ADS 2016.01

# **SIPro and PIPro**



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# SIPro/PIPro

SIPro/PIPro is a simulation and analysis tool that enables you to evaluate the signal integrity (SI) performance of signal nets and the power integrity (PI) performance of power distribution networks (PDNs). This tool provides several capabilities to perform pre-layout analyses and post-layout verifications. The following figure illustrates the analysis setup and results visualization environment of SIPro/PIPro:



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- Getting Started with SIPro and PIPro
- Creating an SIPro and PIPro Setup
- SIPro and PIPro Setup Window Overview
- Using Component Models
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# Getting Started with SIPro/PIPro

Using the SIPro/PIPro simulation and analysis tool, you can evaluate the signal integrity (SI) performance of signal nets and the power integrity (PI) performance of power distribution networks (PDNs). It enables you to perform pre-layout analysis and post-layout verifications. SIPro/PIPro provides the following analysis capabilities:

- PI-DC Analysis
- PI-AC Analysis
- Power Plane Resonance Analysis
- Power-Aware Signal Integrity Analysis

The following figure illustrates the analysis setup and results visualization environment of SIPro/PIPro:



# SIPro/PIPro Workflow

The workflow for evaluating the SI or PI performance of a layout design is displayed in the following figure:



# Analysis Capabilities

## **PI-DC** Analysis

A PI-DC analysis computes the voltage, IR drop (voltage drop), current, and power loss density in the power supply nets. It helps you to identify the IC and connector pins or stitching vias drawing large amounts of current at DC operating conditions. Due to excessive voltage drop, the power supply voltage at the IC might fall below the recommended minimum voltage. This can cause malfunctioning of the IC. Excessive current density in the perforated power supply rails can generate excessive heat, which might lead to board failures due to delamination or fusing. Also, excessive current in the stitching vias can lead to via failures losing connection. Any number of power supply nets with source and sink models can be simulated together.

## **PI-AC** Analysis

A PI-AC analysis computes the impedance for the IC current loads over a broad frequency range. It helps you to identify whether the power distribution network (PDN) provides a low impedance path from the Voltage Regulator Module (VRM) to the IC. An excessive impedance in a certain frequency range can generate excessive voltage noise, also called dynamic IR drop, when the IC power supply pins draw large amounts of transient current, required for I/O or core logic switching, at rates that fall into that frequency range.

### Power Plane Resonance Analysis

A power plane resonance (PPR) analysis computes the self-resonant frequencies and corresponding Q-factors of the power distribution network (PDN). It helps you to identify optimal placement of ICs, decoupling capacitors and stitching vias. A power plane resonance can disturb sensitive analog circuitry and generate excessive radiation. This can cause that EMC specifications cannot be met.

## Power-Aware Signal Integrity Analysis

A power-aware signal integrity analysis computes a model characterizing the behavior of signal and power networks. The model can be assessed from within the SIPro window and can be used as input for further analysis in circuit simulation, e. g. channel or transient simulations.

### NOTE

For PI-AC, Power Plane Resonance Analysis and Power-Aware Signal Integrity Analysis, the minimal recommended memory requirement is 4 GB, preferrably higher. There is a fixed overhead cost even for small designs of 1.5-2GB. The memory growth as the simulated designs get larger is close to linear. The memory requirement is not dependend on the requested frequency range.

# **Design Assumptions**

The recommended starting point for using SIPro and PIPro is **a layout with instantiated components**. A flat layout with top level pins can be used, but an analysis setup is much easier when the component instances are available. **Net names** play a key role in the analysis setup. The file import in ADS for following design transfer formats preserves the net names when that information is provided by the third party tool. Verify the file export options in the third part tool to pass as much design information as possible.

Vendor	Tool	Recommended Design Transfer Format		
Altium®				
	Designer	ODB++		
Cadence®				
	Allegro PCB	BRD or ODB++		
	APD	ADFI		
	SiP	ADFI		
	OrCAD	ODB++		

Mentor Graphics®			
	Expedition	ODB++	
	PADS	ODB++	
	BoardStation	ODB++	
Zuken™			
	CR5000	ODB++	
	CR8000	ODB++	
	CADSTAR	ODB++	
Other Formats			
		ABL	

The **substrate** (layer stackup) defines the arrangement and materials of the signal and power plane layers in a multi-layer board or package design. Always verify the substrate definition in case of a design transfer from a third party tool. The third party tool often does not export the full substrate specification. Once you have the layout with components, net names and substrate, you are ready to open the SIPro/PIPro Setup window.

# Example Workspace

An example workspace to get started with SIPro and PIPro is provided with ADS, see examples/HSD

/SIPro\_PIPro\_Getting\_Started\_Example\_wrk.7zads. The workspace contains a Samsung DDR3 UDIMM memory card. The design files are from the JEDEC (www.jedec.com). The design consists of a 6 layer board with single power rail for core and I/O buffers.

# Creating an SIPro and PIPro Setup

To analyze the SI and PI performance, you can create an SIPro/PIPro setup in the following ways:

- Create a new setup
- Open an existing setup

# Creating a New SIPro/PIPro Setup

To create a new SIPro/PIPro setup:

- 1. Open a Layout window in ADS.
- 2. Select **Tools** > **SIPro/PIPro** > **New Setup** from a Layout window to create a new setup. The New SIPro/PIPro Setup window is displayed, as shown in the following figure:
- 3. Specify the **Cellview** name.

🔁 New SIP	ro/PIPro Setup		? <mark>x</mark>
Cellview: Layout:	PC3-10600-UDIMM:PC3-10600-UDIMM:	sipiSetup 1	
Substrate:	Substrate: PC3-10600-UDIMM:PC3-10600-UDIMM		
		ОК	Cancel

- 4. Select the required substrate.
- 5. click OK. A new SIPro/PIPro Setup window is displayed, where you can set up and run an analysis.

💽 PC4-RDIMM_V090_RC_F0_20131106 (PC4-RDIMM_V090_RC_F0_20131106_jib:PC4-RDIMM_V090_RC_F0_20131106:sipiSetup) (SIPro/PIPro Setup)			
Eile Edit View Jools Help 3 C - x1			
Project & ×	Le Layout View	Geometry	
		Simulations     Parameters     Sorpting	
Highlight Nets: 🔐 📕 🖌		FR .	
	-	Idle	

### NOTE

The SIPro/PIPro window cannot be used for ADS layout designs that contain the following features:

- Derived layers
- 3D EMPro components
- Slot layers
- Multi-technology setup

In addition, the SIPro/PIPro setup assumes meaningful and consistent net definitions in the design.

## Opening an Existing SIPro/PIPro Setup

The SI and/or PI analysis setup data for a specific design is stored in a cell view of the "SIPro/PIPro Setup" type The default view name is "sipiSetup". These views are registered with OA and behave like "Schematic" and "Layout" views. You can perform various tasks such as, renaming, copying, moving, and archiving. A single view can contain multiple analysis setups, such as PI-DC and PI-AC analysis setup.

To open an existing setup:

- 1. Open a Layout window in ADS.
- 2. Select **Tools > SIPro/PIPro > Open Setup** from a Layout window to open an existing setup. The Select one view window is displayed, as shown in the following figure:
- 3. Select the required view.



4. Click OK. The SIPro/PIPro Setup window is displayed.

Alternatively, you can open an existing setup by clicking the sipiSetup view in the Main window.



## SIPro/PIPro Setup Window Elements

The SIPro/PIPro Setup window consists of the following elements:

GUI Element	Description
Project Panel	Consists of a panel that provides a tree-structured representation of the design Parts, Definitions, Graphs, and Analyses.
Geometry Window	Comprises the main viewing area. It enables you to perform various viewing operations.
Simulation Window	Allows you to monitor analyses sent the calculation engine.
Parameters Window	Enables you to create, edit, and delete parameters that can be referenced in an analysis setup
Scripting Window	Allows you to view, edit, and execute scripts.
Menus	Provides File, Edit, View, Tools, and Help menus.
Workspace Tabs	Provides Geometry, Simulation, Parameters, and Scripting tabs to control the associated windows

For more information about SIPro/PIPro windows, see Workspace Windows.

# SIPro and PIPro Setup Window Overview

# SIPro/PIPro Setup Window Overview

### Contents

- SIPro and PIPro Project Panel
- Workspace Windows
- Configuring SIPro and PIPro
- Add-on Manager
- Setup Options for Customizing Results

# SIPro and PIPro Project Panel

In the SIPro/PIPro Setup window, the Project panel provides a tree-structured representation of a design. You can use the Project panel to define a specific PI or SI analysis setup, to run the analysis and to review results. The Project panel toolbar enables you to show or hide specific items of a design. The following figure displays a project panel:



A project panel consists of the following components:

- Design
- Definitions
- Analyses
- Scripts
- Graphs

### Design

The **Design** list displays the physical parts of the design-under-test. Currently, this is the layout view from which the SIPro /PIPro Setup was opened, no other parts can be added. The layout tree contains four items: **Nets**, **Components**, **Substrate** and **Pins**.



### Nets

All nets in the layout view are listed. Each net gets a type, 'Power', 'Ground', 'Signal' or 'Undefined' assigned. The nets are sorted by type.

Туре	Icon
Power	<b>F</b>
Ground	r
Signal	Г.
Undefined	ſ

### NOTE

Verify that the nets that you plan to simulate have been typed correctly. Even though SIPro /PIPro attempts to automatically identify the net type, the algorithm can miss nets with arbitrary names.

## Changing Net Type

To change a net type:

- 1. Select the required net.
- 2. Right-click the selected net and select the required type.



### How to Find a Net

To find a specific net:

- 1. Click the **Filter** icon ( $\mathbf{T}$ ) next to **Nets** in the **Parts** tree.
- 2. Type the required net name.
- 3. Click 🔭 to display a list of matching algorithms, as shown in the following figure:



- $^{\circ}~$  Simple: Display tree nodes that contains specified text
- $^\circ~$  Regular Expression: Display tree nodes that contains specified regular expression.
- **Hierarchical**: Display tree nodes that contains specified regular expression per hierarchy level separated by slash.

Regular Expression is very powerful tool but it requires certain knowledge to use. Below is some convenient example for typical use cases.

Example	Match	Note
U(1 2 5 11)	Matches U1, U2, U5 and U11	" " means "OR"
U[5-8]	Matches U5, U6, U7 and U8	"-" can be used for "range"
U1[1-3]	Matches U11, U12 and U13	U[11-13] doesn't work as expected
DQ[1-8]N?	Matches DQ1, DQ1N, DQ2, DQ2N,,DQ8 and DQ8N	"?" can be used as optional string

- 4. Select the string matching algorithm: Simple, Regular Expression, or Hierarchical.
  - NOTE

The Hierarchical option is relevant when tree nodes are hierarchical

## How SIPro/PIPro Identifies the Net Type

SIPro/PIPro attempts to identify the net type by case-insensitive name matching. In case no match is found, the net type is 'Undefinded'. The algorithm uses following rules by default:

Туре	Regular Expression	Examples
Power	pwr power vdd vcc vref vtt bat ^[\+\-]?\d+[p_]\d+v ^[\+\-]?\d+v ^[\+\-]?\d+	AVDD, DVDD, VREF, VTT, VBAT +1p2v, -1p2v, 1p2v, +1_2v, -1_2v, 1_2v +12v -12v 12v +12, -12, 12
Ground	gnd ground grnd vss	AGND, AVSS
Signal Memory Clock Diff pair HS Serial	dq a\d+ ba\d+ clock clk _[pn]\$ [\+\-]\$ sig tx rx	DQ0, DQ1 A01, A02 BA01, BA02 CLK DQS0_P, DQS0_N DQS0+, DQS0- SIG01

This rule can be modified by user. See here for more detail.

### Setting the Net Type Manually

To override the automatic net type, you can select one or more nets, right-click and choose the appropriate net type.

### Components

All component instances in the layout view are listed and grouped per component.

### How to Find a Component Instance

To find a specific component instance:

- 1. Click the Filter icon ( $\mathbf{1}$ ) next to Components in the Parts tree.
- 2. Type the component instance name.
- 3. Click  $\checkmark$  to display a list of matching algorithms, as shown in the following figure:



4. Select the string matching algorithm: Simple, Regular Expression, or Hierarchical.

### Substrate

The Substrate tree item presents the objects in the layer grouped by Conductor layer, Via layer or Dielectric layer.

### How to View the Geometry by Layer

First, switch off the Parts Visibility toggle. This toggle can be found on the Geometry Window's View toolbar. Then, select the appropriate layer in the Substrate tree. The view displays the objects on the selected layer only.

### Pins

All top level pins in the layout are listed.

### Definitions

The *Definitions* branch stores definitions that can be applied to or shared with other objects within the project. You can apply a definition to other objects in the Project panel by clicking and dragging the definition object on the required object.

### **Materials**

To view a material definition object, select a material from the Materials list.



### Scripts

The *Scripts* branch stores user-defined scripts. Right-click **Scripts** to add a new script or import an existing macro or function script to the project.

You can execute or edit the script in the Scripting workspace window.

To add a new scripts:

1. Right-click **Scripts** in the Project panel:



2. Select New Python Script to create a new script or click Import Scripts to use an existing script.

### Analyses

The Analyses branch enables you to run a PI DC analysis, PI AC analysis, PPR analysis, and SI analysis. By default, it provides an empty template for creating an analysis, as shown in the following figure:



Instead of using the default templates, if you want to add a new analysis:

1. Right-click Analyses in the Project panel:



2. Select the required analysis. A new analysis is added at the end of the Analysis branch.

### Viewing and Hiding Project Tree Components

You can view or hide options present in the Project panel by using toggle buttons. The following figure displays these toggle buttons:



The following table describes each toggle button:

Option	Icon	Description
View Parts		Enables you to view or hide <b>Parts</b> in the project panel.
View Definitions		Enables you to view or hide <b>Definitions</b> in the project panel.

Option	lcon	Description
View Scripts	<b>S</b>	Enables you to view or hide <b>Scripts</b> in the project panel.
Toggle All	<b>\$</b>	Enables you to view or hide all the components of the project panel.

## **Customizing View**

To set a specific view for your design in the layout window, you can right-click the required component and select one of the following options:

Option	lcon	Description
Set Visible	۲	Enables you to view the selected component in the Layout window.
Set Invisible	<b>@</b>	Enables you to hide the selected component in the Layout window.
Solid		Enables you to display components in a solid view in the Layout window.
Wireframe	ță I	Enables you to view or hide all the components of the project panel.
Delete		Enables you to delete a component.
Expand	E	Enables you to display all the subparts of a component in the project panel.

# Workspace Windows

The SIPro/PIPro Setup window consists of the following windows:

- Layout
- Simulation
- Parameters
- Scripting
## Layout Window

The Layout window provides a layout view of your design. In this window, you can use various tools for customizing the view of a simulation space. This window comprises the main design viewing area.

The following table describes options available in the	View menu and View Tools toolbar:
--	-----------------------------------

Option	Icon	Description
Toolbars		View Tools
View Manipulation		<ul> <li>Select: The Select tool is used to select objects as well as manipulate the view of the simulation space.</li> <li>Orbit: The Orbit tool is selected to perform rotation of the simulation space through left-clicking-and-dragging.</li> <li>Pan: The Pan tool is selected to perform translation of the simulation space through right-clicking-and-dragging.</li> <li>Zoom: Zoom-in or zoom-out of simulation space by scrolling up or down the mouse wheel, respectively.</li> <li>Zoom to Window: Zoom into a rectangular shaped area of the geometry as specified by the user. To use, select the tool, then left-click and drag the mouse to designate the rectangular zoom</li> </ul>
Zoom to Extents	<b></b>	Enable you to zoom automatically as
Zoom to Selection	<b>S</b>	Enables you to automatically zoom selected object only.
Standard Views		The Standard View button function is to automatically change the perspective of the objects in the workspace window.

Option	Icon	Description
		<ul> <li>Front (-Y)</li> <li>Back (+Y)</li> <li>Top (-Z)</li> <li>Bottom (+Z)</li> <li>Right (-X)</li> <li>Left (+X)</li> </ul>
Isometric Views		The Isometric Views button function is to automatically change the perspective of the objects in the workspace window. • Front/Right/Top • Front/Left/Top • Front/Left/Bottom • Back/Right/Top • Back/Left/Top • Back/Left/Top
Custom Views	>>	Enable you to define any perspective than the Standard Views and Isometric Views, and display at that perspective. • Add View
Cutting Planes		Cutting Planes button feature allows you to define an arbitrary cross- section of the object and display it. • Toggle Cutting Plane • Edit Cutting Plane • Save Cutting Plane
Field Reader	٨	The Field Reader tool measures field values at the location where the mouse hovers over the geometry.

Option	lcon	Description
Export Image		The Export Image tool takes a screen shot of the geometry as it is currently shown in the workspace window, and saves it to a specified location.
Toggle Parts Visibility	<b>%</b>	Toggles the design parts on and off. Clicking the <i>Opacity</i> button located to the right of this button, opens a slider to customize the translucency of its objects. The sliders change the alpha of the design objects, making them more or less translucent as the slider is dragged right or left, respectively.
Toggle Output Visibility	<b>W</b>	Toggles the output results on and off. Clicking the <i>Opacity</i> button located to the right of this button, opens a slider to customize the translucency of its objects. The sliders change the alpha of the design objects, making them more or less translucent as the slider is dragged right or left, respectively.
Toggle Bounding Box Visibility	j.	Ttoggles the visibility of the bounding box of a design when the design is selected.
Toggle Output Viewing Controls	A.	Toggles the visibility of the output viewing controls for sensor results.

### Simulation Window

The Simulations workspace provides an interface to define simulations to send to the calculation engine. Simulations can be easily created, defined, and stored in the Simulations workspace window. Each time a project is modified and saved, you must define a new simulation to register the change. This workspace window stores definitions such as source types, parameter sweeps, S-Parameters, frequencies of interest, scattered/total field interfaces and termination criteria that are specific to a calculation. EMPro supports the following solver EM simulation technologies:

The following table lists the icons present in the Simulations window:

Option	Icon	Description
Simulation		Starts a simulation.
Add To Queue	<b>\$</b> \$	Selects the required simulation from the upper panel of the Simulations window and add to the queue.
Remove From Queue	20	Selects the required simulation from the upper panel of the Simulations window and remove from the queue.
Delete From Queue		Deletes the selected simulation from the disk.
To start the next phase		To interrupt the current phase of the simulation and start the next phase.
Kill the Queue		Kills the currently executed simulation.

The following information is available in the upper pane of the Simulations window:

Option	Description
ld	Displays a project ID, which references the location of the loaded project in the file directory.
Name	Displays the project name specified by a user.
Date Created	Specifies the date when a simulation was created.
Engine	The simulator used for performing simulation.
Status	Displays whether a result is complete or still being calculated while the simulation is running. This status can be refreshed manually by pressing the Update button or automatically by selecting Auto-scroll.

The following tabs are available in the lower pane of the Simulations window:

Option	Description
Summary	Provides a summary of the simulation such as simulation path, status, boundary conditions, ports, feed, and waveforms.
Notes	Displays any notes that you might have added while setting up a simulation.
Log	Displays a log of tasks performed during the simulation.

## Scripting Window

The Scripting workspace allows you to view, edit, and execute scripts.

To create a new python script;

1. Select **Script** > **New Python Script**, as shown in the following figures:



2. Type commands in the scripting window:

🥖 Scripting	
Script Edit Execute View Editor	
🔊 😼 🏍 🛛 💷 📩 🖒 🛴 🖺 🚳	
NewPythonScript0.py *	0
1 "This script demonstrates how	
<pre>2 to use commandline;</pre>	
	4
<b>S</b>	
<pre>(<type 'exceptions.indexerror'="">, IndexError('list assignm of range',), <traceback 0x0000000154ec208="" at="" object="">)</traceback></type></pre>	ent index out

## **Scripting Options**

The following table describes options available in the Scripting window toolbar:

Option	Description
Script	<ul> <li>New Python Script</li> <li>Commit</li> <li>Revert</li> <li>Clear Output</li> </ul>
Edit	Enables you to copy, cut, or select text in a script.
Execute	<ul><li>Execute Script</li><li>Cancel Execution</li></ul>
View	<ul><li>Script Tools</li><li>Editing Tools</li><li>Execution Tools</li></ul>
Editor	<ul> <li>View</li> <li>Indentation</li> <li>ConvertEOL</li> <li>PsychicPy</li> </ul>

## Parameter Window

The *Parameters* window enables you to create, edit, and delete parameters that are referenced. By default, three parameters are provided **minFreq**, **maxFreq**, and **timestep**.

ល Parameters			
+ 11			
Name	Formula	Value	Description
ඟ minFreq	100 kHz	100000 Hz	Minimum frequency of interest for
ඟ maxFreq	1 GHz	100000000 Hz	Maximum frequency of interest for
Timestep	5.66752e-11	5.66751634761	Simulation timestep in seconds
Revert			Apply ?

To modify the frequency range of the default minimum and maximum frequency parameters:

- 1. Click Parameters. The Parameters window is displayed.
- 2. Double-click the **minFreq** or **maxFreq** value in the **Formula** field.
- 3. Specify the required value.
- 4. Click Apply.

## **Parameter Options**

The following table describes the Parameters options:

Name	Description
Name	Enables you to define a parameter, which can be referenced later.
Formula	Allows you to provide a mathematical formula or a simple numeric value that will define the value of a given parameter. This formula can reference other parameters that have already been defined.
Value	This column is a read-only column that displays the evaluated value of the parameter. If an invalid formula is entered, an error message will appear within this field with a description of the invalidity. Simply hold the mouse over the error message to view this description. Similarly, a parameter is deleted by selecting the unwanted parameter and clicking the button above the table. If a parameter is deleted that is referenced within another parameter's definition, an error message will appear since the parameter that is referenced is no longer defined.
Description	Allows you to describe a parameter.

## Configuring SIPro and PIPro

Before setting up an SIPro/PIPro project, you can configure the project settings by using the Options window. This window consists of various tabs such as General, Interface, Modeling, and Nets. Using these tabs, you can specify the global settings for your project.

Select Tools> Options to open the Options window. In this window, you can use the following tabs:

- General
- Interface
- Modeling

• Nets

#### General

The General tab enables you to set the following options:

- Templates: Enables you to specify the default folder location for storing SIPro/PIPro project templates.
- Rendering Options: Allows you to control several display options in the SIPro/PIPro GUI:
- **Graphics Drivers**: Specifies the display driver to be used for rendering graphics in SIPro/PIPro. The list of available drivers depends on the operating system, graphics card, and on the usage of remote desktop. Using an unsupported display driver may result in a blank Geometry Window. Any change to this setting will take effect until you restart SIPro/PIPro. The display driver can also be changed using the --driver command line option when starting SIPro/PIPro. Available graphics drivers are: OpenGL, OpenGL 2, DirectX 9, X11, MSW.
- **Transparency Algorithm**: Determines the way SIPro/PIPro renders the parts opacity of an object. You can select the values:
  - Z-sort Only Fast: This is the most efficient rendering option, but may contain artifacts (small areas of inaccurate rendering).
  - Z-sort Only Nice: This is a more accurate rendering option than Z-sort Only Fast, but runs slower. It will have less artifacts.
  - **Depth Peeling**: This option is more accurate than both Z-Sort algorithms. It's performance is dependent on the graphics card, and may be significantly slower if the card does not support it.
  - **Painters Algorithm**: This is the most accurate rendering option, but runs the slowest. On modern graphics cards, this option works very well.

NOTE

**Transparency Algorithm**: This setting affects only the way an object is displayed in the SIPro/PIPro interface, and does not affect calculation results.

#### SIPro and PIPro

SIPro/PIPro Setup - Options				<b></b> >
General Interface Modeling Net	S			
Templates		Rendering Options		
User Template Folder:	Default	Graphics Dri	ver: OpenGL	-
al\Documents\Keysight\EMPro\templates	Browse	Transparency Algorit	hm: Depth Peeling F	Fast 🔻
		Text Co	olor:	
		ОК	Cancel App	oly 🔤 🧣

#### Interface Tab

The Interface tab enables you to set the following options:

- **Object Editing**: Controls the editing of objects, when a new object is added to the project tree by right-clicking the project tree. You can select one of the following values from the New Item Action drop-down list:
  - $^{\circ}~$  None: Adds a new object to the project tree.
  - Edit Name: Adds an object to the tree and provides a blinking cursor to add the object name in the project tree.
  - Edit Properties: Adds an object and displays the appropriate window to edit the new object properties. The Material Editor dialog box is displayed to specify settings.
- Layout: Enables you to set preferences for saving or restoring the GUI layout.
- Information: Enables you to to set their preference for decimal precision in tooltips.
- **Gridding**: Enables or disables the use of the simplified grid.
- Project Tree: The Icon/Text Size scroll adjusts the size of the items in the project tree.
- Workspace:
  - Show All Tabs shows all workspace windows in tabbed workspace regardless of whether they are active or not.
  - $^\circ~$  Show Only Active Tabs stores only the active tabs that are stored in the project workspace.
  - $^{\circ}~$  Don't Show Tabs removes the tabbed workspace. Windows can still be accessed from the View menu.

• Appearance: The Appearance pane allows you to change the appearance of the SIPro/PIPro GUI and buttons within.

General     Interface     Modeling     Nets       Object Editing     New Item Action:     Edit Name         Image: Comparison of the second sec	Project Tree Icon/Text Size Workspace Show All Tabs Show Only Active Tabs Don't Show Tabs Appearance Application Style: System Default Button Layout: Default
<ul> <li>Show Full Precision of Value for Expressions' Tooltips</li> <li>Show Full Precision of Dimensions of Bounding Boxes</li> <li>Gridding</li> <li>Use Simplified Grid Specification When Possible</li> </ul>	layout take effect the next time SIPro/PIPro Setup is started.

## Modeling Tab

The Modeling tab provides several options for adjusting the color and appearance of faces, edges, vertices, components, and the background. You can set the default colors used to display faces, edges, and/or vertices for parts when they are first created. You can also set the color of the components (like voltage sources) and Geometry window background color.

- Components: Specifies the color used to render circuit components.
- Background: Specifies the background color of the View.
- Construction Grid: Specifies the color for the lines of the construction grid of the Sketcher and Orientation tools.
- Mesh Slice: The color for mesh edges that are Free Space.
- Invert Mouse Wheel: Switches the zoom direction when rolling the mouse wheel.
- Separate View Tools: Toggles between showing all View tools in a drop-down list or as individual items.
- Smooth View Transitions: Specifies SIPro/PIPro to perform smooth rotations between different view orientations. If you do not select this option, SIPro/PIPro snaps to the selected view orientation.

SIPro/PIPro Setup - Options	×
General Interface Modeling Nets	
View Options	
Components:	
Background:	
Construction Grid:	
Mesh Slice (Free Space):	
Render Sky:	
Invert Mouse Wheel	
Separate View Tools	
Smooth View Transitions	
OK Cancel Apply	2

#### Nets

Using the Nets tab, you can specify the net type recognition rules for ground, power, and signal by using Regular Expression options.

SIPro/PIPro Setup -	Options	23
General Interface	Modeling Nets	
-Net Type Recognition	Rule	
Net Type Rule can be	specified by Regular Expression	
Ground		
.*gnd.* .*ground.* .*	grnd* *vss.*	
Case Sensitive	Reset	)
Power		
wr.* .*pow.* .*vdd.*	*vcc.* *vref.* *bat.* *vtt.* *¥d+[pP¥]¥d+[vV].* [pPmM¥+¥-]?¥d+[p_]?(¥d+)?[vV]? *¥d+[vV].*	1
Case Sensitive	Reset	)
Signal		
.*sig.* .*tx.* .*rx.* .*	dq* *[bB]?[aA][(¥d+)(<¥d+>)]* *clock.* *clk.* *_[nN]\$ *_[pP]\$	
Case Sensitive	Reset	)
Specify Net Name to	test Test	
-Differential Pair Reco	gnition Rule	
Plus Net Name	Minus Net Name Add	
[pP](¥d+)?\$	[nNmM](¥d+)?\$	
	#\$ Remove	
Case Sensitive	Reset	
Specify Net Name to	Test1 Specify Net Name to Test2 Test	
	OK Cancel Apply	2

Also, you can specify differential pair recognition by using pairs of Regular Expression for plus net and minus net. Differential Pair recognition is currently used only for mixed mode of S-parameter plots and TDT/TDR plot window.

Specify regular expression for Plus Net and Minus Net respectively. If given any of two Net names are matched with given regular expressions and rest string that are matched pieces are stripped off are the same, they are recognized as differential pair.

For example, regular expression P\$ for Plus and N\$ detect Sig1P and Sig1N as differential pair.

Either one of Plus or Minus can be empty. This can be used to recognize a case such as pair name is like AAA and AAA#. ( empty regular expression for Plus Net and #\$ for Minus Net).

## Add-on Manager

You can extend the SIPro/PIPro user interface with additional functions, which are customized for your design needs. These tools are python scripts that you can customize for your workflow. You can access the following add-on tools:

- Component Models Add-on: Enables you to Export their Components and ComponetModels to a file and also allows to Import them.
- Introspection Add-on: Enables you to generate the recipie of the setup and the elements of the setup like Sinks, Vrms, Component Models and Results.
- Layers Display Setting: Enables you to change the Display Settings of the Conductive layers and the via layers in the Active Project.
- ScaleViewZ Add-on: Enables you to add a toolbar to the main window to scale the view in the Z direction.

### Add-on Manager

The Add-on Manager allows you to enable or disable add-ons, inspect their status and possible load errors, and modify the search path. It can be accessed from **Tools** > **Add-on Manager**.

The Add-on Manager displays a separate panel with the following elements:

- A check box with the file name of the add-on: Select the check box to enable a add-on. Hovering over the file name will show the full path of the add-on.
- The load status on the left of the check box: A green icon is shown when an add-on is successfully loaded, a yellow exclamation mark when it failed to load. Hover over the icon to see the full error message. No icon will be shown for a disabled add-on that is not loaded.
- If available, a short description of the add-on: Click in the Add-on Manager to display more information about an add-on.
- If available, two labels with the author and version information of the add-on.

📭 Keysight SIPro/PIPro - Add-on Manager	X
🗴 🗵 ComponentModels.py	
Component Models Add-on.	
Author: Keysight Technologies, Inc.	
Version: 1.0	
CreateScript.pv	
Introspection Add-on.	=
Author: Keysight Technologies, Inc.	_
Version: 1.0	
🗴 🔽 LayersDisplay.py	
Layers Display Settings	
Author: Keysight Technologies, Inc.	
Version: 1.0	
🗴 🗹 ScaleViewZ.py	
Add a toolbar to the main window to scale the view in the Z	-
Additional add-ons can be downloaded from the <u>Knowledge Center</u> and so on the search path:	aved
C:\Users\psinghal\Documents\Keysight\EMPro\addons	
OK Car	icel

### Add-on Search Path

You can download additional add-ons, which are saved on the following search path:

• Additional search path: A user specified location where downloaded or custom add-ons can be saved. This path can be modified in the Add-on manager and multiple locations can be specified using the platform specific path separator (colon on Linux, semicolon on Windows). By default, a location in the user home directory is set. Add-ons discovered on the additional search path are disabled by default, and must explicitly be enabled in the Add-on manager.

If multiple add-ons with the same filename are found, only the first one on the path will be loaded. This way, a default add-on can be overridden by a custom version placed in the additional search path.

## Installing Additional Add-ons

You can download more add-ons and updates from the add-on download page. To install an add-on, perform the following steps:

- 1. Save the downloaded Python script to one of the locations configured in the additional search path.
- 2. Open the Add-on Manager.
- 3. Find the new add-on and select its check box to enable it.

If the downloaded add-on is an update of the existing add-on, save the the update on the additional search path. Restart ADS and the updated version should be found and loaded instead of the original.

Once an add-on is added, it cannot be unloaded until the program is exited. While managing add-ons during a session, consider the following factors:

- When a loaded add-on is disabled, the status icon will still be shown in the Add-on Manager. Only the next time that ADS is started, the add-on will no longer be loaded.
- When an add-on fails to load because of a Python exception or other error, it will remain in this state even if the error is fixed. Restart ADS to load the add-on.
- When add-ons with the same file name are found on the search path, only the first to be found is loaded. However, if the first add-on was added only to the path while ADS is already running, it does not overrule an addon by the same name that is already loaded, even if the latter one is found further on the search path.

## Setup Options for Customizing Results

While viewing the results of an analysis, you can specify the setup options displayed in the following figure:

Setup			📝 Auto-Apply	🔏 🛛	Apply Revert
	Range	📝 Automatic	Size Factor:	1.00	膏 📝 Scale Vectors
Min	0 A/mm**2	Default			
Max	100.618 A/mm**2	Default			
Layer	Show All 🗸	]			
Net Type	Power 🔻	]			

### Range

The following table describes the Range options:

Range	Description
Min	Minimum value of the scale bar
Max	Maximum value of the scale bar
Layer	Layer name to show the values
Net Type	Net type to show the values (Not available in some type of filed plots)
Automatic	Automatically set the Min/Max values. Turn this option off if you want to specify your preferred Min/Max.

For complex/multi-layered board, it might be difficult to display the Field plots for all layers. In such a scenario, using Layer Display Settings add-on to limit the displaying layers as well as Layer selector and/or Net Type selector in the Field plot setup provides a better view.

Select the following options for a better view:

• From the Layer drop-down list, select Show All, from the Net Type drop-down list, select Power, and in the Layer Display Settings panel, select All Layers Visible,

lig L	yout	
Vie		
	[VDD_GND_DC]: Voltage (V)	<b></b> -
	1.19 1.191 1.192 1.194 1.195 1.196 1.197 1.198 1.199	ټر 🗸
		<b>S</b>
		- 1
		<b>*</b>
	[2] 学业的业器业器业器、工作业器、制造物理器、制造物理器、制造、	-10 ×
		× 1
		Aa 0
	Contraction and the second s Second second s Second second sec	
		<u>4</u> ) %
	Se eine die bei nache na man die na ma gie eine se in die eine gie na man die gemeen die het het die die het di	
Х.		
	14 150 14 november 20. december	
	GND_DC}-Voltage	
Set	p 📝 Auto-Apply 🛕 Apply R	evert
	Range V Automatic	
	Min 0 V Default	
	Max 119876 V Default	
Net	Type Power	
Lav	er Display Settings 🗗 🗙	
,		
Γ		
	All Layers 🕢 🕢 🗐 🗂	
	ETCH SPLIT3 (1002)	
	ETCH_SPLIT4 (1003) 🕢 🕋 🛅 🔲	
	ETCH S5 (1004)	
	ETCH_VDD6 (1005) 💿 🔯	
	ETCH_S7 (1006) 🕢 🔯	

Layout										
View										
	[VDD_	GND_DC]: Volt	ige (V)							
	1.19	1.191 1	192 1.194	1.195	1.196	1.197	1.198	1.199		<u> </u>
										-
										E.
										<b>_</b>
										🌍 👻
										× 🔅
0 <sup>99</sup> 11									••••	₩.
	dening	-						Sec. 1		Aa
									1.2.2	ß
						88 - A - A		- 18 A		40 %
										<b>1</b>
										-4
7										
x										
T										
[VDD_GND_DC]: Voltage			Hide Others	Unload						
Setup								<table-cell> Auto-App</table-cell>	ily 🔏 🛛 Apply 🗍 Re	vert
Range	AL	tomatic								
Min U V		mault								
Max 1.19870 V		stault								
Net Type Power	•									
	J	1								
Layer Display Se	ettings			- B ×	2					
All Lavers	ſ	a) 👩	) 🥅 (	<b>a</b>						
Thir Edyoro	U									
ETCU SDUT	F9 (1009)			a 🔺						
EICH_SPLI	13 (1002)		坐 [	2						
	(			20						
EICH_SPLI	14 (1003)	I	🥝 (I	¥						
ETCH_S5 (1	004)		<b>1</b>	<b>F</b>						
ETCH_VDD6	6 (1005)		<b>1</b>	1						
				_						
ETCH_S7 (1	006)		<b>1</b>	3						
				_						

• Layer: ETCH\_SPLIT3, Layer Display Settings: ETCH\_SPLIT3, Net Type: Power

### Size Factor

Specify the size factor of the arrows in the window. (Below left is Size Factor = 1, Below right is Size Factor = 2)



**Excitation:** Specify a excitation source from either VRMs or Sinks you defined in the setup.(Not available in some type of filed plots)

Frequency: Specify a frequency to display values.(Not available in some type of filed plots)

## Hiding and Unloading Results

While viewing results in the Layout window, you can hide and unload other results.

- To hide other results, click the **Hide Others** button.
- To unload other results, click the **Unload** button.

#### See Also

- Viewing PI-DC Analysis Results
- Viewing PI-AC Analysis Results
- Viewing PI-PPR Analysis Results
- Viewing Power Aware SI Analysis Results

# **Using Component Models**

## Using Component Models

#### Contents

- Creating and Editing Component Models for Analysis
- Using Vendor Parts DB Browser

# Creating and Editing Component Models for Analysis

For an SIPro/PIPro analysis, you need to calculate the impact of decoupling capacitors. Identify the component models and define electrical models for the selected components by defining component models.

In this section, you will learn how to create component models and then add a lumped, SnP, or model DB for analysis.

## Creating Component Models for Analysis

To create a component model for analysis:

- 1. Select a component group in the Components list.
- Right-click the selected component group and select Create Component Model for Analysis. The SIPro/PIPro Setup window is displayed.



3. Select the target analysis where you want to create the component model:

SIPro/PIPro Setup
Select a target analysis
[PI-DC] Analysis 1
[PI-AC] Analysis 2
[PA-SI] Analysis 4
OK Cancel

#### 4. Click OK.



You can also drag and drop the selected components on **Component Models** in the SIPro/PIPro Setup. The instances will be grouped by component name.

### Editing a Component Model for Analysis

After creating a component model in the SIPro/PIPro Setup panel, you can define the electrical model parameters. The following types of models can be added:

- Lumped
- SnP
- Model DB
- Multiple Model DBs

### Adding a Lumped Model

To define a lumped component model:

- 1. Double-click the component group in the SIPro/PIPro Setup panel. The **Component Model Editor** is displayed.
- 2. Select Lumped from the Add drop-down list.
- 3. Specify the Resistance, Inductance, and Capacitance value.
- 4. Select an **RLC arrangement** option.

	lype	
model	Lumped	
Add	▼ Remove	Set Default
lodel		
Resistance	≌ 0 Ohm	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Inductorio	# 0H	
Inductance		
Capacitance	* 0F	
Capacitance	© All Series	
Capacitance	<ul> <li>O F</li> <li>O All Series</li> <li>C All Parallel</li> </ul>	

- 5. Click Apply.
- 6. Click Done.

### Adding an SnP Model

You can add an SnP model for multi-port components, such as 4-pack resistors and 7-pack resistors. To define an SnP component model:

- 1. Double-click the component group in the SIPro/PIPro Setup panel. The **Component Model Editor** is displayed.
- 2. Select **SnP** from the **Add** drop-down list.
- 3. Specify the S parameter file in the File Name text box. You can also click to browse to the required file.

Name	Туре		
model	Lumped		
A	dd 🔹	Remove	Set Default
odel			
Resist	ance: 0 Ohm		•
Induct	ance: 0 H		
Capacit	ance: 1 uF		$\perp$
	All Series		Т
RLC Arrange	ment: 🔘 All Parallel		
	🔘 RL    C		••

- 4. Click Apply.
- 5. Click Done.

## Selecting an Existing Model DB

To use an existing model:

- 1. Double-click the component group in the SIPro/PIPro Setup panel. The **Component Model Editor** is displayed.
- 2. Select Model DB from the Add drop-down list.
- 3. Click in the **Model** section.
- 4. The Model DB window is displayed.
- 5. Select the required model.

Id	Vendor	Family	Part Number	Part	Series	Part Type
Filter	Filter	Filter	Filter	Filter		Filter
1	Murata	200V and over/ under Japanese Law	GA242QR7E2471MW01	GA242		С
2	Murata	200V and over/ under Japanese Law	GA242QR7E2102MW01	GA242		с
<u>-</u>	 III					-
← 🛃	v 🖓 🖗		Part Details			
	Ir	mpedance	Vendor		Murata	
			Family		ind over/i	under Japanese Law
1e+0	04		Part Number		GA242QF	7E2102MW01
			Part Type		GA242	
			Topology		Series	
(mh			R		199.132	Ohm
ce (o			L		919.687	рН
edan			c		1 nF	
≞ 1e+0	3		Tolerance		20 %	
			Dimension			
			Temperature Charao	teristic	X7R	
			COST Rated Voltage		250 V	
			Start of Frequency R	ange	100 kHz	
	0.01 Ere	100 1e+05	End of Frequency Ra	nge	3 GHz	

- 6. Click **OK**. All the fields are filled with the details of the selected model.
- 7. Click Apply.
- 8. Click Done.

## Selecting Multiple Model DBs

To use an existing model:

- 1. Double-click the component group in the SIPro/PIPro Setup panel. The Component Model Editor is displayed.
- 2. Select Multiple Model DB from the Add drop-down list.
- 3. Click in the **Model** section.
- 4. The Model DB window is displayed.
- 5. Select the required models.
- 6. Click **OK**. All the fields are filled with the details of the selected model.

Name	Type		
model	Model DB		
model 2	Model DB		
model 3	Model DB		
model_4	Model DB		
لملم		Demovo	Cat Dafault
Add		Remove	Set Default
GA243QR7E2332 Part Details	MW01		
GA243QR7E2332 Part Details Vendor	MW01	Murata	
GA243QR7E2332I Part Details Vendor Family	MW01	Murata Ind over/ under Japanese Law	
GA243QR7E23321 Part Details Vendor Family Part Number	MW01	Murata ind over/ under Japanese Law GA243QR7E2332MW01	
GA243QR7E23321 Part Details Vendor Family Part Number Part Series	MW01	Murata ind over/under Japanese Law GA243QR7E2332MW01 GA243	
GA243QR7E23321 Part Details Vendor Family Part Number Part Series Part Type	MW01	Murata ind over/ under Japanese Law GA243QR7E2332MW01 GA243 C	
GA243QR7E23321 Part Details Vendor Family Part Number Part Series Part Type Topology	MW01	Murata nd over/ under Japanese Law GA243QR7E2332MW01 GA243 C Series	
GA243QR7E23321 Part Details Vendor Family Part Number Part Series Part Type Topology R	MW01	Murata Ind over/ under Japanese Law GA243QR7E2332MW01 GA243 C Series 18.0515 Ohm	

- 7. Click Apply.
- 8. Click Done.

### Specifying a Default Model

If you have added multiple models, you can select a default model that will be considered during an analysis. After you have completed a simulation, you can change the default model and view results immediately. You do not need to resimulate your design.

To specify a default model:

- 1. Double-click the component group in the SIPro/PIPro Setup panel. The **Component Model Editor** is displayed.
- 2. Select a model in the Model List section.
- 3. Click **Set Default**. For example, in the following figure, **model\_4** is selected:

model 2	lumped		
model_2	SnP		
model_4	Model DB		 
model	Lumpea		
			6 10 C II
Add		Remove	Set Default
odel			
Resistan	ce: 0 Ohm		0
Inductan	<b>ce:</b> 0 H		
Canacitan	ce: 0 F		
Capacitai			
Сараснан	All Series		
RLC Arrangeme	<ul> <li>All Series</li> <li>All Parallel</li> <li>All Parallel</li> </ul>		
RLC Arrangeme	<ul> <li>All Series</li> <li>nt: All Parallel</li> <li>RL    C</li> </ul>		
RLC Arrangeme	<ul> <li>All Series</li> <li>ant: All Parallel</li> <li>RL    C</li> </ul>		
RLC Arrangeme	<ul> <li>All Series</li> <li>nt: C All Parallel</li> <li>RL    C</li> </ul>		

- 4. Click Apply.
- 5. Click Done.

### Specifying a Model with more than 2 pins

If you have a component that has more than 2 pins, you can specify port numbers for each pins to define how the model is connected when simulated.

If number of pins of component is more than 2 Ports pane appears in the left of the dialog.

To specify ports and models

- Modify Port Number column so each pin connection matches the actual model's port numbers. "0" means common reference ground. In below example, 3 ports are defined where P1(+) and P4(-) as Port1, P2(+) and P4(-) as Port2, P3(+) and P4(-) as Port3. You can make Port Number column blank if you don't want to connect model to that pin.
- 2. Specify model(s) that matches the number of ports you defined in Ports pane.

Arrayed Component  Ports  Pin Port Number  Pin Pin Port Number Pin Pin Port Number Pin Pin Port Number Pin Pin Port Number Pin Pin Port Number Pin Port Number Pin Pin Port Number Port Number Pin Port Number Pin Port Number Pin Port Number Port Number Pin Port Number Port Number Port Number Port Number Pin Port Number Port Number Pin Port Number	
Arrayed Component  Ports  Pin Port Number  O+ P1 1 O+ P2 2 O+ P3 3 O+ P4 0  Model  Add Remove Model	
Arrayed Component  Ports  Pin Port Number  PI PI PI PI Add Remove Model	
Ports   Pin Port Number <ul> <li>P1</li> <li>P2</li> <li>P3</li> <li>P4</li> </ul> <ul> <li>Add&lt; <ul> <li>Remove</li> </ul>    Model List   Model List   Model SnP</li></ul>	
Pin     Port Number            •• P1         1         •• P2         2         •• P3         3         •• P4         0             •• P4         0             •• P4         0	
Pin         Port Number           • P1         1           • P2         2           • P3         3           • P4         0             Add<         Remove   Model	
○• P1       1         ○• P2       2         ○• P3       3         ○• P4       0	
O P2 2 O P3 3 O P4 0 Add ▼ Remove Model	
O P3 3 O P4 0 Add ▼ Remove Model	
O P4 0 Add ▼ Remove Model	
Add  Remove Model	
Add  Remove Model	
Add Remove	
Model	Set Default
Model	
File Name:	
Revert Done Ca	

## Specifying a Arrayed Component

If you have an arrayed component contains multiple 2-pin components, you can define it by using "Arrayed Component" checkbox.

To specify a Arrayed Component

- 1. Check **Arrayed Component** checkbox. Note that the checkbox only appears when the component has more than 2 pins.
- 2. Specify Port Numbers for each pins. Use "-" sign to make pin connects to minus terminal of the port. In below example, P1 connects to plus terminal of port1 and P5 connects to minus terminal of the port1.
- 3. Specify 2-pin model(s). The same model will be applied to each ports.

orts		Model List		
<b>*</b>		Name Ty	pe	
Pin	Port Number	model Lu	mped	
()• P1	1			
O+ P2	2			
O• P3	3			
O• P4	4			
○• P5	-1			
○• P6	-2			
O• P7	-3		Demen	
○• P8	-4	Maa 🔹	Remove	Set Default
		Resistance: Inductance: Capacitance:	0 Ohm 0 H 0 F All Series	°
		RIC Arrangement	All Parallel	

## Using Vendor Parts DB Browser

### Using Vendor Parts DB Browser

SIPro/PIPro provides a database of vendor part electrical models. It provides a complete set of MuRata, Samsung, and TDK components. You can select an electrical model for the required capacitor in the Vendor Parts DB Browser window.

To display the Vendor Parts DB Browser:

- 1. Select Tools > Vendor Parts DB. The Vendor Parts DB Browser window is displayed.
- 2. Select the required electrical model. You can also use the **Filter** text field to search the required model. Type a value in the required column. You can use multiple filter values. For example, the following figure displays results of the **2.2uF** capacitors search.

🛞 Clear Filters			Add Component	from ADS Add C	Custom Component	Remove Custo	m Compon
Part Series	Part Type	Model Type	R Datasheet	L Datasheet	C Datasheet	Topology	R M
Filter	Filter	Filter	Filter	Filter	2.2 uF	Filter	Fil
GCM18		Lumped			2.2 uF	Series	8.07662
GCM18	С	Lumped			2.2 uF	Series	8.07662
GCM21	с	Lumped			2.2 uF	Series	5.84739
GCM21	С	Lumped			2.2 uF	Series	5.84739
GCM21	с	Lumped			2.2 uF	Series	5.84739
100			Family Part Numb Part Series Part Type	er ;	Automotive GCM188R70J225KE2 GCM18 C	2	
			R Datashee L Datashee C Datashee	e et et	2.2 uF		
	$\backslash$		R Model		8.07662 mOhm		
0.01	V		L Model		553.175 pH		_
0.01 100 1e+05			C Model		1 38286 DE		

In the Vendor Parts DB Browser window, you can also view the impedance of various capacitors. You can select multiple capacitors in the window and compare the impedance value, as shown in the following figure:



The properties that are the same for all selected components appear grayed out in the Part Details panel.

### Adding Components to the Vendor Parts DB

SIPro/PIPro allows you to extend the existing vendor parts database. The following types of models are supported:

- Component from ADS
- Lumped
- SnP

#### Adding Custom Component

#### Adding a Lumped Model

To add a custom lumped model type to the Vendor Parts DB:

- 1. Click the Add Custom Component button in the *Vendor Components Browser* window to open the Component Model Creator dialog box.
- 2. Select the Lumped model type from the Select Model Type drop-down list.
- 3. Specify the Lumped Model properties:

Sen Component Mod	lel Creator					
👌 Part Numbe	r: Custom Capa	citor 0001		Select Model Type:	Lumped 🔻	
Vendor / Family / Part Series						
Vendor: P	PC3-10600-UDIMM-V0_50_RC_Fx_20070530_lib_0					
Family: P	C3-10600-UDIMM	1-V0_50_RC_Fx_20	070530_	adfi		
Part Series: K	EY23					
RLC Arrangement	t	Model Values				
All Series		Resistance:	0.46 oh	ım		
O All Parallel		Inductance:	9.43e-1	10 H		
🔘 RL    C	© RL    C Capacitan			: 4.32e-10 F		
$-\infty$	$\sim\sim$					
÷		Resistance:	50 ohm			
T		Inductance:	0 H			
Lm	$n_{-}$	Capacitance:	0 F			
	Ū					
Revert			Don	ne Cancel	Apply	

- 4. Click Apply.
- 5. Click Done.

#### Adding an SnP Model

To add a custom SnP model type to the Vendor Parts DB:

- 1. Click the "Add Custom Component..." button in the *Vendor Components Browser* window to open the Component Model Creator dialog.
- 2. Select the SnP model type from the Select Model Type drop-down list.

3. Specify the S parameter file in the File Name text box. You can also click to browse to the required file. The pin-port configuration is automatically generated from the S parameter file.

🎭 Component Mo	del Ci	reator				- • ×	
🔏 Part Numbe	er: (	Custom Capacitor 0001		Select	Model Typ	e: SNP 🔻	
-Vendor / Family /	Vendor / Family / Part Series						
Vendor:	PC3-1	2C3-10600-UDIMM-V0_50_RC_Fx_20070530_lib_0					
Family:	PC3-1	0600-UDIMM-V0_50_RC_Fx	_20070530_a	adfi			
Part Series:	KEY23	3					
Pin-Port Configu	ration						
Number of Po	rts:	1	Number of	f Pins:	2		
Pin-Port Mapp	oing:	{"P1":"1","Pref":"0"}					
File Name:		C:/Users/samdauwe/vendo	rpartsdb/KE	(23.snp			
Revert			Don	e	Cancel	Apply	

- 4. Click Apply.
- 5. Click Done.

# **PIPro Analysis**

## **PIPro Analysis**

#### Contents

- Tutorial-Performing a PI-DC and PI-AC Analysis
- PIPro Analysis Setup Overview
- PI-DC Static IR Drop Analysis
- PI-AC Dynamic IR Drop Analysis
- PI-PPR Analysis

## Tutorial-Performing a PI-DC and PI-AC Analysis

In this tutorial, you will learn how to create a PI-DC and PI-AC analysis setup, run the analysis, and view results. The example workspace contains a Samsung DDR4 UDIMM memory card. The design files are downloaded from JEDEC (www. jedec.com) and used for demonstration purposes. The example design consists of a 6 layer board with a single power rail for core and I/O buffers, as shown in the following figure:

	an 👾
	🏭 📍
「半年人」ともの時代によった。	1 🗱
	🚎 📞
	20
	HO

You can view the nets, components instances, and individual nets in the navigator window. The main power net passes from the conductor at the bottom of the design to the devices at the top. GND nets are present on the design. The substrate pack consists of routing on the top and bottom layer. The power and GND nets are on layer 3 and 4. Before performing the PIPro analysis, you need to know the names of the power and GND nets.

In this example design, the VRM is connector J1, which is the source of power supply. It is the connector device at the bottom of DDR4 board. There are eight sinks, which are the ICs distributed over the board. The power supply is consumed by sinks. You will analyze the impact of decoupling capacitors.

You can access the example workspace from the following location:

examples/HSD/SIPro\_PIPro\_Getting\_Started\_Example\_wrk.7zadsfcv

In this tutorial, you will perform the following tasks:

- Perform a PI-DC analysis
- Perform a PI-AC analysis

## Performing a PI-DC Analysis

You can analyze the voltage drop in the VDD-GND power distribution network. The supply power comes in through connector 'J1', the ICs that consume current are the 'DDR4...' component instances. There are no series components.

To perform an analysis, open the SIPro/PIPro Setup window:

- 1. Open a Layout window in ADS.
- 2. Select **Tools** > **SIPro/PIPro** > **Open Setup** from a Layout window to create a new or open an existing setup. The SIPro/PIPro Setup window is displayed.

### Creating a PI-DC Analysis Setup

To create a PIPro Static IR Drop (PI-DC) analysis, use the default empty template available in the project panel. Expand **DC Analysis 1** in the SIPro/PIPro panel, as shown in the following figure:



To create a setup, you need to define the following:

- VRM
- Sink
- Options

## Defining a VRM

To setup a VRM:

- 1. Select the J1 connector component instance in the **Components** list, as shown in the following figure:
- 2. Drag and drop the selected instance on the VRMs part in the SIPro/PIPro Setup panel. The Select Net for J1 window is displayed.

Select Net for	л 🗆 🗖 🗙		
Pins are connected to multiple Power nets. Please select a net to connect.			
Net Name	Pin Names		
VDD	J1.197 J1.194 J1.191 J1.189 J1.186 J1.183 J1.182		
VDDSPD	J1.236		
VREFCA	J1.67		
VREFDQ	J1.1		
	OK Cancel		

- 3. Select VDD.
- 4. Click **OK**. A new VRM definition is added in the SIPro/PIPro Setup panel.
- 5. Double click the VRM definition to open the VRM Editor dialog box.

Sp VRM Editor		
		R L
DC Voltage:	1.5 V	
Voltage Tolerance:	0 %	+
Resistance:	0 Ohm	Ξ v dc
Inductance:	0 mH	$-\top$
Revert		Done Cancel Apply

6. Specify the DC Voltage, Voltage Tolerance, Resistance and Inductance.

## Defining a Sink

Sinks are devices that consume current. To define a sink:

1. Select u\_ddr4\_x4\_fbga78-10x13 at component level in the Components list, as shown in the following figure:

- u\_ddr4\_x4\_fbga78-10x13\_\_
  - > 🏳 U1
  - ⊳ 🏳 U2
  - ▷ 1 U3
  - ▷ 🕞 U4
  - ▷ 🔁 U5
  - ⊳ 🕞 U6
  - > 🔁 U7
  - > 🖒 U8
  - > 🖒 U9
  - > 🔁 U11
  - ▷ 🖒 U12
- Drag and drop the component on Sinks. Since the component connects to multiple power nets, the Select Net for U7 dialog box is displayed.

Net Name	Pin Names
VDD	U7.R9 U7.R1 U7.N9 U7.N1 U7.K8 U7.K2 U7.H9 U7.H2 U7
VREFCA	U7.M8
VREFDQ	U7.H1

- 3. Select **VDD** as the power net you want to analyze.
- 4. Select the Use same selection for All Sinks/VRMs option.
- 5. Click **OK**. A Sinks definition is added having a list of 8 sinks, as shown in the following figure:

#### Analyses

- VDD\_GND\_DC
  - + VRMs
    - ▷ 🛨 VDD\_J1
  - ф. Sinks
    - 🗄 VDD\_U1  $\triangleright$  $\triangleright$
    - VDD\_U2
    - VDD\_U3  $\triangleright$
    - VDD\_U4  $\triangleright$
    - VDD\_U5 Þ
    - VDD\_U6  $\triangleright$
    - VDD\_U7 Þ
    - VDD\_U8  $\triangleright$ VDD\_U9  $\triangleright$
    - VDD\_U11  $\triangleright$
    - VDD\_U12  $\triangleright$
    - VDD\_U13  $\triangleright$
    - VDD\_U14  $\triangleright$
    - VDD\_U15  $\triangleright$
- 6. Double click sink\_U4 in the Sinks list to open the Sink Editor dialog box.
- 7. Type 30 in the DC Current field.

Sink Editor	
	ł ł
DC Current:	30 A
Resistance:	1MOhm ( ↓ ) I_DC <
Voltage Tolerance:	5%
Revert	Done Cancel Apply

8. Click Done.

### **Defining Options**

A PI-DC analysis provides the following options:

• Use Ideal Ground Approximation. When enabled, this option will treat all Ground nets as ideal shorts. The power rail is often the dominant contributor to the voltage drop. This option provides you the capability to analyze this dominant factor in less simulation time.

To specify options:

- 1. Double-click **Options** The Analyses list. The Setup PI-DC Simulation window is displayed.
- 2. Select Use Ideal Ground Approximation.

3. Select Custom target mesh size and specify the required value.

Simulation
5 um
60 deg
100 um

4. Click Done.

## Saving the Analysis Setup

After defining your analysis setup, select File > Save. Now, you are ready to perform the analysis.

## Running the Analysis

Double-click **Run** 4 to start the PI-DC analysis. The **Simulations** window is displayed and the PI-DC analysis is initiated.

🜔 Simulatio	ons						
				<b>S</b>			
Id	Name	Date Created	Engine	Host Status			
000001	Analysis 1	Thu Apr 30 10:07:13 2015	PI-DC	Local Queue	Completed		
Summary	Notes Log	Auto-scroll	Update		Completed		
Starting	g the PI-DC s	imulation.			<u> </u>		
Setting	environment EMPROHOME to	for using FEM engine C:\Program Files\Keys	ight\ADS2015 09\f	fem\2015.01\wir	132 64\bin\		
setting	PYTHONHOME t	o C:\Program Files\Key	sight\ADS2015_09	fem\2015.01\wi	n32_64\bin\		
Generati	HPEESOF_DIR	to C:\Program Files\Ke	ysight\ADS2015_09	9\fem\2015.01\w	rin32_64\bin		
Building	y Model						
Building	g Surface Mes	h					
Generati	ing Solver Fi	les					
109054	ea: 4 mesh elemen	ts					
Output v	ritten to C:	\Users\psinghal\SIPro	PIPro4_wrk\simula	ation\PC3-10600	-UDIMM\%P%C -		
			_				

#### **Viewing Results**

After the simulation is complete, the results are listed in the project panel. You can view the results by double-clicking the required Results option:

- 4 🗟 Results
  - Overview
  - 🚺 Voltage
  - 🗊 Current Density
  - 🗾 Power Loss Density
  - 🔛 Generate Test Bench...
  - 🔛 Generate Sub Circuit...

### Overview

Clicking the **Overview** option opens a window with a table based overview of voltages and currents at Sinks, Pins, VRMs, and Vias.

Sinks	Pins	VRMs Vias	Reports					
	Name	Source C	urrent [A]	VRM Voltage [V]	Input Voltage [V]	Resistance [Ohm]	Tolerance	Marg
1	VDD_U1	1	L	1.2	1.18841	0.002	3 %	0.02
2	VDD_U2	1	L	1.2	1.18899	0.0017	3 %	0.02
3	VDD_U3	1	L	1.2	1.19018	0.0013	3 %	0.02
4	VDD_U4	1	L	1.2	1.19176	0.0011	3 %	0.02
5	VDD_U5	1	L	1.2	1.19321	0.0011	3 %	0.02
6	VDD_U6	1	L	1.2	1.19352	0.001	3 %	0.02
7	VDD_U7	1	L	1.2	1.19205	0.0012	3 %	0.02
8	VDD_U8	1	L	1.2	1.1909	0.0015	3 %	0.0
9	VDD_U9	1	L	1.2	1.1903	0.0019	3 %	0.0
10	VDD_U11	1	L	1.2	1.19031	0.0019	3 %	0.02
11	VDD_U12	1	L	1.2	1.19092	0.0015	3 %	0.02
12	VDD_U13	1	L	1.2	1.19209	0.0012	3 %	0.02
13	VDD_U14	1	L	1.2	1.19357	0.001	3 %	0.02
14	VDD_U15	1	L	1.2	1.19318	0.0011	3 %	0.02
15	VDD_U16	1	L	1.2	1.1917	0.0011	3 %	0.0
16	VDD_U17	1	L	1.2	1.19015	0.0013	3 %	0.02
17	VDD_U18	1	L	1.2	1.18897	0.0017	3 %	0.02
18	VDD_U19	1	L	1.2	1.18841	0.002	3 %	0.02
•								Þ

## Voltage

Clicking the **Voltage** option in the Results list loads the voltage plot in the Geometry window. This is a scalar plot. The voltage is forced at 0 at the negative pins of the VRMs.

## **Current Density**

Clicking the **Current Density** option in the Results list loads the current density plot in the Geometry window. This is a vector plot. The color indicates the current density amplitude. The white arrow indicates the direction of the current. The arrow size is not an indication for the current density amplitude.
🕼 Layout				- • •
View				
Area Po	ower Density:(W/mm	**2)		
.7294e-27	0.048066 0.0961	.31 0.1442	0.19226	
Y X				
[Analysis 1]: Power Loss Density	•	Hide Others Un	oad	
Setup		V Auto-App	ly 🔏 🗌 Apply	Revert
Automatic O Custom	Vpda	ate ScaleBar		
R Default Minimum 4.72938e- Default Maximum 0.192263	<b>tange</b> 27 W/mm**2 W/mm**2			
Layer Show All Net Type Show All	▼ ▼			

#### **Power Loss Density**

Clicking the **Power Loss Density** option in the Results list loads the power loss density. This is a scalar plot. This plot shows the power loss per unit area.

#### **Generate Schematic**

Clicking the **Generate Schematic** option opens a Schematic window with the VRMs, Sinks, Component Models and an SNP that points to the DC S-parameter model.

#### Performing a PI-AC Analysis

After running a PI-DC analysis, you can perform the PI-AC analysis. A PI-AC analysis enables you to calculate the impedance of the power distribution networks from different sinks. It helps you to determine and minimize the impedance between power and ground pins at various IC locations on the board. A PDN should have the lowest impedance for achieving good power integrity. Therefore, you need to minimize the impedance between power and ground pins, which will vary based on the location of capacitors and the type and value of capacitor. The goal of PI-AC analysis is to provide low impedance to all sinks.

In this example, the impact of components placed between the capacitors is calculated. You will use component models of the MuRata library.

#### Enable MuRata Library

In this example, you will run simulations with MuRata library components. Download the MuRata library from the Web:

http://www.murata.com/en-global/tool/library/keysight3

Include the MuRata library in the current ADS workspace and enable this library in ADS.

#### Opening the Example Design

Open the *SIPro\_PIPro\_Getting\_Started\_Example\_wrk.7zadsfcv* design. The PI analysis setup data for a specific design is stored in a cell view of the "SIPro/PIPro Setup".

Double-click the **sipiSetup** view in the ADS Main window.

PC3-10600-UDIMM
 layout
 sipiSetup

The SIPro/PIPro Setup window is displayed.

#### Creating a PI-AC Analysis Setup

In this example, you will copy the PI-DC analysis setup. Therefore, you do not need to redefine the VRMs, which are the connectors for supplying power, and sinks that consume the current.

1. Right-click the PI-DC analysis setup in the project panel:



2. Select Copy > To PI-AC Analysis:

- 3. The PI-DC analysis setup is copied to create a new PI-AC Analysis.
- 4. Right-click the copied analysis and select **Rename**.
- 5. Type VDD\_GND\_AC, as shown in the following figure:

▲ C VDD\_GND\_AC
 ▲ + VRMs
 ▷ + VDD\_J1
 ▷ ∳ Sinks
 ▷ ₽ Nets
 ▷ P Component Models
 ☆ Options...
 ♀ Run
 ▷ Results

## Defining a Component Model

For a PI-AC analysis, you need to calculate the impact of decoupling capacitors. Identify the component models and define electrical models for the selected components.

To define a component model:

- 1. Select the component group c\_capacitors\_0603-511-500044\_4.7a in the Components list. This group of components will be analyzed.
- Drag and drop the selected component on Component Models in the SIPro/PIPro Setup window. A new list is created, as shown in the following figure:
  - a c\_capacitors\_0603-511-500044\_4.7a
    - C13
    - ▷ 🖒 C14
    - ▷ 🖒 C15
    - ▷ 🖒 C16
    - ▷ 🖒 C28
    - ▷ ▷ C73
    - ▷ 🕞 C74
    - ▷ 🖒 C79
    - ▷ 🖒 C80
    - ▷ 🖒 C106
    - ▷ 🏳 C112

NOTE

After adding a component model in in the SIPro/PIPro setup panel, you may need to delete the nets that are not connected to GND and VDD.

- 3. Double-click **c\_capacitors\_0603-511-500044\_4.7a** in the Component Models branch to specify the electrical models to be used for analysis.
- 4. Select Lumped from the Add drop-down list.
- 5. Type 4.7 uF in the Capacitance field.

Name	Туре		
model	Lumped		
	Add 🔻	Remove	Set Default
1odel			
Resist	ance: 0 Ohm		• • • • • • • • • • • • • • • • • • •
Induct	ance: 0H		
Capacit	ance: 4.7 uF		1
	All Series		T
RLC Arranger	ment: O All Parallel		
	© RL ∏ C		•0

#### 6. Click Done



You can also search an electrical model in the database provided by the vendor. For more information, see Using Vendor Parts DB Browser and Creating and Editing Component Models for Analysis.

#### **Defining Options**

To define options:

- 1. Double-click **Options** in the PI-AC Analysis list in the SIPro/PIPro Setup panel.
- 2. Accept the default **Resolution** and **Arc Resolution** value.
- 3. Click the Frequency Plans tab.

	Туре	Start	Stop	Points	Step
V	Logarithmic	10 kHz	300 MHz	5/decade (24 points)	5
1	Adaptive	10 kHz	300 MHz	300 (max)	22

4. Click Done.

#### Running the Analysis

Save your PI-AC analysis setup and double-click **Run** 4 to start the PI-AC analysis. The **Simulations** window is displayed and the PI-AC analysis is initiated.

## Viewing PDN Impedance

To view PDN impedance results:

- 1. In the Results list, double-click PDN Impedance. The PDN impedance window is displayed.
- 2. Select the required sinks.
- 3. Right-click the selected sinks and choose Add PDN Impedance. The PDN Impedance plot is displayed.

# PIPro Analysis Setup Overview

To perform a power integrity (PIPro) simulation, you require detailed information about the power distribution network (PDN) in a design. This information includes identifying the voltage regulator module (VRM), the IC that consumes power, the components and component models, and stimulus for the analysis.

#### Prerequisites

Before performing a PIPro analysis, you need to gather the following Information about a PDN:

- Identify the power and ground rail net name(s) that you want to analyze and obtain the DC voltage. A power rail can consist of multiple nets that are connected through series components.
- Identify the instance name (or reference designator) of the Voltage Regulator Module (VRM). In case the VRM is not mounted on the Printed Circuit Board (PCB) and the supply power comes in through one (or more) connectors, identify these instances name(s). Also, the power rail and ground rail might come in through a separate connector. For such designs, you need to identify both connector instance names.
- Identify the instance name(s) of the ICs that consume power. Obtain the DC current consumption properties of each IC. This is the total current that will be distributed among the set of individual pins of the IC. Obtain the allowed DC voltage drop for each power rail. This is the recommended minimum DC supply voltage that is needed by the IC to guarantee proper operation. You might consult the datasheet, ask the vendor, run the power calculator provided by FPGA vendors, or ask the IC designers.
- Identify the instance name(s) of all series components on the power rail. These are typically resistors, inductors, or fuses. Obtain the electrical model parameters for them (RLC values and topology).

#### Setup

In a new SIPro/PIPro setup, you can use the empty templates for PI-DC, PI-AC, and PPR analysis in the Project panel. You can also create a new analysis. To create a new analysis, right-click **Analyses** and choose the required analysis. The following figure displays the PI-DC and PI-AC setup:



#### VRMs

A voltage regulator module (VRM) allows processors with different supply voltage to be mounted on the same motherboard. A VRM regulates the voltage fed to a microprocessor. While creating an analysis setup, you can define various properties of a VRM, such as the DC voltage, voltage tolerance, and resistance.

#### Sinks

A sink is a component, such as ICs, that consumes electricity in a design. While creating a setup, you can define the amount of current the ICs will consume by defining the properties of a sink, such as the DC current, resistance, and voltage tolerance.

#### Options

The following table describes various options available for a PIPro analysis:

Option	Description
Resolution	This option specifies that points closer than the Resolution distance will be considered as equal during simulation
Arc Resolution	Arc resolution is used to discretize arcs and circles during simulation
Custom Target Mesh Size	Specifies the mesh size for generating the global 3D mesh during simulation
Use Ideal Ground Approximation	Ground net metalization is modeled as a perfect conductor during simulation

# PI-DC Static IR Drop Analysis

#### PI-DC Static IR Drop Analysis

- Creating a PI-DC Analysis Setup
- Viewing PI-DC Analysis Results

#### Creating a PI-DC Analysis Set up

Using SIPro/PIPro, you can perform a PI-DC analysis to compute the voltage, IR drop (voltage drop), current, and power loss density in the power supply nets. The DC analysis helps you to identify the IC and connector pins or stitching vias drawing large amounts of current at DC.

Due to excessive voltage drop, the power supply voltage at the IC might fall below the recommended minimum voltage. This can cause malfunctioning of the IC. Excessive current density in the perforated power supply rails can generate excessive heat, which might lead to board failures due to de-lamination or fusing. Also, excessive current in the stitching vias can lead to via failures losing connection. Any number of power supply nets with source and sink models can be simulated together.

You can use the default empty template available in the project panel. Expand the **DC Analysis 1** option present in the **Analyses** node:



You can also create a new analysis. To create a new analysis:

1. Right-click Analyses and select New PI-DC Analysis.



2. Expand the analysis tree node of the new analysis branch:



#### Defining a VRM

A VRM regulates the voltage provided to a microprocessor.

To define a VRM:

- Select a VRM (or connector) component instance in the Parts tree. You can also search the required component. For more information about, see How to Find a Component Instance.
- 2. Drag and drop the selected instance on the **VRMs** part in the project panel. A new VRM definition is added in the project panel.



- 3. If the VRM connects to multiple power nets, the **Select Net for Instance** dialog box is displayed, where you have to select the required net. The same applies for ground nets.
- 4. Double click the VRM definition to open the VRM Editor dialog box.
- 5. Specify the DC Voltage, Voltage Tolerance, and Resistance. The Inductance will not play a role for a DC analysis. The Voltage Tolerance (absolute or in percent) is the voltage drop that is allowed at the output pins of the VRM. There will be no voltage drop in the VRM in case the series resistance and inductance values are 0.
- 6. Click Done.

#### Defining a Sink

A sink is a component that reduces the temperature of an electronic device by dissipating heat into the surrounding air. You can define the following options for a sink:

To define a sink:

- 1. Find the IC component instance(s) in the Components list.
- 2. Select the instance(s) and drag and drop them onto Sinks. New Sink definitions will be added in the tree.

- 3. In case the IC connects to multiple power nets, the **Select Net for Instance** dialog box is displayed, where you can select the required net.
- 4. In case multiple instances were dropped, the **Select Net for Multiple Instances** dialog box provides a check box to **Use same Selection for All Sinks/VRMs**. The same applies for ground nets.
- 5. Double-click the Sink definition to open the Sink Editor dialog box.
- 6. Specify the **DC Current**, **Resistance** and **Voltage Tolerance**. The Voltage Tolerance (absolute or in percent) is maximum voltage drop that is allowed at the input pins of the IC.

#### **Defining Options**

A PI-DC analysis provides following options:

Option	Description
Use Ideal Ground Approximation	When enabled, this option will treat all Ground nets as ideal shorts. The power rail is often the dominant contributor to the voltage drop. This option provides you the capability to analyze this dominant factor in less simulation time.

#### Running the PI-DC Analysis

After saving your analysis setup, double click **Run** to start the PI-DC analysis. The Simulations window is displayed and the PI-DC analysis will start. The Simulations window allows you to monitor and manage simulations.

#### Show Me How Do I Perform a PI-DC Analysis

Video: How to Perform a PI-DC Analysis

#### Viewing PI-DC Analysis Results

After completing a PI-DC analysis setup, you can run the analysis in SIPro/PIPro. You can view the overview, voltage, current density, and power loss density. You can also generate a schematic.

#### Running a PI-DC Analysis

To run a PI-DC analysis and view results:

- 1. Save your PI-DC analysis setup.
- 2. Double-click **Run** to start the PI-DC analysis. The Simulations window is displayed, which allows you to monitor and manage simulations. The results are listed in the project panel.
- 3. Expand Results in the Analysis list of the project panel:

- Results
   Overview
   Voltage
   Current Density
   Power Loss Density
   Generate Schematic...
- 4. Double-click the required analysis result.

#### Overview

Clicking the **Overview** option in the Results list opens the DC Results Overview window. This window provides a tablebased overview of voltages and currents at Sinks, Pins, VRMs, and Vias.

#### Sinks

In the Sinks tab, you can view the source current, VRM voltage, input voltage, resistance, tolerance, and margin values.

1	NI								
4	Name	Sou	irce Curi	rent [A]	VRM Voltage [V]	Input Voltage [V]	Resistance [Ohm]	Tolerance	Marg
1	VDD_U1		1		1.2	1.1895	0.0019	3 %	0.0
2	VDD_U2		1		1.2	1.19003	0.0016	3 %	0.0
3	VDD_U3		1		1.2	1.19114	0.0012	3 %	0.02
4	VDD_U4		1		1.2	1.19258	0.001	3 %	0.02
5	VDD_U5		1		1.2	1.1938	0.0011	3 %	0.0
6	VDD_U6		1		1.2	1.19417	0.001	3 %	0.0
7	VDD_U7		1		1.2	1.19285	0.0011	3 %	0.0
8	VDD_U8		1		1.2	1.19178	0.0014	3 %	0.0
9	VDD_U9		1		1.2	1.19122	0.0018	3 %	0.0
10	VDD_U11		1		1.2	1.19123	0.0018	3 %	0.0
11	VDD_U12		1		1.2	1.1918	0.0014	3 %	0.0
12	VDD_U13		1		1.2	1.1929	0.0011	3 %	0.0
13	VDD_U14		1		1.2	1.19422	0.001	3 %	0.0
14	VDD_U15		1		1.2	1.19377	0.0011	3 %	0.0
15	VDD_U16		1		1.2	1.19252	0.001	3 %	0.0
16	VDD_U17		1		1.2	1.19111	0.0013	3 %	0.02
17	VDD_U18		1		1.2	1.19001	0.0016	3 %	0.0
18	VDD_U19		1		1.2	1.18949	0.0019	3 %	0.0
•									,

#### Pins

To view pins:

- 1. Click the **Pins** tab in the DC Results Overview window.
- 2. Choose the required pin from the Select Pins drop-down list. The table is updated with the selected pin results.

DC	Results Overv	iew				23
Sink	s Pins	VRMs Vias	Reports			
Sele	ct Pins: U4 (F	PC4-RDIMM_V090_I	RC_F0_20131106	_lib:u_ddr4_x4_fbg	a78-10x13_) 🔻	
	Select Pins in Pr	roject Tree 🛛 Dis	splay Results in La	Volto no fV1	C	
	Name	Net Name	Net Type	voitage [v]	Current [A]	_
1	U4.P_A1	VDD	Power	1.19415	0.569227	
2	U4.P_A2	GND	Ground	0.00156432	-0.111885	
3	U4.P_A8	GND	Ground	0.00156432	-0.176586	
4	U4.P_A9	GND	Ground	0.00156432	-0.194285	
5	U4.P_B2	VDD	Power	1.19415	0.146461	
6	U4.P_B8	VDD	Power	1.19415	-0.0468914	
7	114 P C1	VDD	Power	1 19415	0.27006	=

#### VRMs

To view VRMs, click the  $\ensuremath{\text{VRMs}}$  tab in the DC Results Overview window.

#### Vias

To view ID and current of vias, click the **Vias** tab.

#### Reports

To generate a PI-DC analysis report:

1. Click the Reports tab.

DC Results Overview	
Sinks Pins VRMs Vias Reports	
SIPro/PIPro Setup [PI-DC] Analysis Report	<b>^</b>
DESIGN	E
	-
•	P.
Set Templates	Report Save Report
	Close

2. Click Save Report.

#### Setting Template

To set a template for your report, click the **Set Templates** button. Browse to the DocX, ODT, and HTML location for selecting a template for your report.

### Voltage

Clicking the **Voltage** option in the Results list loads the voltage plot. This is a scalar plot. The voltage is forced at 0 at the negative pins of the VRMs.

🕼 Layout		
View		
	0 015 03 045 0599 0749 0899 105 12	Lo 🗸
		6
		~
		<b>•</b> •
		🁘 🛨
		- 8 -
	👫 ja kala taka ata kala kala kala kala kala	-22
	- "我的意思"的话,说是"的话,你是你就是你说不能是你的人们是是不能是?" [1] 她是你你你你你你你你你你你你你你你你你你你你你你你你你你你你你你你你?"	🥮 <b>T</b>
	en het sinde die een de die de	2
		Aa
		ß
		<b>////</b> %
N 10	Ý	10
1		26*
	. y	-*
VDD GND	DC]: Voltage	
Setup	Auto-Apoly Acoly F	Revert
	Kange V Automatic	
Min	0 V Default	
Max	1. 19876 V Default	
Layer	Show All	
Net Type	Show All	

## **Current Density**

Clicking the **Current Density** option in the Results list loads the current density plot. This is a vector plot. The color indicates the current density amplitude. The white arrow indicates the direction of the current. The arrow size is not an indication for the current density amplitude.

Layout	
View	
Total Jc  :(A/mm**2)	
0 163.77 327.54	491.31 655.08
	€ () () -
	<ul> <li>● •</li> <li>-&gt;</li> <li>&gt;&gt;</li> <li< th=""></li<></ul>
	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6
Ý	
×	
[Analysis 1]: Current Density	Hide Others     Unload
Setup	🛛 Auto-Apply 🔥 Apply Revert
● Automatic ○ Custom	leB Size Factor: 1.00 🖉 🗹 Scale Vectors
Range	
Default Minimum 0 A/mm**2	
Default Maximum 55.082 A/mm**2	
Layer Show All 🔻	
Net Type Show All 💌	

## Power Loss Density

Clicking the **Power Loss Density** option in the Results list loads the power loss density. This is a scalar plot. This plot shows the power loss per unit area.

Lavout						- <b>- x</b>
View						
	Area Power	Density:(W/r	nm**2)			·····
1.594	1e-27	0.095398	0.1908			<u>\</u> \ \ \ \ \ \ \ \
		بىقە ئۆت		_	I	
						->- 
X X						2% (************************************
[Analysis 1]: Power Loss Den:	sity		▼ Hide Others	Unload		
Setup			Auto-Apply	Apply	Revert	
Automatic O Custom			Update ScaleBar			
Default Minimum	Ran 3.59406e-27	ge W/mm**2				
Default Maximum Layer	0.254395 W/i	nm**2 ▼				
Net Type	Show All	•				

#### **Generate Schematic**

Clicking the **Generate Schematic** option opens a Schematic window with the VRMs, Sinks, Component Models and an SNP that points to the DC S-parameter model.



#### See Also

• Setup Options for Customizing Results

# PI-AC Dynamic IR Drop Analysis

#### PI-AC Dynamic IR Drop Analysis

- Creating a PI-AC Analysis Setup
- Viewing PI-AC Analysis Results

#### Creating a PI-AC Analysis Setup

A PI-AC analysis computes the impedance for the IC current loads over a broad frequency range. It helps you to identify whether the power distribution network (PDN) provides a low impedance path from the Voltage Regulator Module (VRM) to the IC. An excessive impedance in a certain frequency range can generate excessive voltage noise, also called dynamic IR drop, when the IC power supply pins draw large amounts of transient current, required for I/O or core logic switching, at rates that fall into that frequency range.

#### Defining a PI-AC Analysis Setup

You can create a PI-AC analysis setup in the following ways:

- Copying an existing PI-DC analysis setup.
- Creating a new PI-AC analysis setup.

## Copying the PI-DC Analysis Setup

If you have already performed a PI-DC analysis, you can copy its setup for creating a PI-AC analysis setup. To copy an existing setup:

- 1. Right-click the PI-DC analysis setup in the project panel.
- 2. Select Copy > To PI-AC Analysis.



#### Creating a New PI-AC Analysis Setup

If you want to create a new setup, right-click **Analyses** and then select **New PI-AC Analysis**. After creating a new setup, you need to define VRMs and sinks. For more information, see <u>PIPro Analysis</u> Setup Overview.

#### **Defining VRMs**

To define a VRM:

- 1. Select a VRM (or connector) component instance in the **Components** list. You can also search the required component. For more information about, see How to Find a Component Instance.
- 2. Drag and drop the selected instance on VRMs in the AC Analysis list. A new VRM definition is added.



3. If the VRM connects to multiple power nets, the Select Net for Instance dialog box is displayed. Select a net. Similarly, you can select ground nets.

97 J1.194 J1.191 J1.189 J1.186 J1.183 J1.182
36
7

4. Double-click the VRM definition to open the VRM Editor dialog box.

SI <sub>P</sub> VRM Editor		
Dow h		R L
DC voltage:	1.5 V	1
Voltage Tolerance:	0 %	+
Resistance:	0 Ohm	— _ V_DC
Inductance:	0 mH	_
Revert		Done Cancel Apply

5. Specify the DC Voltage, Voltage Tolerance, and Resistance. The Inductance will not play a role for a DC analysis. The Voltage Tolerance (absolute or in percent) is the voltage drop that is allowed at the output pins of the VRM. There will be no voltage drop in the VRM in case the series resistance and inductance values are 0.

## **Defining Sinks**

To define a sink:

- 1. Find the IC component instance(s) in the Components list.
- 2. Select the instance(s) and drag and drop them onto Sinks. New Sink definitions will be added in the tree.
- 3. In case the IC connects to multiple power nets, the Select Net for Instance dialog pops up where you will have to select one.
- 4. In case multiple instances were dropped, the Select Net for Multiple Instances dialog provides a check box to Use same Selection for All Sinks/VRMs. The same applies for ground nets.
- Double click the Sink definition to open the Sink Editor dialog. Specify the DC Current, Resistance and Voltage Tolerance. The Voltage Tolerance (absolute or in percent) is maximum voltage drop that is allowed at the input pins of the IC.

#### **Defining Component Models**

For a PI-AC analysis, you need to consider the decoupling capacitors because they are not an open circuit at AC.

To define a component model:

- 1. Select the component group, which you want to analyze, in the Components list.
- 2. Drag and drop the component group on Component Models. The instances will be grouped by component name.
- 3. Define the electrical model parameters by using one of the following ways:

- Double-click the component instance to display the Component Model Editor window. For more information, see Creating and Editing Component Models for Analysis.
  - Alternatively, you can open the Vendor Parts database by selecting Tools > Vendor Parts DB. Drag and drop the appropriate vendor part onto the component instance node (single model assignment) or onto the component model group node (group model assignment). For more information, see Using Vendor Parts DB Browser.

#### **Defining Options**

To define options, double-click **Options** in the PI-AC Analysis list in the project panel. provides It provides the following options:

Option	Description
Resolution	Points closer than the specified resolution will be considered equal during the simulation
Arc Resolution	Value used to discretize circles and arcs during the simulation
Custom Target Mesh Size	Mesh size used to generate the global 3D mesh during simulation
Use Ideal Ground Approximation	When enabled, this option specifies that all Ground nets are considered as ideal shorts. The power rail is often the dominant contributor to the voltage drop. This option provides you the capability to analyze this dominant factor in less simulation time.

#### **Defining Frequency Plans**

By default, you can use the Automatic, Logarithmic and Adaptive frequency plan. The Automatic will provide the optimal frequency sampling using a combination of Adaptive and Logarithmic sweeps.

Click the Frequency Plans tab to specify a plan.

equencies	Fields Storage				
+					
	Туре	Start	Stop	Points	Step

#### Saving fields for field plots

By default, the fields valued needed for visualization are not stored. You can enable this using the Field Storage dialog.

riequencies	Tieds biologe	
Save fields f	or:	
All Frequencies	encies from the Frequency Plan an	d the Mesh Frequency
No Field	Data	
O User Det	ined Frequencies	

Note that this will save big files to disc. Depending on the example this can result in multiple GB of saved data.

#### Saving the Setup

Save your PI-AC analysis setup and double-click Run to start the PI-AC analysis.

#### Show Me How Do I Perform a PI-AC Analysis

Video: How to Perform a PI-AC Analysis

#### Viewing PI-AC Analysis Results

After creating a PI-AC analysis setup, you can run the analysis in the SIPro/PIPro Setup window. For a PI-AC analysis, the following results are displayed:

- PDN Impedance
- S-parameters
- Electric Field
- Magnetic Field
- Current Density
- Generate Test Bench
- Generate Sub Circuit

#### Running a PI-AC Analysis

To run a PI-AC analysis and view results:

- 1. Save your PI-AC analysis setup.
- 2. Double-click **Run** to start the PI-AC analysis. The Simulations window is displayed, which allows you to monitor and manage simulations:

Simulat	tions						
						<b>\$</b>	1
Id	Name		Date Created	Engine		Host	Status
000001	Analysis 1	Thu A	Apr 30 10:07:13 2015	PI-DC	Loca	al Queue	Completed
000002	Analysis 1	Wed	May 6 10:33:39 2015	PI-DC	Loca	al Queue	Completed
000003	Analysis 1	Thu M	May 7 14:23:01 2015	PI-DC	Loca	al Queue	Completed
000004	Analysis 4	Thu M	May 21 13:52:38 2015	PI-AC	Loca	al Queue	Completed
000004	Analysis 4	Thu N	May 21 13:53:51 2015	PI-AC	Loca	al Queue	Completed
C	Natura 100	]	Auto-scroll	Undate			Comple
Summary	Notes Log	nbUnknowns	Auto-scroll mem(GB) Ela	Uodate )	CPU time	solver	Comple
Summary	/ Notes Log	nbUnknowns	Auto-scroll mem(GB) Ela	Uodate (	CPU time	solver	Comple
Summary sample	/ Notes Log frequency 1.000 MHz	nbUnknowns 	Auto-scroll      mem(GB) Ela      1.400 0	Uodate psed time	CPU time 00:01:11.8	solver Dm64	Compl
Summary	/ Notes Log frequency   1.000 MHz   1.585 MHz   2.512 MHz	nbUnknowns 273823 273823	✓ Auto-scroll mem(GB) Ela 1.400 0 1.410 0 1.410 0	Update psed time 0:00:54.6 0:00:23.4 0:00:23.5	CPU time 00:01:11.8 00:00:41.7	solver Dm64 Dm64	Compl
Summary sample 1 2 3	V Notes Log	nbUnknowns 273823 273823 273823 273823	Image         Auto-scroll           mem(GB)         Ela           1.400         0           1.410         0           1.410         0	Update psed time 0:00:54.6 0:00:23.4 0:00:23.5 0:00:23.5	CPU time 00:01:11.8 00:00:41.7 00:00:42.0 00:00:41.9	solver Dm64 Dm64 Dm64	Compl
Summary sample 1 2 3 4 5	Notes         Log           frequency	nbUnknowns 273823 273823 273823 273823 273823	Image: Auto-scroll           mem(GB)         Ela           1.400         0           1.410         0           1.410         0           1.410         0           1.410         0           1.410         0	Update psed time 0:00:54.6 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.4	CPU time 00:01:11.8 00:00:41.7 00:00:42.0 00:00:41.9 00:00:41.9	solver Dm64 Dm64 Dm64 Dm64 Dm64	Compl
Summary sample 1 2 3 4 5 6	/         Notes         Log           frequency	nbUnknowns 273823 273823 273823 273823 273823 273823	Auto-scroll           mem(GB)         Ela           1.400         0           1.410         0           1.410         0           1.410         0           1.420         0	Uodate psed time 0:00:54.6 0:00:23.4 0:00:23.5 0:00:23.4 0:00:23.4 0:00:23.4	CPU time 00:01:11.8 00:00:41.7 00:00:41.9 00:00:41.9 00:00:41.4	solver Dm64 Dm64 Dm64 Dm64 Dm64 Dm64	Compl
Summary sample 1 2 3 4 5 6 7	requency           frequency           1.000 MHz           1.585 MHz           2.512 MHz           3.981 MHz           6.310 MHz           10.000 MHz           15.849 MHz	nbUnknowns 273823 273823 273823 273823 273823 273823 273823 273823	Auto-scroll           mem (GB)         Ela           1.400         0           1.410         0           1.410         0           1.410         0           1.410         0           1.420         0	Update psed time 0:00:54.6 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.2 0:00:23.2	CPU time 00:01:11.8 00:00:41.7 00:00:42.0 00:00:41.9 00:00:41.9 00:00:41.5	solver Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64	Comple nbIter
Summary sample 1 2 3 4 5 6 7 8	/         Notes         Log           frequency         -           1.000         MHz           1.585         MHz           2.512         MHz           6.310         MHz           10.000         MHz           15.849         MHz           25.119         MHz	nbUnknowns 273823 273823 273823 273823 273823 273823 273823 273823 273823	Auto-scroll           mem(GB)         Ela           1.400         0           1.410         0           1.410         0           1.410         0           1.420         0           1.420         0           1.420         0	Update psed time 0:00:54.6 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.2 0:00:23.2 0:00:23.2	CPU time 00:01:11.8 00:00:41.7 00:00:42.0 00:00:41.9 00:00:41.9 00:00:41.4 00:00:41.5 00:00:46.1	solver Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64	Compl
Summary sample 1 2 3 4 5 6 7 7 8 9	Notes         Log           frequency            1.585         MHz           2.512         MHz           3.981         MHz           6.310         MHz           15.849         MHz           25.119         MHz           39.81         MHz	nbUnknowns 273823 273823 273823 273823 273823 273823 273823 273823 273823 273823	Auto-scroll           mem(GB)         Ela           1.400         0           1.410         0           1.410         0           1.410         0           1.410         0           1.420         0           1.420         0           1.420         0           1.420         0           1.430         0	Ubdate psed time 0:00:54.6 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.2 0:00:23.2 0:00:25.9 0:00:25.9	CPU time 00:01:11.8 00:00:41.7 00:00:42.0 00:00:41.9 00:00:41.4 00:00:41.5 00:00:46.1 00:00:46.5	solver Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64	Compl
Summary 1 2 3 4 5 6 7 8 9 10	/         Notes         Log           frequency	nbUnknowns 273823 273823 273823 273823 273823 273823 273823 273823 273823 273823	Auto-scroll           mem(GB)         Ela           1.400         0           1.410         0           1.410         0           1.410         0           1.420         0           1.420         0           1.420         0           1.420         0           1.430         0	Ubdate psed time 0:00:54.6 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.2 0:00:23.2 0:00:25.9 0:00:25.9 0:00:25.4 0:00:25.4	CPU time 00:01:11.8 00:00:41.7 00:00:41.9 00:00:41.9 00:00:41.4 00:00:41.4 00:00:41.5 00:00:46.1 00:00:43.4	solver Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64	Compl
Summary sample 1 2 3 4 5 6 7 8 9 10 11	requency           frequency           1.000 MHz           1.585 MHz           2.512 MHz           3.981 MHz           6.310 MHz           10.000 MHz           15.849 MHz           25.119 MHz           39.811 MHz           63.096 MHz           100.000 MHz	nbUnknowns 273823 273823 273823 273823 273823 273823 273823 273823 273823 273823 273823	Auto-scroll           mem(GB)         Ela           1.400         0           1.410         0           1.410         0           1.410         0           1.420         0           1.420         0           1.420         0           1.430         0           1.430         0	Ubdate psed time 0:00:54.6 0:00:23.4 0:00:23.4 0:00:23.4 0:00:23.2 0:00:23.2 0:00:23.2 0:00:25.9 0:00:25.9 0:00:24.5 0:00:24.5 0:00:24.5	CPU time 00:01:11.8 00:00:41.7 00:00:42.0 00:00:41.9 00:00:41.9 00:00:41.5 00:00:41.5 00:00:46.1 00:00:46.1 00:00:43.4 00:00:47.1	solver Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64 Dm64	Complend

- 3. Expand the **Results** tree item.
- 4. Double-click the required result:
  - 🔺 🗟 Results

PDN Impedance

- S-Parameters
- 间 Electric Field
- Magnetic Field
- Current Density
- 🔛 Generate Test Bench...
- Generate Sub Circuit...

#### **PDN** Impedance

A PI-AC analysis computes the impedance of the IC current loads over a broad frequency range. You can identify whether the power distribution network (PDN) provides a low impedance path from the Voltage Regulator Module (VRM) to the sinks or ICs. It provides the input impedance value from each sink.

#### Viewing PDN Impedance

To view PDN impedance results:

- 1. In the Results list, double-click PDN Impedance. The PDN impedance window is displayed.
- 2. Select the required sinks.
- 3. Right-click the selected sinks and choose Add PDN Impedance.



#### **Removing PDN Impedance Plots**

To remove PDN Impedance plots:

- 1. Click the **Plot** tab.
- 2. Select the plots to be removed.
- 3. Click 🔟 . The selected plots are deleted from the PDN Impedance window.

## Importing a Target Impedance File

The PDN impedance window supports the import and visualization of target impedances. The following table lists the contents of a sample CSV file:

Frequency[Hz]	Impedance[Ohm]
100000	0.01
1000000	0.01
1000000	0.1
1000000	0.1
1000000	1.5
1E+08	1.5
1E+08	2
1E+09	2

Frequency[Hz]	Impedance[Ohm]
1E+09	2

To import a series of target impedances:

- 1. Select File > Import Target Impedance. The Import Custom Target Impedance File dialog box is displayed.
- 2. Select a CSV file containing values. This file should contain comma separated frequency and impedance values.

```
NOTE
```

The importer does not perform a validity check on the actual data.

3. Once imported, the values are added as a new plot on the impedance graph, as shown in the following figure:



#### **Result Type Options**

In the Result Type section, you can select the following options:

- Impedance: Displays the PDN impedance values.
- S-Parameters: Displays the s parameter results.

The impedance plots show the PDN impedance values including the default component models specified in the setup. After changing the default model specified in the Component Model Editor dialog (see Creating and Editing Component Models for Analysis), you can update the impedance plots without recalculation. This allows a quick way to vary e.g. decap component models and inspect the effect on the PDN plots.

#### **VRM** Options

If you are viewing Impedance results, you can also select the following VRMs options:

• Open

Closed

## **Viewing Electric Field**

Double-click Electric Field in the Results list of PI AC analysis. The electric field plot is displayed:

🕼 Layout			
View			
No Plots:	dB) Reference value: 0.22	6523 V/m	
128.72103.8	378.94-254.05-229.1634.273	20.61745.50670.396	
			■ <del>-</del>
a de la companya de l		AND A COMPANY	2)
100 C	10 M 10		
			<b>1</b> %
ľ ř			<u>40</u> 16
X			
[Analysis 4]: Electric Field	▼ Hid	e Others Unload	
Setup	V AL	uto-Apply 🔏 Apply	Revert
Automatic Custom	📝 Update S	caleBar	
	Range	Excitation: vrm_J	· •
		Frequency: 398.10	7 MHz 🔻
Default Minimum 6.58410	e-15 V/m		
Default Maximum 0.2265	13 V/m		
LayerId Show A	<b>▼</b>		

### Viewing Magnetic Field

Double-click Magnetic Field in the Results list of PI AC analysis. The magnetic field plot is displayed:

Lavout						
View						
	No Plo	ts:(dB) Refe	erence value: 7.9	3778 A/n	n	
	-90.419	-60.749	-31.078 -1	.4081	28.262	<u>\</u> <u>\</u> <u>\</u>
						© ■ -
	্য	1. V			bet -	
	811	16	A se brites	Č.	564	
¥						<b>()</b> %
X						میں بھی
(						_
[Analysis 4]: Magnetic Fi	eid			Others		
Setup			V Aut	to-Apply		Revert
Automatic O Cu	stom		🔽 Update Sc	aleBar		
		Range			Excitation: sink_U2	•
					Frequency: 10 MHz	•
Default Mini	<b>mum</b> 1.451	55e-05 A/m				
Default Maxi	<b>mum</b> 7.9377	/8 A/m				
Lay	verId Show	All	•			

## NOTE

If you want to view only the recent results and hide previous analysis, click **Hide Others**.

## **Current Density**

Double-click **Current Density** in the Results list of PI AC analysis.

🕼 Layout	- • •
ViewNo Plots (A/mm**2)	
	5-
0 0.07110114238213382847835598427168498385695.	<u> </u>
	- <u>19</u> -
	₹.
。"杨浩大的情况,在他们的学生,这个人的问题,我们的是不是是这些人的问题。	ł
	<b>19</b> %
γ	<b>%</b>
	16
X X	-
[Analysis 4]: Current Density	
Setup 📝 Auto-Apply 🔬 Apply Reve	t
O Automatic ○ Custom     Update Scale     Size Factor: 1.00     Scale Ver     Scale Ver	tors
Range Excitation: vrm_J1 -	
Frequency: 1 MHz 🔻	
Default Minimum 0 A/mm**2	
Default Maximum 59532 A/mm**2	

## Generating a Schematic

Double-click **Generate Schematic** in the Results list of PI-AC analysis. A Schematic window is displayed, which includes the VRMs, Sinks, Component Models and an SNP that points to the S-parameter model.

DC 🔛	3-1060	0-UDIN	IM_PI-	AC_Analysi	s 4 [PC3-10	0600-UD	IMM:PC3	-10600-UDI	MM_PI-AC_A	nalysis 4:schem	atic] (Schemati	c):3			• ×
File	Edit	Select	View	v Insert	Options	Tools	Layout	Simulate	Window	DynamicLink	DesignGuide	Add-Ons	EM Help		
Z=50		s A	Ŵ	H 🕜				3 🗡 🎽	92	•∰• .	» + »	💥 »	Type Component	Na 🔻 »	» 🎦 »
Palette	2	₽×	1	S-PAR	AMETERS	1									^
Lumpe		one 🔻		S_Param SP1											
R	B_M	del		Start=1 MHz Stop=1 GHz Decs 20											
,em.	I Mi		Г	SRL	vm J1 V	VDD			sink U4 VD	<u> </u>			sink U9 VI		
→⊢		٦I	_‡	vrm_J1 R=0.0 C L=0. H	_RL hm					sink_U4 Num=1	sink_U4_R R=100000	tsh D Ohm		sink_U9 Num=6	R=1000
С С		del =	Ť-L	vrm J1 GND		<b>—</b>			sink U4 GN	D Z=50 Oh	<u> </u>		sink U9 G	ND Z=50 Ohm	<u> </u>
DGFeed	I DCBI	ok l			s s	hort -									
		÷							sink U3 VD	D			sink US VI	DD	
HURI		1								sink_U3 Num=2	sink_U3_R R=100000	lsh D Ohm		sink_U8 Num=7	R=1000
PLC	PR								sink U3 GN	Z=50 Oh	<u> </u>		sink_U8_G	ND Z=50 Ohm	
-CC-PRL	PRL	}-													
	<b>_</b>	IF							sink U2 VD	0			sink U7 VI		
SLC										sink_U2 Num=3	sink_U2_R R=100000	tsh D Ohm		sink_U7 Num=8	Rsink_U7 R=1000
SRL	SRL	• <b>  •</b> .C							sink U2 GN		<u>    1    </u>		sink U7 G	ND Z=50 Ohm	1 -
Select	Click	and drag	∢ g to se	lect.						0 items	ads_devi	ce:drawing	6.625, 0.625	6.625, 0.625	in La

You can run a simulation from the schematic. The results display the input impedance for sinks, which is similar to the SIPro/PIPro results.

#### Enable the decoupling capacitors

The key parameter is the index, which determines the location of the switch. If the index is 0, the switch is open. If the value of index is set to 1, the connection is made to the first part. Similarly, if the index is 2, then connection is made to the second part. The following figure displays the results when the index value is set to 1:



#### **Tuning Parameters**

To tune parameters:

- 1. Click the **Tuning** icon. The **TuneParameters** dialog box is displayed.
- 2. Select the decoupling capacitor in Schematic.
- 3. Set the Minimum value to 0.
- 4. Set the maximum value to 5.
- 5. Specify the Step value as 1.

Simulate	
While Slider Moves	PC3-10600-0DIMM:PC3-10600-0DIMM_P1-AC_Analysis 4:schematic
Tune	
Parameters	
Include Opt Params	- vk 113.7
Enable/Disable	(Ohm)
Snap Slider to Step	Value 5
Traces and Values	
Store Recall	
Trace Visibility	
Reset Values	
Close All Data Display	
Update Schematic	Min 0
	Step 1

6. Click the up and down arrows.

#### See Also

• Setup Options for Customizing Results

# **PI-PPR** Analysis

#### **PI-PPR** Analysis

- Creating a PI-PPR Analysis Setup
- Viewing PI-PPR Analysis Results

#### Creating a PI-PPR Analysis Setup

A PI-PPR (Power Plane Resonance) analysis computes the resonances of the design over a broad frequency range. It helps you to identify the resonance frequencies and fields of the design, with and without components. It provides a global view on natural modes (eigenmodes) between the power and ground planes. Some of the modes may cause excessive impedance from VRM to IC. Some modes resonating around the signal frequencies may affect the signal quality.

#### Defining a PI-PPR Analysis Setup

You can create a PI-PPR analysis setup in the following ways:

- Copying an existingPI-DC/AC analysis setup.
- Creating a new PI-PPR analysis setup.

## Copying the PI DC/AC Analysis Setup

If you have already performed a PI-DC or PI-AC analysis, you can copy its setup for creating a PI-PPR analysis setup. To copy an existing setup:

- 1. Right-click the existing PI-DC or PI-AC analysis setup in the project panel.
- 2. Select Copy > To PI-PPR Analysis. The entire setup is copied to create a new PI-PPR analysis setup.

#### Creating a New PI-PPR Analysis Setup

If you want to create a new setup, right-click Analyses and then select New PI-PPR Analysis.

NOTE

Definition of VRMs and sinks are optional in PI-PPR. At least one VRM, or one sink or one component is suggested to be defined to indicate the power and ground nets be put in PPR simulation. For more information, see PIPro Analysis Setup Overview.

## Defining VRMs

To define a VRM:

- Select a VRM (or connector) component instance in the Parts tree. You can also search the required component. For more information about, see How to Find a Component Instance.
- 2. Drag and drop the selected instance on the VRMs part in the project panel. A new VRM definition is added in the project panel.

- 3. If the VRM connects to multiple power nets, the Select Net for Instance dialog pops up where you will have to select one. The same applies for ground nets.
- 4. Double-click the VRM definition to open the VRM Editor dialog box.
- 5. Specify the DC Voltage, Voltage Tolerance, and Resistance. The Inductance will not play a role for a DC analysis. The Voltage Tolerance (absolute or in percent) is the voltage drop that is allowed at the output pins of the VRM. There will be no voltage drop in the VRM in case the series resistance and inductance values are 0.

#### **Defining Sinks**

To define a sink:

- 1. Find the IC component instance(s) in the Parts tree.
- 2. Select the instance(s) and drag and drop them onto Sinks. New Sink definitions will be added in the tree.
- 3. In case the IC connects to multiple power nets, the Select Net for Instance dialog pops up where you will have to select one.
- 4. In case multiple instances were dropped, the Select Net for Multiple Instances dialog provides a check box to Use same Selection for All Sinks/VRMs. The same applies for ground nets.
- Double click the Sink definition to open the Sink Editor dialog. Specify the DC Current, Resistance and Voltage Tolerance. The Voltage Tolerance (absolute or in percent) is maximum voltage drop that is allowed at the input pins of the IC.

#### **Defining Component Models**

For a PI-**PPR** analysis, you need to consider the decoupling capacitors because the R, L and C parameters associated with that component may affect the resonances.

To define a component model:

- 1. Select the component group, which you want to analyze, in the Components list.
- 2. Drag and drop the component group on Component Models. The instances will be grouped by component name.
- 3. Define the electrical model parameters by using one of the following ways:
  - a. Double-click the component instance to specify the electrical model parameters for that instance.
  - b. Alternatively, you can open the Vendor Parts database by selecting Tools > Vendor Parts DB. Drag and drop the appropriate vendor part onto the component instance node (single model assignment) or onto the component model group node (group model assignment). For more information, see Using Vendor Parts DB Browser.

#### **Defining Options**

The same options can be set as for an PI-AC simulation.

#### **Defining Frequency Plan**

There are three parameters in PPR frequency plan: **Start frequency (Fstart)**, **Stop frequency (Fstop)**, and **Number of eigenmodes (N)**. The first N modes with resonant frequencies between Fstart and Fstop would be provided. By default, the Start and Stop frequencies are defined as minFreq and maxFreq. You can change the minFreq, maxFreq, by using the Parameters window. For more information, see Parameters window.

#### Saving the Setup

Save your PI-PPR analysis setup and double-click Run to start the PI-PPR analysis.

#### Viewing PI-PPR Analysis Results

After creating a PI-PPR analysis setup, you can run the analysis in the SIPro/PIPro Setup window. For a PI-PPR analysis, the following results are displayed:

- Electric Field
- Magnetic Field
- Current Density

#### Running a PI-PPR Analysis

To run a PI-PPR analysis and view results:

- 1. Save your PI-PPR analysis setup.
- 2. Double-click **Run** to start the PI-PPR analysis. The Simulations window is displayed, which allows you to monitor and manage simulations.
- 3. Expand the **Results** tree item.
- 4. Double-click the required result:



#### **Electric Field**

Double-click Electric Field in the Results list of PI-PPR analysis. The electric field plot is displayed:

Layout						
view	No Pl	ots (dB) Beferen	ce value: 2.230/	11 e±09 V/m		*******
	-193.64	-145.23	-96.82	-48.41	0	
	-155.04	-145.25	-50.82	-40.41	0	
						~
						6
						<u> </u>
	<u> </u>		and the second		-T-	<b>*</b>
						>∯ ▼
		\$ \$ T	~	631.1	2 all	🥮 🔻
	1	PACE.		<b>FRE</b>	1	l
Y						<b>6</b> %
X L						
[Analysis 6]: Electric E	ield		▼ Hide Others			
[Pindiyolo oj: Electrici						
Setup				V Auto-App	oly 🚺 Apply	Revert
Automatic O C	Custom		Update ScaleBar			
	F	lange		Excitation:	vrm_J1 🔻	
				Frequency:	107.456 MHz 🔻	
Default Min	nimum 0.463812	V/m				
Dofoult Max	vinum 2.22041a	100 V/m				
Derault Max	Z.23041e-	rus v/m				
L L	ayerId Show All	•				

## Magnetic Field

Double-click Magnetic Field in the Results list of PI -PPR analysis. The magnetic field plot is displayed:



## **Current Density**

Double-click Current Density in the Results list of PI-PPR analysis.

10.1			
View			
No Plots	·(Λ/mm**2)		
0	9817e±06 39634e±06	59451e±06 79267e±06	
с .			
			<b>S</b>
			<b>—</b>
	a state to a state		
		FRANK	
			-10 *
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			<b>19</b> %
Y			<b>(</b>
			Jac
<b>∠</b> →×			
[Analysis 6]: Current Density	▼ Hide Others	Unload	
Setup		🛛 Auto-Apply 🔬 🛛 Apply	Revert
Automatic O Custom	<b>V</b> pdate ScaleBar	Size Factor: 1.00	Scale Vectors
Ran	ge	Excitation: vrm_J1	
		Frequency: 107.456 MHz 🔻	
Defut Minimum O & Jun 883			
Default Maximum 7.92674e+06	A/mm**2		
LayerId Show All	•		

#### See Also

• Setup Options for Customizing Results

# SIPro Analysis

# SIPro Analysis

#### Contents

- Tutorial-Performing Power Aware SI Analysis
- Creating a Power Aware SI Analysis Setup
- Viewing Power Aware SI Analysis Results

# Tutorial-Performing Power Aware SI Analysis

In this tutorial, you will learn how to create a Power Aware SI analysis setup, run the analysis, and view results. The example workspace contains a Samsung DDR4 UDIMM memory card. The design files are downloaded from JEDEC (www. jedec.com) and used for demonstration purposes. The example design consists of a 6 layer board with a single power rail for core and I/O buffers, as shown in the following figure:



You can view the nets, components instances, and individual nets in the navigator window. The main power net passes from the conductor at the bottom of the design to the devices at the top. GND nets are present on the design. The substrate pack consists of routing on the top and bottom layer. The power and GND nets are on layer 3 and 4. Before performing the PIPro analysis, you need to know the names of the power and GND nets.

In this example design, the goal is to analyze the signal behavior of the critical line, including the effect of the GND metallization.

The goal of SI analysis is to provide an S-parameter model for the DQR15 line.

#### Example Workspace

examples/HSD/SIPro\_PIPro\_Getting\_Started\_Example\_wrk.7zads

#### Objective

- Set up a Power Aware SI analysis
- Run the Power Aware SI analysis
- View Power Aware SI results (S-parameter and Generate Schematic)

## Opening the Example Design

Open the *SIPro\_PIPro\_Getting\_Started\_Example\_wrk.7zads* design. The SI analysis setup data for a specific design is stored in a cell view of the "SIPro/PIPro Setup".

To create a sipiSetup view, open the layout and select Tools > SIPro/PIPro > Open Setup.

If the sipiSetup view already exists, you can open it with a double-click in the ADS Main window.



The SIPro/PIPro Setup window is displayed.

#### Creating a Power Aware SI Setup

In this example, you will create a new SI analysis setup. To create a new setup, right-click **Analyses** and then select **New SI Analysis**.

#### **Defining Ports**

For an SI analysis, you need to define ports that will be the ports of the S-parameters calculated by the tool. In this example, you will define two ports, one on each side of the single DQR15 line.

To define a port:

1. Select the **DQ15** line in the Nets tree.



In this example, you will use pins 6 and C2 to define the ports.

2. Drag and drop pin RN20 on the ports part of the tree.



By hovering over the exclamation mark, you will see that the GND reference for the port is not defined. You can either manually select a GND pin and drag it to the port. Alternatively, you can automatically find the closest GND pin by right-clicking **1: port** and then selecting **Add Nearby Pins To Minus Terminal**, which will add **J1.P24** as the minus reference to the port:



Two nets were automatically added to the list of nets: GND and DQ15. The metallization associated with these nets will be included in the Power Aware SI simulation.

- 3. Drag and drop pin J1 to the I/O Ports part of the tree.
- 4. Right-click 2: DQ15\_J1 and select Add Nearby Pins To Minus Terminal, which will add J1.P\_165 as the minus reference to the port:



#### **Defining Options**

To define options:

- 1. Double-click **Options** in the SI Analysis list.
- 2. Double-click in the **Points** field of the **Adaptive** frequency plan and type **150**.

Frequen	ncy Plans				
-					
+					
+	Туре	Start	Stop	Points	Step

- 3. Click the **Options** tab.
- 4. Accept the default **Resolution** and **Arc Resolution** value.
- 5. Optionally, you can model the GND metallization as ideal PEC by selecting the 'Use Ideal Ground Approximation' option, which will result in a faster overall simulation.
- 6. Click Done.

#### Running the Analysis

Save your SI analysis setup and double-click **Run** to start the SI analysis. The **Simulations** window is displayed and the SI analysis is initiated.

#### **Viewing Results**

After the analysis is complete, you can view results in the Results list. You can open the results during a simulation to viewing the intermediate results.

To view the S-parameters results:

- 1. Double-click the S-Parameters option in the Results list.
- 2. Select the required nets in the Single-Ended section.
- 3. Right-click the selected nets and select Add Return Loss.



#### View TDR/TDT Results

To View TDR/TDT results:

- 1. Double-click the **TDR/TDT** option in the Results list.
- 2. Select the required nets in the Single-Ended tab.
- 3. Right-click the selected nets and select Add TDR.


# Show Me How Do I Perform a Power Aware SI Analysis

Video: How to Perform a Power Aware SI Analysis

# Creating a Power Aware SI Analysis Setup

A Power Aware SI analysis enables you to compute the S-parameters over a broad frequency range for one or more critical lines defined via I/O ports in the setup.

# Creating a New Power Aware SI Analysis Setup

If you want to create a new setup, right-click Analyses and then select New SI Analysis.

Alternatively, you can copy an existing analysis setup to create a new one.

# Selecting Nets

To add nets to the SI analysis node in the SIPro/PIPro setup:

1. Select the required nets in the Project panel:

Nets 

 DQ15R
 DQ15R
 6 :: RN10
 C2 :: U1
 C8 :: U10

- 2. Right-click the nets and select Add to Analysis.
- 3. Select **PA-SI Analysis** as the target analysis.

SIPro/PIPro Setup
Select a target analysis
[PI-DC] Analysis 1
[PA-SI] Analysis 4
OK Cancel

4. Click OK. The selected nets are added to the SI Analysis list.

# Defining I/O Ports

The I/O ports define the + and - terminals for the S-parameter ports in the Power Aware SI simulation.

To define an I/O Port:

- 1. Select the required nets in the Nets list of the SI Analysis node.
- 2. Right-click the selected nets and select Create Ports or Component Model Groups.

Lib/Cell         Instance Name         Connected Nets         Action										
1	PC4-RDIMM_V090_RC_F0	Л	DQ00,DQ01	Create Ports 🔹						
2	PC4-RDIMM_V090_RC_F0	RN97	DQ00,DQ00R,DQ01,DQ01R	Create Ports 🔹						
3	PC4-RDIMM_V090_RC_F0	U19	DQ00R, DQ01R	Create Ports 🔹						
ro	und Net for searching Pins for I	ninus terminai								

- 3. To create a port, accept the default selection, Create Ports.
- 4. Click OK.

Alternatively, you can drag and drop pins. To define ports:

1. Drag a pin connected to the net that you want to model to the I/O Ports in the project panel. This will create a new I/O port with only the + connection defined.

 To complete the definition of this I/O Port, drag a nearby pin connected to a GND or PWR net to the I/O Port definition, or alternatively automatically connect the closest GND pin to the – terminal of the port by rightclicking the Port and selecting Add Nearby Pins To Minus Terminal.



NOTE

This operation will automatically populate the Nets list with the nets connected to the + and – terminal.

# **Defining Component Models**

Optionally, you can add components (series components such as resistors or decoupling capacitors) in the SI analysis.

To define a component model:

- 1. Select the component group, which you want to analyze, in the Components list.
- 2. Drag and drop the component group on Component Models. The instances will be grouped by component name.
- 3. Define the electrical model parameters by using one of the following ways:
  - a. Double-click the component instance to specify the electrical model parameters for that instance.
  - b. Alternatively, you can open the Vendor Parts database by selecting Tools > Vendor Parts DB. Drag and drop the appropriate vendor part onto the component instance node (single model assignment) or onto the component model group node (group model assignment). For more information, see Using Vendor Parts DB Browser.

# **Defining Options**

To define options, double-click Options in the SI Analysis list in the project panel. It provides the following options:

Option	Description
Resolution	Points closer than the specified resolution will be considered equal during the simulation

Option	Description
Arc Resolution	Value used to discretize circles and arcs during the simulation
Custom Target Mesh Size	Mesh size used to generate the global 3D mesh during simulation
Use Ideal Ground Approximation	When enabled, this option specifies that all Ground nets are considered as ideal shorts. The power rail is often the dominant contributor to the voltage drop. This option provides you the capability to analyze this dominant factor in less simulation time.
Use Optimized Via Modeling	Use via modeling settings optimized for simulation performance.
Model Signal Return Currents in Coplanar Ground	Ground metallization close to signal metallization is included in the signal modeling during simulation

# **Defining Frequency Plans**

Click the **Frequency Plans** tab to specify a plan.You can use the Automatic, Linear, Logarithmic and Adaptive frequency plan. The Automatic uses a optimal combination of Adpative and Linear sweeps to cover the frequency range. The Start frequency can be 0 Hz, the simulator will assume 1 kHz when 0 Hz is specified.

	<u>12</u> - 11 - 11	12347	2213	1026 D 12 1
	Туре	Start	Stop	Points
1	Automatic	0 Hz	1 GHz	300 (max - adaptive)

When using an Adaptive sweep for electrically long lines on a complex board, a large number of frequency points may be required to reach convergence, specifically when a large number of signal lines is being analyzed. A linear frequency plan setup is advised in this case.

To capture the dynamic behavior of a signal line when using a Linear sweep, you will need 10 frequency points per wavelength, so in case the length of the signal line is 5 wavelengths, you will need 50 frequency points. This is typically sufficient when using the SiPro generated S-parameter model in e.g. a transient or channel simulation.

# Saving the Setup

Save your SI analysis setup and double-click **Run** to start the SI analysis.

# Viewing Power Aware SI Analysis Results

After creating an SI analysis setup, you can run the analysis in the SIPro/PIPro Setup window. For an SI analysis, the following results are displayed:

- S-Parameters
- TDR/TDT
- Generate Sub Circuit

#### Running a Power Aware SI Analysis

To run an SI analysis and view results:

- 1. Save your SI analysis setup.
- 2. Double-click **Run** to start the SI analysis. The Simulations window is displayed, which allows you to monitor and manage simulations.
- 3. Expand the Results list:



You can view S-parameters and generate a Schematic.

#### **S-Parameters**

To view the S-parameters results:

- 1. Double-click the **S-Parameters** option in the Results list. The S-Parameters window is displayed.
- 2. Select the required nets in the Single-Ended section.
- 3. Right-click the selected nets and select the required option such as, Add transmission.



# Using the S-Parameters Results Window

The S-Parameters window consists of the following menus:

- Data
- Insert
- View

# Data

The Data menu provides the following options:

- **Export** : Exports the currently displayed plot to a text file.
- Save Plots as New Graph: Copies the current graph including plots and markers. It is saved in the Graphs node in the project tree.

#### Insert

The Insert menu provides the following options:

• Point Marker: Insert a point marker in the graph.



• Crosshair Marker: Insert a crosshair marker.



- Horizontal Marker: Insert a horizontal marker.
- Vertical Marker: Insert a vertical marker.

#### View

The View menu provides the following options:

- Pan: Left-click on the graph and move mouse pointer to pan.
- Zoom: Left click on the graph and move mouse pointer to create a rectangle to zoom.
- Zoom to Extents: Zoom in or out to current plots so that they can fit into the graph.
- **Export Image**: Export plot image to a file.

# **Toolbar Options**

The S-Parameters window provides several toolbar options for customizing the graph.

Icon	Description
	The Export Data icon enables you to export the currently displayed plot to a text file.
	The Export Image icon enables you to export the plot image to a file.
****	The Zoom to Extents icon enables you to zoom in or out to current plots so that they can fit into the graph.
	The Pan icon enables you to move mouse pointer to pan.
<del>Q_</del>	The Zoom Tool icon enables you to move mouse pointer to create a rectangle to zoom.

lcon	Description
	The Legend Visible icon enables you to show or hide the legends of the plots.
	The Selection tool icon enables you to select items in a plot.
	The Point Marker Tool insert a point marker in the graph.
<b>~</b>	The Crosshair Marker icon inserts a crosshair marker.
-0-	The Horizontal Marker icon inserts a horizontal marker.
	The Graph Properties icon displays the graph properties pane. You can change graph appearance, and axis controls.

# Graph Type Selector

O XY Graph: Magnitude ▼ O Smith Chart

You can set the following Graph Type Selector options to select a graph type:

- XY Graph Magnitude: Displays magnitude of the plots in the XY rectangular graph.
- XY Graph Phase: Displays phase of the plots in the XY rectangular graph.
- Smith Chart: Displays plots in the Smith chart.

#### Single Ended Tab

In the Single Ended tab, you can view the port properties, change the port impedance, and manipulate plots by rightclicking on each row in the table.

#### Port Property Table

The Port Property Table shows various port properties in a table.

Nur	mber	Net Type	Port	+Net	-Net	Instance	Z
Filter		Filter	Filter	Filter	Filter	Filter	Filter
10	1	Signal	DQ00_J1	DQ00	GND	J1	50 ohm
10	2	Signal	DQ00R_U19	DQ00R	GND	U19	50 ohm
<u>1</u>	3	Signal	DQ01_J1	DQ01	GND	J1	50 ohm
<u>1</u> 0	4	Signal	DQ01R_U19	DQ01R	GND	U19	50 ohm
10	5	Signal	DQ02_J1	DQ02	GND	J1	50 ohm
10	6	Signal	DQ02R_U19	DQ02R	GND	U19	50 ohm
10	7	Signal	DQ03_J1	DQ03	GND	J1	50 ohm
10	8	Signal	DQ03R_U19	DQ03R	GND	U19	50 ohm
10	9	Signal	DQS00R_C_U19	DQS00R_C	GND	U19	50 ohm
1	10	Signal	DQS00R_T_U19	DQS00R_T	GND	U19	50 ohm
<u>1</u>	11	Signal	DQS00_C_J1	DQS00_C	GND	J1	50 ohm
1	12	Signal	DQS00_T_J1	DQS00_T	GND	J1	50 ohm

- Number: Specifies to the S-parameter index.
- Net Type: Specifies whether the port's plus terminal connects to Signal nets or Power nets
- Port: Port name that you define in the analysis tree
- +Net: Specifies the net name(s) that is connected to the plus terminal of the port.
- -Net: Specifies the net name(s) that is connected to the minus terminal of the port.
- Instance: Specifies the instance name(s) with which a port connected. For top level pins, this property becomes blank.
- Z: Specifies the port impedance. This property is editable. To edit, double-click the cell or select Specify Reference Impedance context menu.

You can perform the following tasks by right-clicking a port and selecting the required option:

• Viewing the Transmission plot : Right-click the selected port and then select Add transmission to display the transmission characteristic(s) of selected port(s) to the graph. This feature will automatically find the other end of connected link of the selected ports. This feature is convenient to check transmission characteristics for the multiple lines.



• Viewing the Return Loss: Right-click the selected port(s) and select Add return loss to display the return plot(s) of selected port(s) to the graph.



• View the Insertion Loss: Right-click a net and then select Add Insertion Loss to display the insertion loss between the selected two ports to the graph.

NOTE

**Insertion loss** here does not necessarily mean "transmission". It means loss between any of two ports.

• View Near End Crosstalk: Right-click a port and then select Add Near End Crosstalk to view the near end crosstalk (s)of selected port(s) in the graph. This feature will automatically find all near end cross talk of the selected ports with using Instance information.



- Add Far End Crosstalk : Add far end crosstalk(s) of selected port(s) to the graph. This feature will automatically find all far end cross talk of the selected ports with using **Instance** information.
- Specify Reference Impedance : Set preferred reference impedance to the selected ports.
- **Remove All Plots** : Remove all plots from the graph.

#### Mixed Mode Tab

In the Mixed Mode tab, you can define differential pair of ports and add mixed mode plots in the graph in addition to most of what you can do in the Single Ended tab.

	Numbe	er	Signal	Net Type	Port	+Net	-Net	Instance	Z
F	ilter	Filt	er	Filter	Filter	Filter	Filter	Filter	Filter
Γ	1	SE		Signal	DQ00_J1	DQ00	GND	J1	50 ohm
	1 2	SE		Signal	DQ00R_U19	DQ00R	GND	U19	50 ohm
	<u>i</u> 3	SE		Signal	DQ01_J1	DQ01	GND	J1	50 ohm
	104	SE		Signal	DQ01R_U19	DQ01R	GND	U19	50 ohm
	105	SE		Signal	DQ02_J1	DQ02	GND	J1	50 ohm
	106	SE		Signal	DQ02R_U19	DQ02R	GND	U19	50 ohm
	10 7	SE		Signal	DQ03_J1	DQ03	GND	J1	50 ohm
	10 👔	SE		Signal	DQ03R_U19	DQ03R	GND	U19	50 ohm
	Þ <u>1</u> 9	D		Signal	DQS00R_C_U19 DQS00R_T_U19_D	DQS00R_C	DQS00R_T	U19	100
	Þ 🚺 10	С		Signal	DQS00R_C_U19 DQS00R_T_U19_C	DQS00R_C DQS00R_T	GND	U19	25
	Þ 🚺 11	D		Signal	DQS00_C_J1 DQS00_T_J1_D	DQS00_C	DQS00_T	J1	100
	Þ 🚺 12	С		Signal	DQS00_C_J1 DQS00_T_J1_C	DQS00_C DQS00_T	GND	J1	25

# Port Property Table

In the Mixed Mode tab, Signal column is added to the ones for Single Ended table.

- Signal: Shows the type of the port.
  - SE stands for Single Ended
  - D stands for Differential
  - C stands for Common.

#### Context menus

In mixed mode tab, some context menus are added and some context menus are removed comparing to the one for Single Ended tab.

#### Context menus only for Mixed Mode tab

- Make Differential Pairs: Make differential pairs for selected ports. This context menu works in two different ways depending on how many ports you select in the table.
  - If you select two ports in the table it means to create an differential pair for the selected two ports explicitly. If selected ports are already a part of other differential pair that differential pair will be broken before creating new differential pair.
  - If you select more than two ports in the table it means to create multiple differential pairs for selected ports. In this case differential pairs will be recognized and created automatically based on net names and instance name with using predefined Differential Pair Recognition Rule. (See more detail here).
  - In below example picture, selecting 4 ports and using Make Differential Pair for them will create two pairs as follows.

Number	Signal	Net Type	Port	+Net	-Net	Instance
Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	SE	Signal	DQ1_Rx	DQ1	Gnd	Rx
<u>1</u> 2	SE	Signal	DQ1_Tx	DQ1	Gnd	Tx
<u>1</u> 3	SE	Signal	DQ1#_Rx	DQ1#	Gnd	Rx
<u>1</u> ] 4	SE	Signal	DQ1#_Tx	DQ1#	Gnd	Tx

- Port1 and 3 as a differential pair because these plus nets are DQ1 and DQ1# which are recognized as differential pair by the recognition rule and also these are on the same instance Rx.
- Port2 and 4 as a differential pair because these plus nets are DQ1 and DQ1# which are recognized as differential pair by the recognition rule and also these are on the same instance Tx.

Number	Signal	Net Type	Port	+Net	-Net	Instance
Filter	Filter	Filter	Filter	Filter	Filter	Filter
Þ 🚺 1	D	Signal	DQ1_Rx DQ1#_Rx_D	DQ1	DQ1#	Rx
Þ <u>1</u> 2	D	Signal	DQ1_Tx DQ1#_Tx_D	DQ1	DQ1#	Tx
Þ <u>1</u> 3	С	Signal	DQ1_Rx DQ1#_Rx_C	DQ1 DQ1#	Gnd	Rx
Þ <u>1</u> 4	С	Signal	DQ1_Tx DQ1#_Tx_C	DQ1 DQ1#	Gnd	Tx

• Break Differential Pairs : Break existing pairs for selected ports.

#### Context menus not available for Mixed Mode tab

- Add Near End Crosstalk
- Add Far End Crosstalk

#### View Mixed Mode S-parameters

- View Return Loss : Use Add Return Loss context menu on desired ports.
- View Insertion Loss : Use Add Insertion Loss context menu on desired two ports that you want to view insertion loss in between. (Note: term of "Insertion Loss" doesn't necessarily mean insertion loss of physically connected link. )

#### Matrix Selector

	1	2	3	4	5	6	7	8	9	10	11	12
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

Matrix Selector allows you to select add/remove plots based on S-parameter index.

#### View TDR/TDT Results

To view TDR/TDT results:

- 1. Double-click the **TDR/TDT** option in the Results list.
- 2. Select the required nets in the **Single-Ended** section.
- 3. Right-click the selected nets and select the required option such as, Add TDR.



#### Using the TDR/TDT Results Window

The TDR/TDT window consists of the following menus:

• Export

#### Export

The Export menu provides the following options:

• Save Plots as New Graph: Copies the current graph including plots and markers. It is saved in the Graphs node in the project tree.

### **Toolbar Options**

The TDR/TDT window provides several toolbar options for customizing the graph. See **Toolbar Options** section in the Using the **S-Parameters Results Window** for more detail.

# **TDR/TDT Setup Options**

Start Time:	0 ns	Stop Time:	5 ns	Delay:	1 ns	Samples:	301
Result Type:	Impedance 🔹	Response Type:	Step 🔹	Pulse Width:	1 ns	Window:	8510 6.0 👻

Start Time : Specify start time.

Stop Time : Specify stop time.

Delay : Specify delay value.

Samples : Specify number of data samples in time domain.

Result Type : Specify Y-axis unit in either Impedance or Voltage.

Response Type : Specify response type either Step or Pulse.

Pulse Width : Specify pulse width for Pulse Response Type. This value is ignored in Step Response Type.

Window : Specify window type

# Single Ended Tab

In the Single Ended tab, you can view the port properties, change the port impedance, and manipulate plots by rightclicking on each row in the table.

Numb	er	Net Type	Port	+Net	-Net	Instance	Z
Filter	Filt	er	Filter	Filter	Filter	Filter	Filter
1	Sig	nal	DQ00_J1	DQ00	GND	J1	50 ohm
1 2	Sig	nal	DQ00R_U19	DQ00R	GND	U19	50 ohm
<u>i</u> 3	Sig	nal	DQ01_J1	DQ01	GND	J1	50 ohm
1 4	Sig	nal	DQ01R_U19	DQ01R	GND	U19	50 ohm
1 5	Sig	nal	DQ02_J1	DQ02	GND	J1	50 ohm
1 6	Sig	nal	DQ02R_U19	DQ02R	GND	U19	50 ohm
1 7	Sig	nal	DQ03_J1	DQ03	GND	J1	50 ohm
1 8	Sig	nal	DQ03R_U19	DQ03R	GND	U19	50 ohm
1 9	Sig	nal	DQS00R_C_U19	DQS00R_C	GND	U19	50 ohm
10	) Sig	nal	DQS00R_T_U19	DQS00R_T	GND	U19	50 ohm
11	L Sig	nal	DQS00_C_J1	DQS00_C	GND	J1	50 ohm
12	2 Sig	nal	DQS00_T_J1	DQS00_T	GND	J1	50 ohm

# Port Property Table

The Port Property Table shows various port properties in a table. See **Port Property Table** section in the Using the **S**-**Parameters Results Window** for more detail of table contents.

You can perform the following tasks by right-clicking a port and selecting the required option:

- Viewing the TDT plot : Right-click the selected port and then select Add TDT to display the TDT characteristic(s) of selected port(s) to the graph. This feature will automatically find the other end of connected link of the selected ports. This feature is convenient to check transmission characteristics for the multiple lines.
- Viewing the TDR plot : Right-click the selected port and then select Add TDR to display the TDR characteristic(s) of selected port(s) to the graph.
- Specify Reference Impedance : Set preferred reference impedance to the selected ports.
- **Remove All Plots** : Remove all plots from the graph.

# Mixed Mode Tab

In the Mixed Mode tab, you can define differential pair of ports and add mixed mode plots in the graph in addition to most of what you can do in the Single Ended tab.

Number	Signal	Net Type	Port	+Net	-Net	Instance	Z
Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	SE	Signal	DQ00_J1	DQ00	GND	J1	50 ohm
<u>1</u> 2	SE	Signal	DQ00R_U19	DQ00R	GND	U19	50 ohm
<u>1</u> 3	SE	Signal	DQ01_J1	DQ01	GND	J1	50 ohm
<u>1</u> 4	SE	Signal	DQ01R_U19	DQ01R	GND	U19	50 ohm
10 5	SE	Signal	DQ02_J1	DQ02	GND	J1	50 ohm
106	SE	Signal	DQ02R_U19	DQ02R	GND	U19	50 ohm
10 7	SE	Signal	DQ03_J1	DQ03	GND	J1	50 ohm
10 8	SE	Signal	DQ03R_U19	DQ03R	GND	U19	50 ohm
Þ 🏥 9	D	Signal	DQS00R_C_U19 DQS00R_T_U19_D	DQS00R_C	DQS00R_T	U19	100
Þ 🚺 10	С	Signal	DQS00R_C_U19 DQS00R_T_U19_C	DQS00R_C DQS00R_T	GND	U19	25
Þ 🚺 11	D	Signal	DQS00_C_J1 DQS00_T_J1_D	DQS00_C	DQS00_T	J1	100
Þ 🚺 12	С	Signal	DQS00_C_J1 DQS00_T_J1_C	DQS00_C DQS00_T	GND	J1	25

# Port Property Table

In the Mixed Mode tab, Signal column is added to the ones for Single Ended table.

- Signal: Shows the type of the port.
  - SE stands for Single Ended
  - **D** stands for Differential
  - C stands for Common.

In mixed mode tab, following context menus are added comparing to the one for Single Ended tab.

- Make Differential Pairs: Make differential pairs for selected ports. See the same section in the Using the S-Parameters Results Window.
- Break Differential Pairs : Break existing pairs for selected ports. See the same section in the Using the S-Parameters Results Window.

#### Matrix Selector

Matrix Selector allows you to select add/remove plots based on S-parameter index.

	1	2	3	4	5	6	7	8	9	10	11	12
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

# Generate Sub Circuit

Double-click Generate Sub Circuit in the Results list. A Schematic window is displayed, as shown in the following figure:



# Installing the Deprecated SI and PI Analysis Addon

#### WARNING

The legacy SI/PI analyzer is still available, but is a deprecated solution. Please use SIPro or PIPro instead, see Getting Started with SIPro and PIPro. This addon will no longer be available in the future major releases of ADS.

# Installing the Deprecated SI and PI Analysis Addon

The legacy SI/PI analyzer is available as an addon. The SI/PI Analyzer addon assists in setting up SI or PI EM and circuit simulations. This addon consists of two parts:

- Setup wizard: The setup wizard guides you through the process of creating a new cell that contains only selected nets (physical interconnects) to be analyzed. The output of the setup wizard is a cell that is ready for EM analysis.
- Analysis guide: The analysis guide assists in setting up typical SI or PI circuit simulation testbench. The output of the analysis guide is a circuit schematic, ready to be simulated, a data display template that captures relevant output figures. In addition, the analysis guide supports Momentum current visualization based on the results.

To install the SI and PI Analyzer addon:

- 1. Select Tools > App Manager in the ADS Main window.
- 2. Click Add User ADS Addon. The Add User Addon dialog box is displayed.
- 3. Click Browse.
- 4. Access the **\$HPEESOF\_DIR/ael\_addons/sipi\_deprecated/ael** folder.
- 5. Select the PhysSipi\_boot.atf file and click Open.
- 6. Click OK. The PhysSipi\_boot option is displayed in the User Addons list.
- 7. Select the Enabled check box for PhysSipi\_boot, as shown in the following figure:

Name	Enabled	Addon File Location
PCB Library Import To	ls - Cadence 📃	
PCB Library Import To	ls - All Vendors 📝	
PCB Library User Tools	- All Vendors 🛛 📝	
ADFI Import Tools	$\checkmark$	
EM Circuit Excitation	<b>v</b>	
Via Drawing Utility	$\checkmark$	
PDK Builder		
Bondwire Utility Tools		
SnP Utilities	$\checkmark$	
User Addons		
PhysSipi_boot	<b>V</b>	C:\Program Files\Keysight\AD
<		4
Add User ADS Addon Remov	User ADS Addon	

- 8. Click **Yes** in the message box.
- 9. Click **OK** in the message box.
- 10. Click **Close** in the App Manager window.
- 11. Open a Layout window. The SI/PI Analyzer addon is displayed in the menu bar, as shown in the following figure:

Add-Ons	SI/PI Analyzer	Ad	fi Tools	<u>H</u> elp
📲 🎦 🥲	Setup		1	
ψψ ··••••	Analysis		-	
		_		

# SIPro/PIPro Videos



Perform a PI-DC Analysis

This video talks about how to perform a PI-DC analysis.

Perform a Power Aware SI Analysis

This video talks about how to perform a Power Aware SI analysis.



Perform a PI-AC Analysis

This video talks about how to perform a PI-AC analysis.