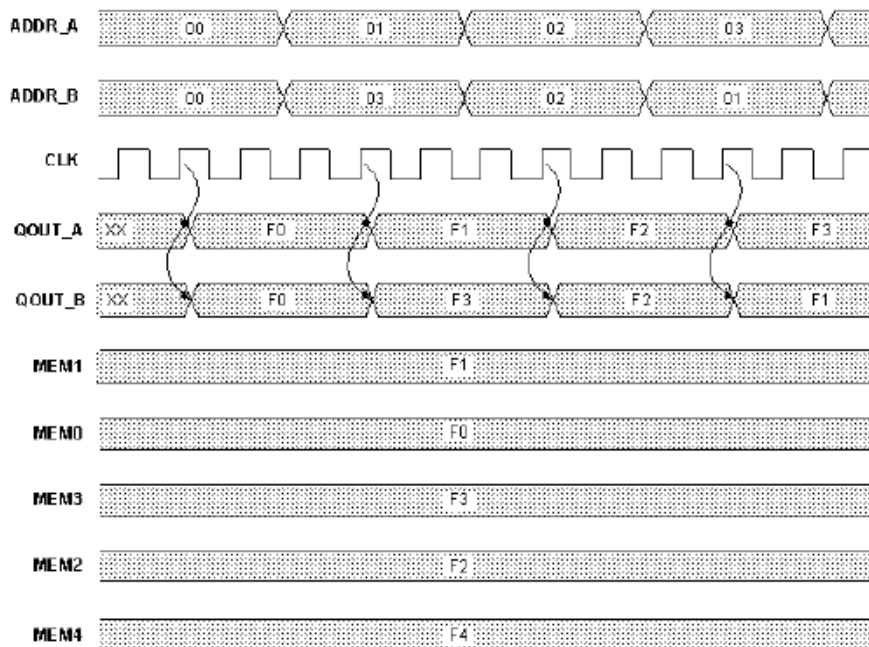




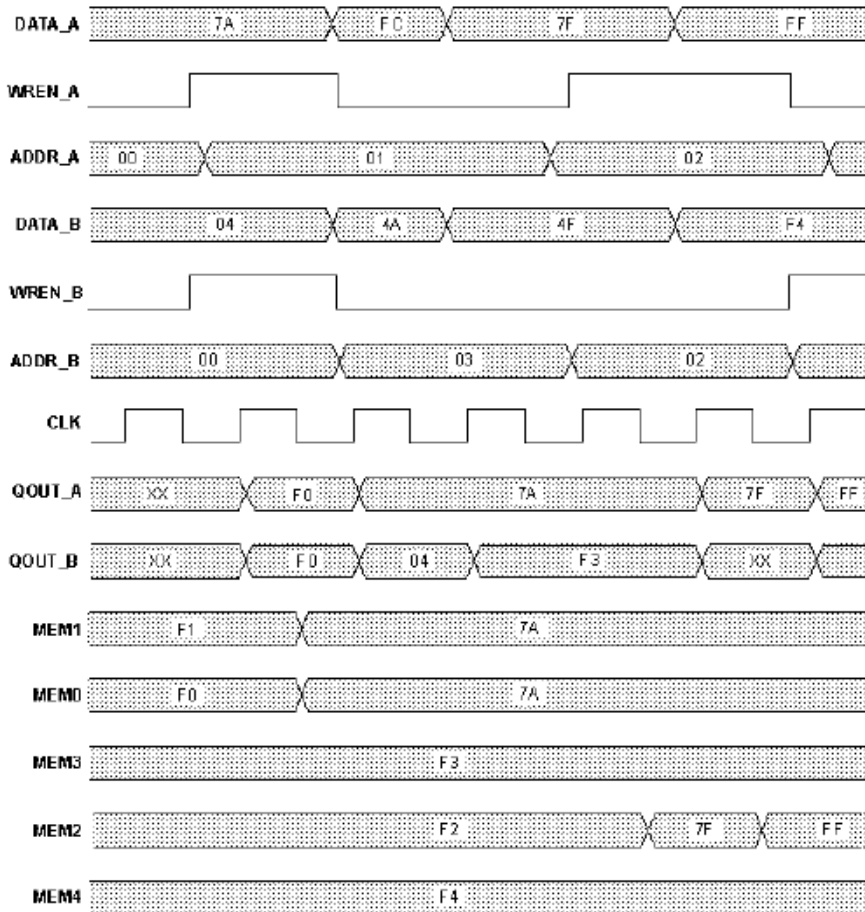
## Dual-Port Single Write



## Dual-Port Read



## Dual-Port Write



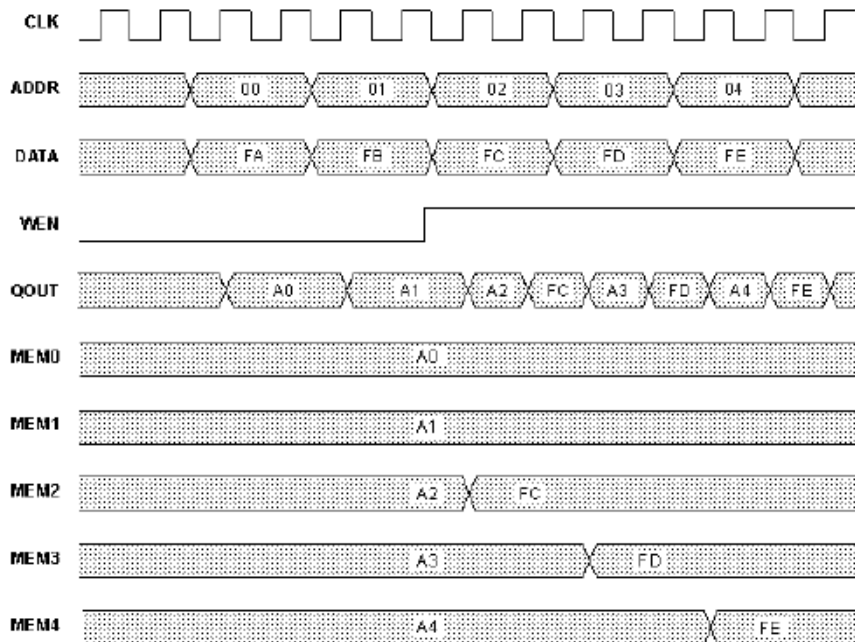
## Read/Write Timing Sequences

The waveforms in this section describe the behavior of the RAM when both read and write are enabled and the address is the same operation. The waveforms show the behavior when each of the read-write sequences is enabled. The waveforms are merged with the simple waveforms shown in the previous sections. See the following:

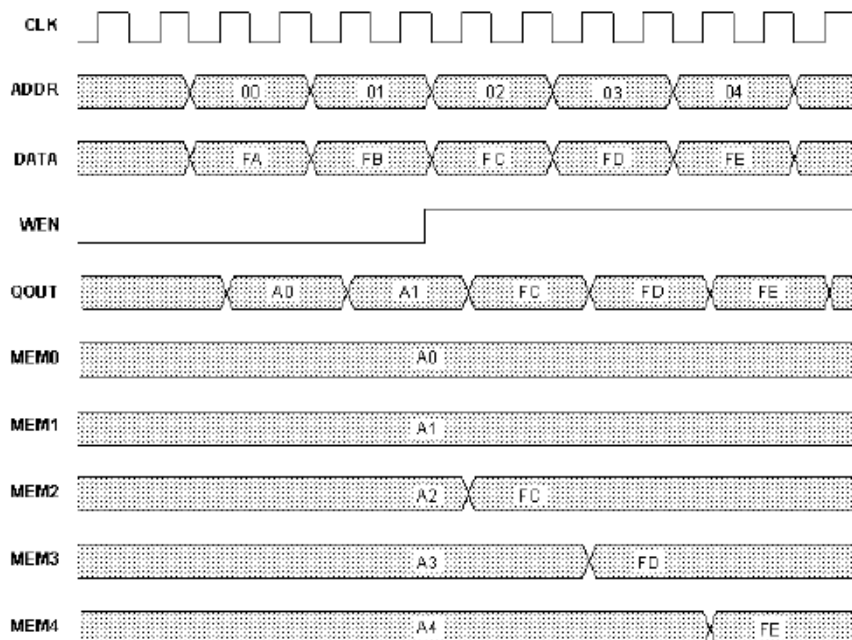
- [Read Before Write](#), on page 300

- [Write Before Read](#), on page 301
- [No Read on Write](#), on page 302

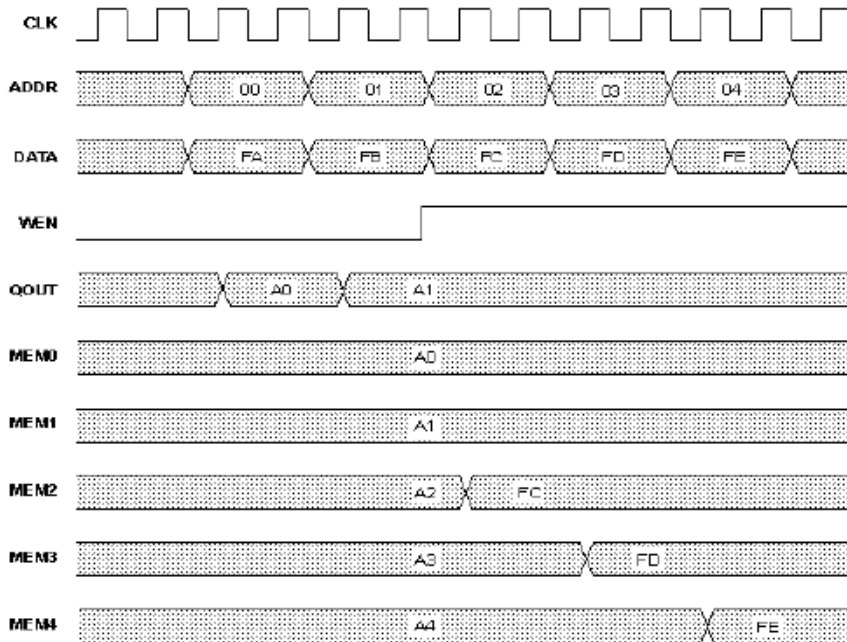
## Read Before Write



## Write Before Read



## No Read on Write



# SYNCore Byte-Enable RAM Compiler

The SYNCore byte-enable RAM compiler generates SystemVerilog code describing byte-enabled RAMs. The data width of each byte is calculated by dividing the total data width by the write enable width. The byte-enable RAM compiler supports both single- and dual-port configurations.

This section describes the following:

- [Functional Overview](#), on page 303
- [Specifying Byte-Enable RAMs with SYNCore](#), on page 304
- [SYNCore Byte-Enable RAM Wizard](#), on page 311
- [Read/Write Timing Sequences](#), on page 314
- [Parameter List](#), on page 317

## Functional Overview

The SYNCore byte-enable RAM component supports bit/byte-enable RAM implementations using block RAM and distributed memory. For each configuration, design optimizations are made for optimum use of core resources. The timing diagrams that follow illustrate the supported signals for byte-enable RAM configurations.

Byte-enable RAM can be configured in both single- and dual-port configurations. In the dual-port configuration, each port is controlled by different clock, enable, and control signals. User configuration controls include selecting the enable level, reset type, and register type for the read data outputs and address inputs.

Reset applies only to the output read data registers; default value of read data on reset can be changed by user while generating core. Reset option is inactive when output read data is not registered.

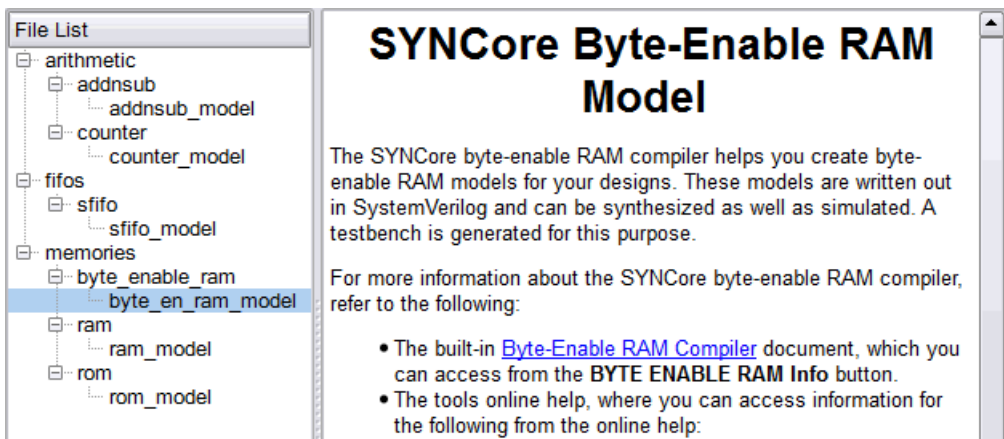
## Specifying Byte-Enable RAMs with SYNCore

The SYNCore IP wizard helps you generate SystemVerilog code for your byte-enable RAM implementation requirements. The following procedure shows you how to generate SystemVerilog code for a byte-enable RAM using the SYNCore IP wizard.

**Note:** The SYNCore byte-enable RAM model uses SystemVerilog. When adding a byte-enable RAM to your design, be sure to enable the System Verilog check box on the Verilog tab of the Implementation Options dialog box or include a `set_option -vlog_std sysv` statement in your project file to prevent a syntax error.

### 1. Start the wizard.

- From the FPGA synthesis tool GUI, select Run->Launch SYNCore or click the Launch SYNCore icon  to start the SYNCore IP wizard.



- In the window that opens, select `byte_en_ram_model` and click Ok to open the first page (page1) of the wizard.



2. Specify the parameters you need in the wizard. For details about the parameters, see [Specifying Byte-Enable RAM Parameters, on page 308](#). The BYTE ENABLE RAM symbol on the left reflects any parameters you set.
3. After you have specified all the parameters you need, click the **Generate** button in the lower left corner. The tool displays a confirmation message (TCL execution successful!) and writes the required files to the directory you specified on page 1 of the wizard. The HDL code is in SystemVerilog.  
  
SYNCore also generates a test bench for the byte-enable RAM component. The test bench covers a limited set of vectors. You can now close the SYNCore byte-enable RAM compiler.
4. Edit the generated files for the byte-enable RAM component if necessary.
5. Add the byte-enable RAM that you generated to your design.

- On the Verilog tab of the Implementation Options dialog box, make sure that SystemVerilog is enabled.
- Use the Add File command to add the Verilog design file that was generated (the filename entered on page 1 of the wizard) and the `syncore_*.v` file to your project. These files are in the directory for output files that you specified on page 1 of the wizard.
- Use a text editor to open the `instantiation_file.vin` template file. This file is located in the same output files directory. Copy the lines that define the byte-enable RAM and paste them into your top-level module.
- Edit the template port connections so that they agree with the port definitions in the top-level module; also change the instantiation name to agree with the component name entered on page 1. The following figure shows a template file inserted into a top-level module with the updated component name and port connections in red.

```

module top
  (input ClockA,
   input [3:0] AddA
   input [31:0] DataIn
   input WrEnA,
   input Reset
   output [31:0] DataOut
  )|

  INST_TAG

  SP_RAM #
    (.ADD_WIDTH(4),
     .WE_WIDTH(2),
     .RADDR_LTNCY_A(1), // 0 - No Latency, 1 - 1 Cycle Latency
     .RDATA_LTNCY_A(1), // 0 - No Latency, 1 - 1 Cycle Latency
     .RST_TYPE_A(1), // 0 - No Reset, 1 synchronous
     .RST_RDATA_A({32{1'b1}}),
     .DATA_WIDTH(32)
    )

  4x32spram
    (// Output Ports
     .RdDataA(DataIn),
     // Input Ports
     .WrDataA(DataOut),
     .WenA(WrEnA),
     .AddrA(AddA),
     .ResetA(Reset),
     .ClkA(ClockA)
    );

```

## Port List

Port A interface signals are applicable for both single-port and dual-port configurations; Port B signals are applicable for dual-port configuration only.

Name	Type	Description
ClkA	Input	Clock input for Port A
WenA	Input	Write enable for Port A; present when Port A is in write mode
AddrA	Input	Memory access address for Port A

ResetA	Input	Reset for memory and all registers in core; present with registered read data when Reset is enabled; active low (cannot be changed)
WrDataA	Input	Write data to memory for Port A; present when Port A is in write mode
RdDataA	Output	Read data output for Port A; present when Port A is in read or read/write mode
ClkB	Input	Clock input for Port B; present in dual-port mode
WenB	Input	Write enable for Port B; present in dual-port mode when Port B is in write mode
AddrB	Input	Memory access address for Port B; present in dual-port mode
ResetB	Input	Reset for memory and all registers in core; present in dual-port mode when read data is registered and Reset is enabled; active low (cannot be changed)
WrDataB	Input	Write data to memory for Port B; present in dual-port mode when Port B is in write mode
RdDataB	Output	Read data output for Port B; present in dual-port mode when Port B is in read or read/write mode

## Specifying Byte-Enable RAM Parameters

When creating a single-port, byte-enable RAM with the SYNCore IP wizard, you must specify a single read address and a single clock; you only need to configure the Port A parameters on page 2 of the wizard.

When creating a dual-port, byte-enable RAM, you must additionally configure the Port B parameters on page 3 of the wizard.

The following procedure lists the parameters you need to specify. For descriptions of each parameter, refer to [Parameter List, on page 317](#).

1. Start the SYNCore byte-enable RAM wizard as described in [Specifying Byte-Enable RAMs with SYNCore, on page 304](#).

2. Do the following on page 1 of the byte-enable RAM wizard:

- Specify a name for the memory in the Component Name field; do not use spaces.
- Specify a directory name in the Directory field where you want the output files to be written; do not use spaces.
- Specify a name in the File Name field for the SystemVerilog file to be generated with the byte-enable RAM specifications; do not use spaces.
- Enter a value for the address width of the byte-enable RAM; the maximum depth of memory is limited to  $2^{256}$ .
- Enter a value for the data width for the byte-enable RAM; data width values range from 2 to 256.
- Enter a value for the write enable width; write-enable width values range from 1 to 4.
- Select Single Port to generate a single-port, byte-enable RAM or select Dual Port to generate a dual-port, byte-enable RAM.
- Click Next to open page 2 of the wizard.

The Byte Enable RAM symbol dynamically updates to reflect the parameters that you set.

3. Do the following on page 2 (configuring Port A) of the wizard:
  - Select the Port A configuration. Only Read and Write Access mode is valid for single-port configurations; this mode is selected by default.
  - Set Pipelining Address Bus and Output Data according to your application. By default, read data is registered; you can register both the address and data registers.
  - Set the Configure Reset Options. Enabling the checkbox enables the synchronous reset for read data. This option is enabled only when the read data is registered. Reset is active low and cannot be changed.
  - Configure output reset data value options under Specify output data on reset; reset data can be set to default value of all '1' s or to a user-defined decimal value. Reset data value options are disabled when the reset is not enabled for Port A.
  - Set Write Enable for Port A value; default for the write-enable level is active high.
4. If you are generating a dual-port, byte-enable RAM, set the Port B parameters on page 3 (note that the Port B parameters are only enabled when Dual Port is selected on page 1).

The Port B parameters are identical to the Port A parameters on page 2. When using the dual-port configuration, when one port is configured for read access, the other port can only be configured for read/write access or write access.

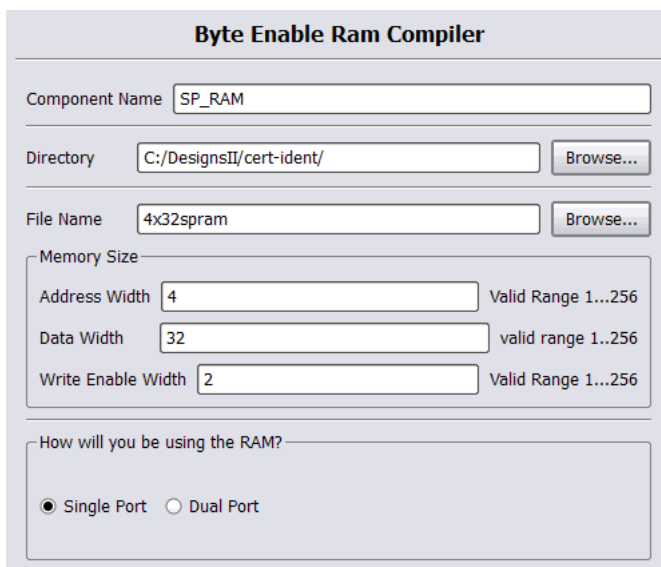
5. Generate the byte-enable RAM by clicking Generate. Add the file to your project and edit the template file as described in [Specifying Byte-Enable RAMs with SYNCore, on page 304](#). For read/write timing diagrams, see [Read/Write Timing Sequences, on page 299](#).

## SYNCore Byte-Enable RAM Wizard

The following describes the parameters you can set in the byte-enable RAM wizard, which opens when you select `byte_en_ram`.

- [SYNCore Byte-Enable RAM Parameters Page 1](#), on page 311
- [SYNCore Byte-Enable RAM Parameters Pages 2 and 3](#), on page 312

### SYNCore Byte-Enable RAM Parameters Page 1



**Byte Enable Ram Compiler**

Component Name

Directory

File Name

Memory Size

Address Width  Valid Range 1...256

Data Width  valid range 1..256

Write Enable Width  Valid Range 1...256

How will you be using the RAM?

☒ Single Port ☐ Dual Port

Component Name	Specifies the name of the component. This is the name that you instantiate in your design file to create an instance of the SYNCore byte-enable RAM in your design. Do not use spaces.
Directory	<p>Specifies the directory where the generated files are stored. Do not use spaces. The following files are created:</p> <ul style="list-style-type: none"> <li>• <code>filelist.txt</code> - lists files written out by SYNCore</li> <li>• <code>options.txt</code> - lists the options selected in SYNCore</li> <li>• <code>readme.txt</code> - contains a brief description and known issues</li> <li>• <code>syncore_be_ram_sdp.v</code> - SystemVerilog library file required to generate single or simple dual-port, byte-enable RAM model</li> <li>• <code>syncore_be_ram_tdp.v</code> - SystemVerilog library file required to generate true dual-port byte-enable RAM model</li> <li>• <code>testbench.v</code> - Verilog testbench file for testing the byte-enable RAM model</li> <li>• <code>instantiation_file.vin</code> - describes how to instantiate the wrapper file</li> <li>• <code>component.v</code> - Byte-enable RAM model wrapper file generated by SYNCore</li> </ul> <p>Note that running the byte-enable RAM wizard in the same directory overwrites the existing files.</p>
Filename	Specifies the name of the generated file containing the HDL description of the compiled byte-enable RAM. Do not use spaces.
Address Width	Specifies the address depth for Ports A and B. The unit used is the number of bits; the default is 2.
Data Width	Specifies the width of the data for Ports A and B. The unit used is the number of bits; the default is 2.
Write Enable Width	Specifies the write enable width for Ports A and B. The unit used is the number of byte enables; the default is 2, the maximum is 4.
Single Port	When enabled, generates a single-port, byte-enable RAM (automatically enables single clock).
Dual Port	When enabled, generates a dual-port, byte-enable RAM (automatically enables separate clocks for each port).

## SYNCore Byte-Enable RAM Parameters Pages 2 and 3

The port implementation parameters on pages 2 and 3 are identical, but page 2 applies to Port A (single- and dual-port configurations), and page 3 applies to Port B (dual-port configurations only). The following figure shows the parameters on page 2 for Port A.



### Byte Enable Ram Compiler

---

**Configuring Port A**

---

How do you want to configure Port A

☒ Read And Write Access
 ☐ Read Only Access
 ☐ Write Only Access

---

Pipelining Address Bus and Output Data

☒ Register address bus AddrA  
☒ Register output data bus RdDataA

---

Configure Reset Options

☒ Reset for RdDataA

---

Specify output data on reset

☒ Default value of '1' for all bits  
☐ Specify Reset value for RdDataA  Valid Range 0...2<sup>DATA\_WIDTH</sup>

---

Configure Write Enable Options

☒ Write Enable for PORTA  
☒ Active High
 ☐ Active Low

Read and Write Access	Specifies that the port can be accessed by both read and write operations (only mode allowed for single-port configurations).
Read Only Access	Specifies that the port can only be accessed by read operations (dual-port mode only).
Write Only Access	Specifies that the port can only be accessed by write operations (dual-port mode only).
Register address bus AddrA/B	Adds registers to the read address lines.
Register output data bus RdDataA/B	Adds registers to the read data lines. By default, the read data register is enabled.

Reset for RdDataA/B	Specifies the reset type for registered read data: <ul style="list-style-type: none"> <li>Reset type is synchronous when Reset for RdDataA/B is enabled</li> <li>Reset type is no reset when Reset for RdDataA/B is disabled</li> </ul>
Specify output data on reset	Specifies reset value for registered read data (applies only when RdDataA/B is enabled): <ul style="list-style-type: none"> <li>Default value of '1' for all bits - sets read data to all 1's on reset</li> <li>Specify Reset value for RdDataA/B - specifies reset value for read data; when enabled, value is entered in adjacent field</li> </ul>
Write Enable for Port A/B	Specifies the write enable level for Port A/B. Default is Active High.

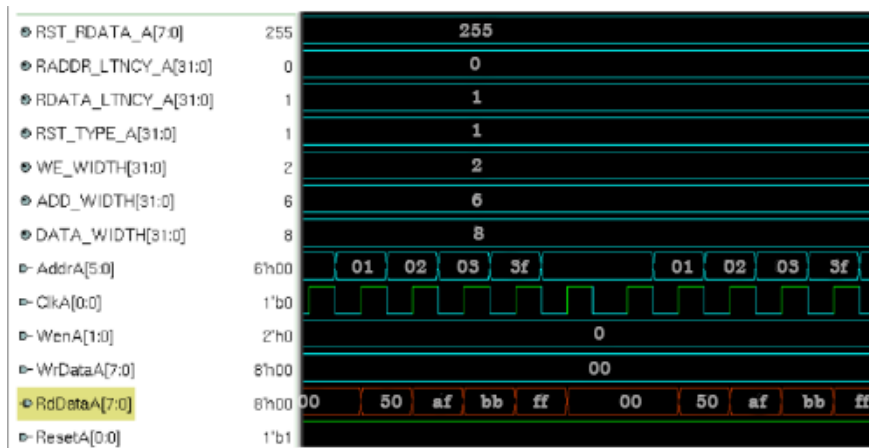
## Read/Write Timing Sequences

The waveforms in this section describe the behavior of the byte-enable RAM for both read and write operations.

### Read Operation

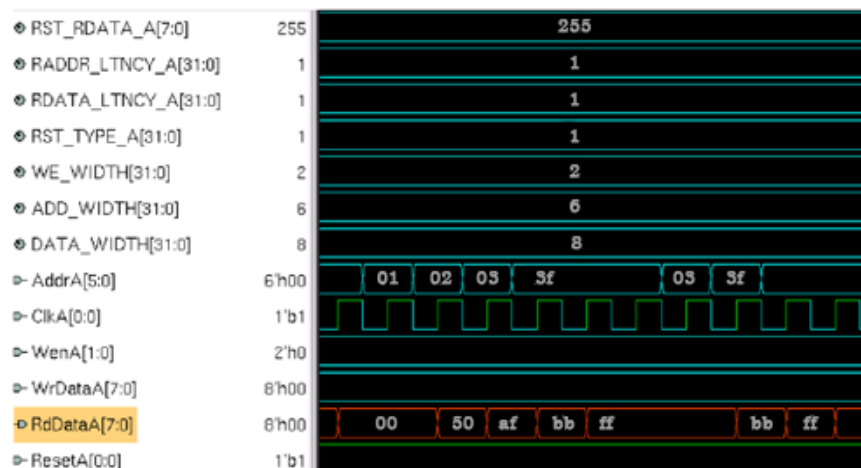
On each active edge of the clock when there is a change in address, data is valid on the same clock or next clock (depending on latency parameter values for read address and read data ports). Active reset ignores any change in input address, and data and output data are initialized to user-defined values set by parameters RST\_RDATA\_A and RST\_RDATA\_B for port A and port B, respectively.

The following waveform shows the read sequence of the byte-enable RAM component with read data registered in single-port mode.



As shown in the above waveform, output read data changes on the same clock following the input address changed. When the address changes from 'h00 to 'h01, read data changes to 50 on the same clock, and data will be valid on the next clock edge.

The following waveform shows the read sequence with both the read data and address registered in single-port mode.



As shown in the above waveform, output read data changes on the next clock edge after the input address changes. When the address changes from 'h00 to 'h01, read data changes to 50 on the next clock, and data is valid on the next clock edge.

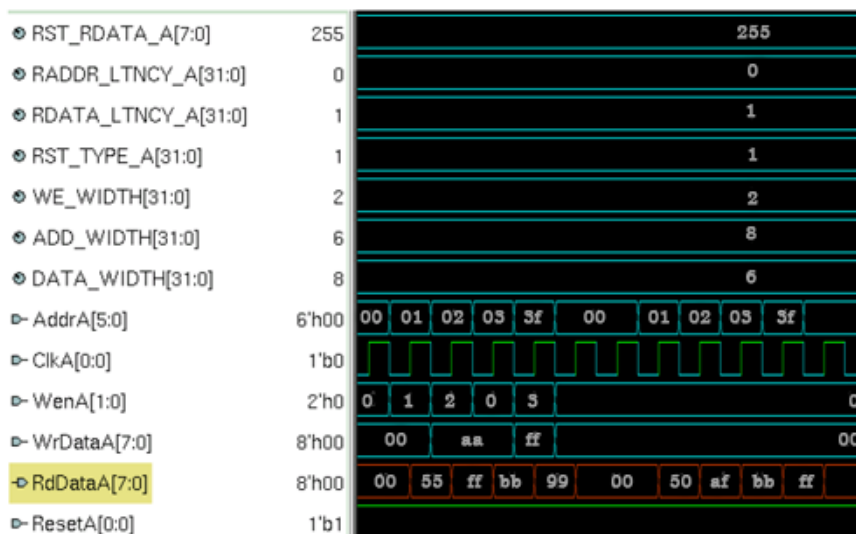
---

**Note:** The read sequence for dual-port mode is the same as single port; read/write conflicts occurring due to accessing the same location from both ports are the user's responsibility.

---

## Write Operation

The following waveform shows a write sequence with read-after write in single-port mode.



On each active edge of the clock when there is a change in address with an active enable, data is written into memory on the same clock. When enable is not active, any change in address or data is ignored. Active reset ignores any change in input address and data.

The width of the write enable is controlled by the WE\_WIDTH parameter. Input data is symmetrically divided and controlled by each write enable. For example, with a data width of 32 and a write enable width of 4, each bit of the write enable controls 8 bits of data ( $32/4=8$ ). The byte-enable RAM compiler will error for wrong combination data width and write enable values.

The above waveform shows a write sequence with all possible values for write enable followed by a read:

- Value for parameter WE\_WIDTH is 2 and DATA\_WIDTH is 8 so each write enable controls 4 bits of input data.
- WenA value changes from 1 to 2, 2 to 0, and 0 to 3 which toggles all possible combinations of write enable.

The first sequence of address, write enable changes to perform a write sequence and the data patterns written to memory are 00, aa, ff. The read data pattern reflects the current content of memory before the write.

The second address sequence is a read (WenA is always zero). As shown in the read pattern, only the respective bits of data are written according to the write enable value.

---

**Note:** The write sequence for dual-port mode is the same as single port; conflicts occurring due to writing the same location from both ports are the user's responsibility.

---

## Parameter List

The following table lists the file entries corresponding to the byte-enable RAM wizard parameters.

Name	Description	Default Value	Range
ADDR_WIDTH	Bit/byte enable RAM address width	2	multiples of 2
DATA_WIDTH	Data width for input and output data, common to both Port A and Port B	8	2 to 256

WE_WIDTH	Write enable width, common to both Port A and Port B	2	
CONFIG_PORT	Selects single/dual port configuration	1 (single port)	0 = dual-port 1 = single-port
RST_TYPE_A/B	Port A/B reset type selection	1 (synchronous)	0 = no reset 1 = synchronous
RST_RDATA_A/B	Default data value for Port A/B on active reset	All 1's	decimal value
WEN_SENSE_A/B	Port A/B write enable sense	1 (active high)	0 = active low 1 = active high
RADDR_LTNCY_A/B	Optional read address register select Port A/B	1	0 = no latency 1 = one cycle latency
RDATA_LTNCY_A/B	Optional read data register select Port A/B	1	0 = no latency 1 = one cycle latency

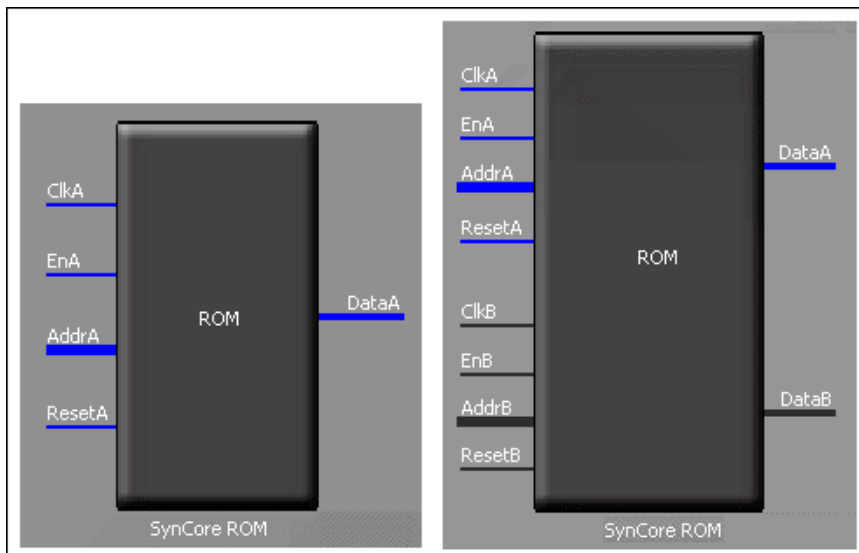
# SYNCore ROM Compiler

The SYNCore ROM Compiler generates Verilog code for your ROM implementation. This section describes the following:

- [Functional Overview](#), on page 319
- [Specifying ROMs with SYNCore](#), on page 321
- [SYNCore ROM Wizard](#), on page 326
- [Single-Port Read Operation](#), on page 330
- [Dual-Port Read Operation](#), on page 331
- [Parameter List](#), on page 331

## Functional Overview

The SYNCore ROM component supports ROM implementations using block ROM or logic memory. For each configuration, design optimizations are made for optimum usage of core resources. Both single- and dual-port memory configurations are supported. Single-port ROM allows read access to memory through a single port, and dual-port ROM allows read access to memory through two ports. The following figure illustrates the supported signals for both configurations.



In the single-port (Port A) configuration, signals are synchronized to ClkA; ResetA can be synchronous or asynchronous depending on parameter selection. The read address (AddrA) and/or data output (DataA) can be registered to increase memory performance and improve timing. In the dual-port configuration, all Port A signals are synchronized to ClkA, and all PortB signals are synchronized to ClkB. ResetA and ResetB can be synchronous or asynchronous depending on parameter selection, and both data outputs can be registered and are subject to the same clock latencies. Registering the data output is recommended.

---

**Note:** When the data output is unregistered, the data is immediately set to its predefined reset value concurrent with an active reset signal.

---



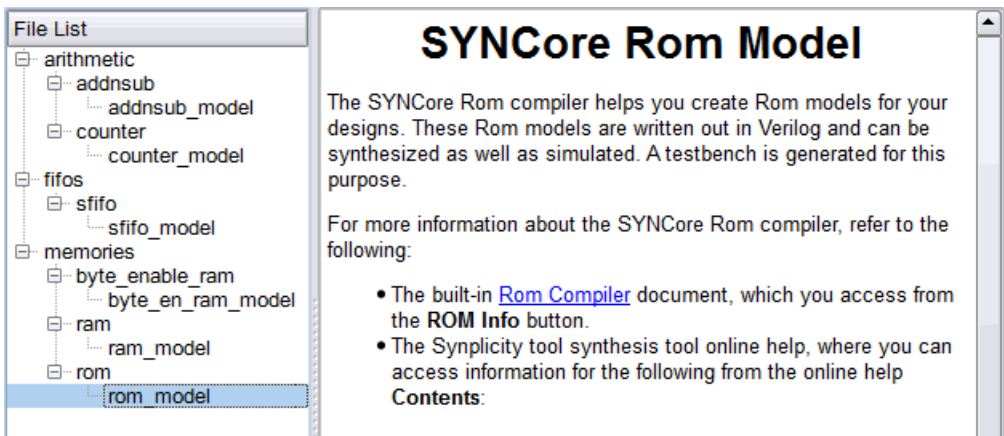
## Specifying ROMs with SYNCore

The SYNCore IP wizard helps you generate Verilog code for your ROM implementation requirements. The following procedure shows you how to generate Verilog code for a ROM using the SYNCore IP wizard.

**Note:** The SYNCore ROM model uses Verilog 2001. When adding a ROM model to a Verilog-95 design, be sure to enable the Verilog 2001 check box on the Verilog tab of the Implementation Options dialog box or include a `set_option -vlog_std v2001` statement in your project file to prevent a syntax error.

### 1. Start the wizard.

- From the FPGA synthesis tool GUI, select Run->Launch SYNCore or click the Launch SYNCore icon  to start the SYNCore IP wizard.



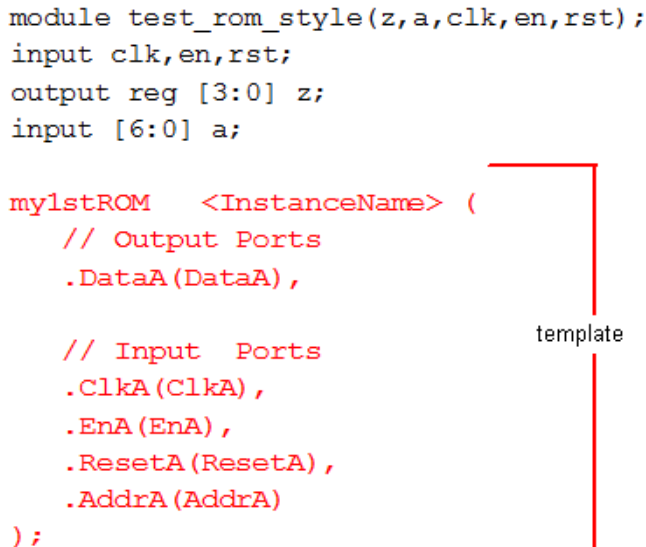
- In the window that opens, select `rom_model` and click Ok to open page 1 of the wizard.

2. Specify the parameters you need in the wizard. For details about the parameters, see [Specifying ROM Parameters, on page 325](#). The ROM symbol on the left reflects any parameters you set.
3. After you have specified all the parameters you need, click the Generate button in the lower left corner. The tool displays a confirmation message (TCL execution successful!) and writes the required files to the directory you specified on page 1 of the wizard. The HDL code is in Verilog.

SYNCore also generates a testbench for the ROM. The testbench covers a limited set of vectors.

You can now close the SYNCore ROM Compiler.

4. Edit the ROM files if necessary. If you want to use the synchronous ROMs available in the target technology, make sure to register either the read address or the outputs.
5. Add the ROM you generated to your design.
  - Use the Add File command to add the Verilog design file that was generated and the `syncore_rom.v` file to your project. These files are in the directory for output files that you specified on page 1 of the wizard.
  - Use a text editor to open the `instantiation_file.vin` template file. This file is located in the same output files directory. Copy the lines that define the ROM, and paste them into your top-level module. The following figure shows a template file (in red text) inserted into a top-level module.



```

module test_rom_style(z,a,clk,en,rst);
input clk,en,rst;
output reg [3:0] z;
input [6:0] a;

my1stROM <InstanceName> (
    // Output Ports
    .DataA(DataA),

    // Input Ports
    .ClkA(ClkA),
    .EnA(EnA),
    .ResetA(ResetA),
    .AddrA(AddrA)
);
  
```

6. Edit the template port connections so that they agree with the port definitions in your top-level module as shown in the example below (the updated connection names are shown in red). You can also assign a unique name to each instantiation.

```

module test_rom_style(z,a,clk,en,rst);
input clk,en,rst;
output reg [3:0] z;
input [6:0] a;

my1stROM decode_rom(
    // Output Ports
    .DataA(z),

    // Input Ports
    .ClkA(clk),
    .EnA(en),
    .ResetA(rst),
    .AddrA(a)
);

```

## Port List

PortA interface signals are applicable for both single-port and dual-port configurations; PortB signals are applicable for dual-port configuration only.

Name	Type	Description
ClkA	Input	Clock input for Port A
EnA	Input	Enable input for Port A
AddrA	Input	Read address for Port A
ResetA	Input	Reset or interface disable pin for Port A
DataA	Output	Read data output for Port A
ClkB	Input	Clock input for Port B
EnB	Input	Enable input for Port B
AddrB	Input	Read address for Port B
ResetB	Input	Reset or interface disable pin for Port B
DataB	Output	Read data output for Port B

## Specifying ROM Parameters

If you are creating a single-port ROM with the SYNCore IP wizard, you need to specify a single read address and a single clock, and you only need to configure the Port A parameters on page 2. If you are creating a dual-port ROM, you must additionally configure the Port B parameters on page 3. The following procedure lists what you need to specify. For descriptions of each parameter, refer to [SYNCore RAM Wizard, on page 289](#).

1. Start the SYNCore ROM wizard, as described in [Specifying ROMs with SYNCore, on page 321](#).
2. Do the following on page 1 of the ROM wizard:
  - In Component Name, specify a name for the memory. Do not use spaces.
  - In Directory, specify a directory where you want the output files to be written. Do not use spaces.
  - In Filename, specify a name for the Verilog file that will be generated with the ROM specifications. Do not use spaces.
  - Enter values for Read Data width and ROM address width (minimum depth value is 2; maximum depth of the memory is limited to  $2^{256}$ ).
  - Select Single Port Rom to indicate that you want to generate a single-port ROM or select Dual Port Rom to generate a dual-port ROM.
  - Click Next. The wizard opens page 2 where you set parameters for Port A.

The ROM symbol dynamically updates to reflect any parameters you set.

3. Do the following on page 2 (Configuring Port A) of the RAM wizard:
  - For synchronous ROMs, select Register address bus AddrA and/or Register output data bus DataA to register the read address and/or the outputs. Selecting either checkbox enables the Enable for Port A checkbox which is used to select the Enable level.
  - Set the Configure Reset Options. Enabling the checkbox enables the type of reset (asynchronous or synchronous) and allows an output data pattern (all 1's or a specified pattern) to be defined on page 4.
4. If you are generating a dual-port ROM, set the port B parameters on page 3 (the page 3 parameters are only enabled when Dual Port Rom is selected on page 1).

5. On page 4, specify the location of the ROM initialization file and the data format (Hexadecimal or Binary). ROM initialization is supported using memory-coefficient files. The data format is either binary or hexadecimal with each data entry on a new line in the memory-coefficient file (specified by parameter `INIT_FILE`). Supported file types are `txt`, `mem`, `dat`, and `init` (recommended).
6. Generate the ROM by clicking **Generate**, as described in [Specifying ROMs with SYNCore, on page 321](#) and add it to your design. All output files are in the directory you specified on page 1 of the wizard.

For read/write timing diagrams, see [Read/Write Timing Sequences, on page 299](#).

## SYNCore ROM Wizard

The following describe the parameters you can set in the ROM wizard, which opens when you select `rom_model`:

- [SYNCore ROM Parameters Page 1](#), on page 327
- [SYNCore ROM Parameters Pages 2 and 3](#), on page 328
- [SYNCore ROM Parameters Page 4](#), on page 330

## SYNCore ROM Parameters Page 1

Component Name:

Directory:

File Name:

ROM Size

Read Data width:  Valid Range 1..256

ROM address width:  Valid Range 2..256

Configuring the ROM

☒ Single Port Rom ☐ Dual Port Rom

Component Name	Specifies the name of the component. This is the name that you instantiate in your design file to create an instance of the SYNCore ROM in your design. Do not use spaces.
Directory	<p>Specifies the directory where the generated files are stored. Do not use spaces. The following files are created:</p> <p>filelist.txt - lists files written out by SYNCore</p> <p>options.txt - lists the options selected in SYNCore</p> <p>readme.txt - contains a brief description and known issues</p> <p>syncore_rom.v - Verilog library file required to generate ROM model</p> <p>testbench.v - Verilog testbench file for testing the ROM model</p> <p>instantiation_file.vin - describes how to instantiate the wrapper file</p> <p>component.v - ROM model wrapper file generated by SYNCore</p> <p>Note that running the ROM wizard in the same directory overwrites the existing files.</p>
File Name	Specifies the name of the generated file containing the HDL description of the compiled ROM. Do not use spaces.

Read Data Width	Specifies the read data width of the ROM. The unit used is the number of bits and ranges from 2 to 256. Default value is 8. The read data width is common to both Port A and Port B. The corresponding file parameter is DATA_WIDTH=n.
ROM address width	Specifies the address depth for the memory. The unit used is the number of bits. Default value is 10. The corresponding file parameter is ADD_WIDTH=n.
Single Port Rom	When enabled, generates a single-port ROM. The corresponding file parameter is CONFIG_PORT="single".
Dual Port Rom	When enabled, generates a dual-port ROM. The corresponding file parameter is CONFIG_PORT="dual".

## SYNCore ROM Parameters Pages 2 and 3

The port implementation parameters on pages 2 and 3 are the same; page 2 applies to Port A (single- and dual-port configurations), and page 3 applies to Port B (dual-port configurations only).

Configuring Port A

Pipelining Address Bus and Output Data

☐ Register address bus AddrA

☒ Register output data bus DataA

Configure Reset Options

☒ Reset for PORTA

☒ Asynchronous Reset ☐ Synchronous Reset

Configure Enable

☒ Enable for PORTA

☒ Active High Enable ☐ Active Low Enable

Specify output data on reset

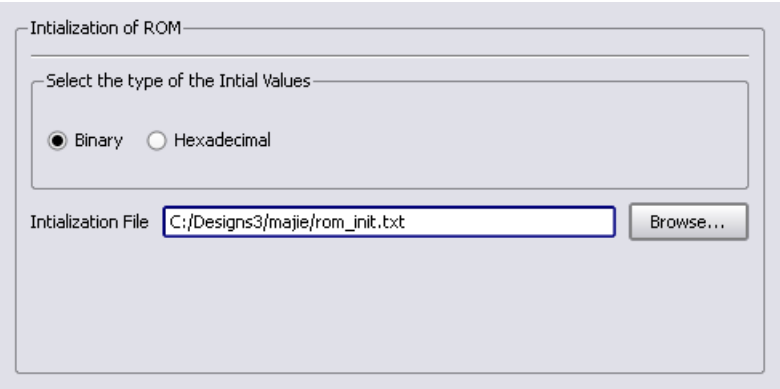
☒ Default value of '1' for all bits

☐ Specify reset value for DataA  Valid Range 0...2<sup>DATA\_WIDTH</sup>



Register address bus AddrA	Used with synchronous ROM configurations to register the read address. When checked, also allows chip enable to be configured.
Register output data bus DataA	Used with synchronous ROM configurations to register the data outputs. When checked, also allows chip enable to be configured.
Asynchronous Reset	Sets the type of reset to asynchronous (Configure Reset Options must be checked). Configuring reset also allows the output data pattern on reset to be defined. The corresponding file parameter is RST_TYPE_A=1/RST_TYPE_B=1.
Synchronous Reset	Sets the type of reset to synchronous (Configure Reset Options must be checked). Configuring reset also allows the output data pattern on reset to be defined. The corresponding file parameter is RST_TYPE_A=0/RST_TYPE_B=0.
Active High Enable	Sets the level of the chip enable to high for synchronous ROM configurations. The corresponding file parameter is EN_SENSE_A=1/EN_SENSE_B=1.
Active Low Enable	Sets the level of the chip enable to low for synchronous ROM configurations. The corresponding file parameter is EN_SENSE_A=0/EN_SENSE_B=0.
Default value of '1' for all bits	Specifies an output data pattern of all 1's on reset. The corresponding file parameter is RST_DATA_A={n{1'b1} }/RST_DATA_B={n{1'b1} }.
Specify reset value for DataA/DataB	Specifies a user-defined output data pattern on reset. The pattern is defined in the adjacent field. The corresponding file parameter is RST_TYPE_A=pattern/RST_TYPE_B=pattern.

SYNCore ROM Parameters Page 4

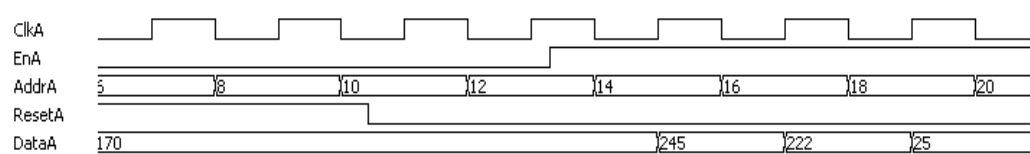


Binary	Specifies binary-formatted initialization file.
Hexadecimal	Specifies hexadecimal-formatted initial file.
Initialization File	Specifies path and filename of initialization file. The corresponding file parameter is INIT_FILE="filename".

Single-Port Read Operation

For single-port ROM, it is only necessary to configure Port A (see [Specifying ROMs with SYNCore, on page 321](#)). The following diagram shows the read timing for a single-port ROM.

On every active edge of the clock when there is a change in address with an active enable, data will be valid on the same clock or next clock (depending on latency parameter values). When enable is inactive, any address change is ignored, and the data port maintains the last active read value. An active reset ignores any change in input address and forces the output data to its predefined initialization value. The following waveform shows the functional behavior of control signals in single-port mode.

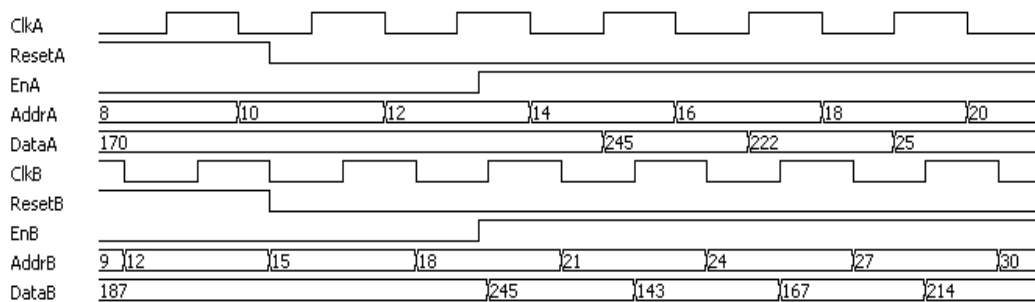


When reset is active, the output data holds the initialization value (i.e., 255). When reset goes inactive (and enable is active), data is read form the addressed location of ROM. Reset has priority over enable and always sets the output to the predefined initialization value. When both enable and reset are inactive, the output holds its previous read value.

**Note:** In the above timing diagram, reset is synchronous.

## Dual-Port Read Operation

Dual-port ROMs allow read access to memory through two ports. For dual-port ROM, both port A and port B must be configured (see [Specifying ROMs with SYNCore, on page 321](#)). The following diagram shows the read timing for a dual-port ROM.



When either reset is active, the corresponding output data holds the initialization value (i.e., 255). When a reset goes inactive (and its enable is active), data is read form the addressed location of ROM. Reset has priority over enable and always sets the output to the predefined initialization value. When both enable and reset are inactive, the output holds its previous read value.

**Note:** In the above timing diagram, reset is synchronous.

## Parameter List

The following table lists the file entries corresponding to the ROM wizard parameters.

Name	Description	Default Value	Range
ADD_WIDTH	ROM address width value. Default value is 10	10	--
DATA_WIDTH	Read Data width, common to both Port A and Port B	8	2 to 256
CONFIG_PORT	Parameter to select Single/Dual configuration	dual (Dual Port)	dual (Dual), single (Single).
RST_TYPE_A	Port A reset type selection (synchronous, asynchronous)	1 - asynchronous	1(asyn), 0 (sync)
RST_TYPE_B	Port B reset type selection (synchronous, asynchronous)	1 - asynchronous	1 (asyn), 0 (sync)
RST_DATA_A	Default data value for Port A on active Reset	'1' for all data bits	0 - 2 <sup>DATA_WIDTH</sup> - 1
RST_DATA_B	Default data value for Port A on active Reset	'1' for all data bits	0 - 2 <sup>DATA_WIDTH</sup> - 1
EN_SENSE_A	Port A enable sense	1 - active high	0 - active low, 1- active high
EN_SENSE_B	Port B enable sense	1 - active high	0 - active low, 1- active high
ADDR_LTNCY_A	Optional address register select Port A	1- address registered	1(reg), 0(no reg)
ADDR_LTNCY_B	Optional address register select Port B	1- address registered	1(reg), 0(no reg)

DATA_LTNCY_A	Optional data register select Port A	1- data registered	1(reg), 0(no reg)
DATA_LTNCY_B	Optional data register select Port B	1- data registered	1(reg), 0(no reg)
INIT_FILE	Initial values file name	init.txt	--

# SYNCore Adder/Subtractor Compiler

The SYNCore adder/subtractor compiler generates Verilog code for a parametrizable, pipelined adder/subtractor. This section describes the functionality of this block in detail.

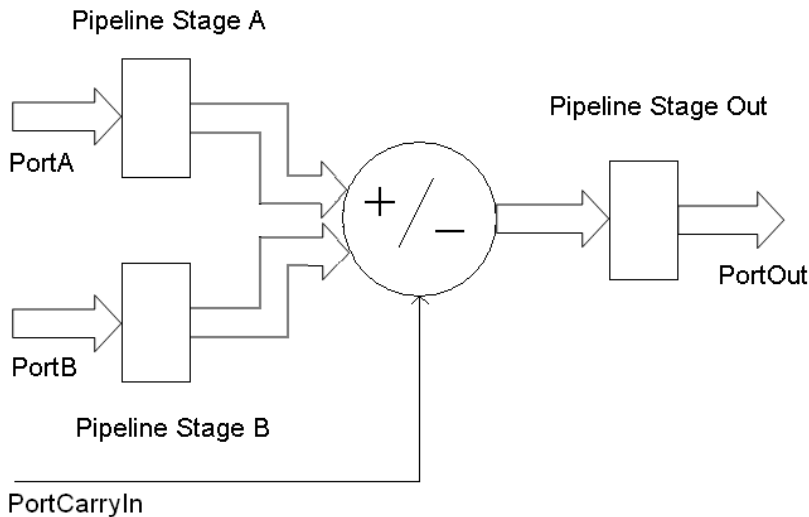
- [Functional Description](#), on page 334
- [Specifying Adder/Subtractors with SYNCore](#), on page 335
- [SYNCore Adder/Subtractor Wizard](#), on page 343
- [Adder](#), on page 346
- [Subtractor](#), on page 349
- [Dynamic Adder/Subtractor](#), on page 352

## Functional Description

The adder/subtractor has a single clock that controls the entire pipeline stages (if used) of the adder/subtractor.

As its name implies, this block just adds/subtracts the inputs and provides the output result. One of the inputs can be configured as a constant. The data inputs and outputs of the adder/subtractor can be pipelined; the pipeline stages can be 0 or 1, and can be configured individually. The individual pipeline stage registers include their own reset and enable ports.

The reset to all of the pipeline registers can be configured either as synchronous or asynchronous using the RESET\_TYPE parameter. The reset type of the pipeline registers cannot be configured individually.



SYNCore adder/subtractor has ADD\_N\_SUB parameter, which can take three values ADD, SUB, or DYNAMIC. Based on this parameter value, the adder/subtractor can be configured as follows.

- Adder
- Subtractor
- Dynamic Adder and Subtractor

## Specifying Adder/Subtractors with SYNCore

The SYNCore IP wizard helps you generate Verilog code for your adder/subtractor implementation requirements. The following procedure shows you how to generate Verilog code for an adder/subtractor using the SYNCore IP wizard.

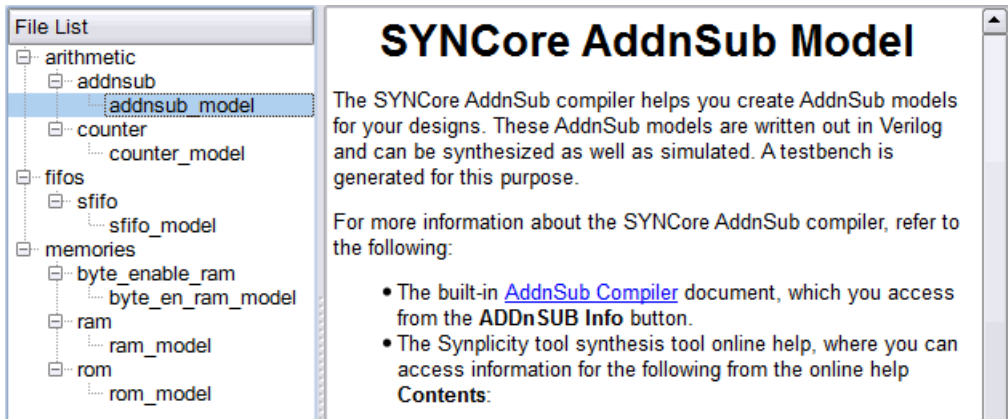
---

**Note:** The SYNCore adder/subtractor models use Verilog 2001. When adding an adder/subtractor model to a Verilog-95 design, be sure to enable the Verilog 2001 check box on the Verilog tab of the Implementation Options dialog box or include a `set_option -vlog_std v2001` statement in your project file to prevent a syntax error.

---

1. Start the wizard.

- From the FPGA synthesis tool GUI, select Run->Launch SYNCore or click the Launch SYNCore icon  to start the SYNCore IP wizard.



- In the window that opens, select addnsub\_model and click Ok to open page1 of the wizard.



2. Specify the parameters you need in the wizard. For details about the parameters, see [Specifying Adder/Subtractor Parameters, on page 341](#). The ADDnSUB symbol on the left reflects any parameters you set.
3. After you have specified all the parameters you need, click the Generate button in the lower left corner.

The tool displays a confirmation message (TCL execution successful!) and writes the required files to the directory you specified on page 1 of the wizard. The HDL code is in Verilog.

The SYNCore wizard also generates a testbench for your adder/subtractor. The testbench covers a limited set of vectors. You can now close the wizard.

4. Add the adder/subtractor you generated to your design.
  - Edit the adder/subtractor files if necessary.
  - Use the Add File command to add the Verilog design file that was generated and the `syncore_addnsub.v` file to your project. These files are in the directory for output files that you specified on page 1 of the wizard.
  - Use a text editor to open the `instantiation_file.v` template file. This file is located in the same output files directory. Copy the lines that define the adder/subtractor and paste them into your top-level module. The following figure shows a template file (in red text) inserted into a top-level module.

```

module top
    output [15:0] Out,
    input Clk,
    input [15:0] A,
    input CEA,
    input RSTA,
    input [15:0] B,
    input CEB,
    input RSTB,
    input CEOut,
    input RSTOut,
    input ADDnSUB,
    input CarryIn );

My_ADDnSUB <InstanceName> (
// Output Ports
.PortOut (PortOut),
// Input Ports
.PortClk (PortClk),
.PortA (PortA),
.PortCEA (PortCEA),
.PortRSTA (PortRSTA),
.PortB (PortB0),
.PortCEB (PortCEB),
.PortRSTBG (PortRSTB),
.PortCEOut (PortCEOut),
.PortRSTOut (PortRSTOut),
.PortADDnSUB (PortADDnSUB),
.PortCarryIn (PortCarryIn) );

endmodule

```

template

5. Edit the template port connections so that they agree with the port definitions in your top-level module as shown in the example below (the updated connection names are shown in red). You can also assign a unique name to each instantiation.

```

module top (
    output [15 : 0] Out,
    input Clk,
    input [15 : 0] A,
    input CEA,

```

```

    input RSTA,
    input [15 : 0] B,
    input CEB,
    input RSTB,
    input CEOut,
    input RSTOut,
    input ADDnSUB,
    input CarryIn);

My_ADDnSUB ADDnSUB_inst(
// Output Ports
    .PortOut(Out),
// Input Ports
    .PortClk(Clk),
    .PortA(A),
    .PortCEA(CEA),
    .PortRSTA(RSTA),
    .PortB(B),
    .PortCEB(CEB),
    .PortRSTB(RSTB),
    .PortCEOut(CEOut),
    .PortRSTOut(RSTOut),
    .PortADDnSUB(ADDnSUB),
    .PortCarryIn(CarryIn));
endmodule

```

## Port List

The following table lists the port assignments for all possible configurations; the third column specifies the conditions under which the port is available.

Port Name	Description	Required/Optional
PortA	Data input for adder/subtractor Parameterized width and pipeline stages	Always present
PortB	Data input for adder/subtractor Parameterized width and pipeline stages	Not present if adder/subtractor is configured as a constant adder/subtractor
PortClk	Primary clock input; clocks all registers in the unit	Always present

Port Name	Description	Required/Optional
PortRstA	Reset input for port A pipeline registers (active high)	Not present if pipeline stage for port A is 0
PortRstB	Reset input for port B pipeline registers (active high)	Not present if pipeline stage for port B is 0 or for constant adder/subtractor
PortADDnSUB	Selection port for dynamic operation	Not present if adder/subtractor configured as standalone adder or subtractor
PortRstOut	Reset input for output register (active high)	Not present if output pipeline stage is 0
PortCEA	Clock enable for port A pipeline registers (active high)	Not present if pipeline stage for port A is 0
PortCEB	Clock enable for port B pipeline registers (active high)	Not present if pipeline stage for port B is 0 or for constant adder/subtractor
PortCarryIn	Carry input for adder/subtractor	Always present
PortCEOut	Clock enable for output register (active high)	Not present if output pipeline stage is 0
PortOut	Data output	Always present

## Specifying Adder/Subtractor Parameters

The SYNCore adder/subtractor can be configured as any of the following:

- Adder
- Subtractor
- Dynamic Adder/Subtractor

If you are creating a constant input adder, subtractor, or a dynamic adder/subtractor with the SYNCore IP wizard, you must select Constant Value Input and specify a value for port B in the Constant Value/Port B Width field on page 2 of the parameters. The following procedure lists the parameters you need to define when generating an adder/subtractor. For descriptions of each parameter, see [SYNCore Adder/Subtractor Wizard, on page 343](#).

1. Start the SYNCore adder/subtractor wizard as described in [Specifying Adder/Subtractors with SYNCore, on page 335](#).
2. Enter the following on page 1 of the wizard:
  - In the Component Name field, specify a name for your adder/subtractor. Do not use spaces.
  - In the Directory field, specify a directory where you want the output files to be written. Do not use spaces.
  - In the Filename field, specify a name for the Verilog file that will be generated with the adder/subtractor definitions. Do not use spaces.
  - Select the appropriate configuration in Configure the Mode of Operation.
3. Click Next. The wizard opens page 2 where you set parameters for port A and port B.
4. Configure Port A and B.
  - In the Configure Port A section, enter a value in the Port A Width field.
  - If you are defining a synchronous adder/subtractor, check Register Input A and then check Clock Enable for Register A and/or Reset for Register A.
  - To configure port B as a constant port, go to the Configure Port B section and check Constant Value Input. Enter the constant value in the Constant Value/Port B Width field.
  - To configure port B as a dynamic port, go to the Configure Port B section and check Enable Port B and enter the port width in the Constant Value/Port B Width field.
  - To define a synchronous adder/subtractor, check Register Input B and then check Clock Enable for Register B and/or Reset for Register B.
5. In the Configure Output Port section:
  - Enter a value in the Output port Width field.
  - If you are registering the output port, check Register output Port.
  - If you are defining a synchronous adder/subtractor check Clock Enable for Register PortOut and/or Reset for Register PortOut.
6. In the Configure Reset type for all Reset Signal section, click Synchronous Reset or Asynchronous Reset as appropriate.

As you enter the page 2 parameters, the ADDnSUB symbol dynamically updates to reflect the parameters you set.

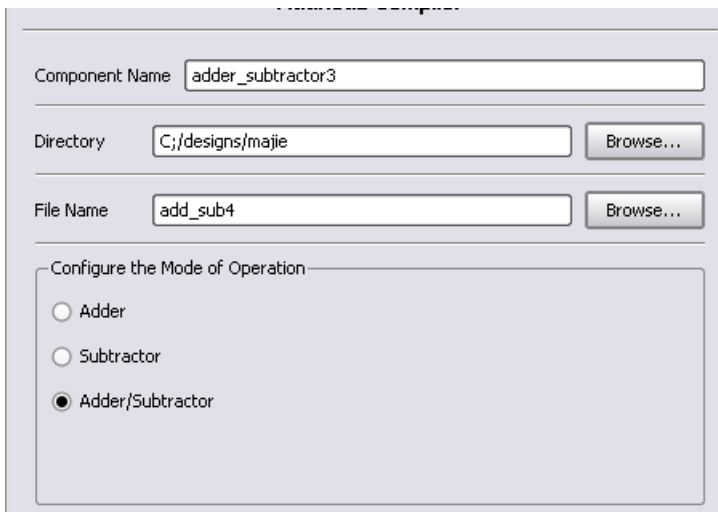
7. Generate the adder/subtractor by clicking the Generate button as described in [Specifying Adder/Subtractors with SYNCore, on page 335](#) and add it to your design. All output files are in the directory you specified on page 1 of the wizard.

## SYNCore Adder/Subtractor Wizard

The following describe the parameters you can set in the adder/subtractor wizard, which opens when you select addnsub\_model:

- [SYNCore Adder/Subtractor Parameters Page 1](#), on page 343
- [SYNCore Adder/Subtractor Parameters Page 2](#), on page 345

### SYNCore Adder/Subtractor Parameters Page 1



The screenshot shows a wizard dialog titled "SYNCore Adder/Subtractor Parameters Page 1". It contains the following fields and options:

- Component Name:** A text box containing "adder\_subtractor3".
- Directory:** A text box containing "C:/designs/majie" and a "Browse..." button.
- File Name:** A text box containing "add\_sub4" and a "Browse..." button.
- Configure the Mode of Operation:** A section with three radio button options:
  - ☐ Adder
  - ☐ Subtractor
  - ☒ Adder/Subtractor

Component Name	Specifies a name for the adder/subtractor. This is the name that you instantiate in your design file to create an instance of the SYNCore adder/subtractor in your design. Do not use spaces.
Directory	<p>Indicates the directory where the generated files will be stored. Do not use spaces. The following files are created:</p> <ul style="list-style-type: none"> <li>• <code>filelist.txt</code> - lists files written out by SYNCore</li> <li>• <code>options.txt</code> - lists the options selected in SYNCore</li> <li>• <code>readme.txt</code> - contains a brief description and known issues</li> <li>• <code>syncore_ADDnSUB.v</code> - Verilog library file required to generate adder/subtractor model</li> <li>• <code>testbench.v</code> - Verilog testbench file for testing the adder/subtractor model</li> <li>• <code>instantiation_file.vin</code> - describes how to instantiate the wrapper file</li> <li>• <code>component.v</code> - adder/subtractor model wrapper file generated by SYNCore</li> </ul> <p>Note that running the wizard in the same directory overwrites any existing files.</p>
Filename	Specifies the name of the generated file containing the HDL description of the generated adder/subtractor. Do not use spaces.
Adder	When enabled, generates an adder (the corresponding file parameter is <code>ADD_N_SUB = "ADD"</code> ).
Subtractor	When enabled, generates a subtractor (the corresponding file parameter is <code>ADD_N_SUB = "SUB"</code> ).
Adder/Subtractor	When enabled, generates a dynamic adder/subtractor (the corresponding file parameter is <code>ADD_N_SUB = "DYNAMIC"</code> ).



## SYNCore Adder/Subtractor Parameters Page 2

**Input and Output Ports Configurations**

**Configure Port A**

Port A Width

☒ Register Input A

☒ Clock Enable for Register A ☒ Reset for Register A

**Configure Port B**

☐ Constant Value Input ☒ Enable Port B

Constant Value/Port B Width

☒ Register Input B

☒ Clock Enable for Register B ☒ Reset for Register B

**Configure Output Port**

Output port Width

☒ Register output PortOut

☒ Clock Enable for Register PortOut ☒ Reset for Register PortOut

**Configure Reset type for all Reset Signals**

☐ Synchronous Reset ☒ Asynchronous Reset

Port A Width	Specifies the width of port A (the corresponding file parameter is PORT_A_WIDTH=n).
Register Input A	Used with synchronous adder/subtractor configurations to register port A. When checked, also allows clock enable and reset to be configured (the corresponding file parameter is PORTA_PIPELINE_STAGE='0' or '1').
Clock Enable for Register A	Specifies the enable for port A register.
Reset for Register A	Specifies the reset for port A register.
Constant Value Input	Specifies port B as a constant input when checked and allows you to enter a constant value in the Constant Value/Port B Width field (the corresponding file parameter is CONSTANT_PORT = '0').

Enable Port B	Specifies port B as an input when checked and allows you to enter a port B width in the Constant Value/Port B Width field (the corresponding file parameter is <code>CONSTANT_PORT = '1'</code> ).
Constant Value/Port B Width	Specifies either a constant value or port B width depending on Constant Value Input and Enable Port B selection (the corresponding file parameters are <code>CONSTANT_VALUE= n</code> or <code>PORT_B_WIDTH=n</code> ).
Register Input B	Used with synchronous adder/subtractor configurations to register port B. When checked, also allows clock enable and reset to be configured (the corresponding file parameter is <code>PORTB_PIPELINE_STAGE='0'</code> or <code>'1'</code> ).
Clock Enable for Register B	Specifies the enable for the port B register.
Reset for Register B	Specifies the reset for the port B register.
Output port Width	Specifies the width of the output port (the corresponding file parameter is <code>PORT_OUT_WIDTH=n</code> ).
Register output PortOut	Used with synchronous adder/subtractor configurations to register the output port. When checked, also allows clock enable and reset to be configured (the corresponding file parameter is <code>PORTOUT_PIPELINE_STAGE='0'</code> or <code>'1'</code> ).
Clock Enable for Register PortOut	Specifies the enable for the output port register.
Reset for Register PortOut	Specifies the reset for the output port register.
Synchronous Reset	Sets the type of reset to synchronous (the corresponding file parameter is <code>RESET_TYPE='0'</code> ).
Asynchronous Reset	Sets the type of reset to asynchronous (the corresponding file parameter is <code>RESET_TYPE='1'</code> ).

## Adder

Based on the parameter `CONSTANT_PORT`, the adder can be configured in two ways.

- `CONSTANT_PORT='0'` - adder with two input ports (port A and port B)
- `CONSTANT_PORT='1'` - adder with one constant port

## Adder with Two Input Ports (Port A and Port B)

In this mode, port A and port B values are added. Optional pipeline stages can also be inserted at port A, port B or at both port A and port B. Optionally, pipeline stages can also be added at the output port. Depending on pipeline stages, a number of the adder configurations are given below.


**Adder with No Pipeline Stages** - In this mode, the port A and port B inputs are added. The adder is purely combinational, and the output changes immediately with respect to the inputs.

Parameters: PORTA\_PIPELINE\_STAGE= '0'

PortA	0	4	9	13	5	1
PortB	0	1	3	5	2	5
PortOut	0	5	12	18	7	6

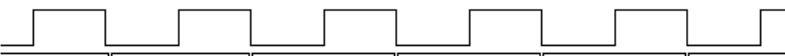
**Adder with Pipeline Stages at Input Only** - In this mode, the port A and port B inputs are pipelined and added. Because there is no pipeline stage at the output, the result is valid at each rising edge of the clock.

Parameters: PORTA\_PIPELINE\_STAGE= '1'  
PORTB\_PIPELINE\_STAGE= '1'  
PORTOUT\_PIPELINE\_STAGE= '0'

PortClk						
PortA	0	4	9	13	5	1
PortB	0	1	3	5	2	5
PortOut	0	5	12	18	7	6

**Adder with Pipeline Stages at Input and Output** - In this mode, the port A and port B inputs are pipelined and added, and the result is pipelined. The result is valid only on the second rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTB\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '1'

PortClk						
PortA	0	4	9	13	5	1
PortB	0	1	3	5	2	5
PortOut	0		5	12	18	7

## Adder with a Port Constant

In this mode, port A is added with a constant value (the constant value can be passed though the parameter `CONSTANT_VALUE`). Optional pipeline stages can also be inserted at port A, Optionally, pipeline stages can also be added at the output port. Depending on the pipeline stages, a number of the adder configurations are given below (here `CONSTANT_VALUE= '3'`)

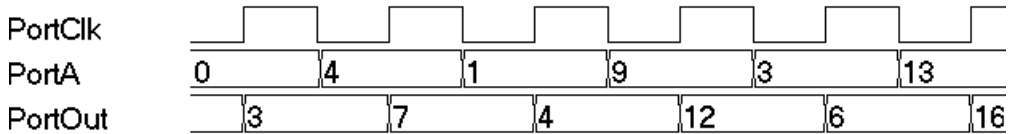
**Adder with No Pipeline Stages** - In this mode, input port A is added with a constant value. The adder is purely combinational, and the output changes immediately with respect to the input.

Parameters:      PORTA\_PIPELINE\_STAGE= '0'  
                      PORTOUT\_PIPELINE\_STAGE= '0'

PortA	0	4	1	9	3	13
PortOut	3	7	4	12	6	16

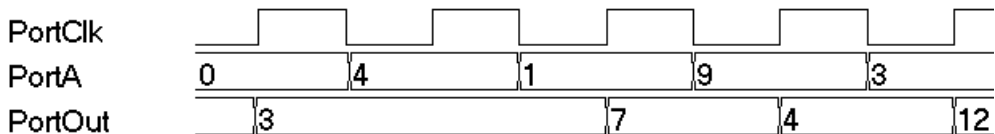
**Adder with Pipeline Stage at Input Only** - In this mode, input port A is pipelined and added with a constant value. Because there is no pipeline stage at the output, the result is valid at each rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '0'



**Adder with Pipeline Stages at Input and Output** - In this mode, input port A is pipelined and added with a constant value, and the result is pipelined. The result is valid only on the second rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '1'



## Subtractor

Based on the parameter `CONSTANT_PORT`, the subtractor can be configured in two ways.

`CONSTANT_PORT='0'` - subtractor with two input ports (port A and port B)

`CONSTANT_PORT='1'` - subtractor with one constant port

## Subtractor with Two Input Ports (Port A and Port B)

In this mode, port B is subtracted from port A. Optional pipeline stages can also be inserted at port A, port B, or both ports. Optionally, pipeline stages can also be added at the output port. Depending on the pipeline stages, a number of the subtractor configurations are given below.


**Subtractor with No Pipeline Stages** - In this mode, input port B is subtracted from port A, and the subtractor is purely combinational. The output changes immediately with respect to the inputs.

Parameters:      PORTA\_PIPELINE\_STAGE= '0'  
                          PORTB\_PIPELINE\_STAGE= '0'  
                          PORTOUT\_PIPELINE\_STAGE= '0'

PortA	0	4	9	13	5
PortB	0	1	3	5	2
PortOut	0	3	6	8	3


**Subtractor with Pipeline Stages at Input Only** - In this mode, input port B and input PortA are pipelined and then subtracted. Because there is no pipeline stage at the output, the result is valid at each rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                          PORTB\_PIPELINE\_STAGE= '1'  
                          PORTOUT\_PIPELINE\_STAGE= '0'

PortClk					
PortA	0	4	9	13	5
PortB	0	1	3	5	2
PortOut	0	3	6	8	3

**Subtractor with Pipeline Stages at Input and Output** - In this mode, input PortA and PortB are pipelined and then subtracted, and the result is pipelined. The result is valid only at the second rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTB\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '1'

PortClk					
PortA	0	4	9	13	5
PortB	0	1	3	5	2
PortOut	0		3	6	8

### Subtractor with a Port Constant

In this mode, a constant value is subtracted from port A (the constant value can be passed through the parameter CONSTANT\_VALUE). Optional pipeline stages can also be inserted at port A. Optionally, pipeline stages can also be added at the output port. Depending on pipeline stages, a number of the subtractor configurations are given below (here CONSTANT\_VALUE= '1').

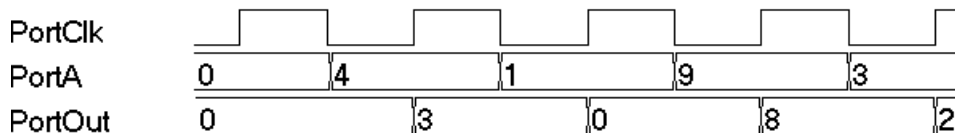
**Subtractor with No Pipeline Stages** - In this mode, a constant value is subtracted from port A. The subtractor is purely combinational, and the output changes immediately with respect to the input.

Parameters:      PORTA\_PIPELINE\_STAGE= '0'  
                      PORTOUT\_PIPELINE\_STAGE= '0'

PortA	0	4	1	9	3
PortOut	0	3	0	8	2

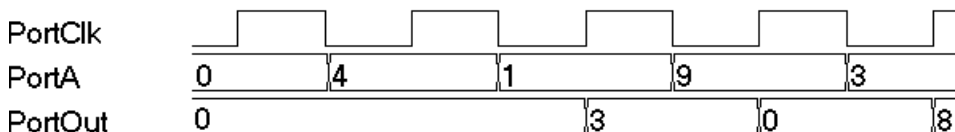
**Subtractor with Pipeline Stages at Input Only** - In this mode, a constant value is subtracted from pipelined input port A. Because there is no pipeline stage at the output, the output is valid at each rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '0'



**Subtractor with Pipeline Stages at Input and Output** - In this mode, a constant value is subtracted from pipelined port A, and the output is pipelined. The result is valid only at the second rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '1'



## Dynamic Adder/Subtractor

In dynamic adder/subtractor mode, port PortADDnSUB controls adder/subtractor operation.

PortADDnSUB='0' - adder operation

PortADDnSUB='1' - subtractor operation

Based on the parameter CONSTANT\_PORT the dynamic adder/subtractor can be configured in one of two ways:



CONSTANT\_PORT='0' - dynamic adder/subtractor with two input ports

CONSTANT\_PORT='1' - dynamic adder/subtractor with one constant port

## Dynamic Adder/Subtractor with Two Input Ports (Port A and Port B)

In this mode, the addition and subtraction is dynamic based on the value of input port PortADDnSUB. Optional pipeline stages can also be inserted at Port A, Port B, or both Port A and Port B. Optionally, pipeline stages can also be added at the output port. Depending on pipeline stages, some of the dynamic adder/subtractor configurations are given below.

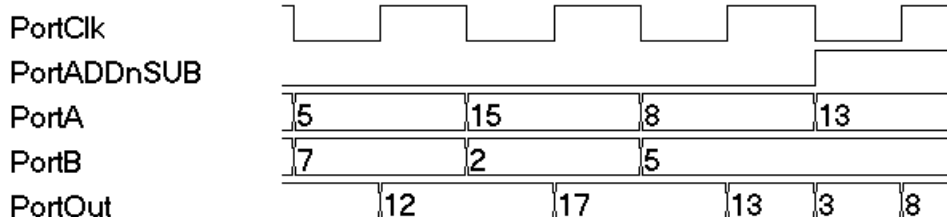
**Dynamic Adder/Subtractor with No Pipeline Registers** - In this mode, the dynamic adder/subtractor is a purely combinational, and output changes immediately with respect to the inputs.

Parameters:      PORTA\_PIPELINE\_STAGE= '0'  
                      PORTB\_PIPELINE\_STAGE= '0'  
                      PORTOUT\_PIPELINE\_STAGE= '0'

PortADDnSUB				
PortA	5	15	8	13
PortB	7	2	5	
PortOut	12	17	13	8

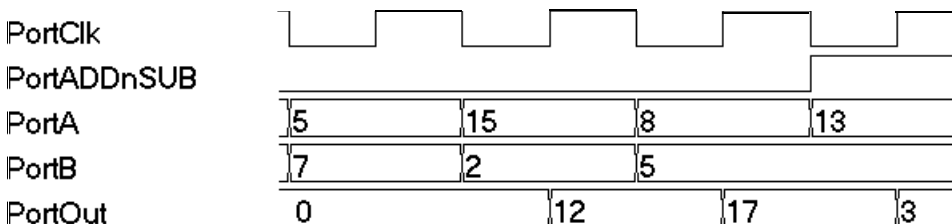
**Dynamic Adder/Subtractor with Pipeline Stages at Input Only** - In this mode, input port A and port B are pipelined and then added/subtracted based on the value of port PortADDnSUB. Because there is no pipeline stage at the output port, the result immediately changes with respect to the PortADDnSUB signal.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTB\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '0'



**Dynamic Adder/Subtractor with Pipeline Stages at Input and Output** - In this mode, input port A and port B are pipelined and then added/subtracted based on the value of port PortADDnSUB. Because the output port is pipelined, the result is valid only on the second rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTB\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '1'

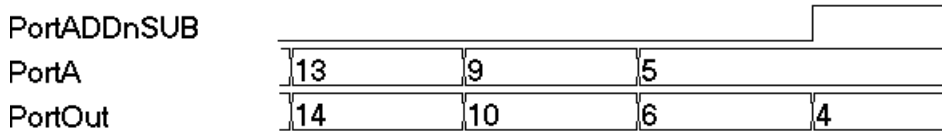


## Dynamic Adder/Subtractor with a Port Constant

In this mode, a constant value is either added or subtracted from port A based on input port value PortADDnSUB (the constant value can be passed though the parameter CONSTANT\_VALUE). Optional pipeline stages can also be inserted at port A. Optionally, pipeline stages can also be added at the output port. Depending on the pipeline stages, a number of the dynamic adder/subtractor configurations are given below (here CONSTANT\_VALUE= '1 ').

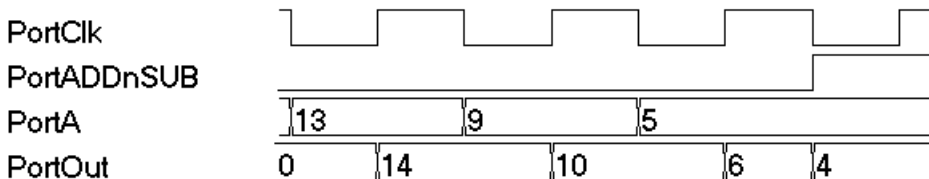
**Dynamic Adder/Subtractor with No Pipeline Registers** - In this mode, dynamic adder/subtractor is a purely combinational, and the output change immediately with respect to the input.

Parameters:      PORTA\_PIPELINE\_STAGE= '0'  
                      PORTOUT\_PIPELINE\_STAGE= '0'



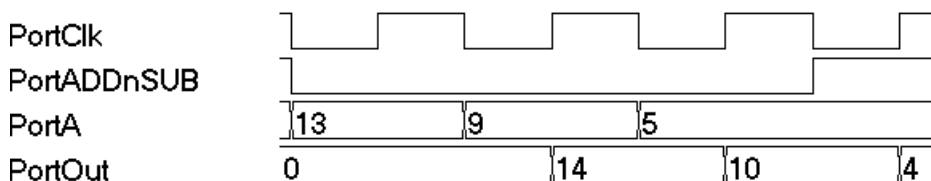
**Dynamic Adder/Subtractor with Pipeline Stages at Input Only** - In this mode, a constant value is either added or subtracted from the pipelined version of port A based on the value of port PortADDnSUB. Because there is no pipeline stage on the output port, the result changes immediately with respect to the PortADDnSUB signal.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '0'



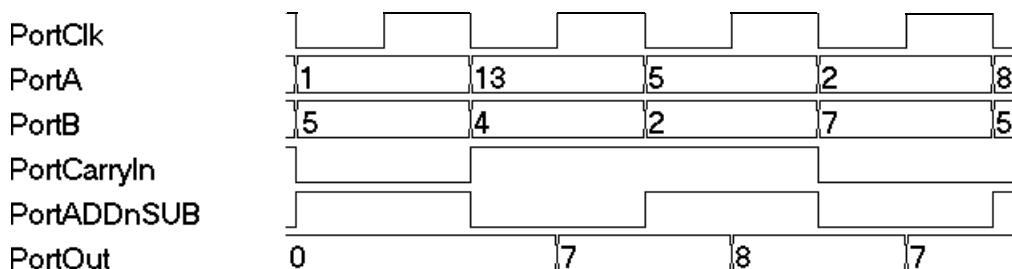
**Dynamic Adder/Subtractor with Pipeline Stages at Input and Output** - In this mode, a constant value is either added or subtracted from the pipelined version of port A based on the value of port PortADDnSUB. Because the output port is pipelined, the result is valid only on the second rising edge of the clock.

Parameters:      PORTA\_PIPELINE\_STAGE= '1'  
                      PORTOUT\_PIPELINE\_STAGE= '1'



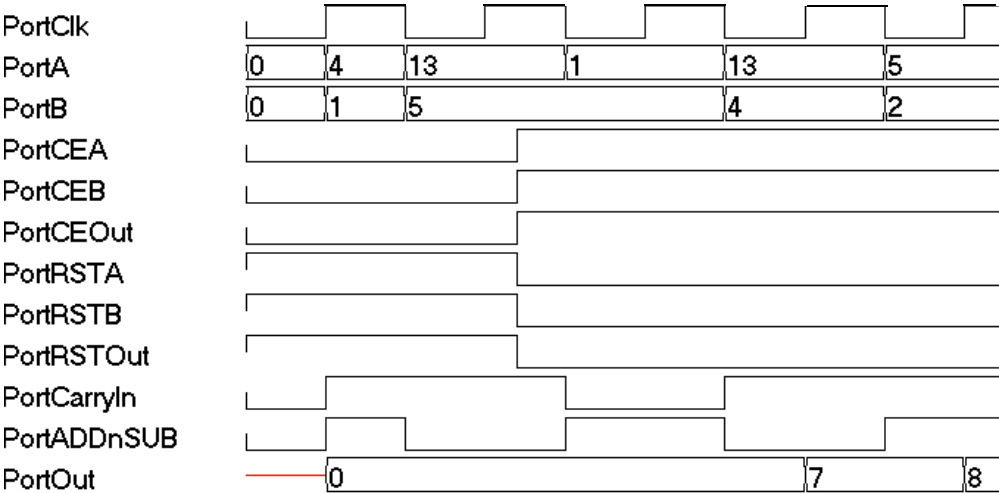
### Dynamic Adder/Subtractor with Carry Input

The following waveform shows the behavior of the dynamic adder/subtractor with a carry input (the carry input is assumed to be 0).



### Dynamic Adder/Subtractor with Complete Control Signals

The following waveform shows the complete signal set for the dynamic adder/subtractor. The enable and reset signals are always present in all of the previous cases.



# SYNCore Counter Compiler

The SYNCore counter compiler generates Verilog code for your up, down, and dynamic (up/down) counter implementation. This section describes the following:

- [Functional Overview](#), on page 358
- [Specifying Counters with SYNCore](#), on page 359
- [SYNCore Counter Wizard](#), on page 365
- [UP Counter Operation](#), on page 368
- [Down Counter Operation](#), on page 369
- [Dynamic Counter Operation](#), on page 369

## Functional Overview

The SYNCore counter component supports up, down, and dynamic (up/down) counter implementations using DSP blocks or logic elements. For each configuration, design optimizations are made for optimum use of core resources.

As its name implies, the COUNTER block counts up (increments) or down (decrements) by a step value and provides an output result. You can load a constant or a variable as an intermediate value or base for the counter. Reset to the counter on the PortRST input is active high and can be configured either as synchronous or asynchronous using the RESET\_TYPE parameter. Count enable on the PortCE input must be value high to enable the counter to increment or decrement.

## Specifying Counters with SYNCore

The SYNCore IP wizard helps you generate Verilog code for your counter implementation requirements. The following procedure shows you how to generate Verilog code for a counter using the SYNCore IP wizard.

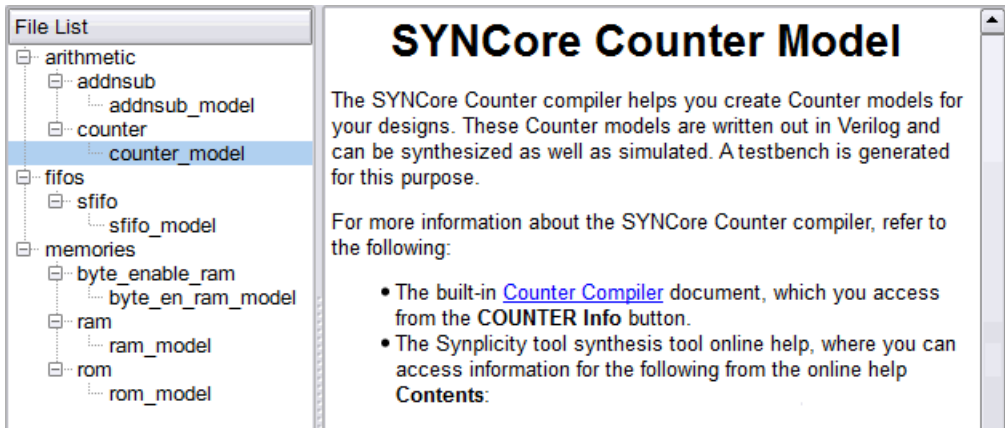
---

**Note:** The SYNCore counter model uses Verilog 2001. When adding a counter model to a Verilog-95 design, be sure to enable the Verilog 2001 check box on the Verilog tab of the Implementation Options dialog box or include a `set_option -vlog_std v2001` statement in your project file to prevent a syntax error.

---

### 1. Start the wizard.

- From the FPGA synthesis tool GUI, select Run->Launch SYNCore or click the Launch SYNCore icon  to start the SYNCore IP wizard.



- In the window that opens, select `counter_model` and click Ok to open page 1 of the wizard.

The screenshot shows the 'Counter Compiler' wizard interface. On the left, a block diagram of a 'COUNTER' is displayed with four ports: PortClk, PortCE, PortRst, and PortCount. Below the diagram is a label 'SynCore COUNTER' followed by a small white box. The right pane is titled 'Counter Compiler' and contains several configuration sections:

- Component Name:** A text input field.
- Directory:** A text input field with a 'Browse...' button.
- File Name:** A text input field with a 'Browse...' button.
- Configure the Counter Parameters:**
  - Width of Counter:** A text input field.
  - Counter Step Value:** A text input field.
- Configure the Mode of Counter:**
  - ☒ Up Counter
  - ☐ Down Counter
  - ☐ UpDown Counter

At the bottom of the wizard, there are 'Back' and 'Next' buttons, and a page indicator 'Page 1 of 2'.

- Specify the parameters you need in the wizard. For details about the parameters, see [Specifying Counter Parameters, on page 364](#). The COUNTER symbol on the left reflects any parameters you set.
- After you have specified all the parameters you need, click the Generate button in the lower left corner.

The tool displays a confirmation message (TCL execution successful!) and writes the required files to the directory you specified on page 1 of the wizard. The HDL code is in Verilog.



The SYNCore wizard also generates a testbench for your counter. The testbench covers a limited set of vectors. You can now close the wizard.

4. Add the counter you generated to your design.

- Edit the counter files if necessary.
- Use the Add File command to add the Verilog design file that was generated and the `syncore_addnsub.v` file to your project. These files are in the directory for output files that you specified on page 1 of the wizard.
- Use a text editor to open the `instantiation_file.v` template file. This file is located in the same output files directory. Copy the lines that define the counter and paste them into your top-level module. The following figure shows a template file (in red text) inserted into a top-level module.

```

module counter #(
    parameter COUNT_WIDTH = 5,
    parameter STEP = 2,
    parameter RESET_TYPE = 0,
    parameter LOAD = 2,
    parameter MODE = "Dynamic")
(
// Output Ports
    output wire [WIDTH-1:0] Count,
// Input Ports
    input wire Clock,
    input wire Reset,
    input wire Up_Down,
    input wire Load,
    input wire [WIDTH-1:0] LoadValue,
    input wire Enable );

SynCoreCounter #(
    .COUNT_WIDTH(COUNT_WIDTH),
    .STEP(STEP),
    .RESET_TYPE(RESET_TYPE),
    .LOAD(LOAD),
    .MODE(MODE) )

SynCoreCounter_inst1 (
    .PortCount(PortCount),
    .PortClk(PortClock),
    .PortRST(PortRST),
    .PortUp_nDown(PortUp_nDown),
    .PortLoad(PortLoad),
    .PortLoadValue(PortLoadLoadValue)
    .PortCE(PortCE) );

endmodule

```

template

5. Edit the template port connections so that they agree with the port definitions in your top-level module as shown in the example below (the updated connection names are shown in red). You can also assign a unique name to each instantiation. You can also assign a unique name to each instantiation.

```

module counter #(
    parameter COUNT_WIDTH = 5,
    parameter STEP = 2,
    parameter RESET_TYPE = 0,
    parameter LOAD = 2,
    parameter MODE = "Dynamic")

(
    // Output Ports
    output wire [WIDTH-1:0] Count,
    // Input Ports
    input wire Clock,
    input wire Reset,
    input wire Up_Down,
    input wire Load,
    input wire [WIDTH-1:0] LoadValue,
    input wire Enable);

SynCoreCounter #(
    .COUNT_WIDTH(COUNT_WIDTH),
    .STEP(STEP),
    .RESET_TYPE(RESET_TYPE),
    .LOAD(LOAD),
    .MODE(MODE))

SynCoreCounter_ins1 (
    .PortCount(Count),
    .PortClk(Clock),
    .PortRST(Reset),
    .PortUp_nDown(Up_Down),
    .PortLoad(Load),
    .PortLoadValue(LoadValue),
    .PortCE(Enable));

endmodule

```

## Port List

The following table lists the port assignments for all possible configurations; the third column specifies the conditions under which the port is available.

Port Name	Description	Required/Optional
PortCE	Count Enable input pin with size one (active high)	Always present
PortClk	Primary clock input	Always present
PortLoad	Load Enable input which loads the counter (active high).	Not present for parameter LOAD=0
PortLoadValue	Load value primary input (active high)	Not present for parameter LOAD=0 and LOAD=1
PortRST	Reset input which resets the counter (active high)	Always present
PortUp_nDown	Primary input which determines the counter mode. 0 = Up counter 1 = Down counter	Present only for MODE="Dynamic"
PortCount	Counter primary output	Always present

## Specifying Counter Parameters

The SYNCore counter can be configured for any of the following functions:

- Up Counter
- Down Counter
- Dynamic Up/Down Counter

The counter core can have a constant or variable input load or no load value. If you are creating a constant-load counter, you will need to select Enable Load and Load Constant Value on page 2 of the wizard. If you are creating a variable-load counter, you will need to select Enable Load and Use Variable Port Load on page 2. The following procedure lists the parameters you need to define when generating a counter. For descriptions of each parameter, see [SYNCore Counter Wizard, on page 365](#).

1. Start the SYNCore counter wizard, as described in [Specifying Counters with SYNCore, on page 359](#).

2. Enter the following on page 1 of the wizard:
  - In the Component Name field, specify a name for your counter. Do not use spaces.
  - In the Directory field, specify a directory where you want the output files to be written. Do not use spaces.
  - In the Filename field, specify a name for the Verilog file that will be generated with the counter definitions. Do not use spaces.
  - Enter the width and depth of the counter in the Configure the Counter Parameters section.
  - Select the appropriate configuration in the Configure the Mode of Counter section.
3. Click Next. The wizard opens page 2 where you set parameters for PortLoad and PortLoadValue.
  - Select Enable Load option and the required load option in Configure Load Value section.
  - Select the required reset type in the Configure Reset type section.

The COUNTER symbol dynamically updates to reflect the parameters you set.
4. Generate the counter core by clicking Generate button. All output files are written to the directory you specified on page 1 of the wizard.

## SYNCore Counter Wizard

The following describe the parameters you can set in the ROM wizard, which opens when you select counter\_model:

- [SYNCore Counter Parameters Page 1](#), on page 366
- [SYNCore Counter Parameters Page 2](#), on page 367

## SYNCore Counter Parameters Page 1

The screenshot shows a web-based configuration interface for the SYNCore Counter Compiler. It contains several input fields and a section for configuring counter parameters and mode.

- Component Name:** A text field containing "up-down\_counter".
- Directory:** A text field containing "C:/designs/majie/monitor" with a "Browse..." button next to it.
- File Name:** A text field containing "udc2" with a "Browse..." button next to it.
- Configure the Counter Parameters:** A section containing two text fields:
  - Width of Counter:** A text field containing "16".
  - Counter Step Value:** A text field containing "1".
- Configure the Mode of Counter:** A section containing three radio buttons:
  - ☐ Up Counter
  - ☐ Down Counter
  - ☒ UpDown Counter

**Component Name** Specifies a name for the counter. This is the name that you instantiate in your design file to create an instance of the SYNCore counter in your design. Do not use spaces.

**Directory** Indicates the directory where the generated files will be stored. Do not use spaces. The following files are created:

- `filelist.txt` - lists files written out by SYNCore
- `options.txt` - lists the options selected in SYNCore
- `readme.txt` - contains a brief description and known issues
- `syncore_counter.v` - Verilog library file required to generate counter model
- `testbench.v` - Verilog testbench file for testing the counter model
- `instantiation_file.vin` - describes how to instantiate the wrapper file
- `component.v` - counter model wrapper file generated by SYNCore

Note that running the wizard in the same directory overwrites any existing files.

**Filename** Specifies the name of the generated file containing the HDL description of the generated counter. Do not use spaces.

Width of Counter	Determines the counter width (the corresponding file parameter is COUNT_WIDTH=n).
Counter Step Value	Determines the counter step value (the corresponding file parameter is STEP=n).
Up Counter	Specifies an up counter (the default) configuration (the corresponding file parameter is MODE=Up).
Down Counter	Specifies a down counter configuration (the corresponding file parameter is MODE=Down).
UpDown Counter	Specifies a dynamic up/down counter configuration (the corresponding file parameter is MODE=Dynamic).

## SYNCore Counter Parameters Page 2

Additional Configurations

Configure Load options

☒ Enable Load option

Configure Load Value

☐ Load Constant Value

Load Value for constant load option

☒ Use the port PortLoadValue to load Value

Configure Reset type

☒ Synchronous Reset ☐ Asynchronous Reset

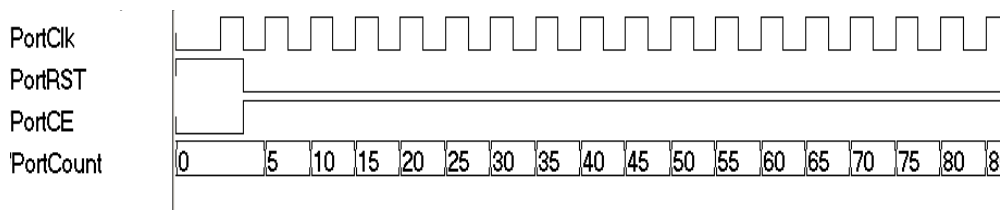
Enable Load option	Enables the load options
Load Constant Value	Load the constant value specified in the Load Value for constant load option field; (the corresponding file parameter is LOAD=1).
Load Value for constant load option	The constant value to be loaded.

Use the port PortLoadValue to load Value	Loads variable value from PortLoadValue (the corresponding file parameter is LOAD=2).
Synchronous Reset	Specifies a synchronous (the default) reset input (the corresponding file parameter is MODE=0).
Asynchronous Reset	Specifies an asynchronous reset input (the corresponding file parameter is MODE=1).

## UP Counter Operation

In this mode, the counter is incremented by the step value defined by the STEP parameter. When reset is asserted (when PostRST is active high), the counter output is reset to 0. After the assertion of PortCE, the counter starts counting upwards coincident with the rising edge of the clock. The following waveform is with a constant STEP value of 5 and no load value.

Parameters:      MODE= 'Up'  
                      LOAD= '0'



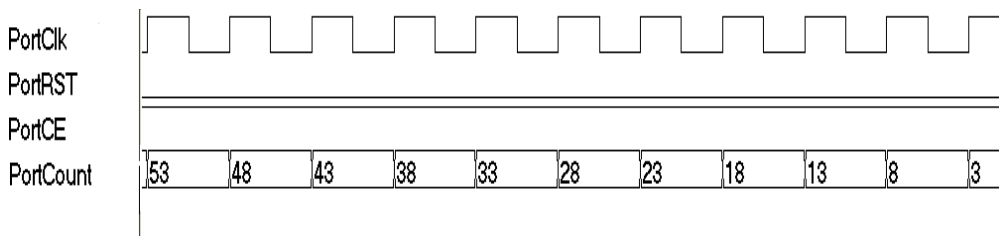
**Note:** Counter core can be configured to use a constant or dynamic load value in Up Counter mode (for the counter to load the PortLoadValue, PortCE must be active). This functionality is explained in [Dynamic Counter Operation, on page 369](#).



## Down Counter Operation

In this mode, the counter is decremented by the step value defined by the STEP parameter. When reset is asserted (when PostRST is active high), the counter output is reset to 0. After the assertion of PortCE, the counter starts counting downwards coincident with the rising edge of the clock. The following waveform is with a constant STEP value of 5 and no load value.

Parameters:      MODE= 'Down'  
LOAD= '0'



**Note:** Counter core can be configured to use a constant or dynamic load value in Down Counter mode (for the counter to load the PortLoadValue, PortCE must be active). This functionality is explained in [Dynamic Counter Operation, on page 369](#).

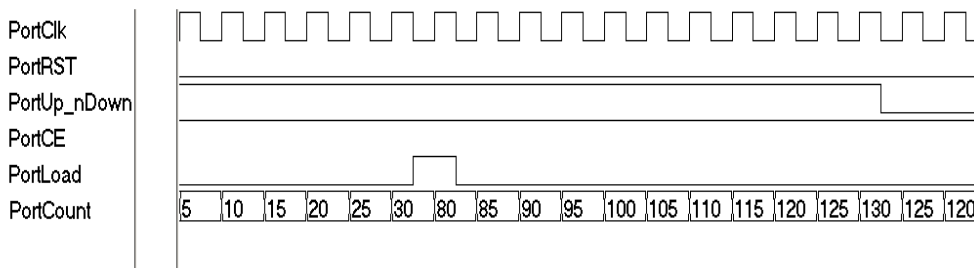
## Dynamic Counter Operation

In this mode, the counter is incremented or decremented by the step value defined by the STEP parameter; the count direction (up or down) is controlled by the PortUp\_nDown input (1 = up, 0 = down).

### Dynamic Up/Down Counters with Constant Load Value\*

On de-assertion of PortRST, the counter starts counting up or down based on the PortUp\_nDown input value. The following waveform is with STEP value of 5 and a LOAD\_VALUE of 80. When PortLoad is asserted, the counter loads the constant load value on the next active edge of clock and resumes counting in the specified direction.

Parameters:      MODE= 'Dynamic'  
                       LOAD= '1'



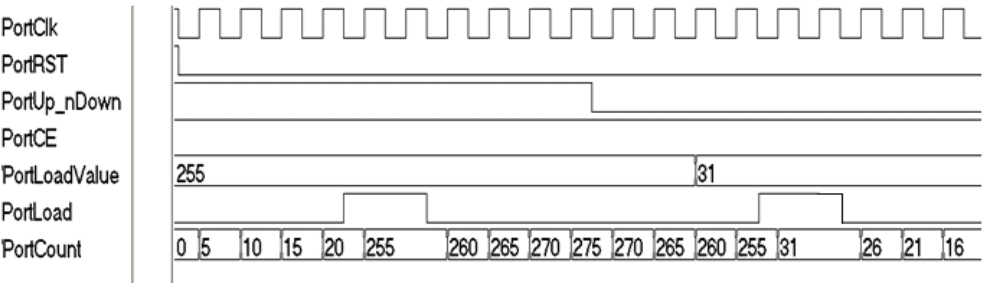
**Note:** \*For counter to load the PortLoadValue, PortCE must be active.

## Dynamic Up/Down Counters with Dynamic Load Value\*

On de-assertion of PortRST, the counter starts counting up or down based on the PortUp\_nDown input value. The following waveform is with STEP value of 5 and a LOAD\_VALUE of 80. When PortLoad is asserted, the counter loads the constant load value on the next active edge of clock and resumes counting in the specified direction.

In this mode, the counter counts up or down based on the PortUp\_nDown input value. On the assertion of PortLoad, the counter loads a new PortLoadValue and resumes up/down counting on the next active clock edge. In this example, a variable PortLoadValue of 8 is used with a counter STEP value of 5.

Parameters:      MODE= 'Dynamic'  
                       LOAD= '2'



**Note:** \* For counter to load the PortLoadValue, PortCE should be active.



## APPENDIX H

# Designing with Microsemi

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This chapter discusses the following topics for synthesizing Microsemi designs:

- [Basic Support for Microsemi Designs](#), on page 374
- [Microsemi Components](#), on page 377
- [Microsemi RAM Implementations](#), on page 386
- [Microsemi Constraints and Attributes](#), on page 414
- [Microsemi Device Mapping Options](#), on page 417
- [Microsemi Output Files and Forward Annotation](#), on page 426
- [Integration with Microsemi Tools and Flows](#), on page 430
- [Microsemi Attribute and Directive Summary](#), on page 433

# Basic Support for Microsemi Designs

This section describes the uses of the tool with Microsemi devices. Topics include:

- [Microsemi Device-specific Support](#), on page 374
- [Netlist Format](#), on page 374
- [Microsemi Features](#), on page 376

## Microsemi Device-specific Support

The tool creates technology-specific netlists for a number of Microsemi families of FPGAs. The following technologies are supported:

FPGAs	Technology Families
Mixed-Signal	SmartFusion2
Low-Power	<ul style="list-style-type: none"><li>• PolarFire</li><li>• IGLOO2</li></ul>
Rad-Tolerant	RTG4

New devices are added on an ongoing basis. For the most current list of supported devices, check the Device panel of the Implementation Options dialog box.

## Netlist Format

The synthesis tool outputs EDIF or VM netlist files for use with the Microsemi place-and-route application. These files have `edn` and `vm` extensions.

After synthesis the tool generates a constraint file as well, which is forward annotated as input into the Microsemi place-and-route tool. These files have the following extensions:

Vendor Support	Forward Annotation Constraint File
Microsemi (PolarFire)	<i>designName_vm.sdc</i>
Microsemi (SmartFusion2)	<i>designName_sdc.sdc</i> and <i>designName_vm.sdc</i>
Microsemi (All, except PolarFire or SmartFusion2)	<i>designName_sdc.sdc</i>

On the Implementation Results tab of the Implementation Options dialog box, two file formats: edif and *vm*, are available depending on your design's device family.

You can also use the project Tcl command to specify the result file format.

```
project -result_format edif/vm
```

## Targeting Output for Microsemi

You can generate output targeted for Microsemi.

1. To specify the output, click the Implementation Options button.
2. Click the Implementation Results tab, and check the output files you need.

The following table summarizes the outputs to set for the different devices, and shows the P&R tools for which the output is intended.

Vendor Support	Output Netlist	P&R Tool
Microsemi (PolarFire)	VM (.vm)	Libero SoC
Microsemi (SmartFusion2)	EDIF/VM (.edn or .vm)	Libero SoC
Microsemi	EDIF (.edn)	Libero SoC or IDE

3. To generate mapped Verilog/VHDL netlists and constraint files, check the appropriate boxes and click OK.

## Customizing Netlist Formats

The following table lists some attributes for customizing your Microsemi output netlists:

For ...	Use ...
Netlist formatting	<a href="#">syn_netlist_hierarchy</a> define_global_attribute syn_netlist_hierarchy {0}
Bus specification	<a href="#">syn_noarrayports</a> define_global_attribute syn_noarrayports {1}

## Microsemi Forward Annotation

The synthesis tool generates Microsemi-compliant constraint files from selected constraints that are forward annotated (read in and then used) by the Microsemi Libero SoC or Libero IDE place-and-route software. The Microsemi constraint file uses the `_vm.sdc` or `_sdc.sdc` extension. This constraint file must be imported into the Microsemi flow.

By default, Microsemi constraint files are generated from the synthesis tool constraints. You can then forward annotate these files to the place-and-route tool. To disable this feature, deselect the Write Vendor Constraint File box (on the Implementation Results tab of the Implementation Options dialog box).

## Microsemi Features

The synthesis tool contains the following Microsemi-specific features:

- Direct mapping to Microsemi c-modules and s-modules
- Timing-driven mapping, replication, and buffering
- Inference of counters, adders, and subtractors; module generation
- Automatic use of clock buffers for clocks and reset signals
- Automatic I/O insertion. See [I/O Insertion, on page 418](#) for more information.



# Microsemi Components

These topics describe how the synthesis tool handles various Microsemi components, and show you how to work with or manipulate them during synthesis to get the results you need:

- [Macros and Black Boxes in Microsemi Designs](#), on page 377
- [DSP Block Inference](#), on page 379
- [Control Signals Extraction for Registers \(SLE\)](#), on page 384
- [Wide MUX Inference](#), on page 385

## Macros and Black Boxes in Microsemi Designs

You can instantiate Smartgen<sup>1</sup> macros or other Microsemi macros like gates, counters, flip-flops, or I/Os by using the supplied Microsemi macro libraries to pre-define the Microsemi macro black boxes. For certain technologies, the following macros are also supported:

- [MACC and RAM Timing Models](#)
- [SmartFusion2 MACC Block](#)
- [SIMBUF Macro](#)

For general information on instantiating black boxes, see [Instantiating Black Boxes in VHDL, on page 401](#), and [Instantiating Black Boxes in Verilog, on page 120](#). For specific procedures about instantiating macros and black boxes and using Microsemi black boxes, see the following sections in the *User Guide*:

- [Defining Black Boxes for Synthesis](#), on page 382
- [Using Predefined Microsemi Black Boxes](#), on page 431
- [Using Smartgen Macros](#), on page 432

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1. Smartgen macros now replace the ACTgen macros. ACTgen macros were available in the previous Designer 6.x place-and-route tool.

## MACC and RAM Timing Models

MACC and RAM timing models are supported for PolarFire, RTG4, SmartFusion2, and IGLOO2 devices. Timing analysis considers the timing arcs for RAM and MACC.

## SmartFusion2 MACC Block

SmartFusion2 devices support bit-signed 18x18 multiply-accumulate blocks. This architecture provides dedicated components called SmartFusion2 MACC blocks, for which DSP-related operations can be performed like multiplication followed by addition, multiplication followed by subtraction, and multiplication with accumulate. For more information, see [DSP Block Inference, on page 379](#).

## SIMBUF Macro

The synthesis software supports instantiation of the SIMBUF macro. The SIMBUF macro provides the flexibility to probe signals without using physical locations, as possible from the Identify tool. The Resource Summary will report the number of SIMBUF instantiations in the IO Tile section of the log file.

## DSP Block Inference

This feature allows the synthesis tool to infer DSP or MATH18x18 blocks for SmartFusion2 devices and MACC\_PA block for PolarFire devices. The following structures are supported for SmartFusion2 devices:

- DOTP Support

The MACC block is configured in DOTP mode when two independent signed 9-bit x 9-bit multipliers are followed by addition. The sum of the dual independent 9x9 multiplier (DOTP) result is stored in the upper 35 bits of the 44-bit output. In DOTP mode, the MACC block implements the following equation:

$$P = D + (\text{CARRYIN} + C) + 512 * ((AL * BH) + (AH * BL)), \text{ when } SUB = 0$$

$$P = D + (\text{CARRYIN} + C) - 512 * ((AL * BH) + (AH * BL)), \text{ when } SUB = 1$$

Below is an example RTL which infers MACC block in DOTP mode after synthesis:

```
module dotp_add_unsign_syn (ina, inb, inc, ind, ine, dout);
parameter widtha = 6;
parameter widthb = 7;
parameter widthc = 7;
parameter widthd = 8;
parameter widthe = 30;
parameter width_out = 44;

input [widtha-1:0] ina;
input [widthb-1:0] inb;
input [widthc-1:0] inc;
input [widthd-1:0] ind;
input [widthe-1:0] ine;
output reg [width_out-1:0] dout;
always @(ina or inb or inc or ind or ine)
begin
    dout <= (ina * inb) + (inc * ind) + ine;
end
endmodule
```

The MACC block does not support DOTP mode if the

- Width of the multiplier inputs is greater than 9-bits when signed.
- Width of the multiplier inputs is greater than 8-bits when unsigned.
- Width of the non-multiplier inputs is greater than 36-bits.

- Multipliers
- Mult-adds — Multiplier followed by an Adder
- Mult-subs — Multiplier followed by a Subtractor
- Wide multiplier inference

A multiplier is treated as wide, if any of its inputs is larger than 18 bits signed or 17 bits unsigned. The multiplier can be configured with only one input that is wide, or else both inputs are wide. Depending on the number of wide inputs for signed or unsigned multipliers, the synthesis software uses the cascade feature to determine how many math blocks to use and the number of Shift functions it needs.

- MATH block inferencing across hierarchy

This enhancement to MATH block inferencing allows packing input registers, output registers, and any adders or subtractors into different hierarchies. This helps to improve QoR by packing logic more efficiently into MATH blocks.

By default, the synthesis software maps the multiplier to DSP blocks if all inputs to the multiplier are more than 2-bits wide; otherwise, the multiplier is mapped to logic. You can override this default behavior using the `syn_multstyle` attribute. See [syn\\_multstyle](#), on page 129 for details.

The following conditions also apply:

- Signed and unsigned multiplier inferencing is supported.
- Registers at inputs and outputs of multiplier/multiplier-adder/multiplier-subtractor are packed into DSP blocks.
- Synthesis software fractures multipliers larger than 18X18 (signed) and 17X17 (unsigned) into smaller multipliers and packs them into DSP blocks.
- When multadd/multsub are fractured, the final adder/subtractor are packed into logic.

The following structures are supported for PolarFire devices:

- Add-mult — Adder followed by a Multiplier
- Multipliers
- Mult-adds — Multiplier followed by an Adder

- Mult-subs — Multiplier followed by a Subtractor
- Mult-acc — Multiplier followed by an Accumulator
- Wide multiplier inference
- MATH block inferencing across hierarchy
- DOTP Support
- Coefficient ROM

This section also includes the following topics:

- [Packing Coefficient ROM in the DSP](#), on page 381
- [DSP Cascade Chain Inference](#), on page 382
- [Symmetric FIR Filter Packing in MACC\\_PA\\_BC\\_ROM](#), on page 382
- [Multiplier-Accumulators \(MACC\) Inference](#), on page 383

## Packing Coefficient ROM in the DSP

Packing the coefficient ROM in the DSP implements the coefficient ROM data as one input to mult-add/add/sub, when inferring the MACC\_PA\_BC\_ROM macro. The MACC\_PA\_BC\_ROM macro extends the functionality of the MACC\_PA macro to provide a 16x18 ROM at the A input. The USE\_ROM pin is available for the primitive to select the input data A or the ROM data at ROM\_ADDR.

Select operand A as follows:

- When USE\_ROM = 0, select input data A.
- When USE\_ROM = 1, select the ROM data at ROM\_ADDR.

The RTL example below infers the MACC\_PA\_BC\_ROM macro after synthesis:

```
module test(in1, rom_addr, out);
  parameter data_width = 17;
  parameter rom_width = 17;
  parameter rom_depth = 4;

  input [data_width-1:0] in1;
  input [rom_depth-1:0] rom_addr;
  output [47:0] out;
```

```
reg [rom_width-1:0] mem [0:2**rom_depth -1];
wire [rom_width-1:0] rom_data;

initial
begin
    $readmemb("mem.dat", mem);
end

assign rom_data = mem [rom_addr];
assign out = rom_data * in1;
endmodule
```

## DSP Cascade Chain Inference

The MATH18x18 block cascade feature supports the implementation of multi-input Mult-Add/Sub for devices with MATH blocks. The software packs logic into MATH blocks efficiently using hard-wired cascade paths, which improves the QoR for the design.

Prerequisites include the following requirements:

- The input size for multipliers is *not* greater than 18x18 bits (signed) and 17x17 bits (unsigned).
- Signed multipliers have the proper sign-extension.
- All multiplier output bits feed the adder.
- Multiplier inputs and outputs can be registered or not.

## Symmetric FIR Filter Packing in MACC\_PA\_BC\_ROM

### *PolarFire*

The tool supports the packing of symmetric FIR filters through the inference of MACC\_PA\_BC\_ROM blocks with shift chain.

## Multiplier-Accumulators (MACC) Inference

The Multiplier-Accumulator structures use internal paths for adder feedback loops inside the MATH18x18 block instead of connecting it externally.

Prerequisites include the following requirements:

- The input size for multipliers is *not* greater than 18x18 bits (signed) and 17x17 bits (unsigned).
- Signed multipliers have the proper sign-extension.
- All multiplier output bits feed the adder.
- The output of the adder must be registered.
- The registered output of the adder feeds back to the adder for accumulation.
- Since the Microsemi MATH block contains one multiplier, only Multiplier-Accumulator structures with one multiplier can be packed inside the MATH block.

The other Multiplier-Accumulator structure supported is with Synchronous Loadable Register.

Prerequisites include the following requirements:

- All the requirements mentioned above apply for this structure as well.
- For the Loading Multiplier-Accumulator structure, new Load data should be passed to input C.
- The LoadEn signal should be registered.

## DSP Limitations

Currently, DSP inferencing does not support the following functions:

- Overflow extraction
- Arithmetic right shift for operand C

---

**Note:** For more information about Microsemi DSP math blocks along with a comprehensive set of examples, see the *Inferring Microsemi RTAX-DSP MATH Blocks* application note on the Synopsys website.

---

## Control Signals Extraction for Registers (SLE)

The synthesis software supports extraction of control signals, the enable, synchronous set or reset, and asynchronous reset on the registers. The tool packs the enable with the EN pin, synchronous set or reset using *SLn* pin and asynchronous reset using *ALn* pin of the SLE.

When the fanout limit is 12, synchronous set or reset is packed using the *SLn* pin. If the fanout limit is less than 12, the tool inserts extra logic for the synchronous set or reset.

The tool supports packing of the enable signal, which has higher priority than the reset signal (synchronous) of the SLE.

## Initial Values for Registers (SLE)

Initial values are not supported on registers (SLE). If the initial value is specified for a register in the RTL code, the tool ignores the value and issues a warning. For the following Verilog code:

```
module test
  input clk,
  input [7:0] a,
  output [7:0] z);
  reg [7:0] z_reg = 8'hf0;
  reg one = 1'd1;
  always@(posedge clk)
    z_reg <= a + one;
  assign z = z_reg;
endmodule
```

The initial value for register *z\_reg* is specified, so the tool issues a warning message in the synthesis log report:

@W: FX1039|User-specified initial value defined for instance *z\_reg[7:0]* is being ignored.



## Wide MUX Inference

Wide MUXs are implemented using ARI1 primitives and is supported for PolarFire, RTG4, and SmartFusion2 technologies.

# Microsemi RAM Implementations

Refer to the following topics for Microsemi RAM implementations:

- [RAM for PolarFire](#)
- [RAM for RTG4](#)
- [RAM for SmartFusion2/IGLOO2](#)
- [PolarFire Asymmetric RAM support](#)
- [RAM Reporting](#)
- [Low Power RAM Inference](#)
- [URAM Inference for Sequential Shift Registers](#)
- [Async Reset and Dynamic Offset in Seqshifts](#)
- [Packing of Enable Signal on the Read Address Register](#)
- [Packing of INIT Value on LSRAM and URAM Blocks in PolarFire](#)
- [RAM Inference in ECC Mode](#)
- [PolarFire RAM Inference for ROM Support](#)
- [Write Byte-Enable Support for RAM](#)
- [RAMINDEX Support](#)

## RAM for PolarFire

The tool supports the following RAM primitives for the PolarFire device:

- RAM1K20 (LSRAM) is supported for both inference and instantiation.

The following configurations are supported for inference:

- True dual-port configuration
- Dual-port ROM
- Two independent data ports
- Non-ECC—1Kx20, 2Kx10, 4Kx5, 8Kx2 or 16Kx1 on each port
- Two-port configuration
- Read from port A and write to port B

- Non-ECC—512x40, 1Kx20, 2Kx10, 4Kx5, 8Kx2 or 16Kx1 on each port
- ECC—512x33 on both ports
  - Generates SB\_CORRECT and DB\_DETECT flags
- Write operations
  - Three modes—simple write, write feed-through, read before write
- Asymmetric RAM is supported. See [PolarFire Asymmetric RAM support](#), on page 392.
- RAM64x12 (USRAM) is supported for both inference and instantiation.

The following configurations are supported for inference:

- The RAM64x12 block contains 768 memory bits and is a two-port memory, providing one write port and one read port. Write operations for the RAM64x12 memory are synchronous. Read operations can be asynchronous or synchronous to set up the address and read out the data.
- Consists of one read-data port and one write-data port.
- Both read-data and write-data ports are configured to 64x12.

## RAM for RTG4

The software supports the following RAM primitives for the RTG4 device:

RAM1K18_RT	Maps to RAM1K18_RT for: <ul style="list-style-type: none"> <li>• Single-port, two-port, and dual-port synchronous read/write memory.</li> <li>• Read-before-write in dual-port mode for single-port and dual-port synchronous memory.</li> <li>• Read-enable extraction<sup>1</sup>.</li> </ul>
RAM64X18_RT	Maps to RAM64X18_RT for single-port, two-port, and three-port synchronous/asynchronous read and synchronous write memory.

1. Currently, read-enable extraction for wide RAM is not supported.

## Read-before-write mode not supported for RAM1K18\_RT primitive of RTG4

Read-before-write mode is not supported for the RTG4 RAM1K18\_RT RAM primitive. By default, when Read/Write Check insertion is OFF, RAM1K18\_RT is inferred in the mode in which Read-data port holds the previous value, with A\_WMODE/B\_WMODE set to 00.

When Read/Write Check insertion is ON, true dual-port RAM in Read-before-write mode errors out due to multiple write clocks or is implemented as registers if a single clock is present. Single-port RAM in Read-before-write mode is inferred as RAM64x18\_RT and logic.

## RAM for SmartFusion2/IGLOO2

Two types of RAM macros are supported: RAM1K18 and RAM64X18. The synthesis software extracts the RAM structure from the RTL and infers RAM1K18 or RAM64X18 based on the size of the RAM.

The default criteria for specifying the macro is described in the table below for the following RAM types.

True Dual-Port Synchronous Read Memory	The synthesis tool maps to RAM1K18, regardless of its memory size.
--	--

Simple Dual-Port or Single-Port Synchronous Memory	<p>If the size of the memory is:</p> <ul style="list-style-type: none"> <li>• 4608 bits or greater, the synthesis tool maps to RAM1K18.</li> <li>• Greater than 12 bits and less than 4608 bits, the synthesis tool maps to RAM64X18.</li> <li>• Less than or equal to 12 bits, the synthesis tool maps to registers.</li> </ul>
Simple Dual-Port or Single-Port Asynchronous Memory	<p>When the size of the memory is 12 bits or greater, the synthesis tool maps to RAM64x18. Otherwise, it maps to registers.</p>
Three-Port RAM Inference Support	<p>This feature supports SmartFusion2 and IGLOO2 devices only.</p> <ul style="list-style-type: none"> <li>• RAM64x18 is a 3-port memory that provides one Write port and two Read ports.</li> <li>• Write operation is synchronous, while read operations can be asynchronous or synchronous.</li> </ul> <p>The tool infers RAM64X18 for these structures.</p>

You can override the default behavior by applying the `syn_ramstyle` attribute to control how the memory gets mapped. To map to

- RAM1K18 set `syn_ramstyle = "lsram"`
- RAM64X18 set `syn_ramstyle = "uram"`
- Registers set `syn_ramstyle = "registers"`

The value you set for this attribute always overrides the default behavior.

## Three-Port RAM Inference Support

### Verilog Example 1: Three-Port RAM—Synchronous Read

```

module ram_infer15_rtl
    (clk,dinc,douta,doutb,wrc,rda,rdb,addra,addrb,addrc);
    input clk;
    input [17:0] dinc;
    input wrc,rda,rdb;
    input [5:0] addra,addrb,addrc;
    output [17:0] douta,doutb;
    reg [17:0] douta,doutb;
    reg [17:0] mem [0:63];

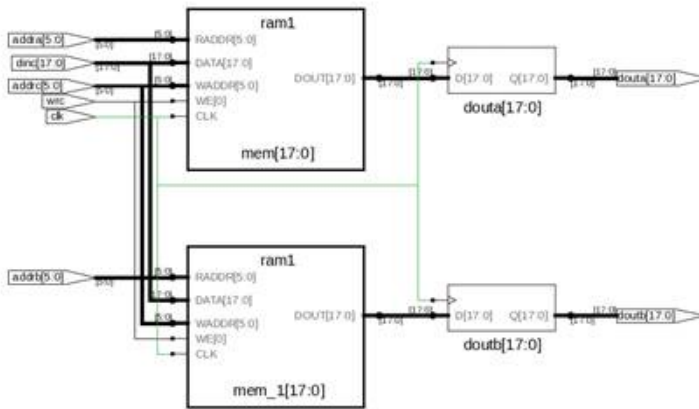
```

```
always@(posedge clk)
begin
if(wrc)
mem[addrc] <= dinc;
end

always@(posedge clk)
begin
douta <= mem[addra];
end

always@(posedge clk)
begin
doutb <= mem[addrb] ;
end
endmodule
```

RTL View:



The tool infers one RAM64X18.

## VHDL Example 2: Three-Port RAM—Asynchronous Read

```
library ieee;
use ieee.std_logic_1164.all;
use ieee.std_logic_unsigned.all;
entity ram_singleport_noreg is
port (d : in std_logic_vector(7 downto 0);
      addw : in std_logic_vector(6 downto 0);
      addr1 : in std_logic_vector(6 downto 0);
      addr2 : in std_logic_vector(6 downto 0);
      we : in std_logic;
      clk : in std_logic;
      q1 : out std_logic_vector(7 downto 0);
      q2 : out std_logic_vector(7 downto 0));
end ram_singleport_noreg;
architecture rtl of ram_singleport_noreg is
type mem_type is array (127 downto 0) of
std_logic_vector (7 downto 0);
signal mem: mem_type;
begin
process (clk)
begin
if rising_edge(clk) then
if (we = '1') then
mem(conv_integer (addw)) <= d;
end if;

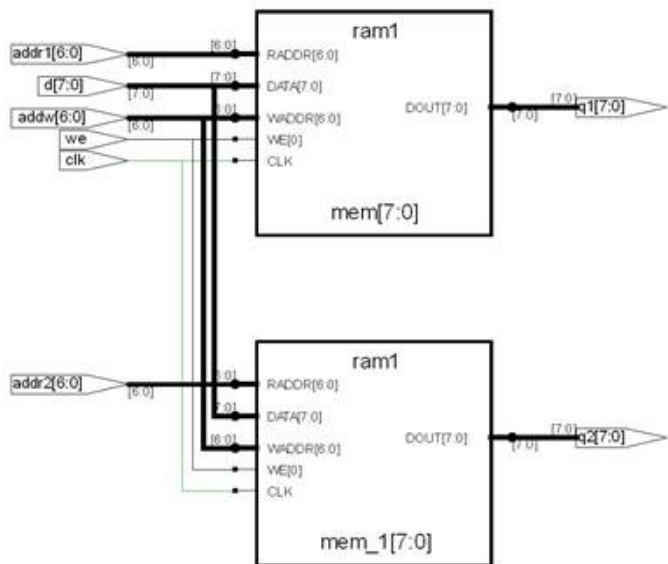
```

```

end if;
end process;
q1<= mem(conv_integer (addr1));
q2<= mem(conv_integer (addr2));
end rtl;

```

RTL View:



The tool infers one RAM64X18.

## PolarFire Asymmetric RAM support

Synthesis of asymmetric simple dual-port RAM is supported. Asymmetric RAM has different widths for read and write access ports. Read and write widths on RAM1K20 are configured independent of each other.

Two-port mode is also supported. For example, for a read configuration of 1Kx20, the following write configurations are supported:

- Write width < read width (4Kx5, 2Kx10)
- Write width > read width (512x40) (two-port mode)



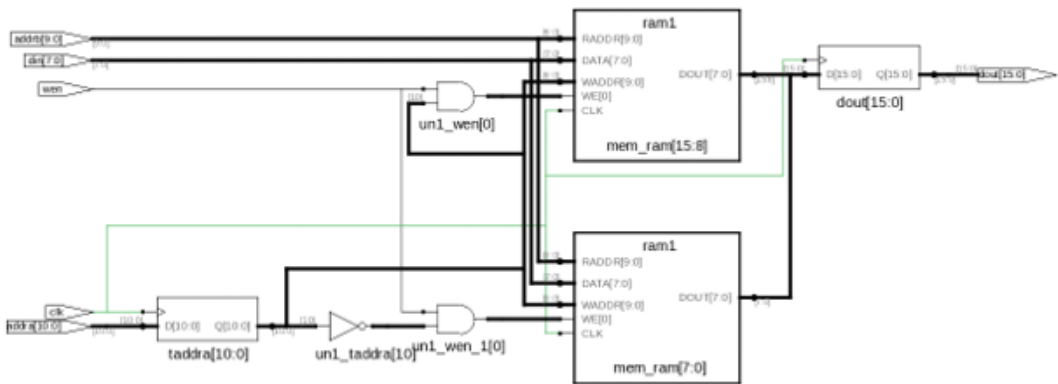
## Example 1—When Write Width < Read Width

In the RTL below, write access configuration is 2Kx8 and read access configuration is 1Kx16.

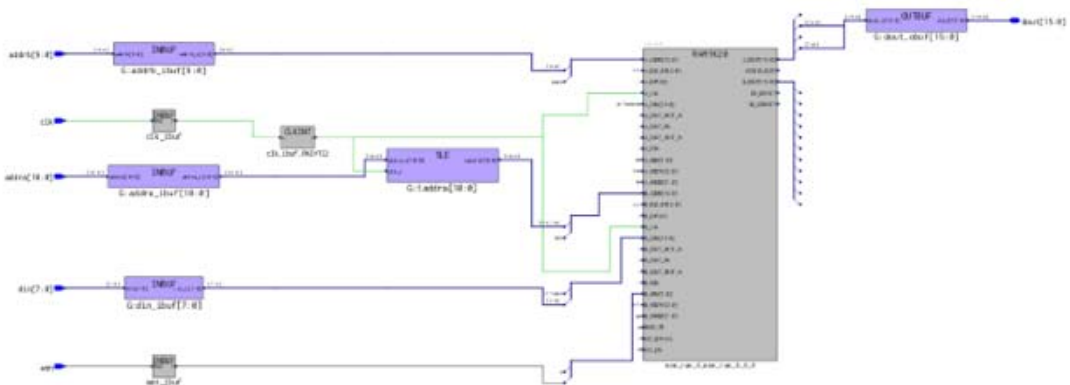
```
module asym_ram (din ,dout, addra, addrb, clk, wen);
input [7:0] din;
input wen;
input [10:0] addra;
output reg [15:0] dout;
input [9:0] addrb;
input clk;
localparam ratio= 2;
localparam max_depth=2048;
localparam min_width=8;
reg [10:0] taddra;
reg [min_width-1:0] mem_ram[max_depth-1:0];
always @(posedge clk)
begin
    if(wen)
        mem_ram[taddra]<=din;
        taddra<=addra;
end

always @(posedge clk)
begin // manual concatenation
    dout[min_width*0+:min_width]<=mem_ram[{0,addrb}]; // it can be
    // written inside generate-loop
    dout[min_width*1+:min_width]<=mem_ram[{1,addrb}];
end
endmodule
```

## RTL View



## Technology View

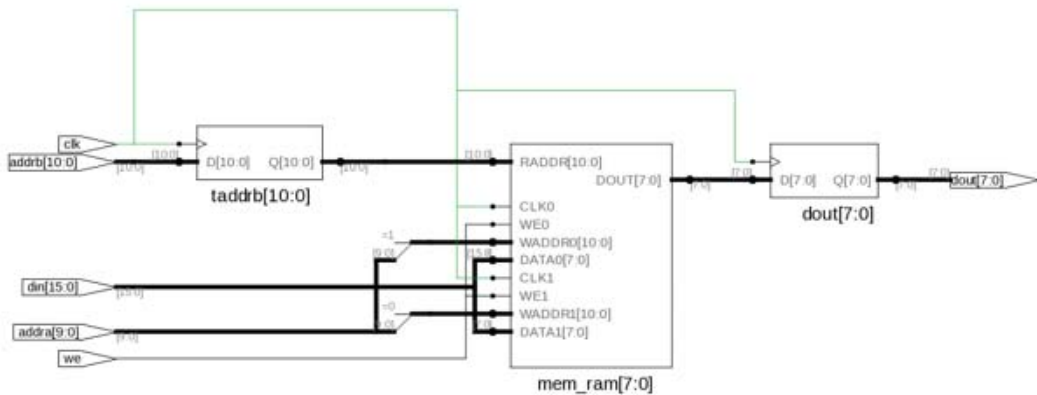


## Example 2—When Write Width > Read Width

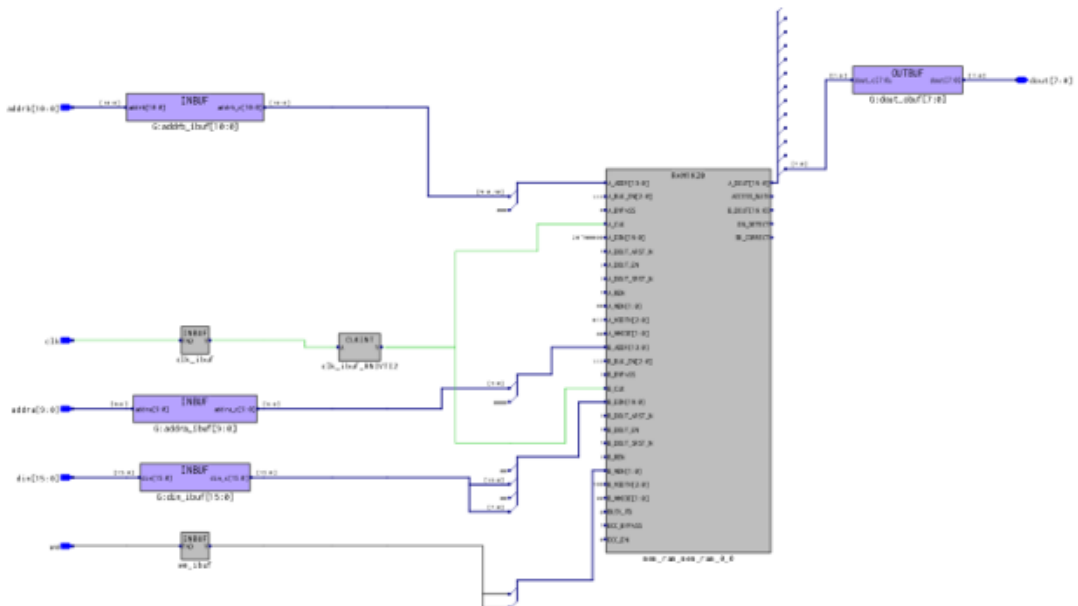
The code below implements asymmetric RAM with 1Kx16 write access and 2Kx8 read access configurations.

```
module asym_ram(din, dout, addra, addrb, clk, we);
input [15:0] din;
input [9:0] addra;
output reg [7:0] dout;
input [10:0] addrb;
input clk;
input we;
localparam max_depth=2048;
localparam min_width=8;
reg [min_width-1:0] mem_ram[max_depth-1:0];
reg [9:0] taddra;
reg [10:0] taddrb;
always @(posedge clk)
begin
dout<=mem_ram[taddrb];
taddrb<=addrb;
end
always @(posedge clk)
if (we)
begin
mem_ram[{0,addra}]<=din[min_width*0+:min_width];
mem_ram[{1,addra}]<=din[min_width*1+:min_width];
end
endmodule
```

## RTL View



## Technology View



## Attributes

RAM attributes, like `syn_ramstyle`, are applied to control the inference.

## Read Write Control Signals

Control signals are the same as that of symmetric RAM implementation:

- Enable read and write
- Synchronous and asynchronous reset on RAM registers
- RAM read-write mode (no change, write-first, read-first)
- Packing of RAM registers or pipelines

## Limitations

- Initial value is not supported.
- Asymmetric true dual-port RAM is not supported.
- Read/write logic check creation is not supported. If the read/write check option is enabled, then the RAM is implemented in symmetric mode.

## RAM Reporting

A detailed report is generated in the `{implname}_ram_rpt.txt` file with details of the LSRAM and URAMs inferred for a design.

## Low Power RAM Inference

*PolarFire, RTG4, SmartFusion2, and IGLOO2 Technologies*

Enhanced RAM inference uses the BLK pin of the RAM for reducing power consumption. By setting the global option `low_power_ram_decomp 1` in the project file, the tool fractures the wide RAMs on the address width, using the BLK pin of the RAM to reduce power consumption. By default, the tool fractures wide RAMs by splitting the data width to improve timing.

This feature is supported for single-port, simple-dual port, and true-dual port RAM modes.

## URAM Inference for Sequential Shift Registers

*PolarFire Technologies*

URAM inference is supported for sequential shift registers.

By default, `seqshift` is implemented using registers. The `syn_srstyle` attribute is used to override the default behavior of `seqshift` implementation using URAM. This attribute can be applied on the top-level module or on a `seqshift` instance in the RTL view, by dragging and dropping the instance to the SCOPE editor.

If the attribute is applied on the top-level module, the tool infers URAM for all the `seqshifts` in the design using the following threshold values:

Depth  $\geq 4$  and Depth\*Width  $> 36$

If the attribute is applied on the `seqshift` instance, the tool infers URAM irrespective of the threshold values.

### syn\_srstyle Values

Value	Description
Registers	<code>seqshifts</code> are inferred as registers.
URAM	<code>seqshift</code> is inferred as RAM64X12.

## syn\_srlstyle Syntax

---

FDC	define_attribute { <i>object</i> } syn_srlstyle {registers uram } define_global_attribute syn_srlstyle {registers uram }
Verilog	object /* synthesis syn_srlstyle = "registers   uram " */;
VHDL	attribute syn_srlstyle : string; attribute syn_srlstyle of <i>object</i> : signal is "registers   uram ";

---

## Example

The tool infers a seqshift primitive for the following HDL:

```
module p_seqshift(clk, we, din, dout);

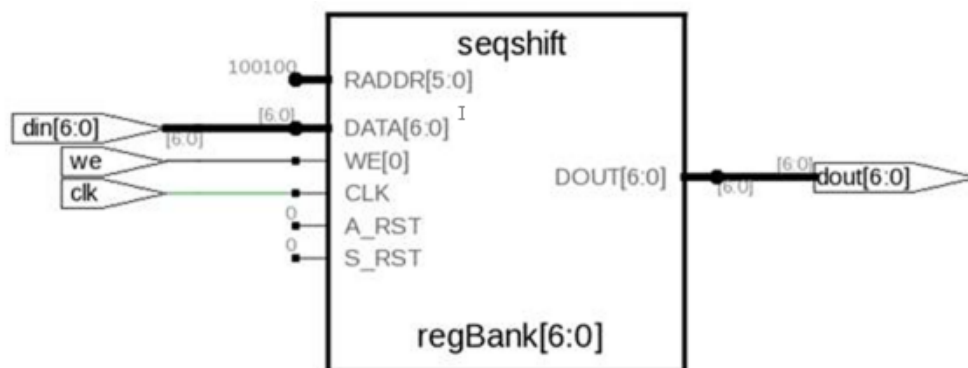
parameter SRL_WIDTH = 7;
parameter SRL_DEPTH = 37;

input clk, we;
input [SRL_WIDTH-1:0] din;
output [SRL_WIDTH-1:0] dout;
reg [SRL_WIDTH-1:0] regBank[SRL_DEPTH-1:0]
    /*synthesis syn_srlstyle = "uram"*/;
integer i;

always @(posedge clk) begin
    if (we) begin
        for (i=SRL_DEPTH-1; i>0; i=i-1) begin
            regBank[i] <= regBank[i-1];
        end
        regBank[0] <= din;
    end
end

assign dout = regBank[SRL_DEPTH-1];
endmodule
```

The seqshift generated for the HDL above is shown in technology view.



## Limitations

Limitations include the following:

- Seqshifts with both reset and set are inferred as registers.
- Seqshifts with enable signal having higher priority than synchronous set or synchronous reset are inferred as registers.

## Async Reset and Dynamic Offset in Seqshifts

The tool supports the packing of async reset and dynamic offset logic in seqshifts through the inference of RAM blocks in PolarFire devices.

## Packing of Enable Signal on the Read Address Register

*PolarFire and RTG4 Technologies*

The tool packs the enable signal on the read address register for the following:

- [PolarFire RAM1K20 and RAM64x12 Enhancements](#)
- [RTG4 RAM64x18, RAM64x18\\_RT, RAM1K18\\_RT Enhancements](#)



## PolarFire RAM1K20 and RAM64x12 Enhancements

The tool supports the packing of enable signal on the read address register into RAM1K20 (A\_REN) and RAM64x12 (R\_ADDR\_EN).

## RTG4 RAM64x18, RAM64x18\_RT, RAM1K18\_RT Enhancements

Packing of enable signal on the read address register into RAM1K18\_RT (A\_REN), RAM64x18 (A\_ADDR\_EN & B\_ADDR\_EN), and RAM64x18\_RT (A\_ADDR\_EN & B\_ADDR\_EN) is supported.

## Packing of INIT Value on LSRAM and URAM Blocks in PolarFire

INIT value packing is supported for RAM1K20 and RAM64x12 RAM blocks in the PolarFire device. It is also supported for ECC mode of RAM1K20 and SeqShifts inferred as URAMs. Here is some sample code:

```
module test (clk,we,waddr,raddr,din,q);
input clk,we;
input [addr_width - 1 : 0] waddr,raddr;
input [data_width - 1 : 0] din;
output [data_width - 1 : 0] q;
reg [data_width - 1 : 0] q;
reg [data_width - 1 : 0] mem [(2**addr_width) - 1 : 0];
initial $readmemb("mem1.dat", mem);
always @ (posedge clk)
    if(we) mem[waddr] <= din;
always @ (posedge clk )
    if(we) q <= din;
    else q <= mem[raddr];
endmodule
```

## RAM Inference in ECC Mode

### *PolarFire and RTG4 Technologies*

Enable Error Correction Code (ECC) using the `syn_ramstyle` attribute with the value shown below.

Attribute	Value	Description	Scope
<code>syn_ramstyle</code>	ECC	Enables RAM inference with ECC	FDC: Global, view, instance HDL: Module, architecture, memory

## ECC Error Flag Generation

To implement ECC error flag generation, use the following commands:

Command	Argument	Description
<code>syn_create_err_net</code>	<code>-name <i>newNetName</i></code>	Specifies the new net name to which the generated error flag is connected.
	<code>-inst i:<i>RAMInstance</i></code>	Specifies the instance name of the high reliability module for error monitoring.
	<code>[-single_bit   -double_bit]</code>	Specifies monitoring of a single-bit or double-bit error flag or both.
<code>syn_connect</code>	<code>-from n:<i>newNetName</i></code>	Specifies the net name created by the <code>syn_create_err_net</code> command.
	<code>-to [n:<i>existingNet</i>   t:<i>submodulePort</i>   p:<i>topPort</i>]</code>	Specifies the destination for the generated error flag, which can be: <ul style="list-style-type: none"> <li>• An existing net or a submodule</li> <li>• Output port or a top-level output port</li> </ul>

To control single-bit and double-bit error flag generation, use the `-single_bit/-double_bit` argument of the `syn_create_err_net` command.

<b>-inst</b>	<b>-single_bit   double_bit</b>	<b>Description</b>
<code>i:ECCRAMInstance</code>	None   Both	Create one error flag by ORing the following ports of all the SRAM blocks: A_SB_CORRECT B_SB_CORRECT A_DB_DETECT B_DB_DETECT
	-single_bit	Create one error flag by ORing the following ports of all the SRAM blocks: A_SB_CORRECT B_SB_CORRECT
	-double_bit	Create one error flag by ORing the following ports of the SRAM blocks: A_DB_DETECT B_DB_DETECT

### Example 1: Using ECC with FDC Constraints

```

module test (clka,clkb,rst,wea,addra,dataina,qa,web,
             addrb,dataainb,qb,error_flag);
parameter addr_width =10;
parameter data_width = 16;
input  clka,clkb,wea,web,rst;
input  [data_width - 1:0] dataina,dataainb;
input  [addr_width - 1:0] addra,addrb;
output error_flag;
output reg [data_width - 1:0] qa,qb;
reg [data_width - 1 : 0] mem [(2**addr_width) - 1:0]
    /* synthesis syn_ramstyle = "ecc" */;
always @ (posedge clka)

begin
    if(wea) mem[addra] <= dataina;
end
always @ (posedge clkb)
begin
    if (~rst)
        qa <=16'd0;

```

```

    else begin
        if(~wea)
            qa <= mem[addrb];
        end
    end
end
endmodule

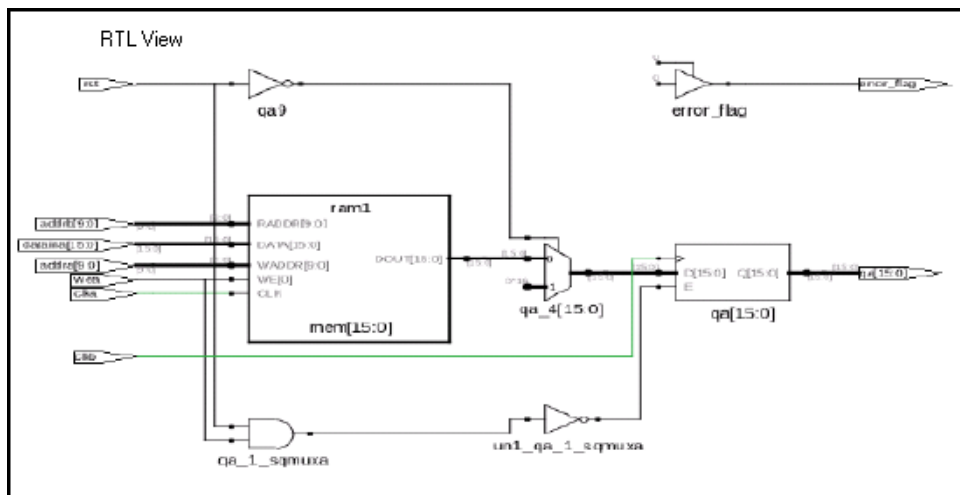
```

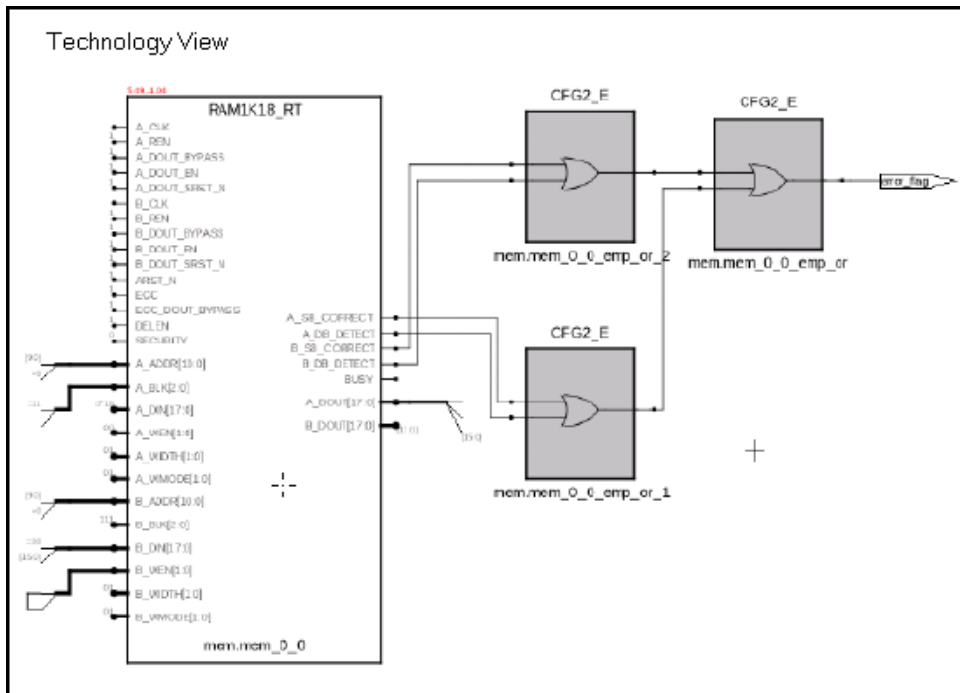
For the code above, specify the following constraints in the FDC file, where one error flag is specified for both single-bit and double-bit errors:

```

define_global_attribute {syn_ramstyle} {ecc}
syn_create_err_net {-name {error_net} -inst {i:mem[15:0]}}
syn_connect {-from {n:error_net} -to {p:error_flag}}

```

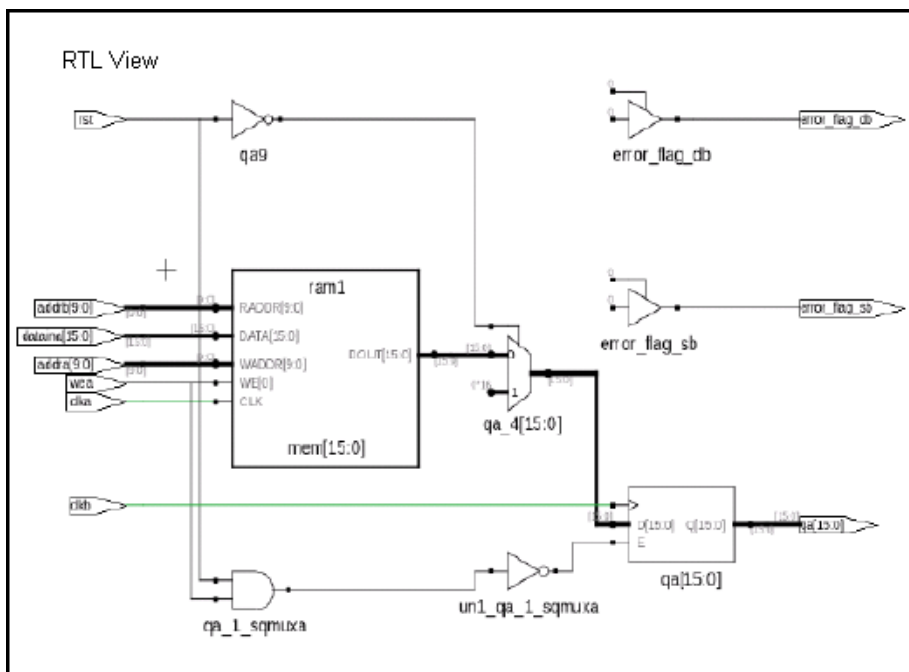


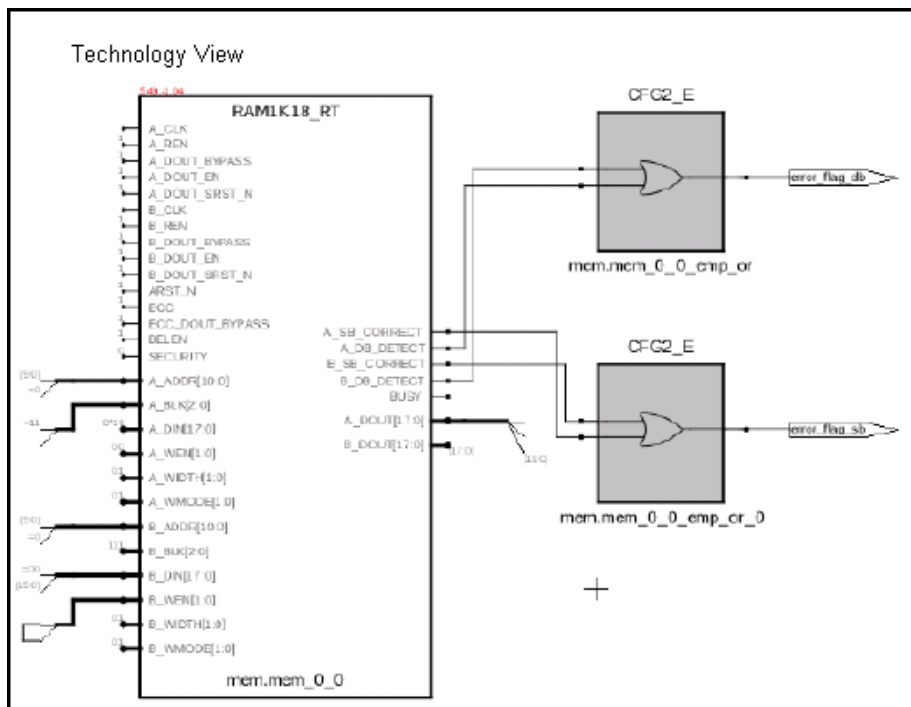


## Example 2: ECC with Single- and Double-bit Errors

For the code above, specify separate error flags for single-bit and double-bit errors.

```
define_attribute {i:mem[15:0]} {syn_ramstyle} {ecc}
syn_create_err_net {-name {error_net_sb} -inst {i:mem[15:0]} -
single_bit}
syn_connect {-from {n:error_net_sb} -to {p:error_flag_sb}}
syn_create_err_net {-name {db_error_net_db} -inst {i:mem[15:0]} -
double_bit}
syn_connect {-from {n:db_error_net_db} -to {p:db_error_flag_db}}
```





Along with ECC, you can enable the Single Event Transient (SET) mitigation using the `syn_ramstyle` attribute.

Attribute	Value	Description	Scope
<code>syn_ramstyle</code>	ECC, SET	Enables RAM inference with ECC or SET mitigation	FDC: Global, view, instance HDL: Module, architecture, memory

Pipeline stages can be inserted on the error flag path by including the bold options below with the `syn_create_err_net` command.

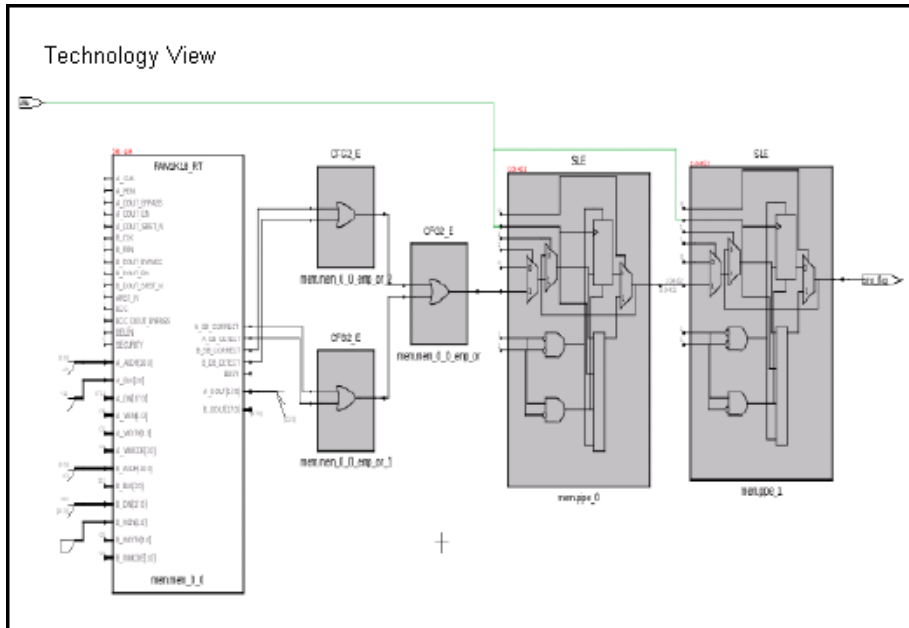
Command	Argument	Description
syn_create_err_net	-name <i>newNetName</i>	Specifies the new net name to which the generated error flag is connected.
	-inst <i>i:RAMInstance</i>	Specifies the instance name of the high reliability module for error monitoring.
	[-single_bit   -double_bit]	Specifies monitoring of a single-bit or double-bit error flag or both.
	[-err_pipe_num {#}]	{#} Specifies the number of pipeline stages to be introduced in the error flag path.
	[-err_clk {n:clockToThePipelineRegisters}]	Specifies the clock signal for the pipeline registers.

### Example 3: Pipeline Stages in the Error Flag Path with FDC Constraints

For the code above, specify the following FDC constraints to insert two pipeline stages in error flag path:

```
define_global_attribute {syn_ramstyle} {ecc}
syn_create_err_net {-name {error_net} -inst {i:mem[15:0]} -err_pipe_num {2}
  -err_clk {n:clkb}}
syn_connect {-from {n:error_net} -to {p:error_flag}}
```





## Limitations

Inferring ECC pipeline stages (ECC\_DOUT\_BYPASS = 0) is not supported.

## PolarFire RAM Inference for ROM Support

By default, ROM is implemented using RAM1K20 and RAM64x12 depending on the RAM threshold values. The RAM is inferred in non-low (speed) mode. Asynchronous ROM is always mapped to RAM64x12.

Use the `syn_romstyle` attribute to override the default behavior of the ROM implementation with RAM or logic.

The `syn_romstyle` attribute can be used to determine the implementation of the ROM components as follows:

FDC	define_attribute {object} syn_romstyle {logic uram lsram} define_global_attribute syn_romstyle {logic uram lsram}
Verilog	object /* synthesis syn_romstyle = "logic   uram   lsram" */ ;
VHDL	attribute syn_romstyle : string; attribute syn_romstyle of object : signal is "logic   uram   lsram";

The syn\_romstyle values are:

Value	Description
logic	ROM is inferred as registers or LUTs.
uram lsram	ROM is inferred as RAM1K20 or RAM64x12. Asynchronous ROM is mapped to RAM64x12 even if the lsram attribute is applied.

### Example 1

```

module test(clk,addr,dataout);
  input clk;
  parameter addr_width = 10;
  parameter data_width = 20;
  input [addr_width-1:0] addr;
  output [data_width-1:0] dataout;
  reg [data_width-1:0] dataout;
  always @ (posedge clk )
  case (addr)
    10'd0 : dataout <= 20'b01000110000010001100;
    10'd1 : dataout <= 20'b11100000110110011100;
    10'd2 : dataout <= 20'b10110101101111011001;
    10'd3 : dataout <= 20'b01111010011000000000;
    10'd4 : dataout <= 20'b00110110100111111100;
    10'd5 : dataout <= 20'b11110101000010001010;
    10'd6 : dataout <= 20'b00010010110101000110;
    10'd7 : dataout <= 20'b01001001010010100110;
    10'd8 : dataout <= 20'b01110111000111111011;
    10'd9 : dataout <= 20'b10010101111110111110;
    ...
    ...
    10'd1015 : dataout <= 20'b11011010000111111101;
    10'd1016 : dataout <= 20'b11001000101001110111;
    10'd1017 : dataout <= 20'b01010000111100100011;
    10'd1018 : dataout <= 20'b11000110011011011011;
    10'd1019 : dataout <= 20'b10000000110101100110;
  endcase
endmodule

```

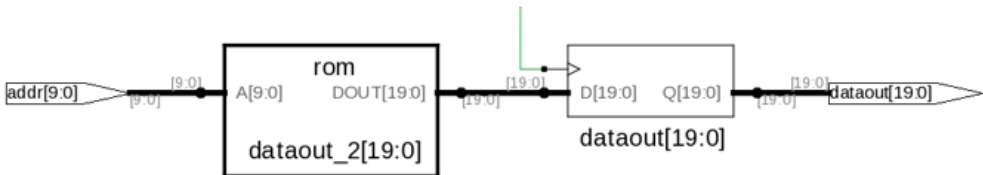
```

10'd1020 : dataout <= 20'b11100101010001001011;
10'd1021 : dataout <= 20'b10010011000110001010;
10'd1022 : dataout <= 20'b00100000110010000101;
10'd1023 : dataout <= 20'b10001010000011111010;
default : dataout <= 20'b00000000000000000000;
endcase

endmodule

```

The following ROM is displayed in the SRS view of the tool for the RTL above. The tool infers RAM1K20 for the ROM below.



## Example 2

```

module test (addr,dataout);
parameter addr_width = 8;
parameter data_width = 10;
input [addr_width - 1 : 0] addr;
output [data_width - 1 : 0] dataout;
reg [data_width - 1 : 0] mem [(2**addr_width) - 1 : 0] ;
initial $readmemh("mem256x10_hex.list", mem);
assign dataout = mem[addr];
endmodule

```

The following ROM is displayed in the SRS view of the tool for the RTL above. Since this is an asynchronous ROM, the tool infers RAM64x12.



## Write Byte-Enable Support for RAM

For RAM with  $n$  write enables used to control writing of data into memory locations, the compiler creates  $n$  sub-instances of the RAM with different write enables. The mapper merges these multiple RAM blocks into single or multiple block RAM, depending on the threshold and number of write enables. The write byte-enable pin (A\_WEN/B\_WEN [1:0]) of the block RAM primitives are configured to control the write operation for block RAMs.

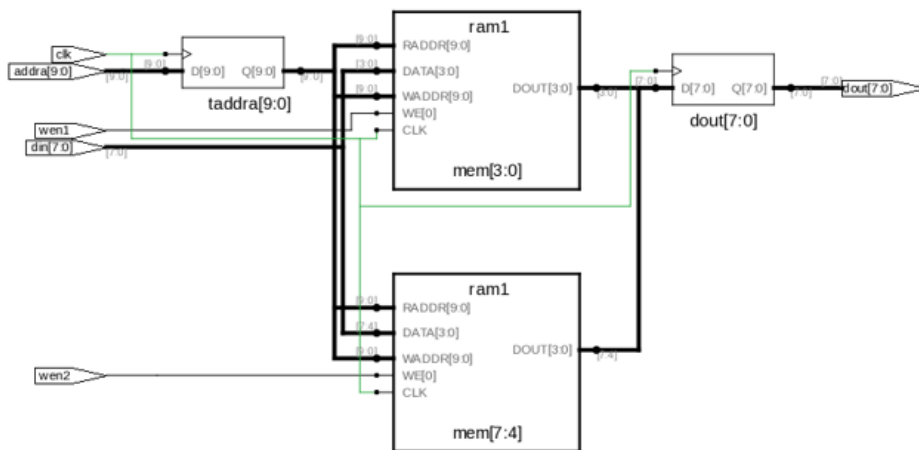
### Example

```
module ram (din, dout, addra, addrb, clk, wen1, wen2);
  input [7:0] din;
  input wen1;
  input wen2;
  input [9:0] addra;
  input clk;
  output reg [7:0] dout;
  localparam max_depth=1024;
  localparam min_width=8;
  reg [9:0] taddra;
  reg [min_width-1:0] mem_ram[max_depth-1:0];

  always @(posedge clk)
  begin
    taddra<=addra;
    if(wen1)
      mem_ram[taddra][3:0]<=din[3:0];

    if(wen2)
      mem_ram[taddra][7:4]<=din[7:4];
  end
  always @(posedge clk)
  begin
    dout <= mem_ram[taddra];
  end
endmodule
```

The compiler infers two ram1 shown in the SRS view below, which can be combined and mapped into a single RAM1K18\_RT or RAM1K20.



## RAMINDEX Support

The RAMINDEX attribute is supported for all inferred RAMs of RTG4, SmartFusion2, IGLOO2 and PolarFire devices.

# Microsemi Constraints and Attributes

The synthesis tools let you specify timing constraints, general HDL attributes, and Microsemi-specific attributes to improve your design. You can manage the attributes and constraints in the SCOPE interface. The following topics explain how to implement constraints and attributes for Microsemi designs. Refer to:

- [Global Buffer Promotion](#), on page 414
- [The syn\\_maxfan Attribute in Microsemi Designs](#), on page 415
- [Radiation-tolerant Applications](#), on page 416

## Global Buffer Promotion

*PolarFire, RTG4, SmartFusion2, IGLOO2 Technologies*

The synthesis software inserts the global buffer (CLKINT) on clock, asynchronous set/reset, and data nets based on a threshold value. The supported devices have specific threshold values that cannot be changed for the different types of nets in the design. Inserting global buffers on nets with fanout greater than the threshold can help reduce the route delay during place and route.

Net	Global buffer inserted for threshold value > or =
PolarFire Devices	
Clock	2
Asynchronous Set/Reset	6
Data	5000
RTG4 Devices	
Clock	2
Asynchronous Set/Reset	200000
Data	5000
SmartFusion2 and IGLOO2 Devices	

Net	Global buffer inserted for threshold value > or =
Clock	2
Asynchronous Set/Reset	12
Data	5000

To override these default option settings you can:

- Use the `syn_noclockbuf` attribute on a net that you do not want a global buffer inserted, even though fanout is greater than the threshold.
- Use `syn_insert_buffer="CLKINT"` so that the tool inserts a global buffer on the particular net, which is less than the threshold value. You can only specify CLKINT as a valid value for SmartFusion2 devices.

## The `syn_maxfan` Attribute in Microsemi Designs

The `syn_maxfan` attribute is used to control the maximum fanout of the design, or an instance, net, or port. The limit specified by this attribute is treated as a hard or soft limit depending on where it is specified. The following rules described the behavior:

- Global fanout limits are usually specified with the fanout guide options (Project->Implementation Options->Device), but you can also use the `syn_maxfan` attribute on a top-level module or view to set a global soft limit. This limit may not be honored if the limit degrades performance. To set a global hard limit, you must use the Hard Limit to Fanout option.
- A `syn_maxfan` attribute can be applied locally to a module or view. In this case, the limit specified is treated as a soft limit for the scope of the module. This limit overrides any global fanout limits for the scope of the module.
- When a `syn_maxfan` attribute is specified on an instance that is not of primitive type inferred by Synopsys FPGA compiler, the limit is considered a soft limit which is propagated down the hierarchy. This attribute overrides any global fanout limits.
- When a `syn_maxfan` attribute is specified on a port, net, or register (or any primitive instance), the limit is considered a hard limit. This attribute overrides any other global fanout limits. Note that the `syn_maxfan` attribute does not prevent the instance from being optimized away and that

design rule violations resulting from buffering or replication are the responsibility of the user.

## Radiation-tolerant Applications

You can specify the radiation-resistant design technique to use on an object for a design with the `syn_radhardlevel` attribute. This attribute can be applied to a module/architecture or a register output signal (inferred register in VHDL), and is used in conjunction with the Microsemi macro files supplied with the software.

Values for `syn_radhardlevel` are as follows:

Value	Description
none	Standard design techniques are used.
cc	Combinational cells with feedback are used to implement storage rather than flip-flop or latch primitives.
tmr	Triple module redundancy or triple voting is used to implement registers. Each register is implemented by three flip-flops or latches that “vote” to determine the state of the register.
tmr_cc	Triple module redundancy is used where each voting register is composed of combinational cells with feedback rather than flip-flop or latch primitives.

For details, see:

- [Working with Microsemi Radhard Designs, on page 542](#)
- [syn\\_radhardlevel, on page 195](#)



# Microsemi Device Mapping Options

To achieve optimal design results, set the correct implementation options. Some options include the following:

- [I/O Insertion](#), on page 418
- [Update Compile Point Timing Data Option](#), on page 419
- [Operating Condition Device Option](#), on page 420

## See Also

- [Microsemi set\\_option Command Options](#), on page 423
- [Microsemi Tcl set\\_option Command Options](#), on page 424

## Promote Global Buffer Threshold

The Promote Global Buffer Threshold option is used for both ports and nets.

The Tcl command equivalent is `set_option -globalthreshold value`, where the value refers to the minimum number of fanout loads. The default value is 1.

Only signals with fanout loads larger than the defined value are promoted to global signals. The synthesis tool assigns the available global buffers to drive these signals using the following priority:

1. Clock
2. Asynchronous set/reset signal
3. Enable, data

## SmartFusion2, IGLOO2, and RTG4 Global Buffer Promotion

The synthesis software inserts the global buffer (CLKINT) on clock, asynchronous set/reset, and data nets based on a threshold value. SmartFusion2, IGLOO2, and RTG4 devices have specific threshold values that cannot be changed for the different types of nets in the design. Inserting global buffers on nets with fanout greater than the threshold can help reduce the route delay during place and route.

The threshold values for SmartFusion2 and IGLOO2 devices are the following:

<b>Net</b>	<b>Global buffer inserted for threshold value &gt; or =</b>
Clock	2
Asynchronous Set/Reset	12
Data	5000

The threshold values for RTG4 devices are the following:

<b>Net</b>	<b>Global buffer inserted for threshold value &gt; or =</b>
Clock	2
Asynchronous Set/Reset	200000
Data	5000

To override these default option settings you can:

- Use the `syn_noclockbuf` attribute on a net that you do not want a global buffer inserted, even though fanout is greater than the threshold.
- Use `syn_insert_buffer="CLKINT"` so that the tool inserts a global buffer on the particular net, which is less than the threshold value. You can specify `CLKINT`, `RCLKINT`, `CLKBUF`, or `CLKBIBUF` as values for SmartFusion2, RTG4, and IGLOO2 devices.

## I/O Insertion

The Synopsys FPGA synthesis tool inserts I/O pads for inputs, outputs, and bidirectionals in the output netlist unless you disable I/O insertion. You can control I/O insertion with the Disable I/O Insertion option (Project->Implementation Options->Device).

If you do not want to automatically insert any I/O pads, check the Disable I/O Insertion box (Project->Implementation Options->Device). This is useful to see how much area your blocks of logic take up, before synthesizing an entire FPGA. If you disable automatic I/O insertion, you will not get any I/O pads in your design unless you manually instantiate them yourself.

If you disable I/O insertion, you can instantiate the Microsemi I/O pads you need directly. If you manually insert I/O pads, you only insert them for the pins that require them.

## Update Compile Point Timing Data Option

*PolarFire, SmartFusion2, IGLOO2Technologies*

The Update Compile Point Timing Data option used with the Synopsys FPGA compile-point synthesis flow lets you break down a design into smaller synthesis units, called *compile points*, making incremental synthesis possible. See [Synthesizing Compile Points, on page 455](#) in the *User Guide*.

The Update Compile Point Timing Data option controls whether or not changes to a locked compile point force remapping of its parents, taking into account the new timing model of the child.

---

**Note:** To simplify this description, the term *child* is used here to refer to a compile point that is contained inside another; the term *parent* is used to refer to the compile point that contains the child. These terms are thus not used here in their strict sense of direct, immediate containment: If a compile point A is nested in B, which is nested in C, then A and B are both considered children of C, and C is a parent of both A and B. The top level is considered the parent of all compile points.

---

### Disabled

When the Update Compile Point Timing Data option is *disabled* (the default), only (locked) compile points that have changed are remapped, and their remapping does *not* take into account changes in the timing models of any of their children. The old (pre-change) timing model of a child is used, instead, to map and optimize its parents.

An exceptional case occurs when the option is disabled and the *interface* of a locked compile point is changed. Such a change requires that the immediate parent of the compile point be changed accordingly, so both are remapped. In this exceptional case, however, the *updated* timing model (not the old model) of the child is used when remapping this parent.

## Enabled

When the Update Compile Point Timing Data option is *enabled*, locked compile-point changes are taken into account by updating the timing model of the compile point and resynthesizing all of its parents (at all levels), using the updated model. This includes any compile point changes that took place prior to enabling this option, and which have not yet been taken into account (because the option was disabled).

The timing model of a compile point is updated when either of the following is true:

- The compile point is remapped, and the Update Compile Point Timing Data option is enabled.
- The interface of the compile point is changed.

## Automatic Compile Points

### *PolarFire Technology*

This feature is enabled, by default, only for PolarFire devices.

The tool supports the Automatic Compile Points (ACP) flow. For details, see [The Automatic Compile Point Flow, on page 456](#) in the *User Guide*.

## Operating Condition Device Option

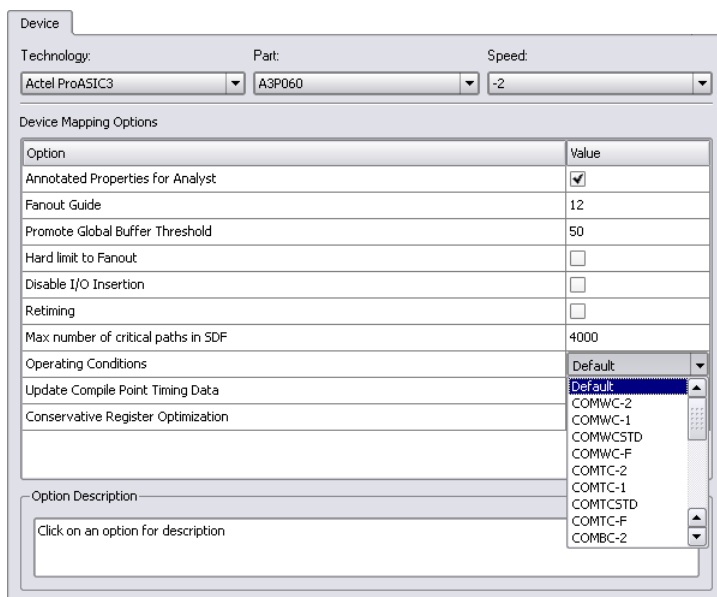
You can specify an operating condition for certain Microsemi technologies:

- PolarFire
- RTG4
- SmartFusion2
- IGLOO2

Different operating conditions cause differences in device performance. The operating condition affects the following:

- optimization, if you have timing constraints
- timing analysis
- timing reports

To set an operating condition, select the value for Operating Conditions from the menu on the Device tab of the Implementation Options dialog box.



To set an operating condition in a project or Tcl file, use the command:

```
set_option -opcond value
```

where *value* can be specified like the following typical operating conditions:

Default	Typical timing
MIL-WC	Worst-case Military timing
MIL-TC	Typical-case Military timing
MIL-BC	Best-case Military timing
Automotive-WC	Worst-case Automotive timing

## For Example

The Microsemi operating condition can contain any of the following specifications:

- MIL—military
- COM—commercial
- IND—Industrial
- TGrade1
- TGrade2

as well as, include one of the following designations:

- WC—worst case
- BC—best case
- TC—typical case

For specific operating condition values for your required technology, see the Device tab on the Implementation Options dialog box.

Even when a particular operating condition is valid for a family, it may not be applicable to every part/package/speed-grade combination in that family. Consult Microsemi's documentation or software for information on valid combinations and more information on the meaning of each operating condition.

## Microsemi set\_option Command Options

To select device mapping options for Microsemi technologies, select Project -> Implementation Options->Device and set the options.

Option	For details, see ...
Automatic Read/Write Check Insertion for RAM	Enabling this option automatically inserts bypass logic when required to prevent simulation mismatch in read-during-write scenarios. For asynchronous clocks, the tool will not generate bypass logic which can cause unintended CDC paths between the clocks. For more information about using this option in conjunction with the <code>syn_ramstyle</code> attribute, see <a href="#">syn_ramstyle</a> , on page 199.
Conservative Register Optimization	See the <a href="#">Microsemi Tcl set_option Command Options</a> , on page 424 for more information about the <code>preserve_registers</code> option.
Disable I/O Insertion	<a href="#">I/O Insertion</a> , on page 418.
Fanout Guide	<a href="#">Setting Fanout Limits</a> , on page 418 of the <i>User Guide</i> and <a href="#">The syn_maxfan Attribute in Microsemi Designs</a> , on page 415.
Operating Conditions (certain technologies)	<a href="#">Operating Condition Device Option</a> , on page 420
Promote Global Buffer Threshold	<a href="#">Controlling Buffering and Replication</a> , on page 420 of the <i>User Guide</i> and <a href="#">Promote Global Buffer Threshold</a> , on page 417.
Resolve Mixed Drivers	When a net is driven by a VCC or GND and active drivers, enable this option to connect the net to the VCC or GND driver.
Update Compile point Timing Data	<a href="#">Update Compile Point Timing Data Option</a> , on page 419

## Microsemi Tcl set\_option Command Options

You can use the `set_option` Tcl command to specify the same device mapping options as are available through the Implementation Options dialog box displayed in the Project view with Project -> Implementation Options (see [in the User Guide Implementation Options Command, on page 342](#)).

This section describes the Microsemi-specific `set_option` Tcl command options. These include the target technology, device architecture, and synthesis styles.

The table below provides information on specific options for Microsemi architectures. For a complete list of options for this command, refer to [set\\_option, on page 110](#). You cannot specify a package (`-package` option) for some Microsemi technologies in the synthesis tool environment. You must use the Microsemi back-end tool for this.

Option	Description
<b>-technology</b> <i>keyword</i>	Sets the target technology for the implementation. Keyword must be one of the following Microsemi architecture names: IGLOO2, SmartFusion2, RTG4, PolarFire.
<b>-part</b> <i>partName</i>	Specifies a part for the implementation. Refer to the Implementation Options dialog box for available choices.
<b>-package</b> <i>packageName</i>	<i>RTG4 and PolarFire families</i> Specifies the package. Refer to Project-> Implementation Options->Device for available choices.
<b>-speed_grade</b> <i>value</i>	Sets the speed grade for the implementation. Refer to the Implementation Options dialog box for available choices.
<b>-disable_io_insertion</b> 1   0	Prevents (1) or allows (0) insertion of I/O pads during synthesis. The default value is <code>false</code> (enable I/O pad insertion). For additional information about disabling I/O pads, see <a href="#">I/O Insertion, on page 418</a> .
<b>-fanout_limit</b> <i>value</i>	Sets the fanout limit guideline for the current project. For more information about fanout limits, see <a href="#">The syn_maxfan Attribute in Microsemi Designs, on page 415</a> .



Option	Description
<b>-globalthreshold</b> <i>value</i>	<i>PolarFire</i> Sets the minimum fanout load value. For more information, see <a href="#">Promote Global Buffer Threshold, on page 417</a> .
<b>-opcond</b> <i>value</i>	<i>PolarFire, IGLOO2</i> Sets the operating condition for device performance in the areas of optimization, timing analysis, and timing reports. Values are Default, MIL-WC, IND-WC, COM-WC, and Automotive-WC. See <a href="#">Operating Condition Device Option, on page 420</a> for more information.
<b>-preserve_registers</b> 1 0	When enabled, the software uses less restrictive register optimizations during synthesis if area is not as great a concern for your device. The default for this option is disabled (0).
<b>-resolve_multiple_driver</b> 1 0	When a net is driven by a VCC or GND and active drivers, enable this option to connect the net to the VCC or GND driver.
<b>-rw_check_on_ram</b> 1   0	Enabling this option automatically inserts bypass logic when required to prevent simulation mismatch in read-during-write scenarios. For asynchronous clocks, the tool will not generate bypass logic which can cause unintended CDC paths between the clocks. For more information about using this option in conjunction with the <code>syn_ramstyle</code> attribute, see <a href="#">syn_ramstyle, on page 199</a> .
<b>-update_models_cp</b> 1   0	<i>PolarFire, IGLOO2</i> Determines whether (1) or not (0) changes to a locked compile point force remapping of its parents, taking into account the new timing model of the child. See <a href="#">Update Compile Point Timing Data Option, on page 419</a> , for details.

# Microsemi Output Files and Forward Annotation

The following procedures show you how to pass information or files that forward annotate information to the Microsemi place-and-route tool. This section describes the following:

- [VM Flow Support](#), on page 426
- [Specifying Pin Locations](#), on page 427
- [Specifying Locations for Microsemi Bus Ports](#), on page 428
- [Specifying Macro and Register Placement](#), on page 429
- [Synthesis Reports](#), on page 429

After synthesis, the software generates a log file and output files for forward annotation to the Microsemi P&R tool as described in some of the reports.

## VM Flow Support

The tool generates a Verilog output netlist (.vm) for the PolarFire, SmartFusion2, RTG4 and IGLOO2 devices for the P&R flow. After synthesis, the tool:

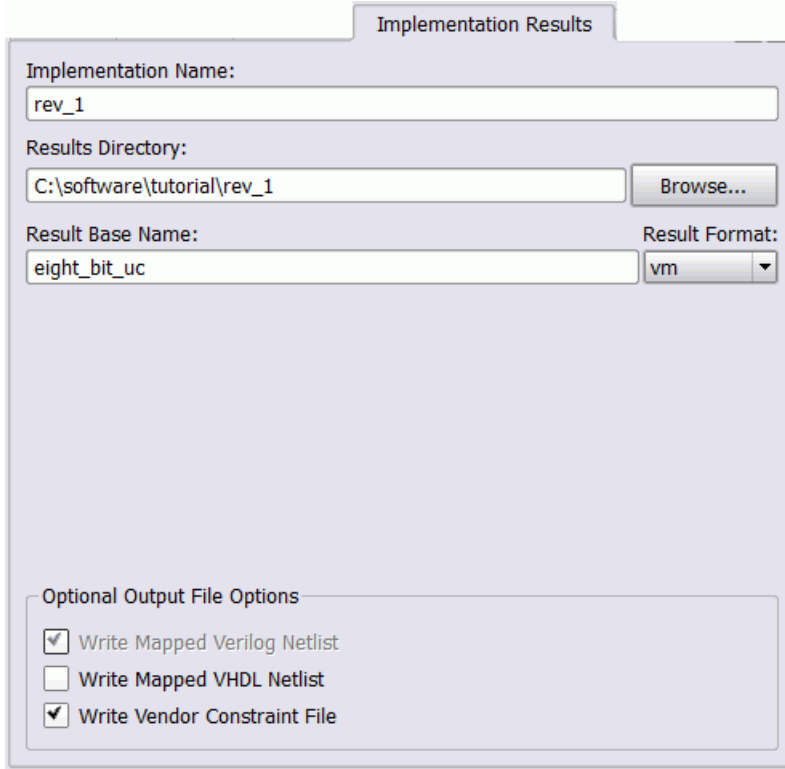
- Writes a separate SDC file (\*\_vm.sdc).
- Writes a separate TCL file (\*\_partition\_vm.tcl) to forward annotate the timestamps on instances in an incremental compile point flow.
- Forward annotates properties like RTL attributes in the .vm netlist and constraints in an SDC file.

By default, the tool generates a .vm netlist. You can change the netlist from Verilog to EDIF.

The tool now supports the Libero Enhanced constraint flow by default. To disable this flow, the following switch needs to be added in the Synplify Pro project .prj file:

```
set_option -microsemi_enhanced_flow 0
```

To select a Verilog output netlist, go to Implementation Options->Implementation Results->Result Format. Select vm from the drop-down menu, click OK and save the project.



The image shows a software dialog box titled "Implementation Results". It contains several input fields and a section for optional output file options. The "Implementation Name" field is set to "rev\_1". The "Results Directory" field is set to "C:\software\tutorial\rev\_1", with a "Browse..." button to its right. The "Result Base Name" field is set to "eight\_bit\_uc", and the "Result Format" dropdown menu is set to "vm". At the bottom, there is a section titled "Optional Output File Options" with three checkboxes: "Write Mapped Verilog Netlist" (checked), "Write Mapped VHDL Netlist" (unchecked), and "Write Vendor Constraint File" (checked).

Implementation Results	
Implementation Name: rev_1	
Results Directory: C:\software\tutorial\rev_1	Browse...
Result Base Name: eight_bit_uc	Result Format: vm
Optional Output File Options	
<input checked="" type="checkbox"/> Write Mapped Verilog Netlist	
<input type="checkbox"/> Write Mapped VHDL Netlist	
<input checked="" type="checkbox"/> Write Vendor Constraint File	

## Specifying Pin Locations

In certain technologies you can specify pin locations that are forward-annotated to the corresponding place-and-route tool. The following procedure shows you how to specify the appropriate attributes. For information about other placement properties, see [Specifying Macro and Register Placement, on page 429](#).

1. Start with a design using an appropriate Microsemi technology.
2. Add the appropriate attribute to the port. For a bus, list all the bus pins, separated by commas. To specify Microsemi bus port locations, see [Specifying Locations for Microsemi Bus Ports, on page 428](#).
  - To add the attribute from the SCOPE interface, click the Attributes tab and specify the appropriate attribute and value.

- To add the attribute in the source files, use the appropriate attribute and syntax. For details about the attributes in the tables, see the *Attribute Reference Manual*.

Vendor Family	Attribute and Value
Microsemi	syn_loc { <i>pin_number</i> } or alspin { <i>pin_number</i> }

## Specifying Locations for Microsemi Bus Ports

You can specify pin locations for Microsemi bus ports. To assign pin numbers to a bus port, or to a single- or multiple-bit slice of a bus port, do the following:

1. Open the constraint file and add these attributes to the design.
2. Specify the `syn_noarrayports` attribute globally to bit blast all bus ports in the design.

```
define_global_attribute syn_noarrayports {1};
```

3. Use the `alspin` attribute to specify pin locations for individual bus bits. This example shows locations specified for individual bits of bus ADDRESS0.

```
define_attribute {ADDRESS0[4]} alspin {26}
define_attribute {ADDRESS0[3]} alspin {30}
define_attribute {ADDRESS0[2]} alspin {33}
define_attribute {ADDRESS0[1]} alspin {38}
define_attribute {ADDRESS0[0]} alspin {40}
```

The software forward-annotates these pin locations to the place-and-route software.

## Specifying Macro and Register Placement

You can use attributes to specify macro and register placement in Microsemi designs. The information here supplements the pin placement information described in [Specifying Pin Locations, on page 427](#) and bus pin placement information described in [Specifying Locations for Microsemi Bus Ports, on page 428](#).

For ...	Use ...
Relative placement of Microsemi macros and IP blocks	<a href="#">alsloc</a> <code>define_attribute {u1} alsloc {R15C6}</code>

## Synthesis Reports

The synthesis tool generates a resource usage report, a timing report, and a net buffering report for the Microsemi designs that you synthesize. To view the synthesis reports, click View Log.

# Integration with Microsemi Tools and Flows

The following procedures provide Microsemi-specific design tips.

- [Compile Point Synthesis](#), on page 430
- [Incremental Synthesis Flow](#), on page 431
- [Using Predefined Microsemi Black Boxes](#), on page 431
- [Using Smartgen Macros](#), on page 432
- [Microsemi Place-and-Route Tools](#), on page 432

## Compile Point Synthesis

*Microsemi PolarFire*

Compile-point synthesis is available when you want to isolate portions of a design in order to stabilize results and/or improve runtime performance during placement and routing, the Synopsys FPGA The compile-point synthesis flow lets you achieve incremental design and synthesis without having to write and maintain sets of complex, error-prone scripts to direct synthesis and keep track of design dependencies. See [Synthesizing Compile Points, on page 455](#) for a description, and [Working with Compile Points, on page 435](#) in the *User Guide* for a step-by-step explanation of the compile-point synthesis flow.

In device technologies that can take advantage of compile points, you break down your design into smaller synthesis units or *compile points*, in order to make incremental synthesis possible. A compile point is a module that is treated as a block for incremental mapping: When your design is resynthesized, compile points that have already been synthesized are not resynthesized, unless you have changed:

- the HDL source code in such a way that the design logic is changed,
- the constraints applied to the compile points, or
- the device mapping options used in the design.

(For details on the conditions that necessitate resynthesis of a compile point, see [Compile Point Basics, on page 436](#), and [Update Compile Point Timing Data Option, on page 419](#).)

## Incremental Synthesis Flow

### *Microsemi IGLOO2 and SmartFusion2 Technologies*

The synthesis tool provides timestamps for each manual compile point in the \*\_partition.tcl file. You can use the timestamps to check whether the compile point was resynthesized in an incremental run of the tool.

To run this flow:

1. Define compile point constraint on the modules in the design. For example:

```
define_compile_point {viewName} -type {locked, partition}  
-cpfile {fileName}
```

2. Run the standard synthesis flow. The synthesis tool writes the timestamps for each compile point in the *designName\_partition.tcl* file. For example:

```
set_partition_info -name partitionName -timestamp timestamp
```

For an incremental synthesis run, only affected compile points display new timestamps, while unaffected compile points retain the same timestamps.

Check the Compile Point Summary report available in the log file.

## Using Predefined Microsemi Black Boxes

The Microsemi macro libraries contain predefined black boxes for Microsemi macros so that you can manually instantiate them in your design. For information about using ACTGen macros, see [Using Smartgen Macros, on page 432](#). For general information about working with black boxes, see [Defining Black Boxes for Synthesis, on page 382](#).

To instantiate an Microsemi macro, use the following procedure.

1. Locate the Microsemi macro library file appropriate to your technology and language (v or vhd) in one of these subdirectories under *installDirectory/lib*.

```
microsemi  Macros for Microsemi technologies.
```

Use the macro file that corresponds to your target architecture.

2. Add the Microsemi macro library *at the top* of the source file list for your synthesis project. Make sure that the library file is first in the list.
3. For VHDL, also add the appropriate library and use clauses to the top of the files that instantiate the macros:

```
library family;  
use family.components.all;
```

Specify the appropriate technology in *family*.

## Using Smartgen Macros

The Smartgen macros replace the ACTgen macros, which were available in the previous Designer 6.x place-and-route tool. The following procedure shows you how to include Smartgen macros in your design. For information about using Microsemi macro libraries, see [Using Predefined Microsemi Black Boxes, on page 431](#). For general information about working with black boxes, see [Defining Black Boxes for Synthesis, on page 382](#).

1. In Smartgen, generate the function you want to include.
2. For Verilog macros, do the following:
  - Include the appropriate Microsemi macro library file for your target architecture in your the source files list for your project.
  - Include the Verilog version of the Smartgen result in your source file list. Make sure that the Microsemi macro library is first in the source files list, followed by the Smartgen Verilog files, followed by the other source files.
3. Synthesize your design as usual.

## Microsemi Place-and-Route Tools

You can run place and route automatically after synthesis. For details on how to set options, see [Running P&R Automatically after Synthesis, on page 558](#) in the *User Guide*.

For details about the place-and-route tools, refer to the Microsemi documentation.



# Microsemi Attribute and Directive Summary

The following table summarizes the synthesis and Microsemi-specific attributes and directives available with the Microsemi technology.

Attribute/Directive	Description
<a href="#">alsloc</a>	Forward annotates the relative placements of macros and IP blocks to Microsemi Designer.
<a href="#">alspin</a>	Assigns scalar or bus ports to Microsemi I/O pin numbers.
<a href="#">alspreserve</a>	Specifies that a net be preserved, and prevents it from being removed during place-and-route optimization.
<a href="#">black_box_pad_pin</a> (D)	Specifies that a pin on a black box is an I/O pad. It is applied to a component, architecture, or module, with a value that specifies the set of pins on the module or entity.
<a href="#">black_box_tri_pins</a> (D)	Specifies that a pin on a black box is a tristate pin. It is applied to a component, architecture, or module, with a value that specifies the set of pins on the module or entity.
<a href="#">full_case</a> (D)	Specifies that a Verilog case statement has covered all possible cases.
<a href="#">loop_limit</a> (D)	Specifies a loop iteration limit for for loops.
<a href="#">parallel_case</a> (D)	Specifies a parallel multiplexed structure in a Verilog case statement, rather than a priority-encoded structure.
<a href="#">syn_allow_retiming</a>	Specifies whether registers can be moved during retiming.
<a href="#">syn_black_box</a> (D)	Defines a black box for synthesis.
<a href="#">syn_direct_enable</a>	Assigns clock enable nets to dedicated flip-flop enable pins. It can also be used as a compiler directive that marks flip-flops with clock enables for inference.
<a href="#">syn_encoding</a>	Specifies the encoding style for state machines.
(D) indicates directives; all others are attributes.	

Attribute/Directive	Description
<a href="#">syn_enum_encoding</a> (D)	Specifies the encoding style for enumerated types (VHDL only).
<a href="#">syn_hier</a>	Controls the handling of hierarchy boundaries of a module or component during optimization and mapping.
<a href="#">syn_insert_buffer</a>	Inserts a clock buffer according to the specified value.
<a href="#">syn_insert_pad</a>	Removes an existing I/O buffer from a port or net when I/O buffer insertion is enabled.
<a href="#">syn_isclock</a> (D)	Specifies that a black-box input port is a clock, even if the name does not indicate it is one.
<a href="#">syn_keep</a> (D)	Prevents the internal signal from being removed during synthesis and optimization.
<a href="#">syn_looplevelimit</a>	Specifies a loop iteration limit for while loops in the design.
<a href="#">syn_maxfan</a>	Overrides the default fanout guide for an individual input port, net, or register output.
<a href="#">syn_multstyle</a>	Determines how multipliers are implemented for Microsemi devices.
<a href="#">syn_netlist_hierarchy</a>	Determines whether the EDIF output netlist is flat or hierarchical.
<a href="#">syn_noarrayports</a>	Prevents the ports in the EDIF output netlist from being grouped into arrays, and leaves them as individual signals.
<a href="#">syn_noclockbuf</a>	Turns off the automatic insertion of clock buffers.
<a href="#">syn_noprune</a> (D)	Controls the automatic removal of instances that have outputs that are not driven.
<a href="#">syn_no_compile_point</a>	Use this attribute with the Automatic Compile Point (ACP) feature. If you do not want the software to create a compile point for a particular view or module, then apply this attribute.
<a href="#">syn_pad_type</a>	Specifies an I/O buffer standard.

(D) indicates directives; all others are attributes.

Attribute/Directive	Description
<code>syn_preserve</code> (D)	Prevents sequential optimizations across a flip-flop boundary during optimization, and preserves the signal.
<code>syn_probe</code>	Adds probe points for testing and debugging.
<code>syn_radhardlevel</code>	Specifies the radiation-resistant design technique to apply to a module, architecture, or register.
<code>syn_ramstyle</code>	Specifies the implementation to use for an inferred RAM. You apply <code>syn_ramstyle</code> globally, to a module, or to a RAM instance.
<code>syn_reference_clock</code>	Specifies a clock frequency other than that implied by the signal on the clock pin of the register.
<code>syn_replicate</code>	Controls replication.
<code>syn_resources</code>	Specifies resources used in black boxes.
<code>syn_safe_case</code>	Enables/disables the safe case option. When enabled, the high reliability safe case option turns off sequential optimizations for counters, FSM, and sequential logic to increase the circuit's reliability.
<code>syn_sharing</code> (D)	Specifies resource sharing of operators.
<code>syn_shift_resetphase</code>	Allows you to remove the flip-flop on the inactive clock edge, built by the reset recovery logic for an FSM when a single event upset (SEU) fault occurs.
<code>syn_state_machine</code> (D)	Determines if the FSM Compiler extracts a structure as a state machine.
<code>syn_tco&lt;n&gt;</code> (D)	Defines timing clock to output delay through the black box. The <i>n</i> indicates a value between 1 and 10.
<code>syn_tpd&lt;n&gt;</code> (D)	Specifies timing propagation for combinational delay through the black box. The <i>n</i> indicates a value between 1 and 10.
<code>syn_tristate</code> (D)	Specifies that a black-box pin is a tristate pin.

(D) indicates directives; all others are attributes.

Attribute/Directive	Description
<code>syn_tsu&lt;n&gt;</code> (D)	Specifies the timing setup delay for input pins, relative to the clock. The <i>n</i> indicates a value between 1 and 10.
<code>syn_useenables</code>	Generates clock enable pins for registers.
<code>translate_off/translate_on</code> (D)	Specifies sections of code to exclude from synthesis, such as simulation-specific code.

(D) indicates directives; all others are attributes.

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