

SmartTime Static Timing Analyzer (STA) User Guide

Introduction

SmartTime is a Libero[®] SoC interactive gate-level static timing analysis tool that allows you to visualize and identify timing issues in your designs. Using this tool, you can evaluate how close you are to meeting your timing requirements, create custom sets to track, set timing exceptions to obtain timing closure, and define cross-probe paths with other tools.

SmartTime is supported in SmartFusion[®]2, IGLOO[®]2, RTG4[™], PolarFire[®], and PolarFire SoC families.

Key SmartTime features allow you to:

- Perform complete timing analysis of your design to ensure that your designs meet all timing constraints and operate at the desired speed, with the appropriate amount of margin across all operating conditions.
- Browse through your design's various clock domains to examine the timing paths and identify those that violate your timing requirements.
- · Create customizable timing reports.
- Navigate directly to the paths responsible for violating your timing requirements.

Note: Creating and editing timing constraints are handled in a separate Timing Constraints Editor. For more information, see the Timing Constraints Editor User Guide.

Table of Contents

Intr	oductic	n	1
1.	About	SmartTime	5
	1.1.	Static Timing Analysis (STA)	5
	1.2.	Timing Constraints	
	1.3.	Timing Analysis	
	1.4.	SmartTime and Place and Route	
	1.5.	Timing Reports	
	1.6.	Cross-probing into Chip Planner	6
	1.7.	Cross-probing into Constraints Editor	
2.	Desig	n Flows with SmartTime	7
3.	Startir	ng and Closing SmartTime	8
4.	Config	guring SmartTime Settings	9
	4.1.	Configuring SmartTime General Settings	9
	4.2.	Configuring SmartTime Analysis Settings	
	4.3.	Configuring SmartTime Advanced Settings	. 11
_	_		
5.	Smarl	Time Toolbar	.13
6.	Smart	Time Timing Analyzer	
	6.1.	SmartTime Analyzer Components	.14
	6.2.	Analyzing Your Design	14
	6.3.	Maximum Delay Analysis View	15
	6.4.	Managing Clock Domains	15
	6.5.	Managing Path Sets	16
	6.6.	Displaying Path List Timing Information	18
	6.7.	Displaying Expanded Path Timing Information	.19
	6.8.	Using Filters	21
7.	Advar	nced Timing Analysis	23
	7.1.	Understanding Inter-Clock Domain Analysis	.23
	7.2.	Activating Inter-Clock Domain Analysis	.23
	7.3.	Displaying Inter-Clock Domain Paths	.24
	7.4.	Deactivating a Specific Inter-Clock Domain	25
	7.5.	Changing Output Port Capacitance	.26
8.	Gene	rating Timing Reports	27
	8.1.	Types of Reports	27
	8.2.	Generating a Timing Report	27
	8.3.	Understanding Timing Reports	
	8.4.	Generating a Timing Violation Report	
	8.5.	Understanding Timing Violation Reports	
	8.6.	Generating a Constraints Coverage Report	31
	8.7.	Understanding Constraints Coverage Reports	
	8.8.	Generating a Bottleneck Report	33

	8.9.	Understanding Bottleneck Reports - SmartFusion2, IGLOO2, RTG4, and PolarFire	33
	8.10.	Generating a Datasheet Report	34
	8.11.	Understanding Datasheet Reports	
	8.12.	Generating a Combinational Loop Report	36
	8.13.	Understanding Combinational Loop Reports	36
	8.14.	Generating a Clock Domain Crossing (CDC) Report	37
9.	Timing	Concepts	47
	9.1.	Static Timing Analysis Versus Dynamic Simulation	47
	9.2.	Delay Models	
	9.3.	Timing Path Types	
	9.4.	Maximum Clock Frequency	
	9.5.	Setup Check	
	9.6.	Arrival Time, Required Time, and Slack	
	9.7.	Timing Exceptions Overview	
	9.8.	Clock Skew	
	9.9.	Cross Probing	
40	0	-	
10.		Time Tutorials	
		Tutorial 1 - 32-Bit Shift Register with Clock Enable	
	10.2.	Tutorial 2 - False Path Constraints	67
11.	Smart ⁻	Time Dialog Boxes	77
		Add Path Analysis Set Dialog Box	
		Analysis Set Properties Dialog Box	
		Edit Filter Set Dialog Box	
		Customize Analysis View Dialog Box	
		Manage Clock Domains Dialog Box	
		Set False Path Constraint Dialog Box	
		SmartTime Options Dialog Box	
	11.8.	Create Filter Set Dialog Box	85
	11.9.	Timing Bottleneck Analysis Options Dialog Box	86
		Timing Datasheet Report Options Dialog Box	
		Timing Report Options Dialog Box	
		Timing Violations Report Options Dialog Box	
	11.13.	Data Change History - SmartTime	95
12.	Tcl Co	mmands	
13	Glossa	ary	98
14.	Revisi	on History	101
15.	Microc	hip FPGA Technical Support	102
		Customer Service	
		Customer Technical Support	
		Website	
	15.4.	Outside the U.S.	102
The	Microc	hip Website	

Product Change Notification Service	103
Customer Support	103
Microchip Devices Code Protection Feature	103
Legal Notice	104
Trademarks	104
Quality Management System	105
Worldwide Sales and Service	106

1. About SmartTime

The following sections describe SmartTime functions.

1.1 Static Timing Analysis (STA)

Static timing analysis (STA) offers an efficient technique for identifying timing violations in your design and ensuring that it meets all your timing requirements. You can communicate timing requirements and timing exceptions to the system by setting timing constraints. A static timing analysis tool will then check and report setup and hold violations as well as violations on specific path requirements.

STA is particularly well suited for traditional synchronous designs. The main advantage of STA is that unlike dynamic simulation, it does not require input vectors. It covers all possible paths in the design and does all the above with relatively low run-time requirements.

The major disadvantage of STA is that the STA tools do not automatically detect false paths in their algorithms as it reports all possible paths, including false paths, in the design. False paths are timing paths in the design that do not propagate a signal. To get a true and useful timing analysis, you need to identify those false paths, if any, as false path constraints to the STA tool and exclude them from timing considerations.

The SmartTime user interface provides efficient, user-friendly ways to define these critical false paths.

1.2 Timing Constraints

SmartTime supports a range of timing constraints to provide useful analysis and efficient timing-driven layout.

1.3 Timing Analysis

SmartTime provides a selection of analysis types that allow you to:

- Find the minimum clock period/highest frequency that does not result in a timing violations
- Identify paths with timing violations
- Analyze delays of paths that have no timing constraints
- Perform inter-clock domain timing verification
- · Perform maximum and minimum delay analysis for setup and hold checks

To improve the accuracy of the results, SmartTime evaluates clock skew during timing analysis by computing individual clock insertion delays for each register.

SmartTime checks the timing requirements for violations while evaluating timing exceptions such as multicycle or false paths.

1.4 SmartTime and Place and Route

Libero SoC Place and Route uses SmartTime STA during timing-driven place-and-route operations run in the background. As a result, your analysis and place and route constraints are always consistent.

1.5 Timing Reports

SmartTime provides robust reporting capabilities that allow you to generate the following report files:

- Timing Report for Max and Min Delay Analysis
- Timing Violations Report for Max and Min Delay Analysis
- Bottleneck Report
- Constraints Coverage Report

Combinational Loop Report

1.6 Cross-probing into Chip Planner

From SmartTime, you can select a design object and cross-probe the same design object in Chip Planner.

Design objects that can be cross-probed from SmartTime to Chip Planner include:

- Ports
- Macros
- Timing paths

1.7 Cross-probing into Constraints Editor

From SmartTime, you can cross-probe into the Constraints Editor. The Constraints Editor must be running for cross-probing to work.

For more information, see 9.9.3 Cross-probing from SmartTime to Chip Planner.

2. Design Flows with SmartTime

You can access SmartTime in Libero SoC during the following design implementation phases:

- During Place and Route when you select timing-driven place-and-route, SmartTime runs in the background to provide accurate timing information.
- After Place and Route run SmartTime to perform post-layout timing analysis and adjust timing constraints. In the Libero SoC Design Flow window, expand Implement Design > Verify Post-Layout Implementation and then either:
 - Double-click **Verify Timing** to generate Timing Reports.
 - Right-click **Open SmartTime > Open Interactively** to run SmartTime.
- During Back-Annotation SmartTime runs in the background to generate the SDF file for timing simulation.

You can also run SmartTime to generate Timing Reports, regardless of which design implementation phase you are in.

For more information about Place and Route and Back-Annotation, see the Libero SoC Design Flow User Guide.

3. Starting and Closing SmartTime

You must complete Place and Route for your design before using SmartTime interactively. Otherwise, Libero SoC completes that phase before starting SmartTime.

To open SmartTime interactively:

- 1. Select Implement Design > Verify Post Layout Implementation.
- Right-click Open SmartTime and select Open Interactively. SmartTime reads your design and displays post- or pre-layout timing information. To close SmartTime, choose Exit from the File menu.

4. Configuring SmartTime Settings

The SmartTime Options dialog box allows you to change general, analysis, and advanced settings.

4.1 Configuring SmartTime General Settings

To configure General settings in the SmartTime Options dialog box:

1. From the SmartTime Maximum/Minimum Delay Analysis View window, choose **Tools > Options**. The SmartTime Options dialog box appears.

Figure 4-1. SmartTime Options Dialog Box - General Settings for SmartFusion2, IGLOO2, and RTG4

SmartTime Options		? ×
Option Categories Select a category: General Analysis Advanced	General Operating Conditions Perform maximum delay analysis based on WORST Perform minimum delay analysis based on BEST Clock Domains Include inter-clock domains in calculations for timing analysis. Image: Clock Provide the recovery and removal checks.	case case Restore Defaults
Help		OK Cancel

Option Categories			
Select a category:	Operating Conditions		
Analysis	Perform maximum delay analysis based on slow_lv_ht <a>case		
Advanced	Perform minimum delay analysis based on fast_hv_lt case		
	Clock Domains Clock Domains Include inter-clock domains in calculations for timing analysis. Enable recovery and removal checks.		
		Restore Defaults	

Figure 4-2. SmartTime Options Dialog Box - General Settings for PolarFire

- 2. In the **General** category, select the settings for the operating conditions. SmartTime performs maximum or minimum delay analysis based on the best, typical, or worst case.
- 3. Specify whether you want SmartTime to use inter-clock domains in calculations for timing analysis.
- 4. To revert the **General** settings to their default value, click **Restore Defaults**.
- 5. Change Analysis and Advanced settings as necessary.
- 6. When finished, click **OK**.

4.2 Configuring SmartTime Analysis Settings

To configure **Analysis** settings in the SmartTime Options dialog box:

- 1. From the SmartTime Maximum/Minimum Delay Analysis View window, choose **Tools > Options**. The SmartTime Options dialog box appears.
- 2. In the left pane, click **Analysis**.

Option Categories	Analysis View	
Select a category: General	Display of Paths	
Analysis	Limit the number of paths shown in a path set to:	20
Advanced	Filter the paths by slack value	
	Slack range from: 2 ns to: 3	ns
	Show clock network details in expanded path	
	Limit the number of parallel paths in expanded path to:	1

Figure 4-3. SmartTime Options Dialog Box - Analysis Settings

- 3. Enter a number greater than 1 to specify the maximum number of paths to include in a path set during timing analysis.
- 4. Check or uncheck whether to filter the paths by slack value. If you check this box, specify the slack range between the minimum slack and maximum slack.
- 5. Check or uncheck whether to include clock network details.
- 6. To specify the number of parallel paths in the expanded path, enter a number greater than 1.
- 7. To revert the Analysis settings to their default value, click Restore Defaults.
- 8. Change General and Advanced settings as necessary.
- 9. When finished, click **OK**.

4.3 Configuring SmartTime Advanced Settings

To configure **Advanced** settings in the SmartTime Options dialog box:

- 1. From the SmartTime Maximum/Minimum Delay Analysis View window, choose **Tools > Options**. The SmartTime Options dialog box appears.
- 2. In the left pane, click **Advanced**.

SmartTime Options			?	
Option Categories	Advanced Special Situtations Use loopback in bi-directional buffers(bibufs) F Break paths at asynchronous pins F Disable non-unate arcs in clock network	F	Restore Defau	Its
Help		ОК	Cance	

Figure 4-4. SmartTime Options Dialog Box - Advanced Settings

- 3. Specify whether to use loopback in bidirectional buffers (bibufs) and/or break paths at asynchronous pins. The specify whether to disable non-unate arcs in the clockpath.
- 4. To revert the **Advanced** settings to their default value, click **Restore Defaults**.
- 5. Change General and Analysis settings as necessary.
- 6. When finished, click **OK**.

5. SmartTime Toolbar

The SmartTime toolbar contains icons for constraining or analyzing designs. Tool tips are available for each icon.

Table 5-1. SmartTime Toolbar Icons

lcon	Description
!!	Saves the changes.
<u></u>	Undoes previous changes.
2	Redoes previous changes.
	Opens the maximum delay analysis view.
\mathbf{k}	Opens the minimum delay analysis view.
<u>®</u>	Opens the manage clock domains manager.
X	Opens the path set manager.
8	Recalculates all analyses.

6. SmartTime Timing Analyzer

The following sections describe the SmartTime Timing Analyzer functions.

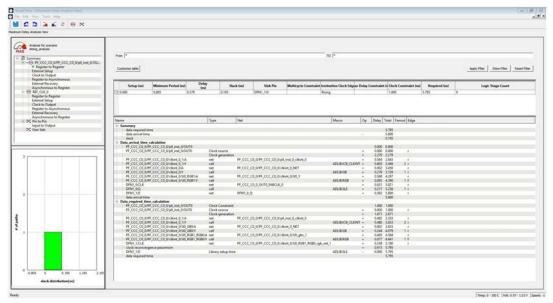
6.1 SmartTime Analyzer Components

SmartTime Timing Analyzer consists of the following components:

- Domain Browser: allows you to perform your timing analysis on a per domain basis.
- Path List: shows paths in a specific set within a given domain sorted by slack.
- Path Details: shows detailed timing analysis of a selected path in the paths list.
- · Analysis View Filter: allows you to filter the content of the paths list.
- Path Slack Histogram: when a set is selected in the Domain Browser, Path Slack Histogram shows a distribution of the path slacks for that set. Selecting one or multiple bars in the Path Slack Histogram filters the paths shown in the Path List.

The following figure shows the SmartTime Timing Analyzer Components. You can copy and change the resolution and number of bars of the chart from the right-click menu.

Figure 6-1. SmartTime Timing Analyzer Components



6.2 Analyzing Your Design

The timing engine uses the following priorities when analyzing paths and calculating slack:

- 1. False path
- 2. Max/Min delay
- 3. Multi-cycle path
- 4. Clock

If multiple constraints of the same priority apply to a path, the timing engine uses the tightest constraint.

You can perform two types of timing analysis:

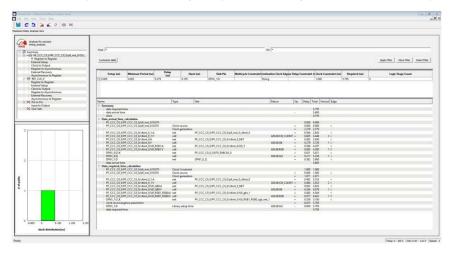
- Maximum Delay Analysis
- Minimum Delay Analysis

To perform the basic timing analysis, use one of the following methods to open the Timing Analysis View:

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SmartTime Timing Analyzer

- From the SmartTime Tools menu, choose Timing Maximum Delay Analysis or Minimum Delay Analysis.
- From the SmartTime window, click the 🚵 icon for Maximum Delay Analysis or the 🔟 icon for Minimum Delay Analysis.
- Note: When you open the Timing Analyzer from Designer, the Maximum Delay Analysis window appears by default.



6.3 Maximum Delay Analysis View

To enter Maximum Delay Analysis View:

- In the Domain Browser, select the clock domain. Clock domains with a vindicate that the timing requirements in these domains were met. Clock domains with an x indicate that there are violations within these domains. Paths List shows the timing paths sorted by slack. The path with the lowest slack (biggest violation) is at the top of the list.
- Select the path you want to view.
 Path Details below the Paths List shows detailed information about how the slack was computed by detailing the arrival time and required time calculation. If a path is violated, the slack is negative and shown in red.
- 3. To display a separate view that includes the path details and schematic, double-click the path.
- 4. Repeat this procedure as necessary.

Note: If the minimum pulse width of one element on the critical path limits the maximum frequency for the clock, an icon for the clock name appears in the **Summary List**. Clicking the icon displays the name of the pin that limits the clock frequency.

6.4 Managing Clock Domains

In SmartTime, timing paths are organized by clock domains.

By default, SmartTime displays domains with explicit clocks. Each clock domain includes at least three path sets:

- Register to Register
- External Setup (in the Maximum Analysis View) or External Hold (in the Minimum Analysis View)
- Clock to Out

You must select a path set to display a list of paths in that specific set.

To manage the clock domains:

1. Right-click anywhere in the Domain Browser and choose **Manage Clock Domains**. The Manage Clock Domains dialog box appears.



Tip: You can click the icon in the SmartTime window bar to display the Manage Clock Domains dialog box.

2. To add a new domain, select a clock domain from the **Available clock domains** list and click **Add**. To add a non-explicit clock domain, click **New Clock**.

The Choose the Clock Source Pin dialog box appears, and you can select the clock source pin. You can choose to filter the available pins and search.

Figure 6-2. Choose the Clock Source Pin Dialog Box

Elter available size :			
Filter available pins :			
Type :	Pattern :		
Clock Network	• *		Search
earch Results :			
CCC_0/clkint_0/U0_RGB1:A			
CCC_0/clkint_0/U0_RGB1:Y			=
CCC_0/clkint_0/U0_RGB1:Y.1			
CCC_0/clkint_0/U0_RGB1:Y.2			
CCC_0/clkint_0/U0_RGB1:Y.3			
CCC_0/clkint_0/U0_RGB1:Y.4			
CCC_0/clkint_0/U0_RGB1:Y.5			
CCC_0/clkint_0/U0_RGB1:Y.6			
CCC_0/clkint_0:A			
CCC_0/clkint_0:Y.2			
CCC_0/clkint_0:Y.3			
CCC_0/clkint_0:Y.4			
CCC_0/clkint_0:Y.5			
CCC_0/clkint_0:Y.6			
CCC_0/clkint_0_1:A			
CCC_0/clkint_0_1:Y			
DDR4_0/CCC_0/clkint_4/U0_RGB1:A			-
•		1	•

- 3. To remove a displayed domain, select a clock domain from the **Show the clock domains in this order** list and click **Remove**.
- 4. To change the display order in the Domain Browser, select a clock domain from the **Show the clock domains** in this order list, and then use **Move Up** or **Move Down** to change the order in the list.
- 5. Click OK.

SmartTime updates the Domain Browser based on your specifications. If you added a new clock domain, it includes at least three path sets, as mentioned above.

6.5 Managing Path Sets

You can create and manage custom path sets for timing analysis and tracking purposes.

Path sets appear below **Custom Path Sets** at the bottom of the Domain Browser. To manage path sets:

1. Right-click anywhere in the Domain Browser and choose **Add Set**. The Add Path Analysis Set dialog box appears.



Tip: You can click the icon in the SmartTime window bar to display the Add Path Analysis Set dialog box.

Figure 6-3. Add Path Analysis Set Dialog Box

ource pins:	Sink Pins:
DFN1_0:CLK DFN1_1:CLK PF_CCC_C0_0/PF_CCC_C0_0/pII_inst_0:REF_CLK_I	.0
Select All	Select All
Select All Filter source pins: Pin Type: Registers by pin names	Select All Filter sink pins: Pin Type: Registers by pin names

- 2. Enter a name for the path set.
- 3. Select the source and sink pins. You can use the 6.8 Using Filters to control the type of pins displayed.
- 4. Click OK.

The new path set appears below **User Sets** in the Domain Browser.

Figure 6-4. Updated Domain Browser with User Sets

From *				
From *				
From *				
	то *			
Customize table	Apply Filter	Store Filter	Reset Filter	l
Source Pin	Sink Pin			
1 CoreAXI4Interconnect_0/Ms	CoreAXI4Interconnect_0/ax	0.958 4.9	52	
Name			7	-
			i i i	
and the second sec	ion			
ddr_x32_0/CCC_0/pll_ins	st_0:OUT1			
				i.
	4/U0 GB0:A			1
	CoreAXIHinterconnect_0/Ms Name Summary data required time data arrival time [slack Data_arrival_time_calculat ddr_x32_0/CCC_0/pll_in ddr_x32_0/CCC_0/pll_in ddr_x32_0/CCC_0/clkint ddr_x32_0/CCC	1 CoreAXI-finiter connect_0/Ms CoreAXI-finiter connect_0/ax Name Summary data required time data arrival time [slack Data_arrival_time_calculation ddr_x32_0/CCC_0/pll_inst_0/OUT1 ddr_x32_0/CCC_0/clkint_4_1:A ddr_x32_0/CCC_0/clkint_4_1:Y ddr_x32_0/CCC_0/clkint_4_1:Y	Source Pin Sink Pin (ns) (ns) 1 CoreAXI4Interconnect_0/Ms CoreAXI4Interconnect_0/ax 0.958 4.9 1 CoreAXI4Interconnect_0/Ms CoreAXI4Interconnect_0/ax 0.958 4.9 Name Image: CoreAXI4Interconnect_0/ms 0.958 4.9 Image: CoreAXI4Interconnect_0/Ms CoreAXI4Interconnect_0/ax 0.958 4.9 Image: CoreAXI4Interconnect_0/Ms CoreAXI4Interconnect_0/ms 0.958 4.9 Image: CoreAXI4Interconnect_0/Ms CoreAXI4Interconnect_0/ax 0.958 4.9 Image: CoreAXI4Interconnect_0/Ms CoreAXI4Interconnect_0/ms 0.958 4.9 Image: CoreAXI4Interconnect_0/Ms<	Source Pin Sink Pin (ns) 1 CoreAXI4interconnect_0/Ms CoreAXI4interconnect_0/xx 0.958 4.952 Name Image: Summary data required time data arrival time [slack Image: Data_arrival_time_calculation ddr_x32_0/CCC_0/pll_inst_0/OUT1 ddr_x32_0/CCC_0/clkint_4_1:A ddr_x32_0/CCC_0/clkint_4_1:Y ddr_x32_0/CCC_0/clkint_4_1:Y ddr_x32_0/CCC_0/clkint_4_1:Y

- 5. To rename a path:
 - a) Select the path set from User Sets in the Domain Browser.
 - b) Right-click the set you want to rename, and then choose Rename Set from the right click menu.
 - c) Edit the name directly in the Domain Browser.
- 6. To remove a path:
 - a) Select the path set from User Sets in the Domain Browser.
 - b) Right-click the set you want to delete, and then choose **Delete Set** from the right click menu.

6.6 Displaying Path List Timing Information

Path List in the Timing Analysis View shows the timing information required to verify the timing requirements and identify violating paths. The Path List is organized in a grid where each row represents a timing path with the corresponding timing information displayed in columns. Timing information is customizable, allowing you to add or remove columns for each type of set.

By default, each type of set displays the following subset of columns:

- Register to Register: Source Pin, Sink Pin, Delay, Slack, Arrival, Required, Setup, Minimum Period, and Skew.
- External Setup: Source Pin, Sink Pin, Delay, Slack, Arrival, Required, Setup, and External Setup.
- · Clock to Out: Source Pin, Sink Pin, Delay, Slack, Arrival, Required, and Clock to Out.
- Input to Output: Source Pin, Sink Pin, Delay, and Slack.
- Custom Path Sets: Source Pin, Sink Pin, Delay, and Slack. You can add the following columns for each type of set:
 - Register to Register: Clock, Source Clock Edge, Destination Clock Edge, Logic Stage Count, Max Fanout, Clock Constraint, Maximum Delay Constraint, and Multicycle Constraint.
 - External Setup: Clock, Destination Clock Edge, Logic Stage Count, Max Fanout, Clock Constraint, Input Delay Constraint, Required External Setup, Maximum Delay Constraint, and Multicycle Constraint.
 - Clock to Out: Clock, Source Clock Edge, Logic Stage Count, Max Fanout, Clock Constraint, Output Delay Constraint, Required Maximum Clock to Out, Maximum Delay Constraint, and Multicycle Constraint.

- Input to Output: Arrival, Required, Setup, Hold, Logic Stage Count, and Max Fanout.
- Custom Path Sets

To customize the set of timing information in the Path List:

Choose Customize table on the top-left corner of path list to open the Customize Paths List Table dialog box.
 Figure 6-5. Customize Paths List Table Dialog Box

Source Pin	Add	Arrival (ns)
Sink Pin Delay		Required (ns) Setup (ns)
(ns)	Move Down	Recovery (ns)
Slack (ns)		External Setup (ns) External Recovery (ns)
	Move Up	Logic Stage Count
	Remove	

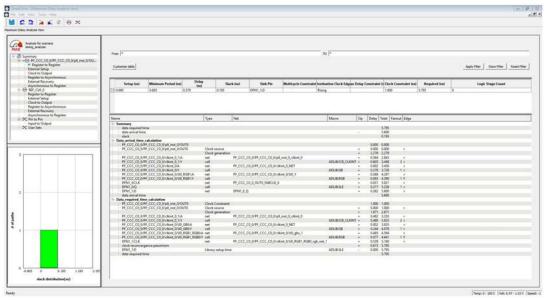
- 2. To add one or more columns, select the fields to add from the Available fields list and click Add.
- 3. To remove one or more columns, select the fields to remove from the **Show these fields in this order** list, and click **Remove**.
- 4. To change the order in which the fields appear, select fields in the **Show these fields in this order** list and click **Move Up** or **Move Down**.
- 5. Click **OK** to add or remove the selected columns. SmartTime updates the Timing Analysis View.

6.7 Displaying Expanded Path Timing Information

SmartTime displays the list of paths and path details for all parallel paths.

The Path Details grid displays the path details for all parallel paths. The Path List displays all parallel paths in your design.

Figure 6-6. Path List View



To display the Expanded Path View:

- 1. From the Path List, double-click the path, or right-click a path and select **expand selected paths**.
- 2. From the Expanded Path View, double-click the path, or right-click the path and select expand path.

Figure 6-7. Expanded Path View

many for path a CPNL OCLX HNL_LD								uth Profile
a Required Time (ns) Data Arrival Time (ns) Slack (n IS 3.4 il.195	•							
	Type	Net	Macro	Op	Delay Total Fa	nout Idee		
Data_arrival_time_calculation	1.110	Protection and Protec					P	
PF_CCC_C0_0/PF_CCC_C0_0/yR_iver_0/OUT0					0.000 0.000			
PF_CCC_C0_0/PF_CCC_C0_0/pR_inst_0/0U10	Clock source				0.000 0.000	- E		
PF CCC C0 0/PF CCC C0 0/cRive 0 1:A	Clock generation	RECCCC CO. D. R. CCC. CD. Rivel. and D. Co. C.			2,279 2,279 0,554 2,541			
PF CCC CE B/PF CCC CE S/CRIMED TA PF CCC CE B/PF CCC CE S/CRIMED TV	net cell	PF_CCC_C0_0/PF_CCC_C0_0/piL/wat_0_riking_0	ADUBICE_CLKP	11	0.605 3.448	21		
PF CCC C0 0/PF CCC C0 0/claim 0.4	net	PF_CCC_C0_0/PF_CCC_C0_0/ukint_0_NET			0.007 3.490	1		
PF_CCC_C0.0/PF_CCC_C0.0/ulkiet.0Y	cel		ADUB-G8		0.279 3.729	11		
PF_CCC_C0.5/PF_CCC_C0.0/cRint_0/U0.RGE1.A	net	PF_CCC_C0_0/PF_CCC_C0_01/8imt_0/00_Y			0.568 4.297	1		
PF_CCC_C0_0/PF_CCC_C0_0/clkiet_0/U0_R081.Y	cell		ADUB/R08		0.095 4.390	3.6		
DRNI BCLK DRNI BQ	net cell	PF_CCC_C0_0_OUT0_FABCLK_0	ADURSE	-	0.631 5.021 0.217 5.238	10		
DENI 10	cell	0FN1_0_Q	ADURSE		0.217 5.238	1		
data arrival time	1000	1000			5,600			
lata required time calculation								
FF CCC_C0.0/PF_CCC_C0.0/pit_inst_0/OUT0	Clock Constraint				1.000 1.000			
PF_CCC_C0_0/PF_CCC_C0_0/yR_inst_0/0UT0	Clock source				0.000 1.000	÷ .		
PF CCC C0 D/PF CCC C0 S/cRive 0 1A	Clock generation				1,871 2,871 0,482 3,353			
PF CCC C0 D/PF CCC C0 0/chird 0 1Y	net cell	PH_CCC_C0_0/PH_CCC_C0_0/pR_exet_0_ckint_0	ADLIBICE_CLKP	a .	0.400 3.813	21		
PF CCC C0 0/PF CCC C0 0/chint 0/U0 GB0A	net	PF_CCC_C0_0/PF_CCC_C0_0/ckint_0_NET	Paranta, LLAS		0.002 3.835			
PF_CCC_C0.0/PF_CCC_C0.0/cNive.0/U0.680/V	cel.		ADUB-G8		0.344 4.079	11		
PF CCC C0 G/PF CCC C0 S/ckies 0/U0 RGB1 RGB RF CCC C0 D/RF CCC C0 S/ckies 0/U0 RGB1 RGB	0.A net	PF_CCC_C0_0/PF_CCC_C0_0/rikint_0/U0_gbo_1			0.405 4.564	F		
BE CON ON MIRE CON ON NUMBER ANN BOBI DOB	SVR		A76 IB-873		6.077 2.635	14		
	p r	#F.CCC_ CCC_CD_BIPE_CCC_CD_BIGHT_0_1 100_CLRW1	28_0/14_CCC_ 48_002 A CE P1_CC		A			

The Expanded Path Summary provides a summary of all parallel paths for the selected path. The Path Profile chart shows the percentage of time taken by cells and nets for the selected path. If no parallel path is selected in this view, the Path Profile shows the percentage for all paths. By default, SmartTime shows only one path for each Expanded Path. To change this default, use the SmartTime Options dialog box.

The Expanded Path View includes a schematic of the path and a path profile chart for the paths selected in the Expanded Path Summary.

6.8 Using Filters

You can use filters in SmartTime to limit the Path List content (that is, create a filtered list on the source and sink pin names).

Filtering options appear at the top of the Timing Analysis View. You can save these filters one level below the set under which they have been created.

To use the filter:

- 1. Select a set in the Domain Browser to display a given number of paths, depending on your SmartTime Options settings (100 paths by default).
- 2. Enter the filter criteria in both the From and To fields, and then click **Apply Filter**. The display limits the paths to those that match your filter criteria.

Figure 6-8. Maximum Delay Analysis View

num Delay Analysis View								
Analysis for scenario timing_analysis								
Summary	From *				то *			_
CLK Register to Register External Setup	Customize tal	sie			Apply Fil	ter Store Filter	Reset	Filter
Clock to Output Register to Asynchronous	Setup (ns)	Minimum Period (ns)	Delay (ns)	Slack (ns)		Sink P	in	
External Recovery Asynchronous to Register	1 0.000	0.448	0.434	-0.348 DFN	11_1:0			
🗏 🌫 Pin to Pin								
Input to Output			_				_	,
St. User Sets	Name			Туре	Net	Macro	Op D	elay ^
	Summary							
		equired time rrival time						
	^ slack	mvaitime						
		val_time_calculat	ion					
	CLK	an_unit_curcum					C	0.000
	CLK			Clock source			+ 0	0.000
	CLK_it	ouf/U_IOPAD:PAD		net	CLK		+ 0	0.000
		ouf/U_IOPAD:Y		cell		ADLIB:IOPAD_IN		1.726
		ouf/U_IOIN:YIN		net	CLK_ibuf/YIN			0.000
		ouf/U_IOIN:Y		cell		ADLIB:IOIN_IB_E		0.409
		ouf_RNIVQ04:A		net	CLK_ibuf_Z			2.067
		ouf_RNIVQ04:Y	201010	cell		ADLIB:GB		0.224
		ouf_RNIVQ04/U0_I		net	CLK_ibuf_RNIVQ04/U0_Y			0.662
		ouf_RNIVQ04/U0_	RGB1:Y	cell		ADLIB:RGB		0.110
	DFN1			net	CLK_c			0.741
	DFN1			cell		ADLIB:SLE		0.256
	C DEN1	1:0		net	DFN1 0 O		+ 0	0.178 4

3. Click **Store Filter** to save your filter criteria with a special name. The Create Filter Set dialog box appears.

Figure 6-9.	Create	Filter Set	Dialog	Вох
-------------	--------	------------	--------	-----

Create Filter Set		? ×
Name : my_filter01		
Help	OK	Cancel

4. Enter a name for the filter, such as myfilter01, and click **OK**.

Your new filter name appears below the set under which it was created.

Figure 6-10. Specifying the Filter my_filter01

aximum Delay Analysis View
Analysis for scenario MAX Primary
🔺 💩 Summary
⊿ ⊻@ my_clk
🔺 🗹 Register to Register
my_filter01
External Setup
Clock to Output
Register to Asynchronous
External Recovery
Asynchronous to Register
🔺 🏹 Pin to Pin
Input to Output
▲ Inter Sets
my_set

- 5. Repeat this procedure to cascade as many sets as you need using the filtering mechanism.
- 6. To edit a filter in the set:
 - a) Select the filter you want to edit.
 - b) Right-click the filter and choose **Edit Set** from the shortcut menu.
- 7. To rename a set created with filters:
 - a) Select the set that uses filters.
 - b) Right-click the set, and choose Rename Set from the shortcut menu.
 - c) Edit the name directly in the Domain Browser.

7. Advanced Timing Analysis

The following sections describe advanced timing analysis.

7.1 Understanding Inter-Clock Domain Analysis

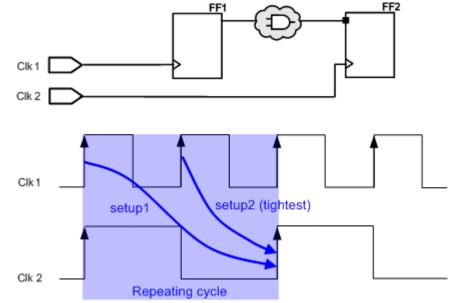
When functional paths exist across two clock domains (the register launching the data and the one capturing it are clocked by two different clock sources), you must provide accurate specification of both clocks to allow a valid inter-clock domain timing check. This is important especially when the clocks are specified with different waveforms and frequencies.

When you specify multiple clocks in your design, consider whether the inter-clock domain paths are false or functional. If the paths are functional, perform setup and hold checks between the clock domains in SmartTime. Unless specified otherwise, SmartTime considers the inter-clock domain as false, and therefore does not perform setup or hold checks between the clock domains.

If you have several clock domains that are subset of a single clock (such as if you want to measure clock tree delay from an input clock to a generated clock), you must configure Generated Clock Constraints for each of the clock domains in order for SmartTime to execute the calculation and show timing for each of the inter-clock domain paths.

Once you include the inter-clock domains for timing analysis, SmartTime analyzes for each inter-clock domain the relationship between all the active clock edges over a common period equal to the least common multiple of the two clock periods. The new common period represents a full repeating cycle (or pattern) of the two clock waveforms (as shown below).

Figure 7-1. New Common Period



For setup check, SmartTime considers the tightest relation launch-capture to ensure that the data arrives before the capture edge. The hold check verifies that a setup relationship is not overwritten by a following data launch.

7.2 Activating Inter-Clock Domain Analysis

To activate the inter-clock domain checking:

- 1. From the SmartTime **Tools** menu, choose **Options**. The SmartTime Options dialog box appears (as shown below).
- 2. In the General category, check Include inter-clock domains in calculations for timing analysis.

Option Categories	General
 Select a category: General 	Operating Conditions
Analysis Advanced	Perform maximum delay analysis based on WORST
	Perform minimum delay analysis based on BEST
	Clock Domains
	Enable recovery and removal checks.
	Restore Defaults

Figure 7-2. SmartTime Options Dialog Box for SmartFusion2, RTG4, and IGLOO2

Figure 7-3. SmartTime Options Dialog Box for PolarFire

Option Categories	General		
 Select a category: General Analysis Advanced 	Operating Conditions Perform maximum delay analysis based on slow_lv_ht Perform minimum delay analysis based on fast_hv_lt Clock Domains Include inter-clock domains in calculations for timing analysis. Image: Clock Domains Image: Clock Domains	case case	
Help		Restore De	efaults Cancel

3. Click **OK** to save the dialog box settings.

7.3 Displaying Inter-Clock Domain Paths

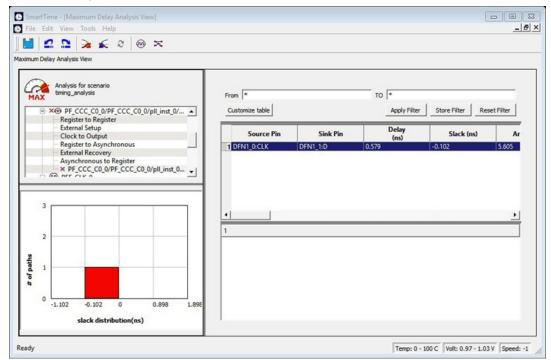
After you activate the inter-clock domain checking for a given clock domain CK1, SmartTime detects automatically all other domains CKn with paths ending at CK1.

SmartTime creates inter-clock domain sets CKn to CK1 under the domain CK1. Each set allows you to display the inter-clock domain paths between a given clock domain and CK1.

To display an inter-clock domain set:

1. Expand the receiving clock domain of the inter-clock domain in the Domain Browser to display its related sets. For the inter-clock domain CK1 to CK2, expand clock domain CK2.

Figure 7-4. Expanding the Inter-Clock Domain



 Select the inter-clock domain you want to expand from these sets. All paths between the related two domains are displayed in Paths List in the same way as any register to register set.

7.4 Deactivating a Specific Inter-Clock Domain

To deactivate the inter-clock domain checking for the specific clock domains clk2->clk1, without disabling this option for the other clock domains:

- 1. From the Tools menu, choose Constraints Editor > Primary Scenario to open the Constraints Editor View.
- 2. In the Constraints Browser, double click **False Path** under **Exceptions**. The Set False Path Constraint dialog box appears.
- Click the Browse button to the right of the From text box. The Select Source Pins for False Path Constraint dialog box appears.
- 4. For Specify pins, select by keyword and wildcard.
- 5. For Pin Type, select Registers by clock names from the Pin Type drop-down list.
- 6. In the filter box, type the inter-clock domain name (for example, Clk2), and then click Filter.
- Click OK to begin filtering the pins by your criteria. In this example, [get_clocks {Clk2}] appears in the From text box in the Set False Path Constraint dialog box.
- 8. Repeat steps 3 to 7 for the **TO** option in the Set False Path Constraint dialog box and type Clk1 in the filter box.
- 9. Click **OK** to validate the new false path and display it in the Paths List of the Constraints Editor.
- 10. Click the Recalculate All icon 2 in the toolbar.
- 11. Select the inter-clock domain set clk2 -> clk1 in the Domain Browser.
- 12. Verify that the set does not contain any paths.

7.5 Changing Output Port Capacitance

Output propagation delay is affected by both the capacitive loading on the board and the I/O standard.

The I/O Attribute Editor in Chip Planner provides a way to set the expected capacitance to improve the propagation delay model. SmartTime uses the modified delay model automatically for delay calculations. To change the output port capacitance and view the effect of this change in SmartTime Timing Analyzer, see the following example. The following figure shows a delay of 6.603 ns from DFN1 to output port Q based on the default loading of 5 pF.

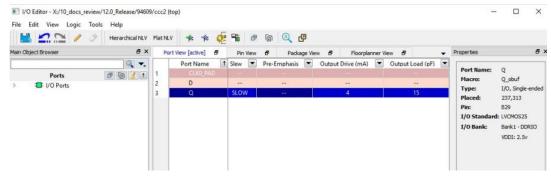


mum Del										
	ay Analysis View									
MAX	Analysis for scenario timing_analysis	From *				то 🔹				
	External Recovery Asynchronous to Register	Customize table						Apply Filter	Store Filter	Reset Filter
•••	FCCC_C0_0/FCCC_C0_0/CCC_INST/GL1 Register to Register External Setup	Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required (ns)	Clock to	Out (ns)	
_	Clock to Output Register to Asynchronous External Pacause	1 DFN1_LICLK	Q	5.251		10,442			10	. 442
		Name		Туре		Net			Macro	10
		✓ Summary								
		data required time								
		data required time data arrival time								
		data required time data arrival time slack								
	This set has no path.	data required time data arrival time slack ✓ Data_arrival_time_calculat								
	This set has no path.	data required time data arrival time slack Data arrival time_calculat FCCC_C0_0/FCCC_C0_0	/CCC_INST/GL1							
	This set has no path.	data required time data arrival time slack Data arrival time_calculat FCCC_C0_0/FCCC_C0_0		P:GL1 Clock		Her ou				•
	This set has no path.	data required time data arrival time slack Data arrival time_calculat FCCC_C0_0/FCCC_C0_0 FCCC_C0_0/FCCC_C0_0	I/CCC_INST/GL1 I/CCC_INST/INST_CCC_I	P:GL1 Clock Clock	: source : generatio					
	This set has no path.	data required time data arrival time slack Data_arrival time_calculat FCCC_C0_0/FCCC_C0_1 FCCC_C0_0/FCCC_C0_1 FCCC_C0_0/FCCC_C0_1	I/CCC_INST/GL1 I/CCC_INST/INST_CCC_I I/GL1_INST:An	P:GL1 Clock Clock net			0_0/FCCC_C0_0	/GL1_net		-
	This set has no path.	data required time data arrival time slack Data arrival time calculat FCCC_C0_0/FCCC_C0_1 FCCC_C0_0/FCCC_C0_1 FCCC_C0_0/FCCC_C0_1 FCCC_C0_0/FCCC_C0_1	I/CCC_INST/GL1 I/CCC_INST/INST_CCC_I I/GL1_INST:An	P:GL1 Clock Clock net cell		FCCC_C		/GL1_net /GL1 INST/U0 YW	ADLIB:GBM	

If your board has an output capacitance of 15 pf on Q, perform the following steps to update the timing number.

1. Open the I/O Attribute Editor and change the output load to 15 pf.

Figure 7-6. I/O Attribute Editor



- 2. Select File > Save.
- 3. Select **File > Close**.
- 4. Open the SmartTime Timing Analyzer and confirm that the **Clock to Output** delay changed to 5.952 ns.

8. Generating Timing Reports

The following sections describe how to generate timing reports.

8.1 Types of Reports

The following table describes the types of timing reports you can generate using SmartTime. **Table 8-1. Types of Timing Reports**

Report	Description
Timer Report	Displays the timing information organized by clock domain.
Timing Violations Report	Provides information about constraint violations.
Bottleneck Report	Displays points in the design that contribute to the most timing violations.
Datasheet Report	Describes the characteristics of the pins, I/O technologies, and timing properties in the design.
Constraints Coverage Report	Displays the overall coverage of the timing constraints set on the current design.
Combinational Loop Report	Displays loops found during initialization.
Clock Domain Crossing Report	Analyzes timing paths that cross from one clock domain (the source clock) to another clock domain (the destination clock).

8.2 Generating a Timing Report

The Timing Report allows you to determine whether timing problems exist in your design.

The Maximum Delay Analysis Timing Report lists the following information about your design:

- Maximum delay from input I/O to output I/O
- Maximum delay from input I/O to internal registers
- Maximum delay from internal registers to output I/O
- Maximum delays for each clock network
- Maximum delays for interactions between clock networks

To generate a Timing Report:

- 1. From the SmartTime Max/Min Delay Analysis View, choose **Tools > Reports > Timer**. The Timing Report Options dialog box appears.
- 2. Select the options you want to include in the report, and then click **OK**. The Timing Report appears in a separate window.

8.3 Understanding Timing Reports

The Timing Report contains the following sections:

Section	Description
Header	 Lists the: Report type Version of Designer used to generate the report Date and time the report was generated General design information (name, family, and so on)
Summary	Reports the timing information for each clock domain. By default, the clock domains reported are the explicit clock domains that are shown in SmartTime. To filter the domains and show only specific sections in the report, use the Timing Report Options dialog box.
Path	Lists the timing information for different types of paths in the design. This section is reported by default. You can deselect this option in the Timing Report Options dialog box. By default, the number of paths displayed per set is 5. You can filter the domains using the Timing Report Options dialog box. You can also view the stored filter sets in the generated report using the Timing Report options. The filter sets are listed by name in their appropriate section. The number of paths reported for the filter set is the same as for the main sets. By default, the filter sets are not reported.

Table 8-2. Timing Report Sections

8.3.1 Clock Domains

Paths are organized by clock domain.

8.3.2 Register to Register Set

This set reports the paths from the registers clock pins to the registers data pins in the current clock domain.

8.3.3 External Setup Set

This set reports the paths from the top-level design input ports to the registers in the current clock domain.

8.3.4 Clock to Output Set

This set reports the paths from the registers clock pins to the top-level design output ports in the current clock domain.

8.3.5 Register to Asynchronous Set

This set reports the paths from registers to asynchronous control signals, such as asynchronous set/reset.

8.3.6 External Recovery Set

This set reports the external recovery check timing for asynchronous control signals, such as asynchronous set/reset.

8.3.7 Asynchronous to Register Set

This set reports the paths from asynchronous control signals, such as asynchronous set/reset, to registers.

8.3.8 Inter-clock Domain

This set reports the paths from the registers clock pins of the specified clock domain to the registers data pins in the current clock domain. Inter-domain paths are not reported by default.

8.3.9 Pin to Pin

This set lists input to output paths and user sets. Input-to-output paths are reported by default. To see the userdefined sets, use the Timing Report Options dialog box.

8.3.10 Input to Output Set

This set reports the paths from the top-level design input ports to the top-level design output ports.

8.3.11 Expanded Paths

Expanded paths can be reported for each set. By default, the number of expanded paths to report is set to 1. You can select and change the number when you specify Timing Report options.

Figure 8-1. Timing Report

```
🕒 Timer Report
                                                                     File Actions Help
                                                                             ~
 Timing Report Max Delay Analysis
 SmartTime Version v12.0
 Microsemi Corporation - Microsemi Libero Software Release v12.0 (Version 12.500.0.4)
 Date: Fri Sep 14 11:55:24 2018
 Design: top
 Family: PolarFire
 Die: MPF100T
 Package: FCG484
 Temperature Range: 0 - 100 C
 Voltage Range: 0.97 - 1.03 V
 Speed Grade: STD
 Design State: Post-Layout
 Data source: Preliminary
 Operating Conditions: slow lv lt
 Scenario for Timing Analysis: timing_analysis
         _____
 SUMMARY
 Clock Domain:
 Required Frequency (MHz): 10000.000
                       -1.983
13.607
 External Setup (ns):
 Max Clock-To-Out (ns):
                          Input to Output
 Max Delay (ns):
                          N/A
 END SUMMARY
                  _____
 Clock Domain CLK
 Info: The maximum frequency of this clock domain is limited by the minimum pulse
 widths of pin CLK ibuf/U IOPAD:PAD
 SET Register to Register
 Path 1
   From: DFN1 0:CLK
   To: DFN1 1:D
  Delay (ns):
                         0.434
   Slack (ns):
                        -0.348
```

8.4 Generating a Timing Violation Report

The Timing Violations Report provides a Flat Slack Report centered around constraint violations.

To Timing Violations Report:

- 1. From the SmartTime Max/Min Delay Analysis View window, choose **Tools > Reports > Timing Violations**. The Timing Violations Report Options dialog box appears.
- 2. Select the options you want to include in the report, and then click **OK**. The Timing Violations Report appears in a separate window.

8.5 Understanding Timing Violation Reports

The following figure shows an example of a Timing Violations Report.

Figure 8-2. Sample Timing Violation Report

```
- 0
Timing_violations Report
  File Actions Help
 Timing Violation Report Max Delay Analysis
  SmartTime Version v11.6
 Microsemi Corporation - Microsemi Libero Software Release v11.6 (Version
 11.6.0.16)
 Date: Thu Apr 30 16:18:45 2015
  Design: false path
  Family: SmartFusion2
 Die: M2S050
 Package: 484 FBGA
 Temperature Range: 0 - 85 C
 Voltage Range: 1.14 - 1.26 V
 Speed Grade: STD
 Design State: Post-Layout
 Data source: Production
 Min Operating Conditions: BEST - 1.26 V - 0 C
 Max Operating Conditions: WORST - 1.14 V - 85 C
 Scenario for Timing Analysis: Primary
 Path 1
   From:
                                 D2 reg:CLK
                                Q reg:D
   To:
                                 1.341
   Delay (ns):
   Slack (ns):
                                -0.373
   Arrival (ns):
                                5.333
   Required (ns):
                                4.960
```

The Timing Violation Report contains the following sections:

Section	Description
Header	 This section lists the: Report type Version of Designer used to generate the report Date and time the report was generated General design information (name, family, and so on)
Paths	 This section lists the timing information for different types of paths in the design. The number of paths displayed is controlled by the following parameters: A maximum slack threshold to report A maximum number or path to report
	By default, the slack threshold is 0 and the number of paths is limited. The default maximum number of paths reported is 100.All clocks domains are mixed in this report. The paths are listed by decreasing slack.
	You can also choose to expand one or more paths. By default, no paths are expanded. For details, see the Timing Violation Report options.

Table 8-3. Timing Violation Report Sections

8.6 Generating a Constraints Coverage Report

The Constraints Coverage Report contains information about the constraints in the design.

To generate a Constraints Coverage Report:

- 1. From the SmartTime Max/Min Delay Analysis View, choose **Tools > Reports > Constraints Coverage**.
- 2. Select the text format and number of unconstrained instances and click **OK**. The report appears in a separate window.

8.7 Understanding Constraints Coverage Reports

The Constraints Coverage Report shows the overall coverage of the timing constraints set on the current design. You can generate this report either from within Designer or within SmartTime Analyzer.

Actions Help				
Design		false_path		
Family		SmartFusio	n2	
Die		M2S050		
Package		484 FBGA		
Temperature Ran		0 - 85 C		
Voltage Range		1.14 - 1.2	6 V	
Speed Grade		STD		
Design State		Post-Layou	t	
Analysis Min Ca		BEST		
Analysis Max Ca Scenario for Ti		WORST		
		(and)		
Coverage Summary				
Type of check				
	*		*	
Setup	1 0	1 10	40 20 10	50
Recovery	1 0	0	1 20	20
Output Setup	1 0	0	1 10	10
Total Setup	1 0	1 15	1 105	120
Hold	+	+	+	
Removal	1 10	0	40	50
		0	40 20 10	20
Output Hold Total Hold	0	0	10	120
Iotal hold				
Clock domain: my	-			
Type of check	Met	Violated	Untested	Total
Carup				
Setup Recovery	I 0 I 0	3	12	15
Recovery		0		0
Output Setup Total Setup			42	40
	+		+	
		0	1 12	15
		0	1 6	6
Hold	1 0			3
		0	1 3 1 42	3

Figure 8-3. Sample Constraints Coverage Report

The Constraints Coverage Report contains the following sections:

Table 8-4. Constraints Coverage Report Sections

Section	Description
Coverage Summary	Shows statistical information about the timing constraint in the design. For each type of timing checks (Setup, Recovery, Output, Hold, and Removal), it specifies how many are Met (there is a constraint and it is satisfied), Violated (there is a constraint and it is not satisfied), or Untested (no constraint was found).
Results by Clock Domain	This section provides a coverage summary for each clock domain.

continued				
Section	Description			
Enhancement Suggestions	Reports, per clock domain, a list of constraints that can be added to the design to improve the coverage. It also reports if some options impacting the coverage can be changed.			
Detailed Stats	Provides detailed suggestions about specific clocks or I/O ports that may require to be constrained for every pin/port that requires checks.			

8.8 Generating a Bottleneck Report

To generate a Bottleneck Report:

1. From the SmartTime Max/Min Delay Analysis View, choose **Tools > Reports > Bottleneck**. The report appears in a separate window.

8.9 Understanding Bottleneck Reports - SmartFusion2, IGLOO2, RTG4, and PolarFire

A bottleneck is a point in the design that contributes to multiple timing violations. The Bottleneck Report lists the bottlenecks in the design. You can generate this report from SmartTime Analyzer.

- Notes: The bottleneck can be computed only when a cost type is defined. There are two cost type options available:
 Path count: associates the severity of the bottleneck to the count of violating/critical paths that traverse the instance.
 - **Path cost**: associates the severity of the bottleneck to the sum of the timing violations for the violating/critical paths that traverse the instance.

Figure 8-4. Sample Bottleneck Report

ile Actions Help			
Sottleneck Report Max Delay An	alysis		
martTime Version 11.6.0.13			
icrosemi Corporation - Micros	emi Libero Software Release v11.6 (Version 11.6.0.13)		
ate: Tue Apr 21 13:18:30 2015			
Design	TOP		
Family	RTG4		
Die	RT4G150		
Package	1657 CG		
Radiation Exposure	0		
Temperature	MIL		
Voltage	MIL		
Speed Grade	-1		
Design State	Post-Layout		
Data source	Advanced		
Analysis Max Case	WORST		
Set selection type	Select Entire Design		
Cost type	Path Count		
Max Paths	100		
Max Parallel Paths	1		
Bottleneck instances	10		
Slack Threshold	0		
Scenario for Timing Analysis	Primary		
Sottleneck Analysis			
Instance Name		Path Count	
		++	
FDDR_INIT_0/COREABC_0/IO_OUT		1 50 1	
		16	
CoreAHBLite_0/matrix4x16/sla		15 1	
		15 1	
		11 1	
		11 1	
		11 1	
	vestage_0/slave_arbiter/arbRegSMCurrentState_nss_1_0[0]:Y	11 1	
CoreAHBLite_0/matrix4x16/s1a	vestage_0/slave_arbiter/arbRegSMCurrentState_RNO[7]:Y	1 1	

The Bottleneck Report contains the following parts: **Table 8-5. Bottleneck Report Sections**

Part	Description
Device Description	 Contains general information about the design, including: Design name Family Die Package Software version
Bottleneck Analysis	 Lists the core of the bottleneck information. It is organized into two columns: Instance Name: refers to the output pin name of the instance. Path Count: shows the number of violating paths that include the instance pin.

8.10 Generating a Datasheet Report

The Datasheet Report shows information about a design's external characteristics.

To generate a Datasheet Report:

1. From the SmartTime Max/Min Delay Analysis View, choose **Tools > Reports > Datasheet**. The report appears in a separate window.

8.11 Understanding Datasheet Reports

The Datasheet Report displays the external characteristics of the design. You can generate this report from SmartTime Max/Min Delay Analysis View.

Figure 8-5. Sample Datasheet Report

AT7 AU7 AW4									
I AU7	Inpu								
I AV4									
BA5									
AY5									
			1						
			1						
AN39	e Outp	at SSTI	181 (1)						
AG40	O Outp	ut SSTI	181 (1)						
AM39	9 Outp	at SSTI	18I (1)						
AC36	5 Outp	at SSTI	181 (1)						
AE40	Outp	at SSTI	18I (1)						
AH39	Outp	it SSTI	.181 (1)						
			IOS18 (2)						
			1						
			1						
			1						
			1						
			1						
			1						
			1						
AW8	Outp	at	1						
Vccr	Direction	Output Load	Odt_Static	Odt Imp	Input Delay	Resistor Pull	Schmitt Trigger	Slew 	Output
		+	+					+	++
		5	1					STOR	
	Output				1	None	1	3LOW	
1	Trout	3	1.055	50	OFF	1			
-	Toput	0	LOFE	50	1 OFF	1	1 8	5 E	
	Tubuc		UII	50	UII			Second Second	
	BA7 AY7 AY7 AY9 AN93 AG4(AA93(AG4(AA93(AG4(AA93(AJ31) AJ31 AJ31 AJ31 AJ31 AJ31	BA7 Input AY7 Input AY9 Input BA9 Input AX39 Input AX39 Outpy AL39 Outpy AL39 Outpy AL39 Outpy AG40 Outpy AG40 Outpy AA39 Outpy AC36 Outpy AA39 Outpy AA39 Outpy AA39 Outpy AJ39 Outpy AJ39 Outpy AJ39 Outpy AJ39 Outpy AJ39 Outpy AJ31 Outpy AJ33 Outpy AJ31 Outpy AJ32 Outpy AV6 Outpy AW6 Outpy AW8 Outpy Input Input Input Input Input Input	BA7 Input AY7 Input AY7 Input AY9 Input AY9 Input AX39 Output SSTI AL39 Output SSTI AG40 Output SSTI AG39 Output SSTI AG40 Output SSTI AC36 Output SSTI AC36 Output SSTI AC36 Output SSTI AA39 Output SSTI AJ39 Output SSTI AJ39 Output IVCM AJ31 Output IVCM AT3 Output IVCM AV6 Output IVCM AV6 Output I AW8 Output I	BA7 Input AY7 Input AY9 Input AY9 Input AX9 Output SSTL18I (1) AL39 Output SSTL18I (1) AG40 Output SSTL18I (1) AG39 Output SSTL18I (1) AG40 Output SSTL18I (1) AC36 Output SSTL18I (1) AC36 Output SSTL18I (1) AA39 Output SSTL18I (1) AA39 Output SSTL18I (1) AA39 Output SSTL18I (1) AA39 Output SSTL18I (1) AJ39 Output SSTL18I (1) AJ39 Output SSTL18I (1) AJ39 Output SSTL18I (2) AJ31 Output LVCMOS18 (2) AJ33 Output AV6 Output AV6 Output AV6	BA7 Input AY7 Input AY9 Input AY9 Input AY9 Output SSTL18I (1) AL39 Output SSTL18I (1) AG40 Output SSTL18I (1) AG40 Output SSTL18I (1) AC36 Output SSTL18I (1) AC36 Output SSTL18I (1) AA39 Output SSTL18I (1) AA39 Output SSTL18I (1) AJ38 Output SSTL18I (1) AJ3 Output LVCMOS18 (2) AT5 Output AV6 Output AW6 Output	BA7 Input AY7 Input AY9 Input AY9 Input AX9 Output SSTL18I (1) AL39 Output SSTL18I (1) AG40 Output SSTL18I (1) AG59 Output SSTL18I (1) AG40 Output SSTL18I (1) AC36 Output SSTL18I (1) AA39 Output SSTL18I (1) AA39 Output SSTL18I (1) AA39 Output SSTL18I (1) AA39 Output SSTL18I (1) AJ39 Output SSTL18I (1) AJ39 Output SSTL18I (2) AJ39 Output LVCNOS18 (2) AJ31 Output AJ31 Output AV6 Output AV6 Output AW6 Output AW8 Output	BA7 Input	BA7 Input	BA7 Input

The Datasheet I	Report	contains	three	tables:
-----------------	--------	----------	-------	---------

Table	Description
Pin Description	Provides the port name in the netlist, location on the package, type of port, and I/O technology assigned to it. Types can be input, output, or clock. Clock ports are ports shown as "clock" in the Clock domain browser.
DC Electrical Characteristics	Provides the parameters of the different I/O technologies used in the design. The number of parameters displayed depends on the family for which you have created the design.

continued				
Table	Description			
AC Electrical Characteristics	Provides the timing properties of the ports of the design. For each clock, this section includes the maximum frequency. For each input, it includes the external setup, external hold, external recovery, and external removal for every clock where it applies. For each output, it includes the clock-to-out propagation time. This section also displays the input-to-output propagation time for combinational paths.			

8.12 Generating a Combinational Loop Report

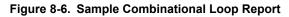
The Combinational Loop Report shows all loops found during initialization and reports pins associated with the loop(s) and the location where a loop is broken.

To generate a Combinational Loop Report:

- 1. From the **Tools** menu, choose **Reports > Combinational Loops**. The Combinational_Loops Report Options dialog box appears.
- 2. Select either Plain Text or Comma Separated Values.
- 3. Click OK.

8.13 Understanding Combinational Loop Reports

The Combinational Loop Report shows all loops found during initialization, reports the pins associated with the loops, and identifies the locations where loops are broken.



```
X
Combinational_loops Report
  File Actions Help
 Combinational Loop Report
 SmartTime Version 11.6.0.15
 Microsemi Corporation - Microsemi Libero Software Release v11.6 (Version
  11.6.0.15)
 Date: Fri May 01 15:50:15 2015
                                  TOP
  Design
  Family
                                  RTG4
  Die
                                  RT4G150
                                  1657 CG
  Package
  Radiation Exposure
                                  0
                                  -55 - 125 C
  Temperature Range
                                 1.14 - 1.26 V
  Voltage Range
  Speed Grade
                                  -1
  Design State
                                 Post-Layout
  Analysis Min Case BEST - 1.26 V - -55 C
Analysis Max Case WORST - 1.14 V - 125 (
                                 WORST - 1.14 V - 125 C
  Analysis Max Case
  Scenario for Timing Analysis Primary
 No combinational loops were detected in the design.
```

8.14 Generating a Clock Domain Crossing (CDC) Report

The Clock Domain Crossing (CDC) Report analyzes timing paths that cross from one clock domain (the source clock) to another clock domain (the destination clock). The CDC report helps identify instances where there may be data loss or metastability issues.

To generate the CDC Report:

- From the Tools menu, choose Reports > Clock Domain Crossing (CDC).. The Clock Domain Crossing Report Options dialog box appears.
- 2. Select either CDC Table or Comma Separated Values.
- 3. Click OK.

Selecting **CDC Table** displays a graphical table with color-coded cells. Each cell represents a CDC type between the source clock and the destination clock domains that have constraints. Clocks without constraints do not appear in the CDC table.

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> (lock Selection					Destination Clock	(S			
[en_clk_12p5mh	/pll_inst_0/OUT	/pll_inst_0/OUT	asyn_reg_c	k lk_input_100n	h :lk_input_25mha	g_com_clk_10m	:lk_input_50mh	g_com_clk_5ml
	gen_clk_12p5m	hz								
2	/pll_inst_0/0UT	го								
Clocks	/pll_inst_0/0U1	n								
8	asyn_reg_clk	Section and the section of the secti								
	clk_input_100ml									
	clk_input_25mh							<u> </u>		
1	reg_com_clk_10	mhz								
_	id o Path				E	User Ignored	Paths			
N						User Ignored Timed (Unsafe				
N T	o Path	Destination clock	Worst Slack (ns)	Worst Slack Edge	Max Delay Cstr			Clock Uncertainty Cstr	Num of paths	Clock Pair Status
N T	o Path imed	Destination clock clk_input_25mhz				Timed (Unsafe Multicycle Path Cstr) Clock		paths	
N T S Ik_inp	o Path imed ource Clock					Timed (Unsafe Multicycle Path Cstr) Clock Group Cstr		paths 0	Pair Status
N T S lk_inp en_cl	o Path imed ource Clock ut_50mhz	clk_input_25mhz				Timed (Unsafe Multicycle Path Cstr) Clock Group Cstr Yes		paths 0	Pair Status User Ignored
T S Ik_inp en_cl en_cl	o Path imed ource Clock ut_50mhz k_12p5mhz	clk_input_25mhz clk_input_25mhz		Slack Edge		Timed (Unsafe Multicycle Path Cstr	Clock Group Cstr Yes Yes		paths 0 0 0	Pair Status User Ignored User Ignored

The attributes present in the path table are as follows:

- Source Clock: Source of the clock
- Destination Clock: Destination of the clock
- Worst Slack (ns): Worst slack of the CDC path in nanoseconds
- · Worst Slack Edge: This is the source/sink edge for the worst path of CDC
- Max Delay Cstr:

Value	Description
Yes	All paths in CDC have set_max_delay applied
No	No paths in CDC have the constraints applied
Partial	Any path in CDC has the constraint applied

• Multicycle Path Cstr:

Value	Description
Yes	All paths in CDC have set_multicycle_path applied
No	No paths in CDC have the constraints applied
Partial	Any path in CDC has the constraint applied

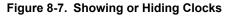
Clock Group Cstr:

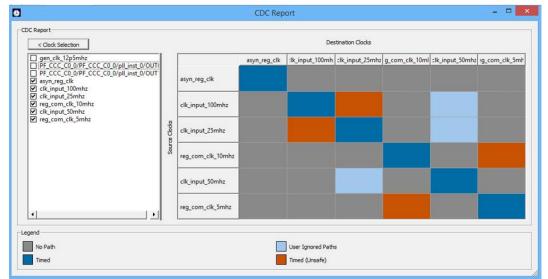
Value	Description
Yes	CDC has set_clock_group applied
No	CDC does not have set_clock_group applied

- Clock Uncertainty Cstr: It is the uncertainty value for the worst path in CDC; else, the clock uncertainty field is left empty.
- Num of Paths: Number of paths in CDC. For User Ignored paths, the value is 0.
- Clock Pair Status: The status can be Timed Safe, Timed Unsafe or User Ignored.

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In the CDC Report dialog box, you can select the clocks to view or hide. Clicking the **Clock Selection** button at the top left of the dialog box lists all clocks that can be viewed or hidden. By default, all clocks are checked and visible. To hide a clock, clear its check box.





The following table describes the colors in the CDC Report shown in the preceding figure.

Pattern	Status	Color
Paths from the source clock domain to the destination clock domain have all been disabled by false path or clock group constraints.	User-Ignored Paths	Light blue
No Paths found from the source clock domain to the destination clock domain.	No Paths	Gray
The source and destination clocks are synchronous: Both the clocks have a common primary clock and paths are found from the source clock domain to the destination clock domain.	Timed	Dark Blue
The source and destination clocks are asynchronous: Both the clocks have NO common primary clock, while paths are found from the source clock domain to the destination clock domain. Currently, synchronizers, if present, are not accounted for in this report.	Timed (unsafe)	Brown

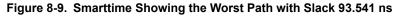
There are certain scenarios related to the path table as explained in the following:

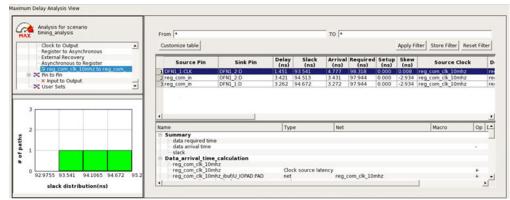
1. When CDC report is generated, path table is shown by default for all CDC having paths. Each row shows the worst slack for a clock crossing. Similarly, when clicking on a particular CDC crossing in CDC report, you can have a single row showing the worst slack for CDC crossing.

Example: The path table shown in the following figure, the worst path for reg_com_clk_10mhz to reg_com_clk_5mhz has the worst slack of 93.541. The same path is displayed by default, when the CDC crossing is selected.

Figure 8-8. Worst Path with Slack 93.541 ns

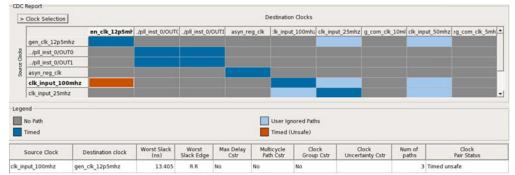
Source Clock	Destination clock	Worst Slack (ns)	Worst Slack Edge	Max Delay Cstr	Multicycle Path Cstr	Clock Group Cstr	Clock Uncertainty Cstr	Num of paths	Clock Pair Status
gen_clk_12p5mhz	clk_input_25mhz					Yes		0	User Ignored
gen_clk_12p5mhz	clk_input_50mhz					Yes		0	User Ignored
reg_com_clk_10mhz	reg_com_clk_5mhz	93.541	RR	No	No	No	5.000	3	Timed unsafe
reg_com_clk_5mhz	reg_com_clk_10mhz	89.703	R F	No	No	No	2.000	2	Timed unsafe





2. Clicking on the CDC box shows the worst slack for a clock crossing as in path table in the following figure.

Figure 8-10. Highlighted CDC Box Showing the Worst Slack in Path Table



Clicking on the same CDC box again will show the details for all the clocks selected in CDC report.

Figure 8-11. CDC Path Table Showing All Clocks on Deselecting the Selected CDC Box

> (Clock Selection						Destinatio	on Clocks							
			n_clk_12p5mł	/pll_inst_0/OUTC	/pll_inst_0/OL	JTI asyn_re	eg_clk :lk_inp	ut_100mh; clk_ir	put_25mhz	g_com_clk_1	.0ml clk_i	put_50n	nhz eg	_com_clk	5mh
	gen_clk_12p5mh								_						
Clocks	/pll_inst_0/OUT														-
Source	/pll_inst_0/OUT	1				-									
	asyn_reg_clk														
	clk_input_100														
_	nd io Path						User Ig	nored Paths							
T		Dest	ination clock	Worst Slack (ns)	Worst Slack Edge	Max Delay Cstr	User Ig Timed Multicycle Path Cstr		Clo	ock iinty Cstr	Num of paths			lock Status	
T	io Path Timed		ination clock _C0_0/PF_CCC	Worst Slack (ns) 23.459	Slack Edge	Max Delay Cstr	Multicycle	(Unsafe) Clock			paths	1 Timed	Pair		
T S	io Path fimed Source Clock	PF_CCC_		(ns)	Slack Edge	Cstr	Multicycle Path Cstr	(Unsafe) Clock Group Cstr		inty Cstr	paths	1 Timed	Pair I safe		
T	io Path fimed Source Clock C_C0_0/PF_CCC	PF_CCC_ PF_CCC_	C0_0/PF_CCC	(ns) 23.459	Slack Edge	Cstr	Multicycle Path Cstr Yes	(Unsafe) Clock Group Cstr No		inty Cstr	paths	-	Pair I safe I safe	Status	

For all clocks having large names, tool-tips for columns have been added.

CUC Report

Figure 8-12	CDC Path Table Show	ving Tool-Tip for a Sourc	e Clock Name
riguie o-iz.		ang tool-np tot a bourd	

Source Clock	Destination clock	Worst Slack (ns)
PF_CCC_C0_0/PF_CCC	PF_CCC_C0_0/PF_CCC	23.459
PF_CCC_PF_CCC_C0_0/PI	CCC_C0_0/pll_inst_0/OUT	0 3.928
clk_input_100mhz	clk_input_25mhz	

3. Selecting/deselecting clocks in clock selection will dynamically change the path table along with the CDC table. Both the tables are in sync. Example: Here, clk_input_100mhz is selected, therefore, the clock is displayed in CDC table and path table.

Figure 8-13. CDC Table in Sync with Clock Selection Section

< Clock Selection							Destinal	bon Clocks							
Select All gen_clk_12p5ml PF_CCC_C0_0/PF	CCC C0 0/pll inst 0/OUTO		gen_cl	lk_12p5mhz	_clk_12p	Il_inst_0/Ol	l_inst_0/Ol	syn_reg_cl	input_100r	_input_25n	:om_cl	k_1(_ir	nput_50n	.com_clk_	5
PF_CCC_C0_0/PF asyn reg clk	CCC_C0_0/pll_inst_0/OUT1	10	/pll_ir	nst_0/OUT0											
Clk input 100mh	z	Source Clocks	/pll_ir	nst_0/OUT1											
Clk_input_25mhz reg_com_clk_10	mhz	3	asyn_r	reg_clk	1										r
Clk_input_50mhz reg_com_clk_5m	hz		clk_in	put_100mh	z										
C. regularization			clk_inp	out_25mhz	1										
and the second second							an occod Dath								
egend No Path Timed						-	gnored Path (Unsafe)	15							
No Path	Destination clock	Worst S (ns		Worst Slack Edge	Max Delay Cstr	-		ck	Clock Uncertainty (im of aths		Cloc Pair St		
No Path Timed Source Clock		(ns				Multicycle	(Unsafe)	ck	Uncertainty (aths	Timed	Pair St		
No Path Timed Source Clock	PF_CCC_C0_0/PF_CCC	(ns 23		Slack Edge	Cstr	Multicycle Path Cstr	(Unsafe) Clo Group	ck	Uncertainty (Cstr p	aths 1	Timed	Pair Sta safe		
Timed	PF_CCC_C0_0/PF_CCC	(ns 23	1.459	Slack Edge R R	Cstr	Multicycle Path Cstr Yes	(Unsafe) Clor Group No	ck	Uncertainty (Cstr p	aths 1 1	Timed	Pair Sta safe		

When the clock clk_input_100mhz is unselected, then the same clock is removed from the CDC table. The crossings related to the clock are also removed from the path table as shown in the following figure.

Figure 8-14	Deselecting	a Clock in Cloc	k Selection	Section Sy	vncs the Path	Table Accordingly
1 iguie 0-14.	Deselecting		K Oelection	Occupii o	yncs the i at	i lable Accolutingly

< Clock Selection												
Select All gen_clk_12p5mh	z CCC_C0_0/pll_inst_0/OUT0		gen (clk 12p5mhz	_clk_12p	Sr >ll_inst_0/OL	J sll_inst_0/OL is	syn_reg_cli	:_input_25m	_com_clk_1	0 :_input_50m	_com_clk_5r
PF_CCC_CO_0/PF_ asyn_reg_clk	CCC_C0_0/pll_inst_0/OUT1	Clocks	-	inst_0/OUT0								
clk_input_100mh;	z	8	_/pll_	inst_0/OUT1								
Clk_input_25mhz reg_com_clk_10m		S.	asyn	reg_clk								
Clk_input_50mhz reg_com_clk_5mi	hz		clk_in	put_25mhz	-					4		
C. reg_com_cm_sm			100 0	om clk 10mh								
No Path			lied_e	on_ck_ronn	-	-	nored Paths					
No Path Timed	Γ	Worrt	,			Timed ((Unsafe)		ock	Num of	- di	ack
No Path	Destination clock	Worst S (ns	ilack	Worst Slack Edge	Max Delay Cstr	-			ock ainty Cstr	Num of paths		ock Status
No Path Timed Source Clock	Destination clock	(ns	ilack	Worst	Max Delay	Timed ((Unsafe)			paths		
No Path Timed Source Clock		(ns 2	ilack	Worst Slack Edge	Max Delay Cstr	Multicycle Path Cstr	(Unsafe) Clock Group Cstr		ainty Cstr	paths	Pair 9	
Timed	PF_CCC_C0_0/PF_CCC	(ns 2	ilack) 3.459	Worst Slack Edge R R	Max Delay Cstr No	Multicycle Path Cstr Yes	(Unsafe) Clock Group Cstr No		ainty Cstr	paths 1	Pair S Timed safe	Status

On clicking any one of the four options in the CDC category, the clock table is filtered according to the CDC category selected.

The following is a scenario where Timed button has been selected, and Timed safe CDC is only displayed in the clock table.

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Figure 8-15. CDC Report When Timed Button is Selected in CDC Category

Timed					Timed (Unsafe)			
Worst Slack (ns)	Worst Slack Edge	CORNER INFO	Max Delay Cstr	Multicycle Path Cstr	Clock Group Cstr	Clock Uncertainty Cstr	Num of paths	Clock Pair Status
23.459	RR		No	Yes	No	0.5	1	Timed safe
3.928	RR		No	No	No		1	Timed safe

Clicking on the same CDC category shows the details for all the clocks selected in CDC report. Selecting/ unselecting clocks in clock selection does dynamically change the clock table along with the CDC table.

In the following figure, the User Ignored CDC category button is chosen and clk_input_100mhz is selected. Therefore, the clock is displayed in CDC table and clock table.

< Clock Selection	The second se			Destin	ation Clocks		
Select All gen_clk_12p5n PF_CCC_C0_0/P	nhz F CCC C0 0/pll	gen_clk_12p5mh	-	inst_0/ inst_0/	n_reg_ put_10	1put_2! m_clk_	iput_5()m_clk
PF_CCC_C0_0/P	F_CCC_C0_0/pll	/pll_inst_0/OUT)				
Clk_input_100m	F_CCC_C0_0/pll	/pll_inst_0/OUT					- 199
✓ clk_input_25ml ✓ reg_com_clk_1	0mhz	asyn_reg_clk					
Clk input 50ml	nz 🗸	clk_input_100mh					
CDC Category		elle innut 25mbz					·
<u></u>				ser Ignored Pai imed (Unsafe)	hs		
CDC Category	Destination clo	Worst Clack		-	hs Max Delay Cstr	Multicycle Path Cstr	Clock
CDC Category		ck Worst Slack	Worst	imed (Unsafe)	Max Delay	Multicycle Path Cstr	Clock
CDC Category	Destination clo	ck Worst Slack	Worst	imed (Unsafe)	Max Delay	Multicycle Path Cstr	Clock Group Cstr

Now, when clock clk_input_100mhz is unselected, the same clock is moved from CDC table and the crossings related to that clock are also removed from clock table. Therefore, when the User Ignored CDC category is selected, entries related to clk_input_100mhz are not visible.

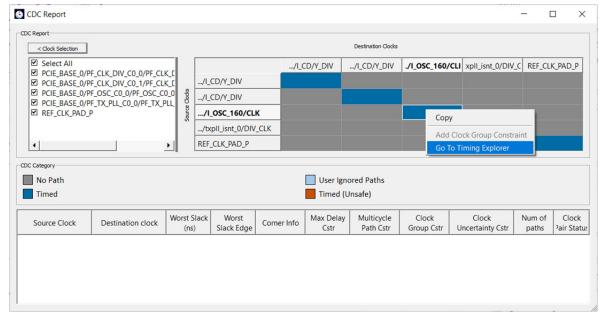
Libero[®] SoC v2021.2

Generating Timing Reports

			CDC Repor						
CDC Report < Clock Selection]			Des	stination Clocks	5			
Select All gen_clk_12p5m PF_CCC_C0_0/PI	nhz F CCC C0 0/pll	gen_clk_12p5mhz	:lk_12p	inst_0/(in	st_0/(/n_reg_	nput_25	∍m_clk_:	nput_5C om_clk	-
PF_CCC_C0_0/Pl asyn_reg_clk	F_CCC_C0_0/pll	/pll_inst_0/OUT0							L
clk_input_100m	F_CCC_C0_0/pll	/pll_inst_0/OUT1							L
✓ clk_input_25mh ✓ reg_com_clk_1	0mhz	asyn_reg_clk							
Clk_input_50mh	z. 💌	clk_input_25mhz							
1		rea com clk 10ml	h7						•
CDC Category									
CDC Category		Worst Slack	ш Ті	ser Ignored) 	alay	Multicycl	e Clock	
No Path	Destination clo	ck Worst Slack (ns)		-) 		Multicycle Path Cst		str
No Path	Destination clo clk_input_50mhz		Worst	imed (Unsafe	e)				str
No Path Timed Source Clock			Worst	imed (Unsafe	e)			Group Cs	str
No Path Timed	clk_input_50mhz		Worst	imed (Unsafe	e)			r Group Cs Yes	str

On right-clicking a CDC box, you can choose to **Copy**, **Add a Clock Group Constraint** or **Go to Timing Explorer**.





Selecting the **Go to Timing Explorer** option opens the Timing Explorer dialog box.

Figure 8-17. Timing Report Explorer

		Timing Repo	ort Expl	orer [active]					
Image: Solution of the second state in the second state									
	À Max Analysi	is 🛛 🗲 Min Analysis 📄							
peed: -1 p_range: 0 - 100 C	All Paths	Save Save As							
oduction	PF_CCC_C0_0/	PF_CCC_C	ce Type:	All 🔻 Destinat	ion Type	All 🔹 Check Type:	All 🔹 More	 Apply 	
								[Columns
Il Paths	Slack (ns)	From/To	Edges				Destination Clock	perating Co	ondition
egister to Register	31 💙 23.4		RR	11.488	34.947	PF_CCC_C0_0/ PF_CCC_C0_0/pll_inst	PF_CCC_C0_0/ PF_CCC_C0_0/pll_inst	slow_lv_ht	
aved Filters bc									
be									

There are corner scenarios when cross probing between CDC and Timing Explorer:

Scenario 1:

This is a scenario where difference is seen between SmartTime and Verify timing, when two clocks are defined on same port and when cross probing for CDC reg_com_clk_10mhz and reg_com_clk_5mhz is unable to find the same in Timing Report Explorer.

The constraints are as follows:

```
create_clock -name {reg_com_clk_10mhz} -period 100 -waveform {0 50 } [ get_ports
{ reg_com_clk_10mhz } ]
create_clock -name {reg_com_clk_5mhz} -period 200 -waveform {0 100 } -add [ get_ports
{ reg_com_clk_10mhz } ]
```

The Timing Report Explorer does not pick reg_com_clk_5mhz as destination clock, and Smart time does pick the reg_com_clk_10mhz and reg_com_clk_5mhz pair as CDC, as shown in the following.

Figure 8-18. Timing Report Explorer Snapshot - 1

All Paths	Save Save As						
reg_com_clk_10mhz	Destination Clock: All Source Type	ype: All 🔻	Destination	Type: All 🔻	Check Type: All 🔻	More App	Columns
Slack (ns)	From/To	Edges	Arrival (ns)	equired (ns	Source Clock	Destination Clock	perating Co
1 🗙 -11.56	From: reg_com_in To : DFN1 1:D	FF	1.902	13.462	reg_com_clk_10mhz	reg_com_clk_10mhz	slow_lv_ht

Figure 8-19. Timing Report Explorer Snapshot - 2

≽ Max Analysis 🔰 🎽	Min Anal	ysis		
All Paths	53	ave	Save As	
reg_com_clk_10mhz			tion Clock: All	▼ Source Type: All
		and the second se	ation Clock: All CO 0inst 0/OU	то
× -11.56	From: ro To : [PF_CCC	CO_0inst_0/OU eq_clk	
× -11.44	To .I	clk inp	ut_100mhz ut_25mhz	clk_10mhz
× -9.87	From: D	reg_co	<_12p5mhz m_clk_10mhz	clk 10mhz ibuf/

Figure 8-20. SmartTime Snapshot

Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arriva (ns)	(ns)	d Hold ic
1 reg_com_in	DFN1_1:D	2.392	-1.060	2.402	3.462	0.136
2 reg com in	DFN1 2:D	2.512	-0.940	2.522	3.462	0.136
3 DFN1_1:CLK	DFN1_2:D	0.825	0.681	3.769	3.088	0.136
	1 reg_com_in 2 reg_com_in	1 reg_com_in DFN1_1:D 2 reg_com_in DFN1_2:D	Source Pin Sink Pin (ns) 1 reg_com in DFN1_1:D 2.392 2 reg_com in DFN1_2:D 2.512	Source Pin Sink Pin (ns) (ns) l reg.com.in DFN1_1.D 2.392 -1.060 2 reg.com.in DFN1_2.D 2.512 -0.940	Source vin Sink Pin (ns) (ns) <th(ns)< th=""> (ns) <th(ns)< th=""></th(ns)<></th(ns)<>	Source Pin Sink Pin (ns) (ns) (ns) 1 reg_com in DFN1 1:D 2.392 -1.060 2.402 3.462 2 reg_com in DFN1 2:D 2.512 D940 2.522 3.462

Timing Explorer is picking the worst slack path for a pair of start and end point. Therefore, you can miss CDC and other reg to reg paths with lower slack values.

Scenario 2:

This is a scenario where due to different operating conditions set in Smart Time, you can have different results, when cross probing between CDC and Timing Report Explorer. SmartTime and CDC are in sync.

Figure 8-21. Worst Slack of 97.958 ns in Timing Report Explorer

reg_com_clk_10mhz	•	reg_com_clk_5mhz 🔹	Source Type: All	•	Destination T	ype: All 🔻	Check Type: All 🔻	More 🔹	Apply	Y F
										Columns
Slack (ns)		From/To		Edge	sArrival (ns)	equired (ns	Source Clock	Destination	Clock	perating Con

Figure 8-22. Worst Slack of 98.154 ns in SmartTime

Asynchronous to Register ✓ reg com clk 10mhz to reg com	Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required (ns)	Setup (ns)	Skew (ns)	Source Clock
Pinto Pin Vinput to Output	1 DFN1_1:CLK 2 reg com in		1.266	98.154 98.904	3.555	101.709 101.453	0.000	0.005	reg_com_clk_10mhz reg_com_clk_10mhz
Set Sets	3 reg_com_in		2.449	98.994	2.459	101.453	0.000		reg_com_clk_10mhz
Figure 8-23. Operating Cor	nditions								
Operating Conditi	ons								
			Ē				14	-	
Perform maximum	delay analysis	based or	n 1	fast_l	nv_lt		_		case
Perform minimum	dolay analysis	hasad or	. F	fast I	ny It			7.	case
renorminimi	uelay allalysis	based of	. 1	asc_i	···		-	_ '	case

The Timing Report Explorer reports the path from slow_lv_lt, and SmartTime reports using the operating condition fast_hv_lt. When the operating condition in SmartTime is changed to slow_lv_lt, the worst slack becomes the same as in the Timing Report Explorer.

Figure 8-24. Slack After Changing the Operating Condition to slow_lv_lt

☑ reg_com_clk_10mhz to reg_com	Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required (ns)	Setup (ns)	Skew (ns)	Source Clock
Pin to Pin	1 DFN1_1:CLK	DFN1_2:D	1.460	97.958	4.513	102.471	0.000	0.007	reg_com_clk_10mhz
→ Input to Output	2 reg_com_in	DFN1_2:D	3.190	98.925	3.200	102.125	0.000	-2.690	reg_com_clk_10mhz
• User sets	3 reg_com_in	DFN1_1:D	3.037	99.078	3.047	102.125	0.000	-2.690	reg_com_clk_10mhz

CDC reports worst path for a particular corner selected in SmartTime, and Timing Report Explorer reports the worst path across all the corners.

In such cases, you can see changes in values when navigating from CDC to Timing Report Explorer. To make you aware of such situations, Corner Info column is added to display the operating conditions.

Note:

- The path details for the same clock crossing (C1 to C1) are not shown in the path tale as they are not valid clock crossings and are currently shown as timed safe by default in CDC report.
- The clock table has CDC details only related to clocks checked in clock selection from CDC report.
- Path table will not show any CDC having no paths.
- For User Ignored CDC columns, "Worst Slack (ns)", "Worst Slack Edge", "Max Delay Cstr", "Multicycle Path Cstr", and "Clock Uncertainty Cstr" are empty.
- Cross probing is allowed to Timing Report Explorer for the same clock crossing (C1 to C1).
- For User Ignored CDC category, Corner Info column is empty.

Selecting **Comma Separated Value** exports the CDC Report to a CSV file. If you select this option, a window appears in which you assign a name to the CSV file and specify the location where it will be exported. The

CSV file shows details about the CDC between each clock domain in numeric format. Each CDC type is represented as a number similar to colors in the table. The CSV file includes an explanation of each number type and CDC type.

Figure 8-25. Sample CSV Report

A		c	0	1 A		0	м		1
SmartTime Version v12.4									
Microvens Corporation - Microsomi Liboro Software Release v22.4 (Version 12.900.8.1)									
Date: Weil Mar 11 23:48:02 2020									
Cerips	test								
Family	PolarFire								
De	MPF100T								
Package	PCG484								
Temperature Range	0 - 100 C								
VuR.age Range	0.97-1.03V								
Speed Grade		1							
Design State	Post-Layout								
Cata source	Production								
Operating Conditions	tion_ly_ht								
Scenario for Timing Analysis	Clock Domain Crossings								
Searce Clacks / Destination Clocks	gen ofk 12p6m/s	PF_CCC_CD_QRF_CCC_CD_Q/pil_mut_Q/DU/10	PF COC CD 0/PF CCC CO 0/bill inst 0/DUTS	mys reg ch	ek rout 200mhs	ulk input 25mbs	reg corn dk 20m/s	cik input somha	reg com ck 5mh
gen ck 12p6mhz	Timed	No Path	No Path	No Peth	User (prored	Timed	No Path	User Ignored	No Peth
PF CCC CD B/PF CCC CD B/p# wit B/OUTD	No Path	Tined	User Ignored	No Puth	No Puth	No Path	No Path	No Path	No Path
97 CCC CO 6/97 CCC CD 6/98 Int 6/OUT1	No Path	User ignored	Timed	No Puth	No Path	No Path	No Path	No Path	No Path
anya_reg_dk	No Path	No Path	Na Path	Taned	No Path	No Path	No Path	No Park	No Path
ck_saur_soowha	Trend (unsafe)	No Path	No Path	No Futh	Timed	Timed (ancafe)	No Path	User Ignared	No Path
ch_mput_25mlp	User ignored	No Path	No Path	No Fath	timed (unsafe)	Timod	No Path	User Ignored	No Path
reg con ck 20nhe	No Path	No Path	No Path	No Path	No Path	No Path	Timed	No Path	Timed (unsefe)
ck input 50mhz	No Path	No Path	No Path	No Path	No Peth	User Ignored	No Path	Timed	No Peth
reg. com cik 5mhz	No Path	No Path	No Path	No Path	No Peth	No Path	Timed (unsafe)	No Path	Tened

9. Timing Concepts

The following sections describe timing concepts associated with the RTG4 FPGA Clock Conditioning Circuit with PLL configuration.

9.1 Static Timing Analysis Versus Dynamic Simulation

STA offers an efficient technique for identifying timing violations in your design and ensuring that it meets all your timing requirements. You can communicate timing requirements and timing exceptions to the system by setting timing constraints. A static timing analysis tool will then check and report setup and hold violations as well as violations on specific path requirements.

STA is well suited for traditional synchronous designs. The main advantage of STA is that, unlike dynamic simulation, it does not require input vectors. It covers all possible paths in the design and does all the above with relatively low run-time requirements. The major disadvantage of STA is that the STA tools do not automatically detect false paths in their algorithms.

9.2 Delay Models

The first step in timing analysis is the computation of single component delays. These components can be either a combinational gate or block or a single interconnect connecting two components.

Gates that are part of the library are pre-characterized with delays under different parameters, such as input-slew rates or capacitive loads. Traditional models provide delays between each pair of I/Os of the gate and between rising and falling edges.

The accuracy with which interconnect delays are computed depends on the design phase. These can be estimated using a simple Wire Load Model (WLM) at the pre-layout phase or a more complex Resistor and Capacitor (RC) tree solver at the post-layout phase.

9.3 Timing Path Types

Path delays are computed by adding delay values across a chain of gates and interconnects. SmartTime uses this information to check for timing violations. Traditionally, timing paths are presented by static timing analysis tools in four categories or "sets."

- Paths between sequential components internal to the design. SmartTime displays this category under the Register to Register set of each displayed clock domain.
- Paths that start at input ports and end at sequential components internal to the design. SmartTime displays this category under the External Setup and External Hold sets of each displayed clock domain.
- Paths that start at sequential components internal to the design and end at output ports. SmartTime displays this category under the Clock to Out set of each displayed clock domain.
- Paths that start at input ports and end at output ports. SmartTime displays this category under the Input to Output set.

9.4 Maximum Clock Frequency

Generally, you set clock constraints on clocks for which you have a specified requirement. The absence of violations indicates that this clock can run at least at the specified frequency. However, in the absence of such requirements, you may still be interested in computing the maximum frequency of a specific clock domain.

To obtain the maximum clock frequency, a static timing analysis tool computes the minimum period for each path between two sequential elements. To compute the maximum period, the tool evaluates the maximum data path delay and the minimum skew between the two elements, as well as the setup on the receiving sequential element. It also considers the polarity of each sequential element. The maximum frequency is the inverse of the largest value among the maximum period of all the paths in the clock domain. The path responsible for limiting the frequency of a given clock is called the "critical path."

9.5 Setup Check

The setup and hold check ensures that the design works as specified at the required clock frequency.

Setup check specifies when data is required to be present at the input of a sequential component so that the clock can capture the data effectively into the component. Timing analyzers evaluate the setup check as a maximum timing budget allowed between adjacent sequential elements.

For more information about how setup check is processed, see Arrival Time, Required Time, and Slack.

9.6 Arrival Time, Required Time, and Slack

You can use arrival time and required time to verify timing requirements in the presence of constraints. The following simple example is applied to verify the clock requirement for setup between sequential elements in the design.

The arrival time represents the time at which the data arrives at the input of the receiving sequential element. In this example, the arrival time is considered from the setup launch edge at CK, taken as a time reference (instant zero). It follows the clock network along the blue line until the clock pin on FF1 (delay d1). Then it continues along the data path always following the blue line until the data pin D on FF2. Therefore,

Arrival_TimeFF2:D = d1 + d2

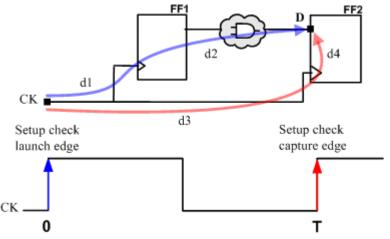
The required time represents when the data is required to be present at the same pin FF2:D. Assume in this example that in the presence of an FF with the same polarity, the capturing edge is simply one cycle following the launch edge. Using the period T provided to the tool through the clock constraint, the event gets propagated through the clock network along the red line until the clock pin of FF2 (delay d3). Taking FF2 setup (delay d4) into account. This means the clock constraint requires the data to be present d4 time before the capturing clock edge on FF2. Therefore, the required time is:

Required_TimeFF2:D = T + d3 - d4

If the slack is negative, the path is violating the setup relationship between the two sequential elements.

The slack is simply the difference between the required time and arrival time: SlackFF2:D = Required_TimeFF2:D - Arrival_TimeFF2:D

Figure 9-1. Arrival Time and Required Time for Setup Check



9.7 Timing Exceptions Overview

Use timing exceptions to overwrite the default behavior of the design path.

Timing exceptions include:

• Setting multicycle constraint to specify paths that (by design) will take more than one cycle.

- Setting a false path constraint to identify paths that must not be included in the timing analysis or the
 optimization flow.
- Setting a maximum/minimum delay constraint on specific paths to relax or to tighten the original clock constraint requirement.

9.8 Clock Skew

The clock skew between two sequential components is the difference between the insertion delays from the clock source to the clock pins of these components. SmartTime calculates the arrival time at the clock pin of each sequential component. Then it subtracts the arrival time at the receiving component from the arrival time at the launching component to obtain an accurate clock skew.

Both setup and hold checks must account for clock skew. However, for setup check, SmartTime looks for the smallest skew. This skew is computed by using the maximum insertion delay to the launching sequential component and the shortest insertion delay to the receiving component.

For hold check, SmartTime looks for the largest skew. This skew is computed by using the shortest insertion delay to the launching sequential component and the largest insertion delay to the receiving component.

SmartTime makes the distinction between setup and hold checks and hold checks automatically.

9.9 Cross Probing

Design objects displayed in SmartTime can be cross-probed into other Libero SoC tools. Libero SoC allows crossprobing from SmartTime to the Constraints Editor (but not vice versa) and from SmartTime to Chip Planner (but not vice versa). When cross-probing from SmartTime to one of the other tools, both SmartTime and the other tool must first be opened.

9.9.1 Cross-probing from SmartTime into the Constraints Editor

To add a timing exception constraint from SmartTime and have the Constraints Editor display the constraint:

- 1. From the SmartTime Maximum or Minimum Delay Analysis view, click a timing path to add a timing exception constraint.
- 2. When the Constraints Editor's Add Constraint dialog box appears, the fields for source (from) pin and destination (to) pin are populated with the correct names from the timing path you selected.

9.9.2 Adding a Timing Exception Constraint from a Timing Path

To add a timing exception constraint from a timing path in SmartTime Max/Min Delay Analysis View:

- 1. Open SmartTime (Design Flow Window > Verify Timing > Open interactively).
- 2. Open the Constraints Editor (Constraint Manager > Timing Tab > Edit with Constraints Editor).
- 3. Select Max/Min Delay Analysis View, and then right-click a timing path in the table.
- 4. Select a timing exception constraint to add:
 - False Path Constraint
 - Maximum Delay Constraint
 - Minimum Delay Constraint
 - Multicycle Path Constraint

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C	ustomize table		Appl	y Filter Store F	ilter Reset Filte	ər	
	Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	1	
1	Q[6]:CLK	Q[6]	3.990		7.592	-	
2	Q[4]:CLK	Q[4]	3.899		7.499	-	
3	Q[3]:CLK	Q[3]	3.872	7.472			
4	Q[2]:CLK	Q[2]	Copy Print				
5	Q[1]:CLK	Q[1]	Add False Path	Constraint	6.640	-	
6	Q[0]:CLK	Q[0]	Add Max Delay	Constraint	6.633		
	· • [m	Add Min Delay	Constraint		-	
Na	me	Туре	Add Multicycle	Path Constraint	Macro	-	
4	Summary		Show Path in C	hip Planner		-	
	data required time data arrival time		Expand selected	d paths			
	slack						
4	Data_arrival_time_calc	ulation					

Figure 9-2. Add Timing Constraint from SmartTime's Reported Timing Path

Note: If the Constraint Editor is not open, the **Add Max/Min Delay**, **False Path**, and **Multicycle Path Constraint** menu items are grayed out.

- 5. Add the Constraint in the Add Constraint dialog box. The **source/from pin** and **destination/to pin** fields are populated with the appropriate pin names captured from the SmartTime reported path (Source Pin and Sink Pin) you clicked.
 - a) Click **OK** to exit the Add Constraint dialog box.
 - b) Click **Save** in the Constraints Editor.
 - c) Exit the Constraints Editor.
 - d) Exit SmartTime.
 - e) If the newly added constraint that is added to a file (the Target file) is used for Place and Route and Verify Timing, rerun Place and Route.
 - f) Open SmartTime Maximum/Minimum Delay Analysis View.

Set Maximum Delay Constraint	8
Maximum delay : 1.0 ns	
From :	
[get_pins { q_reg[3]/CLK }]	·
	-
4	ь.
Through :	
	·
	-
4	F.
То :	
[get_pins { Q[3]/D }]	·
	*
<	•
Comment :	
Help	OK Cancel

Figure 9-3. Add Maximum Delay Constraint

9.9.3 Cross-probing from SmartTime to Chip Planner

Cross-probing of design objects is available from SmartTime to Chip Planner, but not vice versa. Cross-probing allows you to select a design object in one application and display the selected object in another application.

Complete the Place and Route step on the design, and then open both SmartTime and Chip Planner. Because Libero SoC allows you to cross-probe design objects from SmartTime to Chip Planner, you can better understand how the two applications interact with each other. With cross-probing, a timing path not meeting timing requirements can be fixed with relative ease when you see the less-than-optimal placement of the design object (in terms of timing requirements) in Chip Planner. Cross-probing from SmartTime to Chip Planner is available for the following design objects:

- Macros
- Ports
- · Nets/Paths

To cross-probe from SmartTime to Chip Planner, use a design macro in SmartTime.

9.9.4 Design Macro Example

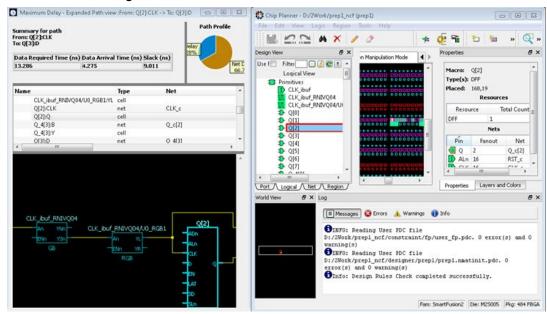
- 1. Make sure the design completed the Place and Route step successfully.
- 2. Open SmartTime Maximum/Minimum Analysis View.
- 3. Open Chip Planner.
- 4. In the SmartTime Maximum Analysis View, right-click the instance Q[2] in the Timing Path Graph and choose **Show in Chip Planner**.

The Properties window in Chip Planner displays the properties of Q[2].With cross-probing, the Q[2] macro is selected in Chip Planner's Logical View and highlighted (white) in the Chip Canvas.

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Note: If Chip Planner is not open, Show in Chip Planner is gray and unavailable.

Figure 9-4. Cross-Probing – Macro



5. If necessary, zoom in to view the highlighted Q2 Macro in the Chip Canvas.

9.9.5 Timing Path Example

The following procedure provides an example of working with timing paths.

- 1. Make sure the design completed the Place and Route step successfully .
- 2. Open SmartTime Maximum/Minimum Analysis View.
- 3. Open Chip Planner.
- 4. In the SmartTime Maximum/Minimum Analysis View, right-click the net CLK_ibuf/U0/U_IOPAD:PAD in the table and choose **Show Path in Chip Planner**.

The net is selected (highlighted in red) in the Chip Canvas view and the three macros connected to the net are highlighted in white in the Chip Canvas view.

Note: If Chip Planner is not open, Show Path in Chip Planner is gray and unavailable.

Figure 9-5. Cross-Probing – Timing Path

🔲 🖴 🍱 🍂 🌬	2 🐵 🌫			/ 2	\$ ∉ » 占 » 🔍
ummary for path rom: Q[2]:ELK o: Q[3]:D Data Required Time (ns) Data / 3.286 4.275		Path Profile Delay 20% Net Dr .65.77		Chip Canvas - Region Mar	
Vame Data_arrival_time_calculation prep3[CLK CLK CLK_ibuf/U8/U_JOPAD:PA CLK_ibuf/U8/U_JOPAD:PA	Clock source	ADL Port	Q[4] Q[5] Q[6] Q[7] Q[7]		
CARD	Show Path in Chip Planner		New 6×	00 Im Messages Strors OINFO: Reading User D:/ZWOrk/prepl_ncf/co c. 0 error(s) and 0 w OINFO: Reading User D:/ZWOrk/prepl_ncf/de tinit.pdc. 0 error(s)	PDC file mstraint/fp/user_fp.p varning(s) PDC file signer/prepl/prepl.nm

Figure 9-6.	Cross-Probing Path	i from Max/Min Dela	ay Analysis View Table
-------------	--------------------	---------------------	------------------------

Analysis for scenario									
AX timing_analysis	From .								TO -
Si Summary ⊟- Si CLKD, PAD Register to Register - External Setup	Customize table								
Clock to Output Register to Asynchronous External Recovery	Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required (ns)	Setup (ns)	External Setup (ns)	
Asynchronous to Register	1 0	DFN1_0:D	0.154	_	0.154		0.262	-1.341	
Register to Register External Setup Clock to Output		_			Copy Print				
Register to Asynchronous Eternal Recovery							_		
Asynchronous to Register						ay Constraint			
Input to Output						y Constraint			
						e Path Constra	<i>n.</i>		
				1000	discontrologi	Chip Planner			
					Expand selec	ited paths			

Instead of performing step 4, you can right-click a path in the Max/Min Delay Analysis View and choose **Show Path in Chip Planner** to cross-probe the path.

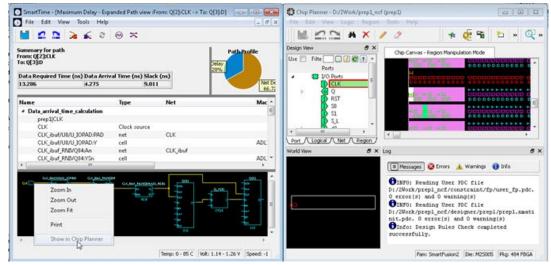
9.9.6 Port Example

- 1. Make sure the design completed the Place and Route step successfully.
- 2. Open SmartTime Maximum/Minimum Analysis View.
- 3. Open Chip Planner.
- 4. In the SmartTime Maximum/Minimum Analysis View, right-click the Port "CLK" in the Path and choose **Show** in Chip Planner.

The Port "CLK" is selected and highlighted in the Chip Planner Port View.

Note: If Chip Planner is not open, Show in Chip Planner is gray and unavailable.

Figure 9-7. Cross-Probing – Port



From the Properties View inside Chip Planner, you will find useful information about the Port "CLK" you are cross- probing:

- Port Type
- Port Placement Location (X-Y coordinates)
- I/O Bank Number

- I/O Standard
- Pin Assignment

Figure 9-8. Properties View of Port "CLK"

Macro:	CLK_ibuf			
Port(s):	CLK			
Type(s):	I/O, Single-	ended I/O, Input I/O		
Placed:	0,19			
Package Pin(s):	H1			
I/O Standard(s)	: LVCMOS25			
I/O Bank:	Bank6 - MS	IO 🗌 Locked		
		Resources		
Resource		Total	Count	
IO	1			
		Nets		
Pin	Fanout		Net	
0 U_IOPAD:Y	2	CLK_ibuf		
		CLK_ibuf	Net	

10. SmartTime Tutorials

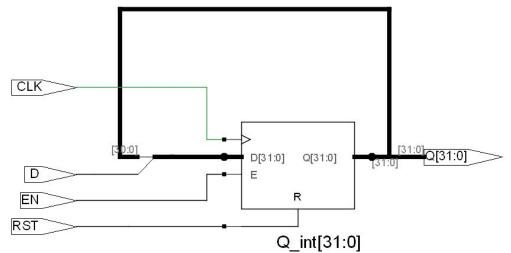
The following sections describe SmartTime tutorials.

10.1 Tutorial 1 - 32-Bit Shift Register with Clock Enable

This tutorial describes how to enter a clock constraint for the 32-bit shift register on SmartFusion2 device.

You will use the SmartTime Constraints Editor and perform post-layout timing analysis using the SmartTime Timing Analyzer.

Figure 10-1. 32-bit Shift Register



To set up your project:

- 1. Invoke Libero SoC. From the **Project** menu, choose **New Project**.
- 2. Type sf2_shift32 for your new project name and browse to a folder for your project location.
- 3. Select **Verilog** as the Preferred HDL Type.
- 4. Leave all other settings at their default values.

Figure 10-2. New Project Creation - 32 Bit Shift Register

lew project			
oject details Specify project details			
Project Details	Project name:	sf2_shft32	
Device Selection	Project location:	d. \actelprj	Browse.
Device Settings	Description:		
Design Template	Preferred HDL type	Contraction of the second	
Add HDL Sources	Enable block or	tion	
Add Constraints			
Help			< Back Next > Finish Conc

- 5. Click **Next** to go to Device Selection page. Make the following selection from the pull-down menus:
 - Family: SmartFusion2
 - Die: M2S090TS
 - Package: 484 FBGA
 - Speed: STD
 - Core Voltage: 1.2 V
 - Range: COM

Figure 10-3. Selections from Pull-down Menus

Project Details	Part filter Family: SmartFu	sion2 🔻	Die:	M2S090TS	• Padka	oe: 484 FBGA	•	
	Speed: -1			Citemanenen II.		ge: COM	•	
Device Selection						Res	et filters	
Device Settings	Search part:							
-	Part Number	4LUT	DFF	User I/Os	uSRAM 1K	LSRAM 18K	Math (18x18)	PLLs ar
Design Template	M25090TS-1FG484	86184	86184	267	112	109	84	6
Add HDL Sources								
Add Constraints								

- 6. Click the M2S090TS-1FG484 part number and click .
- 7. Accept the default settings in the Device Settings page and click Next.
- 8. Accept the default settings in the Design Template page and click Next.
- 9. Click **Next** to go to the Add Constraints page.
- 10. Since you are not adding any constraints, click Finish to exit the New Project Creation wizard.
- 11. To add a new HDL file, select **File> New> HDL**. The Create a new HDL file dialog box appears.
- 12. Name the HDL file shift reg32 as shown below and click OK.

Figure 10-4. Create a New HDL File Dialog Box

		8 2
HDL Type		
Verilog	C VHDL	
Name: shift_reg32		

13. Copy the following code and paste it into the Verilog file:

<pre>module shift32 (Q,CLK,D,EN,RESET); input D,EN,CLK,RESET;</pre>	
output[31:0] Q; reg [31:0] Q_int;	
assign Q=Q_int;	
always@ (posedge CLK) begin	
if(RESET)	
Q_int<=0; else begin if(EN)	
<pre>Q_int<={Q_int[30:0],D}; end</pre>	
end endmodule	

- 14. Check the HDL file to confirm there are no syntax errors.
- 15. Confirm that the shift_reg32 design appears in the Design Hierarchy window, as shown in the following figure.

Figure 10-5. shift_reg32 in the Design Hierarchy Window

Design Hierarchy		8 >
Build Hierarchy	Show: Components	
	32 (shift_reg32.v) [work]	
🗄 📄 User HI	OL Source Files	

In the Design Flow window, double-click Synthesize to run Synplify Pro with default settings.
 A green check mark appears next to Synthesize when Synthesis is successful, as shown in the following figure.

	<u>⊡ 0</u>	I.I.			_	
sign Flow			8 ×	Reports & X	StartPage 🗗 🗙	
hift_reg32		0	ø	 Project Summa shift32.log 		🔳 🔊 0 Errors 🗼 0 Warnings 🌒 0 Info
A Conf ID Creat ID Creat ID Creat ID Creat Creat Creat Creat S Creat ID Creat S Creat S Creat ID Creat S C	m Builder gure MSS e SmartDesign e HDL e SmartDesign Testte e HDL Testbench rate Memory Map y Prc-Synthesized mulate sige Constraints int Design	Design	s e f i i	run_op shift_re shift_re		<pre>sourcing Y:\production\Synopsys\Synplify\pc\synplify_J201503M-3\lib\mess Starting: Y:\production\Synopsys\Synplify\pc\synplify_J201503M-3\lib\mess Bostname: W764-WN08A Bostname: W764-WN08A Bostname: J-2015.03M-3 Arguments: -product synplify_pro -licensetype synplify_J00_actel -batch ProductType: synplify_pro actel from server sage Licensed Vendor: actel License Vendor: actel License Vendor: actel License Vendor: actel Running in Vendor Mode Implementation not found: synthesis </pre>
a		1				
🔳 Messages 🛛 🚱 Erro	rs 🗼 Warnings	🚺 Info				
DINFO: No User P Cleaning tool 'Exp	port Netlist'		-3			

Figure 10-6. Synthesis and Compile Complete - 32-Bit Shift Register with Clock Enable

10.1.1 Add a Clock Constraint - 32 Bit Shift Register

To add a clock constraint to your design:

1. In the Design Flow window, double-click **Manage Constraints**. The Constraint Manager appears.

Figure 10-7. Constraint Manager

Reports 🗗 🗙	StartPage & ×	Constraint Manager		
New	Timing V Floor Planner Import Link		Check Help	† f
		Place and Rout	e	

- 2. Click the **Timing** tab.
- 3. Click Edit with Constraints Editor > Edit Place and Route Constraints.

Figure 10-8. Constraints Editor – Add Clock Constraint

Constraints Requirements	Syntax	Clock Name	Clock Source	Period (ns)	Frequency (MHz)	Dutycycle (%)	First Edge	Offset (ns)	Waveform	Add	File	
- Clock	1 Click within			0.000		50%	rising	0.000	0.00 0.00		GUI	
Generated Clock						Control of the second se	Received and a second	- Accessed one	Annaherin		line in the second s	
- Input Delay												
Output Delay External Check												
- Clock To Out												
Exceptions												
Exceptions Max Delay												
Exceptions Max Delay Min Delay												
 Exceptions Max Delay Min Delay Multicycle 												
Exceptions Max Delay Min Delay Multicycle False Path												
Exceptions Max Delay Min Delay Multicycle False Path Advanced												
Exceptions Max Delay Min Delay Multicycle False Path Advanced Disable Timing												
Exceptions Max Delay Min Delay Multicycle False Path Advanced												

The Constraints Editor appears.

4. In the Constraints Editor, right-click **Clock** under **Requirement** and select **Add Clock Constraint**. The Create Clock Constraint dialog box appears.

Figure 10-9. Create Clock Constraint Dialog Box

Create Clock Constraint	Clock Source :	[? X
Period :	ns	Hr Frequency:	Mhz
← Offset : Duty cyde : 0.000 ns 50.0000 %	⊮		
Add this clock to existing one with same source			
Help		ОК	Cancel

- 5. From the **Clock Source** drop-down menu, choose the **CLK** pin.
- 6. In the Clock Name field, type my_clk.
- 7. Set the Frequency to 250 MHz (as shown in the following figure) and accept all other default values.

Libero[®] SoC v2021.2 SmartTime Tutorials

Clock Name : my_dk			Clock Source :	[get_ports { CLK }]		
	н— р	Period : 4	ns	Hor Frequency:	250	Mhz
	- 1			1	-	
Ē	3	5.				
05-1	Duty cy	/de :				
unset:						
Offset : 0.000 ns	50.0000	%				
0.000 ns	50.0000					
	50.0000					

Figure 10-10. Add a 250 MHz Clock Constraint

8. Click **OK** to continue.

The clock constraint appears in the SmartTime Constraints Editor.

Figure 10-11. 250 MHz Clock Constraint in the Constraint Editor

Constraints E Requirements		Syntax	Clock Name	Clock Source	Period (ns)	Frequency (MHz)	Dutycycle (%)	First Edge	Offset (ns)	Waveform
Clock	10	ick withir			0.000	(50%	rising	0.000	0.00 0.00
Generated Clock	2	٣	my_clk	[get_ports { CL	4.000	250.000	50.000000	rising	0.000	0.00 2.00
Clock To Out Clock Source Latency Clock Source Latency Clock Groups										

- 9. From the File menu, choose Save to save the constraints.
- From the SmartTime File menu, choose Exit to exit SmartTime. Libero creates a constraint file to store the clock constraint. This file appears in the Constraint Manager. It is named user.sdc and designated as Target.

Note: A target file is used to store newly added constraints from the Constraint Editor. If you invoke the Constraint Editor with no SDC timing constraint file present, Libero SoC creates the user.sdc file and marks it as **Target** to store the timing constraints you create in the Constraint Editor.

11. In the Constraint Manager, check the check boxes under **Place and Route** and **Timing Verification** to associate the constraint file to the tools. The constraint file is used for both Place and Route and Timing verification.

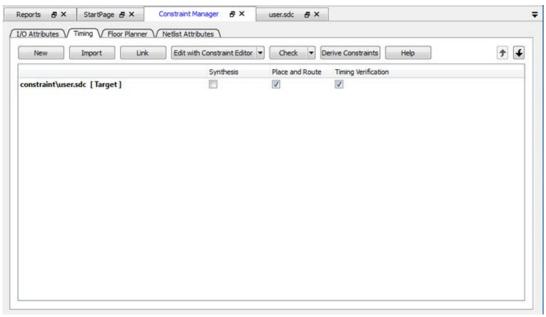


Figure 10-12. SDC Constraint File and Tool Association

10.1.2 Run Place and Route

To run Place and Route:

- 1. Right-click **Place and Route** and choose **Configure Options**. The Layout Options dialog box appears.
- 2. Click the check box to enable **Timing-driven** layout ans accept the other default values shown in the following figure.

Figure 10-13. Layout Options Dialog Box

Layout Options	
Timing-driven	
Power-driven	
I/O Register Co	ombining
Global Pins Dem	notion
Driver Replication	on
High Effort Lay	out
Repair Minimum	Delay Violations
Use Multiple Passes	
Incremental Layout Use Multiple Passes Configure	
Use Multiple Passes	OK Cancel

- 3. Click **OK** to continue.
- 4. In the Design Flow window, double-click **Place and Route** to start the Place and Route.

10.1.3 Maximum Delay Analysis with Timing Analyzer - 32-Bit Shift Register Example

The SmartTime Maximum Delay Analysis window shows the design maximum operating frequency along with any setup violations.

To perform maximum delay analysis:

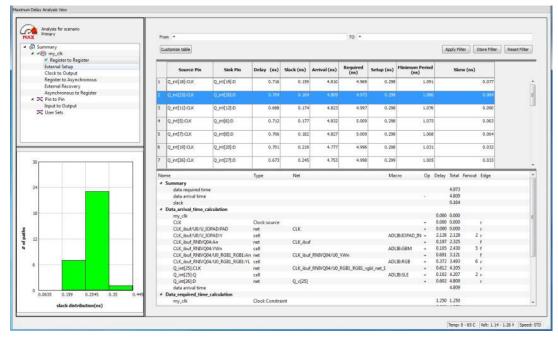
1. Right-click **Open SmartTime** in the Design Flow window and choose **Open Interactively** to open SmartTime. The Maximum Delay analysis window appears. A green check next to the clock name indicates there are no timing violations for that clock domain. The Summary page displays a summary of the clock domain timing performance.

The Maximum Delay Analysis Summary appears with the following information shown:

- Maximum operating frequency for the design
- External setup and hold requirements
- Maximum and minimum clock-to-out times. In this example, the maximum clock frequency for CLK is 609.75 MHz.

- SmartTime [Maximum Delay Ana 🖬 🖸 🗅 🎽 🗲 0 🐵 ≍ lav Analysis View Analysis for scenario timing_analysis Design shift_reg32 Summary
 ✓ my_clk
 ✓ Register to Register
 Etenal Setup
 Clock to Output
 Register to Asynchronous
 Etenal Recovery
 Asynchronous to Register
 ➤ Pin to Pin Family SmartFusion2 SI Su Die M2S090TS Package 484 FBGA Temperature Rang 0 - 85 C Voltage Range 1.14 - 1.26 V Speed Grade STD Design State Post-Layout out to Output Production Data source NU Min Operating Conditions BEST - 1.26 V - 0 C Max Operating Conditions WORST - 1.14 V - 85 C Scenario for Timing Analysis timing analysis Summary Select a set of paths to see e of paths Clock Period Frequency Required Domain (ns) (MHz) Period (ns) Min Clock-To-Out (ns) Max Clock To-Out (ns) External External Setup (ns) Hold (ns) ncy Frequ my_clk 1.640 609.756 4.000 1,297 0.510 250.000 3,781 9.880 Min Delay (ns) Max Delay (ns) slack distribution(ns) \$31A 8.17.6 Temp: 0 - 85 C Volt: 1.14 - 1.26 V Speed: STD
- Figure 10-14. Maximum Delay Analysis Summary

2. Expand **my_clk** to display the Register to Register, External Setup, and Clock to Output path sets. **Figure 10-15. SmartTime Register-to-Register Delay**



- Select Register to Register to display the register-to-register paths. The window displays a list of register- to-register paths and detailed timing analysis for the selected path. All the slack values are positive, indicating that there are no setup time violations
- Double-click a path row to open the Expanded Path window. The window shows a calculation of the data arrival and required times, along with a schematic of the path.
 Note: Timing numbers in the reports may vary slightly with different versions of the Libero software, and may not be what you see when you run the tutorial.

imments of path model (1995) Deck Required Time (ms) Stack (ms) <u>4.809</u> 0.164 Name Type Net Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) <u>4.809</u> 0.164 Name Calc Advisor (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) (K. K. Marco Op Delay Total Fanout Edge * Dia Arrival Time (ms) Stack (ms) * Dia Arrival Time (ms) Stack (ms) * Dia Arrival Time (ms	File Edit View Tools Help	⊜ ×							Pa	th Profile	
1973 4869 0.144 Imme Type Net Macro Op Delay Total Famout Edge 4 DBa production 0000 0000 r CK Clock source ADLBROPAD N 0.2187 2232 r CLK, but /RNVQ04/UD, RGBL, net CLK, but /RNVQ04/UD, RGBL, RGBL N net CLK, but /RNVQ04/UD, RGBL, RGBL N net Qumt251Q cell cell source ADLBROP e 0.012 4207 2 r data annual time data annual time RGB Note ADLBROP RGB Qumt251Q Qumt251Q Cell & but//UO/U JOPAD Cell & but//UO/U ADLP Cell & but	om: Q_int[25]:CLK s: Q_int[26]:D								Cell De 0,001	ary St	
* Dispersive Line Cut Sub Control Line Cut Sub Cont											
my.ck 0.000 0000 CLK 0.000 0000 CLK,bufVMUJDPADPAD net CLK,bufVMUJDPADPAD net CLK,bufVMUQDADN cell CLK,bufVMUQDADN net CLK,bufVMUQDADN net CLK,bufVMUQDADN net CLK,bufVMUQDADN net CLK,bufVMUQDADN cell CLK,bufVMUQDADN net CLK,bufVMUQDADN cell CLK,bufVMUQDADN cell CLK,bufVMUQDADN cell CLK,bufVMUQDAUD,RGBLRGBLAR net CLK,bufVMUQDAUD,RGBLRGBLAR net CLK,bufVMUQDAUD,RGBLRGBLRGBLAR 0.012 2430 CLK,bufVMUQAUD,RGBLRGBLRGBLRGBLYBLAR 0.012 2430 Q_int25]CLK net Q_int25]CL	ame	Туре	Net	Масто	Op	Delay Total	l Fanout Edge		 		
CLK CLK CLK 0.000 r CLK,but/ND/JOPAD/PLO net CLK 0.000 0.000 r CLK,but/ND/JOPAD/PLO ret CLK 0.000 0.000 r CLK,but/ND/JOPAD/PLO ret CLK/but/ND/DPAD/PLO 0.000 0.000 r CLK,but/ND/JOPAD/PLO ret CLK/but/ND/DPAD/PLO 0.000 0.000 r CLK,but/ND/QDAD/PLO ret CLK/but/ND/DPAD/PLO 0.000 0.000 1 CLK,but/ND/QDAD/PLO ret CLK/but/ND/DPAD/PLO 0.000 1.000 1.000 CLK,but/ND/QDAD/PLO ret CLK/but/PAN/QAU/UD_RGBI_RGBL/RGEL/plo 0.0072 3.030 6 CLK,but/ND/QDAU/DE ret CLK/but/PAN/QAU/UD_RGBI_RGBL/rgBL/net1 0.002 4.007 2 Q_int251Q calt 0.002 4.009 r 4.009 r data anival time Q_int251 0.002 4.009 r 4.009 r CLK_but/UD/U_JOPAD CLK_but/RMIVQAU/UD_RGBI_RGBI_RGBI_RGBI_RGBI_RGBI_RGBI_RGBI											
CLX_bar/M0U JOPAD-PDD net CLK ADLB:OPAD, 1 2128 212 2; CLX_bar/M0U JOPAD-Y cel CLX_bar/M0U JOP											
CLC, Burl/ND(1) JOPADY cell CLC, Burl/ND(904A) net CLC, Burl/ND(904A	CLK	Clock source			+						
CUC, dat FN0/Q04/un ret CLK, lbuf PN0/Q04/UB vVin ADLB:50H + 0.197 2.325 + 1 CUC, dat FN0/Q04/UB vR01 PR81 PR81 an net CLK, lbuf PN0/Q04/UB vVin ADLB:50H + 0.973 3.433 6 + 0.973 3.430 + 0			CLK								
CLC, Bud RNNQQ4/Wh cell CLC, Bud RNNQQ4/Wh Cell Gell Gell An et CLC, Bud RNNQQ4/Wh Cell Gell Gell An et CLC, Bud RNNQQ4/Wh Cell Gell Gell An et Quet251Q cell Quet251Q cell Quet251D net Quet251D net Quet251D net Quet251D net Quet251D net Quet251D net Quet251D net Quet251D net Quet251C CLC, Bud RNNQQ4/Wh RGBLRGBL, gBL, gBL, gBL, gBL, gBL, gBL, gBL, g	CLK_ibuf/U0/U_IOPAD:Y	cell		ADLIB:JOPAD_IN	4 +						
C LL, Sie / RAVQU/UD, RGBL / RGBL / R Ref. C LLK, Bud / RAVQU/UD, V/M + 0.69/3 12.1 f C LLK, Bud / RAVQU/UD, V/M + 0.69/3 12.1 f ADLBR.6GB + 0.372 13/3 6 ; 0.372 13/3 6 ;		net	CLK_ibuf	and the second second	+						
C LK, bief, RNIVQQA/UQ, RGBL, RGBL, An et Q, LM 251; CLK net Q, LM 251; CLK net Q, LM 251; CLK net Q, LM 251; CLK net Q, LM 251; O data anival time t CLK, bief, RNIVQQA/UQ, RGBL,	CLK_ibuf_RNIVQ04:YWn	cell		ADLIB:GBM	+						
Q_int25[cLK net CLK_ibuf_RNVQQ4/U0_RGBL_RGBL_rgBL_ngBL_ngBL_ngBL_ngBL_ngBL_ngBL_ngBL_n	CLK_ibuf_RNIVQ04/U0_RGB1_RGB1:An	n net	CLK_ibuf_RNIVQ04/U0_YWn		+	0.691 3.121					
Q_int[25]Q data annual time ADLBS.E ADLBS.E OUX_L207 2 r 4809 r ADLBS.E OUX_L207 2 r 4809 r ADLBS.E OUX_L207 2 r 4809 r ADD CLK_buf/RNIVQ04/UD_RGB1_RGB2 Q_int[26] ADD CLK_buf/RNIVQ04/UD_RGB2 CLK_buf/R	CLK_ibuf_RNIVQ04/U0_RGB1_RGB1:YL	cell			+	0.372 3.493	3 6 r				
Q_int[25]Q data annual time ADLBS.E ADLBS.E OUD. 4207 2 r ADLBS.E C ADLBS.E OUD. 4207 2 r ADD C	Q_int[25]:CLK	net	CLK_ibuf_RNIVQ04/U0_RGB1_RGB1_rgbl_net_1		+	0.612 4.105	5 r				
Q_int25jD data anival time Q_cl23 Q_int25jD Q_int25jD Q_int25jD Q_int25jD Q_int25jD Q_int25jD Q_int25j Q_int25											
data simical time 4.809				ADLIB:SLE	+						
CLK_budf_UVU/U_JOPAD CLK_budf_RNIVQO4 CLK_budf_RNIVQO4/U0_RGB1_RGB2 Q_nt[26] Ann YEn IOPAD_INUNN WWN 			0. d251	ADLIB:SLE	*						
	Q_int[26]:D	net		ADLIB:SLE		0.602 4.809	9 r 9	1/1/2 8/28	 0.5420		

Figure 10-16. Register-to-Register Expanded Path View

5. Select External Setup to display the Input to Register timing.

6. Select Path 3.

The Input Arrival time from the EN pin to Q_int[27]:EN is 4.547 ns.



num Delay	Analysis View															
(1	Analysis for scenario Primary		om *						то •							
MAX									10 -							-
* & Su		0	ustomize table									Apply P	liter	Store F	ilter Reset Fil	ter
	29 my_clk					-		-		-						
	Register to Register External Setup		Source Pin	Sink		lay	Slack	Arrival	Required	Setup	External					
	Clock to Output		Juniter Lini	Jan K	0	ns)	(ns)	(ns)	(ns)	(ns)	Setup (ns)					
	Register to Asynchronous	1	EN	Q_int[31]:EN		4,547		4.547		0.399	1.258					
	External Recovery					100		2611		222.00						-
	Asynchronous to Register	2	BN	Q_int[30]:EN	1	4.547		4.547		0.399	1.248					14
- 7	C Pin to Pin		in the second se	Q_1rt(27):EN	-	4.547	_	4.547		0.399	1.248					
	Input to Output										312785					
24	User Sets	4	EN	Q_int[29]:EN	13	4.547		4.547		0.399	1.248					
				a georgeogram												
		5	BN	O int/281:EN		4.547		4.547		0.399	1.248					1.1
		Ne	me		Туре	Ne	et.			1000000000	Macro	On	Delay	Total	Fanout Edge	
		1.0	Summary		900		17				maria	a h	000	10.001	initial code	
		_	data required time											N/C		
1			data arrival time											4.547		
			slack											N/C		
			Data_arrival_time_calco	ulation												
			EN											0.000	f	
			EN_ibuf/00/U_JOPAI		net	EN	4					•		0.000	f	
			EN_ibuf/U0/U_IOPAI		cell						ADLIB:JOPAD_IN	+		2.720	11	
			EN_ibuf/U0/U_IOINF EN_ibuf/U0/U_IOINF		net cell	EN	Libuf/U0	VVIN1			ADUBIOINEE BYPA	+		2.720	32 f	
			Q_int[27]:EN	110	cell	-	i.c				ADUBIOINFF_BYP	+ 666		4.547	34 1	
			data arrival time		net	en	e"c					•	1.721	4.547		
6	This set has no path.		Data_required_time_ca	iculation												
			my_clk										N/C	N/C		
			CLK		Clock source							+	0.000	N/C	*	
			CLK_ibuf/U0/U_IOPA	AD:PAD	net	CL	К					+	0.000	N/C		
			CLK_ibuf/U0/U_IOP/	AD:V	cell						ADLIB:JOPAD_IN	+	1.915	N/C	2 x	
			CLK_ibuf_RNEVQ04:/		net	CL	K_ibuf					+		N/C	f	
			CLK_ibuf_RNIVQ04:1		cell						ADLIB:GBM		0.095		5 f	
			CLK_ibuf_RNIVQ04/			CL	K_ibuf_R	MIVQ04/U0	YWn			+		N/C	1	
			CLK_ibuf_RNEVQ04/	UD_RGB1_RGB3:VL							ADLIB:RGB	+		N/C	5 e	
1.5			Q_int[27]:CLK		net		K_Ibuf_R	NIVQ04/U0	RGB1_RGB3	rgbl_net_1	ADUDO CLE	*		N/C N/C		
			Q_int[27]:EN		Library setup ti	me					ADLIB:SLE	-	0.339	NUC		

7. Select **Clock to Output** to display the register to output timing.

8. Select Path 1.

The maximum clock to output time from Q_int[16]:CLK to Q[16] is 9.486 ns.

Support of	me - [Maximum Delay Analysis View]	_		-	_									
File	Edit View Tools Help													
1 2	x 🛛 🕉 🖌 🐔 🕰 🗖													
ainum Dei	iay Analysis View													
MAX	Analysis for scenario Primary	Pr	on *					то	• 3					
	Summary		ustomize table								Apply Filt	er 55	ore Pilter	Pilter
	vഈ my_clk		and a second										administrative Complete	anna an
	Register to Register External Setup		Source Pin	Sink	Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required (ns)	Clock to 0	Dut (ns)			
	Clock to Output Register to Asynchronous	1	Q_int[16]:CUK	Q[16]		\$ 379		9.486				9,486		
	External Recovery Asynchronous to Register	2	Q_int[15]:CLK	Q[15]		5.354		9.461				9.461	1	100
	F Pin to Pin Input to Output	3	Q_int[28]:CLK	Q[28]		3.945		8.054				8.054	i.	
	DC User Sets	4	Q_int[4]:CLK	Q[4]		3.817		7.937				7.937	7	
		N	ime		Type	Net	-			Macro	Op Dei	av Total	Fanout Edge	-
			Summary											
_		-	data required time									N/C		
			data arrival time								(a)	9.486		
			slack									N/C		
			Data_arrival_time_calc	ulation										
			my_clk								0.0	00.0.00		
			CLK		Clock source						+ 0.0	00 0.000	r -	
			CLK ibuf/U0/U IOP	AD:PAD	net	CLK					+ 0.0	000.0 00		
			CLK ibuf/U0/U IOP	AD:Y	cell					ADLIB-JOPAD IN	+ 2.1	28 2.128	2 /	
			CLK ibuf RNIVQ04:		net	CLK_ibuf					+ 0.1	97 2.325	1	
			CLK_ibuf_RNEVQ04:		cell					ADLIB:GBM	+ 0.1	05 2.430	5 f	
			CLK_ibuf_RNIVQ04/			CLK ibuf	RNIVQ04	/U0_YWn			+ 0.6	87 3.117	1	
	12 25 22		CLK_ibuf_RNEVQ04/					and the second sec		ADLIB:RGB	+ 0.3	72 3.489	8 r	
	This set has no path.		Q_int[16]:CLK			CLK ibuf	RNIVQ04	/U0_RGB1_RGB0				18 4.107		
of paths			Q_int[16]:Q		cell					ADUB-SLE		27 4.234		
2			Q_obuf[16]/U0/U_K	OUTFF:A		Q_c[16]				2001202000	+ 14	71 5.905		
*			Q_obuf[16]/U0/U_K		cell					ADLIB-JOOUTFF BYPASS		03 6.308	11	
			Q_obuf[16]/U0/U_N			Q_obuf[10	51/U0/DO	UT				00 6.308		
			Q_obuf[16]/U0/U_0		cell			(214)		ADLIB-JOPAD TRI	+ 3.1	78 9,486	0 f	
			Q[16]			Q[16]						00 9.486		
			data arrival time			Place?						9,486		
		4	Data_required_time_c	alculation										
			my_clk								N	C N/C		
			CLK		Clock source							00 N/C		
			Q(16)		cross source							N/C		
	slack distribution(ns)		-direct											-

Figure 10-18. SmartTime Clock to Output Path Analysis

10.1.4 Minimum Delay Analysis with Timing Analyzer - 32-Bit Shift Register Example

The SmartTime Minimum Delay Analysis window identifies any hold violations that exist in the design.

To perform minimum delay analysis:

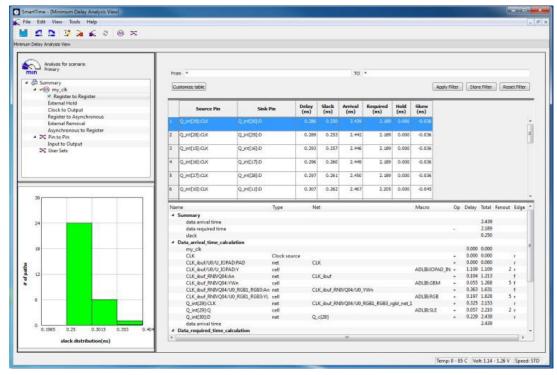
1. From the SmartTime Analysis window, choose **Tools > Minimum Delay Analysis**. The Minimum Delay Analysis View appears, as shown in the following figure.

Figure 10-19. SmartTime Minimum Delay Analysis View- Summary

	lit View Tools Help									
2	x 😔 🤉 🗎 🖌 🖸									
m Delay	y Analysis View									
~										
N	Analysis for scenario timing_analysis	Design		1	shift reg32					
		Family		5	SmartFusion2					
	iummary / Immy_clk	Die		1	M2S090TS					
-	✓ Register to Register	Package			184 FBGA					
	External Hold Clock to Output	Temperat		oe (- 85 C	1				
	Register to Asynchronous	Voltage F			1.14 - 1.26 V					
	External Removal Asynchronous to Register	Speed G			STD					
4.3	Register	Design S			Post-Layout	-				
-	Input to Output	Data sou			Production					
_		Min Oper	ating Co	nditions E	BEST - 1.26 V	.0C				
		Max Ope		and the second se	WORST - 1.14	the second s				
- 1					iming analysis	and the second se				
				di marjana	and a start of					
		Summ	ary							
8	Select a set of paths to see its slack distribution.									
		Clock Domain	Period (ns)	Frequency (MHz)	Required Period (ns)	Required Frequency (MHz)	External Setup (ns)	External Hold (ns)	Min Clock- To-Out (ns)	Max Clock- To-Out (ns)
		my_clk	1.640	609.756	4.000	250.000	1.297	0.510	3.781	9.880
			A	lin Delay (na) Max Delay	(ns)				
	slack distribution(ns)	Input to 0	Dutput N	I/A	N/A					
	and an and a stand of the stand									

- 2. Expand **my_clk** to display Register to Register, External Hold, Clock to Output, Register to Asynchronous, External Removal, and Asynchronous to Register path sets.
- 3. Click **Register to Register** to display the reg to reg paths. The window displays a list of register to register paths and detailed timing analysis for the selected path. All the slack value are positive, indicating that there are no hold time violations.
- 4. Click to select the first path and observe the hold analysis calculation details, as shown in the following figure.

Figure 10-20. SmartTime Minimum Delay Analysis



10.1.5 Changing Constraints and Observing Results - 32-Bit Shift Register Example

You can use the Constraints Editor to change your constraints and view the results in your design. The following procedure describes how.

 Open the Constraints Editor (Constraints Manager > Timing Tab > Edit Constraints with Constraint Editor > Edit Timing Verifications Constraints).

The Constraints Editor shows the clock constraint at 250 MHz you entered earlier.

Figure 10-21. Clock Constraint Set to 250 MHz

Constraints A Requirements	î.		Syntax	Clock Name	Clock Source	Period (ns)	Frequency (MHz)	Dutycycle (%)	First Ed	ge	Offset (ns)
T Clock Generated Clock		1	Click within this row to ad:			0.000		50.0%	rising		0.00
Input Delay		2	*	my_dk	[get_ports (CLK)]	4.000	250.000	50.000000	rising	•	0.0
 Exceptions Max Delay 	1										

2. Select the second row. Right-click and choose **Edit Clock Constraint**. The Edit Clock Constraint dialog box appears.

- 3. Change the clock constraint from 250 MHz to 800 MHz, and then click the green check mark to continue.
- 4. Click Open SmartTime > Open Interactively.
- 5. Choose Maximum Delay Analysis View to view the max delay analysis.
- 6. In the Maximum Delay Analysis window, expand my_clk.
- 7. Click **Register to Register** to observe the timing information. The slacks decrease after you increase the frequency. You may see the slacks go negative, which indicates Timing Violations. Negative slacks are shown in red.

Note: The actual timing numbers you see may be slightly different.

Figure 10-22. Maximum Delay Analysis After Setting Clock Constraint to 800 MHz

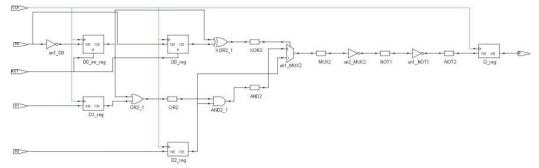
	5						10				
Summary	1 6	ustomize table								Apply Filter 54	ore filter Reset
X my_clk	-									(constraint) (co	
× Register to Register External Setup		Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required	Setup (ns)	Hinimum Period	Skew (ns)	
Clock to Output							(m)		(ns)		
Register to Asynchronous External Recovery										0.139	
Asynchronous to Register	2	d"Neletictk	Q_M(7):0	1.041	-0.175	5.184	5.009	0.298	1.425	0.086	
Pin to Pin Input to Output	3	Q_MEDICLK	Q_M(1)/D	0.970	-0.102	5.117	5.015	0.298	1.352	0.084	
CUser Sets		-									
	4	d"M(SS) OK	Q_W[21]/D	0.969	-0.064	5.069	5.005	0.298	1.314	0.047	
	5	Q_WEXERCLK	Q_H([31])D	0.885	-0.002	5.007	5.005	0.298	1.252	0.069	
	6	Q. HR[15]:CLK	Q_HE140	0.732	0.141	4.845	4.986	0.298	1.109	0.079	
		a used and		0.731	0.142	4,831	4,973		1.108		
	/	Q_HK[15]:CLK	Q_ME[16]:D	0.731	0.142	4,831	4,973	0.298	1. 108	0.079	
	8	Q_H4[22]:CLK	Q_int[23]:0	0.723	0.148	4.857	5.005	0.298	1. 102	0.083	
	9	Q_HE[18]:CLK	Q_int[15]:D	0.722	0.150	4.835	4.905	0.298	1.100	0.080	
	10	Q_M(10):CLK	Q_Int[11]:D	0.730	0.155	4.865	5.020	0.298	L.095	0.067	
	11	Q_M(28)-C.K	Q_M(29).0	0.713	0.170	4.834	5.004	0.298	1.080	0.069	
	12	d"w@t5jx0rk	Q_MELED	0.715	0.184	4.800	4,984	0.298	1.066	0.053	
		ime	-	Type	Net	-		Ма	cre Op D	elay Total Fanout Edge	
	1	Summary data required tin								4.959	
		data arrival time								6.533	
		slack Data arrival time of	alculation							-1.574	
		my_clk								0.000 0.000	
		CLK		Clock source						1.000 0.000 v	
-1.574 -0.627 0 0.32	-267	CLK, Bull VO.V.)		net cell	CLK					1.000 0.000 r 2.128 2.128 2 r	

8. Close SmartTime. When prompted to save changes, click No.

10.2 Tutorial 2 - False Path Constraints

This section describes how to enter false path constraints in SmartTime. You will import an RTL source file from the following design. After routing the design, you will analyze the timing, set false path constraints, and observe the maximum operating frequency in the SmartTime Timing Analysis window.

Figure 10-23. Example Design with False Paths



10.2.1 Set Up Your False Path Example Design Project

To set up your false path example design project:

- 1. Open Libero.
- 2. From the Project menu, choose New Project to create a new project.
- 3. Name the project false path and set the project location according to your preferences.
- 4. Click Next.
- 5. Enter the following values for your **Device Selection** settings:
 - Family: SmartFusion2
 - Die: M2S050
 - Package: 484 FBGA
 - Speed: STD
 - Die Voltage: 1.2 V
 - Range: COM
- 6. Click Finish to create the new project.

10.2.2 Import the false_path Verilog File and Add Constraints

For this tutorial, you will import the 10.2.5 false_path.v Verilog source file into your design, and then run Libero SoC. To import the Verilog source file:

- 1. From the **File** menu, choose **Import > HDL Source Files**.
- 2. Browse to the location of the false_path.v you saved and select it. Click **Open** to import the file.
- 3. Verify that the file appears in Design Hierarchy.
- 4. In the Design Flow window, double-click **Synthesize** to run synthesis. A green check mark appears when the Synthesis step completes successfully.
- 5. Expand Edit Constraints.
- 6. Right-click **Timing Constraints** and choose **Open Interactively**.
- 7. Double-click Manage Constraints.
- 8. Select the **Timing** tab.
- 9. Expand the **Edit with Constraint Editor** sub-menu, and select **Edit Place and Route Constraints**. The Constraints Editor appears.
- 10. Double-click **Requirements: Clock**. The Create Clock Constraint dialog box appears.
- 11. Double click the **Browse** button for **Clock Source**, select **CLK**, and assign it a name (for example, clk).
- 12. Set the frequency to 100 MHz.

Figure 10-24. Clock Constraint of 100 MHz

Clock Name : dk	Clock Source	e : [get_ports { CLK }]	·
Perio	od : 10 ns —	Her Frequency: 100	Mhz
Offset : Duty cycle Offset : Duty cycle O.000 ns 50.0000 Add this clock to existing one with same set	%		
Comment :			

13. Click **OK** to return to the Constraints Editor and observe that the clock information has been filled in, as shown in the following figure.

Figure 10-25. Clock Constraint of 100 MHz in false_path design

ConstraintsEditor - (Constraints E	Sitor]									6	1
Dile - Constraints - Restore - H	-										
M 34 34 3+ 30 3+ 1	- 2	* 10 17 1	p.								
Canab ants Editor											
Constraints Requirements		Syntax	Clock Name	Clock Source	Period (ns)	frequency (Http:)	Dutycycle (%)	First Edge	Offset (ns)	Waveform	
Clock Generated Clock	ī	Click within this row			0.000		\$0.0%	rising +	0.000	0.00 0.00	aut
Input Delay Output Delay	2	. 💎	dk .	[get_ports {CLK.}]	80.000	100.000	\$0.000000	raing +	0.000	0.00 5.00	ų,
Esternal Check Clock To Dut Exceptions May Delay											

- 14. Save your changes (File > Save) and close the Constraints Editor (File > Close).
- 15. In the Constraint Manager, check the check boxes under **Place and Route** and **Timing Verification** to associate the constraint file to both tools. The constraint file is used for both Place and Route and Timing verification.

10.2.3 Place and Route Your FALSE_PATH Design

To run Place and Route on false_path design:

1. In Libero SoC, right-click **Place and Route** and choose **Configure Options**. The Layout Options dialog box appears.

Figure 10-26. Layout Options Dialog Box

Layout Options	8
Timing-driven	
Power-driven	
I/O Register (Combining
Global Pins De	emotion
	ation
High Effort La	ayout
Repair Minimu	um Delay Violations
Use Multiple Passes	
Use Multiple Passes	

- 2. Click the check box to enable **Timing-Driven** layout and leave all other values unchecked.
- 3. Click **OK** to close the Layout Options dialog box.
- Right-click Place and Route and choose Run.
 A green check mark appears next to Place and Route in the Design Flow window when Place and Route completes successfully.

Libero[®] SoC v2021.2 SmartTime Tutorials

esign Flow		-	~
Top Module(root): false_path	-	0	19
Active Synthesis Implementation: synthesis			
Tool			 -
E Create Design			
- 🖧 System Builder			
- 🖧 Configure MSS			
Create SmartDesign			
Create HDL			
📲 Create SmartDesign Testbench			
Create HDL Testbench			
Generate Memory Map			
Verify Pre-Synthesized Design			
Simulate			
Constraints			
Manage Constraints			
🖌 🖻 🕨 Implement Design			
C: Netlist Viewer			
🗸 🖕 🖕 Synthesize			
Verify Post-Synthesized Design			
• 🗋 Generate Simulation File			
🔤 🚟 Simulate			
• • Configure Flash*Freeze			
Configure Register Lock Bits			
V Place and Route			
Verify Post Layout Implementation			
Generate Back Annotated Files			_
Simulate			
···· 🕰 Verify Timing			
Open SmartTime			
🗠 🖹 Verify Power			
E IO Analyzer			

Figure 10-27. Synthesize and Place and Route Successful Completion

10.2.4 Timing Analysis - Maximum Clock Frequency

The SmartTime Maximum Delay Analysis View displays the design maximum operating frequency and lists any setup violations.

To perform maximum delay analysis:

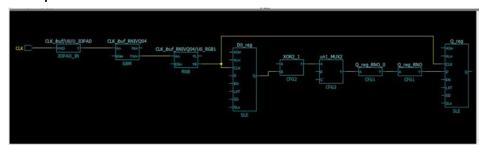
- 1. Expand Verify Post Layout Implementation.
- Right-click Open SmartTime and choose Open Interactively to open SmartTime. The Maximum Delay Analysis View appears. The Maximum Delay Analysis View summarizes design performance and indicates that the design will operate at a maximum frequency of 442.48 MHz. Note: You may see a slightly different maximum frequency with a different version of Libero SoC.

	lt View Tools Help									-
Maximu	am Delay Analysis View ay Analysis View									0
<u>_</u>	Analysis for scenario timing, analysis	Design			false path	1				
MAX		Family			SmartFusion2	-				
	Summary	Die		M2S050						
	 Register to Register 	Package	and the second se		484 FBGA					
	External Setup Clock to Output			0 - 85 C						
	Register to Asynchronous	and the second se	Voltage Range		1.14 - 1.26 V					
	External Recovery Asynchronous to Register				STD	-				
	F. Pin to Pin			Post-Layout	-					
Input to Output		Data sour			Production	-				
	I User Sets				BEST - 1.26 V - 0 C	_				
		Max Operating Conditions		WORST - 1.14 V - 85	C					
		Scenario for Timing Analysis		nalvsis	timing analysis					
		Summ	Period	Freque		Required	External	External	Min Clock-To-	Max Clock-To-
		Domain	(ns)	(MHz)	Period (ns)	Frequency (MHz)	Setup (ns)	Hold (ns)	Out (ns)	Out (ns)
Select a set of paths to see its slack distribution.		clk	2.294	435.920	10.000	100.000	0.114	0.791	5.333	10.355
-			Min Delay (ns) Max Delay (ns)							
paths		Input to O	Input to Output N/A		N/A					
# of paths										
# of paths										
# of paths										
# of paths										

3. Expand **clk** to expand the display and show the Register to Register path sets.

Figure 10-28. Maximum Delay Analysis Summary

4. Select **Register to Register to** display the register-to-register paths. Notice that the slack values are positive. **Figure 10-29. Expanded Path**



5. Double-click to select and expand the row in the path list with the path is from the CLK pin of flip-flop D0_reg to the D input of flip flop Q_reg. Note that the path goes through the S input of multiplexer un1_MUX2.

Looking at the code in false_path.v, you can see on lines 51 and 52, that D0_reg and D)_inv_reg are always the inverse of each other in "operational" mode (i.e., except for when RST is active). Line 56 says that XOR2 is the XOR of these two signals, and hence always 1 (except when RST is active). Line 59 says that XOR2 is the select of MUX2.

We might reasonably decide that we are not interested in the reset mode delay for this design; therefore, this path is a false path for our timing analysis purposes.

Figure 10-30. Analyzing the False Paths

```
43
         if (RST)
44 🚍
         begin
45
             D0 reg
                          <= 1'b0;
46
             D0 inv reg
                          <= 1'b0;
47
         end
48
49
         else
50
         begin
  F
51
             D0 req
                          <= D0;
52
             D0 inv reg
                          <= ~D0:
53
         end
54
    end
55
56
    assign XOR2 = D0 reg ^ D0 inv reg;
57
    assign OR2 = D0 inv reg || D1 reg;
58
    assign AND2 = OR2 && D2 reg;
59
    assign MUX2 = (XOR2) ? (D2 reg) : (AND2);
60
61
```

Similar analysis shows that the path from D0_inv_reg:CLK to Q_reg:D shares exactly the same false-path characteristic. We should disable both paths.

- 6. Restart the Libero Constraints Editor. The Constraints Editor must be running to use SmartTime's backannotation feature. Go to the **Constraint Manager** tab, then go to the **Timing** sub-tab, pull down **Edit with Constraint Editor**, and choose **Edit Timing Verification Constraints**.
- 7. Leave this running and return to SmartTime.
- 8. From the **Tools** menu, select **Max Delay Analysis**.
- 9. To set the path from D0_inv_reg:CLK to Q_reg :D as false, select the row containing this path in the Register to Register path set, right-click and choose Add False Path Constraint. The Set False Path Constraint dialog box appears. It might pop behind the current dialog box, so check other Constraint Manager windows.

Figure 10-31. Right-clicking Add False Path Constraint

n Delay Analysis Yew											
Analysis for scenario Primary		from *					10				
Ø Summary ★ √⊗ my_clk ★ Register to Register External Setup		Customize table								Apply Filter	Store Filter
Clock to Output Register to Asynchronous External Recovery		Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required (ns)	Setup (ns)	Minimum Period (ns)	Skew (ns)	
Asynchronous to Register		XDqat_re_00	0,149.0	1.906	7.740	51807	13.627	0.298	2.260	0.096	
 X: Pin to Pin Input to Output 	2	ND:peg_00	Copy Print		7.882	5.745	13.627	0.298	2.118	0.066	
X User Sets	3	D1_HepiOJK	Add False Dath (Add False Bath Constraint		5.731	13.627	0.298	2.104	0.067	
		D2_rep:CLK	Add Max Delay Add Min Delay	Constraint R	8.294	5.333	13.627	0.298	1.796	0.067	
			Add Multicycle Expand selected								

- 10. Click **OK** to close the Set False Path Constraint dialog box.
- 11. In the Constraints Editor window, check for an entry below **Exceptions > False Path**.
- 12. Return to the SmartTime window and repeat for the D0_reg:CLK -> Q_reg:D path.
- 13. Because we are interested only in timing analysis through the MUX when select = 1, we can ignore the MUX "0" path from D1_reg:D through the AND2. We make this a false path. At this point the Constraints Editor should now look as follows. Save the file and exit the Constraints Editor and SmartTime.

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Constraints Editor traints Editor						-
E Constraints		Syntax	From	Through	То	File
Y Clock Generated Clock	1	Click with				GUI
Input Delay Output Delay	z	7	[get_pins { D0_inv_reg/CLK }		[get_pins { Q_reg/D }]	X:\sandhya\de
External Check Clock To Out	3	7	[get_pins {D0_reg/CLK }]		[get_pins {Q_reg/D}]	X:\sandhya\de
Exceptions Max Delay	4	7	[get_pins {D1_reg/CLK }]		[get_pins { Q_reg/D }]	X:\sandhya\de
 Advanced Disable Timing Clock Source Latency Clock Uncertainity Clock Groups 						

Figure 10-32. False Path Constraints in the SmartTime Constraint Editor

Place and Route is now invalidated and must be re-run before we can perform timing analysis again. This is because we changed the constraint file we are using for both P&R and for Timing Analysis. We can use different constraint files, in which case we would not need to re-run P&R.

- 14. Right-click Open SmartTime and choose Update and Open Interactively.
 - You will see that Place and Route is run automatically before SmartTime is restarted.
- 15. View the summary in the Maximum Delay Analysis View (**Tools > Max Delay Analysis**). SmartTime now reports the maximum operating frequency as 586.17 MHz, as shown in the following figure.

Note: The maximum operating frequency may vary slightly with a different version of the Libero software.

	🚨 💱 達 ≨ R 🐵 🛪											
nun vea	Analise new											
MAX	Analysis for scenario Primary	Design			false_pat	th						
- 61 S		Family			SmartFu	sion2						
	emmary	Die			M2S050							
	 Register to Register 	Package			484 FBG	A						
	External Setup Clock to Output	Temperatu	re Range		0 - 85 C							
	Register to Asynchronous	Voltage Range 1		1.14 - 1.2	26 V							
	External Recovery Asynchronous to Register	Speed Gra	de		STD							
4 3	C Pin to Pin	Design State F		Post-Lay	out							
3	Input to Output C User Sets	Data source	e.		Productio	on						
		Min Operat	ting Conditi	ons I	BEST - 1	1.26 V - 0 C						
		Max Opera	ting Condit	ons	WORST	- 1.14 V - 85 C						
_		Scenario fe	or Timing Ar	alysis	Primary							
[Summa	ary									
baths	Select a set of paths to see its slack distribution.	Clock Domain	Period (ns)	Freque (MHz)	ency	Required Period (ns)	Required Frequency (MHz)	External Setup (ns)	External Hold (ns)	Min Clock-To- Out (ns)	Max Clock-To- Out (ns)	
3		my_clk	1.706	586.16	6	10.000	100.000	-0.025	0.753	5.117	9.781	
• [Min	elay (n	s) May	Delay (ns)						
			tput N/A	and the	N/A	a could food						

Figure 10-33. Maximum Delay Analysis View - Summary

16. Select the Register to Register set for my_clk. Observe that only one path is visible, from D2_reg: CLK to Q_reg:D. This is the only path that propagates a signal, as shown in the following figure.

Figure 10-34. Maximum Delay Analysis View - Register to Register

um Delay Analysis View											
Analysis for scenario Primary	From *	From * TO *									
l Summary l ≤ Summary	Customize table								Apply Fi	Iter Store Filter	Reset Filter
Register to Register External Setup	Source Pin	Sink Pa	Delay (ns)	Slack (ns) An	rrival (ns)	Required (ns)	Setup (ns)	Minin	um Period (ns)	Skew (ns	0
Clock to Output Register to Asynchronous	1 D2_repCLK	Q_repiD	1.341	8.294	5.333	13.627	0.25		1.70		0.067
External Recovery											
Asynchronous to Register											
 X Pin to Pin Inset to Output 											
Input to Output											
Input to Output											
Input to Output											
Input to Output	Name		Туре	Net		Macro	Op	Delay	Total Fanc	out Edge	
Input to Output	# Summary		Туре	Net		Macro	Op			out Edge	-
Input to Output	 Summary data required time 	2	Туре	Net		Macro	Op	1	3.627	ut Edge	5
Input to Output	 Summary data required time data arrival time 	ve	Туре	Net		Macro	Op -	1	3.627 5.333	vut Edge	1
Input to Output	 Summary data required time data arrival time slack 		Туре	Net		Macro	Op -	1	3.627	out Edge	
Input to Output User Sets	Summary data required time data arrival time slack Data_arrival_time_ca		Type	Net		Macro	Op -	1	3.627 5.333 8.294	out Edge	1
Input to Output	Summary data required time data arrival time slack Data_arrival_time_ca my_clk		Туре	Net		Macro	Ор -	0.000	3.627 5.333 8.294 0.000	ut Edge	[
Input to Output X User Sets	Summary data required time data arrival time slack Data_arrival_time_ca my_clk CLK	alculation	Clock source			Масто	Op -	0.000	3.627 5.333 8.294 0.000 0.000	vit Edge	1
Input to Output User Sets	Summary data required time data arrival time slack Data_arrival_time_ca my_clk	alculation	Clock source	Net		Macro		0.000	3.627 5.333 8.294 0.000 0.000		
Input to Output C User Sets	Summary data required time data arrival time slack Data_arrival_time_ca my_clk CLK	alculation	Clock source			Macro	•	0.000	3.627 5.333 8.294 0.000 0.000 0.000		1
Input to Output	Summary data required time data arrival time_ca slack Data_arrival_time_ca my_clk CLK CLK_bd/100/UJK CLK_bd/100/UJK	alculation OPAD:PAD OPAD:Y	Clock source net cell				•	0.000 0.000 0.000	13.627 5.333 8.294 0.000 0.000 0.000 2.128	1	1
lipot to Output There Sets	 Summary data required time data arrival time slack Data_arrival_time_ci CIX, CIX, biot/100/UX, CIX, biot/100/UX, CIX, biot_800(00) 	alculation OPAD:PAD OPAD:Y M:An	Clock source net cell	cuk		ADLIBJOPA	D_JN .	0.000 0.000 0.000 2.128	3.627 5.333 8.294 0.000 0.000 0.000 2.128 2.480	1	1
lipot to Output X User Sets	Summary data required time data arrival time_ca slack Data_arrival_time_ca my_clk CLK CLK_bd/100/UJK CLK_bd/100/UJK	alculation OPAD:PAD OPAD:Y M:An M:YWn	Clock source net cell net cell	cuk	448 Wm		D_JN .	0.000 0.000 0.000 2.128 0.352	13.627 5.333 8.294 0.000 0.000 0.000 2.128 2.480 2.585	r 2 r f	1

- 17. Close SmartTime.
- 18. Close Libero SoC.

10.2.5 false_path.v

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	Joe X // //
// module input input input input output	<pre>////////////////////////////////////</pre>
reg reg reg reg	D0_reg; D0_inv_reg; D1_reg; D2_reg;
reg	Q_reg;
wire wire wire wire wire wire	XOR2/*synthesis syn_keep=1*/;AND2/*synthesis syn_keep=1*/;OR2/*synthesis syn_keep=1*/;MUX2/*synthesis syn_keep=1*/;NOT1/*synthesis syn_keep=1*/;NOT2/*synthesis syn_keep=1*/;
assign Q =	Q_reg /*synthesis syn_keep=1*/;
always @(p	osedge CLK or posedge RST)
end	<pre>if (RST) begin D0_reg <= 1'b0; D0_inv_reg <= 1'b0; end else begin D0_reg <= D0; D0_inv_reg <= ~D0; end assign XOR2 = D0 reg ^ D0 inv reg;</pre>
	<pre>assign OR2 = D0_inv_reg D1_reg; assign AND2 = OR2 && D2_reg; assign MUX2 = (XOR2) ? (D2_reg) : (AND2); always @(posedge CLK) begin D1_reg <= D1; D2_reg <= D2;</pre>
	Q_reg <= NOT2; end
	not u1 (NOT1, MUX2); not u2 (NOT2, NOT1);
	endmodule

11. SmartTime Dialog Boxes

The following sections describe the SmartTime dialog boxes.

11.1 Add Path Analysis Set Dialog Box

Use the Add Path Analysis Set dialog box to specify a custom path analysis set.

To open the Add Path Analysis Set dialog box from the SmartTime Timing Analyzer, choose any path and right-click to select **Add Set**.

Note: The Analysis menu is available only in Maximum or Minimum Delay Analysis view.

Figure 11-1. Add Path Analysis Set Dialog Box

ame :- ource pins:	Trace from :- 🕤 Source to sink 🔿 Sink to source Sink Pins:
DFN1_0:CLK DFN1_1:CLK PF_CCC_C0_0/PF_CCC_C0_0/pll_inst_0:RI	EF_CLK_0
Select All Filter source pins: Pin Type: Registers by pin names	Select All Filter sink pins: Pin Type: Registers by pin names

11.1.1 Name

Enter the name of your path set.

11.1.2 Trace from

Select whether you want to trace connected pins from **Source to sink** or from **Sink to source**. By default, the pins are traced Source to sink.

11.1.3 Source Pins

Displays a list of available and valid source pins. You can select multiple pins. To select all source pins, click the **Select All** button below the **Source Pins** list.

11.1.4 Select All

Selects all the pins in the Source Pins list to include in the path analysis set.

11.1.5 Filter Source Pins

Allows you to specify the source **Pin Type** and the **Filter**. The default pin type is Registers by pin name. You can specify any string value for the **Filter**. If you change the pin type, the **Source Pins** shows the updated list of available source pins.

11.1.6 Sink Pins

Displays list of available and valid pins. You can select multiple pins. To select all source pins, click the **Select All** button below the **Sink Pins** list.

11.1.7 Select All

Selects all the pins in the Sink Pins list to include in the path analysis set.

11.1.8 Filter Sink Pins

Allows you to specify the sink **Pin Type** and the **Filter**. The default pin type is **Registers (by pin)**. You can specify any string value for the **Filter**. If you change the pin type, the **Sink Pins** shows the updated list of available sink pins.

11.2 Analysis Set Properties Dialog Box

Use the Analysis Set Properties dialog box to view information about a user-created set.

To open the Analysis Set Properties dialog box from the Timing Analysis View, right-click a user-created set in the Domain Browser, and then choose **Properties** from the shortcut menu.

Figure 11-2. Analysis Set Properties Dialog Box

Analysis Set I	Properties	? X
Name : Parent set :	ss	
From :	FN1_1:CLK PF_CCC_C0_0/PF_CCC	_C0_0/pll_inst_0:REF_CLK_0
To :	_0/PF_CCC_C0_0/pll_inst_0:REF_C	CLK_0 DFN1_1:CLK DFN1_1:D
Help	ок	Cancel

11.2.1 Name

Specifies the name of the user-created path set.

11.2.2 Parent Set

Specifies the name of the parent path set to which the user-created path set belongs.

11.2.3 Creation Filter

Specifies a list of source pins in the user-created path set.

11.2.4 To

Specifies a list of sink pins in the user-created path set.

11.3 Edit Filter Set Dialog Box

Use the Edit Filter Set dialog box to specify a filter.

To open the Edit Filter Set dialog box from the SmartTime Max/Min Delay Analysis view, right-click a filter set in the clock domain browser, and then choose **Edit Set** from the shortcut menu.

Figure 11-3. Edit Path Analysis Set Dialog Box

Edit Path Analysis Set	? ×
Name :- my set1	Trace from :- Source to sink Sink to source
Source pins:	Sink Pins:
CFG0 GND INST:Y	SerDes AHBBUS 0/PCIE SERDES IF 0/SERDESIF INST RNO
CoreAHBLite_0/matrix4x16/masterstage_0/DEFSLAVEDATAS	SerDes_AHBBUS_0/PCIE_SERDES_IF_0/SERDESIF_INST_RNO_
CoreAHBLite_0/matrix4x16/masterstage_0/DEFSLAVEDATAS CoreAHBLite_0/matrix4x16/masterstage_0/DEFSLAVEDATAS	SerDes_AHBBUS_0/PCIE_SERDES_IF_0/SERDESIF_INST_RNO_ SerDes_AHBBUS_0/PCIE_SERDES_IF_0/SERDESIF_INST_RNO_
CoreAHBLite_0/matrix4x10/masterstage_0/DEFSLAVEDATAS	SerDes_AHBBUS_0/PCIE_SERDES_IF_0/SERDESIF_INST_RNO_
CoreAHBLite_0/matrix4x10/masterstage_0/DEFSLAVEDATAS	SerDes_AHBBUS_0/PCIE_SERDES_IF_0/SERDESIF_INST_RNO_
CoreAHBLite 0/matrix4x10/masterstage_0/DEFSLAVEDATAS	SerDes_AHBBUS_0/PCIE_SCROES_II_0/SERDESII_INVST_INVO_
CoroAUPLite 0/matrix4x10/masterstage_0/DEFSLAVEDATAS	
	4 III >
Select All	Select All
Filter source pins:	Filter sink pins:
Pin Type: All pins	Pin Type: All pins
* Filter	* Filter
Help	OK Cancel

11.3.1 Name

Specifies the name of the path you want to edit.

11.3.2 Creation filter

Source Pins: Displays a list of source pins in the user-created path set. **Sink Pins**: Displays a list of sink pins in the user-created path set.

11.4 Customize Analysis View Dialog Box

Use the Customize Analysis View dialog box to customize the timing analysis grid.

Libero[®] SoC v2021.2 SmartTime Dialog Boxes

To open the Customize Analysis View dialog box from the SmartTime Max/Min Delay Analysis View, click the **Customize table** button (circled in red in the following figure) in the Max/Min Delay Analysis View. The Customize Paths List Table dialog box appears.



le Edit View Tools Help								
Z 🗅 🖸 🌶 🖌 C 🐵 🛪								
n Delay Analysis View								
Analysis for scenario Primary	From *			то				
	Customize table			10		Apply F	Iter Store Filter	Reset Filter
Register to Asynchronous	Customize table					Apply P	store Hitter	Reset Filler
Asynchronous to Register	Source Pin	Sink Pin	Delay (ns)	Slack (ns)	Arrival (ns)	Required (ns)	Hold (ns)	Skew (n
× Register to Register External Hold	1 FOOR_INIT_0/COREABC_	D/LRTG#PODRC_0/U0/INST_	0.764	-0.980	3.010	3.990	1.744	
Clock to Output Register to Asynchronous	2 FDOR_INIT_0/COREABC_	0/LIRTG4FDDRC_0/U0/0NST	0.681	-0.914	2.927	3.841	1.595	
External Removal Asynchronous to Register	3 FOOR_INIT_0/COREABC_	0/1 RTG4FDDRC_0/U0/INST_	0.766	-0.892	3.012	3.904	1.658	
a opp GIT	4 FOOR_INIT_0/COREABC_	a/LRTG4FDDRC_0/U0/3NST_	0.626	-0.762	2.872	3.634	1.388	
80	5 FOOR_INIT_0/COREABC_	0//RTG4FDDRC_0/U0/0NST	0.717	-0.749	2.963	3.712	1.466	
64		0/LRTG4PDDRC_0/U0/INST_	0.648	-0.727	2.894	3.621	1.375	
48	() ()							*
32	Name			Туре	Net		1	Macro
16	 Summary data arrival time data required time 							-
0 -0.98 -0.465 0 0.05 0.565	slack							
slack distribution(ns)	Data_arrival_time_calcu	lation	111					

Figure 11-5. Customize Paths List Dialog Box

Available fields: Clock Source Clock Edge Destination Clock Edge Logic Stage Count Clock Constraint (ns) Multicycle Constraint	Add Source Pin Sink Pin Delay (ns) Slack (ns) Arrival (ns) Required (ns) Hold (ns) Skew (ns)

11.4.1 Available Fields

Displays a list of all the available fields in the timing analysis grid.

11.4.2 Show These Fields in This Order

Shows the list of fields you want to see in the timing analysis grid. Use **Add** or **Remove** to move selected items from **Available fields** to **Show these fields in this order** or vice versa. You can change the order in which these fields are displayed by using **Move Up** or **Move Down**.

11.4.3 Restore Defaults

Resets all the options in the **General** panel to their default values.

11.5 Manage Clock Domains Dialog Box

Use the Manage Clock Domains dialog box to specify the clock pins you want to see in the Expanded Path view.

To open the Manage Clock Domain dialog box from the SmartTime Max/Min Delay Analysis view, click the *icon*. **Figure 11-6. Manage Clock Domains Dialog Box**

DQS[2]	^	Add	DQS[0]	
PLL_REF_CLK			DQS[1]	
ddr_x32_0/CCC_0/pll_inst_0/OUT1			DQS[3]	
ddr_x32_0/CCC_0/pll_inst_0/OUT2		Move Down	ddr_x32_0/DDRPH	Y_BLK_0/IOD_TRAINING_0/CC
ddr_x32_0/CCC_0/pll_inst_0/OUT3				
ddr_x32_0/DDRPHY_BLK_0/IOD_TRAINING_0 ddr x32 0/DDRPHY_BLK_0/IOD_TRAINING_0		Mausilla		
ddr x32 0/DDRPHY BLK 0/IOD TRAINING 0		Move Up		
ddr x32 0/DDRPHY BLK 0/IOD TRAINING 0				
ddr_x32_0/DDRPHY_BLK_0/IOD_TRAINING_0		Remove		
<			<	>

11.5.1 Available Clock Domains

Displays alphanumerically sorted list of available clock pins. The first clock pin is selected by default.

11.5.2 Show the Clock Domains in This Order

Shows the clock pins you want to see in the Expanded Path view. Use **Add** or **Remove** to move selected items from **Available clock domains** to **Show the clock domains in this order** or vice versa. You can change the order in which these clock pins are displayed by using **Move Up** or **Move Down**.

11.5.3 New Clock

Allows you to add a non-explicit clock domain. Clicking this option opens the Choose the Clock Source Pin dialog box, where you can select the clock source pin.

11.6 Set False Path Constraint Dialog Box

Use the Set False Path Constraint dialog box to define specific timing paths as being false.

This constraint removes timing requirements on these false paths so that they are not considered during the timing analysis. The path starting points are the input ports or register clock pins and path ending points are the register data pins or output ports. This constraint disables setup and hold checking for the specified paths.

Note: The false path information always takes precedence over multiple cycle path information and overrides maximum delay constraints.

To open the Set False Path Constraint dialog box from the SmartTime Constraints Editor, choose **Constraints > Exceptions False Path > Add False Path Constraint**.

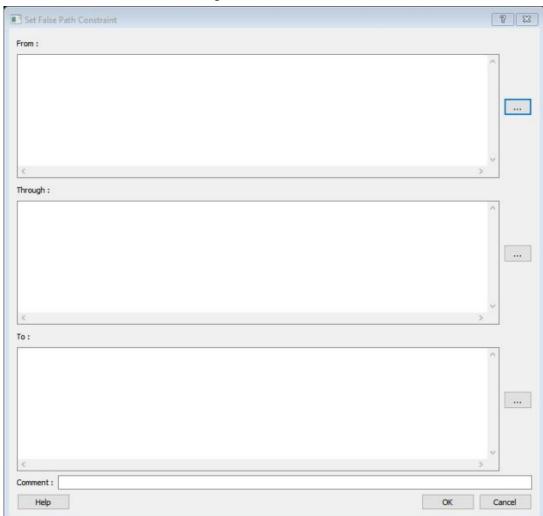


Figure 11-7. Set False Path Constraint Dialog Box

11.6.1 From

Specifies the starting points for false path. A valid timing starting point is a clock, a primary input, an input port, or a clock pin of a sequential cell.

11.6.2 Through

Specifies a list of pins, ports, cells, or nets through which the disabled paths must pass.

11.6.3 To

Specifies the ending points for false path. A valid timing ending point is a clock, a primary output, an input port, or a data pin of a sequential cell.

11.6.4 Comment

Allows you to provide comments for this constraint.

11.7 SmartTime Options Dialog Box

Use the SmartTime Options dialog box to specify the SmartTime options to perform timing analysis. This interface includes the following categories:

- General
- Analysis
- Advanced

To open the SmartTime Options dialog box from the SmartTime tool, choose **Tools > Options**.

Figure 11-8. SmartTime Options- General Dialog Box for SmartFusion2, IGLOO2, and RTG4

Option Categories Select a category: General	General Operating Conditions		
Analysis Advanced	Perform maximum delay analysis based on	WORST 🔻	case
	Perform minimum delay analysis based on	est 🝷	case
	Clock Domains Clock	for timing analysis.	
			Restore Defaults
Help			OK Cancel

Figure 11-9. SmartTime Options - General Dialog Box for PolarFire

Option Categories	General
 Select a category: General 	Operating Conditions
- Analysis - Advanced	Perform maximum delay analysis based on slow_lv_ht case
	Perform minimum delay analysis based on fast_hv_lt case
	-Clock Domains
	Include inter-clock domains in calculations for timing analysis.
	F Enable recovery and removal checks.
	Restore Defaults

11.7.1 Operating Conditions

Allows you to perform maximum or minimum delay analysis based on the Best, Typical, or Worst case. By default, maximum delay analysis is based on WORST case and minimum delay analysis is based on BEST case.

11.7.2 Clock Domains

- Include inter-clock domains in calculations for timing analysis: Allows you to specify whether SmartTime must use inter-clock domains in calculations for timing analysis. By default, this option is unchecked.
- Enable recovery and removal checks: Allows SmartTime to check removal and recovery time on asynchronous signals. Additional sets are created in each clock domain in Analysis View to report the corresponding paths.

11.7.3 Restore Defaults

Resets all the options in the General panel to their default values.

11.7.4 Analysis

Figure 11-10. SmartTime Options - Analysis View Dialog Box

Option Categories	Analysis View	
Select a category: General Analysis Advanced	Display of Paths Limit the number of paths shown in a path set to: Filter the paths by slack value Slack range from: Slack range from: Show clock network details in expanded path Limit the number of parallel paths in expanded path to:	100 ns
		Restore Defaults

11.7.5 Display of Paths

Limits the number of paths shown in a path set for timing analysis. The default value is 100. You must specify a number greater than 1.

11.7.5.1 Filter the Paths by Slack Value

Specifies the slack range between minimum slack and maximum slack. This option is unchecked by default.

11.7.6 Show Clock Network Details in Expanded Path

Displays the clock network details as well as the data path details in the Expanded Path views.

Limit the number of parallel paths in expanded path to: For each expanded path, specify the maximum number of parallel paths that SmartTime displays. The default number of parallel paths is 1.

11.7.7 Restore Defaults

Resets all the options in the Analysis View panel to their default values.

11.7.8 Advanced Dialog Box

Figure 11-11. SmartTime Options - Advanced Dialog Box

Option Categories	Advanced	
 Select a category: General Analysis Advanced 	Special Situtations Use loopback in bi-directional buffers(bibufs) Gr Break paths at asynchronous pins Gr Disable non-unate arcs in dock network	

11.7.9 Special Situations

Allows you to specify whether you need to use loopback in bi-directional buffers (bibufs) and/or break paths at asynchronous pins.

11.7.10 Scenarios

Allows you to select the scenario to use for timing analysis and for timing-driven place-and-route.

11.7.11 Restore Defaults

Resets all the options in the Analysis View panel to their default values.

11.8 Create Filter Set Dialog Box

Use the Create Filter Set dialog box to specify a filter.

To open the Create Filter Set dialog box from the SmartTime Timing Analyzer, select a path, and click the **Store Filter** button in the Analysis View Filter.

Figure 11-12. Create Filter Set Dialog Box

Create Filter Set		8 🛛
Name :	10×4	
Help	ОК	Cancel

11.8.1 Name

Specifies the name of the filtered set.

11.9 Timing Bottleneck Analysis Options Dialog Box

Use the Timing Bottleneck Analysis Options dialog box to customize the Timing Bottleneck Report. You can set report options for the following categories:

- General pane
- Bottleneck pane
- Sets pane

To open the Timing Bottleneck Analysis Options dialog box from the SmartTime tool, choose **Tools > Bottleneck Analysis**.

11.9.1 General Pane

Figure 11-13. Timing Bottleneck Report - General Pane Dialog Box

Option Categories	General	
 Select a category: General Bottleneck Sets 	Slack Maximum slack to include	0 ns
Help		Restore Defaults OK Cancel

11.9.2 Slack

Allows you to specify whether the reported paths is filtered by threshold and, if so, what maximum slack to report. By default, the paths are filtered by slack and the slack threshold is 0.

11.9.3 Restore Defaults

Resets all the options in the **General** pane to their default values.

11.9.4 Bottleneck Pane

Option Categories	Bottleneck options	
 Select a category: General Bottleneck Sets 	Cost Type: Limit the number of paths per section to: Limit the number of parallel paths per section to: Limit the number of reported instances to:	Path Count
Help		Restore Defaults OK Cancel

Figure 11-14. Timing Bottleneck Report - Bottleneck Pane Dialog Box

11.9.5 Bottleneck Options

Cost Type: Select the cost type that SmartTime will include in the Bottleneck Report. By default, path count is selected. You can select one of the following two items from the drop-down list:

- **Path Count**: This cost type associates the severity of the bottleneck to the count of violating/critical paths that traverse the instance. This is the default.
- **Path Cost**: This cost type associates the severity of the bottleneck to the sum of the timing violations for the violating/critical paths that traverse the instance.

Limit the number of paths per section to: Specify the maximum number of paths per set type that SmartTime will include per section in the report. The default maximum number of paths reported is 100.

Limit the number of parallel paths per section to: For each expanded path, specify the maximum number of parallel paths that SmartTime will include in the report. Only cells that lie on these violating paths are reported. The default number of parallel paths is 1.

Limit the number of reported instances: Specify the maximum number of cells that SmartTime will include per section in the report. The default number of cells is 10.

11.9.6 Restore Defaults

Resets all the options in the **Bottleneck** panel to their default values.

11.9.7 Sets Pane

The Sets pane has four mutually exclusive options:

- Entire design
- Clock Domain
- Use existing user set
- Use Input to Output Set

Bottleneck Sets	Clock Domain Clock: Type: Vuse existing user set Name: Muse input to Output Set Filter From: To: To:
	From:

Figure 11-15. Timing Bottleneck Report - Sets Pane Dialog Box

Entire design: Displays bottleneck information for the entire design.

Clock Domain: Displays bottleneck information for the selected clock domain. You can specify the following options:

- **Clock**: Allows pruning based on a given clock domains. Only cells that lie on these violating paths are reported.
- Type: This option can only be used with -clock. The following table shows the acceptable values.

Table 11-1. Acceptable Type Values

Value	Description
Register to Register	Paths between registers in the design.
Asynchronous to Register	Paths from asynchronous pins to registers.
Register to Asynchronous	Paths from registers to asynchronous pins.
External Recovery	The set of paths from inputs to asynchronous pins.
External Setup	Paths from input ports to register.
Clock to Output	Paths from registers to output ports.

Use existing user set: Displays bottleneck information for the existing user set selected. Only paths that lie within the name set will be considered towards the Bottleneck Report.

Filter: Allows you to filter the Bottleneck Report by the following options:

- From: Reports only cells that lie on violating paths that start at locations specified by this option.
- To: Reports only cells that lie on violating paths that end at locations specified by this option. Filter defaults to all outputs.

11.9.8 Restore Defaults

Resets all the options in the Paths panel to their default values.

11.10 Timing Datasheet Report Options Dialog Box

Use the Timing Datasheet Report Options dialog box to select the output format for the Timing Datasheet Report.

To open the Timing Datasheet Report Options dialog box from the SmartTime Max/Min Delay Analysis view, choose **Tools > Reports > Datasheet**.

You can generate your report in one of two formats:

- Plain Text: Saves your report to disk in plain ASCII text format.
- Comma Separated Values: Saves your report to disk in comma-separated value format (.CSV) format, which you can import into a spreadsheet

Note: This Datasheet Report feature is not supported for PolarFire.

Figure 11-16. Report Options Dialog Box

 Deption Categories Select a category: General 	Format	
	Plain Text	O Comma Separated Values
		OK Cancel

11.11 Timing Report Options Dialog Box

Use the Timing Report Options dialog box to customize the Timing Report. You can set report options for the following categories:

- General
- Paths
- Sets
- Clock Domains

To open the Timing Report Options dialog box from the SmartTime Max/Min Delay Analysis View, choose **Tools > Reports > Timer**.

11.11.1 General

Timing Report Options	7	?	×
Option Categories	Format Plain Text C Comma Separated Values Summary Include a summary of timing results in this report		
	Slack Filter paths by slack threshold Maximum slack to include	s	
	OKC	ancel	
Help			

Figure 11-17. Timing Report Options - General Dialog Box

11.11.1.1 Format

Specifies whether the report exports as a Comma Separated Value (CSV) file or a plain text file. By default, the **Plain Text** option is selected.

11.11.1.2 Summary

Specifies whether the summary section is included in the report. By default, this option is selected.

11.11.1.3 Analysis

Specifies the type of analysis to be included in the Timing Report is a Maximum Delay Analysis Report or a Minimum Delay Analysis Report. By default, the Maximum Delay Analysis Report is included in the Timing Report.

11.11.1.4 Slack

Allows you to specify whether the reported paths is filtered by threshold and, if so, what maximum slack to report. By default, the paths are not filtered by slack.

11.11.2 Paths

Option Categories			
⊡- Select a category: General Paths Sets Clock Domains	Display of paths Image: Display of paths Display of paths Displ	5	

Figure 11-18. Timing Report Options - Paths Dialog Box

11.11.3 Display of Paths

Include detailed path information in this report: Check this box to include the detailed path information in the Timing Report.

Limit the number of reported paths per section to: Specify the maximum number of paths that SmartTime will include per section in the report.

Limit the number of expanded paths per section to: Specify the maximum number of expanded paths that SmartTime will include per section in the report.

Limit the number of parallel paths in expanded path to: For each expanded path, specify the maximum number of parallel paths that SmartTime will include in the report. The default number of parallel paths is 1.

×

11.11.4 Set

Timing Report Options		
Option Categories 	Display of Sets Include user sets in this report Include Input to Output sets in this report	

Fig

11.11.4.1 Display of Sets

Specifies whether user sets are included in the Timing Report.

User sets are either filters you created and stored on the default paths sets (Register to Register, Inputs to Register, and so on) or Pin-to-Pin user sets. By default, the paths for these sets are not reported.

You can also specify whether the Inputs to Output sets are included in the report. By default, the Input to Output sets are reported.

11.11.5 Clock Domains

Option Categories			
 Select a category: General Paths Sets Clock Domains 	□Display of Clock Domains Include clock domains Image: Limit reporting on clock domains to specified domains CLK CLK_RNIQ092/U0:Y.5 BLOCK_INTERFACE_LCLK:A CLK_RNIQ092/U0:Y.5 CLK_RNIQ092/U0:Y.5 CLK_RNIQ092/U0:RGB1:Y.1 CLK_RNIQ092/U0_RGB1:Y.4 CLK_RNIQ092/U0_RGB1:Y.6 CLK_RNIQ092:Y	ns	
Help			

Figure 11-20. Timing Report Options - Clock Domains Dialog Box

11.11.5.1 Display of Clock Domains

Allows you to specify the clock domains included in the report. By default, the current clock domains used by the timing engine is reported.

11.11.5.2 Include Clock Domains

Allows you to include or exclude clock domains in the report. Click the check box to include clock domains.

11.11.5.3 Limit Reporting on Clock Domains to Specified Domains

Allows you to include clock domain names in the box, or include additional clock domain names using **Select Domains**.

11.12 Timing Violations Report Options Dialog Box

Use the Timing Violations Report Options dialog box to customize the Timing Violation Report. You can set report violation options for the following categories:

- General
- Paths

To open the Timing Report Options dialog box from the SmartTime tool, choose **Tools > Reports > Timing Violations**.

11.12.1 General

Option Categories	General	
Select a category: General Paths	Format	 ns
		 Restore Defaults

Figure 92 · Timing Violations Report - General Dialog Box

11.12.1.1 Format

Specifies whether the report exports as a Comma Separated Value (CSV) file or a plain text file. By default, the **Plain Text** option is selected.

11.12.1.2 Analysis

Allows you to specify what type of analysis is reported in the report. By default, the report includes Maximum Delay Analysis.

11.12.1.3 Slack

Allows you to specify whether the reported paths is filtered by threshold and, if so, what maximum slack to report. By default, the paths are filtered by slack and the slack threshold is 0.

11.12.1.4 Restore Defaults

Resets all the options in the **General** panel to their default values.

11.12.2 Paths

Timing Violations Report Options		-? <mark>-</mark> >
Option Categories	Display of paths	
Select a category: General Paths	☑ Limit the number of reported paths	
	Limit the number of paths per section to:	100
	Limit the number of expanded paths per section to:	0
	Limit the number of parallel paths in expanded path to:	1
		Restore Defaults
Help		OK Cancel

Figure 11-21. Timing Violations Report - Paths Dialog Box

11.12.2.1 Display of Paths

Limit the number of reported paths: Check this box to limit the number of paths in the report. By default, the number of paths is limited.

Limit the number of paths per section to: Specify the maximum number of paths that SmartTime will include per section in the report. The default maximum number of paths reported is 100.

Limit the number of expanded paths per section to: Specify the maximum number of expanded paths that SmartTime will include per section in the report. The default number of expanded paths is 0.

Limit the number of parallel paths in expanded path to: For each expanded path, specify the maximum number of parallel paths that SmartTime will include in the report. The default number of parallel paths is 1.

11.12.2.2 Restore Defaults

Resets all the options in the Paths panel to their default values.

11.13 Data Change History - SmartTime

The data change history lists features, enhancements, and bug fixes for the current software release that may impact timing data of the current design.

To generate a data change history, choose **Data Change History** from the **Help** menu to display a data change history in text format.

Figure 11-22. SmartTime Data Change History Report

```
    Data Change History Report

    File Actions Help

    SmartTime Data Change History
    Family: SmartFusion2/IGLO90
    Die: M2S0907/M2S090/M2GL0907/M2G090/M2S090TV
    Data source: Production

    Libero 11.6
    67526 - Update CCC arc delays
    66997 - Update clock net delays
    67272 - Update MSS/FDDR setup time in AXI mode
    54350 - Update IO enable HZ/LZ arc delay

    Libero 11.5 SP2A
    S9225 - Timing data (IND/COM) updated from advanced to production
    S9228 - Support 1.0V timing (for M2S090TV, -1, IND)
```

12. Tcl Commands

For details about the Tcl commands supported by SmartTime, refer to the SmartFusion2, IGLOO2, RTG4 Tcl Commands Reference Guide or the PolarFire FPGA Tcl Commands Reference Guide.

13. Glossary

The following glossary defines terms in this user guide.

Table 13-1. Glossary

Term	Definition
Arrival time	Actual time in nanoseconds when data arrives at a sink pin when considering the propagation delays across the path.
Asynchronous	Two signals that are not related to each other. Signals not related to the clock are usually asynchronous.
Capture edge	The clock edge that triggers the capture of data at the end point of a path.
Clock	A periodic signal that captures data into sequential elements.
Critical path	A path with the maximum delay between a starting point and an end point. In the presence of a clock constraint, the worst critical path between registers in this clock domain is the path with the worst slack.
Data timing analysis	The standard method for verifying design functionality and performance. Both pre-layout and post-layout timing analysis can be performed via the SDF interface.
Exception	See timing exception.
Explicit clock	Clock sources that can be traced back unambiguously from the clock pin of the registers they deserve, including the output of a DLL or PLL.
Filter	A set of limitations applied to object names in timing analysis to generate target specific sets.
Launch edge	The clock edge that triggers the release of data from a starting point to be captured by another clock edge at an end point.
Minimum period	Timing characteristic of a path between two registers. It indicates how fast the clock will run when this path is the most critical one. The minimum period value takes into consideration both the skew and the setup on the receiving register.
Parallel paths	Paths that run in parallel between a given source and sink pair.
Path	A sequence of elements in the design that identifies a logical flow starting at a source pin and ending at a sink pin.
Path details	An expansion of the path that shows all the nets and cells between the source pin and the sink pin.
Path set	A collection of paths.
Paths list	Same as path set.

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Glossary

continued	
Term	Definition
Post-layout	The state of the design after you run Layout. In post-layout, the placement and routing information are available for the whole design.
Potential clock	Pins or ports connected to the clock pins of sequential elements that the Static Timing Analysis (STA) tool cannot determine whether they are is enabled sources or clock sources. This type of clock is generally associated with the use of gated clocks.
Pre-layout	The state of the design before you run Layout. In pre- layout, the placement and routing information are not available.
Recovery time	The amount of time before the active clock edge when the de-activation of asynchronous signals is not allowed.
Removal time	The amount of time after the active clock edge when the de-activation of asynchronous signals is not allowed.
Required time	The time when data must be at a sink pin to avoid being in violation.
Requirement	See timing requirement.
Scenario (timing constraints scenario)	Set of timing constraints defined by the user.
Setup time	The time in nanoseconds relative to a clock edge during which the data at the input to a sequential element must remain stable.
Sink pin	The pin located at the end of the timing path. This pin is usually the one where arrival time and required time are evaluated for path violation.
Skew	The difference between the clock insertion delay to the clock pin of a sink register and the insertion delay to the clock pin of a source register.
Slack	The difference between the arrival time and the required time at a specific pin, generally at the data pin of a sequential component.
Slew rate	The time needed for a signal to transition from one logic level to another.
Source pin	The pin located at the beginning of a timing path.
STA	See static timing analysis.
Standard delay format (SDF)	A standard file format used to store design data suited for back-annotation.
Static timing analysis	An efficient technique to identify timing violations in a design and to ensure that all timing requirements are met. It is well suited for traditional synchronous designs. The main advantages are that it does not require input vectors, and it exclusively covers all possible paths in the design in a relatively short run-time.

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Glossary

continued	
Term	Definition
Synopsys design constraint (SDC)	A standard file format for timing constraints. Synopsys Design Constraints (SDC) is a Tcl-based format used by Synopsys tools to specify the design intent, including the timing and area constraints for a design. Microsemi SoC tools use a subset of the SDC format to capture supported timing constraints. You can import or export an SDC file from the Designer software. Any timing constraint that you can enter using Designer tools, can also be specified in an SDC file.
Timing constraint	A requirement or limitation on the design to be satisfied during the design implementation.
Timing exception	An exception to a general requirement usually applied on a subset of the objects on which the requirement is applied.
Timing requirement	A constraint on the design usually determined by the specifications at the system level.
Virtual clock	A virtual clock is a clock with no source associated to it. It is used to describe clocks outside the FPGA that have an impact on the timing analysis inside the FPGA. For example, if the I/Os are synchronous to an external clock.
Wire Load Model (WLM)	A timing model used in pre-layout to estimate a net delay based on the fan-out.

14. Revision History

Revision	Date	Description
С	08/2021	Changed clk2 to clk1 in point 8 of 7.4 Deactivating a Specific Inter-Clock Domain.
В	04/2021	Generating a CDC Report: Added information related to cross probing, corner scenarios, and updated notes.
A	11/2020	Document converted to Microchip template. Initial Revision.

15. Microchip FPGA Technical Support

Microchip FPGA Products Group backs its products with various support services, including Customer Service, Customer Technical Support Center, a website, and worldwide sales offices. This section provides information about contacting Microchip FPGA Products Group and using these support services.

15.1 Customer Service

Contact Customer Service for non-technical product support, such as product pricing, product upgrades, update information, order status, and authorization.

- From North America, call 800.262.1060
- From the rest of the world, call 650.318.4460
- Fax, from anywhere in the world, **650.318.8044**

15.2 Customer Technical Support

Microchip FPGA Products Group staffs its Customer Technical Support Center with highly skilled engineers who can help answer your hardware, software, and design questions about Microchip FPGA Products. The Customer Technical Support Center spends a great deal of time creating application notes, answers to common design cycle questions, documentation of known issues, and various FAQs. So, before you contact us, please visit our online resources. It is very likely we have already answered your questions.

You can communicate your technical questions through our Web portal and receive answers back by email, fax, or phone. Also, if you have design problems, you can upload your design files to receive assistance. We constantly monitor the cases created from the web portal throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request.

Technical support can be reached at soc.microsemi.com/Portal/Default.aspx.

For technical support on RH and RT FPGAs that are regulated by International Traffic in Arms Regulations (ITAR), log in at soc.microsemi.com/Portal/Default.aspx, go to the **My Cases** tab, and select **Yes** in the ITAR drop-down list when creating a new case. For a complete list of ITAR-regulated Microchip FPGAs, visit the ITAR web page.

You can track technical cases online by going to My Cases.

15.3 Website

You can browse a variety of technical and non-technical information on the Microchip FPGA Products Group home page, at www.microsemi.com/soc.

15.4 Outside the U.S.

Customers needing assistance outside the US time zones can either contact technical support at (https://soc.microsemi.com/Portal/Default.aspx) or contact a local sales office.

Visit About Us for sales office listings and corporate contacts.

The Microchip Website

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- **Product Support** Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
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Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

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