

Voltus-Fi Custom Power Integrity Solution XL User Guide

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Voltus-Fi Licensing Information

This section contains the licensing requirements to run Voltus-Fi-XL.

Voltus-Fi-XL Licensing Requirements

You need the following licenses to use the Voltus-Fi Custom Power Integrity Solution XL software:

License	License Number	Description
Virtuoso Framework License (running Voltus-Fi-XL in the GUI mode requires checkout availability of the following license sets)		
Cadence Design Framework II (DFII)	111	This license must be checked out at Virtuoso startup.
Virtuoso Analog Design Environment XL (ADE XL)	95210	This license is required to run Voltus-Fi-XL from the Virtuoso Analog Design Environment (ADE L/ADE XL).
Simulator License (you need one of the following licenses for performing simulation)		
Spectre Accelerated Parallel Simulator (Spectre APS) with Spectre Power	91400	This license must be purchased separately. The Spectre Power option enables EMIR analysis with the Spectre APS base product.
Spectre eXtensive Partitioning Simulator (XPS) with Spectre Power	91400	This license must be purchased separately. The Spectre Power option enables EMIR analysis with the Spectre XPS base product.

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Voltus-Fi Licensing Information

License	License Number	Description
Voltus-Fi License (the Voltus-Fi Custom Power Integrity Solution software includes the following products. When you run a command to use a product, a license is checked out)		
Voltus-Fi Custom Power Integrity Solution-L (VTS-Fi-L)	VTS400	License string: Voltus_Power_Integrity_Fi_L Uses the extracted view to perform IR drop and Electromigration (EM) analysis. It uses the results of the simulation performed using the <code>vavo-db</code> or the <code>psf</code> data.
Voltus-Fi Custom Power Integrity Solution-XL (VTS-Fi-X)	VTS500	License string: Voltus_Power_Integrity_Fi_XL Performs multi-mode simulation (MMSIM) electromigration and voltage drop (EMIR) analysis for power and signal nets using the simulation database generated by Spectre APS or Spectre XPS. It is tightly integrated within Virtuoso. Note: With this license, you can also run Voltus-Fi Custom Power Integrity Solution-L (VTS-Fi-L).
Voltus-Fi Custom Power Integrity Solution-AA (VTS-Fi-AA)	VTS501	License string: Voltus_Power_Integrity_Fi_AA Supports the following advanced features: ■ Hierarchical EMIR Analysis ■ Hierarchical SHE Analysis

Note: Voltus-Fi will be obsolete in the next base IC release. The “next-generation” solution, Voltus-XFi, is available in this release of Virtuoso. It offers significant improvements to the overall EM-IR flow, including a unified use model, simplified simulation setup, and faster loading of results. The Voltus-XFi license is backward compatible and can be used to run Voltus-Fi if needed.

Voltus-Fi-XL Compatibility with MMSIM/SPECTRE and EXT Product Versions

The table below provides the mapping between the Voltus-Fi-XL product version and the corresponding EXT and MMSIM/Spectre versions that are compatible with it. It is recommended that you use these version specifications to avoid erroneous results.

Voltus-Fi-XL Version	EXT Version	MMSIM/SPECTRE Version
Voltus-Fi-XL ICADVM20.1	EXT 20.1x	SPECTRE 19.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR15	EXT 20.1x	SPECTRE 19.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR16	EXT 20.1x	SPECTRE 19.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR17	EXT 20.1x	SPECTRE 19.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR18	EXT 21.1x	SPECTRE 19.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR19	EXT 21.1x	SPECTRE 20.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR20	EXT 21.1x	SPECTRE 20.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR21	EXT 21.1x	SPECTRE 21.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR22	EXT 21.1x	SPECTRE 21.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR23	EXT 21.1x	SPECTRE 21.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR24	EXT 21.1x	SPECTRE 21.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR25	EXT 21.1x	SPECTRE 21.1.0 ISRx
Voltus-Fi-XL ICADVM20.1 ISR26	EXT 21.1x	SPECTRE 21.1.0 ISRx

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Voltus-Fi Licensing Information

Voltus-Fi-XL Version	EXT Version	MMSIM/SPECTRE Version
Voltus-Fi-XL ICADVM20.1 ISR27	EXT 21.2x	SPECTRE 21.1.0 ISRx

Voltus-Fi-XL Compatibility with Voltus IC Power Integrity Solution

The table below provides the mapping between the Voltus-Fi-XL product version and the corresponding Voltus IC Power Integrity Solution (Voltus) version that is compatible with it. It is recommended that you use this version specification to avoid erroneous results.

Important

The power-grid view (PGV) generation flow—Voltus-Fi and Voltus—does not provide backward compatibility with the earlier Voltus versions. It is recommended that you use the version specifications provided below.

Voltus-Fi-XL Version	Voltus Version
Voltus-Fi-XL ICADVM20.1	Voltus IC Power Integrity Solution 19.14
Voltus-Fi-XL ICADVM20.1 ISR15	Voltus IC Power Integrity Solution 19.14
Voltus-Fi-XL ICADVM20.1 ISR16	Voltus IC Power Integrity Solution 19.17
Voltus-Fi-XL ICADVM20.1 ISR17	
Voltus-Fi-XL ICADVM20.1 ISR18	
Voltus-Fi-XL ICADVM20.1 ISR19	
Voltus-Fi-XL ICADVM20.1 ISR20	Voltus IC Power Integrity Solution 20.62
Voltus-Fi-XL ICADVM20.1 ISR21	Voltus IC Power Integrity Solution 20.62
Voltus-Fi-XL ICADVM20.1 ISR22	Voltus IC Power Integrity Solution 20.63
Voltus-Fi-XL ICADVM20.1 ISR23	Voltus IC Power Integrity Solution 20.63
Voltus-Fi-XL ICADVM20.1 ISR24	Voltus IC Power Integrity Solution 20.63
Voltus-Fi-XL ICADVM20.1 ISR25	Voltus IC Power Integrity Solution 20.63
Voltus-Fi-XL ICADVM20.1 ISR26	Voltus IC Power Integrity Solution 20.63

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Voltus-Fi-XL Version	Voltus Version
Voltus-Fi-XL ICADVM20.1 ISR27	Voltus IC Power Integrity Solution 20.63

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Voltus-Fi Licensing Information

Getting Started with Voltus-Fi-XL

This section contains an overview of Voltus-Fi-XL, its key features, and how to start working with the tool.

Overview of Voltus-Fi-XL

Voltus-Fi-XL is used for transistor-level power-integrity analysis, which includes multi-mode simulation (MMSIM) electromigration and voltage drop (EMIR) analysis for transistor designs. The target designs include analog, analog/mixed-signal (AMS), and custom digital designs of large sizes that are created using Virtuoso.

This product is tightly integrated within Virtuoso. The results of the analyses are displayed on the Virtuoso layout. Voltus-Fi-XL also generates text reports of the analyses and lets you query the analyses results to view specific violations in the layout. This is used to identify and debug regions of high IR drop and EM violations in the design. After analyzing the EMIR results, you can create power-grid views (PGVs) of the design block, which can then be used in Voltus for mixed-signal analysis.

Voltus-Fi-XL uses the simulation database generated by simulators—Spectre Accelerated Parallel Simulator (APS) and Spectre eXtensive Partitioning Simulator (XPS)—as inputs to perform EMIR analysis.

Note: Voltus-Fi will be obsolete in the next base IC release. The “next-generation” solution, Voltus-XFi, is available in this release of Virtuoso. It offers significant improvements to the overall EM-IR flow, including a unified use model, simplified simulation setup, and faster loading of results. The Voltus-XFi license is backward compatible and can be used to run Voltus-Fi if needed.

A brief description of the capabilities of the two simulators is provided below.

- Spectre APS is a new-generation SPICE simulator that provides high performance, high capacity circuit simulation with full Spectre accuracy. APS achieves maximum simulation performance by enabling multi-threading on multi-core and multi-CPU shared memory systems.

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- Spectre XPS is a new-generation transistor-level circuit simulator that emphasizes high simulation performance and large simulation capacity, and addresses the design and verification needs of full-chip low-power designs at advanced process nodes.

Related Topics

- [Key Features of Voltus-Fi-XL](#)
- [Running Voltus-Fi-XL in Batch Mode](#)
- [Running Voltus-Fi-XL in GUI Mode](#)
- [Accessing Documentation and Help](#)

Key Features of Voltus-Fi-XL

The following table lists the key features of Voltus-Fi-XL.

Feature	Description
Extraction	Supports the generation of the Detailed Standard Parasitic Format (xDSPF) file using Quantus. This file provides all the parasitic information of the design for performing simulation using Spectre.
Simulation-based analysis	Uses APS/XPS—direct or iterated method for EMIR analysis.
Support for multiple simulation results files for EMIR analysis	Supports the following: ■ Multiple bin files that contain simulation results for different nets from the same testbench ■ Multiple bin files that contain simulation results from different testbenches for the same design
Static current analysis	Evaluates IR drop and EM currents based on user-provided subcircuit instance current consumptions without running a transient or DC simulation.

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Feature	Description
Signal net and power-rail IR drop analysis	Supports the following: ■ Solid shape highlighting ■ Displaying and querying results ■ Analyzing power-gated designs ■ The following plot types: peak and average IR drop, transistor voltage, peak and average tap current, RMS tap current, powergate current, powergate voltage, peak, average, and RMS resistor current, and effective resistance plots
Signal net and power-rail EM analysis	Supports the following: ■ Solid shape highlighting ■ Displaying and querying results ■ All types of EM analysis: peak, average, rms, AC-peak, and absavg ■ Text-based ICT file for specifying EM rules ■ Advanced EM rules with <code>qrcTechFile</code> for 20nm and below technologies ■ The <code>emDataFile.txt</code> file for backward compatibility in 28nm and above technologies
Static and dynamic PGV generation	Creates PGVs of an analog design block that can be used in Voltus for mixed-signal analysis.

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Feature	Description
Advanced debug features	Structural analysis is a shape-based geometrical analysis that is used to quickly identify power-grid weaknesses in designs and mark them on the Virtuoso layout for you to view and debug. Structural analysis cuts down on the sign-off analysis time. The following checks are supported: ■ Missing Via analysis ■ Via coverage ratio ■ Skewed via ratio
	Effective resistance is calculated between any two nodes (pins, tap nodes, or subnodes), either on the same net or on different layers of the same net. This feature uses the DSPF file, used for Spectre simulation, and the SPGS feature of Spectre.
	Least-Resistive Path (LRP) analysis helps you identify weakly connected instances in the design during early stages of power planning. It displays the worst IR drop violations and plots the LRP on demand for any node.
	What-If analysis feature lets you analyze the impact of potential layout changes, without implementing these changes in the layout, and re-extracting the xDSPF file. These changes are also called the ECO changes.
	Self-Heating Effect (SHE) analysis flow visualization and the thermal-aware DC EM flow visualization. You can view the results of the these analyses by plotting them on the Virtuoso layout to show the worst deltaT violations. You can then debug your design to reduce the self-heating effect.
Viewing Results in vfiplot	The vfiplot utility is used to view the results of the IR drop and EM analysis that is performed in Voltus-Fi-XL. The key benefits of viewing the results of IR drop and EM analysis in vfiplot are as follows: ■ No dependency on the Virtuoso layout ■ Increased speed of visualization

Installation Information

- Voltus-Fi-XL is launched within the Virtuoso Platform. To use this product, you must have the Virtuoso ICADVM20.1 release version.
- To check whether Voltus-Fi-XL is available in your Virtuoso Studio Design Environment, type the following in the UNIX window, shell, or xterm:

```
vfibatch -v
```

This prints the product version available in your Virtuoso Studio Design Environment.

- Voltus-Fi-XL is supported only on the Linux (only 64-bit) platform. To specify the 64-bit version, you need to set the `CDS_AUTO_64BIT` environment variable before starting the software. If you are using the `lnx86` operating system, verify that it supports 64-bit applications.

- To run all applications in 64-bit mode, run the following command:

```
setenv CDS_AUTO_64BIT ALL
```

- To run specific applications in 64-bit mode, such as Spectre and Voltus-Fi-XL, and all other applications in 32-bit mode, run the following command:

```
setenv CDS_AUTO_64BIT spectre:vfibatch
```

Related Topics

- [Running Voltus-Fi-XL in Batch Mode](#)
- [Running Voltus-Fi-XL in GUI Mode](#)

Running Voltus-Fi-XL in Batch Mode

You can run Voltus-Fi-XL as a batch command, running it from Virtuoso in non-graph mode. Batch mode is used when the simulation database is already generated, and you want to print the IR/EM text reports without viewing the plots on the layout.

The batch mode flow of Voltus-Fi-XL supports both the configuration file or the `conf` file and the command file, `cmd_file`.

To run Voltus-Fi-XL in batch mode, do one of the following:

- Use the following command to run Voltus-Fi-XL from the UNIX window, shell, or xterm:

```
vfibatch -cmd <cmd_file>
```

Where, *<cmd_file>* is a file with a list of batch commands that define the input data, control the execution of the analysis, and specify the output location.

Note: You can also use the `emirreport` command, from the simulation hierarchy, to generate textual and HTML reports for IR and EM analysis.

- Use the following command to run Voltus-Fi-XL by specifying the EMIR configuration file:

```
vfibatch -c <emir conf> -db <simulation directory path> -outdir  
<output directory>
```

You can specify the control file options in the configuration file using the `emirutil` command.

Related Topics

- [Running Voltus-Fi-XL in GUI Mode](#)
- [Batch Commands in Voltus-Fi-XL](#)

Running Voltus-Fi-XL in GUI Mode

The flow to run Voltus-Fi-XL in GUI mode comprises the following steps:

1. [Starting the Virtuoso Studio Design Environment](#)
2. [Opening the Schematic or Layout View](#)
3. [Launching Voltus-Fi-XL](#)

Starting the Virtuoso Studio Design Environment

To start the Virtuoso Studio design environment, do the following:

- Type `virtuoso &` in the UNIX window, shell, or xterm.

The Command Interpreter Window (CIW) opens. You interact with the design environment from the CIW.

Opening the Schematic or Layout View

You need to open the schematic or layout view of your design in the Virtuoso Schematic Editor or Virtuoso Layout Suite, respectively. To do this, use either the *File* menu or the *Tools* menu of the CIW.

File Menu of CIW

1. Choose *File – Open*.

The Open File form is displayed.

2. In the *File* group box, select a *Library*, select a cell name from the *Cells* list or directly type the cell name in the *Cell* field, and select a *View* (either *schematic* or *layout*).

Alternatively, you can click *Browse* to open the Library Browser – Open File window and select your design.

3. In the *Application* group box, select an item from the *Open with* drop-down list.
4. Select one of the *Open for* options: *edit* or *read*.
5. Click *OK*.

Tools Menu of CIW

1. Choose *Tools – Library Manager*.

The Library Manager form is displayed.

2. To select a library and its corresponding cell and view, click the item names in the order: *Library*, *Cell*, and *View*. Select *schematic* or *layout* in the *View* section.
3. Double-click the view to open the design in the Virtuoso Schematic Editor or Virtuoso Layout Suite.

Launching Voltus-Fi-XL

You can run Voltus-Fi-XL from the Virtuoso Studio Design Environment in two ways. You can run it either from the Virtuoso Layout Suite using the plug-in option, or from the Virtuoso Analog Design Environment (ADE L/ADE XL) after adding the DSPF file and performing postlayout simulation with EMIR analysis.

From Virtuoso Layout Suite

1. Choose *Launch – Plugins – Voltus-Fi-XL*.

The Voltus-Fi-XL console opens.

From ADE L/ADE XL

The steps for launching Voltus-Fi-XL using ADE L are detailed below. The same steps can be used to launch Voltus-Fi-XL using ADE XL.

1. From Virtuoso Schematic Editor or Virtuoso Layout Suite, choose *Launch – ADE L*.

The ADE L window opens.

2. Set up and run simulation, and generate the simulation database.
3. In the main menu of the ADE L window, choose *Results – EM/IR Data – Layout Analysis*.
4. In the Select Layout View form, select the cell name from the *Cell* drop-down list and click *OK*.

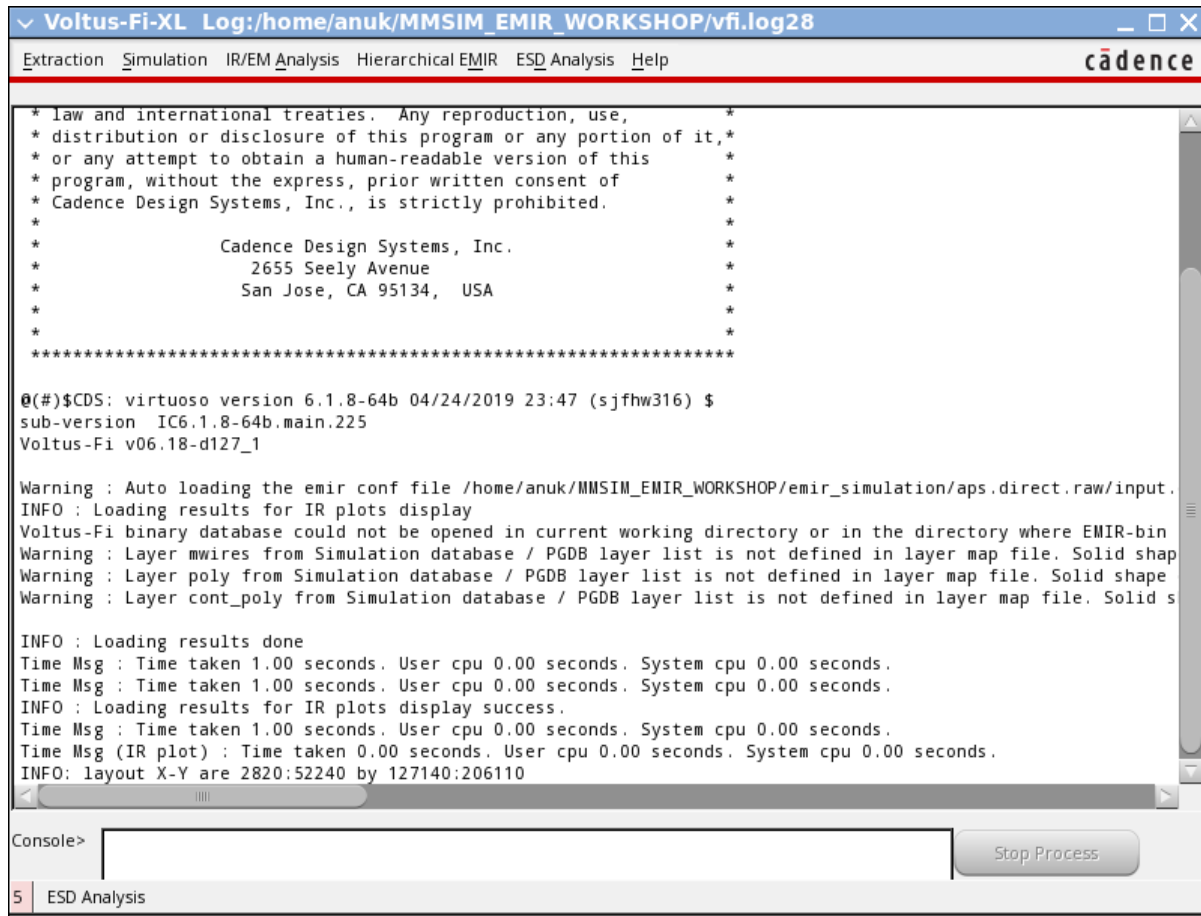
The following windows open:

- ☐ Voltus-Fi-XL console
- ☐ IR/EM Results form of Voltus-Fi-XL

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Voltus-Fi-XL Console



The screenshot shows the Voltus-Fi-XL console window with the title bar 'Voltus-Fi-XL Log:/home/anuk/MMSIM_EMIR_WORKSHOP/vfi.log28'. The menu bar includes 'Extraction', 'Simulation', 'IR/EM Analysis', 'Hierarchical EMIR', 'ESD Analysis', and 'Help'. The Cadence logo is in the top right corner. The main text area displays the following content:

```
* law and international treaties. Any reproduction, use,
* distribution or disclosure of this program or any portion of it,*
* or any attempt to obtain a human-readable version of this
* program, without the express, prior written consent of
* Cadence Design Systems, Inc., is strictly prohibited.
*
* Cadence Design Systems, Inc.
* 2655 Seely Avenue
* San Jose, CA 95134, USA
*
*****

@(#)CDS: virtuoso version 6.1.8-64b 04/24/2019 23:47 (sjfhw316) $
sub-version IC6.1.8-64b.main.225
Voltus-Fi v06.18-d127_1

Warning : Auto loading the emir conf file /home/anuk/MMSIM_EMIR_WORKSHOP/emir_simulation/aps.direct.raw/input.
INFO : Loading results for IR plots display
Voltus-Fi binary database could not be opened in current working directory or in the directory where EMIR-bin
Warning : Layer mwires from Simulation database / PGDB layer list is not defined in layer map file. Solid shap
Warning : Layer poly from Simulation database / PGDB layer list is not defined in layer map file. Solid shape
Warning : Layer cont_poly from Simulation database / PGDB layer list is not defined in layer map file. Solid s

INFO : Loading results done
Time Msg : Time taken 1.00 seconds. User cpu 0.00 seconds. System cpu 0.00 seconds.
Time Msg : Time taken 1.00 seconds. User cpu 0.00 seconds. System cpu 0.00 seconds.
INFO : Loading results for IR plots display success.
Time Msg : Time taken 1.00 seconds. User cpu 0.00 seconds. System cpu 0.00 seconds.
Time Msg (IR plot) : Time taken 0.00 seconds. User cpu 0.00 seconds. System cpu 0.00 seconds.
INFO: layout X-Y are 2820:52240 by 127140:206110
```

At the bottom, there is a 'Console>' input field, a 'Stop Process' button, and a status bar showing '5 ESD Analysis'.

Related Topics

- [Running Voltus-Fi-XL in Batch Mode](#)
- [Batch Commands in Voltus-Fi-XL](#)
- [Voltus-Fi-XL Console Description](#)
- [Launching Voltus-Fi-XL from Virtuoso ADE Explorer Environment \(video\)](#)
- [Launching Voltus-Fi-L/XL from Virtuoso Layout Suite for EMIR Analysis \(video\)](#)

Specifying Simulation Settings in ADE L/ADE XL

Before you run simulation, you need to specify the simulation settings in ADE L/ADE XL. The steps required in ADE L are detailed below. The same steps can be used in ADE XL.

To specify simulation settings in ADE L, do the following:

1. In the main menu of the ADE L window, choose *Setup – Simulation/Directory/Host* and specify the *Simulator* as *spectre*.
2. Choose *Setup – High Performance Simulation* and ensure that *APS* and its *Post-Layout Settings* group box options are selected.
3. Choose *Setup – Model Libraries* and load the appropriate model files.
4. Choose *Setup – Simulation Files* and in the Simulation Files Setup form, specify the *Definition Files* and *Parasitic Files (DSPF)*.

Note: The Definition File contains the UTI commands. This file is required for generating power-grid views in Voltus-Fi-XL.

Related Topics

- [Running Voltus-Fi-XL in GUI Mode](#)
- [Specifying EMIR Analysis Settings in ADE L/ADE XL](#)
- [Generating Simulation Database in ADE L/ADE XL](#)

Specifying EMIR Analysis Settings in ADE L/ADE XL

Before performing EMIR analysis in Voltus-Fi-XL, you need to specify the EMIR analysis settings in ADE L/ADE XL. The settings required for static and dynamic EMIR analysis are different. The steps required in ADE L are detailed below. The same steps can be used in ADE XL.

Setting up Static EMIR Analysis

Static EMIR analysis estimates the IR and EM current density without performing a circuit simulation based on the user-specified current estimates in the static current file. To set up static EMIR analysis, do the following:

1. In the main menu of the ADE L window, choose *Setup – EM/IR Analysis*.

The Voltus-Fi XL Analysis Setup form opens.

2. In the *Analysis* tab, select the *Type* of analysis as *Static*.
3. In the *Net Selection* group box, click *Select* to choose the *Net Name* for the nets to be analyzed in the schematic. In the schematic, select an instance. Selecting an instance chooses all the nets of the instance with the wild card “*”.
4. Specify the *Static Current File*.
5. Select *avg* current analysis for both *IR Drop Analysis* and *EM Current Analysis*.
Note: By default, IR drop is calculated only for the power nets and not for the signal nets. For EM analysis, both the power and signal nets are considered.
6. Click *Add/Modify* to add the net and analysis combination statements to the summary information in the EMIR configuration file.
7. In the *Solver* tab, ensure that the *Speed* is set to *default*.
8. In the *Option* tab, select an option from the *Advanced Option* drop-down list or specify the required option in the *Additional Option* field.
Note: The DSPF file included through the *Simulation Files* submenu of ADE L is automatically populated in the *DSPF File Checking* group box.
9. Click *Run* to invoke the spfchecker.
10. Select the *EMIR Analysis for Static* check box at the bottom of the form.
11. Click *OK* to save the static EMIR analysis settings for the run.

Setting up Dynamic EMIR Analysis

Dynamic EMIR analysis requires a DC or transient simulation. To set up dynamic EMIR analysis, do the following:

1. In the main menu of the ADE L window, choose *Setup – EM/IR Analysis*.
The Voltus-Fi XL Analysis Setup form opens.
2. In the *Analysis* tab, select the *Type* of analysis as *Dynamic*.
3. In the *Net Selection* group box, click *Select* to choose the *Net Name* for the nets to be analyzed in the schematic. In the schematic, select an instance. Selecting an instance chooses all the nets of the instance with the wild card “*”.
4. Select the analysis types from available options: *IR Drop Analysis*, *EM Current Analysis*, and *Advanced IR Drop Analysis*.
Note: Select the *EM Current Analysis* options, *max* and *avg*, if you want to perform AC-Peak analysis later in Voltus-Fi-XL.

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5. Click *Add/Modify* to add the net and analysis combination statements to the summary information in the EMIR configuration file.
6. In the *EM Rule Check Setup* group box, specify the *EM Tech File*.
7. In the *Solver* tab, select *direct* as the *Solver Method*.
8. In the *Time Window Setup* group box, select an option to specify EMIR analysis duration.

Full Transient is selected by default, which means the EMIR analysis is run over the entire simulation period. You can also select *Time Window* and provide the start and stop times.

9. In the *Option* tab, select an option from the Advanced Option drop-down list or specify the required option in the *Additional Option* field.

Note: The DSPF file included through the *Simulation Files* submenu of ADE L is automatically populated in the *DSPF File Checking* group box.

10. Click *Run* to invoke the spfchecker.
11. Select the *Enable EMIR Analysis in Transient or DC Simulation* check box at the bottom of the form.
12. Click *OK* to save the dynamic EMIR analysis settings for the run.

The *Summary Information* group box at the bottom of the Voltus-Fi XL Analysis Setup form is updated as you make changes in the form or click *Add/Modify* where applicable. The summary section contains the final set of commands in the EMIR configuration file. This file is later used by Spectre APS for performing EMIR analysis.

Related Topics

- [Performing Static EMIR Analysis in the Virtuoso ADE Explorer Environment](#) (video)
- [Setting Up and Running Dynamic EMIR Analysis in Virtuoso ADE Explorer](#) (video)
- [Running Voltus-Fi-XL in GUI Mode](#)
- [Specifying Simulation Settings in ADE L/ADE XL](#)
- [Generating Simulation Database in ADE L/ADE XL](#)

Generating Simulation Database in ADE L/ADE XL

After specifying simulation and EMIR analysis settings, you need to run a simulation in ADE L/ADE XL to generate the simulation database.

To do this:

- In the main menu of the ADE L/ADE XL window, choose *Simulation – Netlist and Run*.

You should use this option when you run the simulation for the first time and also when you have edited your design. Using this option ensures that your design, the ADE setup, and the output netlist for simulation are synchronized. A progress bar appears at the bottom of the simulation window displaying the status of netlisting and simulation runs. You can view the details of the run in the UNIX window, shell, or xterm.

Related Topics

- [Running Voltus-Fi-XL in GUI Mode](#)
- [Specifying Simulation Settings in ADE L/ADE XL](#)
- [Specifying EMIR Analysis Settings in ADE L/ADE XL](#)

Accessing Documentation and Help

You can access the Voltus-Fi-XL documentation and Cadence Help using one of the following methods:

From the Command Prompt

1. Change to the following directory: `installation_dir/tools/bin`
2. Enter the following command:

```
./cdnshelp
```

After launching Cadence Help, press **F1** or choose *Help – Contents* to display the help page for Cadence Help.

From the Voltus-Fi-XL GUI

Do one of the following:

- Click *Help* in the Voltus-Fi-XL console.
- Click *Help* on the bottom-right corner of any form.

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Getting Started with Voltus-Fi-XL

Clicking *Help* opens the Voltus-Fi-XL user guide entry for the form in the Cadence Help window.

From Cadence Online Support

- Select Cadence Online Support on the Virtuoso *Help* menu.

The Cadence Online Support website is opened in your browser. You are required to have a Cadence Online Support account to access these materials.

Related Topic

- [Voltus-Fi-XL Console Description](#)

Voltus-Fi-XL Console Description

The following main menus of Voltus-Fi-XL are available. In addition to the menus, there is a *Stop Process* button in the console. This button is enabled when you run a process. Click this button to stop a process while it is running.

Menu	Description
<i>Extraction</i>	Opens the Extract xDSPF form that lets you generate an xDSPF file.
<i>Simulation</i>	Opens the Setup and Run Current Analysis form that lets you set up and run the static current analysis mode for peak current analysis.
<i>IR/EM Analysis</i>	Opens the following forms: ■ IR/EM Results: Lets you view the IR drop and EM analysis results. ■ Create Power Grid Views: Lets you create PGVs. ■ Connect and vfi: Lets you connect to the port and opens the vfi form using which you can view the IR drop and EM analysis results.

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Menu	Description
<i>Hierarchical EMIR</i>	Opens the following forms for performing hierarchical EMIR analysis: ■ Create Power Grid Views: Lets you create block-level PGVs and xDSPF files. ■ Extract xDSPF: Lets you generate the top-level xDSPF file. ■ Hierarchical Top Simulation: Lets you perform top-level simulation.
<i>Help</i>	■ Opens the <i>Voltus-Fi Custom Power Integrity Solution XL User Guide</i> and the Voltus-Fi Custom Power Integrity Solution XL What's New chapter in the <i>Virtuoso What's New</i> document. ■ Provides the version information of Voltus-Fi-XL.

Related Topics

- [Key Features of Voltus-Fi-XL](#)
- [Accessing Documentation and Help](#)

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Getting Started with Voltus-Fi-XL

Data Preparation

This section contains information about the inputs that are required for running EMIR analysis in Voltus-Fi-XL.

Voltus-Fi-XL Flow Overview

The Voltus-Fi-XL-Spectre® Accelerated Parallel Simulator (APS)/eXtensive Partitioning Simulator (XPS) flow is a two-step flow.

Step1: Simulation is run using Spectre APS/XPS and the simulation database is generated.

Step2: The simulation output generated in the above step is provided as input to Voltus-Fi-XL, which performs the following electromigration and voltage drop (EMIR) analyses:

- ☐ Power IR/EM analysis
- ☐ Signal IR/EM analysis
- ☐ Structural analysis

Voltus-Fi-XL generates text reports of IR drop and EM violations and displays them as plots on the Virtuoso® layout. It also provides batch mode support for IR/EM analysis and report generation.

Note: Voltus-Fi-XL supports both static and dynamic EMIR analysis.

Spectre APS/XPS EMIR Flow Overview

With MMSIM/SPECTRE12.1, Spectre APS and Spectre XPS, Cadence delivers a new EMIR solution. This dynamic power EMIR and signal EM capability uses a new technology, and is designed to provide higher capacity and better performance compared to existing EMIR solutions. Within this flow, Spectre APS can be used for high accuracy EMIR analyses; while Spectre XPS can be deployed for high performance and high capacity EMIR simulation.

In an EMIR flow, a circuit is evaluated together with the parasitic resistor and capacitor network, which models the IR drop or the EM effect. There are two general approaches of solving such a problem.

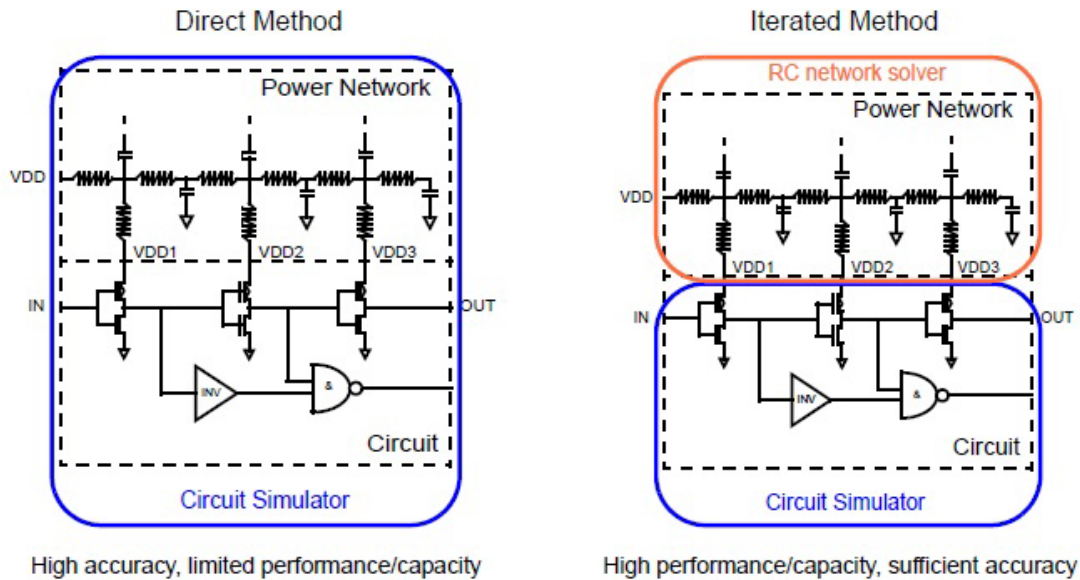
- 1. Direct EMIR analysis:** When high accuracy is needed, a brute-force simulation of the entire system – circuit plus parasitic resistances and capacitances – can be performed to accurately calculate EMIR of any net. This approach is called the “one-step” method, where the EMIR simulation performance and capacity is subject to the limitation of the circuit simulator being used.
- 2. Iterated EMIR analysis:** To conduct EMIR simulation on circuits with much larger power and signal nets, within a shorter time, there is an alternative approach that involves decoupling the nonlinear circuit simulation from the linear RC net analysis. You can iterate the linear RC net analysis by modifying the layout, however, the nonlinear circuit

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simulation is done only once. This approach is called the “two-step” method. The decoupling of the linear RC nets from the nonlinear circuit is not mathematically equivalent to the original design and certain inaccuracy is introduced but it provides the benefit of simulation performance and capacity.

The above two approaches are depicted in the figure below.



For high accuracy EMIR analysis of small design blocks, or designs with smaller numbers of RC nets, the direct EMIR analysis method is recommended, where Spectre APS and Spectre XPS SPICE mode are fully supported. Spectre XPS does not support direct EMIR analysis.

To gain higher performance and higher capacity on medium to large designs, the iterated EMIR analysis method is recommended. Spectre XPS is used for these large-scale simulations as it is able to take full advantage of the FastSPICE technology. Both, Spectre APS and Spectre XPS SPICE mode support iterated EMIR analysis.

The Spectre APS/XPS EMIR flow requires a complete testbench that contains Detailed Standard Parasitic Format (DSPF) files – with parasitic and instance sections describing the circuit to be analyzed – and stimuli, device models, and so on. The presence of a `+emir` statement on the Spectre command line enables the EMIR analysis during circuit simulation. The details of EMIR analysis, including the type of analyses to be performed, nets to be analyzed, and the output to be generated, are specified using an EMIR configuration file.

Using either direct EMIR analysis or iterated EMIR analysis, the circuit simulation is performed first with various voltages and currents being calculated. Next, a standalone tool,

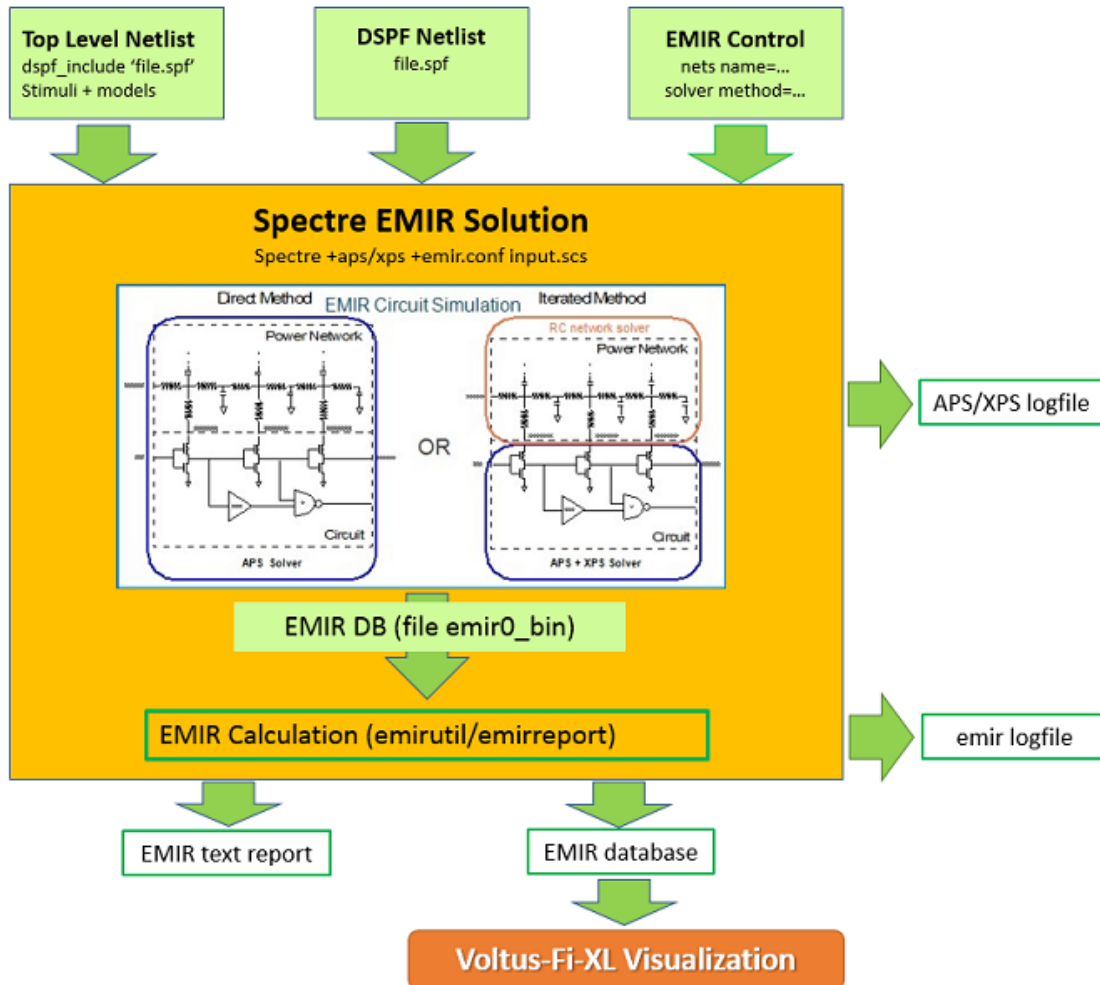
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`emirutil`, is called to post-process the simulation results and generate IR and EM reports. By default, this postprocessing step is invoked automatically.

The output of the EMIR analysis is an EMIR text report, which lists the EM and/or IR information of the specified nets. In addition, an OA database is generated to enable the visualization of the EMIR results on the Virtuoso layout using Voltus-Fi Custom Power Integrity Solution tool.

This flow is shown in the below figure.



Data Requirements for Voltus-Fi-XL

The following inputs are required for EMIR analysis in Voltus-Fi-XL:

- A simulation output directory that contains the EMIR database

- The `qrcTechFile` with EM Models for EM rules, text-based ICT file, or the `emDataFile.txt` file with EM rules
 - Layer map file – this file is required to map the layer names in the simulation result file and the technology file
- Note:** This file is required only if the layer names in the two files are different.
- APS/XPS-to-DFII layer map file for solid shape display and structural analysis
 - Net names (optional)
 - Information about the type of analysis to be performed (peak, avg, rms, absAvg)

xDSPF Requirements

The third-party netlist file or xDSPF is used to provide all the parasitic information of the design for performing simulation using the Spectre APS/XPS simulators. The xDSPF must include the following information:

- All power ground nets extracted
- Layer information with each resistor
- x, y co-ordinates of the parasitic resistors, and
- Decoupled RC of all signal nets

DSPF files are created using the parasitic extraction tools and their content and format is heavily dependent on the extraction tool and the extraction runset. Often simulation problems occur due to problems in the DSPF file. To ensure that the DSPF file is compatible with the simulation requirements use the Standard Parasitic Format (SPF) Checker utility before using the file in the MMSIM/SPECTRE EMIR flow.

The SPF Checker utility analyzes the DSPF file, reports problems that may cause simulation problems, and creates an EMIR conf file with recommended mapping statements.

Note:

- Ensure that there is no pin on the substrate shorting in the xDSPF. Set the extractor accordingly.
- Voltus-Fi-XL supports the generation of the xDSPF file using Quantus both from the GUI and in batch mode.

Simulation Requirements and Setup

For viewing IR drop and EM analysis results in Voltus-Fi-XL, the simulation database generated using Spectre APS/XPS simulators is loaded into Voltus-Fi-XL.

For EMIR analysis, ensure the following while performing simulation.

- Create a complete simulation testbench with the DSPF files containing the post-layout data of the design, including fingered devices and net parasitics. Use the `dspf_include` statement to read the DSPF content, as shown below.

```
dspf_include "sram.spf" (Spectre syntax)
.dspf_include "sram.spf" (SPICE syntax)
```

Note: Though `include/.include` statements are also supported, it is recommended to use `dspf_include/.dspf_include` statements, which automatically handle duplicated subcircuit definitions and port order differences.

Important

Use the SPF Checker utility before using the file in the MMSIM/SPECTRE EMIR flow.

- Define the EMIR configuration using the EMIR control file (`emir.config`), and include the control file with the `+emir` statement on the Spectre command line, as shown below.

```
% spectre +aps +emir=emir.conf input.scs (APS solver)
% spectre +xps +emir=emir.conf input.scs (XPS solver)
```

- Before plotting EMIR results, ensure that the simulation result file is available in the output directory of the simulation results.

The naming convention for the simulation results file is; `*.emir#_bin`. For example, the result file could be named, `xps.emir0_bin`. This file is required for displaying IR and EM plots and generating text reports in Voltus-Fi-XL.

Note: In the APS direct method of simulation, no intermediate database files are created. However, in the iterated method, EMIR files have the `emirtap` file extension. The 1st stage EMIR circuit simulation creates the tap device voltage profiles that are stored in the `pwl` files, and used in the 2nd stage. The 2nd stage RC network solver writes all IR drop and EM current values into the binary database with the extension `emir0_bin`. This binary database is used by `emirutil/emirreport` for creating the text/HTML/CSV reports, and by Voltus-Fi-XL to visualize the results in the layout.

```
Direct method: design.emir0_bin, design.rpt_ir, design.rpt_em
Iterated method: design.emirtap.emir0_bin, design.emirtap.rpt_ir,
design.emirtap.rpt_em
```

All intermediate and output files are written into the Spectre output (raw) directory.

For large designs, you can compress the intermediate (pwl, pdb) and the EMIR database files (emir0_bin) by specifying the “eisopt zipfiles=2” option in the EMIR conf file.

EMIR Control File Options Supported in Voltus-Fi-XL

The following table summarizes the EMIR control file options supported in Voltus-Fi-XL. These are specified in the configuration file using the `emirutil` command.

Keyword	Option Set	Explanation	Default Value
net	name=[instance1.net1instance1.net2....]	Defines the nets for which the analysis is performed. instance defines the instance of the subcircuit containing the net. net defines the net name inside the subcircuit instance as it is defined in the DSPF * NET definition. If the DSPF file is included on the top level, the instance name is not required. Wildcarding is supported for net names but not instance names.	none
	analysis=[imax iavg iavgpos iavgneg iavgabs iacpeak irms vmax vavg]	peakEM, avgEM, avgEM for i>0, avgEM for i<0, avgabsEM, rmsEM, peakIR, avgIR Note: To perform AC-Peak analysis in Voltus-Fi-XL, ensure that the <code>imax</code> and <code>iavg</code> options are specified in the control file.	iavg, vmax

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Keyword	Option Set	Explanation	Default Value
	pwrgate=[powernet1 powernet2...]	Enables power gate handling. You need to specify the power supply net driving the power gate and the internal power supply net driven by the powergate. If one power supply net drives multiple power gates, then you need to specify one statement with all internal power supply nets. For example: If the internal and external net names are as follows and XTOP is the top cell name: <pre>pair1 ->[VDD VSS] pair2 ->[VDDM VDDM1] pair3 ->[VDDM VDDM2]</pre> Then the following settings can be specified where the second setting will not override the first: <pre>pwrgate=[XTOP.VDD XTOP.VSS] pwrgate=[XTOP.VDDM XTOP.VDDM1 XTOP.VDDM2]</pre>	none

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Keyword	Option Set	Explanation	Default Value
	<code>analysis=[sigvmax sigvavg] reftype=[avg max] [findsrc=yes]</code>	<code>sigvmax</code> - max signal net IR drop. <code>sigvavg</code> - avg signal net IR drop. <code>avg</code> - reference voltage for IR drop is the average voltage of all subnodes at every time point. <code>max</code> - reference voltage for IR drop is the maximum voltage of all subnodes at every time point. <code>findsrc=yes</code> - Use voltage from subnode which is connected to <code>vsource</code>. The feature automatically traces through the design or source resistors.	none

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Keyword	Option Set	Explanation	Default Value
	For versions before MMSIM/SPECTRE15.1 ISR2, the syntax is as follows: <pre>design_res_models=[name=<cell_name> w=<width parameter name> l=<length parameter name> layer=<layer name> unit=<multiplier to get length/width * geounit in um>]</pre> For MMSIM/SPECTRE15.1 ISR2 and later versions, the syntax is as follows: <pre>design_res_models=[name=<cell_name> w=<width parameter name> l=<length parameter name> layer=<layer name> unit=<multiplier to get length/width in m>]</pre>	Specifies the design resistor models for which EMIR analysis will be performed. Note: The design resistor models are specified for cells and not for the instances of the cell. For example, for the design resistor provided in the xDSPF file as: <pre>XR1 XR1#PLUS XR1#MINUS r_user wr=1e-06 lr=5e-06</pre> In this example, width (<i>w_r</i>) and length (<i>l_r</i>) are in meters. The design resistor models will be specified in the following manner: Before MMSIM/SPECTRE15.1 ISR2, <pre>design_res_models=[name=r_user w=wr l=lr layer=mt1 unit=1e6]</pre> MMSIM/SPECTRE15.1 ISR2 and later: <pre>design_res_models=[name=r_user w=wr l=lr layer=mt1 unit=1]</pre> where, <i>r_{user}</i> is the design resistor model name <i>l_r</i> is the length parameter name specified in the xDSPF <i>w_r</i> is the width parameter name specified in the xDSPF <i>mt1</i> is the layer for the EM rules. The tool will apply <i>mt1</i> layer rules from the ICT file for this resistor	none

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Keyword	Option Set	Explanation	Default Value
		Before MMSIM/SPECTRE15.1 ISR2 1e6 is the unit that is calculated as design resistor W/L in netlist * unit/geounit. For example: For $1r=5e-06$ and $unit=1e6$, the length value of design resistor in μm is as follows: $l=5e-06*1e06=5\mu m$ MMISM15.1ISR2 and later 1 is the unit that is calculated as design resistor W/L in netlist * unit. For example: For $1r=5e-06$ and $unit=1$, the length value of design resistor in meters is as follows: $l=5e-06*1=5e-06m$	
solver	method=[auto direct iterated profonly iteronly]	auto - direct for APS, iterated for XPS (default) direct - forced direct method, not available for XPS iterated - forced iterated approach, available for APS and XPS profonly - iterated flow - circuit profile generation iteronly - iterated flow - RC network iteration	auto

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Keyword	Option Set	Explanation	Default Value
	speed=[1 2 3 4 5 6 7 8]	Defines the speed/accuracy trade-off for PN and SN RC network solver. 1 - highest accuracy, lowest speed 8 - lowest accuracy, highest speed	5
	inputwf=file_name	Specifies the waveform file that contains the results from circuit simulation when method=iteronly is used.	none
	report_tapi=on	Specifies to generate tap current reports. When this option is specified, outputs the rms, avg, and max tap currents in the .emir#_bin simulation result file.	none
static	ifile="filename"	Enables static EMIR analysis. The file defines the subckt instance port currents. Note: Static EMIR analysis cannot be combined with the dynamic EMIR analysis.	none

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Keyword	Option Set	Explanation	Default Value
	<code>analysis=[ipwc]</code> <code>pwc_threshold=1e-6</code>	Enables pulse-wise EM current calculation for violation visualization. The <code>pwc_threshold</code> option defines the current threshold for finding the start of the pulse. Any value below <code>pwc_threshold</code> is considered as zero. The <code>emirutil_dump_pwc_info=1</code> option generates an ascii report in the <code><name>.pwc0_raw</code> file for debugging purpose only.	none
	<code>vref</code>	Defines the optional voltage reference value for <code>vmax</code> and <code>vavg</code> analyses.	none

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Keyword	Option Set	Explanation	Default Value
emirutil	techfile="emDataFile"	Specifies the EM rule file in the emdatafile, qrctechfile, or ictfile format. Layer names that are not case-sensitive are supported, allowing easier match between the DSPF and emData file. The EM rule file can be predefined in the configuration file using the EMTECHFILE environment variable or in the .cdsinit file as follows: <pre>envSetVal("spectre.env Opts" "emTechFile" string <path to the file></pre> The rule file defined in the configuration file has a higher priority followed by the rule file specified in .cdsinit. Alternatively, you can use the emdatafile="emDataFile" option to specify the techfile in the emdata format, qrctechfile="qrcTechFile" to specify the Quantus tech files, and ictfile="ictfile" to specify the file in the ICT format. The EM rule file in emdatafile format can be predefined using the EMDATAFILE environment variable, or emRuleFile in cdsenv. The EM rule file defined in cdsenv has a higher priority.	none

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Keyword	Option Set	Explanation	Default Value
		The <code>layermap</code> file provides the mapping between the xDSPF and the layout database. It is applicable only for <code>qrcTechfile</code> and <code>ictfile</code> .	
	<code>EMOnlyICTFile="emOnlyICTFile"</code>	Specifies the process and EM models to be used for EM analysis. Note: This file can only be provided with the <code>qrcTechFile</code> flow.	none
	<code>res_pdata_sw=[on]</code>	When the bounding box coordinates are included in the xDSPF file and this option is set to <code>on</code> , prints the coordinates of resistor bounding box in the electromigration report. If this option is not specified in the EMIR conf file or the coordinates are not included in xDSPF, the node coordinates of resistors are printed instead of the bounding box coordinates.	none
	<code>rcIrcxFile=[./RC_your_file.ircx]</code>	Specifies the RC iRCX file provided by the foundry to be used for EM analysis.	none
	<code>emirIrcxFile=[./EMIR_your_file.ircx]</code>	Specifies the EMIR iRCX file provided by the foundry to be used for EM analysis.	none

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Keyword	Option Set	Explanation	Default Value
	<code>ir_in_em=[true false]</code>	When set to <code>true</code>, reports the maximum IR drop value for each metal resistor/via in the EM current report. It adds a “Max IR” column in the EM report. Note: This value is the higher IR drop value of the two nodes of the resistor.	<code>false</code>
	<code>tap_model_report=yes no</code>	When set to <code>yes</code>, the software reports the device model names for all the tap devices in the dynamic and static analysis report files – <code>*.rpt_ir</code> and <code>*.spgs</code>.	<code>none</code>
	<code>layerSetupFile=filename</code>	Specifies the name of the layer setup file to be used for the Voltus-Fi Quantus shape server flow. By default, the Voltus-Fi Quantus shape server flow reads the “<code>layer_setup</code>” file from the path specified in the “<code>_qrc_tech_dir</code>” file of the <code>qrc run dir</code>. Use this option to specify a file other than the default file. For example: <pre>emirutil layerSetupFile=layer_setup_1</pre>	<code>none</code>

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Keyword	Option Set	Explanation	Default Value
	<code>mdLayers="mdlayers1 mdlayers2 mdlayers#"</code>	Specifies the list of metal diffusion layers that need to be combined for EM analysis. For example, to calculate the distance between terminal vias (Lv2v), for thermal analysis (SHE) and so on. The default value is shown below. <pre>emirutil mdLayers="MD_STI MD_OD MD_STI_SRM MD_OD_SRM M0_OD M0_STI MD_STI_CPP85 MD_OD_CPP85"</pre>	MD_STI MD_OD MD_STI_SRM MD_OD_SRM M0_OD M0_STI MD_STI_CPP 85 MD_OD_CPP8 5
	<code>mergeMDLayers=[true false]</code>	Enables combining of metal diffusion layers that are specified using the variable, <code>mdLayers</code>, for calculating the effective Blech length. When set to <code>false</code>, no merging of metal diffusion layers is done for the Blech length calculation. <pre>emirutil mergeMDLayers=true</pre>	true
	<code>mt=8</code>	Specifies the number of CPUs used by clients for multithreading. <pre>emirutil mt=8</pre>	8

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Keyword	Option Set	Explanation	Default Value
	<code>postTclCmdFile=[conf.tcl]</code>	Specifies the Tcl file that contains user-specified commands for querying specific resistor and node information and creating customized EM and IR drop analysis reports. For details about the commands that can be written in the file (<code>conf.tcl</code>), see the “Batch Mode Execution” chapter.	none
	<code>layermapfile="mapfile"</code>	Specifies the layer map file that provides the mapping between the layer names in the simulation database to the layer names in the technology file.	none

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Keyword	Option Set	Explanation	Default Value
	<code>layermap=[(rcxLayer=rcx_layer_name1 ictLayer=ict_layer_name1) (rcxLayer=rcx_layer_name2 ictLayer=ict_layer_name2)]</code>	Specifies the mapping between the layer names in the simulation database to those specified in the technology files (qrcTechFile and ICT file) for the EM analysis flow. It maps the layer names in the xDSPF file to the ICT layer names. <code>rcxLayer</code> is the layer name in the simulation database. <code>ictLayer</code> is the layer name in the ICT EM file. Example: <pre>emirutil layermap=[(rcxLayer=M1 ictLayer=T1) (rcxLayer=M2 ictLayer=T2)]</pre> Note: This option is used if the <code>layermapfile</code> option is not available.	none
	<code>autorun=[true false]</code>	<code>true</code> - run <code>emirutil</code> automatically to generate a text report. <code>false</code> - manually run <code>emirutil</code>.	true
	<code>reportCurrentAmp=[true false]</code>	<code>true</code> - reports the current of the resistor in ampere (A). <code>false</code> - reports the current of the resistor in milliampere (mA).	true

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Keyword	Option Set	Explanation	Default Value
	report=[text html csv]	Defines the type of report created by emirutil. text - creates a report in text format. html - creates the report in HTML format. csv - creates the report in CSV format. Note: Multiple entries are supported.	text
	report_voltage=[true false]	When set to true, IR reports display the absolute voltage value instead of the IR drop value and in the GUI, the Virtuoso layout displays the absolute voltage plots instead of the voltage drop plots. emirutil report_voltage=true	false
	notation=[s e]	Notation for the text and html reports. e - engineering scale number (for example, 5.02m) s - scientific notation (for example, 5.02e-3)	e
	sort_by_net=yes no	Report IR and EM results per net, or all nets. yes - report EMIR results per net no - combine EMIR results or all nets into one report.	yes

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Keyword	Option Set	Explanation	Default Value
	<code>power_gate_extra_report</code>	When specified, adds additional information in the <code>rpt_pwg</code> file about power gates. This option is used only for power-gated designs.	none
	<code>filter_ir_threshold=value</code>	Defines the IR voltage drop threshold for the node being reported. <code>filter_ir_threshold=0.01</code> reports all nodes with IR drop above 0.01V.	no filter
	<code>filter_ir_percent=value</code>	Defines the percentage of nodes being reported starting from the biggest IR drop. For example, <code>filter_ir_percent=5</code> reports the top 5 percent IR drop nodes in the report.	no filter
	<code>filter_em_threshold=value</code>	Defines the EM analysis threshold value for the resistors being reported. The value for <code>filter_em_threshold</code> is the J/Jlimit value. <code>filter_em_threshold=1</code> reports only those resistors that have a J/Jlimit value above 1. Note: Specifying this option is equivalent to filtering all passed resistors.	none

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Keyword	Option Set	Explanation	Default Value
	<code>filter_resistance=0.001</code>	Specifies that the shorting via resistors with the resistance value equal to or less than 0.001 ohm (1 mohm) are to be filtered out from the EMIR and SHE analysis reports.	none
	<code>geounit=value</code>	Defines the scaling of all DSPF geometry parameters (W, L, X, Y). It applies only to the * NET section, and not to the instance section.	1um
	<code>geounit_XY</code>	Defines the scaling of DSPF geometry parameters X and Y. It applies only to the * NET section, and not to the instance section. Note: If the <code>geounit_XY</code> and <code>geounit</code> options are specified together, the <code>geounit_XY</code> option takes precedence over the <code>geounit</code> option.	1um
	<code>geounit_WL</code>	Defines the scaling of DSPF geometry parameters W and L. It applies only to the * NET section, and not to the instance section. Note: If the <code>geounit_WL</code> and <code>geounit</code> options are specified together, the <code>geounit_WL</code> option takes precedence over the <code>geounit</code> option.	1um

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Keyword	Option Set	Explanation	Default Value
	enableDesignResistorPeakFactor= [true false]	Specifies the addition of the factor, $1/(r)^{1/2}$, in the current limit calculation for the AC-Peak analysis of the design resistor. The software, by default, calculates the current limit for the AC-Peak analysis of the design resistor using the following equation: $I_{\text{peak\_ac}}(\text{limit}) = I_{\text{peak\_dc}}(\text{limit})$ To apply the factor, $1/(r)^{1/2}$, in your calculation, set this variable to true. The current limit will then be calculated in the following manner: $I_{\text{peak\_ac}}(\text{limit}) = I_{\text{peak\_dc}}(\text{limit}) / (r)^{1/2}$	false
	enableDesignResistorScaling=[true false]	Enables the scaling of the width and length values based on the layout_scale factor specified in the technology file before the EM rules are applied for EM analysis of design resistors. By default, the scaling of design resistors is enabled.	true

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Keyword	Option Set	Explanation	Default Value
	<code>enableResShape true false</code>	When set to <code>true</code>, enables tagging of shapes on the layout based on full resistor shapes and terminal nodes. This option is enabled by default. To disable tagging of shapes, set the variable to <code>false</code>. <code>emirutil</code> <code>enableResShape false</code>	<code>true</code>
	<code>enableRMSHotSpotWaiving=[true false]</code>	Enables the RMS EM hot spot waiving analysis. By default, this feature is disabled. Note: This variable is applicable only to the RMS EM hot spot waiving feature, which is a limited-access feature. To use this feature, contact your Cadence representative and explain your usage requirements.	<code>false</code>

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Keyword	Option Set	Explanation	Default Value
	<code>extendPWLMatch=[true false]</code>	When the EM rules are specified in terms of PWL and the width of metal or the area of via does not match with any width/area of the PWL, the EM limit will not be calculated for this metal resistor/via. When set to <code>true</code>, the software interpolates the limit value for the <code>resistor/via</code> from the selected rule PWL as follows: minimum of PWL i^{th} value * (metal's width or via's area) / (PWL i^{th} width or PWL area).	<code>false</code>
	<code>enablePWLDensityInterpolation=[true false]</code>	Enables the current density calculation from the given PWL using current density and width, or current density and area linear interpolation for either the metal's width or the via's area. The calculation is only done when the metal's width or the via's area does not match the PWL width or area values. <code>emirutil enablePWLDensityInterpolation=true</code>	<code>false</code>
	<code>viaCountResistance=[true false]</code>	This option is set to <code>true</code> when third-party DSPF with missing via count (\$N) is used for EM analysis.	<code>false</code>

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Keyword	Option Set	Explanation	Default Value
	<code>process_scale=value</code>	Specifies the value by which the width and length values will be multiplied before the EM rules are applied.	1.0
	<code>prioritizedPwlRulesLayers=[all none list_layers]</code>	Specifies the list of layers for which area-based PWL search is performed first. When no match is found, then non-PWL rules are used. The default value of this variable is "all", which means that this behavior is enabled for all layers. To enable the behavior for specific layers, you can specify a list of layers. To disable this behavior for all layers, set the value of this variable to <code>none</code>. In the GUI, you can set this variable in the Variables form. Example rules: <pre>em_jmax_dc_avg 10 jmax_factor 90 2.384 95 2.078 - non-PWL baseline rule</pre> <pre>em_jmax_dc_avg PWL 0.3582 0.001444 0.5694 0.003364 0.7164 0.0038 jmax_factor 90 2.384 - PWL rule</pre> When both the above rules are specified, the second rule is given priority over the first.	all

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Keyword	Option Set	Explanation	Default Value
	via_count=[useR useArea]	Defines the method used for calculating the via count. useR - calculation based on via resistance $(emdatafile\_via\_resistance / dspf\_via\_resistance)$. useArea - calculation based on via area $(dspf\_via\_area / emdatafile\_via\_area)$.	useR
	idirn=[true false]	Prints the current direction in the EM report (<i>Current Direction</i> column). For metal resistors, the current direction is printed. That is, <i>W</i> means that the current is flowing from east to west. For via resistors, the direction from/to layer is printed.	false
	recovery_factor	Defines the recovery factor for iavg calculation with recovery factor. If specified, then $iavg = \max(iavgpos , iavgneg) - recovery\_factor * \min(iavgpos , iavgneg)$ If not specified, then $iavg = iavgpos + iavgneg$	

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>Tlife="hours" "years"</code>	Specifies the lifetime for which the EM analysis will be performed. You can specify the value in either <code>years</code> or <code>hours</code> . For example: <code>emirutil</code> <code>Tlife="20000hours"</code>	<code>"10 years"</code>

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>emLimitScale=scale_factor_value "scale_factor_netfile"</code>	Scales the EM limits of the parasitic resistors in the design before generating the EM reports. You can either apply the same scale factor to all the nets or specify different scale factors for different nets. To apply the same scale factor to the parasitic resistors of all the nets in the design, provide the value of the scale factor. <pre>emirutil emLimitScale=scale_factor_value</pre> For example, <pre>emirutil emLimitScale=0.04</pre> Note: This is applicable to avg, avg abs, and rms analyses. For the avg and avg abs analyses, the limit is directly multiplied by this factor. For rms analysis, the limit is multiplied by the root of this factor. To apply different scale factors to different nets in the design, provide the name of the file that contains information about the net names and the corresponding scale factors to be applied to these nets. <pre>emirutil emLimitScale="scale_factor_netfile"</pre> For example, <pre>emirutil emLimitScale="scale_limit_file"</pre>	none

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>rmsMetalLineNumberPower=number</code>	Specifies the value of power on the metal lines for RMS EM analysis of power nets. If this option is not specified, the default value of 0 is considered, which means the software uses the <code>em_dc_rms_metal_line_num</code> value specified in the ICT file. If, however, this option is specified, it overrides the <code>em_dc_rms_metal_line_num</code> value specified in the ICT file.	0
	<code>rmsMetalLineNumberSignal=number</code>	Specifies the value of power on the metal lines for RMS EM analysis of signal nets. If this option is not specified, the default value of 0 is considered, which means the software uses the <code>em_ac_rms_metal_line_num</code> value specified in the ICT file. However, if this option is specified, it overrides the <code>em_ac_rms_metal_line_num</code> value specified in the ICT file.	0

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>print_em_report</code>	Defines the EM analysis report file to be generated in the Voltus-Fi-XL flow. <code>filename</code>: create report with specified filename <code>net</code>: create report for specified nets - all power nets (<code>all_power</code>), all signal nets (<code>all_signal</code>), all nets (<code>all_nets</code>), or net (<code>netname</code>). <code>threshold</code> - create report for resistors or nodes that have a threshold value of EM ratio above the specified value <code>type</code> - create report for specified analysis type; <code>javg</code>, <code>jmax</code>, <code>jabsavg</code>, <code>jacpeak</code>, <code>jacrms</code>, <code>rc</code>, <code>rcavg</code>, <code>rcrms</code>, <code>tc</code>, <code>tcavg</code>, or <code>tcrms</code>. <code>rule</code> - specifies the custom EM rule for which the report should be generated	
	<code>extendedreport=true</code> <code>false</code>	Specifies that the following information should be included in the EM analysis report file: ■ <code>Td</code>: time duration in micro second or total 'On Time' period ■ <code>dutyR</code>: duty ratio ■ <code>I_{limit}</code>: current limit	<code>false</code>

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>extendedRMSReport=true false</code>	When set to <code>true</code>, the following parameters are reported in the RMS EM report: ■ <code>rmsT</code>: Delta temperature value ■ <code>Lv2v</code>: Distance between terminal vias ■ <code>rmsMetalLineNumRelaxFactor</code>: It specifies the rating factor corresponding to the number of power on metal lines In addition, the following is added in the header section of the report: ■ <code>rmsMetalLineNumberS</code> pecifies the value of power on the metal lines for RMS EM analysis	<code>false</code>
	<code>reportUnmatchedRuleResistor=true false</code>	When set to <code>true</code>, specifies that while generating the EM analysis reports, the resistors that do not match any EM rule for the specified analysis in the ICT file should be reported in the <code>"#.rpt_unmatch"</code> file.	<code>true</code>

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>reportAllResistor=true false</code>	When set to <code>true</code>, reports all resistors of the specified nets in the <code>"#.rpt_all"</code> file. Note: If both, <code>reportUnmatchedRuleResistor</code> and <code>reportAllResistor</code>, are set to <code>true</code>, the <code>reportAllResistor</code> setting gets priority.	<code>false</code>
	<code>consolidatedReport=true</code>	Specifies that consolidated EM and IR reports for multiple bin files will be generated in Voltus-Fi-XL.	<code>false</code>
	<code>worstResult=true</code>	Specifies that the worst result will be reported in the consolidated EM and IR reports. This option is enabled by default when the <code>consolidatedReport</code> parameter is set to <code>true</code>. For example, <pre>consolidatedReport=true worstResult=true</pre> Note: To view all the results in the consolidated report, set this option to <code>false</code>.	<code>true</code>

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>layer_filter=[layer1 layer2...]</code>	Specifies the layers that are to be filtered out from the EMIR analysis reports. For example, <pre>emirutil layer_filter=[cont odcont]</pre> Note: If you have specified this option and also set the <code>reportAllResistor</code> option to <code>true</code>, the resistor information for the specified layers will be filtered out from the reports.	none

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>violation_columns=[column_names]</code>	Specifies the columns to be displayed in the Violation Browser. You can specify multiple columns separated by a space from the following list of columns: LENGTH_COLUMN RESISTANCE_COLUMN VIA_AREA_COLUMN NEEDED_NUM_VIA_COLUMN NET_COLUMN WIDTH_COLUMN MIN_WIDTH_COLUMN DENSITY_COLUMN CURRENT_LIMIT_COLUMN CURRENT_COLUMN PEAK_TIME_COLUMN TAP_NAME_COLUMN For example, <pre>emirutil violation_columns=[LENGTH_COLUMN RESISTANCE_COLUMN]</pre>	All columns are displayed

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>disableLayoutScale=true</code>	When set to <code>true</code>, disables the layout scale factor defined in the ICT file for Voltus-Fi-XL EM analysis. The <code>layout_scale</code> factor is the ratio of the scaled dimensions divided by the drawn dimensions. The ICT file is defined based on the scaled dimensions. Quantus applies the <code>layout_scale</code> factor to the input design during extraction so that the design dimensions and the ICT file dimensions are consistent.	<code>false</code>
	<code>simpleSingleViaDefinition=true false</code>	The keyword, <code>single</code> is used to differentiate between a single square cut via and square via array. It is applicable to square via, with width equal to <code>'vc_width/min_width'</code>, only. To support the <code>single</code> keyword for all via sizes, set the <code>simpleSingleViaDefinition</code> parameter to <code>true</code>.	<code>false</code>

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>cdf_percentage=value</code>	The variable holds the value which is mapped to the <code>cdf_percentage</code> keyword in the EM rules specified in the ICT file or the technology file. The value of the <code>cdf_percentage</code> should be between 0 and 100. For example, <pre>emirutil cdf_percentage="10.0"</pre>	none
	<code>device_temp_file=file name</code>	Specifies the file that includes information about resistor names and their corresponding temperature values. The EM analysis for these resistors is performed at their corresponding temperatures. For example, <pre>emirutil device_temp_file=resistor_temp.txt</pre>	none

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>toggleNetFrequency=" (net1, frequency1) (net2, frequency2) (net#, frequency#) "</code>	Specifies the frequency of the nets so that the tool can derive the T_d (total on-time period) for multiple clock cycles. You can specify frequencies for different nets as shown below. Wild cards are also supported. For example, <pre>emirutil toggleNetFrequency=" (C LK*, 2.3e9) (NET1, 4.6e9) "</pre>	none
	<code>toggleNetFrequencyFile=filename</code>	Specifies the name of the file that contains the net names and their corresponding frequency values. This file is used to specify the frequency of nets to compute the T_d (total on-time period) for multiple clock cycles. This file contains net names separated by commas and the frequency values. For example, <pre>emirutil toggleNetFrequencyFile=freq_file</pre> A sample <code>freq_file</code> is shown below. <pre>VDD, 2e08 D*, 4e08 GSS, 3e08</pre>	none

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>multiplePeakPercentThreshold=value</code>	Specifies the threshold percentage for the peak current above which the T_d (total on-time period) for a particular peak is added to the final T_d. Note: This variable is applicable only when the <code>dynamicACPeak</code> analysis is set to <code>multiPeak</code>. For example, <pre>emirutil multiplePeakPercentThreshold=7</pre>	5
	<code>deltaT=temp_value</code>	Specifies the maximum rise in temperature in degree Celsius, caused due to Joule heating. It must be a positive value. If the rise in temperature is not specified, Voltus-Fi-XL considers a default temperature of 5 degrees Celsius. This is an ideal condition wherein the design must be EM free. Example: <pre>emirutil deltaT=4.0</pre> This option can also be specified in the Variables form and in the command file by using the <code>set_variable</code> command.	5.0 degree Celsius

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>deltaTLayers=[(layer=layer_name deltaT=temp_value) (layer=layer_name deltaT=temp_value)]</code>	Specifies layer-specific deltaT values. For layers that do not have deltaT value specified for them, global deltaT value will be used. Example: <pre>emirutil deltaTLayers=[(layer=rhim hi_em=1 deltaT=25) (layer=rhim hi_em=0 deltaT=5) (layer=M7 deltaT=10)]</pre> In the above example, hi_em=1 indicates high current carrying design resistor for which the deltaT value is 25 degree Celsius while hi_em=0 indicates general design resistor for which the deltaT value is 5 degree Celsius. The deltaT value for M7 layer is 10 degree Celsius. This option can also be specified in the Variables form and in the command file by using the <code>set_variable</code> command.	none

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>resistor_filter=[resistor_names]</code>	Filters the specified resistors in the plot. You can specify multiple resistors separated by a space. These resistors will not be displayed in the plot. Wildcards are supported. Example: <pre>emirutil resistor_filter=[rx ry]</pre> or <pre>emirutil resistor_filter=[rx*]</pre>	All resistors are displayed
	<code>exclusion_resistor_filter=[resistor_names]</code>	Filters all resistors in the plot except those that are specified. This option is used to view plots for specific resistors. Wildcards are supported. Example: <pre>emirutil exclusion_resistor_filter=[rx ry]</pre> or <pre>emirutil exclusion_resistor_filter=[rx*]</pre>	All resistors are displayed

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	<code>removeBulkShorting=true false</code>	When set to true, this option removes bulk-shorting in the design. Bulk-shorting in the design results in an increase in the EM analysis runtime. This variable is only used as a troubleshooting option. Example: <pre>emirutil removeBulkShorting=true</pre>	false
	<code>emVariableValues=[(variable=configA value=#) (variable=configB value=#)]</code>	Specifies the EM variable values for current density limit calculation in the EMIR configuration file. Example: <pre>emirutil emVariableValues=[(variable=configA value=20) (variable=configB value=10)]</pre> Where the values of configA and configB are 20 and 10, respectively. Note: The EM variable values passed through the configuration file will get priority over the value of same variable specified in the techfile.	none

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Data Preparation

Keyword	Option Set	Explanation	Default Value
	enableContextAwareS rmsRelaxation=true false	When set to true, this option enables the context-aware RMS Relaxation flow. Example: emirutil enableContextAwareSrms Relaxation=true Note: This flow is foundry-specific. For more information, contact your Cadence representative.	false
time	window=[start1 stop1 start2 stop2 ...]	Time window to which the EMIR analysis is applied. Multiple none-overlapping windows are supported.	[0 tend]
spf	aliasterm="alias library_terminal name"	Alias used when DSPF instance terminal names do not match the cell terminal name in the libraries.	none
spgs	net=[net1 net2 ...]	Enables static power grid solver, and defines power nets to be analyzed.	none
	pwrgate=[powernet1 powernet2 ...]	Defines power gates to be analyzed in static power grid solver.	none
	rshort=value	Resistors with $R < rshort$ are shorted during static power grid analysis.	0
	tap2sub net=<net_name> include=[<tap_name>] exclude=[<tap_name>]	Converts tap to subnode.	none

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Keyword	Option Set	Explanation	Default Value
	tap2pin net=<net_name> include=[<tap_name>] exclude=[<tap_name>]	Converts tap to pin.	none
	sub2tap net=<net_name> include=[<node_name>] exclude=[<node_name>]	Converts subnode to tap.	none
	sub2pin net=<net_name> include=[<node_name>] exclude=[<node_name>]	Converts subnode to pin.	none
	pin2sub net=<net_name> include=[<pin_name>] exclude=[<pin_name>]	Converts pin to subnode.	none
	pin2tap net=<net_name> include=[<pin_name>] exclude=[<pin_name>]	Converts pin to tap.	none

Important

In earlier releases, Voltus-Fi-XL 12.1 ISR 10 and before, the `geounit*` option was specified as follows:

`geounit*` = 1e6 – when values in DSPF were in meter

`geounit*` = 1 – when values in DSPF were in um

From 12.1 ISR 11 release onwards, the behavior of the `geounit*` option is modified as follows to synchronize it with `emirutil`:

`geounit*` = 1 – when values in DSPF are in meter

`geounit*` = 1e-6 – when values in DSPF are in um

Note: Every `net` statement only supports one name and one analysis definition. If different analyses are required, use multiple `net` statements.

The following example performs the EMIR analysis on the `x1` instance. EM and IR analyses are performed on `net VDD` and `VSS` to measure `vmax` and `iavg`. EM analysis is performed on

all other nets to calculate the `irms` value. The Current Density limits for the EM report are read from file `./em_dir/qrcTechFile.txt`. In this release, only one instance is allowed for EMIR analysis per Spectre run.

Example EMIR control file (emir.config)

```
net name=[X0.VDD X0.VSS] analysis=[vmax vavg]
net name=[X0.*] analysis=[iavg imax] emirutil techfile = qrcTechfile
layermapfile = contactmapfile

emirutil deltaT=10.0
emirutil dbu=200
emirutil dynamicACPeak=false
emirutil applyRThreshold=0.05
emirutil rmsMultiplierPin=1.0
emirutil rmsMultiplierSignal=1.0
emirutil useEncryptedWidth=true
net design_res_models = [name=resTwoTerm l=lr w=wr layer=mt2 unit=1e6]
solver method=[iterated]
```

Note: Multiple net names must be specified in different lines in the control file to avoid any errors. This is shown in the above example.

Output of EMIR Analysis

As output, Voltus-Fi-XL produces the following:

- Power-rail and signal IR drop and EM analysis result plots displayed on the Virtuoso layout
- Power-rail and signal IR drop and EM analysis result reports
- Structural analysis results displayed on the Virtuoso layout
- Power-grid views

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Data Preparation

EM Rules Specification

This section contains information about the EM rule requirements in Voltus-Fi-XL.

EM Rule File Requirements in Voltus-Fi-XL

Before running EMIR analysis in Voltus-Fi-XL, you need to specify the EM reliability rules. EM rules are defined in the technology files. The Voltus-Fi - Spectre EMIR solution supports the following technology file formats:

- The Quantus technology file (`qrcTechFile`)
- The ICT, ICT-EM (EM Rules only) file
- Interoperable interconnect extraction (iRCX) file
- The EM data file (`emDataFile`).

Important

The `emDataFile` support is provided only for backward compatibility. It is recommended that you convert your `emDataFile` into an ICT file to specify the EM rules for performing EM analysis.

The ICT file contains the process information for the design and information about the EM rules. This is a text-based file that can be edited using any text editor. You can either specify the ICT file directly as an input for EM analysis or use the information in the ICT file to update the `qrcTechFile`.

Related Topics

- [Conversion of EM Data File into ICT File](#)
- [Parameters for Limit-Based EM Analysis in Voltus-Fi-XL](#)
- [Supported Current Density Keywords in Voltus-Fi-XL](#)

Parameters for Limit-Based EM Analysis in Voltus-Fi-XL

Voltus-Fi-XL supports parameters for only limit-based EM analysis. The following parameters can be used to specify EM rules in the ICT EM file. The EM rules might also be embedded in the ICT file or the `qrcTechFile`.

Parameter Name	Description
<code>em_vcwidth</code> <code><value></code>	Optional parameter for <code>via</code> layers that defines the minimum size via that is used by the software to identify single square via.
<code>em_W_n</code>	Optional parameter that specifies the wire width in microns below which a line is considered narrow. All lines are considered wide unless you specify otherwise using this parameter Note: It helps to select the rule between <code>em_jmax*_w</code> and <code>em_jmax*_n</code> . If <code>w < em_W_n</code> , then <code>em_jmax*_n</code> is selected, otherwise <code>em_jmax*_w</code> selected.
<code>em_jmax_dc_rms_metal_line_factor</code>	Defines the relationship between the value of power on metal lines and the <code>Irms</code> rating values for DC RMS analysis.
<code>em_jmax_ac_rms_metal_line_factor</code>	Defines the relationship between the value of power on metal lines and the <code>Irms</code> rating values for AC RMS analysis.
<code>em_ac_rms_context_aware_pitch_num</code>	Specifies the pitch count values for RMS relaxation for AC RMS analysis in the context-aware RMS Relaxation flow. For example, <code>em_ac_rms_context_aware_pitch_num 5</code> Note: The context-aware RMS Relaxation flow is foundry-specific. For more information, contact your Cadence representative.
<code>em_dc_rms_context_aware_pitch_num</code>	Specifies the pitch count values for RMS relaxation for DC RMS analysis in the context-aware RMS Relaxation flow. For example, <code>em_dc_rms_context_aware_pitch_num 5</code> Note: The context-aware RMS Relaxation flow is foundry-specific. For more information, contact your Cadence representative.

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EM Rules Specification

`em_jmax_ac_rms_context_aware_factor` Specifies the benefit factor for RMS relaxation for AC RMS analysis in the context-aware RMS Relaxation flow.

For example,

```
em_jmax_ac_rms_context_aware_factor 1.5
srms_0>= 0.008 srms_1> 0.0004
```

Where,

`srms_0` is the worst `srms` value in the neighboring area within the context-aware region of the parasitic.

`srms_1` is the second worst `srms` value in the neighboring area within the context-aware region of the parasitic.

Note: The context-aware RMS Relaxation flow is foundry-specific. For more information, contact your Cadence representative.

`em_jmax_dc_rms_context_aware_factor` Specifies the benefit factor for RMS relaxation for DC RMS analysis in the context-aware RMS Relaxation flow.

For example,

```
em_jmax_dc_rms_context_aware_factor 1.5
srms_0>= 0.008 srms_1> 0.0004
```

Where,

`srms_0` is the worst `srms` value in the neighboring area within the context-aware region of the parasitic.

`srms_1` is the second worst `srms` value in the neighboring area within the context-aware region of the parasitic.

Note: The context-aware RMS Relaxation flow is foundry-specific. For more information, contact your Cadence representative.

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EM Rules Specification

em_segment_length	A process definition parameter that determines how to calculate the length of a wire segment. This parameter determines whether the segment length is of the type perimeter, centerline, or total. The difference between the different length types is as follows: ■ perimeter: specifies that the length calculation is along the wire's outer edge boundary. This value is used for 28nm process nodes. ■ centerline: specifies that the length is extended to the edge of the segment along the centerline path. This value is used for 20nm process nodes. ■ total: specifies that the segment length is calculated by adding the path lengths of all the resistors in the segment.
em_recover	Optional parameter that specifies the recovery factor used for calculating the average current density with recovery. You can set the recovery factor to -1.0 when you want to account for the average of the absolute current (avg(abs(current))) so that the negative current does not cancel the positive current values in arriving at the average current result. <i>Default:</i> 1 <i>Range:</i> A positive integer or floating point number

Related Topics

- [Supported Current Density Keywords in Voltus-Fi-XL](#)
- [EM Rule File Requirements in Voltus-Fi-XL](#)

Supported Current Density Keywords in Voltus-Fi-XL

The table below lists the Current Density (JMAX) keywords that can be specified in the ICT EM file.

Keyword	Description
em_jmax_dc_avg*	Optional keyword that specifies the DC AVG analysis in Voltus-Fi-XL
em_jmax_ac_avg*	Optional keyword that specifies the AC AVG analysis in Voltus-Fi-XL

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EM Rules Specification

<code>em_jmax_dc_peak*</code>	Optional keyword that specifies DC PEAK analysis in Voltus-Fi-XL
<code>em_jmax_ac_peak*</code>	Optional keyword that specifies AC_PEAK analysis in Voltus-Fi-XL
<code>em_jmax_dc_rms*</code>	Optional keyword that specifies DC RMS analysis in Voltus-Fi-XL
<code>em_jmax_ac_rms*</code>	Optional keyword that specifies AC RMS analysis in Voltus-Fi-XL
<code>em_jmax_ac_rec</code>	Optional keyword that specifies the maximum recovery AC current analysis in Voltus-Fi-XL.

Where star '*' implies that '_w' and '_n' rules are also supported.

For example,

- `em_jmax_ac_peak_w` is an optional parameter that is essentially the same as `em_jmax_ac_peak`, with the exception that it is specified for wide wires (as defined by `em_W_n`).
- `em_jmax_ac_peak_n` is an optional parameter that is essentially the same as `em_jmax_ac_peak`, with the exception that it is specified for narrow wires (as defined by `em_W_n`).

Related Topics

- [EM Rule File Requirements in Voltus-Fi-XL](#)
- [Parameters for Limit-Based EM Analysis in Voltus-Fi-XL](#)

EM Model Syntax

```
em_model {  
# Width Independent parameters are not affected by width or area  
[em_vcwidth <value>]  
[em_W_n <value>]  
[em_recover <value>]  
# Parameters applying specifically to narrow or wide wires  
[em_jmax_ac_avg_n <value>]  
    [jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]  
[em_jmax_ac_avg_w <value>]  
    [jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]  
[em_jmax_ac_peak_n <value>]  
    [jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]  
[em_jmax_ac_peak_w <value>]
```

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EM Rules Specification

```
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_ac_rms_n <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_ac_rms_w <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_ac_rec_n <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_ac_rec_w <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_dc_avg_n <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_dc_avg_w <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_dc_peak_n <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_dc_peak_w <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_dc_rms_n <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[em_jmax_dc_rms_w <value>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
# Width dependent parameters for a conductor or diffusion layer
[em_jmax_ac_avg <value> | <value_1> <width_1> [...] | EQU <fn(E)> ]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[via_range <value>]
[em_jmax_ac_peak <value> | <value_1> <width_1> [...] | EQU <fn(E)> ]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[via_range <value>]
[em_jmax_ac_rms <value> | <value_1> <width_1> [...] | EQU <fn(E)> ]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[via_range <value>]
[em_jmax_ac_rec <value> | <value_1> <width_1> [...] | EQU <fn(E)> ]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[via_range <value>]
[em_jmax_dc_avg <value> | <value_1> <width_1> [...] | EQU <fn(E)> ]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
```

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EM Rules Specification

```
[via_range <value>] [L < | <= | > | >= <value in microns>]
    [W < | <= | > | >= <value in microns>]
[em_jmax_dc_peak <value> | <value_1> <width_1> [...] | EQU <fn(E)> ]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[via_range <value>] [L < | <= | > | >= <value in microns>]
    [W < | <= | > | >= <value in microns>]
[em_jmax_dc_rms <value> | <value_1> <width_1> [...] | EQU <fn(E)> ]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[via_range <value>] [L < | <= | > | >= <value in microns>]
    [W < | <= | > | >= <value in microns>]
# Area dependent parameters for a via layer
[em_jmax_ac_avg <value> | <value_1> <area_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[current_direction up|down|both] [via_range <value>]
[em_jmax_ac_peak <value> | <value_1> <area_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[current_direction up|down|both] [via_range <value>]
[em_jmax_ac_rms <value> | <value_1> <area_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[current_direction up|down|both] [via_range <value>]
[em_jmax_ac_rec <value> | <value_1> <area_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[current_direction up|down|both] [via_range <value>]
[em_jmax_dc_avg <value> | <value_1> <area_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[current_direction up|down|both] [via_range <value>]
[L < | <= | > | >= <value in microns>]
    [W < | <= | > | >= <value in microns>]
[em_jmax_dc_peak <value> | <value_1> <area_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[current_direction up|down|both] [via_range <value>]
[L < | <= | > | >= <value in microns>]
    [W < | <= | > | >= <value in microns>]
```

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EM Rules Specification

```
[em_jmax_dc_rms <value> | <value_1> <area_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]
[current_direction up|down|both] [via_range <value>]
[L < | <= | > | >= <value in microns>]
  [W < | <= | > | >= <value in microns>]
}
```

Special Variables in ICT-EM File

The following list of special variables are defined by Cadence. You must not define these variables as custom variables in the ICT-EM file. It is recommended to contact your Cadence representative if you wish to use these variables in the file.

a	areaCM2	bridgeVia
cdf_percentage	color	connect_pin
context_benefit_factor	delta_T	delta_Td
designRes	dynamicTj	hi_em
Iabs_avg	Iabs_B_max	Iabs_C_max
Iabs_max	Iacpeak_max	Iavg
Iavg_B_max	Iavg_C_max	Iavg_max
Iavg_sh_max	Idc_max	Imax_pulse
Imax_wind	Imin_pulse	Imin_wind
Ineg_avg	Ineg_max	Ipeak
Ipeak_max	Ipeak_pulse	Ipeak_sh_max
Ipeak_wind	Ipos_avg	Ipos_max
Irms	Irms_max	Irms_sh_max
Itolerance	jmax_factor_multiplier	jmax_life_multiplier
l	La	La_x
La_y	Lb	length_benefit_not_eligible

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EM Rules Specification

length_benefit_not_eligible_bottom	length_benefit_not_eligible_upper	Lu
Lv	Lv2v	Lv2v_priority
Lv2v_rms	mask	N
net_type	pgRail	power_rail_w
priority	pulseW	r
redundant	rmsMultiplier	segment_W
segment_Wb	segment_Wu	singleSquareVia
special_geometry	special_geometry_bottom	special_geometry_upper
srms	stack_down_via	stack_up_via
Sv	T	tau
tau_n	tau_narrow	tau_p
tau_wide	Td	thickness
Tj	Tlife	Tref
Tsh	Vg	viaPairDistance
viaPairTWb	viaPairTWu	VO_LL_min
VO_LLb_min	VO_LLu_min	VO_LQ_min
VO_LQb_min	VO_LQu_min	VO_LS_min
VO_LSb_min	VO_LSu_min	VO_min
VO_QL_min	VO_QLb_min	VO_QLu_min
VO_QQ_min	VO_QQb_min	VO_QQu_min
VO_QS_min	VO_QSb_min	VO_QSu_min
VO_SL_min	VO_SLb_min	VO_SLu_min
VO_SQ_min	VO_SQb_min	VO_SQu_min
VO_SS_min	VO_SSb_min	VO_SSu_min
VOb_min	VOu_min	Vu_current_direction
w	W_S	Wb
Wb_S	Wu	Wu_S

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EM Rules Specification

Wv

Rules for Defining EM Parameters in Voltus-Fi-XL

An example of the EM rule for defining the `em_jmax_dc_avg` parameter is provided below:

```
[em_jmax_dc_avg <value> | <value_1> <area_1/width_1> [...] | EQU <fn(E)>]
[jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]]
[jmax_life <life1> <scale1> [<life2> <scale2>.....]]
[current_direction up | down | both]
[via_range <value>]
[conditions]
[single]
[power_rail/power_grid]
[priority==<priority no.>]
[device=="<device model names>"]
[sub_conductor=="<subconductor names>"]
[color=="<list of color no.>"]
[mask==<mask no.>]
```

All other EM parameters are defined with the same structure but apply to different characteristics of the `em_model` (peak current versus average for instance). The following rules apply to all the limit-based `em_model` parameters:

■ Single Value Current Density

Specifying a single value or an equation is an enhancement for width or area dependent parameters (such as `em_jmax_ac_avg`).

Note: For narrow/wide wire parameters (such as `em_jmax_ac_avg_n` or `em_jmax_ac_avg_w`) you can only specify a single value. It will not accept either a PWL table or an equation.

■ Piece-wise Linear (PWL) Interpolation

In a width-dependent model for a conductor layer, or for an area-dependent model for a via layer, PWL interpolation uses a series of data points that are points on a graph of X versus Y, where X can be either a value or an expression and Y is a value. For example, current density value and area `<value1> <area1>`, current density value and width `<value1> <width1>`, current density expression and area `<expression1> <area1>`, or current density expression and width `<expression1> <width1>`.

The following syntax are supported:

```
em_jmax_dc_avg PWL <value1> <area1/width1> <value2> <area1/width1>
em_jmax_dc_avg PWL (<value1> <area1/width1> <value2> <area1/width1>)
em_jmax_dc_avg PWL (<expression1> <area1/width1> <expression2> <area1/width1>)
```

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EM Rules Specification

For example:

```
em_jmax_dc_avg PWL 0.3582 0.001444 0.5694 0.003364 0.7164 0.0038
em_jmax_dc_avg PWL (0.3582 0.001444 0.5694 0.003364 0.7164 0.0038)
em_jmax_dc_avg PWL (0.05*0.5 0.002 0.1*0.5 0.004 0.2*0.5 0.008)
```

■ Equations in EM Model

The EQU keyword denotes the definition of an equation for current density.

An EOL or one of the qualifiers (`jmax_factor`, `current_direction`, or `single`) marks the end of an equation specifying the Current Density limit. If the equation resolves into two separate equations, then this will result in an error.

For EQU, the following operators (not case-sensitive) are supported:

- ☐ SQRT
- ☐ LOG
- ☐ EXP
- ☐ * / + -
- ☐ ()
- ☐ e
- ☐ ^
- ☐ `expr1? expr2: expr3`

Where, `expr1` is a conditional expression. If `expr1` evaluates to true, then `expr2` is evaluated, else `expr3` is evaluated.

For example:

```
Life_factor= ((A < 5 and B > 2)? 3:4)
em_jmax_dc_avg EQU 3.0*w * Life_factor jmax_factor 50 1.1 110 1.0
125 0.92 L > 5
```

Note: Square brackets '[''] are not supported. A comma ',' implies multiple equations, and results in an error. The period '.' is ambiguous and should not be used to indicate multiplication (use * instead).

Spaces are permitted to make an equation more readable.

Variables within equations will be populated by the analysis tool at run-time. Use the `em_variables` parameter in the process definition to globally declare variables that are used within the various `em_models`. List of supported variables are provided below:

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EM Rules Specification

- ❑ a: area of the resistor
- ❑ w: width
- ❑ l: length
- ❑ La: length of pseudo via
- ❑ La_x: length of pseudo via along the x-axis
- ❑ La_y: length of pseudo via along the y-axis
- ❑ N: number of vias
- ❑ delta_T: rise in temperature in degree Celsius
- ❑ r: duty ratio
- ❑ Tref: refers to `em_tref`, the nominal temperature for EM analysis defined in the process section of the ICT file. If `em_tref` is not defined, then default value(110C) is set.

- ❑ `cdf_percentage`: This variable lets you use the value specified using the keyword `cdf_percentage` in the `emir` config file or command file, in the EM rules. For example,

```
conductor "m1" {
    min_spacing      0.3
    min_width        0.3
    height           1.05
    thickness         0.53
    resistivity       0.1
    gate_forming_layer false
    thermal_conductivity 0.39
    em_model {
        cxyz=exp(normsinv(cdf_percentage*10.0))
        em_jmax_dc_avg EQU 2*w*cxyz L > 5
        em_jmax_dc_avg EQU 3*w*cxyz L <= 5
    }
}
```

- ❑ Tlife: This variable provides the value of lifetime at which EM analysis is performed. This value can be specified in hours or years.

The value of lifetime can be specified in the config file as follows:

```
emirutil Tlife = "20000 hours"
```

It can also be specified in techfile in the process block section as follows:

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```
em_lifetime 20000
```

Note: The lifetime value specified in the techfile gets priority over the value specified in the config file. If the value is not specified in either of these files, the default value of “10 years” is used.

- ❑ **jmax_factor_multiplier:** This variable provides the value of jmax_factor for the resistor.
- ❑ **jmax_life_multiplier:** This variable provides the value of jmax_life for the resistor.

For example:

```
derate = jmax_factor_multiplier * jmax_life_multiplier
em_jmax_dc_avg EQU 3.0*derate jmax_factor 50 1.1 110 1.0 125 0.92
L > 5
```

The equation definition ends when reaching the end of line (EOL) or another keyword (jmax_factor, current_direction, or single).

The following are supported for equations in the ICT EM file:

- ❑ **Support for min max functions:** The min and max functions accepts two arguments:

min(a,b) => It returns the smallest value of a and b

max(a,b) => It returns the largest value of a and b

Nested min and max functions are also supported as shown below:

```
min(a, max(b, c))
```

```
max(max(a, b), c)
```

```
min(min(a, b), max(c, d))
```

```
max(min(a, b), max(c, d))
```

- ❑ **Support for defining the normsinv function:** The normsinv function accepts a single argument. It returns the value by taking the inverse normal distribution of the fraction x. The value of x must always be between 0 to 1.

```
normsinv(x)
```

- ❑ **Support for defining variables:** Variables can be defined to be used in equations specifying the current density limit. An example of how these are specified in the ICT file is shown below. In the below equation, s1, s2, s3 and s4 are variables.

```
em_model {
    s1 = 2.0*w
    s2 = s1*1.0
    s3 = 3.0*w
    s4 = s3
```

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EM Rules Specification

```
em_jmax_dc_avg EQU s2*4 jmax_factor 50 1.1 110 1.0 125 0.92 L> 5
em_jmax_dc_avg EQU s4*2 jmax_factor 50 1.1 110 1.0 125 0.92 L<=5
}
```

Note: A variable needs to be defined before it is used.

- ❑ **Support for keyword “cond” and logical operator “not”:** The keyword “cond” can be used to group multiple conditions logically for EM rules. for example:

```
em_jmax_dc_avg EQU 0.1*w      cond (L <=0.024 and L>=0.026)
em_jmax_dc_avg EQU 0.2*w      cond (((L == 0.020) or (L == 0.030))and (W <
0.01))
em_jmax_dc_avg EQU 0.2*w      cond ( not(L == 0.020 or L == 0.030))
```

- ❑ **Support for jmax_factor_dc_avg and jmax_factor_ac_avg:** These are specified for defining the jmax_factor information at the layer level.

jmax_factor_dc_avg: specifies the jmax_factor information for the DC avg EM rules at the layer level.

jmax_factor_ac_avg: specifies the jmax_factor information for the AC avg EM rules at the layer level.

For example:

```
conductor "M1" {
    em_model {
        jmax_factor_dc_avg 85 3 90 2 100 1 110 0.6 120 0.2 125 0.1
        jmax_factor_ac_avg 85 3 90 2 100 1 110 0.6 120 0.2 125 0.1

        em_jmax_dc_avg EQU 2 * w      L < 0.5
        em_jmax_ac_avg EQU 2 * w      L < 0.5
        em_jmax_dc_avg EQU 1.5 * w    L >= 0.5
        em_jmax_ac_avg EQU 1.5 * w    L >= 0.5
    }
}
```

Note: For EM rules that have jmax_factor construct, jmax_factor will be calculated from the rule jmax_factor information instead of the layer-level construct jmax_factor_dc_avg or jmax_factor_ac_avg.

- ❑ **Support for jmax_life_dc_avg and jmax_life_ac_avg:** These are specified for defining the jmax_life information at the layer level.

jmax_life_dc_avg: specifies the jmax_life information for the DC avg EM rules at the layer level.

jmax_life_ac_avg: specifies the jmax_life information for the AC avg EM rules at the layer level.

When the lifetime has an exact match in the PWL, jmax_life gets the corresponding value from the PWL. If not, then the expression in the below syntax is evaluated to get the value of jmax_life.

```
jmax_life_dc_avg <life1> <scale1> <life2> <scale2> <life3> <scale3>  
jmax_life_equ <expression>
```

```
jmax_life_ac_avg <life1> <scale1> <life2> <scale2> <life3> <scale3>  
jmax_life_equ <expression>
```

For example:

```
jmax_life_dc_avg PWL 43800 1.8 52560 1.5 61320 1.3 70080 1.2 78840 1.1  
87600 1 131400 0.6 175200 0.5 jmax_life_equ (10/Tlife)^0.9
```

```
jmax_life_ac_avg 43800 1.8 52560 1.5 61320 1.3 70080 1.2 78840 1.1 87600  
1 131400 0.6 175200 0.5 jmax_life_equ (10/Tlife)^0.9
```

Note: For EM rules that have jmax_life construct, jmax_life will be calculated from the rule jmax_life information instead of the layer-level construct jmax_life_dc_avg or jmax_life_ac_avg.

■ Order Dependency

The actual Current Density limit (value, piece-wise linear or PWL pairs, or equation) should follow immediately after the Current Density keyword (em_jmax_dc_avg). Any of the qualifiers (jmax_factor, current_direction, or single) will come after that. The order of the qualifiers is not important.

■ Units of Values

The unit should be specified in accordance with the setting defined by the em_conductor_unit, em_via_unit, and em_via_area_unit parameters defined in the process definition. Units are specified as:

- ❑ For a single value or an equation:
 - A/cm² or mA for metal layers (width based)
 - A/via or mA for via layers (per via)
- ❑ For a PWL table:
 - A/cm² or mA, with width specified in microns for metal layers
 - A/cm² or mA, with area specified in square microns for via layers

■ JMAX Factor

```
jmax_factor <temp1> <scale1> [<temp2> <scale2> ...]
```


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`jmax_factor` is the optional scaling factor to use at different temperatures compared to the reference temperature (defined by `em_tref` in the process definition). The temperature for `jmax_factor` should be specified in degrees Celsius.

Scaling factor is a positive integer: >1 to scale up, <1 to scale down, or 1 for no scale effect.

If the specified temperature, T , falls between the defined minimum and maximum temperatures, the software will calculate a new scale factor (RT) using the formula, $TTF = A * J^{(-n)} * \exp(Ea/kT)$.

For example:

$$RT = RT1 * \exp((Ea/kT) * (1/T - 1/T1))$$

where

$$Ea/kT = (T1 * T2 / (T1 - T2)) * \ln(RT2 / RT1)$$

Note:

- ❑ The temperatures T , $T1$, and $T2$ mentioned in the above formula are in Kelvin.
- ❑ If the specified temperature, T , is either below or above the defined minimum and maximum temperatures, the software will use the minimum and maximum temperature for calculating the scale factor, respectively.
- ❑ When setting scale factors for multiple temperatures, they should be specified in an ascending sequence to enable interpolation.

■ Format of the Conditions

Condition = [`L/W/Lu/Wu/Lb/Wb/Lv2v/Sv/Td/r/a/N` < | <= | > | >= | == | != <value in microns/micro seconds> | `ground_net` | `supply_net` | `Vu_current_direction` {up | down}] | [`Itolerance` < | <= | > | >= | == | != <value in percentage>]

Conditions = [condition]*

The `L` parameter specifies the length-based `jmax` values in microns.

The `W` parameter specifies the width-based `jmax` values in microns.

`L` and `W` are applicable for both metals and vias.

`Lu`, `Lb`, `Wu`, and `Wb` are applicable for vias only.

`Lv2v` and `Itolerance` are applicable only for the `power_rail` rule.

Where,

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L = length

W = Width

L_u = Upper metal length

L_b = Bottom metal length

W_u = Upper metal width

W_b = Lower metal width

L_{v2v} = Distance between terminal vias

S_v = Distance between the two top vias enclosing a metal/via. For metals, it indicates the distance between the immediate top vias across a metal. For via, it indicates the distance between two neighboring vias with the same current direction.

$Vu\_current\_direction$ {up | down} = Current direction of the top vias across a metal/via. For metal, it indicates the current direction of the immediate top vias across a metal layer. For via, it indicates the current direction of the immediate top vias across a particular via.

$supply\_net$ = specifies that the EM rule is applicable only to the supply net

$ground\_net$ = specifies that the EM rule is applicable only to the ground net

$Itolerance$ = Difference in the current values of terminal vias. For example, if a difference of up to 5 percent is acceptable, then specify ' $Itolerance \leq 0.05$ '.

Td = Time duration in micro second or total 'On Time' period

r = Duty ratio

a = Area of the single cut in the via or in the via array

N = Number of vias in the via array

Voltus-Fi-XL supports metal length/width rules above and below vias, where, the dimensions to be checked for the rules are different for the metal above and the metal below. In this case, L_u/W_u refers to dimensions of the metal above the via and L_b/W_b refers to dimensions of the metal below the via.

■ Single

The keyword, `single` can be specified to differentiate between a single square cut via and square viaarray. The following example shows how to use the `single` keyword:

```
em_jmax_dc_avg PWL 0.022 0.01 jmax_factor 105 1.1 110 1.0 115
0.9 120 0.8 125 0.7 130 0.6 140 0.5 150 0.4 current_direction up
Lb > 4 Wb >= 0.05 current_direction up single
```

■ JMAX Life

The keyword, `jmax_life` provides the ability to set the scaling factor that applies to the Current Density limits for different lifetimes. The syntax is as follows:

```
jmax_life <life1> <scale1> [<life2> <scale2>.....]
```

Note: The software will take the unit of lifetime from the `em_lifetime_units` parameter specified in the process section of the ICT file. In case the specified `life` value does not match any of the `life` values provided using `jmax_life`, the software

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EM Rules Specification

performs linear interpolation to calculate the T_{life} factor.

■ rating_factor

The keyword, `rating_factor` specifies the temperature derating factor for different lifetimes using the rating factor table. The table is used along with the global lifetime factor table that lists the lifetime variables for different lifetimes. These variables can be used in the EM equation. For example,

```
em_model {
    GLOBAL_LIFETIME_FACTOR = (
        ( LIFETIME      HOURS      LF0 LF1 )
        ( 3_YEAR        26280      5.0 6.0 )
        ( 4_YEAR        35040      7.0 8.0 )
        ( DEFAULT       100000     9.0 10.0 )
    )
    RATING_FACTOR = (
        ( LIFETIME      100 105 110 115 120 125 130 140 150 )
        ( 3_YEAR      2.0 1.7 1.3 1.0 0.9 0.8 0.7 0.6 0.5 )
        ( 4_YEAR      2.0 1.6 1.4 1.2 1.0 0.4 0.3 0.2 0.1 )
        ( DEFAULT     1.8 1.7 1.6 1.4 1.1 0.9 0.5 0.4 0.3 )
    )
    em_jmax_dc_avg EQU 2.0*w*1.0*LF0 rating_factor L > 5
    em_jmax_dc_avg EQU 2.0*w*3.0*LF1 rating_factor
}
```

Where,

The different lifetimes, 3 years, 4 years..., are specified in the `rating_factor` table and the lifetime variables for these lifetimes, `LF0`, `LF1`, are specified in the global lifetime factor table.

Note: The rating factor is only applied to EM rules that have the `rating_factor` keyword.

■ Length

[L < | <= | > | >= <value in microns>]

The L parameter specifies the length-based j_{max} values in microns.

■ Width

[W < | <= | > | >= <value in microns>]

Similar to the L parameter, the W parameter specifies the width-based j_{max} values in microns.

■ Current Direction

`current_direction` [`up` | `down` | `both`] can be specified for via current direction. The syntax of `current_direction` is:

- ❑ `up` - means the direction of the current is from bottom to top and specifies to use the length and width of the metal below `Lb/Wb` for the VIA `Jmax` factor
- ❑ `down` - means the direction of the current is from top to bottom and specifies to use the length and width of the metal above `Lu/Wu` for VIA `Jmax` factor
- ❑ `both` - This rule is applicable only when the direction of the current is uncertain. This rule is unlikely to be applied since the software calculates the current direction

■ Via Range

`via_range` <value>

`via_range` is an optional parameter which can be used with the via layers. The value of `via_range` denotes the number of vias for which the calculated limits are valid.

`via_range` is specified as a positive integer.

■ Power Rail/Power Grid

The keyword `power_rail` or `power_grid` can be specified to enable the particular EM rule for power-rail analysis. When power-rail analysis is enabled, an EM rule with the `power_rail` or `power_grid` keyword will have a higher priority than any other rule.

```
em_jmax_dc_avg PWL 0.022 0.01 jmax_factor 105 1.1 110 1.0 115
0.9 120 0.8 125 0.7 130 0.6 140 0.5 150 0.4
Lb > 4 Wb >= 0.05 current_direction up
power_rail Lv2v <= 5 Itolerance <= 0.05
```

■ ApplyR

The keyword `applyR` can be used to modify the threshold value of ratio “r” in AC-Peak analysis. The default value of this parameter is 0.05. Modifying this parameter is useful in scenarios where the value of “r” is very small. A small “r” value results in an unreasonable increase in the `Ipeak_ac` limit. You can avoid such scenarios by resetting the value of “r” in the ICT file. For example:

```
em_jmax_ac_peak EQU 4.0 r < 0.01 applyR 0.01
```

■ Priority

Specifies the priority of a rule. It is an integer number. Currently the only value that is supported is 1. The syntax is as follows:

```
priority==<integer no.>
```

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Note: The rule with `priority==1` is only enabled when the variable `'powerRailRules=n10_special'` is set and when the `power_grid` and `power_rail` keywords are also specified.

■ Device

This keyword is used to specify different EM rules for device resistors, which are subsets of other layers. The syntax is as follows:

```
device=="device model names"
```

For example, the following keyword specifies that the particular EM rule is applicable only to device with the model names, "devRA devRB".

```
device=="devRA devRB"
```

■ Subconductor

This keyword is used to specify different EM rules for subconductors, which are subsets of poly or other layers. The syntax is as follows:

```
sub_conductor=="subconductor names"
```

For example, the following keyword specifies that the particular EM rule is applicable only to subconductor layers, `ppoly` and `gpoly`.

```
sub_conductor=="ppoly gpoly"
```

■ bridge_via

This keyword is used to specify that the particular EM rule will apply only to bridge vias.

■ Color

This keyword is used to specify that the particular EM rule is applicable only to the resistor with the specified color number.

For example,

`color=="2 4 5"` specifies that the particular EM rule is applicable only to the resistor with property, `$M=2` OR `$M=4` OR `$M=5`.

■ Masks

This keyword is used to specify that the particular EM rule is applicable only to the resistor with the specified mask number.

For example,

`mask==2` specifies that the particular EM rule is applicable only to the resistor with property, `$M=2`.

■ **hi_em**

This keyword is used to specify that the particular EM rule is applicable only to the design resistor with the specified value of `hi_em` parameter.

For example,

`hi_em==1` specifies that the particular EM rule is applicable only to the design resistor with the property, `hi_em=1`.

Note: The `Sh` keyword is not supported in the EM rules condition. It is ignored if specified in the EM rules condition inside the techfile.

Rules for Specifying Via Area

You can specify PWL in either one of the following ways:

- Provide PWL for a specific area:

```
em_jmax_* PWL Value_1 area_1 ... Value_N areaN
```

For example,

```
em_jmax_* PWL 1.3 2.0 1.7 3.0
```

- Provide PWL for a specified area range:

```
em_jmax_* EQU <equation with 'a'> conditions
```

For example,

```
em_jmax_* EQU (1.3 * a)/2.0 a>=0.0 a<2.5
```

```
em_jmax_* EQU (1.7 * a)/3.0 a>=2.5 N>=3
```

```
em_jmax_* EQU (1.9 * a)/3.0 a>=2.5 N<3
```

Rules for Specifying the EM Analysis Type for Power and Ground Nets

Set the variable, `splitACDCRules`, to `true` for specifying different rules for EM analysis of power and signal nets. You can set this variable in the following ways:

- `setenv VOLTUSFI_SPLIT_ACDC_RULES true`
`set_variable splitACDCRules true`
When this variable is specified using the `set_variable` command, it takes priority over the `setenv` variable.
- Set the variable, `splitACDCRules`, to `true` in the Variables form. You can open this form from the EM tab of the IR/EM Results form.

The table below shows the rules for power and signal nets both when the variable is set and not set.

splitACDCRules is set to false	splitACDCRules is set to true Description	
Power and Signal Nets	Power Nets	Signal Nets
■ <code>em_jmax_dc_peak</code> rules are used when MAX analysis is specified ■ <code>em_jmax_ac_peak</code> rules are used when ACPEAK analysis is specified Note: If ACPEAK analysis is specified but the <code>em_jmax_ac_peak</code> rules are not specified in the technology file, then <code>em_jmax_dc_peak</code> rules are used for the ACPEAK analysis.	<code>em_jmax_dc_peak</code>	<code>em_jmax_ac_peak</code>
<code>em_jmax_dc_avg</code>	<code>em_jmax_dc_avg</code>	<code>em_jmax_ac_avg</code>
<code>em_jmax_ac_rms</code>	<code>em_jmax_dc_rms</code>	<code>em_jmax_ac_rms</code>

EM Rule Selection Priority

This section details the order of priority in which the EM rules are applied by Voltus-Fi-XL based on the specified keywords. The order of priority of keywords in descending order is provided below:

1. device --> **highest priority**
2. sub_conductor
3. bridge_via
4. priority
5. power_grid/power_rail
6. color
7. mask
8. current_direction
9. Conditions
10. Area matching in case of PWL
11. Base rule
12. Optimistic/pessimistic rules --> **lowest priority**

These are detailed below.

■ device

When a device is specified in the EM rule file, the software first looks for the `device` keyword and applies the EM rules to the specified device.

For example, for a device with model name, `devRA`, if the following rules are specified in the ICT file:

- ```
1. em_jmax* ... device=="devRA"
2. em_jmax* ... device=="devRB"
3. em_jmax* ...
```

Then the software follows the order of priority provided below:

- ☐ Match rule 1 because it has a matching `device` keyword
- ☐ Match rule 3 if rule 1 does not match
- ☐ Skip rule 2 because it is for device, `devRB`

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#### ■ sub\_conductor

When a sub conductor is specified in the EM rule file, the software first looks for the `sub_conductor` keyword and applies the EM rules to the specified sub conductor.

For example, for a resistor on layer, `ppoly`, if the following rules are specified in the ICT file:

1. `em_jmax* ... sub_conductor=="ppoly"`
2. `em_jmax* ... sub_conductor=="gpoly"`
3. `em_jmax* ...`

Then the software follows the order of priority provided below:

- ☐ Match rule 1 because it has a matching `sub_conductor` keyword
- ☐ Match rule 3 if rule 1 does not match
- ☐ Skip rule 2 because it is for sub conductor, `gpoly`

#### ■ bridge\_via

When a `bridge_via` is specified in the EM rule file, the software first looks for the `bridge_via` keyword and applies the EM rules having `bridge_via` keyword for the bridge via. In case, the via is not bridge via, rules having `bridge_via` keyword will be ignored.

For example, for a bridge via, if the following rules are specified in the ICT file:

1. `em_jmax* ... bridge_via`
2. `em_jmax* ...`

Then the software follows the order of priority provided below:

- ☐ Match rule 1 because it is a bridge via
- ☐ Match rule 2 if rule 1 does not match

In case, the via is not bridge via, then the software will match rule 2.

#### ■ priority

When a priority is specified in the EM rule file, in the following manner:

1. `em_jmax* ... priority==1`
2. `em_jmax* ...`

Then the software follows the order of priority provided below:

- ☐ Match rule 1 when `powerRailRules=n10_special` is set
- ☐ Match rule 2 if rule 1 does not match

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#### ■ power\_rail/power\_grid

When the `power_rail/power_grid` keyword is specified in the EM rule file, in the following manner:

1. `em_jmax* ... power_grid`
2. `em_jmax* ...`

Then the software follows the order of priority provided below:

- ☐ Match rule 1 when the power grid analysis is enabled
- ☐ Match rule 2 if rule 1 does not match

#### ■ color

When the `color` keyword is specified in the EM rule file, in the following manner:

1. `em_jmax* ... color=="1 3 5"`
2. `em_jmax* ...`

For example, if a resistor has color number 5, specified using `$M=5`, then the software follows the order of priority provided below:

- ☐ Match rule 1 for the specified color number
- ☐ Match rule 2 if rule 1 does not match

#### ■ mask

When the `mask` keyword is specified in the EM rule file, in the following manner:

1. `em_jmax* ... mask==2`
2. `em_jmax* ...`

For example, if a resistor has mask number 2, specified using `$M=2`, then the software follows the order of priority provided below:

- ☐ Match rule 1 for the specified mask number
- ☐ Match rule 2 if rule 1 does not match

#### ■ current\_direction

When the `current_direction` keyword is specified in the EM rule file, in the following manner:

1. `em_jmax* ... current_direction up`
2. `em_jmax* ... current_direction down`
3. `em_jmax* ...`

Then, for a resistor with `current_direction up`, the software follows the order of priority provided below:

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- ☐ Match rule 1 because it has a matching `current_direction` keyword
- ☐ Match rule 3 if rule 1 does not match
- ☐ Skip rule 2 because the current direction is not matching

#### ■ Conditions

When conditions are specified in the EM rule file, in the following manner:

1. `em_jmax* ... L <=5`
2. `em_jmax ... L > 5`
3. `em_jmax* ...`

Then the software follows the order of priority provided below:

- ☐ Match rules 1 and 2 because conditions are specified
- ☐ Match rule 3 if rules 1 and 2 are not matching

#### ■ Area Matching from the PWL

When the PWL for specific via areas are specified in the EM rule file, in the following manner:

1. `em_jmax* ... PWL VAL_1 AREA_1 VAL_2 AREA_2 L <=5`
2. `em_jmax ... PWL VAL_3 AREA_3 VAL_4 AREA_4 L <=5`

Then the software follows the order of priority provided below:

- ☐ Match the exact areas provided in the rule file
- ☐ The software does not interpolate for unmatched areas (other than `AREA_1`, `AREA_2`, `AREA_3`, and `AREA_4` in above example)

#### ■ Base Rule Selection

When the PWL for specific via area is specified in the EM rule file, **without any conditions** in the following manner:

- `em_jmax* ... PWL VAL_1 AREA_1 VAL_2 AREA_2`

Then the software follows the order of priority provided below:

- ☐ Match the exact areas from the base rule
- ☐ The software does not interpolate for unmatched areas (other than `AREA_1` and `AREA_2` in above example)

#### ■ Optimistic/Pessimistic Rule Selection

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When multiple rules are selected after all conditions match, the software selects the optimistic/pessimistic value based on whether the variable, `optimisticEMRuleSelection`, is set to `true` or `false`.

By default, the software selects the pessimistic value.

For example, when the following rule set is provided:

```
1. em_jmax* EQU 1.5 ...
2. em_jmax* EQU 3.5 ...
3. em_jmax* EQU 2.5 ...
```

- ❑ Rule 1 is selected by default because it is more pessimistic as compared to rules 2 and 3
- ❑ When the variable, `optimisticEMRuleSelection`, is set to `true`, then rule 2 is selected because it is more optimistic as compared to the other rules
- ❑ Rule 2 is skipped because it is neither the most pessimistic nor the most optimistic

### Example

Consider the two scenarios provided below for EM rule selection.

The given rule set is as follows:

```
1. em_jmax*... current_direction up L>=5
2. em_jmax*... current_direction up L<5
3. em_jmax*... current_direction down L>=5
4. em_jmax*... L<5
```

**Case 1:** EM rule selection for a resistor with current direction “up” and with  $L=3$  will be as follows:

- The tool will select rules 1 and 2 because they match the current direction “up”
- Of the two selected rules, the tool will discard rule 1 because of the non-matching condition,  $L \geq 5$  and it will select rule 2 because of the condition,  $L=3$ , which matches the condition  $L < 5$

The final rule selection in Case 1 will be rule 2.

**Case 2:** EM rule selection for a resistor with current direction “down” and  $L=2$  will be as follows:

- The tool will first select rule 3 as it matches the current direction “down”

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- The tool will then discard the selected rule 3 because of the non-matching condition,  $L \geq 5$
- The tool will then select rule 4 from the remaining rules, as rule 4 does not have any current direction condition but it matches the condition,  $L < 5$

The final rule selection in Case 2 will be rule 4.

## Process

```
process "name" {
 # Specify silicon based erosion tables
 use_silicon_density true
 background_dielectric_constant value
 layout_scale value
 temp_reference value

 # EM_Model parameters
 [em_tref <value>]
 [em_output_wlt <silicon|drawn>]
 [em_variables <variable1> [<variable2> [...]]]
 [em_conductor_unit A/cm^2 | mA/um | mA]
 [em_via_unit A | mA]
 [em_via_area_unit A/cm^2 | mA]
 [em_lifetime_units hours | years]
}
```

The process command specifies key characteristics of the device, such as background dielectric constant, reference temperature, and overall scale.

## Arguments

|                                             |                                                                                                                                       |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <i>"name"</i>                               | Specifies the name of the process.                                                                                                    |
| background_dielectric_constant <i>value</i> | Specifies the dielectric constant for the region above the top or last dielectric layer. This field is required.                      |
| layout_scale <i>value</i>                   | Specifies the ratio of the scaled dimensions divided by the drawn dimensions. The ICT file is defined based on the scaled dimensions. |

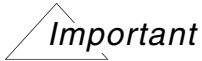
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|                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>temp_reference value</code>                                             | Specifies the reference temperature in degrees Celsius.                                                                                                                                                                                                                                                                                                                                                        |
| <b>EM_Model parameters</b>                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                                               | The process definition parameters described below are provided to establish variables or properties that apply to all <code>em_models</code> in the ICT file, across all layers. All process parameters for EM models are optional.                                                                                                                                                                            |
| <code>em_tref &lt;value&gt;</code>                                            | Specifies nominal temperature for EM analysis specified in Celsius.                                                                                                                                                                                                                                                                                                                                            |
| <code>em_output_wlt [silicon<br/>  drawn]</code>                              | This determines whether the width and length parameters are written out as drawn dimensions or silicon dimensions.                                                                                                                                                                                                                                                                                             |
| <code>em_variables<br/>&lt;variable1&gt;<br/>[&lt;variable2&gt; [...]]</code> | Globally declares variables used inside the EM models. Examples of variables are: <code>delta_T</code> , <code>w</code> , <code>l</code> . The analysis tool will calculate the value for the variable as it applies to a specific <code>em_model</code> and apply that value during EM analysis. Variables can be declared as a string, with a space between variables. There is no default variable defined. |
| <code>em_conductor_unit [ A/cm^2   mA/um   mA]</code>                         | Specifies the units to use for current density limits on conductor layers. The choices are amps per square centimeter ( <code>A/cm^2</code> ), milliamps per micron ( <code>mA/um</code> ), and milliamps ( <code>mA</code> ). Most processes use equation to specify current limit in <code>mA</code> (default value). The selection is not case-sensitive.                                                   |
| <code>em_via_unit [ A   mA ]</code>                                           | Specifies the units to use for current density limits on via layers on a simple per via basis. The choices are amps ( <code>A</code> ) or milliamps ( <code>mA</code> ). The default is <code>A</code> . The selection is not case-sensitive.                                                                                                                                                                  |
| <code>em_via_area_unit [A/cm^2<br/>  mA]</code>                               | Specifies the units to use for piecewise linear (PWL) current density limits for via layers using density/area value pairs. The choices are amps per square centimeter ( <code>A/cm^2</code> ) or milliamps ( <code>mA</code> ).<br><br>The default is <code>A/cm^2</code> . The selection is not case-sensitive.                                                                                              |

## EM Data File in Voltus-Fi-XL

An EM data file specifies the technology information, such as current density limits, and provides a mapping between the layers for highlighting. The EM data file syntax is case-sensitive. The file must start with parenthesis.



EM data file support in Voltus-Fi-XL is provided only for backward compatibility. It supports all the rules that were supported by APS EMIR. Any new rules are supported in the ICT file.

Following is a sample EM data file.

```
(
; this file is case sensitive
routingLayers = ("Poly" "Metal1" "Metal2" "Metal3" "Metal4" "Metal5" "Metal6")
viaLayers = ("Cont" "Nimp" "Pimp" "Via1" "Via2" "Via3" "Via4" "Via5")
viaWidthList = (("Nimp" 0.2) ("Pimp" 0.2) ("Cont" 0.2) ("Via1" 0.2)
("Via2" 0.2) ("Via3" 0.2) ("Via4" 0.2) ("Via4" 0.2))
xrefLayers = (
("POLYcont" ("Cont" "Cont"))
("NSDcont" ("Nimp" "Nimp"))
("PSDcont" ("Pimp" "Pimp"))
("poly" ("Poly" "Poly"))
("mt1" ("Metal1" "Metal1"))
("mt2" ("Metal2" "Metal2"))
("mt3" ("Metal3" "Metal3"))
("mt4" ("Metal4" "Metal4"))
("mt5" ("Metal5" "Metal5"))
("mt6" ("Metal6" "Metal6"))
("Via2NoCapInd" ("Via2" "Via2"))
("Via2" ("Via2" "Via2"))
)
avgCurrentDensSpecList = (
(nil layer "Poly" minW 0.0 maxW -1.0 minL 0 maxL 5 currentDensity ((1.0 , 110)))
(nil layer "Metal1" minW 0.0 maxW -1.0 currentDensity ((1.1 , 110)))
(nil layer "Metal2" minW 0.0 maxW -1.0 currentDensity ((1.2 , 110)))
(nil layer "Metal3" minW 0.0 maxW -1.0 currentDensity ((1.3 , 110)))
(nil layer "Metal4" minW 0.0 maxW -1.0 currentDensity ((1.4 , 110)))
(nil layer "Metal5" minW 0.0 maxW -1.0 currentDensity ((1.5 , 110)))
(nil layer "Metal6" minW 0.0 maxW -1.0 currentDensity ((1.6 , 110)))
)
```



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```
(nil layer "Cont" minW 0.0 maxW -1.0 res 1.0 currentDensity ((2.0 , 110)))
(nil layer "Nimp" minW 0.0 maxW -1.0 res 1.1 currentDensity ((2.1 , 110)))
(nil layer "Pimp" minW 0.0 maxW -1.0 res 1.2 currentDensity ((2.2 , 110)))
(nil layer "Via1" minW 0.0 maxW -1.0 res 1.3 currentDensity ((2.3 , 110)))
(nil layer "Via2" minW 0.0 maxW -1.0 res 1.4 currentDensity ((2.4 , 110)))
(nil layer "Via3" minW 0.0 maxW -1.0 res 1.5 currentDensity ((2.5 , 110)))
(nil layer "Via4" minW 0.0 maxW -1.0 res 1.6 currentDensity ((2.6 , 110)))
(nil layer "Via5" minW 0.0 maxW -1.0 res 1.7 currentDensity ((2.7 , 110)))
)

peakCurrentDensSpecList = (
 (nil layer "Poly" minW 0.0 maxW -1.0 currentDensity ((1.1 , 110)))
 (nil layer "Metal1" minW 0.0 maxW -1.0 currentDensity ((1.2 , 110)))
 (nil layer "Metal2" minW 0.0 maxW -1.0 currentDensity ((1.3 , 110)))
 (nil layer "Metal3" minW 0.0 maxW -1.0 currentDensity ((1.4 , 110)))
 (nil layer "Metal4" minW 0.0 maxW -1.0 currentDensity ((1.5 , 110)))
 (nil layer "Metal5" minW 0.0 maxW -1.0 currentDensity ((1.6 , 110)))
 (nil layer "Metal6" minW 0.0 maxW -1.0 currentDensity ((1.7 , 110)))
 (nil layer "Cont" minW 0.0 maxW -1.0 res 1.0 currentDensity ((2.1 , 110)))
 (nil layer "Nimp" minW 0.0 maxW -1.0 res 1.1 currentDensity ((2.2 , 110)))
 (nil layer "Pimp" minW 0.0 maxW -1.0 res 1.2 currentDensity ((2.3 , 110)))
 (nil layer "Via1" minW 0.0 maxW -1.0 res 1.3 currentDensity ((2.4 , 110)))
 (nil layer "Via2" minW 0.0 maxW -1.0 res 1.4 currentDensity ((2.5 , 110)))
 (nil layer "Via3" minW 0.0 maxW -1.0 res 1.5 currentDensity ((2.6 , 110)))
 (nil layer "Via4" minW 0.0 maxW -1.0 res 1.6 currentDensity ((2.7 , 110)))
 (nil layer "Via5" minW 0.0 maxW -1.0 res 1.7 currentDensity ((2.8 , 110)))
)
```

## iRCX Files for EM analysis

Voltus-Fi supports interoperable interconnect extraction (iRCX) files as an input for running EM analysis. This file contains process and EM model information for EM analysis and is provided by the foundry.

The iRCX file is further divided into two separate files, iRCX-RC and iRCX-EM. The iRCX-RC file is an encrypted file that contains confidential technology information of the foundry, whereas the iRCX-EM file is a plain text file that contains EM model information. The iRCX-EM file can further be converted into the ICT-EM file.

The iRCX-EM file is supported in both the qrcTechFile flow and the emDataFile flow. However, the qrcTechFile flow is the recommended flow to be used in Voltus-Fi-XL.

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### EM Rules Specification

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Set the following parameters in the EMIR control file (`emir.conf`) to directly use an iRCX file in Voltus-Fi-XL:

```
emirutil rcIrcxFile=[./RC_your_file.ircx]
```

```
emirutil emirIrcxFile=[./EMIR_your_file.ircx]
```

### Support of iRCX Files in the qrcTechFile Flow

When you get a new iRCX or ICT-EM file from the foundry, you must update the `qrcTechFile` with the updated EM model information using the Techgen utility.

**Note:** The Techgen utility is located in the bin directory of the Quantus installation tree. For newer process nodes, use the latest EXT release to ensure correctness.

You can use one of the following ways to update the `qrcTechFile` using Techgen:

- Use the following recommended option for advanced nodes:

```
Techgen -update_em <qrcTechFile> <RC.iRCX EM.iRCX| ICT-EM>
```

- Use the following option if a single iRCX file contains both RC and EM information:

```
Techgen -update_em <qrcTechFile> <iRCX | ICT-EM>
```

- Use the following option for a non-encrypted ICT or iRCX file:

```
Techgen -process_out <qrcTechFile>
```

It dumps the `RCGEN.ict` file containing EM model information. However, it works only when the `qrcTechFile` is compiled with the `openprocess` option.

```
ircxtoict -i <ICT output> -em_update <ICT with/without EM> <iRCX file>
```

It updates the ICT file with the EM models specified in the iRCX file.

```
Techgen -update_process <qrcTechFile> <ICT from ircxtoict>
```

It updates the `qrcTechFile` with the EM models specified in the ICT file.

#### Note:

- If the `qrcTechFile` is encrypted, contact the foundry to get the original ICT file that was used to compile the encrypted `qrcTechFile`.
- It is recommended not to generate an ICT file from scratch using the `ircxtoict` utility and the iRCX file. It is strongly recommended to start from an ICT file dumped out of an existing `qrcTechFile` for updating the EM model information.

## Support of iRCX Files in the emDataFile Flow

When you get a new iRCX file, you must convert it to the ICT format using the `ircxtoict` utility and then generate an emDataFile using the `ict2emfiles` utility.

**Note:** The `ircxtoict` utility is located in the bin directory of the Quantus installation tree. The `ict2emfiles` utility is located in the bin directory of the Voltus-Fi installation tree.

Do the following:

1. Use the following command to convert the iRCX file to the ICT format with EM rules:

```
ircxtoict -i <ICT output> <iRCX file>
```

2. Use the following command to generate the emDataFile:

```
ict2emfiles -i <ict_file> <-eps|-ic|-both> [-im <mapping_file>] [-w
<width_file> OR -l <lef_technology_file> -lm <lefdef_layer_map>]
```

## Conversion of EM Data File into ICT File

Voltus-Fi-XL supports the conversion of an EM data file (`emDataFile`) into an interconnect technology (ICT) file in batch mode. The converted ICT file can then be used, both in batch and GUI modes, to perform EM analysis in Voltus-Fi-XL.

To convert an EM data file into an ICT file, perform the following step:

- Provide information about the `convert_emdatafile_to_ict` command in the command file, which is specified using the `vfibatch` command.

```
vfibatch -cmd cmd-file-name
```

The `convert_emdatafile_to_ict` command converts the specified EM data file into an ICT file.

### convert\_emdatafile\_to\_ict

```
convert_emdatafile_to_ict
-emDataFile emDataFile_path \
[-ictfile converted_ict_file] \
[-cmdfile additional_cmd_file] \
-extracted_lib_name lib_name \
-extracted_cell_name cell_name \
-extracted_view_name view_name
```

Converts the specified EM data file into an ICT file to be used for performing EM analysis in Voltus-Fi-XL.

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### Parameters

`-cmdfile additional_cmd_file`

Specifies the name of the command file that is generated from the specified `emDataFile`. If this parameter is not specified, a file with the name `additional.cmd` is created in the current working directory.

This is an optional parameter.

`-emDataFile emDataFile_path`

Specifies the location of the `emDataFile` that is to be converted into the ICT file.

This is a required parameter.

`-extracted_cell_name cell_name`

Specifies the cell name for the design.

This is a required parameter.

`-extracted_lib_name lib_name`

Specifies the library name for the design.

This is a required parameter.

`-extracted_view_name view_name`

Specifies the view name for the design.

This is a required parameter.

`-ictfile converted_ict_file`

Specifies the name of the converted ICT file. If this parameter is not specified, a file with the name, `toolgenerated.ict` is generated in the current working directory.

This is an optional parameter.

### Example

In the following example, the `emDataFile.txt` file in the `amsPLL/vco/layout` cellview is converted into the `myict.ict` file. The command file, `mycmd.cmd`, is generated from the `emDataFile.txt` file.

```
convert_emdatafile_to_ict \
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### EM Rules Specification

---

```
-emDataFile emDataFile.txt \
-ictfile myict.ict \
-cmdfile mycmd.cmd \
-extracted_lib_name amsPLL \
-extracted_cell_name vco \
-extracted_view_name layout
```

## Supported EM Rules for Converting EM Data File into ICT File

The following EM rules are supported in the conversion of an EM data file into an ICT file:

| Rule              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| currentDensityMPV | Specifies the current density of via in milliamps per via instead of the standard milliamps per micron.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| deltaT            | <p>Specifies the maximum rise in temperature in degree Celsius, caused due to Joule heating. It must be a positive value. If the value is not specified, Voltus-Fi uses a default value of 5 degree Celsius. This is an ideal condition where the design must be EM free.</p> <p>deltaT can be used in defining the Current Density limit: <math>I_{rms}</math></p> <p>For example,</p> <pre>(nil layer "M1" minW 0.09 maxW 12.0 currentDensity<br/>((sqrt(18.33*deltaT*(w-.016)*(w-.016)*(w-.016+.352)/(w-.016+.0443))/w), 110)))</pre> |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### EM Rules Specification

| Rule               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| recoveryFactor     | <p>Calculates the effective DC electromigration in bipolar current wave forms. This accounts for some 'sweep back recovery' of EM during the negative portion of the current wave form. The recovery factor is specified in the EM Rules specification file as:</p> <pre>recoveryFactor=&lt;value&gt;</pre> <p>where the user-specified value ranges from 0 to 1.0. The default value is 1.</p> <p>The following equation shows how the recovery factor is used by the software while calculating the total average EM current:</p> $I_{avg} = \max(I_+, I_-) - (\text{recovery factor}) * \min(I_+, I_-)$ <p>where <math>I_+</math> is the average of <math>I</math> in the positive direction and <math>I_-</math> is the average of <math>I</math> in the negative direction.</p> |
| recoveryFactorList | <p>Specifies the list of layers and the corresponding recovery factors to be used for these layers during EM analysis. The following example shows how different recovery factors are specified for layers, Via1 and mt1.</p> <pre>recoveryFactorList= ("Via1" 0.7) ("mt1" 0.3))</pre> <p><b>Note:</b> If both <code>recoveryFactor</code> and <code>recoveryFactorList</code> are specified, the list of layers and their corresponding values specified using the <code>recoveryFactorList</code> keyword get preference.</p>                                                                                                                                                                                                                                                      |
| cadGrid            | <p>Specifies the minimum width of parasitic resistor. The unit of measurement is micrometer (<math>\mu\text{m}</math>) or micron.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| routingLayers      | <p>Specifies the names of the DFII layers that are used for routing. Include only the poly and metals. For example:</p> <pre>routingLayers= ("poly1" "m1" "m2" "m3" "m4" "m5" "m6" "m7" "m8" "m9" "MD")</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| viaLayers          | <p>Specifies the DFII layer names of via layers.</p> <pre>( Metall Cont Poly) //the via layer is Cont</pre> <p>An example of the viaLayers syntax follows:</p> <pre>viaLayers= ("cw" "v1" "v2" "v3" "v4" "v5" "v6" "v7" "v8")</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## EM Rules Specification

| Rule                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| xrefLayers          | <p>These are the cross-reference layers that provide mapping between the Quantus layer names, Current Density names, and the DFII layer names. If a layer is not present in xreflayers mapping, its DFII name is used as the Current Density name and Quantus name.</p> <pre>(( "QuantusName" ("currentDensityName" "DFIIName"))</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| CurrentDensSpecList | <p>Refers to the Current Density specification declared by the foundry. The syntax allows one layer to support two different Current Density specifications according to the width of the material. The following Current Density specifications are supported: avgCurrentDensSpecList, avgAbsCurrentDensSpecList, rmsCurrentDensSpecList, DCrmsCurrentDensSpecList, peakCurrentDensSpecList, and ACpeakCurrentDensSpecList</p> <p>The following optional parameters are supported:</p> <pre>minW, maxW, minL, maxL, minLu, maxLu, minWu, maxWu, minWb, maxWb, minLb, maxLb</pre> <p><b>Note:</b> The conversion procedure of emDataFile to ICT file categorizes the Current Density specification rule in the following two ways:</p> <p><b>Standard Form:</b> <math>(EQU/w) * J_{maxFactor}</math></p> <p><b>Non-Standard Form:</b> Any form except the above. The software uses interpolation for specifying the EM Rules in the ICT file.</p> |
| LayerStack          | <p>The layer stack contains a list of via names and the corresponding upper metal and bottom metal layer names.</p> <pre>(( "LayerName" ("upperMetalLayerName" "bottomMetalLayerName"))</pre> <ul style="list-style-type: none"> <li>■ <i>LayerName</i> is the layer name specified in the layout view</li> <li>■ <i>upperMetalLayerName</i> is the upper metal layer name in the layout view</li> <li>■ <i>bottomMetalLayerName</i> is the bottom metal layer name in the layout view</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### EM Rules Specification

| Rule            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| viaWidthList    | <p>Specifies the minimum via width. For example:</p> <pre>viaWidthList= ("Cont" 0.2) ("Via1" 0.2))</pre> <p>Where,</p> <p>Cont is the DFII name of via layer.</p> <p>0.2 is the minimum width of the default via for this layer.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| extViaWidthList | <p>Specifies the minimum via width. For example:</p> <pre>extViaWidthList= ("extCont" 0.2) ("extVia1" 0.2))</pre> <p>Where</p> <p>extCont is the Quantus (Extraction) name of via layer.</p> <p>0.2 is the minimum width of the default via for this layer.</p> <p><b>Note:</b> viaWidthList will be ignored if extViaWidthList is specified.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DesignResistors | <p>Specifies the list of design resistor cell names. For each cell name, you can specify the resistor property name, width property name, length property name, and units for width and length property names for which the design resistors are to be analyzed.</p> <p>The default unit for both width and length property name is meter. Specifying the resistor property name, width property name, length property name, and unit name is optional. If any of these property names is not specified, the software uses “r”, “w”, and “l” as the default values for these properties.</p> <p>The width and length property names are specified when the names of these properties are different from the “w” and “l” in the layout view.</p> <p><b>Syntax:</b></p> <pre>DesignResistors = ("CellName1" "CellName2" "CellName3") DesignResistors = ("CellName.*")</pre> |
| junctionTemp    | <p>Specifies the temperature to be used for EM analysis. Used as <math>t_j</math> in ICT.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| applyRThreshold | <p>Specifies the threshold ratio “r” for AC-Peak analysis. The default value of threshold ratio is 0.05.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### EM Rules Specification

| Rule                             | Description                                                                               |
|----------------------------------|-------------------------------------------------------------------------------------------|
| <code>rmsMultiplierPin</code>    | Specifies the RMS relaxation factor for EM power-grid analysis. The default value is 1.0. |
| <code>rmsMultiplierSignal</code> | Specifies the RMS relaxation factor for signal EM analysis. The default value is 1.0.     |

## Unsupported EM Rules for Converting EM Data File into ICT File

The following EM rules are not supported in the conversion of an EM data file (`emDataFile`) into an ICT file:

| Rule                          | Description                                                                                                           |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <code>Jmaxlife</code>         | Specifies the scaling factor that applies to the Current Density limits for different lifetimes.                      |
| <code>BulkTerminal</code>     | Specifies the bulk terminals of the design resistors that are to be ignored while performing EM analysis.             |
| <code>minI</code>             | Used to limit the reporting of small currents that are of little or no interest.                                      |
| <code>durationTime</code>     | Specifies the maximum time period for which violations are allowed.                                                   |
| <code>technologyNode</code>   | Specifies the technology-dependent calculation.                                                                       |
| <code>viaLengthList</code>    | Specifies the via length.                                                                                             |
| <code>extViaLengthList</code> | Specifies the via length. It get preference over <code>viaLengthList</code> .                                         |
| <code>selectResistors</code>  | Selects resistors by their names. All other resistors are ignored for the analysis.                                   |
| <code>selectLayers</code>     | Selects resistors based on the layer name. All resistors on other layers will be ignored for the analysis.            |
| <code>ignoreLayers</code>     | Ignores resistors based on the extracted layer name. All resistors on other layers will be selected for the analysis. |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### EM Rules Specification

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| Rule            | Description                                                                             |
|-----------------|-----------------------------------------------------------------------------------------|
| ignoreResistors | Ignores resistors by their name. All other resistors will be selected for the analysis. |
| meshR           | Specifies regions for mesh resistance extraction.                                       |
| fracture_vias   | Specifies whether or not there are dummy vias present.                                  |
| Thickness       | Specifies the thickness of the layers.                                                  |
| preExecuteFiles | Includes the list of pre-loaded custom files when reading the emDataFile.               |

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## xDSPF Generation using Quantus

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This section contains information about Detailed Standard Parasitic Format (xDSPF) files and how to generate an xDSPF file in Voltus-Fi-XL.

### Overview of Detailed Standard Parasitic Format file

A Detailed Standard Parasitic Format (xDSPF) file is a third-party netlist file that is used to provide all the parasitic information of the design for performing simulations using the Spectre APS/XPS simulators.

The xDSPF file is created using an extractor. This file is then used as the input for performing a simulation. The simulation database that is generated is used to perform EMIR analysis in Voltus-Fi-XL. However, if you are using Quantus for extraction, you can also generate the xDSPF file from within Voltus-Fi-XL.

To create an xDSPF file, you can use either the GUI or batch mode. In batch mode, run the `extract_xdspf` command to create the file.

#### ***Related Topics***

- [Generating xDSPF File](#)
- [extract\\_xdspf \(batch command\)](#)
- [Extract xDSPF Form Description](#)

## Generating xDSPF File

You can generate an xDSPF file using Quantus in Voltus-Fi-XL. This file is then used as the input for performing a simulation, and the generated simulation database is used to perform EMIR analysis in Voltus-Fi-XL.

Before generating the xDSPF file, ensure the following:

- The Quantus hierarchy is available as the software calls the Quantus binary from this path.
- The Pegasus, PVS, or Calibre run is performed successfully to generate the Pegasus, PVS, or Calibre database, which is the input database for generating the xDSPF file using Quantus.
- The SPF Checker utility is located at the MMSIM/Spectre installation directory. SPF Checker works only when the top-level Quantus run is successful.

To generate an xDSPF file, perform the following steps:

1. [Specifying Input Data Information](#)
2. [Specifying Process Node-Specific Information](#)
3. [Specifying Technology Data Information](#)
4. [Specifying Output Information](#)

### Specifying Input Data Information

1. Choose *Extraction – Extract DSPF*.

The Extract xDSPF form is displayed.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### xDSPF Generation using Quantus

**Extract xDSPF**

**Input**

Data Type: ☒ PVS/Pegasus ☐ Calibre ☐ Assura

Data Directory:

Run Name:

Post Processing Script:

LSF Number:  LSF Command:

☒ Hierarchical EMIR flow

PGV Library Name:

**Process**

Process Node:

☒ Signal EM PG Net(s):  Nets File:

Extraction Type:  Cap Coupling Model:

☐ Parasitic RES Color ☐ Compression ☐ Reduce I-Cards

☐ Comment Sub Ckt ☐ Sub Conductor Model ☐ Filter RES Center

☐ Filter RES By Layer:

Ref Node:  Sub-Node Char:  Fracture Via Count:

☐ Via Array Spacing: ☒ auto ☐

Via Array Count:  ☒ Bounding box options

**Technology**

Technology Library File:

Technology Name:  Corner:

Temperature:  No of CPUs:

SubCkt Pin Order File:

Customized Extract Commands File:  ☐ Add Extract Command

Parasitic blocking device cells file:

**Output**

Directory:

xDSPF File Name:  ☒ Autorun Spfchecker

2. Select one of the *Data Type* options: *PVS/Pegasus*, *Calibre*, or *Assura*.

3. Specify the *Data Directory*.
4. Specify the *Run Name*.
5. Specify values for *Lib Name*, *Cell Name*, and *View Name*.

These options are available only when *Assura* is selected as the data type.

6. Specify the *Post Processing Script*.
7. Specify the Load Sharing Facility (LSF) options for a distributed run.

## Specifying Process Node-Specific Information

1. Select a *Process Node*.
2. Select *Signal EM* if you want signal nets to be included in the xDSPF file.
3. Specify the power and ground nets in the *PG Net(s)* field.  
You can specify a value here only when the *Signal EM* option is deselected.
4. Specify the *Nets File*.  
If the Nets File is specified, the *Signal EM* and *PG Net(s)* options are ignored.
5. Select an *Extraction Type*.
6. Select a coupling mode in the *Cap Coupling Model* field.
7. Select the following check boxes, if required: *Parasitic RES Color*, *Compression*, *Reduce I-Cards*, *Comment Sub Ckt*, *Sub Conductor Model*, and *Filter RES Center*.
8. Select *Filter RES By Layer* if you want to specify the LVS layer name for which the minimum resistance value for the extracted parasitic resistors is to be applied.
9. Specify the reference node in the *Ref Node* field.
10. Specify the subnode identification character in the *Sub-Node Char* field.
11. Specify the *Fracture Via Count*.
12. Select *Via Array Spacing* and specify a value that will be used as the maximum distance criteria for grouping vias within the same array.
13. Specify the *Via Array Count*.

## Specifying Technology Data Information

1. Specify either a *Technology Library File* or a *Technology Directory*.
2. Specify the *Technology Name and Corner* if the *Technology Library File* is specified.
3. Specify the *Temperature* at which the extraction will be performed.
4. Specify the *No of CPUs* to be used during the Quantus extraction run.
5. Specify the *SubCkt Pin Order File*.
6. Specify the *Customized Extract Commands File* that contains user-defined commands. When you select *Add Extract Command*, the Voltus-Fi-generated extract commands override the user-defined extract commands.
7. Specify the *Parasitic blocking device cells file*.

## Specifying Output Information

1. Specify the *Directory* in which the xDSPF file will be saved.
2. Specify the *xDSPF File Name*.
3. Select *Autorun Spfchecker* to automatically run the SPF Checker utility after the extraction run. This check box is selected by default.

After you specify the required values in the *Input*, *Process*, *Technology*, and *Output* group boxes of the form, click one of the following options to complete the task.

- Click *Generate CCL* to create the common command language (CCL) file or the Quantus command file that will be used to run Quantus.  
  
By default, `vfiQuantus-<cellname>.ccl` is created and the file opens in the Voltus-Fi-XL console. You can view the file and modify it, if required.
- Click *Generate and Run* to create the CCL file and run Quantus to create the xDSPF file in a single step. This is useful when you do not want to view the CCL file before running Quantus.
- Click *Run* to select the CCL file to use for running Quantus. This is useful if you have modified the auto-generated CCL file.

The log is saved both in the `vfiQuantus-<cellname>.log` and in the Voltus-Fi-XL console.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### xDSPF Generation using Quantus

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#### ***Related Topics***

- [Extract xDSPF Form Description](#)
- [extract\\_xdspf](#) (batch command)
- [How to Generate xDSPF Using Quantus in Voltus-Fi](#) (video)
- [Customized Extract Commands File](#)
- [Voltus-Fi Quantus Log File](#)



## Extract xDSPF Form Description

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| Field                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Input</b>                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <i>Data Type</i>              | Lets you specify whether the input data will come from <i>PVS/Pegasus</i> , <i>Calibre</i> , or <i>Assura</i> . By default, <i>PVS/Pegasus</i> is selected.                                                                                                                                                                                                                                                                                         |
| <i>Data Directory</i>         | Provides the path to the directory in which the input data is stored.                                                                                                                                                                                                                                                                                                                                                                               |
| <i>Run Name</i>               | Specifies the name of the PVS/Pegasus or Calibre run.                                                                                                                                                                                                                                                                                                                                                                                               |
| <i>Lib Name</i>               | Specifies the name of the library that contains the layout cellviews. This option is available only when <i>Assura</i> is selected as the data type.                                                                                                                                                                                                                                                                                                |
| <i>Cell Name</i>              | Specifies the name of the block or cellview that contains the layout cellviews. This option is available only when <i>Assura</i> is selected as the data type.                                                                                                                                                                                                                                                                                      |
| <i>View Name</i>              | Specifies the name of the layout view. This option is available only when <i>Assura</i> is selected as the data type.                                                                                                                                                                                                                                                                                                                               |
| <i>Post Processing Script</i> | Specifies the name of the post-processing script file.                                                                                                                                                                                                                                                                                                                                                                                              |
| <i>LSF Number</i>             | Specifies the number of jobs that is submitted to parallel systems in a distributed run. The specified number must be greater than 1.                                                                                                                                                                                                                                                                                                               |
| <i>LSF Command</i>            | Specifies the command to use in a distributed run under LSF. The command "string" defines job groups and available hosts among other things. You must ensure that the LSF options are valid. The specified "string" must be enclosed in quotation marks.<br><br><b>Example:</b><br><pre>"bsub -K -W 24:00 -q lnx64 -o bsub.lsf -P<br/>QUANTUS:1911:RD:TEST -R 'OSNAME==Linux &amp;&amp;<br/>(OSREL==EE60  OSREL==EE70) &amp;&amp; OSBIT==64'"</pre> |
| <i>Hierarchical EMIR flow</i> | Enables hierarchical EMIR analysis.<br><br><b>Note:</b> This field is specific to the hierarchical EMIR flow.                                                                                                                                                                                                                                                                                                                                       |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### xDSPF Generation using Quantus

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|                         |                                                                                                                  |
|-------------------------|------------------------------------------------------------------------------------------------------------------|
| <i>PGV Library Name</i> | Specifies the block PGV library that is used for the block-level extraction performed for the hierarchical flow. |
|-------------------------|------------------------------------------------------------------------------------------------------------------|

**Note:** This field is specific to the hierarchical EMIR flow.

#### **Process**

|                     |                                                                         |
|---------------------|-------------------------------------------------------------------------|
| <i>Process Node</i> | Lets you specify the process node. The following options are available: |
|---------------------|-------------------------------------------------------------------------|

- *N3*: for N3 process nodes
- *N6/N5*: for N6 and N5 process nodes
- *N7*: for N7 process nodes
- *N10-PG*: for N10 process nodes with PG rules
- *N10*: for N10 process nodes
- *N16/N12*: for N16 and N12 process nodes
- *N20*: for N20 process nodes
- *N14*: for N14 process nodes
- *Others > =28*: for process nodes greater than N28

---

### *Signal EM*

Indicates that signal nets should be included in the xDSPF file.

When *Signal EM* is selected, the following command is added to the Quantus command file or the common command language (CCL) file, to perform decoupled RC extraction (`rc_decoupled`) for all nets.

**Note:** In `rc_decoupled` extraction, an RC network for the specified nets with both parasitic resistance and capacitance decoupled to ground is extracted.

```
extract \
-selection "all" \
-type "rc_decoupled"
```

When *Signal EM* is not selected, you need to provide the names of the power or ground nets on which `rc_decoupled` extraction will be performed. For all other nets, `c_only_decoupled` extraction is performed.

**Note:** In `c_only_decoupled` extraction, only parasitic capacitance between the specified nets and adjacent nets decoupled to the specified cap ground is extracted.

For example, when the following command is specified, `c_only_decoupled` extraction is performed on all nets:

```
extract \
-selection "all" \
-type "c_only_decoupled"
```

When the following command is specified, `rc_decoupled` extraction is performed on nets specified in the `vfiQrc_nets` file. For all other nets, `c_only_decoupled` extraction is performed.

```
extract \
-selection "nets_file ./vfiQrc_nets" \
-type "rc_decoupled"
```

### *PG Net(s)*

Provides information about the power and ground nets that should be included in the xDSPF file.

This field is enabled only when the *Signal EM* check box is deselected. If the *Signal EM* check box is not selected and *PG Nets* are not specified, a pop-up window opens asking for the list of power and ground nets.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### xDSPF Generation using Quantus

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|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Nets File</i>           | <p>Displays the names of the nets to be included in extraction.</p> <p>When the <i>Nets File</i> option is checked, the <i>Signal EM</i> and <i>PG Net(s)</i> options are ignored.</p>                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Extraction Type</i>     | <p>Specifies the extraction type.</p> <ul style="list-style-type: none"><li>■ <i>RC</i>: Specifies that both parasitic resistors and capacitors will be extracted.</li><li>■ <i>R only</i>: Specifies that only parasitic resistors will be extracted.</li></ul> <p>When <i>Extraction Type</i> selected is <i>R only</i>, the simulation time is short. While selecting the extraction type, consider the type of simulation being run. For example, to run a DC operating point (DCOP) simulation, select <i>R only</i> as the <i>Extraction Type</i> because the capacitance values are not required.</p> |
| <i>Cap Coupling Model</i>  | <p>Specifies the coupling mode.</p> <ul style="list-style-type: none"><li>■ <i>De-coupled</i>: Specifies that decoupled capacitance extraction will be performed.</li><li>■ <i>Coupled</i>: Specifies that coupled capacitance extraction will be performed.</li></ul> <p>By default, <i>De-coupled</i> mode is selected.</p> <p>While specifying the coupling mode, ensure that there is no <code>extract</code> command defined in the additional CCL file. The <code>extract</code> command in the additional CCL file will override the above options.</p>                                               |
| <i>Parasitic RES Color</i> | <p>Enables color-aware EM analysis.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Compression</i>         | <p>Generates xDSPF in a compressed format.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <i>Reduce I-Cards</i>      | <p>Enables the <code>reduce_i_cards</code> option in the CCL file that is used for generating the xDSPF file. If a net is “capacitance only”, it is qualified for reduced I card or instance card treatment. This means that when this option is selected, the instance cards and the corresponding dummy resistors are not printed in the results.</p>                                                                                                                                                                                                                                                      |
| <i>Comment Sub Ckt</i>     | <p>Comments out the top sub circuit statements from the xDSPF file.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### xDSPF Generation using Quantus

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|                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Sub Conductor Model</i>  | Provides information about the parasitic resistor models for the subconductor layers that should be included during extraction. This is used to support different EM rules for poly layers during EM analysis.                                                                                                                                                                                                                                                                 |
| <i>Filter RES Center</i>    | Includes sub-nodes after eliminating resistors with small resistance values. When this option is selected, the survivor sub-nodes, among a group of sub-nodes that are formed by the filtered resistors, are chosen based on their proximity to the geometric center of the group. This field is specific to process nodes 5nm and below.                                                                                                                                      |
| <i>Filter RES By Layer</i>  | Lets you specify the LVS layer name for which the minimum resistance value for the extracted parasitic resistors is to be applied. If the layer name is not specified, the default value, RH_TN_6 0, is used. This field is specific to process nodes 5nm and below.                                                                                                                                                                                                           |
| <i>Ref Node</i>             | Specifies the reference node on which the extraction is to be performed. By default, 0 is specified.                                                                                                                                                                                                                                                                                                                                                                           |
| <i>Sub-Node Char</i>        | Indicates the subnode identification character. By default, # is specified.                                                                                                                                                                                                                                                                                                                                                                                                    |
| <i>Fracture Via Count</i>   | Indicates the number that will be used to divide pseudo vias into segments during extraction.                                                                                                                                                                                                                                                                                                                                                                                  |
| <i>Via Array Spacing</i>    | Indicates the distance that will be used as the maximum distance criteria for grouping vias within the same array. This means that if the distance between vias is less than the specified maximum distance, they are grouped within the same array. The default value of the via array spacing is 0.35 times the via size for N10, N16, N12, and N20 processes. For other processes, the default is <i>auto</i> , in which case Voltus-Fi sets the via spacing automatically. |
| <i>auto</i>                 | Indicates that Voltus-Fi sets the via spacing automatically.                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <i>Via Array Count</i>      | Indicates the number of vias per side allowed in an array (without the per via layer count option). The default value is 4. For example, if the via array count is set to 2, the number of vias allowed per array side will be 2.                                                                                                                                                                                                                                              |
| <i>Bounding box options</i> | Sets the conductor bounding box and the via bounding box by layer.                                                                                                                                                                                                                                                                                                                                                                                                             |

### **Technology**

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### xDSPF Generation using Quantus

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|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Technology Library File</i> | Displays the location of the technology file to be used for reading the technology data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <i>Technology Directory</i>    | Displays the name of the directory that contains the technology file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Technology Name</i>         | <p>Displays the name of the technology file to be used for extraction.</p> <p>This field is optional if the technology directory has been specified.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <i>Corner</i>                  | Displays the name of the technology corner to be picked from the library.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <i>Temperature</i>             | <p>Indicates the temperature at which the extraction will be performed.</p> <p>By default, a temperature of 25 degree Celsius is used. The temperature specified for extraction is optional. The options, <code>temperature</code> and <code>temp_coeff</code>, specified in the CCL file are mutually exclusive. The following scenarios hold true.</p> <ul style="list-style-type: none"><li>■ If you specify a temperature for extraction in the Extract xDSPF form or by using the <code>-temperature</code> parameter of the <code>extract_xdspf</code> command in batch mode, the following option in the CCL file will be set to <code>false</code>:<br/><pre>-include_parasitic_res_temp_coeff "false" \</pre><p>The software displays the following message:</p><pre>User specified temperature will be used for extraction. The option include_parasitic_res_temp_coeff will be set as false.</pre></li><li>■ If you do not specify a temperature for extraction, the following option in the CCL file will be set to <code>true</code>:<br/><pre>-include_parasitic_res_temp_coeff "true" \</pre><p>The software displays the following message:</p><pre>No user specified temperature value so the option include_parasitic_res_temp_coeff will be set as true</pre></li></ul> |
| <i>No of CPUs</i>              | Displays the number of CPUs to be used during the Quantus extraction run.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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***SubCkt Pin Order File*** Provides the order of pins to be used during extraction.

The pin order is specified in the xDSPF file using the `.SUBCKT` and `.ENDS` statements. You can use this option to provide a file with a different pin order that will override the order specified using the default `.SUBCKT` statement in the xDSPF file.

Below are examples of pin orders in the xDSPF file before and after specifying the pin order file.

Without the sub-circuit pin order file

```
.SUBCKT top In_001 VDD Out_001 VSS In_002 Out_002
In_003 Out_004 ...
.ENDS
```

With the sub-circuit pin order file

```
.SUBCKT top VDD VSS In_001 Out_001 In_002 Out_002
In_003 Out_004 ...
.ENDS
```

***Customized Extract Commands File*** Lets you specify the file with user-customized extract commands.

***Add Extract Command*** Indicates that Voltus-Fi adds the extract commands to the CCL file.

By default, when a `customextract` file is specified, all commands, including the extract commands, from that file are added to the Voltus-Fi-generated CCL file. However, when you select ***Add Extract Command***, Voltus-Fi adds the extract commands to the CCL file, and all other commands specified in the `customextract` file are added to the CCL file.

***Parasitic blocking device cells file*** Lets you specify the file containing parasitic blocking device cell names, if any.

Once a cell is declared a blocking cell, all the parasitic RCs inside the cell are not extracted. If the cell content overlaps top cell routing, then, the top cell routing's RCs in the overlapping regions are also not extracted.

## ***Output***

***Directory*** Specifies the output directory in which the xDSPF file will be saved. If this file is not specified, a pop-up window opens asking for the name of the directory.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### xDSPF Generation using Quantus

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|                           |                                                                                                                                                                                                                                                                                                                                    |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>xDSPF File Name</i>    | Specifies the name of the xDSPF file that will be generated. If you do not specify the filename, Voltus-Fi generates a file with the name, <i>&lt;runName&gt;.dspf</i> , by default.                                                                                                                                               |
| <i>Autorun Spfchecker</i> | Runs the SPF Checker utility after the extraction run. SPF Checker checks the syntax of the DSPF/SPEF followed by opening the output log. It also compares the terminal names in the DSPF and the device models and populates the summary section with the recommended mapping statements or the <i>spf alias term</i> statements. |
| <i>Generate CCL</i>       | Creates the CCL or the Quantus command file that will be used to run Quantus.                                                                                                                                                                                                                                                      |
| <i>Generate and Run</i>   | Creates the CCL file and runs Quantus to create the xDSPF file in a single step.                                                                                                                                                                                                                                                   |
| <i>Run</i>                | Selects the CCL file to use for running Quantus.                                                                                                                                                                                                                                                                                   |
| <i>Reset</i>              | Displays all the default values.                                                                                                                                                                                                                                                                                                   |
| <i>Cancel</i>             | Closes the form without executing the command.                                                                                                                                                                                                                                                                                     |
| <i>Save</i>               | Saves the xDSPF file.                                                                                                                                                                                                                                                                                                              |
| <i>Load</i>               | Loads the configuration file.                                                                                                                                                                                                                                                                                                      |
| <i>Help</i>               | Opens help information in Cadence Help.                                                                                                                                                                                                                                                                                            |

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#### **Related Topic**

#### ■ Generating xDSPF File

## Customized Extract Commands File

The customized extract commands file is a file in which you can specify extract commands as per your requirements. When this file is specified, the Voltus-Fi-generated common command language (CCL) file will not have any extract commands, and the commands from the customized extract commands file will be added in the Voltus-Fi-generated CCL file.

A sample customized extract commands file is as follows:

```
extract \
-selection "all" \
-type "rc_coupled"
```



```
extract \
-selection nets_file "file.txt" \
-type "none"
```

**Note:** You can create a `customextract` file by using either single or multiple extract settings. Ensure that the commands are in the Quantus CCL file syntax because this file is added as is in the Voltus-Fi-generated CCL file.

### ***Related Topic***

- [Generating xDSPF File](#)

## **Voltus-Fi Quantus Log File**

The Voltus-Fi Quantus log file (`vfiQuantus-<cellname>.log`) stores all the common command language (CCL) commands and the info, warning, and error messages issued by Voltus-Fi during the extraction run. This file is saved in the output directory that is specified in the Extract xDSPF form.

With every successive extraction run, the name of the log file is updated to `vfiQuantus-<cellname>.log.(n-1)`. Here, `n-1` is the run number. Therefore, the greater the numeric value in the filename, the more recent or latest that file is.

For example, after three extraction runs, the following log files are created:

- `vfiQuantus-<cellname>.log` (log file for the first run)
- `vfiQuantus-<cellname>.log.1` (log file for the second run)
- `vfiQuantus-<cellname>.log.2` (log file for the latest run)

### ***Related Topic***

- [Generating xDSPF File](#)

## **Voltus-Fi Extract xDSPF GUI Last File**

The Voltus-Fi Extract xDSPF GUI last file (`.vfiExtractDSPFGuiLast`) is created by Voltus-Fi to save the settings of the Extract xDSPF form of the previous session. This file gets loaded automatically when the next session starts. If you do not want to load these settings, remove this file before starting the session. This file is created along with `cds.lib`.

The values specified in the `.cdsinit` file override the values of the `.vfiExtractDSPFGuiLast` file of the previous session.

### ***Related Topic***

#### ■ Generating xDSPF File

## **Missing Number of Vias in Third-Party DSPF Files**

The DSPF files are created using the parasitic extraction tools, and the content and format of these files are heavily dependent on the extraction tool and the extraction runset.

In the EM analysis flow, after you calculate the current density of a presistor, you can compare it with the current density limits from the `qrcTechFile`, the ICT file, or the `emDataFile` that you have provided in order to locate violations. The current density limit is width-based for the metal or diffusion layers and area-based for via layers. The value of `$L` or `$W` is used to select the current density limit for metal layers, and the value of `$A` is used to select the current density limit for via layers. In case of a via array, the total area of the via specified in the DSPF file is divided by the value of `$N`, which is the number of vias, in order to obtain the area of a single via, and the current density related to that area is selected from the technology file to check the EM violations.

You can view two examples below, one of a Quantus-extracted DSPF file and the other of a third-party-extracted DSPF file.

### **Examples**

#### **Quantus-Extracted DSPF**

```
Rk173 AVSS#200 AVSS#201 0.020247 $metal1_conn $L=0.17 $W=0.54 $X=13.301 $Y=0.43
Rw174 AVSS#44 AVSS#45 0.250000 $Via1 $A=0.0098 $N=2 $X=18.545 $Y=16.18
```

#### **Third-Party-Extracted DSPF**

```
Rg1 XR1#PLUS A#2 1.209331 $metal1 $L=0.56205 $W=0.1071 $X=5.582 $Y=0.13
Ro31 net06 net06#7 12.500000 $VIA1 $A=0.003969 $X=23.085 $Y=0.135
```

Information about the number of vias (`$N`) is missing in the third-party-extracted DSPF file example. The EMIR analysis performed using such files leads to erroneous results because the correct EM rules are not picked from the ICT file or the `emDataFile`.

As in the case of the example shown above, the resistance value, area, and coordinates of the via resistor are given, but the number of vias or `$N` is not mentioned. Without this

information, Voltus-Fi fails to calculate the area of a single via and check the current density limit related to that via area.

## Solution

To resolve the problem of missing number of vias or \$N information in a third-party DSPF file, use one of the following options in batch mode:

- Set the following variable in the `vfibatch` command file before running the `load_em_results` command:

```
set_variable viaCountFromResistance true
```

Alternatively, include the following option in the EMIR control file before running simulation:

```
emirutil viaCountFromResistance=[true]
```

**Note:** Specifying the `viaCountResistance` variable using the `set_variable` command will generate EM results (taking care of \$N) during the batch mode run. Specifying the `viaCountResistance` variable using the `emirutil` command will generate EM results (taking care of \$N) in the report file `*rpt_em`, during Spectre simulation itself. The file, `*rpt_em` is created along with the simulation result file, `*.emir#_bin` file.

- Include the "area\_resistance" of vias in the ICT file. The format is as follows:

```
area_resistance <resistance value 1> <area 1> <resistance value 2> <area 2> ... <resistance value N> <area N>
```

- Include the "contact\_resistance" of vias in the ICT file. The resistance of a single via is equal to `contact_resistance`.

**Note:** If no `area_resistance` value is matching, Voltus-Fi will use `contact_resistance`.

Voltus-Fi-XL calculates the number of vias (without \$N) from the following:

- Resistance value of the via array resistor (from the DSPF)
- Resistance value of a single via, which is equal to the `contact_resistance` (from the ICT file)

OR

Resistance value of all vias, which is equal to `area_resistance` (from the ICT file)

# **Voltus-Fi Custom Power Integrity Solution XL User Guide**

## **xDSPF Generation using Quantus**

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## Static Current Analysis

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This section contains information about static current analysis, types of static current analysis, and how to run these analyses in Voltus-Fi-XL.

### Overview of Static Current Analysis

Static current analysis is performed in Voltus-Fi-XL using Thunder. It is performed before running a simulation in Spectre. The static current analysis output file, `static_current.txt`, is used as an input for performing a Spectre simulation. Following are the key aspects of this feature:

- Support for both, peak and average modes for static analysis
- Support for both, GUI and Tcl commands

A static EMIR analysis allows the evaluation of IR drop and EM currents based on user-provided subcircuit instance current consumption w/o running a transient or DC simulation. The user-provided currents are distributed to the tap devices based on the W/L ratio of the devices in the design. The IR drop and EM current analysis is performed based on the current at each tap device.

The static EMIR analysis is enabled with the `static ifile` statement in the EMIR conf file.

```
net name=[I1.VDD I1.VSS] analysis=[vavg iavg]

static ifile="static_currents.txt"
```

Since the analysis is static, the IR drop `vmax` and `vavg`, and the EM current `imax`, `irms`, and `iavg` values will be the same, and just one can be selected in the statement.

### Types of Static Current Analysis

Static current analysis can be either static peak current analysis (`lpeak`) or static average current analysis (`iavg`). Static peak current analysis is based on the peak saturation transistor

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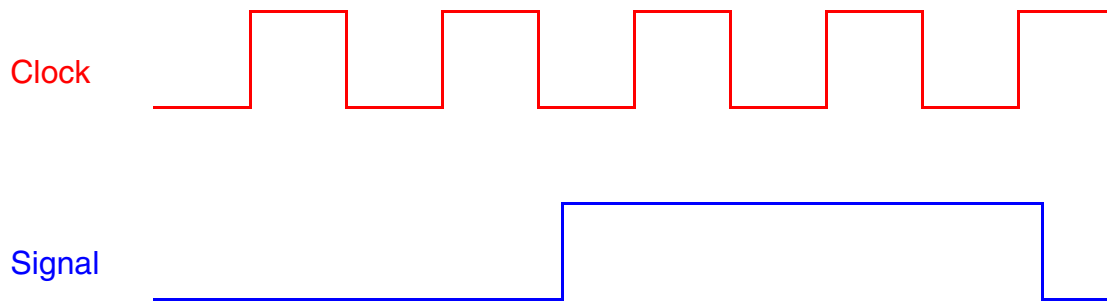
### Static Current Analysis

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currents. Because of simplicity and ability to find problems quickly in power grids, static current analysis is the most commonly performed analysis.

Static average current analysis or activity-based analysis resolves the distribution of currents on your power grid better than the static peak current analysis. The activity-based approach assumes that you have a mechanism such as a Verilog simulator to compute and report the relative activity of the nets in the design. These relative activities can be used in conjunction with net capacitances to estimate the average current load of each gate in the design. This form of analysis clearly provides more realistic current data than the  $I_{peak}$  approach.

**Activity** means the probability of all the signal nets in design switching from 0→1 or 1→0 in one clock cycle. For instance, if the activity of a net or instance is 0.1, then the power engine assumes that the net or instance will switch from 0→1 or 1→0 once every ten clock cycles.



For the above diagram,

$$\text{Activity} = (\text{Number of (0} \rightarrow \text{1 or 1} \rightarrow \text{0) transitions} / \text{Number of clock cycles})$$
$$= 2 / 5 = 0.4$$

**Duty Cycle** means the probability that a signal net has the value of 1.

For example, if the signal of a net is 1 for 2ns in the total simulation time of 10ns, then the duty cycle of net is 0.2. The duty cycle of the signal in the previous diagram is 0.5 (2.5/5). However, if a signal is Z or X for some time and 0 for the rest of the time then the duty cycle of the signal is 0.

**Transition Density** means the number of times the signal toggles from 0→1 or 1→0 in 1 second.

For the previous diagram, if you assume that one clock cycle is 4ns, then:

$$\text{Transition Density} = 1e+08 \quad (2 / 20\text{ns})$$

## Running Peak Static Current Analysis

Peak static current ( $I_{peak}$ ) analysis gives the peak current (saturated current) of every transistor connected to the power nets.

The following data is required to perform peak static current analysis:

- A Quantus-generated DSPF file
- SPICE model libraries and SPICE corners
- An activity, clock, or value change dump (VCD) file—These inputs are required for the average static current analysis

To set up and run peak static current analysis, do the following:

1. In the Virtuoso® console, choose *Simulation* and then *Setup and Run Simulation*.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Static Current Analysis

The Setup and Run Current Analysis form opens.

**Setup and Run Current Analysis**

Basic Advanced

Analysis Type: ☒ Peak ☐ Average

Top Cell Name: adc\_sample\_hold Net Names: VDD VSS

**Netlist Files**

Spice Netlist: /SIM\_EMIR\_WORKSHOP/emir\_simulation/adc\_sample.spice

**Pins**

Power Pins: VDD Voltages: 1.0 Gnd Pins: VSS

**Model Files**

Spice Models: Spice Corners:

|   | Model                              | Corners |
|---|------------------------------------|---------|
| 1 | /h/MMSIM_EMIR_WORKSHOP/emir_si...  | TT      |
| 2 | /MMSIM_EMIR_WORKSHOP/emir_simul... | TT_D1   |

Add Remove

**Output**

Directory: /home/anuk/MMSIM\_EMIR\_WORKSHOP/vps\_simulation\_1

Run Cancel Default Save Load Help

2. On the *Basic* tab, select *Peak* as the *Analysis Type*.
3. Specify the *Net Names* for which you want to calculate the peak current.
4. Specify the *Spice Netlist* file.

The Spice netlist file can also be edited using the edit button provided next to this field.

5. In the *Pins* group box, specify the *Power Pins* and *Gnd Pins*, and the corresponding *Voltages* for the power pins.



6. In the *Model Files* group box, choose the *Spice Models* and the corresponding *Spice Corners* used by the SPICE netlist.
7. Click *Add* to add the SPICE model – SPICE corner pair to the table.
8. In the *Output* group box, specify the output directory in which all the current data will be saved.
9. On the *Advanced* tab, specify the *Hierarchical Separator*. This is required only if the netlist used is hierarchical.
10. Specify the *Simulation Temperature*, in degree Celsius.
11. Specify the *Cmd Include File*.
12. Click *Run*.

## Tcl Command for Peak Static Current Analysis

An example of the set of Tcl commands for the peak static current calculation is as follows:

```
setup_simulation\
 -spice_netlist design.spice\
 -topcell design_name\
 -output_directory ./vps_simulation_1
spice_model\
 -spice_lib ./models/model1.1\
 -spice_corner {TT TT_dio}
spice_model\
 -spice_lib ./models/model2.1.special\
 -spice_corner {TT_sr}
power_pin\
 -pin_name VDD\
 -voltage 0.9
ground_pins VSS
run_static_simulation\
 -method Ipeak\
 -nets {VDD VSS}
```

## Running Average Static Current Analysis

Average static current analysis is a method of analyzing a circuit to obtain the average current flowing through each tap point without using time-based simulation.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Static Current Analysis

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The following data is required to perform average static current analysis:

- A Quantus-generated DSPF file
- SPICE model libraries and SPICE corners
- An activity, clock, or value change dump (VCD) file—These inputs are required for the average static current analysis

To set up and run average static current analysis, do the following:

1. In the Virtuoso® console, choose *Simulation* and then *Setup and Run Simulation*.
2. On the *Basic* tab of the Setup and Run Current Analysis form, select *Average* as the *Analysis Type*.
3. Specify the *Net Names* for which you want to calculate the peak current.
4. Specify the *Spice Netlist* file.

The Spice netlist file can also be edited using the edit button provided next to this field.

5. In the *Pins* group box, specify the *Power Pins* and *Gnd Pins*, and the corresponding *Voltages* for the power pins.
6. In the *Model Files* group box, choose the *Spice Models* and the corresponding *Spice Corners* used by the SPICE netlist.
7. Click *Add* to add the SPICE model – SPICE corner pair to the table.
8. In the *Output* group box, specify the output directory in which all the current data will be saved.
9. On the *Advanced* tab, specify the *Hierarchical Separator*. This is required only if the netlist used is hierarchical.
10. Specify the *Simulation Temperature*, in degree Celsius.
11. Specify the *Cmd Include File*.
12. In the *Static Options* group box, specify the dominant *Frequency* of the design, the *Clock File*, and the *VCD File*.
13. Specify a value for *Global Activity* in the design.
14. Specify the *Avg Power (All Nets)* of the design. Alternatively, specify the path of the *Avg Power File*.
15. Select *Net based average power* to specify different power values for different nets.

When you check this option, a list box is enabled. The list box has two columns, *Net Name* and *Average Power in W*. The *Net Name* column is already populated with the names of nets specified on the *Basic* tab. For each net, specify the power value in the *Average Power in W* column.

**Note:** The *Avg Power (All Nets)* and *Net based average power* options are mutually exclusive.

**16. Click *Run*.**

**Note:** You can also create or edit the clock file, VCD file, activity file, and the average power file by using the edit buttons provided against each of these options in the form.

## Tcl Command for Average Static Current Analysis

The example Tcl command for the average static current analysis is as follows:

```
setup_simulation\
-spice_netlist adc_sample_hold.spice\
-topcell adc_sample_hold\
-output_directory ./vps_simulation_1\
spice_model models/spectre/gpdk090.scs\
-spice_corner {NN}
power_pin\
-pin_name VDD\
-voltage 2.5
ground_pins VSS
run_static_simulation\
-method Iavg\
-nets {VDD VSS}
-freq 333\
-global_activity 0.25\
-average_power 20mW
```

## Static Current Analysis Report

The output of the static current analysis in Voltus-Fi-XL using Thunder is a text report that is saved in the output directory. The report is used by Spectre to run a simulation and create the simulation result file, which is then used for EMIR analysis and visualization in Voltus-Fi-XL. The default text report generated for both peak and average current analysis is `static_current.txt`.

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### Static Current Analysis

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#### Format:

Node Name                      Static Current

#### Format Description:

Node Name specifies the name of the node for which the static current is being reported.

Static Current specifies the value of the static current on the specified node.

#### Sample Report

|                         |          |
|-------------------------|----------|
| X0.AbcI2/avI33/avD30_32 | 9.83e-05 |
| X0.AbcI2/avI30/avD30_35 | 9.83e-05 |
| X0.AbcI86/avD27_135     | 1.96e-05 |
| X0.AbcI86/avD27_134     | 1.96e-05 |
| X0.AbcI86/avD27_133     | 1.96e-05 |
| X0.AbcI86/avD27_122     | 1.96e-05 |
| X0.AbcI86/avD27_121     | 1.96e-05 |
| X0.AbcI86/avD27_120     | 1.96e-05 |

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## IR Drop Analysis Results

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### Overview of IR Drop Analysis

Voltus-Fi-XL uses the simulation database generated by Spectre APS/XPS simulators and displays the results of the IR drop analysis on the Virtuoso layout. It also generates text reports of the analyses and lets you query the analyses results to view specific violations in the layout. This is used to debug the high IR drop regions in the design.

Batch mode support is provided for loading IR drop analysis results and generating text reports. The following commands are used to load and print IR drop analysis results in Voltus-Fi-XL:

- `load_ir_results`: Loads the IR drop analysis results
- `print_ir_report`: Prints the IR drop analysis reports

### Signal Net IR Drop Analysis

By default, IR drop analysis can only be applied to power nets, which are nets driven by DC or constant voltage sources. The advanced feature, signal net IR drop analysis, lets you perform IR drop analysis on signal nets, which are nets that are not connected to any DC or constant voltage source.

In the signal net IR drop analysis, the maximum or average IR drop is reported using the `analysis=[sigvmax sigvavg]` statement in the EMIR control file (`emir.config`). The signal net IR drop is reported as the difference between the reference voltage and the voltage of the sub node ( $v_{ref} - v_{node}$ ). For a particular signal net, the reference voltage for calculating the IR drop value at each sub node and time point is defined as the average voltage of all sub nodes (`reftype=[avg]`), the maximum voltage of all sub nodes (`reftype=[max]`), or the voltage of a user-specified pin (`reftype=[pin]`).

Alternatively, for nodes driven by voltage sources and the voltage of the net driven by the voltage source can be used as reference (`findsrc=yes`).

The following is an example of the EMIR control file (`emir.config`):

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

```
net name=[X1.*] analysis=[sigvmax] reftype=[max] findsrc=yes
solver method=direct
```

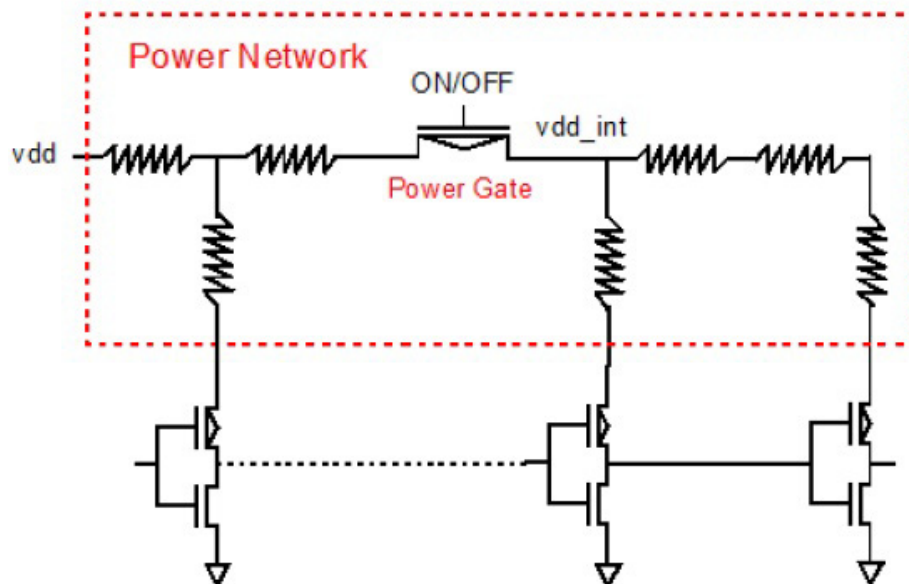
In the above example, the signal net IR drop analysis is performed for all nets `x1.*`. The maximum IR drop for the sub nodes of each net is reported. For the IR drop analysis at each net and time point, the sub node with the highest voltage is picked as the reference voltage. For any net driven by a vsource, the voltage of the sub node driven by the vsource is used as reference.

When using `reftype=[max]` for a net with three sub nodes: `net1_1` (1V), `net1_2` (2V), and `net1_3` (3V), the detected reference voltage will be 3V, and the IR drop calculated will be 2V for `net1_1`, 1V for `net1_2`, and 0V for `net1_3`. When using `reftype=[avg]` the reference voltage will be 2V, and the IR drop calculated will be 1V for `net1_1`, 0V for `net1_2`, and -1V for `net1_3`.

In addition, if `net1_2` is driven by a `vsource` and `findsrc` has been specified as `yes`, the voltages of `net1_2`, at all time points, will be used as the reference voltages.

## Power Gate Support in Voltus-Fi-XL

Power networks may contain power gates which enable or disable the power supply in the circuit. These power gates split the power supply RC network into two parts. The RC network driving the power gate, and the RC network being driven by the power gate. This is shown in the figure below. The MMSIM EMIR analysis can handle such power gates.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

---

To invoke the power gating handling, add the power gate setting in the EMIR control file (`emir.config`), as shown below.

```
net pwrgate=[vdd vdd_int] analysis=[vavg]
```

Both, the power supply net (`vdd`) driving the power gates, and the internal power supply net (`vdd_int`) driven by the power gates, need to be specified in the net statement in any order. Wildcarding is supported for the internal power supply net(s), but not for the power supply net.

Next, the required analyses need to be defined, as shown above. The IR drop report includes both the power supply net in the usual report filename, for example, `input.rpt_ir` and the internal power supply net is reported in a file, such as `input.rpt_pwg` or `input.emirtap.rpt_pwg` for direct and iterated methods, respectively. As for the EM analyses, they are performed as usual, if specified.

In addition, an important parameter `Ton` is also be reported in the `.rpt_pwg` file. It reports the time taken to power up the terminal of the internal power supply net to 95% of the power supply level (VDD).

**Note:** The parameter `Ton` can be infinity if the internal power supply level does not reach 95% of VDD.

The subsequent sections cover the various options available in Voltus-Fi-XL for viewing the IR drop analysis results on the Virtuoso layout.

## Power-Up Summary Report

Voltus-Fi-XL supports viewing of the power-up test summary report in the GUI. The feature is enabled only after the IR drop analysis results are loaded. For this, the *Power-up Report* button is provided on the IR tab of the IR/EM Results form.

When clicked, a view-only power-up summary report is displayed in the GUI. The report is available only if the following conditions are met:

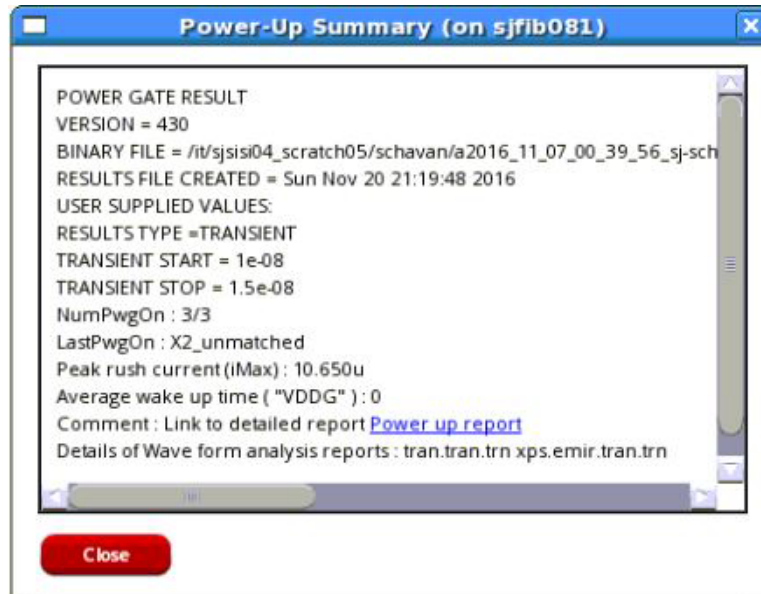
- ☐ The `emirutil power_gate_extra_report` command is specified in the EMIR configuration file
- ☐ Spectre simulation is run with the above option and a `rpt_pwg` file is generated.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

---

A sample power-up report is shown below.



In addition to information about the type of simulation results, the report contains the following information:

- *NumPwgOn*: The number of power switches turned on during the simulation vs. the total number of power switches
- *LastPwgOn*: The name of the last power switch to be turned on in the simulation
- *Peak rush current (iMax)*: The peak rush current of the power-up net in the simulation
- *Average wake up time*: The average wake-up time of the switch net in the design
- *Comment*: The link to the detailed power-up report
- Details of the wave form analysis reports

## Static EMIR Analysis

A static EMIR analysis evaluates IR drop and EM currents based on user-provided subcircuit instance current consumptions without running a transient or DC simulation. The user-provided currents are distributed to the tap devices based on the W/L ratio of the devices in the design. The IR drop and EM current analysis is performed based on the value of current at each tap device.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

---

The static EMIR analysis is enabled with the “static ifile” statement in the EMIR configuration file.

```
net name=[I1.VDD I1.VSS] analysis=[vavg iavg]
static ifile="static_currents.txt"
```

Since the analysis is static, the IR drop `vmax` and `vavg`, and the EM current `imax`, `irms`, and `iavg` values will be the same, and just one of these can be selected in the statement.

The subckt instance currents are defined (in A) in the “static\_currents.txt” file with the subckt instance name, the subckt port name, and the value of current flowing in the port.

```
I1 VDD 0.001
I1.I2 VDD 0.005
I1.I2/I3 VDD 0.000001
I1.I2/I3/I4 VDD 0.0000005
I1 VSS ?0.005
```

The accuracy of the static EMIR analysis depends greatly on the detailed current information in the `static_ifile`. It is highly recommended that you provide the current consumption for each subckt instance.

The results of the static EMIR analysis are written into the same IR drop and EM current text reports, and into the same binary EM database as the dynamic EMIR analysis. Static EMIR analysis cannot be combined with the dynamic analysis. You can perform either a static or a dynamic EMIR analysis at one time. When running the static EMIR analysis all other Spectre analyses like DC, TRAN and so on will be ignored.

The static EMIR analysis can also be applied to designs with power gates. In that case the `pwrgate` statement needs to be added to the EMIR configuration file as follows:

```
net name=[I1.VDD] analysis=[vavg iavg]
static ifile="static_currents.txt"
net pwrgate=[I1.VDD I1.VDD_INT] analysis=[vavg iavg]
```

and the power gate current is required to be added to the “static\_currents.txt” file as follows:

```
I1 VDD 0.001
I1 VDD_INT 0.0005
```

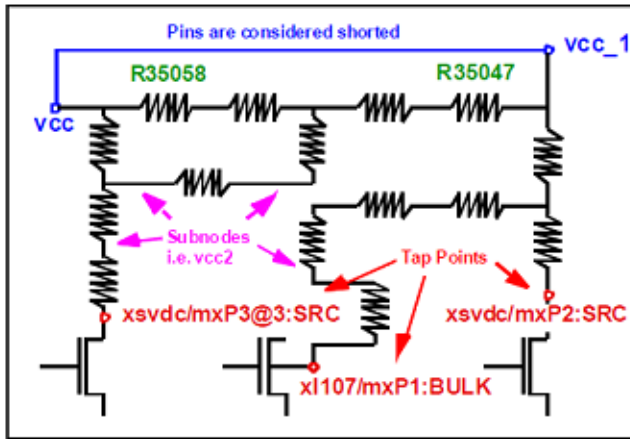
**Note:** To support users setting up the static EMIR flow, the static EMIR current file is automatically generated when running a dynamic EMIR analysis (file extension: static).

## Static Power Grid Solver

The static power grid solver (SPGS) feature of Spectre can be used in Voltus-Fi-XL to calculate all pin-to-tap resistances based on the description of a DSPF file and the options set in the EMIR configuration file. The resistances calculated by SPGS are electrically equivalent resistances, and not the summation of resistors. The calculation assumes that all pins are connected together to form a global pin. After calculation, the resistance between the global pin and all taps is generated and listed based on the significance of their values.

This feature can also be used to calculate the pin to pin resistance between any two nodes of the same net.

The diagram below shows the definition of pin, sub nodes, and tap nodes in the DSPF file.



```
*|NET vcc 0PF
*|P (vcc_1 B 0 -1.441 419.479)
*|P (vcc B 0 2158.41 419.491)
*|I (x107/mxP1:BULK x107/mxP1 BULK B 0 2128.46 392.112)
*|I (xsvdc/mxP3@3:SRC xsvdc/mxP3@3 SRC B 0 1837.78 431.24)
*|I (xsvdc/mxP2:SRC xsvdc/mxP2 SRC B 0 1837.78 429.16)
*|S (vcc:2 40.43 193.665)
...
R35047 vcc_1 vcc_7 0.001 $I=0.004 $w=10 $Iv=195
...
```

pll.spf

The static EMIR analysis is enabled with the “spgs net=...” statement in the EMIR configuration file.

```
spgs net=[i1.vcc i1.vss]
spgs rshort=1e-12
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

---

```
spgs pwrgate = [il.vcc il.outp]
```

The net statement defines the power nets to be analyzed. Resistors in the power net can be optionally shorted with the `rshort` option. If the power net contains a power gate, then the `pwrgate` option needs to be defined in the configuration file.

The SPGS flow requires the DSPF file to be included in the Spectre input file with the `dspf_include` statement, as shown below.

```
dspf_include "pll.spf"
```

The power nets need to be connected to voltage sources, and device models need to be defined for the devices in the instance section in the DSPF file. For running the SPGS feature, Spectre is run as in the regular EMIR flow, as shown below.

```
spectre +aps input.scs +emir=spgs.conf
```

The SPGS report provides a list of the pin to tap node resistors ordered highest to lowest, as shown below.

| Count | R         | W/L   | (x:y)      | (x:y) in GDSII | name            |
|-------|-----------|-------|------------|----------------|-----------------|
| #1    | 1920.2579 | 5.00  | (1440:366) | (1440:366)     | xI107/mxP1:BULK |
| #2    | 1577.1482 | 10.00 | (1440:476) | (1440:476)     | xsvdc/mxP3@3    |
| #3    | 1353.6123 | 4.00  | (1446:509) | (1446:509)     | xsvdc/mxP2:SRC  |

It is recommended to run the SPGS feature separately and not together with any other EMIR analysis. SPGS also supports the conversion between pin, tap node, and sub node. The following statements specified in the emir conf file convert the tap node, MPM3@44:s of net I1.vdd to a pin, and the subnode VDD:5 to a tap node.

```
spgs tap2pin net=[il.vdd] include=[MPM3@44:s]
spgs sub2tap net=[il.vdd] include=[VDD:5]
```

## Solid Shape Highlighting

The rail analysis plots that are displayed on the Virtuoso Layout can be viewed as either stick diagrams or solid shape highlights. In the solid shape display, the plots highlight the full shape of the presistors, while in the stick diagram display, the presistors are connected with thin lines over the layout shapes.

The solid shape display is more useful for designers because it allows them to see the shapes that are failing the analysis. There are two flows for solid shape display. You can either specify the DFII layer map file or the Quantus run name for viewing solid shape display for plots. When you specify the Quantus run name, the plots are displayed based on the shape database generated by Quantus.

## **Quantus Shape Database-Based Flow**

To display plots using the shape database generated by Quantus, you must ensure the following:

- The Quantus command file or the CCL file should include the following command:  
`extraction_setup -analysis em`
- Quantus should be set in the path and its version should be compatible with the Voltus-Fi-XL version being used.

## **Support for Specifying Cut-Layers for Metal Layers while Highlighting Solid Shapes**

In Voltus-Fi, cut-layers can be specified for metal layers for displaying the EMIR result plots. The cut-layers do not actually chop the shapes on the metal layers in the layout, but when plotting the results, while the shapes on the metal layers are highlighted, those on the specified cut-layers are not highlighted. This helps to view more accurate plots.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

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An example of a plot is shown below. In this plot, the shapes on metal layer, M1 are highlighted while those on the cut-layer, CM1 are excluded.



To let you specify cut-layers for metal layers, the following SKILL function is provided:

```
vsaSetLayersToMergeDuringResultsLoading
```

Use the SKILL function to specify the metal layer and the corresponding cut-layer as a pair. For example,

```
vsaSetLayersToMergeDuringResultsLoading("M1 CM1A")
```

where CM1A is the cut-layer for metal layer, M1.

**Note:** The above SKILL function must be called before loading the results in Voltus-Fi.

Following are the key aspects of this feature:

- You can specify multiple pairs of metal and cut-layers. For this, call the function multiple times. Voltus-Fi honors all these calls. For example,

```
vsaSetLayersToMergeDuringResultsLoading("M1 CM1A")
vsaSetLayersToMergeDuringResultsLoading("PO CPO")
```

where CM1A is the cut-layer for metal layer, M1 and CPO is the cut-layer for layer, PO.

- You can specify multiple cut-layers for one metal layer. For example, if the following sequence of calls are made, Voltus-Fi honors both the calls.

```
vsaSetLayersToMergeDuringResultsLoading("M1 CM1A")
vsaSetLayersToMergeDuringResultsLoading("M1 CM1B")
```

where, CM1A and CM1B layers are cut-layers for the same metal layer, M1.

## Display of Finer Color Gradient for Selected Layers in IR and EM Plots

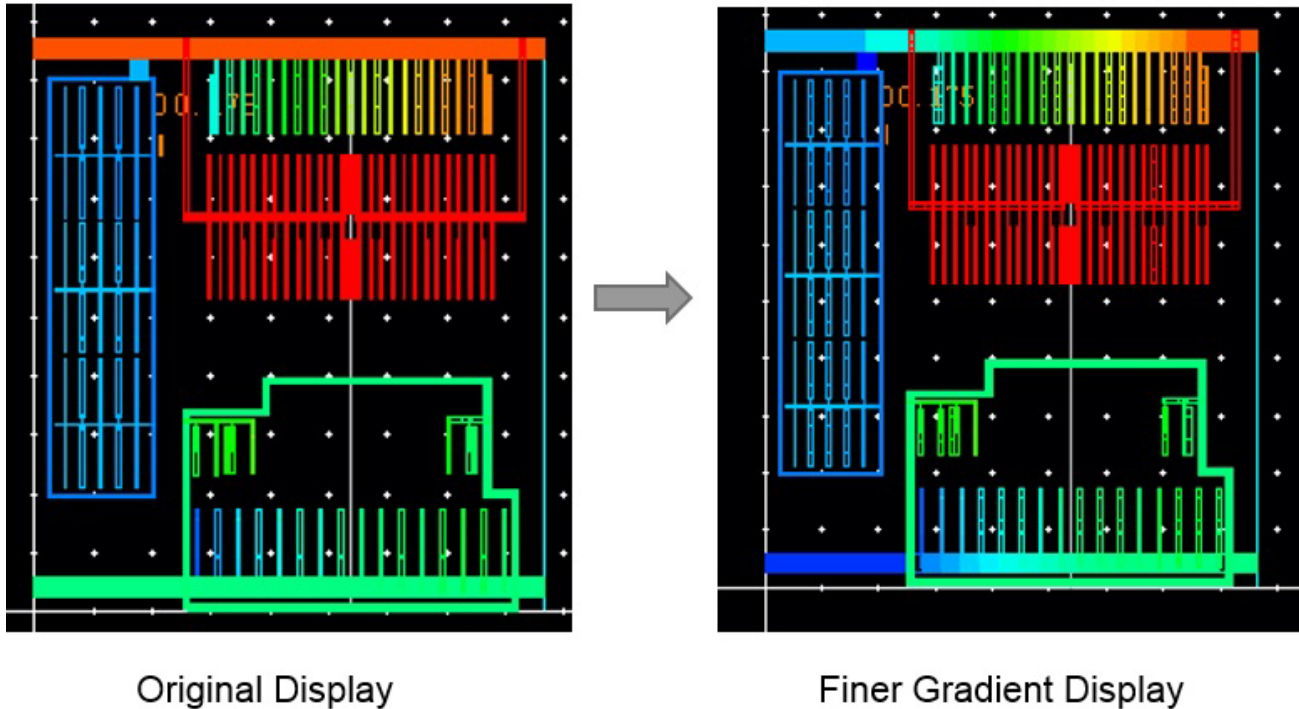
In the DFII layer map flow, for solid shape display of IR/EM violations on the Virtuoso layout, Voltus-Fi-XL locates all the nodes lying on a shape and then colors the shape with the worst violation value among all resistors connected to these nodes.

However, sometimes resistors do not align well with the shapes used to display the violations. This may be because the shapes are large and have multiple nodes and resistors. Voltus-Fi supports a finer display of the color gradient for violations in different segments of such layers. The shape polygons are split into subpolygons and then the subpolygons are colored with the worst violation value for all resistors connected to the nodes in the split shape. This feature is turned on by default for all layers. However, you can select specific layers to view their finer gradient instead of viewing for all layers.

For this, specify the *DFII Layermap* file and then click the *Finer Gradient* button provided on the IR or EM tabs of the IR/EM Results form. In the *Finer Gradient Layer Selection* pop-up, click *Deselect All* and then select the PGDB layers for which you want to view finer gradient.

**Note:** Perform this step before loading the IR or EM Results. After loading the results, when you click *Show Plot*, you can see the finer gradient for the selected layers.

A comparison of finer gradient display versus the original display is shown in below figure.



## Specifying Multiple Simulation Result Files for EMIR Analysis

While performing EMIR analysis in Voltus-Fi-XL, multiple bin files can be specified, both in the GUI mode as well as in batch mode. There are two different use models for specifying multiple bin files depending upon whether they are present in the same or different directories.

### Specifying Multiple Bin Files in Different Directories

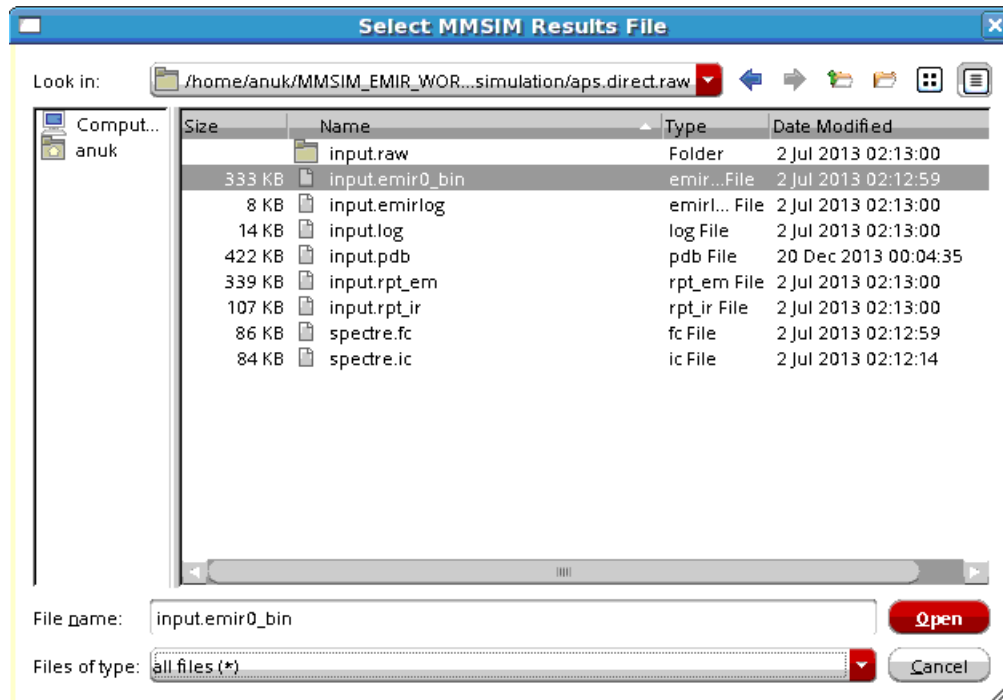
To specify multiple bin files located in different directories, follow these steps:

1. Open the IR/EM Results form.
2. Click the + button is provided for the *State Directory/Results File* field. This button is provided on both the IR and EM tabs of the IR/EM Results form.

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### IR Drop Analysis Results

3. The *Select MMSIM Results File* pop-up window opens. Use this to add multiple bin files for EMIR analysis.



### Specifying Multiple Bin Files in the Same Directory

To specify multiple bin files located in the same directory, follow these steps:

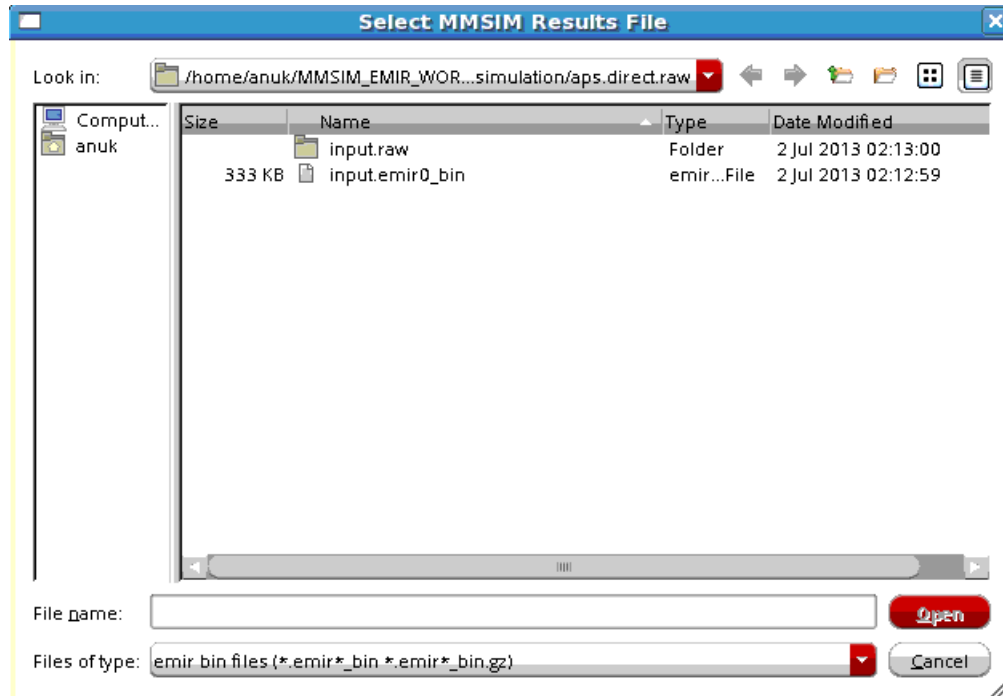
1. Open the IR/EM Results form.
2. Click the browser button next to the *State Directory/Results File* field. The *Select MMSIM Results File* pop-up window opens.
3. Open the directory containing all the bin files. In the *Files of type* field, only the bin files will be visible. This is shown below.
4. Any sub-directories in this directory will also be visible and can be selected.



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### IR Drop Analysis Results

5. Select all the bin files that are required and click *Open*.



**Note:** In the above flow, the + button located next to the *State Directory/Results File* field on the IR tab of the IR/EM Results form is not needed for selecting multiple bin files.

## Batch Mode Support for Specifying Multiple Bin Files

In batch mode, different options of the `vfibatch` command are used to specify multiple bin files in different scenarios. The following use models are supported:

- **Specifying multiple bin files that contain simulation results for different nets from the same testbench.** This is useful in large designs, where simulation is run separately for different nets of the same testbench to improve the runtime. In such cases, you can create `emir_bin` for different nets in different bin files. In batch mode, the `-db` option of the `vfibatch` command is used to generate reports in this scenario.

Consider an example where separate bin files are created for nets, VDD and VSS. The `emir.conf` files for the two nets will be as follows:

```
emir.conf.vdd net name=[X0.VDD] analysis=[iavg imax sigvmax vmax] emirutil
techfile = qrcTechfile layermapfile = contactmapfile solver method=[iterated]
emir.conf.vss net name=[X0.VSS] analysis=[iavg imax sigvmax vmax] emirutil
techfile = qrcTechfile layermapfile = contactmapfile solver method=[iterated]
```

- **Specifying multiple bin files that contain simulation results from different testbenches for the same design.** You can specify multiple bin files that are located either in the same directory or in different directories. In batch mode, the `-db_path` and `-db_multi_path` options of the `vfibatch` command are used to generate reports in these scenarios, respectively.

## Viewing the IR Drop Analysis Results

To plot EMIR results in Voltus-Fi-XL, ensure the following:

- The `emir` mode is enabled while performing simulation.
- The simulation result file is available in the output directory of the simulation results. The naming convention of the simulation result file is, `*.emir#_bin`. For example, your result file could be named, `xps.emir0_bin`.

Follow these steps to view the IR drop analysis results.

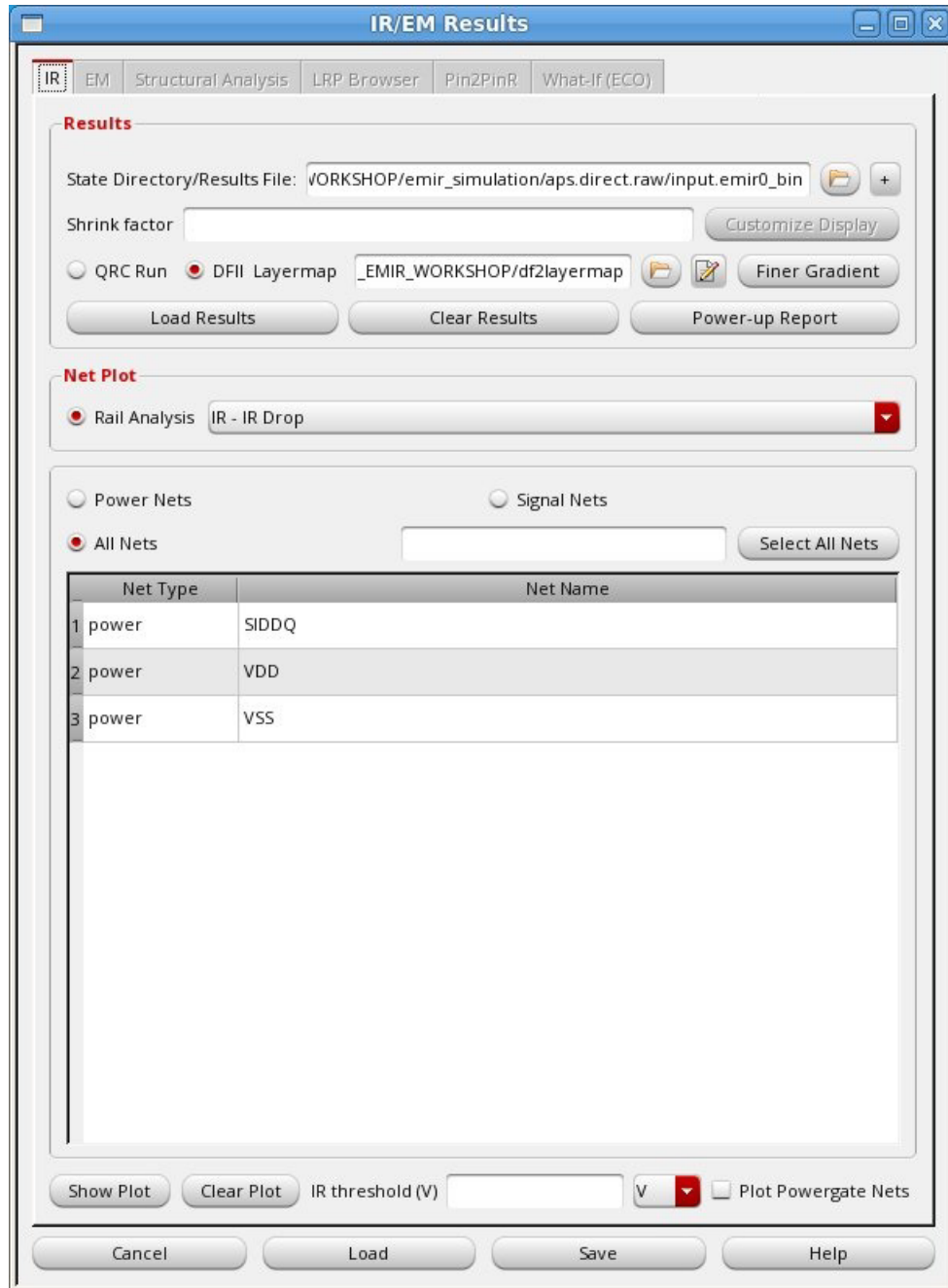
1. In the Voltus-Fi-XL console, choose *IR/EM Analysis – Rail Analysis Results*.

The IR/EM Results form opens.

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### IR Drop Analysis Results

- Click the *IR* tab to plot the IR drop analysis results.



- In the *Results* group box, specify the *State Directory / Results File* that stores the results of the simulation. The naming convention of the result file is \*.emir#\_bin.
- Select the + button to specify multiple result files or bin files.
- Specify the *Shrink factor*, if any, by which the xDSPF was shrunk.

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### IR Drop Analysis Results

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6. Click *Customize Display* to select the nets for which you want to view the display.

The *Customize Display* button is enabled only before the results are loaded. It is disabled once the results are loaded.

7. Specify either the *QRC Run* or the *DFII Layermap*.

When either of these options is specified, the plots displayed in the layout show solid shape highlighting.

- ☐ If you select *QRC Run*, specify the path to the *QRC Run Directory* and the *QRC Run Name*, respectively.
- ☐ If you select *DFII layermap*, you can also create a new layer map file or edit an existing file, using the edit button provided next to the field.

8. For the DFII layer map flow, click *Finer Gradient* to view the finer gradient for the selected layers.

9. Click *Load Results*.

10. From the *Rail Analysis* list, select the type of plot you want to view.

11. Select the nets for which you want to view the IR plots.

12. Click *Select All Nets* to select all the nets listed in the table.

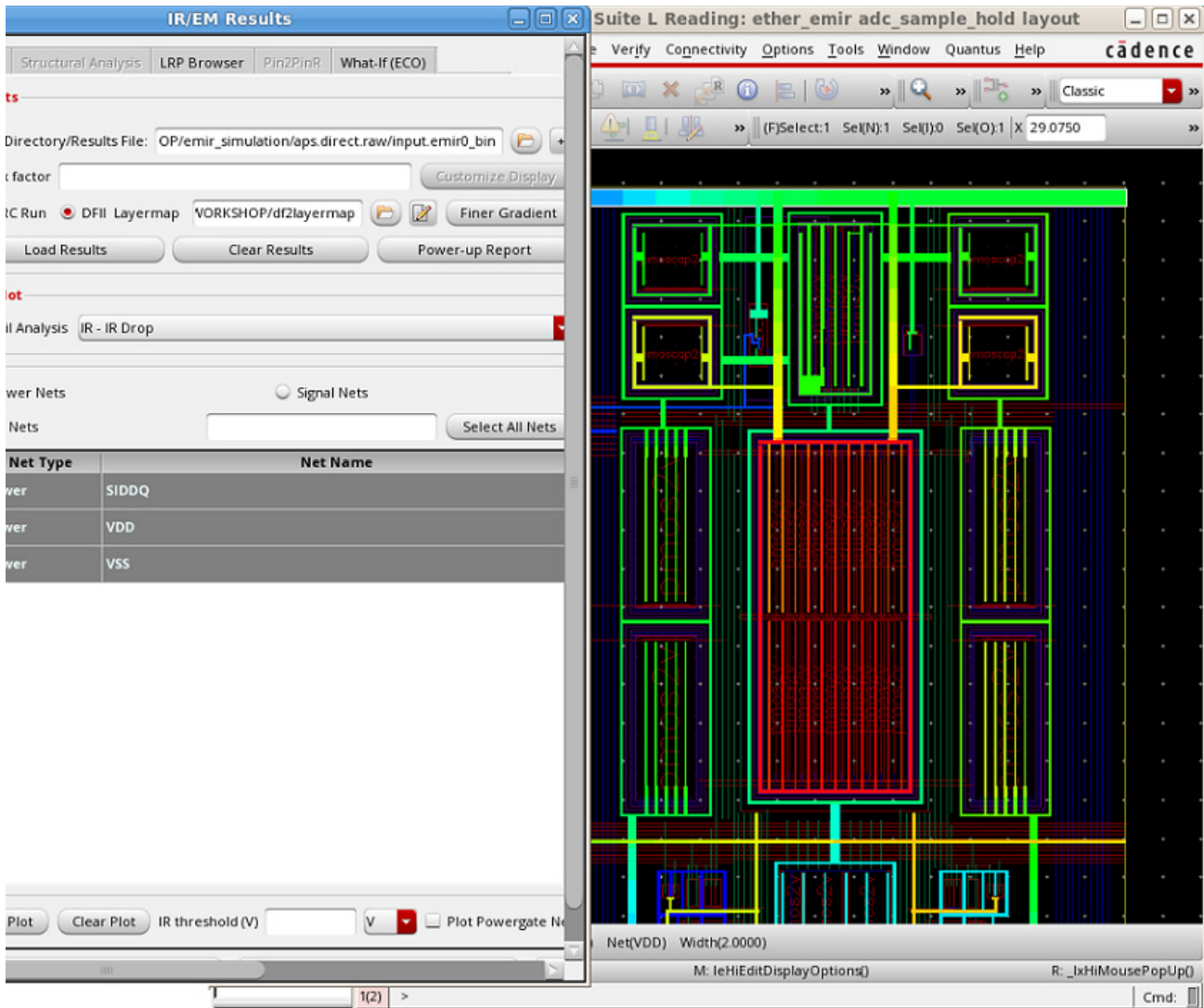
13. Specify *IR threshold* for viewing IR drop violations above the specified threshold value.

14. Click *Show Plot* to view the plot on the Virtuoso layout.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## IR Drop Analysis Results

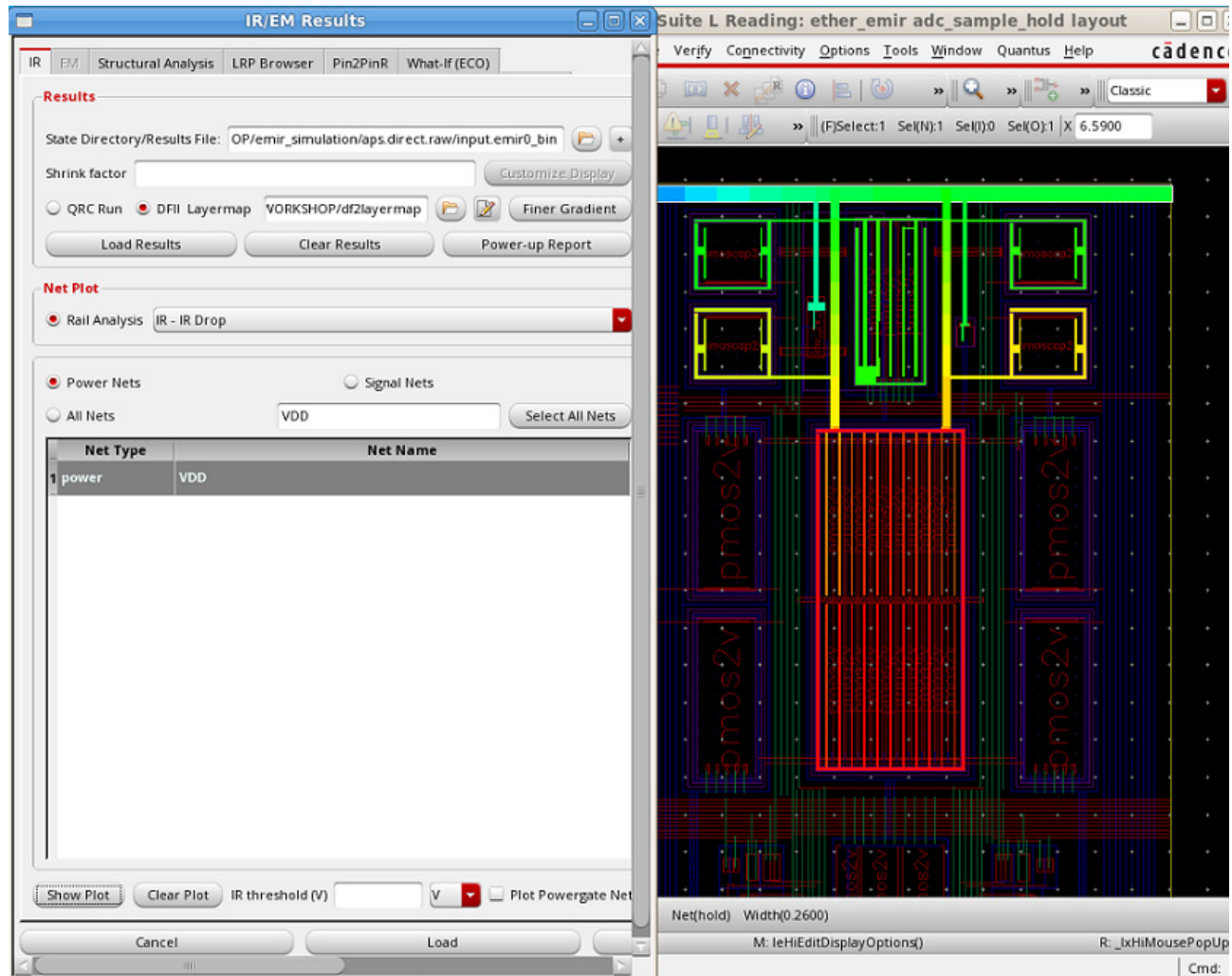
The IR plot for all power nets appears, as shown below.



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### IR Drop Analysis Results

The IR plot for selected nets appears, as shown below.



### Related Topics

- [Viewing and Querying the IR Drop Analysis Results in Voltus-Fi-XL \(video\)](#)

## Displaying and Querying EMIR Results

Voltus-Fi-XL lets you specify the plot display settings for the IR drop and EM plots that are displayed on the Virtuoso layout.

The plot display options include a *Min - Max* slider that lets you customize the range of violations you want to view. A continuous RGB gradient is used to highlight the worst violation regions in the design. The vast range of color options provided by the RGB gradient makes it easier to view a range of violations in the layout. The available plot display options of the IR/EM Results form are shown in [Figure 7-3](#) on page 178.

The details of specifying the display options in this form are provided in [Specifying the Display Options for IR/EM Plots](#) section.

In addition to specifying settings for plots displayed in the layout, there are options to query the layout for viewing specific violations. The results of the query are highlighted in the EM/IR tab of Annotation Browser.

The following topics are covered in this section:

- [Viewing EMIR Violations in Annotation Browser](#)
- [Querying EMIR Results](#)
- [Specifying the Display Options for IR/EM Plots](#)

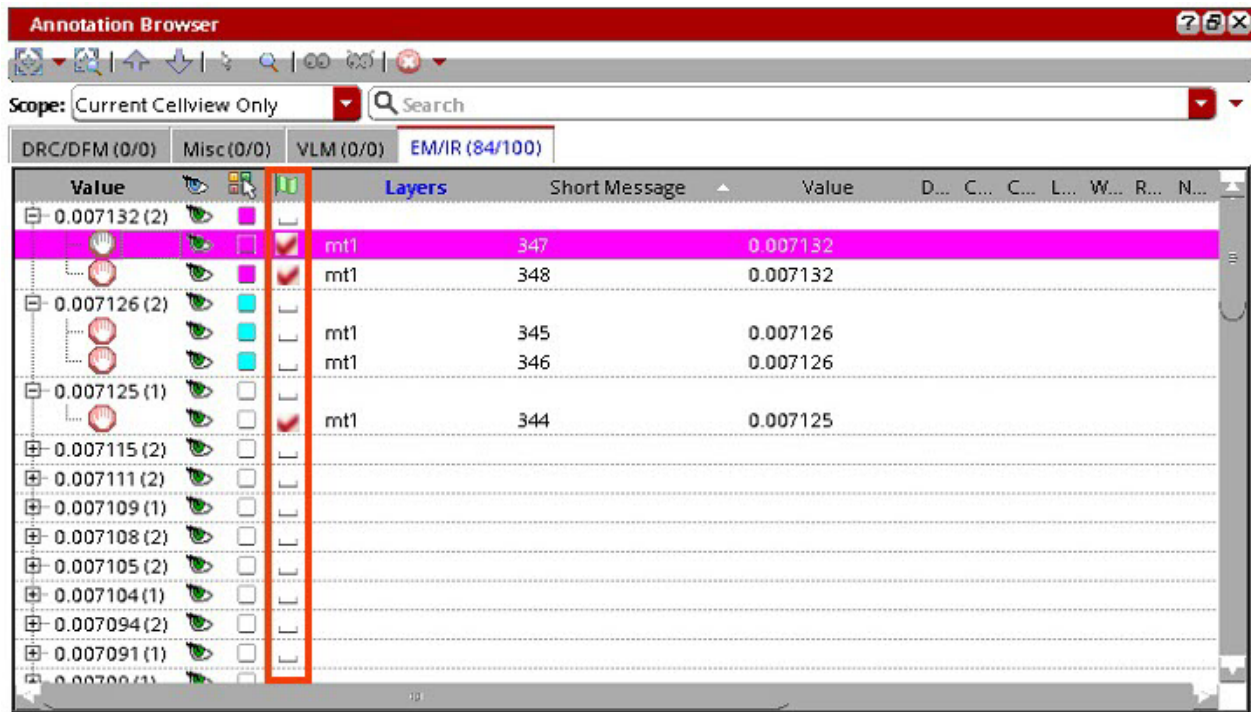
## Viewing EMIR Violations in Annotation Browser

Annotation Browser lets you view and manage violation markers generated for the design. When you click *Violation Browser* in the IR/EM Results form, Annotation Browser window appears in the upper-right corner of the Virtuoso layout window, and the *EM/IR* tab opens by default.

The following topics are covered in this section:

- Information Displayed in the EM/IR Tab of Annotation Browser
- Information Displayed in the Description Section of Annotation Browser

**Figure 7-1 EM/IR Tab of Annotation Browser**



The *EM/IR* tab is used for viewing the violations of IR drop and EM analyses, and it is enabled only when Voltus-Fi-XL is launched. The number of violations displayed in the *EM/IR* tab is based on the number specified in the *Elements count* field in the IR/EM Results form.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

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**Note:** The check state of a violation marker is saved in the *EM/IR* tab of Annotation Browser and is reloaded when you start a new Virtuoso session.

#### Information Displayed in the EM/IR Tab of Annotation Browser

The following information is available in columns in the EM/IR tab of Annotation Browser. The columns that are displayed vary for different analyses types. The complete list of available columns is provided below.

- Value: Provides the violation value.
- Layers: Provides the name of the layer on which the violation is located.
- Short Message: Provides the name of the node or the resistor.
- BBox: Shows the coordinates of the marker bounding box.
- Density: Provides the Current Density value across the resistor.
- Current: Provides the current value across the resistor.
- Current Limit: Provides the current rules as per the specified EM rules.
- Length: Provides the resistor length value.
- Width: Provides the resistor width value.
- Resistance: Provides the resistance value of the resistor.
- Number of Vias: Provides the number of vias in the via array. This is valid only for via layers.
- Needed No. of Vias: Provides the number of vias needed to pass the EM violation. This is valid only for via layers.
- Via Area: Provides the area of the via array.
- Needed Width: Provides the minimum width required for metal layer resistors to pass the EM violation.
- Net: Provides the name of the net associated with the marker.
- Time: Time for peak IR drop in seconds.
- Power Gate Transistor: Provides the name of the power-gate transistor instance. This is valid only for power-gated resistors.

By default, the columns displaying the resistor/node name, layers, and violation values are visible for all types of plots.

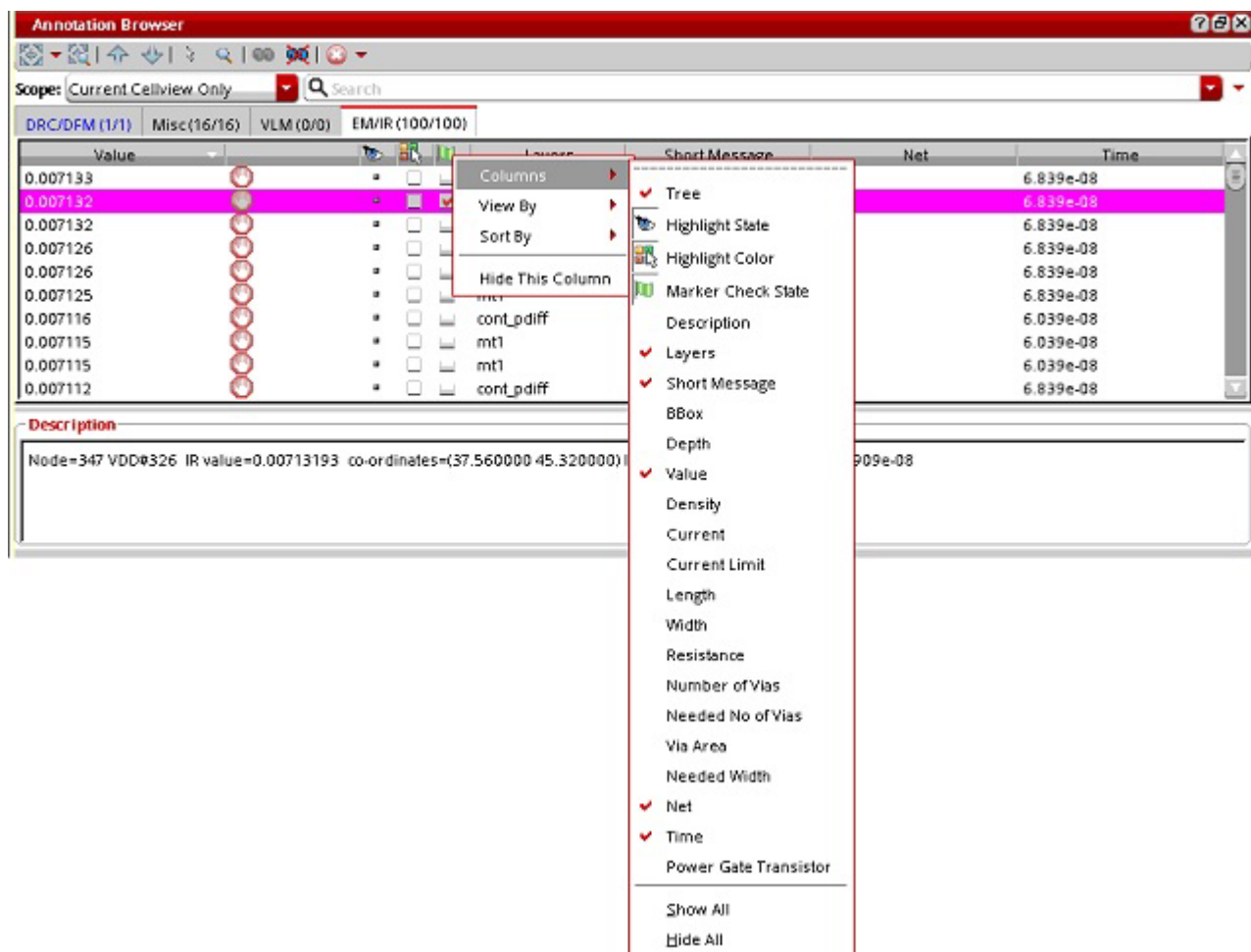
## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

**Note:** The information about columns available for different analyses types for IR plots is provided in the [Types of IR Drop Analysis Plots](#) section in this chapter and for EM plots in the [Types of EM Analysis Plots](#) section of the “EM Analysis Results” chapter.

You can add or remove columns to customize the information you want to view in Annotation Browser. For this, right-click the column heading, select *Columns* from the list, and then select the columns you want to view in the tab. This is shown below.

**Figure 7-2 Selecting Columns in the EM/IR Tab**



### Information Displayed in the Description Section of Annotation Browser

Detailed information about the selected node is provided in the *Description* section of Annotation Browser. For example, for an RJ JMAX analysis type, the following information is provided:

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### IR Drop Analysis Results

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Net = VSS Resistor=ri875 RJ value=3.155 layer=mt1 co-ordinates=(12.017000-23.025000,11.225000-23.020000) resistance=0.247689 length=0.7875um width=0.24um needed Width=0.757201um

For an IR drop analysis type, the following information is provided:

Node=459 VSS#453 IR value=0.00495278 co-ordinates=(58.334999 27.959999) layer=mt1  
Net=VSS Time=7.64774e-08

You can view the units for corresponding values in the description section.

**Note:** The entries in Annotation Browser honor the user-specified plot display settings in the display options specified in the IR/EM Results form. Therefore, the results of the query comply with the user-specified plot settings.

For more information about how to use Annotation Browser and manage the different views, see the “Layout XL Assistants” chapter in *Virtuoso Layout Suite XL User Guide*.

## Querying EMIR Results

The following layout query features are supported in Voltus-Fi-XL.

- **Viewing worst violations:** You can select an area in the layout and zoom into the worst violation in the selected area by using the *Zoom Select Max Region* button provided in the Display form or the expanded section of the IR/EM Results form. The worst violation in the selected area is highlighted in Annotation Browser. For details, see [Viewing Worst Violations](#).
- **Viewing all violations in selected area:** You can select an area in the layout and retrieve the values of all violations in the selected area by using the *Get Value on Layout* button provided in the Display form. All violations in the selected area are highlighted in Annotation Browser. For details, see [Viewing all Violations in Selected Area](#).
- **Querying Specific Points and Areas in the layout for Resistor Information:** click any point or select an area in the layout to display the resistor information for that point or for all points that lie within that area in the console. This query feature is independent of Annotation Browser. For this, a *Query* check box is provided in the Display form. For details, see [Querying Specific Points and Areas in the layout for Resistor Information](#).

## Specifying the Display Options for IR/EM Plots

After you load the IR drop or the EM analysis results on the IR and EM tabs of the IR/EM Results form, select the nets for which you want to view the plots, and click *Show Plot*. The IR/EM Results form expands to provide options for customizing the plot display in the layout.

Use the scroll bar provided at the bottom of the form to view the display options. Click the arrow provided on the top-left corner of the form to hide or unhide the Display form. This is shown in [Figure 7-3](#) on page 178.

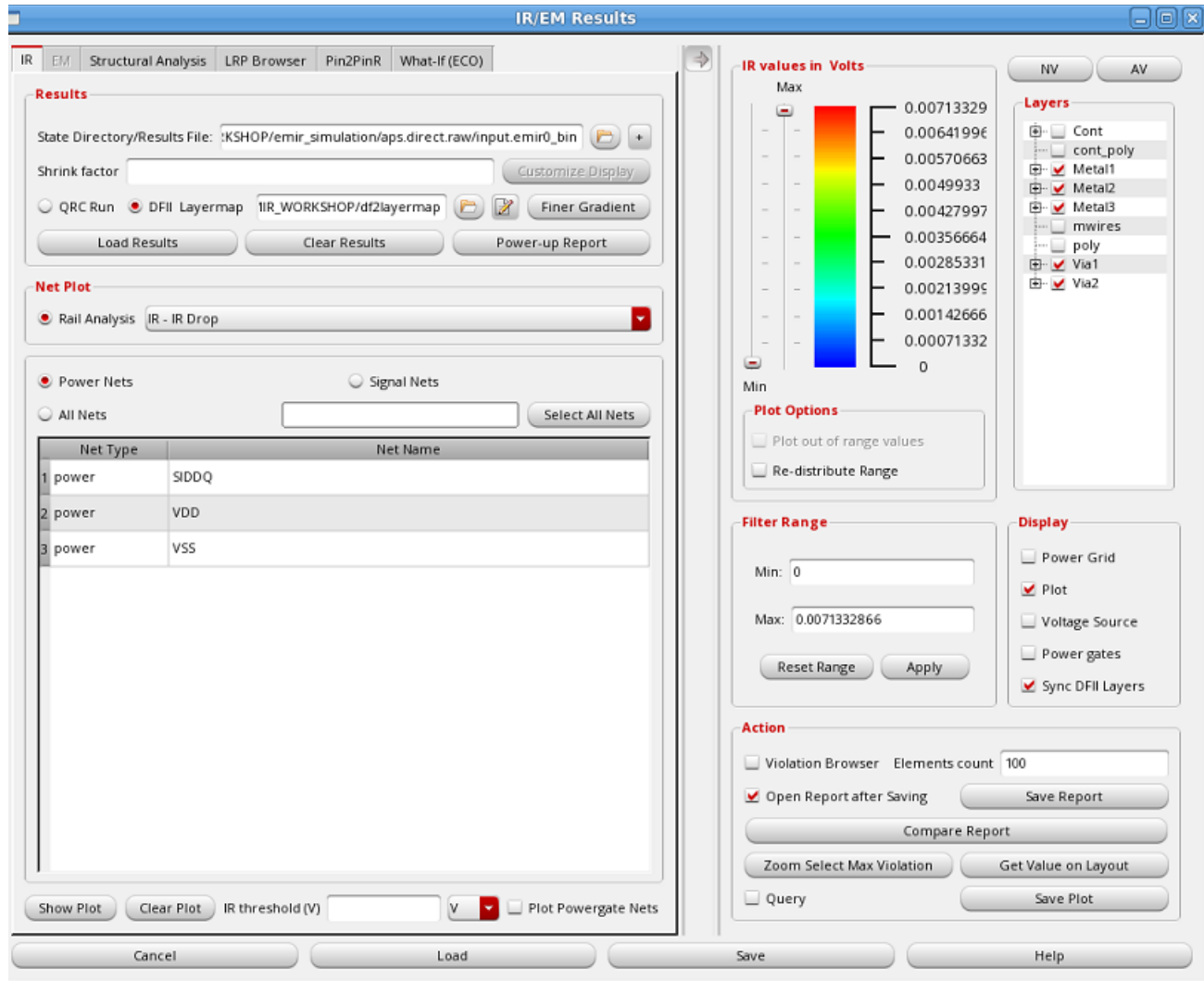
The following topics are covered in this section:

- [Selecting Layers for Viewing Violations](#)
- [Customizing the Range for Viewing Violations](#)
- [Customizing the Display Options for Plots](#)
- [Viewing and Managing Violations in the layout](#)
  - [Viewing Worst Violations](#)
  - [Viewing all Violations in Selected Area](#)
- [Querying Specific Points and Areas in the layout for Resistor Information](#)
  - [Query Box Information for IR Drop Analysis](#)
  - [Query Box Information for EM Analysis](#)
  - [Query Box Information for SHE Analysis](#)
- [Saving the IR Drop Analysis Result Plots and Reports](#)

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## IR Drop Analysis Results

Figure 7-3 Specifying the Display Options for Plots



### Selecting Layers for Viewing Violations

The following options are provided in the *Layers* group box of the Display form for selecting layers:

- Click **AV** or **NV** to select or deselect all layers. Use the check boxes provided against layer names to select or deselect specific layers. By default, all layers are selected.

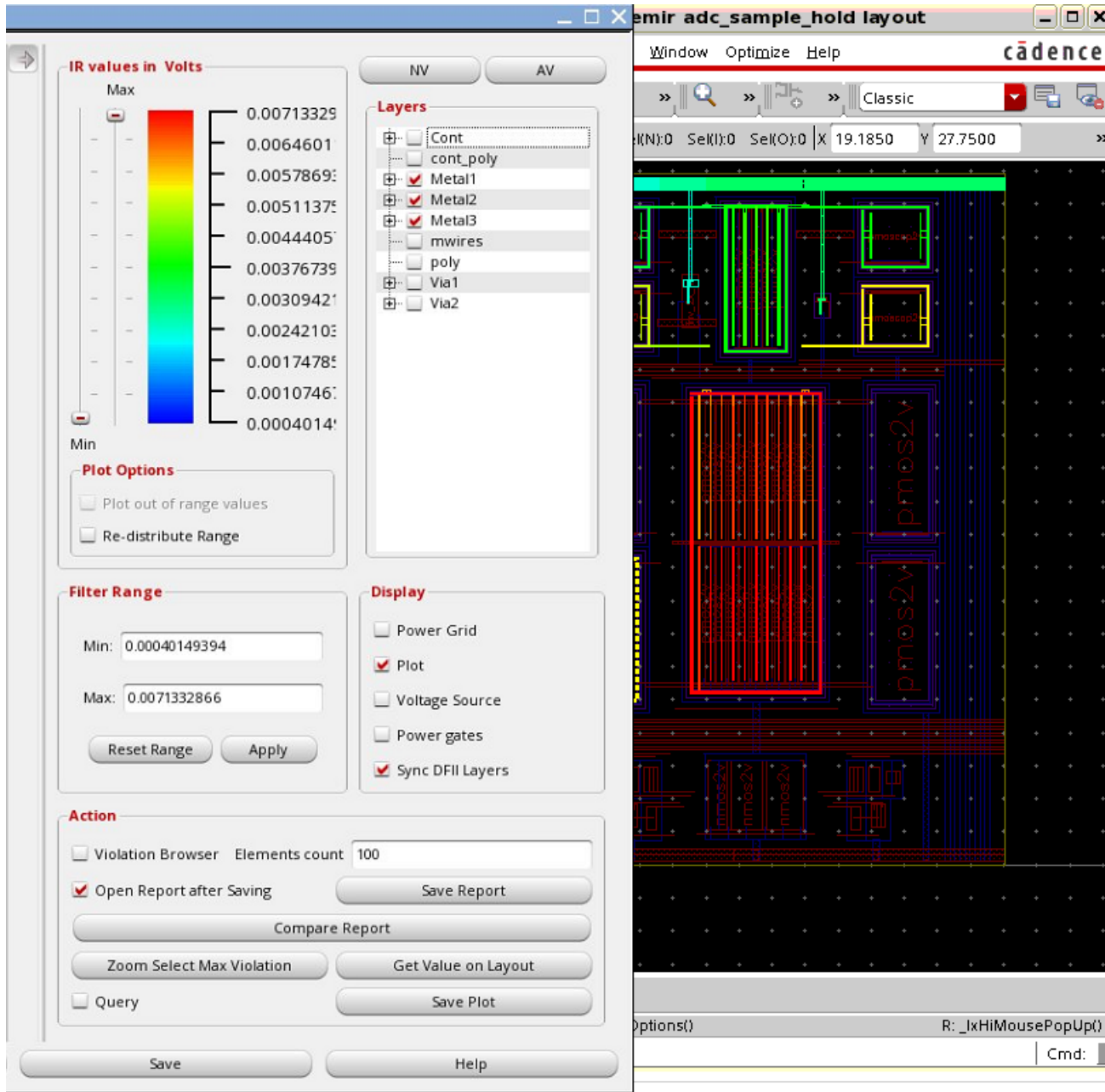
When the layer selection is updated, the plot in the layout is updated automatically. The image below shows the layout display of the total violation range for the selected layers for an IR drop analysis type plot.

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**Note:** For all layers defined in the DFII layer map file, the DFII layer names and the corresponding extraction layer names are listed in a tree view. For example, when you click `Metal1`, you will see the extraction layer name, `mt1`. This is shown in below image.

**Figure 7-4 Displaying the Total Violation Range for Specified Layers in the layout – IR Analysis Type**



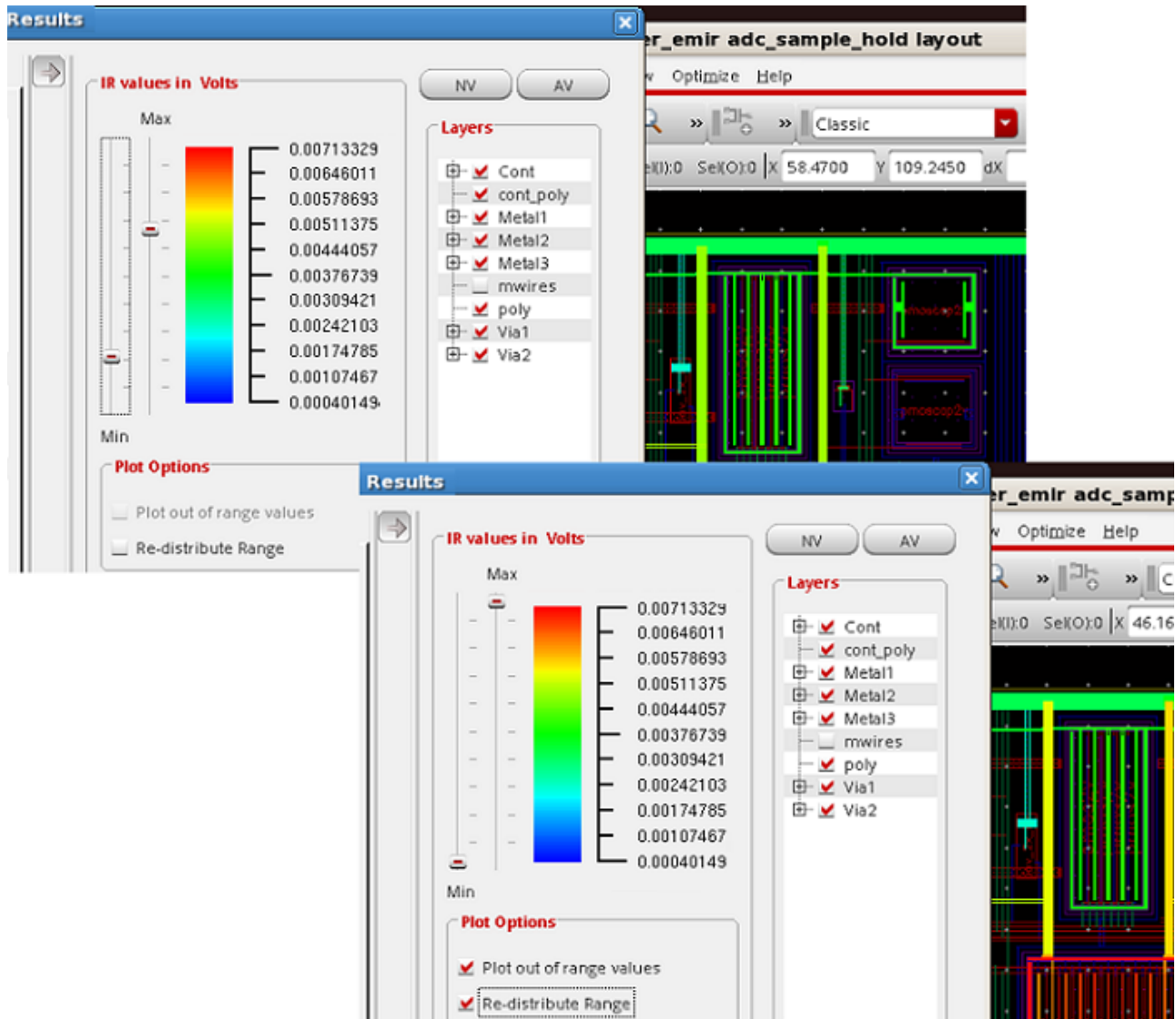
## Customizing the Range for Viewing Violations

The following options are provided in the Display form for customizing the range for viewing violations.

- *Min* and *Max* sliders are provided for viewing violations that fall within the specified slider range. Move the *Min* - *Max* sliders up and down. The display highlights are updated according to the new slider positions. The *Min* - *Max* slider range functionality works differently in the following scenarios:
  - ❑ When the *Re-distribute Range* option in the Plot Options group box is unchecked, moving the *Min* - *Max* sliders only updates the plot display, which means, the violation range outside the color spectrum of this range will be toggled. For example, in [Figure 7-3](#) on page 181, the *Min* and *Max* slider range is changed from showing violations between “green” and “light blue” to “red” and “light blue”.
  - ❑ When the *Re-distribute Range* option is checked, moving the *Min* - *Max* sliders re-distributes the range on the ruler and the plot is updated to reflect this new range. This will also update the *Min* and *Max* values in the Filter Range group box.
- The RGB color spectrum is provided next to the slider for viewing violations in different colors.
- The ruler range of violation values, for all or selected layers, is provided next to the color spectrum.



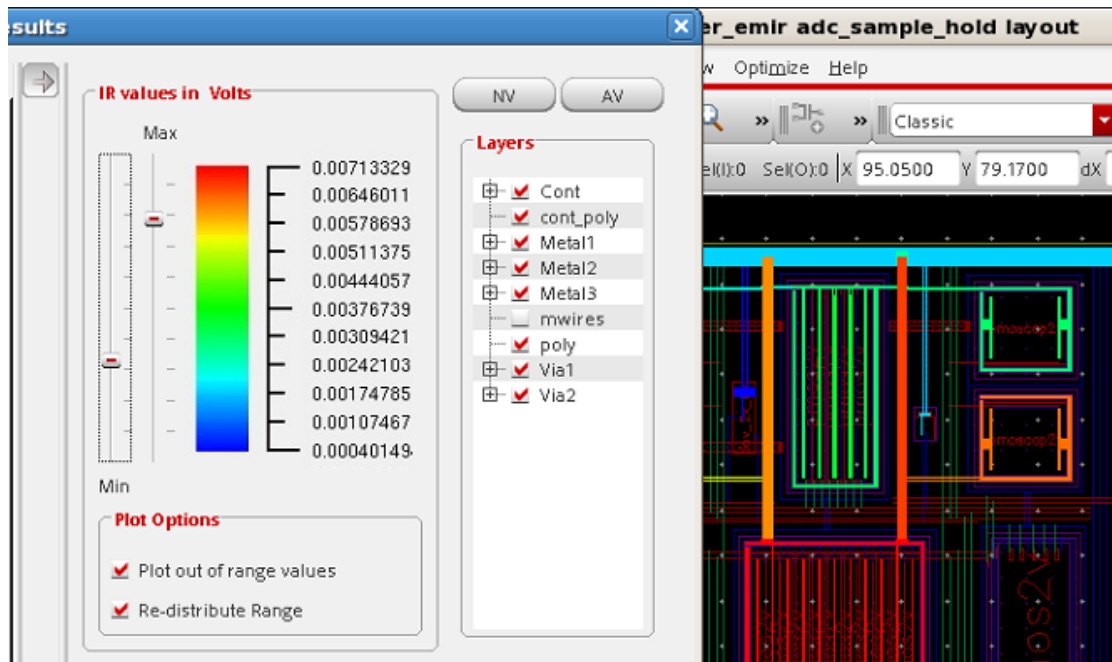
**Figure 7-5 Customizing the Range for Viewing IR Drop Violations for Specified Layers**



- In the Plot Options group box, select *Plot out of range* to view the violation values outside the specified *Min - Max* slider range. For example, in the image below, the selected range is between “green” and “light blue” but since the *Plot out of range values* is selected, the violations above and below the slider marks are also displayed in “deep red” and “deep blue”, respectively.

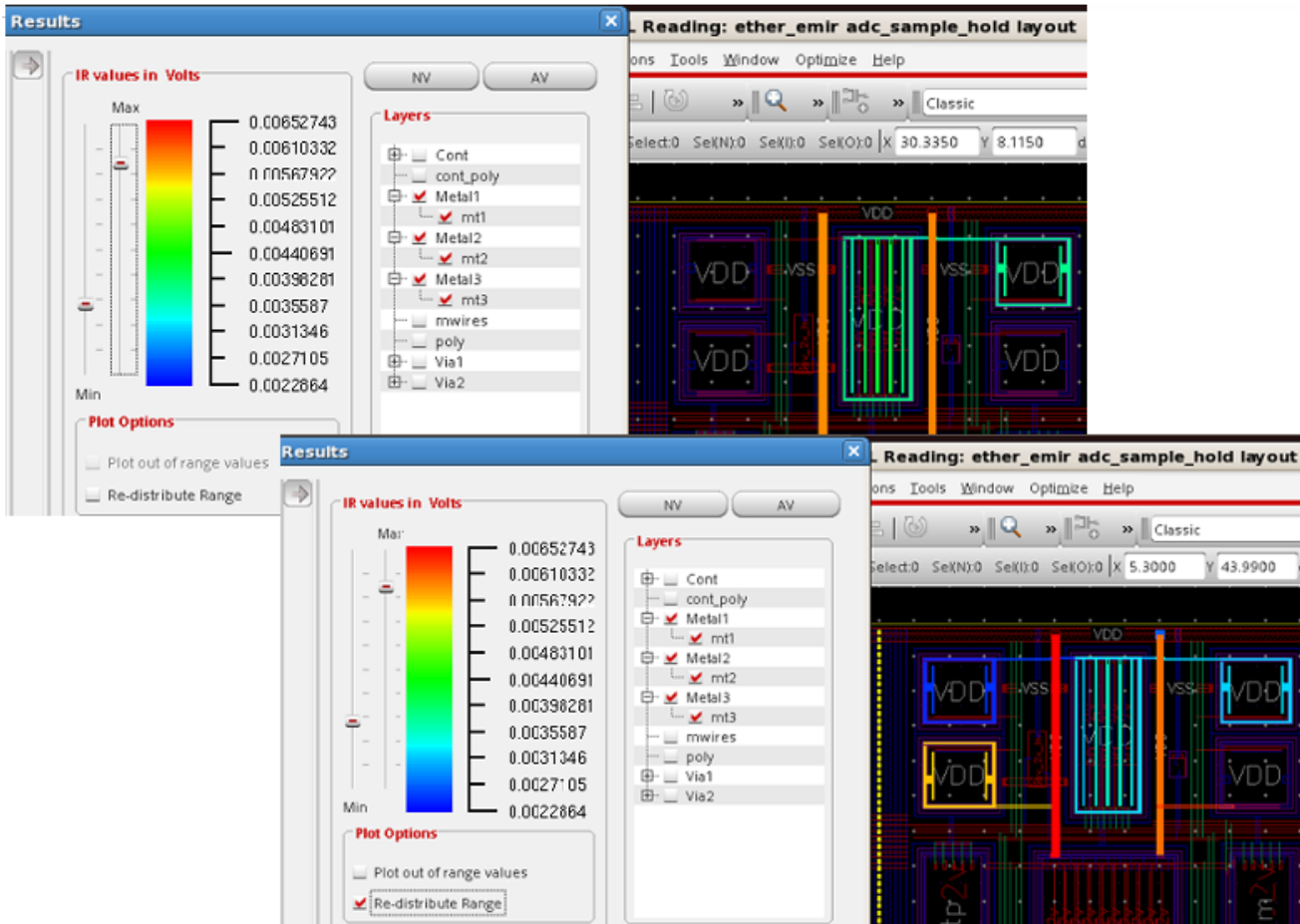
**Note:** The *Plot out of range values* option is only enabled when the *Re-distribute Range* option is selected.

Figure 7-6 Viewing IR Drop Violations for the Out of Range Values



- Select *Re-distribute Range* to view the complete spectrum, from “deep red” to “deep blue”, for the specified layer selection. For example, in the image below, when this option is not selected, the slider range only shows the color range for the violations in the selected range, from “orange” to “light blue”. However, when this option is selected, the slider re-distributes the range to show the complete color spectrum, from “deep red” to “deep blue”, for the selected range.

**Figure 7-7 Re-Distributing the Color Spectrum for the Selected Range**



- In the Filter Range group box, specify the *Min* and *Max* values, which are the minimum and maximum values for the filter range. When a plot type is chosen on the IR or EM tab, the filter values are filled in automatically in these fields. To change the default values, you can either type the new Min and Max values and click Apply or enter. The plot is updated automatically.
- Click *Reset Range* to restore the default values of filters in the *Min* and *Max* fields.

### Customizing the Display Options for Plots

The following options are used to customize the plot displays:

- Click *Power Grid* to view the power grids. This option is disabled for EM plots.
- Click *Plot* to view the plots.

- Click *Voltage Source* to view the voltage source locations. This option is disabled for EM plots.
- Click *Power gates* to view the power gates in the layout. This option is relevant only for power-gated designs.
- Click the *Sync DFII Layers* option to toggle the display of the DFII layers for the layers selected in the Layers group box. By default, this option is checked, which means the layers are in synch.

### Viewing and Managing Violations in the layout

The following options are provided in the *Action* group box of the Display form for viewing and managing violations on the Virtuoso layout:

- Click *Violation Browser* to view and manage the violation markers generated for the current design. The Annotation Browser window opens on the right side of the Virtuoso Layout and displays the top violations. This is shown in [Figure 7-3](#) on page 185.

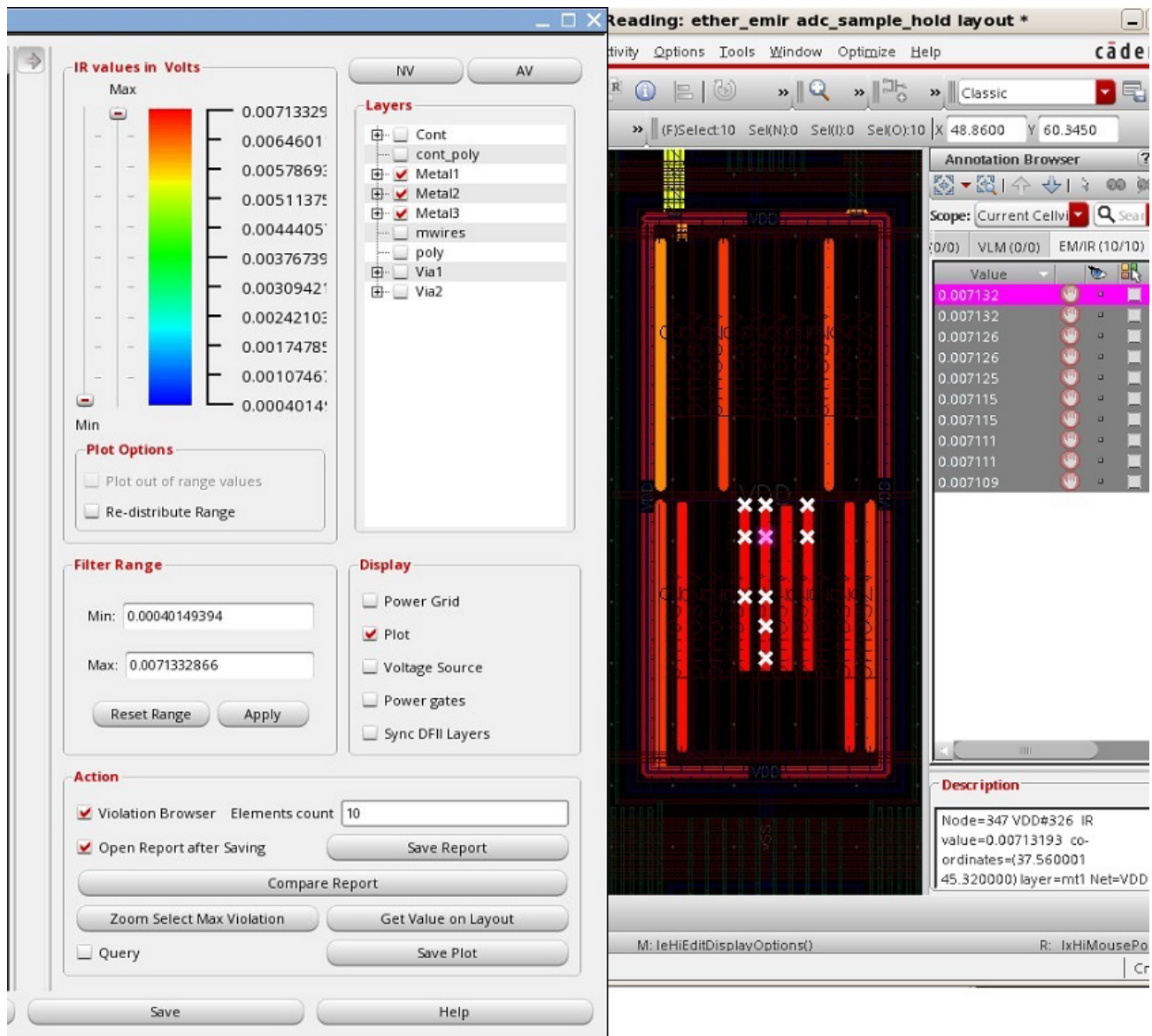
**Note:** For more information, see [Viewing EMIR Violations in Annotation Browser](#).

- Specify the number of violations you want to view in the *Elements count* field. For example, you can choose to view only the top ten violations. The image below shows the top ten violations listed in the EM/IR tab of Annotation Browser and the violation markers in the plot on the Virtuoso layout.

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Figure 7-8 Viewing the Top Ten Violations in the layout



If the number of elements specified is 1000 and above, then the list of violations in Annotation Browser is suppressed by default. To view the violations, select *Unsuppress Expansion* from the context menu of Annotation Browser.

**Note:** For more information about how to use Annotation Browser and manage the different views, see the "Layout XL Assistants" chapter in *Virtuoso Layout Suite XL User Guide*.



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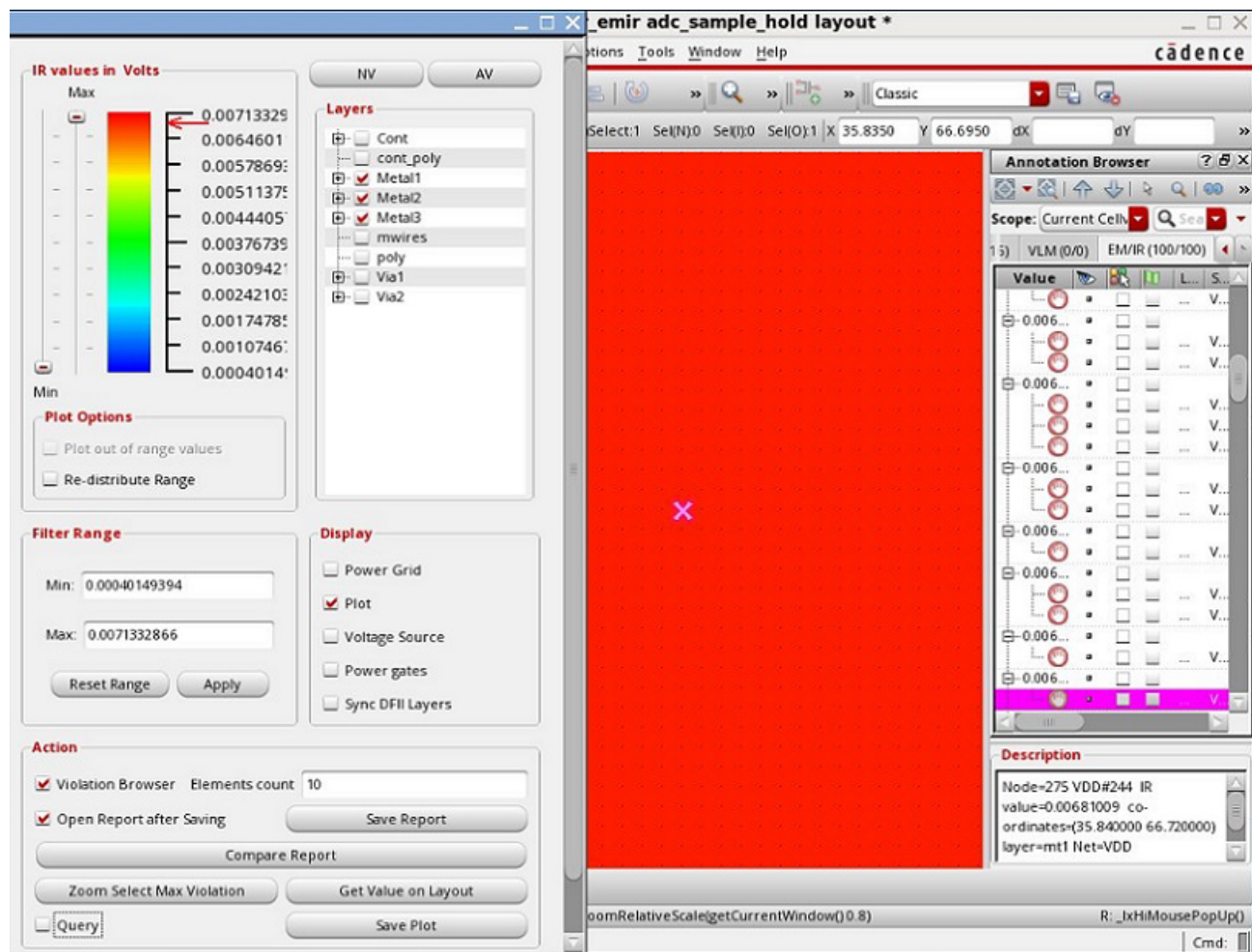
### IR Drop Analysis Results

## Viewing Worst Violations

Click *Zoom Select Max Violation* to zoom into and highlight the maximum violation in the selected area in the layout. For this, first click *Zoom Select Max Violation*, and then select an area in the layout to locate and zoom into the maximum violation in that area. Annotation Browser opens and the node or presistor with the worst violation in the selected area is highlighted in the browser.

In addition, the maximum violation in the selected area is marked on the ruler in the IR/EM Results form with a red arrow. This is shown in the image below.

### Figure 7-9 Zooming into the Maximum Violation in the Selected Area



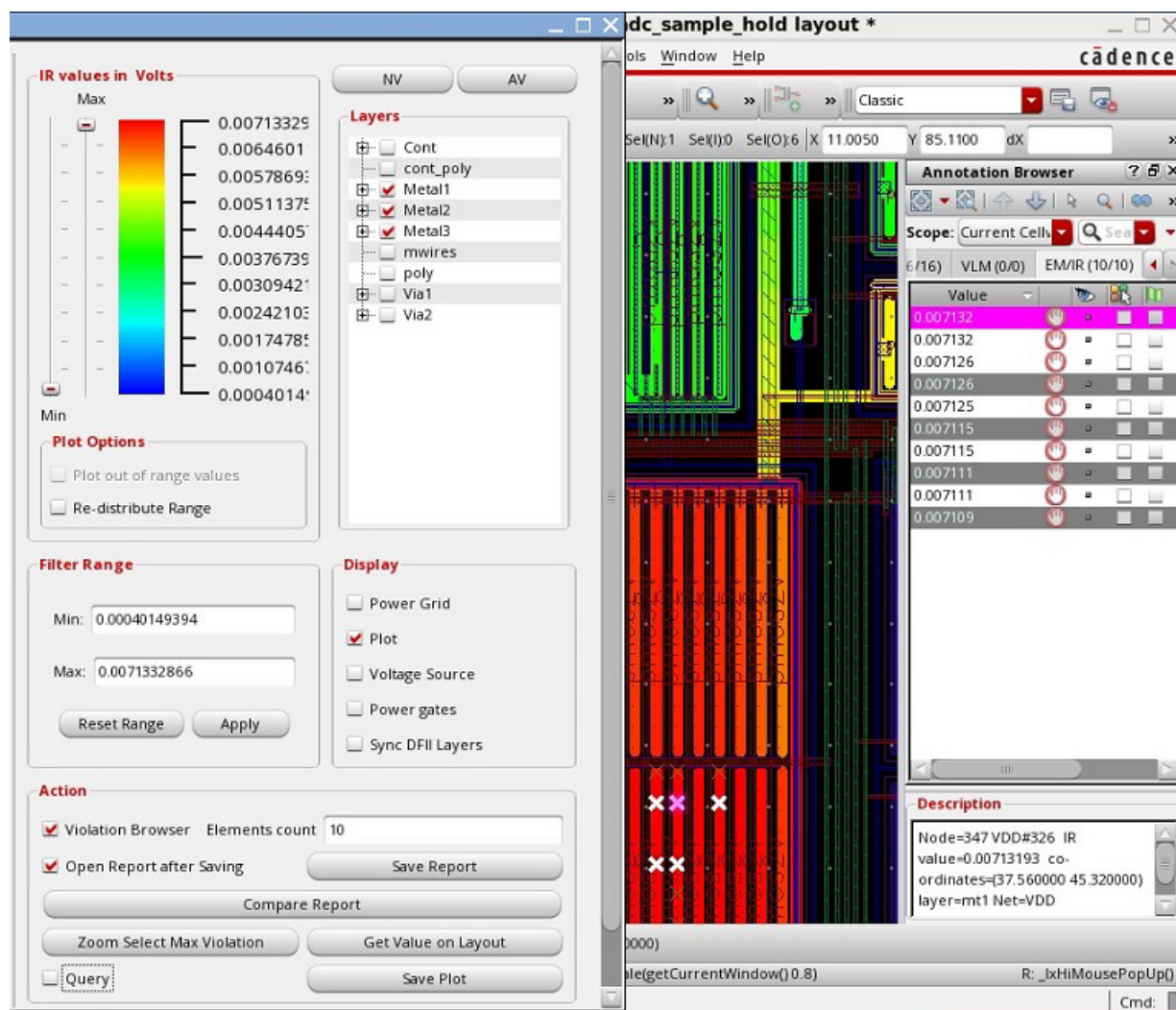
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### Viewing all Violations in Selected Area

Click *Get Value on Layout* to retrieve the values of violations in the selected area from the layout view. For this, first click *Get Value on Layout* and then select an area in the layout. The violations in the selected area are marked on the ruler with red arrows and are highlighted in Annotation Browser. If there are multiple violations in the selected area, all violations will be marked in Annotation Browser. This is shown in the image below.

**Figure 7-10 Retrieving Violation Values from the Layout**

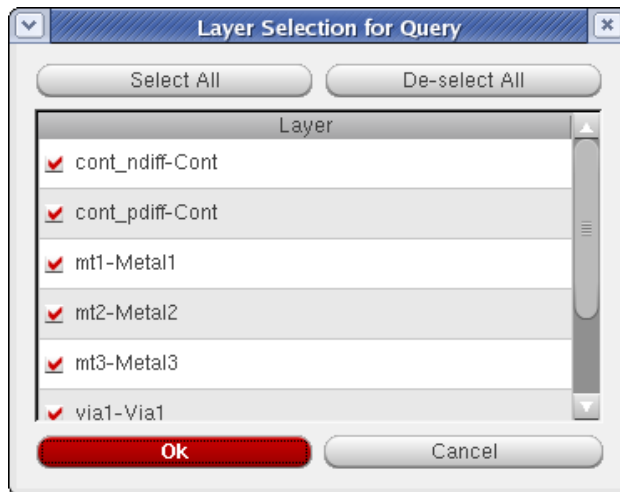


### Querying Specific Points and Areas in the layout for Resistor Information

Select *Query* to display the resistor information for a point or points within a specified area in the layout. For this, first select *Query* and then use the left mouse button to click any point or to select an area in the layout.

The Layer Selection for Query form opens. In this form, select the layers for which you want to perform the query and click OK. By default, all layers that are selected in the *Layers* group box of the Display form are selected in this form. This form is shown below.

**Figure 7-11 Layer Selection for Query Form**



**Note:** The above form opens when multiple layers are selected in the *Layers* group box or the layer selection window.

The result of the query or the resistor information for the selected point or for points in the selected area is displayed in the Query Box.

You can add or remove columns to customize the information you want to view in the Query Box. To do this:

- Right-click a row, select *Columns* from the list, and then select the columns you want to view in the tab.

To rearrange the columns:

- Drag the columns to the required position.

To save the configuration:

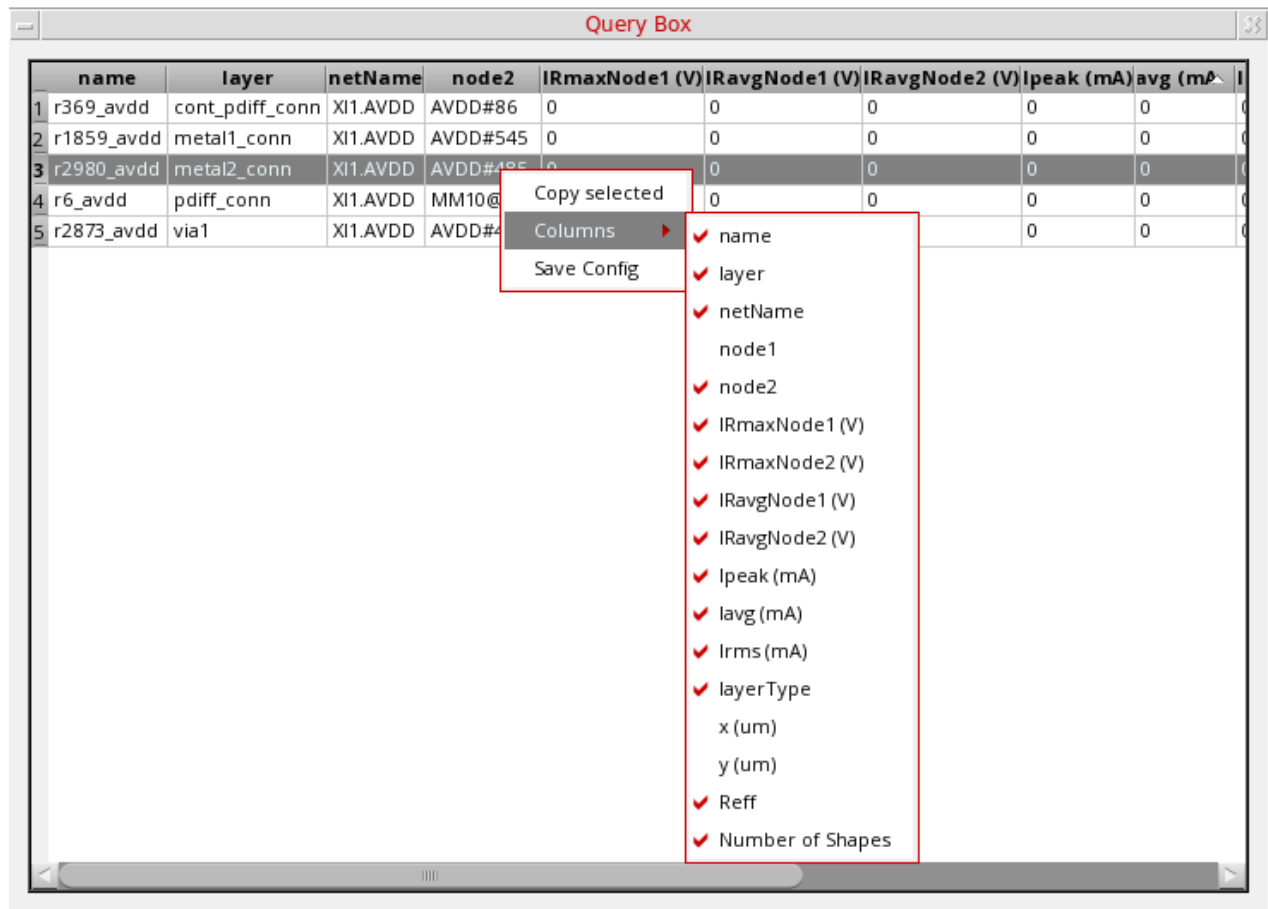
- Right-click anywhere in the Query Box and select *Save Config*.



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## IR Drop Analysis Results

**Figure 7-12 Selecting Columns in the Query Box**



Different information is displayed in the query box depending upon whether the query is for IR drop, EM analysis, SHE analysis, or RMS hot-spot waiving analysis. This is covered in the following sections:

- [Query Box Information for IR Drop Analysis](#)
- [Query Box Information for EM Analysis](#)
- [Query Box Information for SHE Analysis](#)
- [Query Box Information for RMS EM Hot Spot Waiving Analysis](#)

### **Query Box Information for IR Drop Analysis**

The following information is reported in the Query Box columns for IR drop analysis query:

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1. *name*: The name of the resistor for which information is being queried
2. *layer*: The name of the layer on which the resistor is located
3. *netName*: The net name of the resistor
4. *node1*: The name of the first node of the resistor
5. *node2*: The name of the second node of the resistor
6. *IRmaxNode1(mA)*: The maximum IR drop on node 1 in milliamperes
7. *IRmaxNode2(mA)*: The maximum IR drop on node 2 in milliamperes
8. *IRavgNode1(mA)*: The average IR drop on node 1 in milliamperes
9. *IRavgNode2(mA)*: The average IR drop on node 2 in milliamperes
10. *Ipeak(A)*: The peak current of the resistor in amperes
11. *Iavg(A)*: The average current of the resistor in amperes
12. *Irms(A)*: The RMS current of the resistor in amperes
13. *layerType*: The layer type, metal or via
14. *x(um)*: The x-coordinate of the resistor in micrometers
15. *y(um)*: The y-coordinate of the resistor in micrometers
16. *Reff*: The effective resistance value of the resistor. The effective resistance values are displayed only when effective resistance plot type is selected. For other IR drop analysis plots, *NA* is displayed in the query box column.
17. *Number of Shapes*: The number of shapes in power net layout

A part of a sample query box for querying a selected area for IR drop analysis is shown below.

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**Figure 7-13 Displaying IR Drop Analysis Query Results for a Selected Area in the Query Box**

| name  | layer           | netName | node1   | node2   | I <sub>Rmax</sub> Node1 (V) | I <sub>Rmax</sub> Node2 (V) | I <sub>Ravg</sub> Node1 (V) | I <sub>Ravg</sub> Node2 (V) | I <sub>peak</sub> (A) | I <sub>avg</sub> (A) | I <sub>rms</sub> (A) | layerType | x (um) | y (um) | Reff |
|-------|-----------------|---------|---------|---------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------|----------------------|----------------------|-----------|--------|--------|------|
| rs395 | via1            | VDD     | VDD#33  | VDD#70  | 0.00497933                  | 0.00497793                  | 0.00448571                  | 0.00448572                  | 3.53172e-05           | 7.19112e-08          | 3.26424e-06          | Metal     | 15.945 | 78.480 | NA   |
| rg7   | mt3             | VDD     | VDD#82  | VDD#83  | 0.00416405                  | 0.00449885                  | 0.00384609                  | 0.0041636                   | 0.00132807            | 0.00125874           | 0.00125881           | Metal     | 30.100 | 84.856 | NA   |
| rs396 | via1            | VDD     | VDD#71  | VDD#72  | 0.00582559                  | 0.00559969                  | 0.00544837                  | 0.00522806                  | 0.00130496            | 0.00125894           | 0.00125897           | Metal     | 30.095 | 71.540 | NA   |
| rh26  | mt2             | VDD     | VDD#67  | VDD#68  | 0.00485625                  | 0.0049069                   | 0.00448626                  | 0.00448602                  | 9.59088e-05           | 1.95354e-07          | 8.86367e-06          | Metal     | 27.411 | 78.480 | NA   |
| ri86  | mt1             | VDD     | VDD#36  | VDD#37  | 0.00500817                  | 0.0050006                   | 0.00448559                  | 0.00448562                  | 1.72314e-05           | 3.50863e-08          | 1.59268e-06          | Metal     | 11.535 | 83.703 | NA   |
| ri207 | mt1             | VDD     | VDD#185 | VDD#229 | 0.0064886                   | 0.0064659                   | 0.00609394                  | 0.00624976                  | 0.000123725           | 0.000119357          | 0.000119359          | Metal     | 39.280 | 70.340 | NA   |
| ri85  | mt1             | VDD     | VDD#35  | VDD#36  | 0.00500055                  | 0.00500817                  | 0.00448562                  | 0.00448559                  | 3.06103e-05           | 6.23282e-08          | 2.82927e-06          | Metal     | 11.535 | 81.526 | NA   |
| ri81  | mt1             | VDD     | VDD#31  | VDD#32  | 0.00497816                  | 0.00498067                  | 0.00448572                  | 0.00448571                  | 3.19126e-05           | 6.49791e-08          | 2.94956e-06          | Metal     | 19.081 | 78.480 | NA   |
| rr646 | via2_out_capind | VDD     | VDD#72  | VDD#87  | 0.00559969                  | 0.00537379                  | 0.00522806                  | 0.00500774                  | 0.00130496            | 0.00125894           | 0.00125897           | Metal     | 30.095 | 71.540 | NA   |
| ri92  | mt1             | VDD     | VDD#36  | VDD#44  | 0.00500817                  | 0.00501002                  | 0.00448559                  | 0.00448558                  | 4.78417e-05           | 9.74145e-08          | 4.42195e-06          | Metal     | 12.095 | 82.130 | NA   |
| ri84  | mt1             | VDD     | VDD#34  | VDD#35  | 0.00498843                  | 0.00500055                  | 0.00448567                  | 0.00448562                  | 1.63642e-05           | 3.33203e-08          | 1.5125e-06           | Metal     | 12.791 | 79.606 | NA   |
| ri170 | mt1             | VDD     | VDD#188 | VDD#189 | 0.00647101                  | 0.00638381                  | 0.00607862                  | 0.00599364                  | 0.000154188           | 0.000148767          | 0.000148771          | Metal     | 34.980 | 71.360 | NA   |
| ri94  | mt1             | VDD     | VDD#44  | VDD#46  | 0.00501002                  | 0.00501072                  | 0.00448558                  | 0.00448558                  | 1.23683e-05           | 2.51841e-08          | 1.14319e-06          | Metal     | 12.655 | 83.633 | NA   |
| ri178 | mt1             | VDD     | VDD#195 | VDD#196 | 0.00596731                  | 0.00611754                  | 0.00558612                  | 0.0057324                   | 0.000241788           | 0.000233302          | 0.000233309          | Metal     | 28.400 | 70.925 | NA   |
| ri79  | mt1             | VDD     | VDD#28  | VDD#30  | 0.00500563                  | 0.0049971                   | 0.0044856                   | 0.00448564                  | 3.42883e-05           | 6.98149e-08          | 3.16908e-06          | Metal     | 21.335 | 81.526 | NA   |
| ri78  | mt1             | VDD     | VDD#26  | VDD#28  | 0.00500749                  | 0.00500563                  | 0.00448559                  | 0.0044856                   | 4.78388e-05           | 9.74047e-08          | 4.42146e-06          | Metal     | 20.775 | 82.588 | NA   |
| ri77  | mt1             | VDD     | VDD#26  | VDD#27  | 0.00500749                  | 0.00501622                  | 0.00448559                  | 0.00448556                  | 2.94809e-05           | 6.00261e-08          | 2.72476e-06          | Metal     | 20.215 | 82.398 | NA   |
| ri91  | mt1             | VDD     | VDD#41  | VDD#42  | 0.00499902                  | 0.00500196                  | 0.00448563                  | 0.00448562                  | 1.35551e-05           | 2.75994e-08          | 1.25281e-06          | Metal     | 21.337 | 84.720 | NA   |
| ri83  | mt1             | VDD     | VDD#33  | VDD#34  | 0.00497933                  | 0.00498843                  | 0.00448571                  | 0.00448567                  | 3.21691e-05           | 6.55013e-08          | 2.97328e-06          | Metal     | 14.996 | 78.480 | NA   |
| ri87  | mt1             | VDD     | VDD#37  | VDD#38  | 0.0050006                   | 0.00499671                  | 0.00448562                  | 0.00448564                  | 5.24138e-06           | 1.06725e-08          | 4.84458e-07          | Metal     | 12.666 | 86.308 | NA   |
| ri223 | mt1             | VDD     | VDD#246 | VDD#247 | 0.00687127                  | 0.00687168                  | 0.00647337                  | 0.00647377                  | 9.71944e-06           | 9.37623e-06          | 9.37641e-06          | Metal     | 35.840 | 58.140 | NA   |
| ri80  | mt1             | VDD     | VDD#30  | VDD#31  | 0.0049971                   | 0.00497816                  | 0.00448564                  | 0.00448572                  | 2.85923e-05           | 5.82179e-08          | 2.64266e-06          | Metal     | 20.340 | 79.606 | NA   |
| ri299 | mt1             | VDD     | VDD#333 | VDD#334 | 0.00707481                  | 0.00708072                  | 0.0066729                   | 0.00667873                  | 1.83465e-06           | 1.76998e-06          | 1.77001e-06          | Metal     | 39.280 | 42.850 | NA   |
| ri289 | mt1             | VDD     | VDD#322 | VDD#323 | 0.00705489                  | 0.00712512                  | 0.00665334                  | 0.00672261                  | 2.18023e-05           | 2.10341e-05          | 2.10345e-05          | Metal     | 37.560 | 32.970 | NA   |

#### Query Box Information for EM Analysis

The following information is reported in the Query Box columns for EM analysis query:

1. *name*: The name of the resistor for which information is being queried.
2. *layer*: The name of the layer on which the resistor is located.
3. *netName*: The net name of the resistor.
4. *node1*: The name of the first node of the resistor.
5. *node2*: The name of the second node of the resistor.
6. *type*: The layer type, metal or via.
7. *current\_direction*: The current direction of the resistor.
8. *Iavg\_rule*: The EM rule used for average analysis.
9. *Ipeak\_rule*: The EM rule used for max/peak analysis.
10. *Irms\_rule*: The EM rule used for RMS analysis.
11. *Iacpeak\_rule*: The EM rule used for AC peak analysis.
12. *x(um)*: The x-coordinate of the resistor in micrometer.

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- 13.  $y(um)$ : The y-coordinate of the resistor in micrometer.
- 14.  $w(um)$ : The width of the resistor in micrometer.
- 15.  $l(um)$ : The path length in micrometer.
- 16.  $I_{peak}(A)$ : The peak current of the resistor in ampere.
- 17.  $I_{avg}(A)$ : The average current of the resistor in ampere.
- 18.  $I_{rms}(A)$ : The RMS current of the resistor in ampere.
- 19.  $I_{avg\_max}(A)$ : The maximum average Current Density in ampere.
- 20.  $I_{peak\_max}(A)$ : The maximum peak Current Density in ampere.
- 21.  $I_{rms\_max}(A)$ : The maximum rms Current Density in ampere.
- 22.  $ac_{peak\_max}(A)$ : The maximum AC peak Current Density in ampere.
- 23.  $\Delta T(C)$ : The rise in temperature of the resistor caused due to Joule heating in degree Celsius.
- 24.  $Td(us)$ : The total on-time period in microsecond.
- 25.  $r$ : The duty ratio.
- 26.  $a(um^2)$ : The area of the via in micrometer square. In case of metal layer, the value will be " - " .
- 27.  $N$ : The number of vias in the via array. In case of metal layer, the value will be " - " .

A part of a sample query box for querying a selected area for EM analysis is shown below.

**Note:** All columns in the EM analysis query are not visible in the query box when it opens. Use the scroll bar to see more information in the query box.

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**Figure 7-14 Displaying EM Analysis Query Results for a Selected Area in the Query Box**

Query Box

|    | name  | layer  | netName | node1   | node2   | type  | current_direction | lmax_rule | lavg_rule | lrms_rule | lpeak_rule | x(um)  | y(um)  | w(um) | l(um)   | lavg(A)  | lpeak(A)  | lrms(A)   | lavg_max(A) | lpeak_max(A) | lrms_max(A) |
|----|-------|--------|---------|---------|---------|-------|-------------------|-----------|-----------|-----------|------------|--------|--------|-------|---------|----------|-----------|-----------|-------------|--------------|-------------|
| 1  | rr650 | via... | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 45.025 | 71.540 | 0     | -1      | 0.00...  | 0.0011... | 0.0011... | 0           | 0            | 0           |
| 2  | rs392 | via1   | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 27.350 | 87.845 | 0     | -1      | 1.50...  | 6.4041... | 5.265...  | 0           | 0            | 0           |
| 3  | rg17  | mt3    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 45.020 | 89.059 | 1     | 31.5... | 0.00...  | 0.001...  | 0.0011... | 0           | 0            | 0           |
| 4  | rr645 | via... | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 30.100 | 78.480 | 0     | -1      | 1.95...  | 9.590...  | 8.863...  | 0           | 0            | 0           |
| 5  | rh43  | mt2    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 47.709 | 78.480 | 0.26  | 16.5... | 9.414... | 0.000...  | 1.0445... | 0           | 0            | 0           |
| 6  | rs400 | via1   | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 45.025 | 71.540 | 0     | -1      | 0.00...  | 0.0011... | 0.0011... | 0           | 0            | 0           |
| 7  | rs396 | via1   | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 30.095 | 71.540 | 0     | -1      | 0.00...  | 0.001...  | 0.001...  | 0           | 0            | 0           |
| 8  | ri123 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 39.280 | 87.350 | 0.26  | 154...  | 1.62...  | 1.6591... | 1.628...  | 0           | 0            | 0           |
| 9  | rr646 | via... | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 30.095 | 71.540 | 0     | -1      | 0.00...  | 0.001...  | 0.001...  | 0           | 0            | 0           |
| 10 | ri98  | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 27.631 | 95.436 | 0.5   | 14.5... | 1.507... | 6.4172... | 5.2717... | 0           | 0            | 0           |
| 11 | rh25  | mt2    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 27.510 | 88.145 | 1     | 0.92    | 1.50...  | 6.4076... | 5.266...  | 0           | 0            | 0           |
| 12 | ri104 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 41.000 | 93.460 | 0.26  | 154...  | 1.50...  | 1.5378... | 1.509...  | 0           | 0            | 0           |
| 13 | ri348 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 47.570 | 87.739 | 0.5   | 19.6... | 1.33...  | 1.0471... | 3.7675... | 0           | 0            | 0           |
| 14 | ri170 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 34.980 | 71.360 | 0.24  | 583...  | 0.00...  | 0.000...  | 0.000...  | 0           | 0            | 0           |
| 15 | ri122 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 39.280 | 89.820 | 0.26  | 154...  | 1.62...  | 1.6591... | 1.628...  | 0           | 0            | 0           |
| 16 | ri347 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 47.640 | 85.625 | 0.5   | 19.6... | 1.143... | 9.658...  | 3.1619... | 0           | 0            | 0           |
| 17 | ri101 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 41.000 | 83.580 | 0.26  | 154...  | 2.07...  | 2.1182... | 2.078...  | 0           | 0            | 0           |
| 18 | ri136 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 35.840 | 83.580 | 0.26  | 154...  | 4.151... | 4.228...  | 4.1518... | 0           | 0            | 0           |
| 19 | ri162 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 44.675 | 71.360 | 0.6   | 583...  | 0.00...  | 0.000...  | 0.000...  | 0           | 0            | 0           |
| 20 | ri157 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 46.160 | 68.020 | 0.12  | 583...  | 5.19...  | 5.459...  | 5.199...  | 0           | 0            | 0           |
| 21 | ri188 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 44.410 | 71.299 | 0.12  | 583...  | 0.00...  | 0.000...  | 0.000...  | 0           | 0            | 0           |
| 22 | ri192 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 44.440 | 60.610 | 0.12  | 583...  | 2.86...  | 2.9731... | 2.867...  | 0           | 0            | 0           |
| 23 | ri164 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 42.075 | 71.360 | 0.24  | 583...  | 0.00...  | 0.000...  | 0.000...  | 0           | 0            | 0           |
| 24 | ri309 | mt1    | VDD     | VDD#... | VDD#... | Metal | UnKnown           | NA        | NA        | NA        | NA         | 41.860 | 26.120 | 0.24  | 583...  | 3.61...  | 3.7438... | 3.613...  | 0           | 0            | 0           |

### Query Box Information for SHE Analysis

The following information is reported in the Query Box columns for SHE analysis query in addition to that displayed for EM analysis:

1. *feoI(T(C))*: The self-heating coupling temperature in degree Celsius.
2. *beoI(T(C))*: The temperature in degree Celsius caused by Joule heating and self-heating coupling.
3. *lavg\_sh(A)*: The average current of the resistor in ampere while performing SHE analysis.
4. *lavg\_sh\_max(A)*: The maximum average Current Density in ampere while performing SHE analysis.

### Query Box Information for RMS EM Hot Spot Waiving Analysis

The columns below are displayed when the RMS EM hot spot waiving analysis is enabled, which is a limited-access feature:

**Note:** The RMS EM hot spot waiving analysis, is a limited-access feature. To use this feature, contact your Cadence representative and explain your usage requirements.

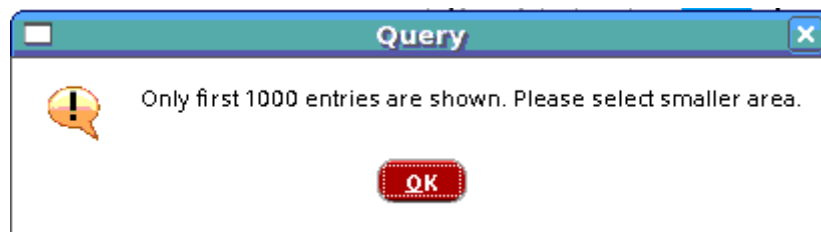
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1. *rms\_%fail*: The pass or fail percentage for RMS EM analysis
2. *avg\_%fail*: The pass or fail percentage for average EM analysis
3. *rms\_minW(um)*: The minimum width in micrometer required for the metal layer resistors to pass the RMS EM violation
4. *rmsT(C)*: The temperature of the resistor in degree Celsius caused by its own Joule heating
5. *jouleHeatT(C)*: The temperature of the resistor in degree Celsius caused by its own Joule heating and that of neighboring resistors
6. *Tmetal(C)*: The effective temperature of the resistor in degree Celsius, which also includes the temperature caused by Joule heating.
7. *PG\_wire*: Indicates whether or not supply net exists in the allowed range of the resistor
8. *rms\_waived*: Indicates whether or not RMS violation is waived

**Note:** The Query Box displays results for the first thousand entries at one time. If your query results in more than 1000 entries, the following pop-up box is displayed:



#### Important

When the *Query* check box is selected, the left mouse button is used to click a point or select an area in the layout. At this time, you cannot perform any other operation with the left mouse button. To use this button for any other layout operation, deselect the *Query* option.

### Highlighting Query Results in the layout

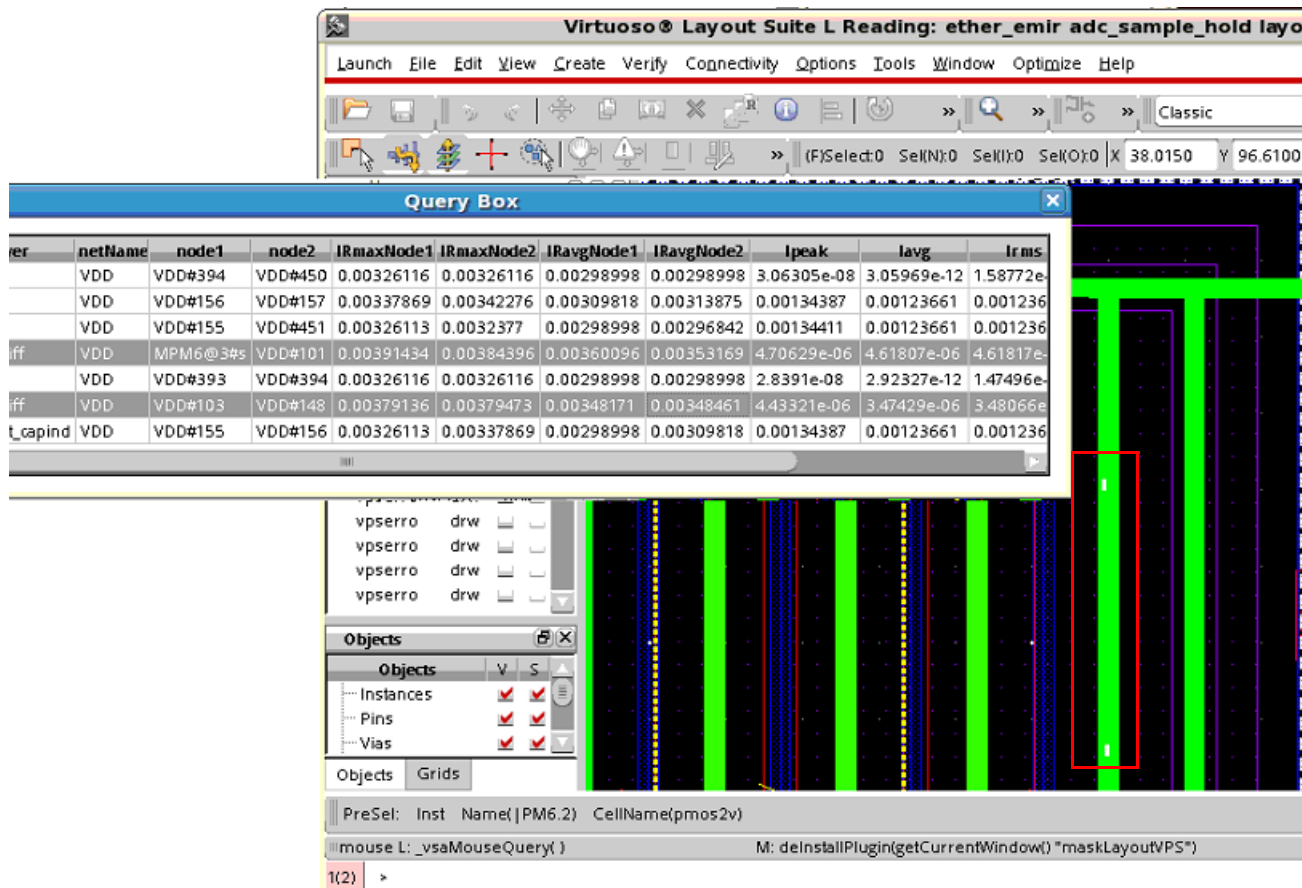
For the query results listed in the Query Box window, you can highlight the resistor in the layout. You can select multiple rows to highlight multiple resistors at the same time.

In the figure below, you can see the two resistors selected in the query box are highlighted in the layout in white. This is shown using a red text box for better visibility.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

Figure 7-15 Highlighting Query Results in the layout



### Saving the IR Drop Analysis Result Plots and Reports

The following options are provided for saving the plots and reports of IR drop analysis results:

- Click *Save Plot* to save a screen capture of the plot. When you click this button, the Export Image form opens. This form lets you take a screen capture of the plot displayed in the Virtuoso layout and save it to a standard image format. This form is shown below.



**Figure 7-16 Export Image Form**

**Export Image (window 2)**

**Export Region**

☒ Visible area  
☐ Entire design  
☐ Selected area:

**Size**

☒ Scale exported region by:    
☐ Custom: ☐ Maintain aspect ratio  
Width:   Height:

**Appearance**

☒ Full color ☐ Monochrome ☐ Bi-color ☐ Transparent background  
Background:  Foreground:

**Halos**

Style: ☒ Gradient ☐ Flat ☐ Scale with image size

**Output**

Name:  Type:      
☒ Close dialog after saving image

You can save images in any of these: BMP, JPG, PNG, PPM, XBM, and XPM. To specify the format, use the appropriate suffix with the filename. Note, however, that PNG is the recommended format; not all features are supported by the other formats.

**Note:** For more information about the settings that can be specified in this form, see “Screen Capture Functions” in the *Cadence® User Interface SKILL Reference* guide.

- Click *Save Report* to save the report for the analysis type as a text file. When the *Save Report* button is clicked, the Select report file dialog box opens. You can choose an

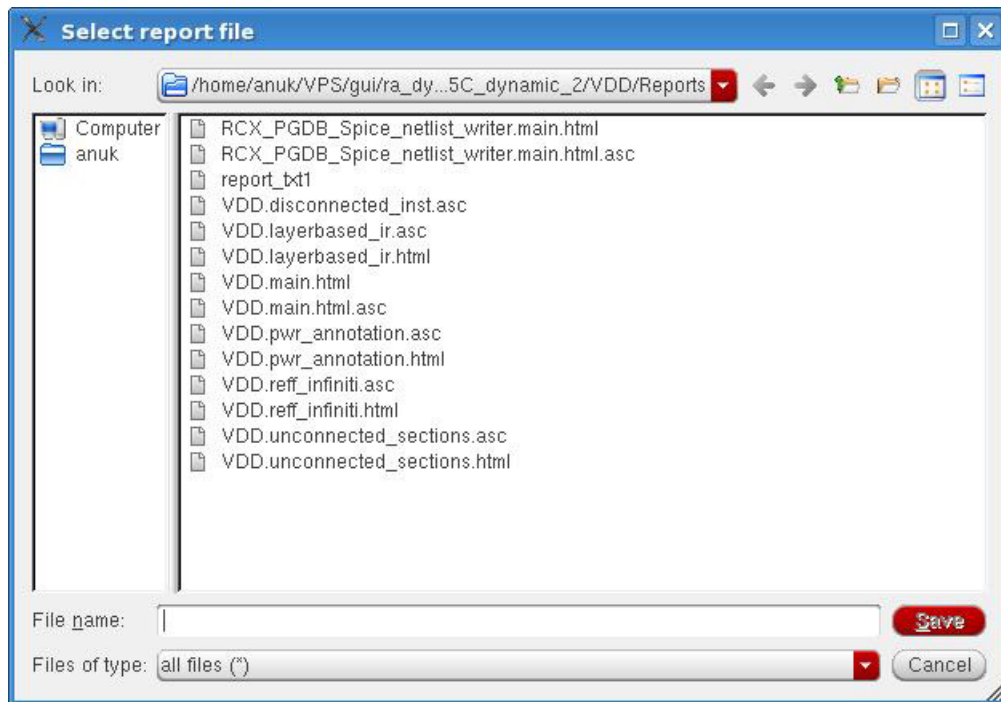


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### IR Drop Analysis Results

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existing file to save the report, or you can save the report in a new file. The dialog box is shown below.



**Note:** To save and print the report for all elements, leave the *Elements count* field empty and then select *Save Report*.

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### IR Drop Analysis Results

- Click *Open Report after Saving* to view the report in the text editor. A sample report for IR drop analysis that opens when you select this option and click *Save Report* is shown below.

**IR RESULTS**

BINARY FILE = /home/anuk/MMSIM\_EMIR\_WORKSHOP/emir\_simulation/aps.direct.raw/input/emir0\_bin  
 RESULTS FILE CREATED = 2019-Feb-18 06:04:45 (2019-Feb-18 14:04:45 GMT)  
 USER SUPPLIED VALUES:  
 RESULTS TYPE =  
 TRANSIENT START = 0  
 TRANSIENT STOP = 1.2e-07  
 SIM TEMPERATURE = 27 C

----- "VDD" NET: Vref = 2.5V -----

max

| Resistor | IR value   | Layer      | X1       | Y1       | X2       | Y2       | Res      | Length (u) | Width (u) | Ipeak (mA)  |
|----------|------------|------------|----------|----------|----------|----------|----------|------------|-----------|-------------|
| rww661   | 0.00713329 | mwires     | 37.56000 | 38.04000 | 37.56000 | 38.04000 | 0.001    | 0          | 1         | 0           |
| ru608    | 0.00713329 | cont_pdiff | 37.56000 | 38.04000 | 37.56000 | 47.92000 | 15       | 0          | 0         | 8.2601e-05  |
| ru607    | 0.00713329 | cont_pdiff | 37.56000 | 38.04000 | 37.56000 | 45.32000 | 0.789474 | 0          | 0         | 0.00175077  |
| ru606    | 0.00713329 | cont_pdiff | 37.56000 | 38.04000 | 37.56000 | 40.38000 | 0.789474 | 0          | 0         | 0.00939879  |
| ru605    | 0.00713329 | cont_pdiff | 37.56000 | 38.04000 | 37.56000 | 35.44000 | 0.789474 | 0          | 0         | 0.0105702   |
| ru604    | 0.00713329 | cont_pdiff | 37.56000 | 38.04000 | 37.56000 | 30.50000 | 0.789474 | 0          | 0         | 0.10152     |
| ri293    | 0.00713207 | mt1        | 37.56000 | 45.32000 | 37.56000 | 47.92000 | 1.73333  | 2.6        | 0.12      | 8.2601e-05  |
| ri292    | 0.00713193 | mt1        | 37.56000 | 40.38000 | 37.56000 | 45.32000 | 3.29333  | 4.94       | 0.12      | 0.00183337  |
| ri291    | 0.00712603 | mt1        | 37.56000 | 38.04000 | 37.56000 | 40.38000 | 0.039    | 2.34       | 0.12      | 0.0112322   |
| ri290    | 0.0071256  | mt1        | 37.56000 | 35.44000 | 37.56000 | 38.04000 | 0.043333 | 2.6        | 0.12      | 0.0112322   |
| ri289    | 0.00712512 | mt1        | 37.56000 | 30.50000 | 37.56000 | 35.44000 | 3.29333  | 4.94       | 0.12      | 0.0218023   |
| rww668   | 0.00711602 | mwires     | 35.84000 | 38.04000 | 35.84000 | 38.04000 | 0.001    | 0          | 1         | 0           |
| ru603    | 0.00711602 | cont_pdiff | 35.84000 | 38.04000 | 35.84000 | 47.92000 | 15       | 0          | 0         | 8.26195e-05 |
| ru602    | 0.00711602 | cont_pdiff | 35.84000 | 38.04000 | 35.84000 | 45.32000 | 0.789474 | 0          | 0         | 0.00175117  |
| ru601    | 0.00711602 | cont_pdiff | 35.84000 | 38.04000 | 35.84000 | 40.38000 | 0.789474 | 0          | 0         | 0.0094009   |
| ru600    | 0.00711602 | cont_pdiff | 35.84000 | 38.04000 | 35.84000 | 35.44000 | 0.789474 | 0          | 0         | 0.0105726   |
| ru599    | 0.00711602 | cont_pdiff | 35.84000 | 38.04000 | 35.84000 | 30.50000 | 0.789474 | 0          | 0         | 0.101543    |

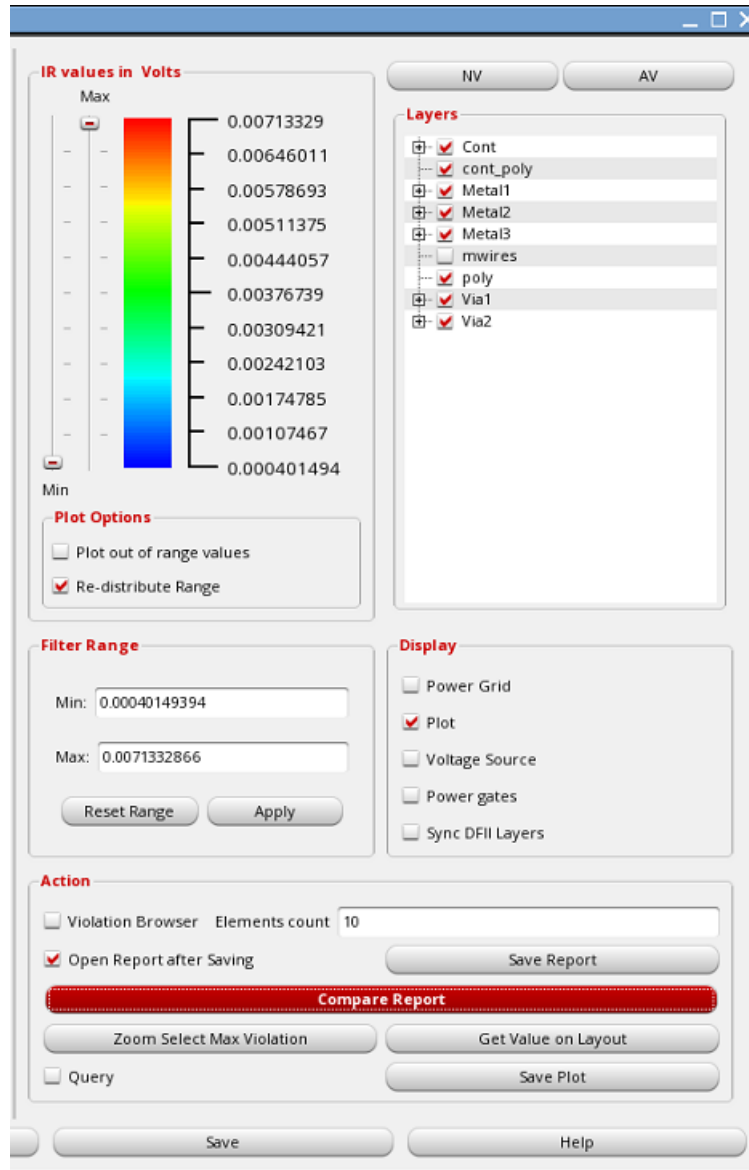
## Comparing Reports

The Display form provides an option to compare reports for different analysis types that are generated in the GUI and batch mode. For this, click *Compare Report* in the Display form.

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### IR Drop Analysis Results

Figure 7-17 Comparing Reports

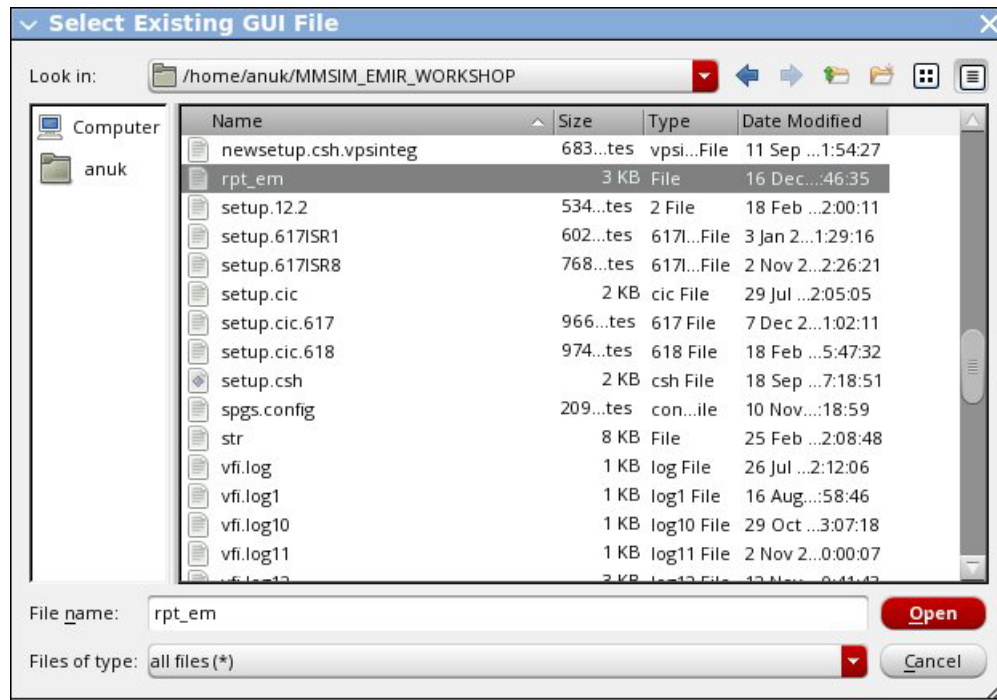


The pop-up window, *Compare Reports*, opens. In this window, you can perform the following tasks:

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### IR Drop Analysis Results

- Specify the path to the *GUI Report File* generated earlier. When you click the *Browse* button, the Select Existing GUI File pop-up window opens. Select an existing report file and click *Open*.

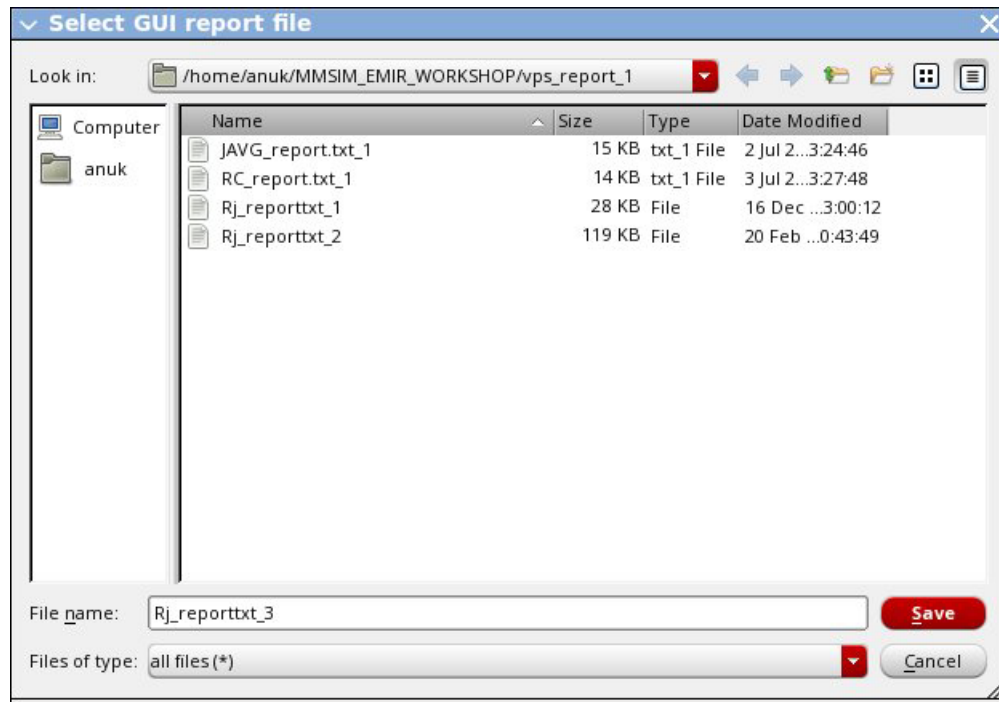


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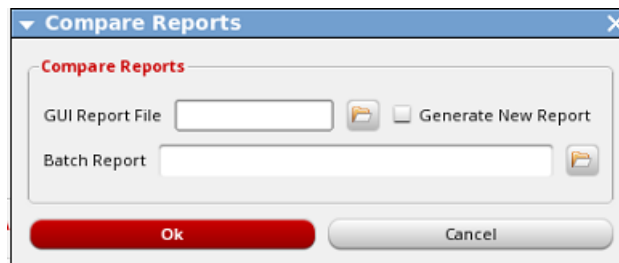
### IR Drop Analysis Results

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- Generate a new report for any plot. For this, first select *Generate New Report* and then use the Browse button. The Select GUI report file pop-up window opens. Provide the location and the name of the new report and click *Save*.

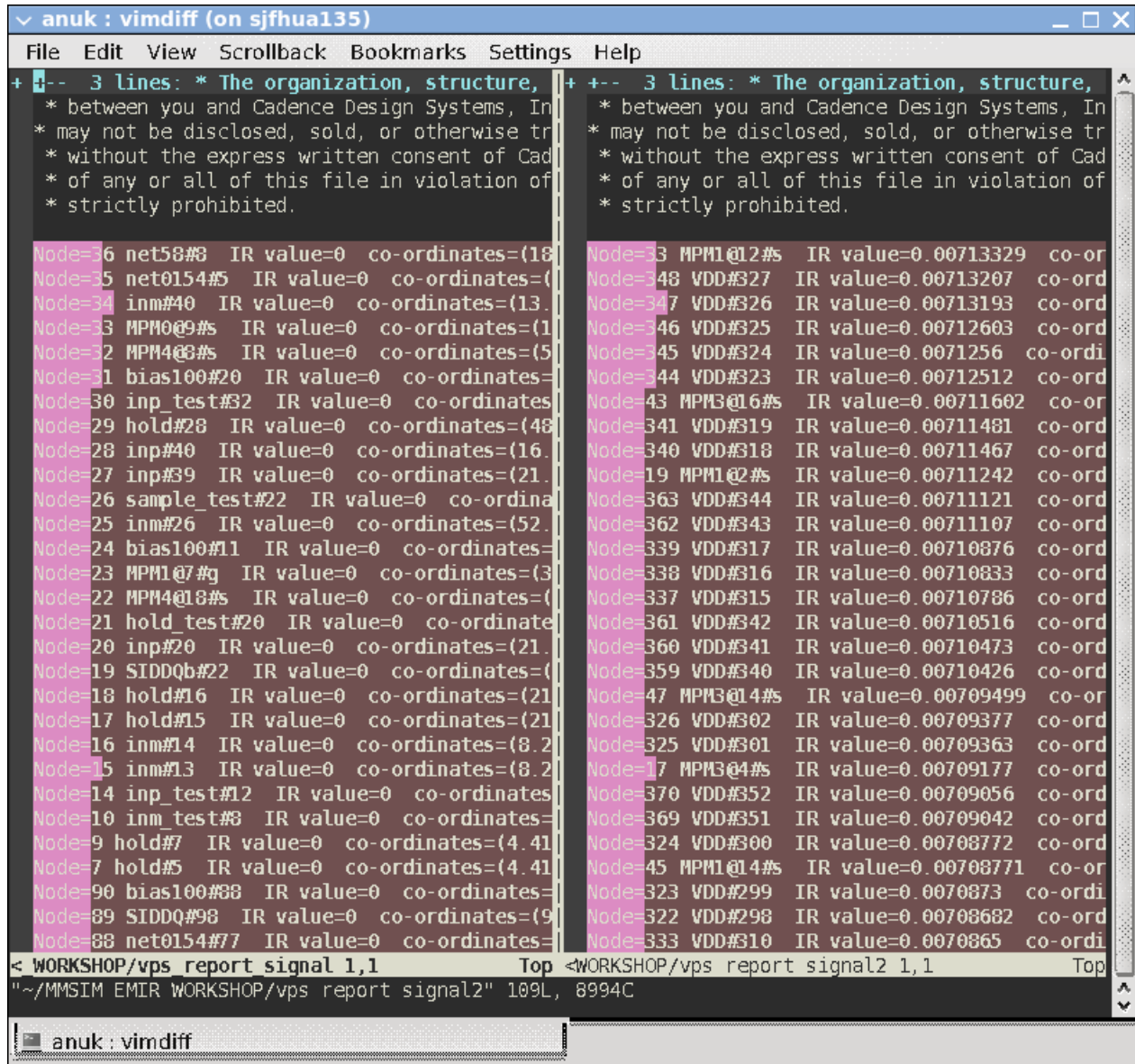


- Specify the path to the existing *Batch Report*. Click *OK*.



The vimdiff window opens. In this window, you can see the contents of the two reports next to each other for easy comparison. The figure below displays a vimdiff window comparing two signal violation reports.

**Figure 7-18 Viewing Reports in vimdiff**



## Types of IR Drop Analysis Plots

All rail analysis plots are available in the list in the *Rail Analysis* field in the IR/EM Results form.

Following types of IR drop analysis results plots are available:

- IR, IRAVG – IR Drop Plots

- RC, RCAVG, and RCRMS – Resistor Current Plots
- IV – Transistor Voltage Plot
- TC, TCAVG, TCRMS – Tap Current Plots
- POWER – Resistor Power Plots
- PI – Powergate Current Plot
- PV – Powergate Voltage Plot
- REffective – Effective Resistance Plot

## **IR, IRAVG – IR Drop Plots**

Analyzes and reports voltage drop. The IR drop plot is displayed on the Virtuoso layout. The IR drop data is saved inside the state directory or the simulation result file of the net. The worst case voltage drop can be displayed using the *Violation Browser* check box. The segments of the design with high IR drop can then be debugged.

There are two types of IR plots available in the list – **IR - IR Drop** and **IRAVG - IR Avg Drop**. The IR Drop plot displays the peak voltage drop while the IRAVG plot displays the average voltage drop.

**Note:** If in the `emir.conf` file in the bin directory, the `report_voltage` variable is set to true, the IR plots will display absolute voltage values instead of the IR drop values.

## **Information Displayed in Annotation Browser for IR Drop Analysis**

The EM/IR tab of Annotation Browser displays the following columns for this analysis type:

- Value
- Layers
- Short Message
- Net
- Time

The IR plot is shown in the Displaying and Querying EMIR Results section.

## **RC, RCAVG, and RCRMS – Resistor Current Plots**

Analyze and report resistor currents. After observing IR drop plots, the next step is to understand how the current flows in the design to create the generated IR drop plot. It is important to examine resistor currents (RC) plots because they exhibit behaviors that are not obvious from examining only IR drop plots. The RC plots show current-flow trends that you either might not have expected or current from several power pins reconverging in the middle of the chip to create high currents in some wires.

There are three types of RC plots available in the list – **RC - Resistor Current**, **RCAVG - Average Resistor Current**, and **RCRMS - RMS Resistor Current**.

**Note:** The **RC - Resistor Current** plot is available for all analysis types for both IR drop and EM analysis results (both for the `grcTechFile` and `emDataFile` flow).

**Note:** The **RCAVG** and **RCRMS** plots are available for all analysis types for viewing the IR drop results but only available in the `grcTechFile` flow and the EM Only ICT File flow for viewing the EM analysis results. These plots are not available in the `emDataFile` flow.

### **Information Displayed in Annotation Browser for RC Plot Types**

The EM/IR tab of Annotation Browser displays the following columns for RC - Peak, RCAVG, and RCRMS plot types:

- Value
- Layers
- Short Message
- Width
- Length
- Resistance
- Via Area
- Number of Vias

The plots shown below display peak and average resistor currents. The violation range is customized by using the *Min Max* sliders in the IR/EM Results form.



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### IR Drop Analysis Results

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Figure 7-19 RC – Peak Resistor Current Plot

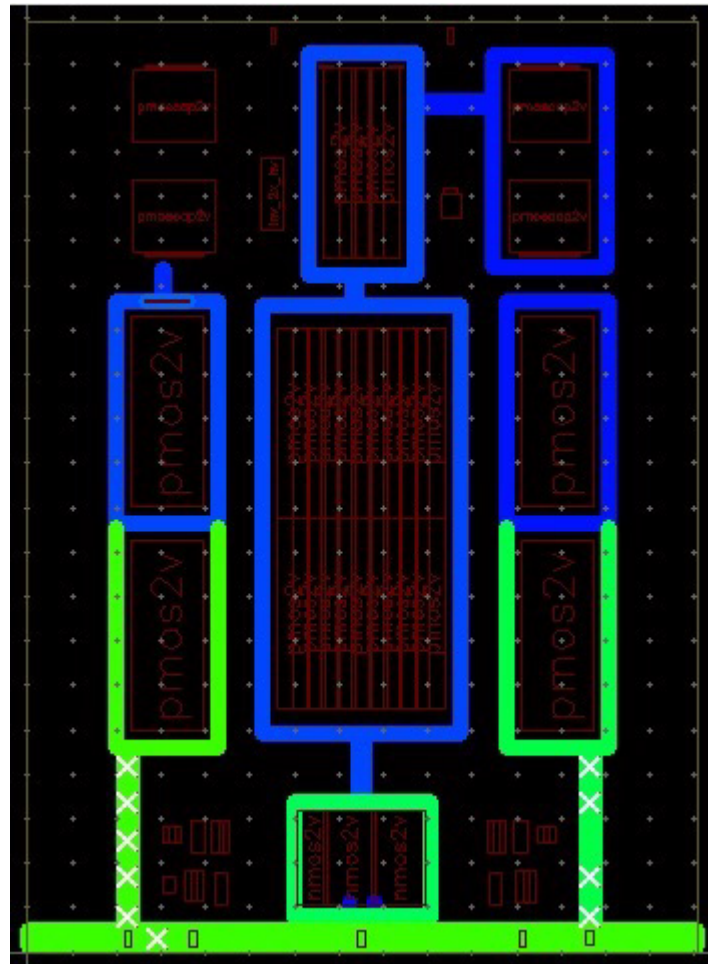
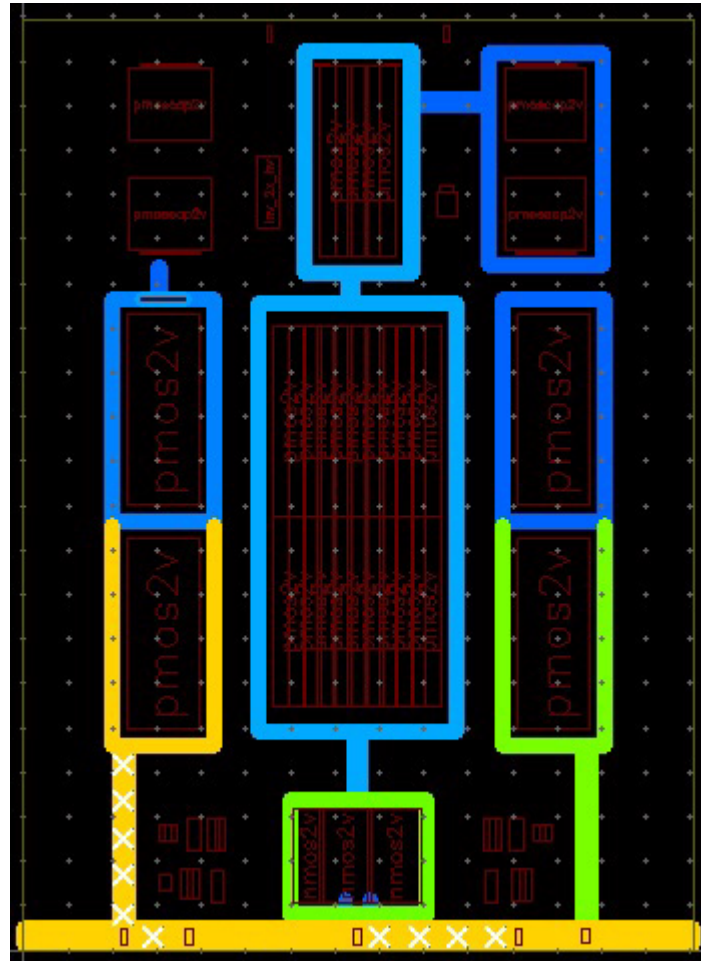


**Figure 7-20 Average Resistor Current Plot**



## IV – Transistor Voltage Plot

Analyzes and reports the voltage drop at device nodes, also known as tap nodes.

### Information Displayed in Annotation Browser for Transistor Voltage Plot Type

The EM/IR tab of Annotation Browser displays the following columns for transistor voltage plot type:

- Value
- Layers
- Short Message

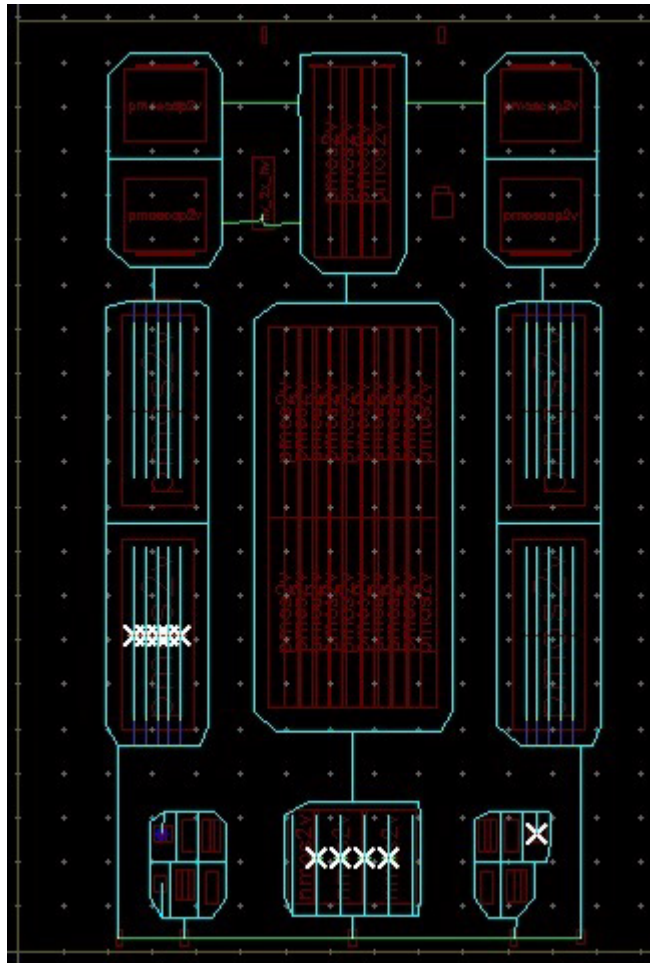
## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

- Net
- Time

This plot is shown below.

**Figure 7-21 Transistor Voltage Plot**



### TC, TCAVG, TCRMS – Tap Current Plots

Analyze and report tap currents. These plots show the current distribution inside the transistor. The power-grid library generation program characterizes the distribution of the current inside the transistor and replaces the devices connected to the power grid with current taps (sink). The relative distribution of the current inside the transistor power-grid view library is based on the device width and length.

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### IR Drop Analysis Results

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If an accurate power-grid view is used for the memories during rail analysis, the tap current plots clearly highlight the low current distribution in the transistor region and high power distribution in the sense amplifier and the decoder circuit of the memory.

There are three types of TC plots available in the list – **TC - Peak Tap Current**, **TCAVG - Average Tap Current**, and **TCRMS - RMS Tap Current**.

**Note:** Spectre simulation should be run with the `report_tapi=on` option specified in the EMIR configuration file to output the `rms`, `avg`, and `max` tap currents in the `.emir#_bin` simulation result file.

**Note:** The **TC - Peak Tap** Current plot is available for all analysis types for both IR drop and EM analysis results.

**Note:** The **TCAVG** and **TCRMS** plots are available for all analysis types for viewing the IR drop results but only available in the `qrcTechFile` flow and the EM Only ICT File flow for viewing the EM analysis results. These plots are not available in the `emDataFile` flow.

#### ***Information Displayed in Annotation Browser for Tap Current Plot Types***

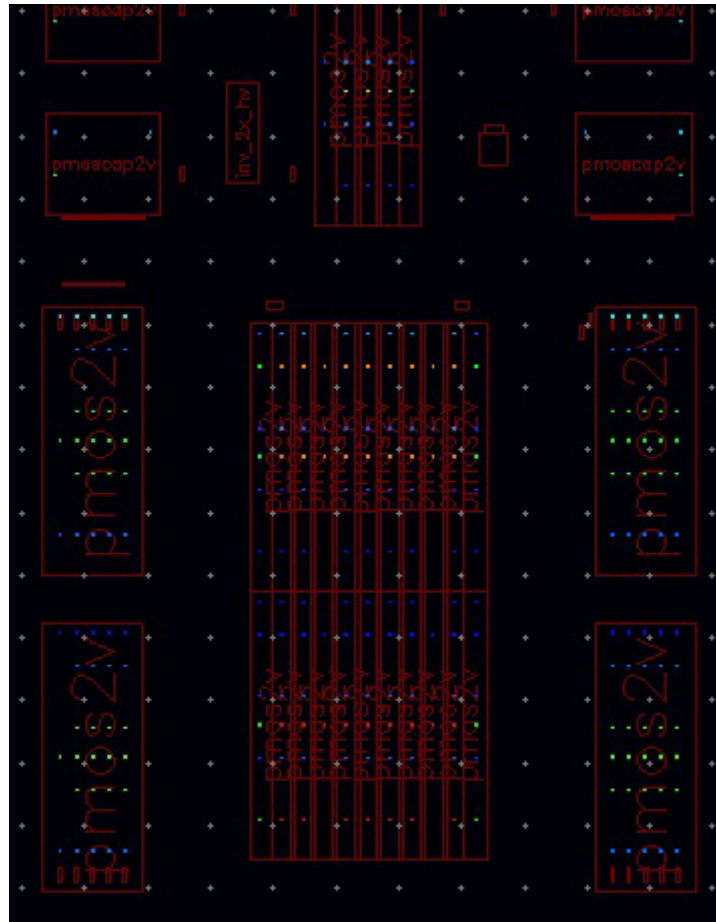
The EM/IR tab of Annotation Browser displays the following columns for TC - Peak, TCAVG, and TCRMS plot types:

- Value
- Layers
- Short Message
- Resistance
- Via Area
- Number of Vias
- Needed Number of Vias
- Net

**Note:** For details about the information displayed in the columns of Annotation Browser, see [Information Displayed in the EM/IR Tab of Annotation Browser](#).

The plot shown below displays peak tap currents. The violation range is customized by using the *Min Max* sliders in the IR/EM Results form. This plot is shown below.

**Figure 7-22 Peak Tap Current Plot for All Power Nets – Displaying Total Violation Range**



## POWER – Resistor Power Plots

Analyze and report resistor power, which is the value of current through a resistor multiplied by the voltage across the resistor.

### *Information Displayed in Annotation Browser for Resistor Power Plot Types*

The EM/IR tab of Annotation Browser displays the following columns for Resistor Power plot types:

- POWER Value
- Layers

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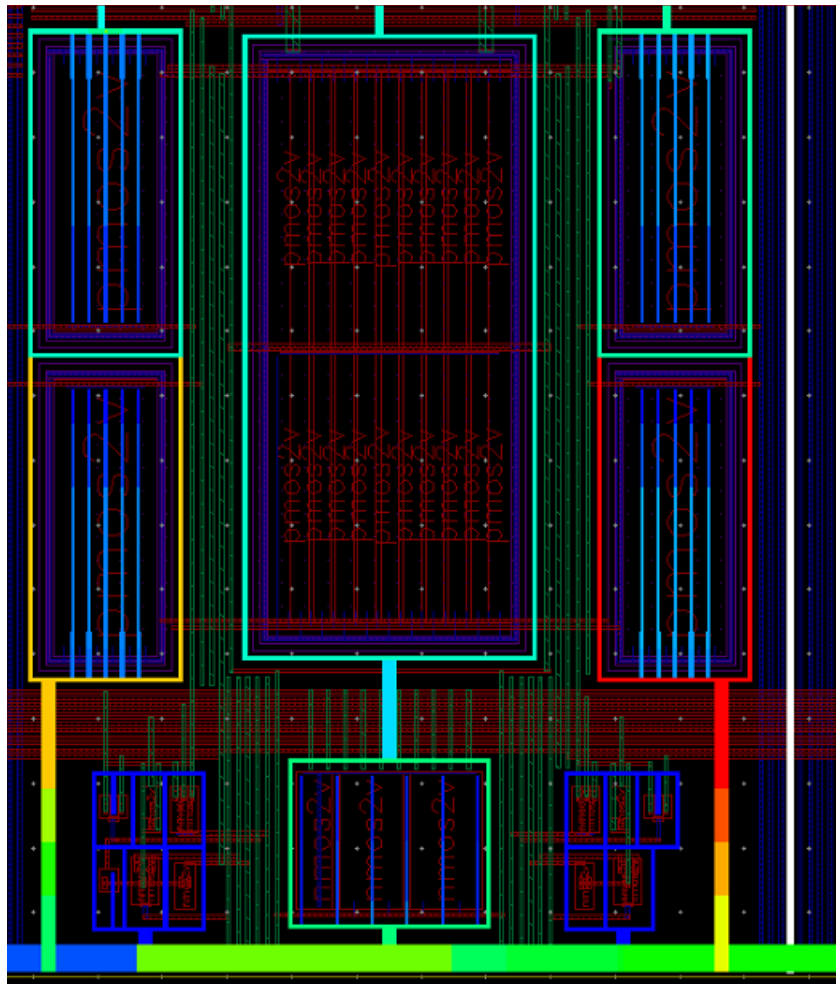
### IR Drop Analysis Results

- Short Message
- Resistance
- Length
- Width
- Via Area
- No. of Vias

**Note:** For details about the information displayed in the columns of Annotation Browser, see [Information Displayed in the EM/IR Tab of Annotation Browser](#).

The plot shown below displays resistor power plot for the top ten violations.

**Figure 7-23 Resistor Power Plot – Displaying Top Ten Violations**

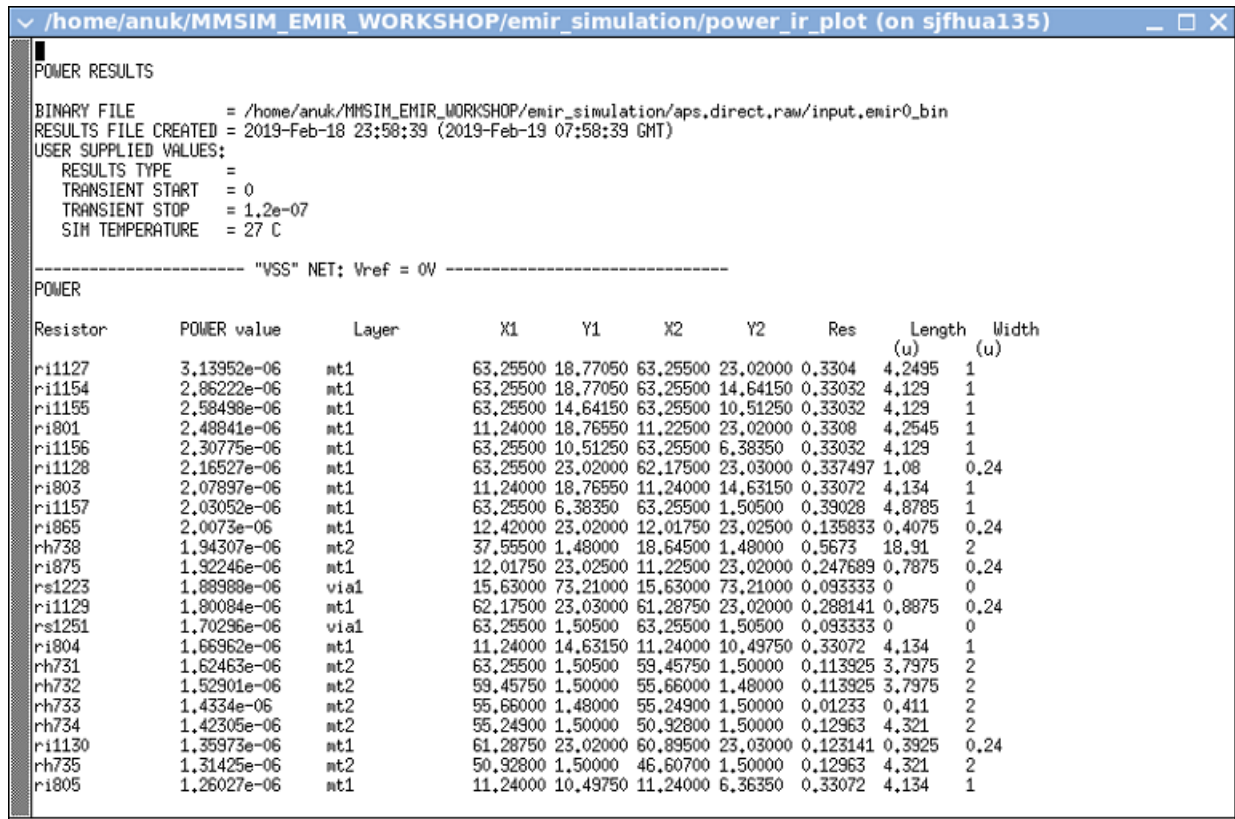


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### IR Drop Analysis Results

Click *Save Report* in the Display form to save the report for this plot. You can open the report for viewing. A sample report is shown below. The reporting for this plot is only supported in the GUI mode.

**Figure 7-24 Sample Report for Power - Resistor Power Plot**



```
POWER RESULTS
BINARY FILE = /home/anuk/MMSIM_EMIR_WORKSHOP/emir_simulation/aps.direct.raw/input.emir0_bin
RESULTS FILE CREATED = 2019-Feb-18 23:58:39 (2019-Feb-19 07:58:39 GMT)
USER SUPPLIED VALUES:
RESULTS TYPE =
TRANSIENT START = 0
TRANSIENT STOP = 1.2e-07
SIM TEMPERATURE = 27 C

----- "VSS" NET: Vref = 0V -----
POWER
```

| Resistor | POWER value | Layer | X1       | Y1       | X2       | Y2       | Res      | Length (u) | Width (u) |
|----------|-------------|-------|----------|----------|----------|----------|----------|------------|-----------|
| ri1127   | 3.13952e-06 | nt1   | 63,25500 | 18,77050 | 63,25500 | 23,02000 | 0,3304   | 4,2495     | 1         |
| ri1154   | 2,86222e-06 | nt1   | 63,25500 | 18,77050 | 63,25500 | 14,64150 | 0,33032  | 4,129      | 1         |
| ri1155   | 2,58498e-06 | nt1   | 63,25500 | 14,64150 | 63,25500 | 10,51250 | 0,33032  | 4,129      | 1         |
| ri801    | 2,48841e-06 | nt1   | 11,24000 | 18,76550 | 11,22500 | 23,02000 | 0,3308   | 4,2545     | 1         |
| ri1156   | 2,30775e-06 | nt1   | 63,25500 | 10,51250 | 63,25500 | 6,38350  | 0,33032  | 4,129      | 1         |
| ri1128   | 2,16527e-06 | nt1   | 63,25500 | 23,02000 | 62,17500 | 23,03000 | 0,337497 | 1,08       | 0,24      |
| ri803    | 2,07897e-06 | nt1   | 11,24000 | 18,76550 | 11,24000 | 14,63150 | 0,33072  | 4,134      | 1         |
| ri1157   | 2,03052e-06 | nt1   | 63,25500 | 6,38350  | 63,25500 | 1,50500  | 0,39028  | 4,8785     | 1         |
| ri865    | 2,0073e-06  | nt1   | 12,42000 | 23,02000 | 12,01750 | 23,02500 | 0,135833 | 0,4075     | 0,24      |
| rh738    | 1,94307e-06 | nt2   | 37,55500 | 1,48000  | 18,64500 | 1,48000  | 0,5673   | 18,91      | 2         |
| ri875    | 1,92246e-06 | nt1   | 12,01750 | 23,02500 | 11,22500 | 23,02000 | 0,247689 | 0,7875     | 0,24      |
| rs1223   | 1,88988e-06 | via1  | 15,63000 | 73,21000 | 15,63000 | 73,21000 | 0,093333 | 0          | 0         |
| ri1129   | 1,80084e-06 | nt1   | 62,17500 | 23,03000 | 61,28750 | 23,02000 | 0,288141 | 0,8875     | 0,24      |
| rs1251   | 1,70296e-06 | via1  | 63,25500 | 1,50500  | 63,25500 | 1,50500  | 0,093333 | 0          | 0         |
| ri804    | 1,68962e-06 | nt1   | 11,24000 | 14,63150 | 11,24000 | 10,49750 | 0,33072  | 4,134      | 1         |
| rh731    | 1,62463e-06 | nt2   | 63,25500 | 1,50500  | 59,45750 | 1,50000  | 0,113925 | 3,7975     | 2         |
| rh732    | 1,52901e-06 | nt2   | 59,45750 | 1,50000  | 55,66000 | 1,48000  | 0,113925 | 3,7975     | 2         |
| rh733    | 1,4334e-06  | nt2   | 55,66000 | 1,48000  | 55,24900 | 1,50000  | 0,01233  | 0,411      | 2         |
| rh734    | 1,42305e-06 | nt2   | 55,24900 | 1,50000  | 50,92800 | 1,50000  | 0,12963  | 4,321      | 2         |
| ri1130   | 1,35973e-06 | nt1   | 61,28750 | 23,02000 | 60,89500 | 23,03000 | 0,123141 | 0,3925     | 0,24      |
| rh735    | 1,31425e-06 | nt2   | 50,92800 | 1,50000  | 46,60700 | 1,50000  | 0,12963  | 4,321      | 2         |
| ri805    | 1,26027e-06 | nt1   | 11,24000 | 10,49750 | 11,24000 | 6,36350  | 0,33072  | 4,134      | 1         |

## PI – Powergate Current Plot

This plot is applicable only to power-gated design and analysis.

This plot displays the currents across resistors when power gates are connected. This plot is used to analyze whether the current through power gates exceeds the saturation current or not, and if it does, to debug such instances in the design. The saturation current and the on-resistance of the power switches are characterized and stored inside the power-grid library of the power-gate transistor.

### **Information Displayed in Annotation Browser for Powergate Plot Types**

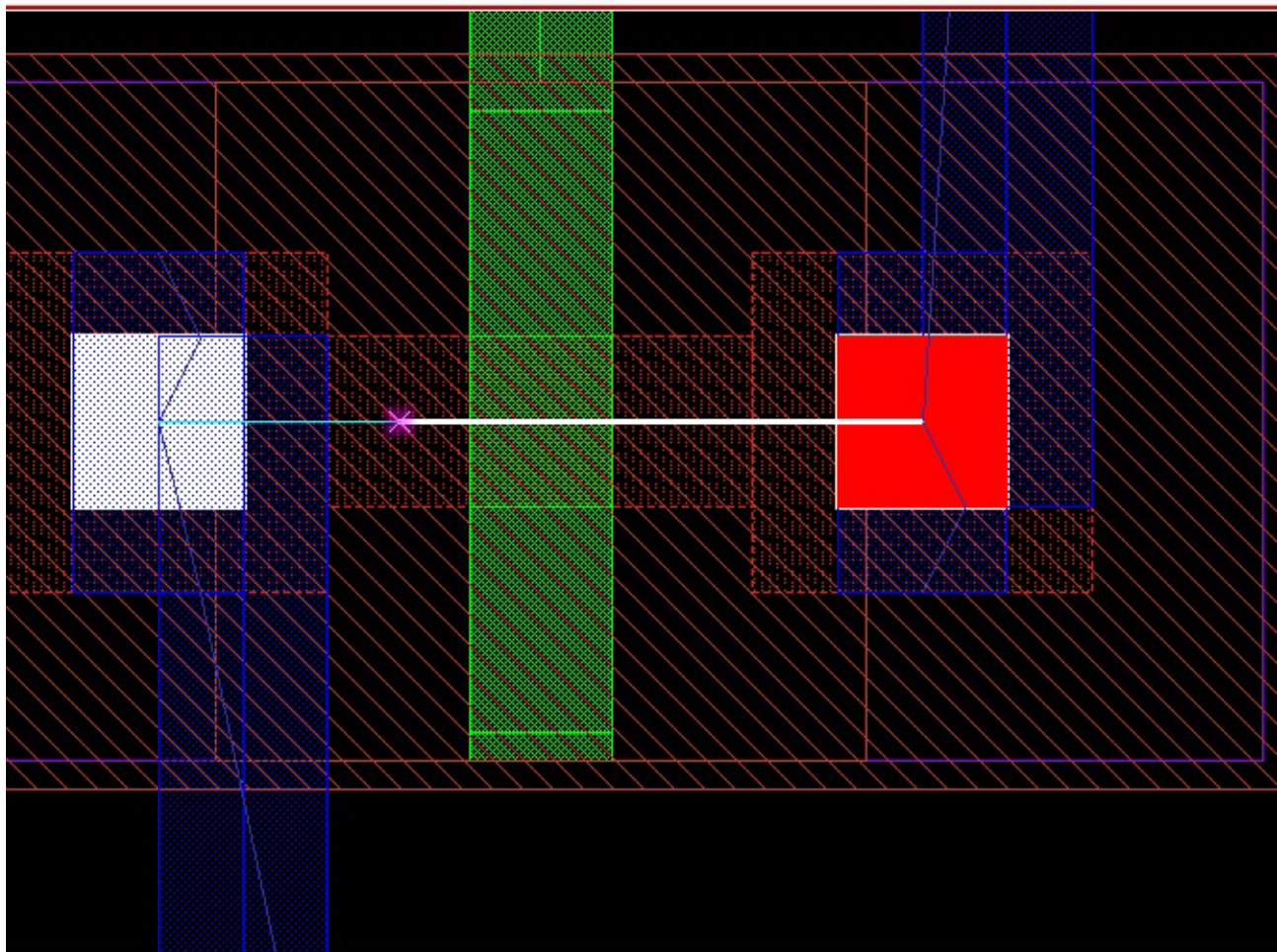
The EM/IR tab of Annotation Browser displays the following columns for both, powergate current and powergate voltage plot types:

- Value
- Layers
- Short Message
- Resistance
- Power Gate Transistor

This PI plot is shown below. In this plot, the resistor with the maximum current violation is zoomed into using the *Zoom Select Max Violation* option in the IR/EM Results form.



**Figure 7-25 Powergate Current Plot**



A sample PI report is shown below:

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

---

pi RESULTS

BINARY FILE = /vols/ssvrd\_t1\_010/nanduc/VPS/CCRs/ruchin\_pg\_case/vps\_pg\_design/header\_vpsml/output.pg/xps.emir0\_bin  
RESULTS FILE CREATED = 2013-Dec-03 23:17:20 (2013-Dec-04 07:17:20 GMT)

USER SUPPLIED VALUES:

RESULTS TYPE = TRANSIENT  
TRANSIENT START = 0  
TRANSIENT STOP = 3e-08  
SIM TEMPERATURE = 25 C

----- "VDDG" NET: Vref = 1.200000V -----  
max

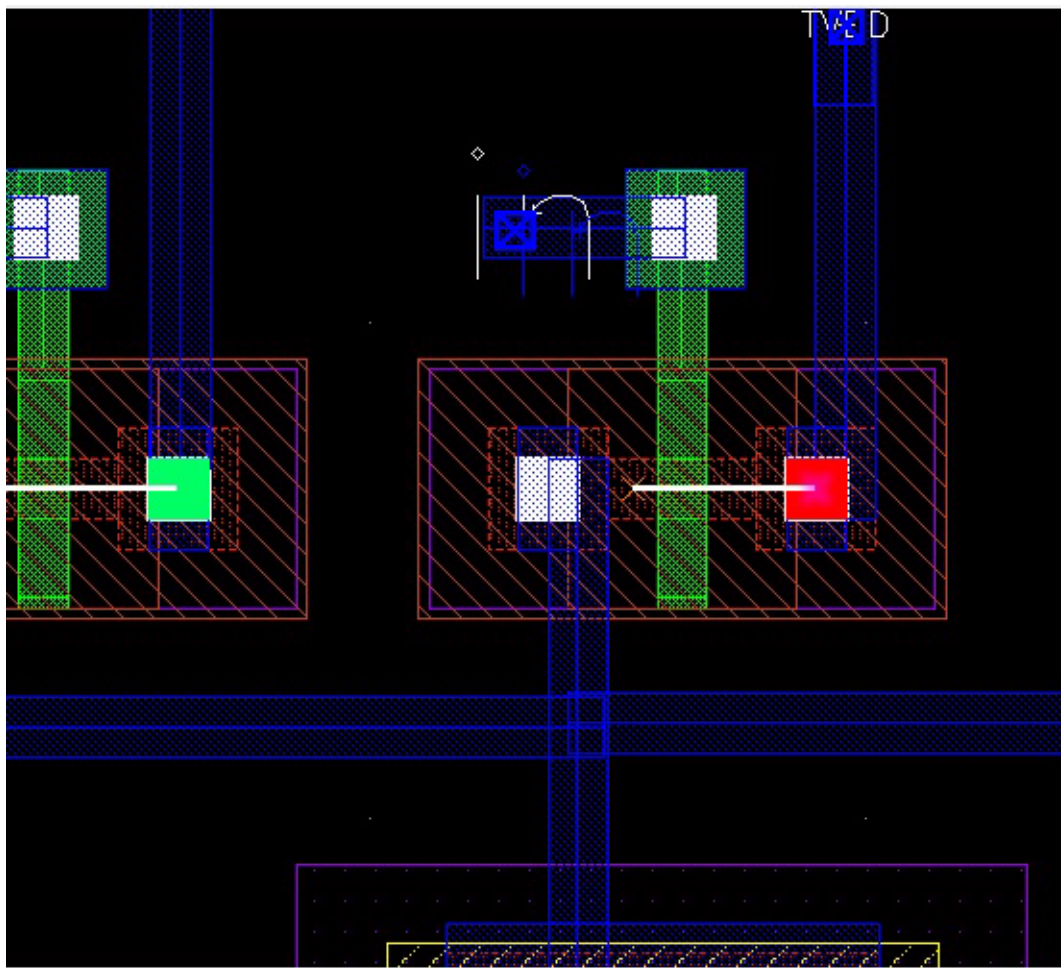
| Resistor | Idsat | pi Value    | Power Gate Transistor | X1       | Y1       | X2       | Y2       | Resistance |
|----------|-------|-------------|-----------------------|----------|----------|----------|----------|------------|
| rk167    | NA    | 4.906e-06   | XM16                  | 3.179000 | 4.335000 | 3.210000 | 4.335000 | 3.75       |
| rk166    | NA    | 4.90562e-06 | XM15                  | 3.179000 | 2.125000 | 3.210000 | 2.125000 | 3.75       |
| rk162    | NA    | 1.01019e-06 | XM10                  | 2.114000 | 1.260000 | 2.145000 | 1.260000 | 3.75       |
| rj159    | NA    | 1.00065e-06 | XM8                   | 1.759000 | 3.855000 | 1.790000 | 3.855000 | 3.75       |
| rk164    | NA    | 9.62062e-07 | XM13                  | 2.544000 | 0.395000 | 2.575000 | 0.395000 | 3.75       |
| rj157    | NA    | 9.5882e-07  | XM6                   | 1.049000 | 3.855000 | 1.080000 | 3.855000 | 3.75       |
| rj158    | NA    | 9.58674e-07 | XM7                   | 1.759000 | 2.555000 | 1.790000 | 2.555000 | 3.75       |
| rk165    | NA    | 9.58373e-07 | XM14                  | 3.179000 | 1.260000 | 3.210000 | 1.260000 | 3.75       |
| rk163    | NA    | 4.82571e-07 | XM11                  | 2.469000 | 2.125000 | 2.500000 | 2.125000 | 3.75       |
| rj156    | NA    | 4.7966e-07  | XM5                   | 1.049000 | 1.260000 | 1.080000 | 1.260000 | 3.75       |

## PV – Powergate Voltage Plot

This plot displays the IR drop across power-switch instances. This plot can be used to analyze and debug the regions of IR drop inside the power-gated block. For example, if the IR drop, across power gate is already high, the IR drop inside the power-gated block will be much higher. In this case, the power-gate placement will have to be refined or more power gates will have to be added to resolve the IR drop problem.

This plot is shown below.

**Figure 7-26 Powergate Voltage Plot**



A sample PV report is shown below:

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## IR Drop Analysis Results

---

pv RESULTS

BINARY FILE | = /vol/s/ssvrd\_t1\_010/nanduc/VPS/CCRs/ruchin\_pg\_case/vps\_pg\_design/output.pg/xps.emir0\_bin  
RESULTS FILE CREATED = 2013-Dec-03 23:18:03 (2013-Dec-04 07:18:03 GMT)

USER SUPPLIED VALUES:

RESULTS TYPE = TRANSIENT  
TRANSIENT START = 0  
TRANSIENT STOP = 3e-08  
SIM TEMPERATURE = 25 C

----- "VDDG" NET: Vref = 1.200000V -----  
max

| Resistor | Idsat | pv Value | Power | Gate Transistor | X1       | Y1       | X2       | Y2       | Resistance |
|----------|-------|----------|-------|-----------------|----------|----------|----------|----------|------------|
| rj159    | NA    | 0.51355  | XM8   |                 | 1.759000 | 3.855000 | 1.790000 | 3.855000 | 3.75       |
| rj157    | NA    | 0.513548 | XM6   |                 | 1.049000 | 3.855000 | 1.080000 | 3.855000 | 3.75       |
| rk167    | NA    | 0.513542 | XM16  |                 | 3.179000 | 4.335000 | 3.210000 | 4.335000 | 3.75       |
| rj158    | NA    | 0.513535 | XM7   |                 | 1.759000 | 2.555000 | 1.790000 | 2.555000 | 3.75       |
| rk164    | NA    | 0.51353  | XM13  |                 | 2.544000 | 0.395000 | 2.575000 | 0.395000 | 3.75       |
| rj156    | NA    | 0.513523 | XM5   |                 | 1.049000 | 1.260000 | 1.080000 | 1.260000 | 3.75       |
| rk162    | NA    | 0.513521 | XM10  |                 | 2.114000 | 1.260000 | 2.145000 | 1.260000 | 3.75       |
| rk163    | NA    | 0.51352  | XM11  |                 | 2.469000 | 2.125000 | 2.500000 | 2.125000 | 3.75       |
| rk165    | NA    | 0.513462 | XM14  |                 | 3.179000 | 1.260000 | 3.210000 | 1.260000 | 3.75       |
| rk166    | NA    | 0.513273 | XM15  |                 | 3.179000 | 2.125000 | 3.210000 | 2.125000 | 3.75       |

## REffective – Effective Resistance Plot

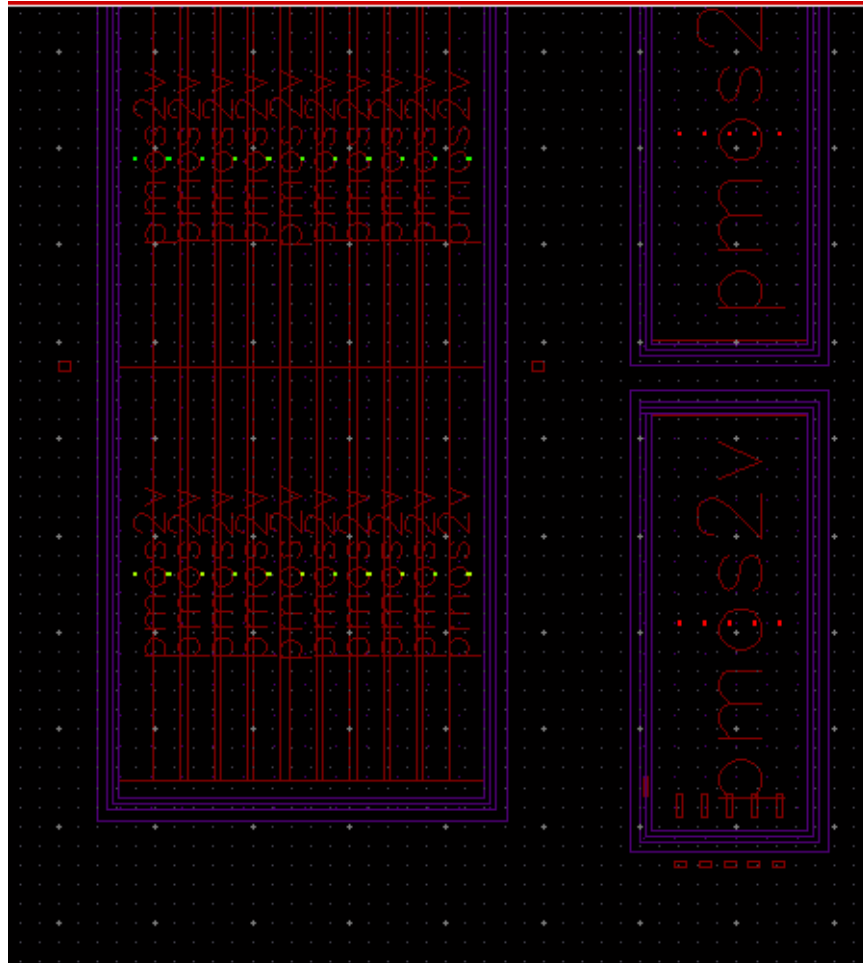
Uses the data generated by the static power grid solver (SPGS) to display the pin-to-node resistances on the Virtuoso layout. For more information about how resistances are calculated and reported by the SPGS, see the [Static Power Grid Solver](#) section.

In this plot type, you can also plot the least-resistive path for a net. For details, see [Plotting the Least-Resistive Path](#).

The effective resistance plot for all nets is shown below.



Figure 7-27 REffective Plot for All Nets



## Plotting the Least-Resistive Path

The least-resistive path (LRP) plot lets you identify weakly connected instances in the design during early stages of power planning. The resistance for an instance pin is calculated as the total resistance along the least resistance path. If an instance has multiple power pins connected to the power grid, the LRP plot uses the pin with the worst (highest) resistance value to plot the instance-based data. This plot highlights the current path for the selected instance to the voltage source. A long LRP usually results in high resistance and potentially high voltage drop.

In addition to identifying and displaying the worst IR drop violations, the LRP feature in Voltus-Fi-XL lets you plot LRP on demand for any node. You can view the LRP for any high IR drop node by selecting it in the layout. There are two options provided in the GUI, *Get Layout*

*Node* and *Get Marker Node*, to let you select a node on the GUI and view its LRP and to select an object in Annotation Browser and view the LRP for the node on the selected marker. For details, see [The LRP Browser](#) and [Displaying LRP for the Node on the Selected Marker](#), respectively.

## Batch Mode Support for LRP Analysis

The following batch commands is used for loading and printing RLRP analysis reports in Voltus-Fi-XL:

- `load_ir_results`  
Loads the IR drop analysis results
- `print_rlrp_report`  
Prints the RLRP analysis report

## Batch Mode Support for LRP Analysis

The following batch commands is used for loading and printing RLRP analysis reports in Voltus-Fi-XL:

- `load_ir_results`  
Loads the IR drop analysis results
- `print_rlrp_report`  
Prints the RLRP analysis report

### ***Tcl Commands:***

An example of the set of Tcl commands for loading and printing the LRP analysis reports is as follows:

```
load_ir_results\
./abc/raw.out/xps.emirtap.emir0_bin\
print_rlrp_report \
-net TVDD \
-filename RLRP.rpt \
-tap MavD7_1_unmatched#d \

```

The detailed description, syntax and examples of how to use these commands are provided in the [load\\_ir\\_results](#) section of the “Batch Mode Execution” chapter.

## GUI Support for LRP Analysis

The use model for LRP analysis is detailed below. To view the LRP plot for a net, perform the following steps after loading the IR drop analysis results:

- Click *Select Nets* to select the net for which you want to view the LRP plot.

**Note:** The LRP plot feature works for one net at a time. It can only be used in the “*Select Nets*” mode and not in the “*All Nets*” mode.

- Click *Show Plot*. The LRP Browser tab in the IR/EM Results form gets enabled. This is shown below.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## IR Drop Analysis Results

**Figure 7-28 IR/EM Results Form – Plotting the Least-Resistive Path**

**IR/EM Results**

IR EM Structural Analysis LRP Browser Pin2PinR What-If (ECO)

**Results**

State Directory/Results File: OP/emir\_simulation/aps.direct.raw/input.emir0\_bin

Shrink factor

QRC Run DFII Layermap WORKSHOP/df2layermap

Customize Display

Finer Gradient

Load Results Clear Results Power-up Report

**Net Plot**

Rail Analysis IR - IR Drop

Power Nets Signal Nets

All Nets

Select All Nets

| Net Type | Net Name |
|----------|----------|
| 1 power  | SIDDQ    |
| 2 power  | VDD      |
| 3 power  | VSS      |

Show Plot Clear Plot IR threshold (V) V Plot Powergate Nets

**IR values in Volts**

Max 0.0049619 0.00446571 0.00396952 0.00347333 0.00297714 0.00248095 0.00198476 0.00148857 0.00099238 0.00049619 0

Min

**Plot Options**

Plot out of range values

Re-distribute Range

**Filter Range**

Min: 0

Max: 0.0049619044

Reset Range Apply

**Display**

Power Grid

Plot

Voltage Source

Power gates

Sync DFII Layers

**Action**

Violation Browser Elements count 100

Open Report after Saving Save Report

Compare Report

Zoom Select Max Violation Get Value on Layout

Query Save Plot

Cancel Load Save Help

## The LRP Browser

The LRP Browser tab lets you specify nets, layers, and nodes for which you want to view the LRP plots. The various options provided for this are detailed below.

Voltus-Fi-XL provides support in the form of tips about the information to be filled out in the various fields in the LRP Browser form. This tooltip appears when you hover over a field in the form. This is shown below.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

Figure 7-29 Tooltips for LRP Browser Tab

**IR/EM Results**

IR EM Structural Analysis **LRP Browser** Pin2PinR What-If (ECO)

**LRP Paths**

Select Nets

|   | Net Type | Net Name |
|---|----------|----------|
| 1 | power    | SIDDQ    |
| 2 | power    | VDD      |
| 3 | power    | VSS      |

Layer: conn\_res Shorted Layers

Get Layout Node X Y Get Marker Node

Node Id Or Name Paths: 100

Node ID - Node Name P Value

Used to get a node from layout. Click this button and then click anywhere in virtuoso layout window. The node-name text-box will print the nearest node present in the clicked location. Also the layer name and x, y of the node will be shown. The LRP path of the selected node will be shown below.

To start, click the LRP Browser tab of the IR/EM Results form. The form shown below opens.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

**Figure 7-30 LRP Browser Tab of the IR/EM Results Form**

**IR/EM Results**

IR | EM | Structural Analysis | **LRP Browser** | Pin2PinR | What-If (ECO)

**LRP Paths**

Select Nets

| Net Type | Net Name |
|----------|----------|
| 1 power  | VDD      |
| 2 power  | VSS      |

Layer:

X:  Y:

Node Id Or Name:  Number Of Paths:

| Node ID - Node Name | LRP Value |
|---------------------|-----------|
| 31 - MPM4@14#d      | 10.3784   |
| 17 - MPM0@10#d      | 12.3248   |
| 377 - VSS#363       | 7.74764   |
| 55 - MPM0@8#d       | 9.11058   |

**Resistance Path**

| Res-Name | R val (Ohm) | V-drop (V) | Layer | Length (u) |
|----------|-------------|------------|-------|------------|
| 2 rh738  | 0.5673      | 0.0664884  | mt2   | 18.91      |
| 3 rs1253 | 0.093333    | 0.0701825  | via1  | 0          |

☐ Auto Zoom    ☐ segmentwise

There are two group boxes in this tab, the LRP Paths and Resistance Path.

- In the LRP Paths group box, specify the nets for which you want to perform the LRP analysis in the *Select Nets* field. The net selected in the IR tab is selected by default.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

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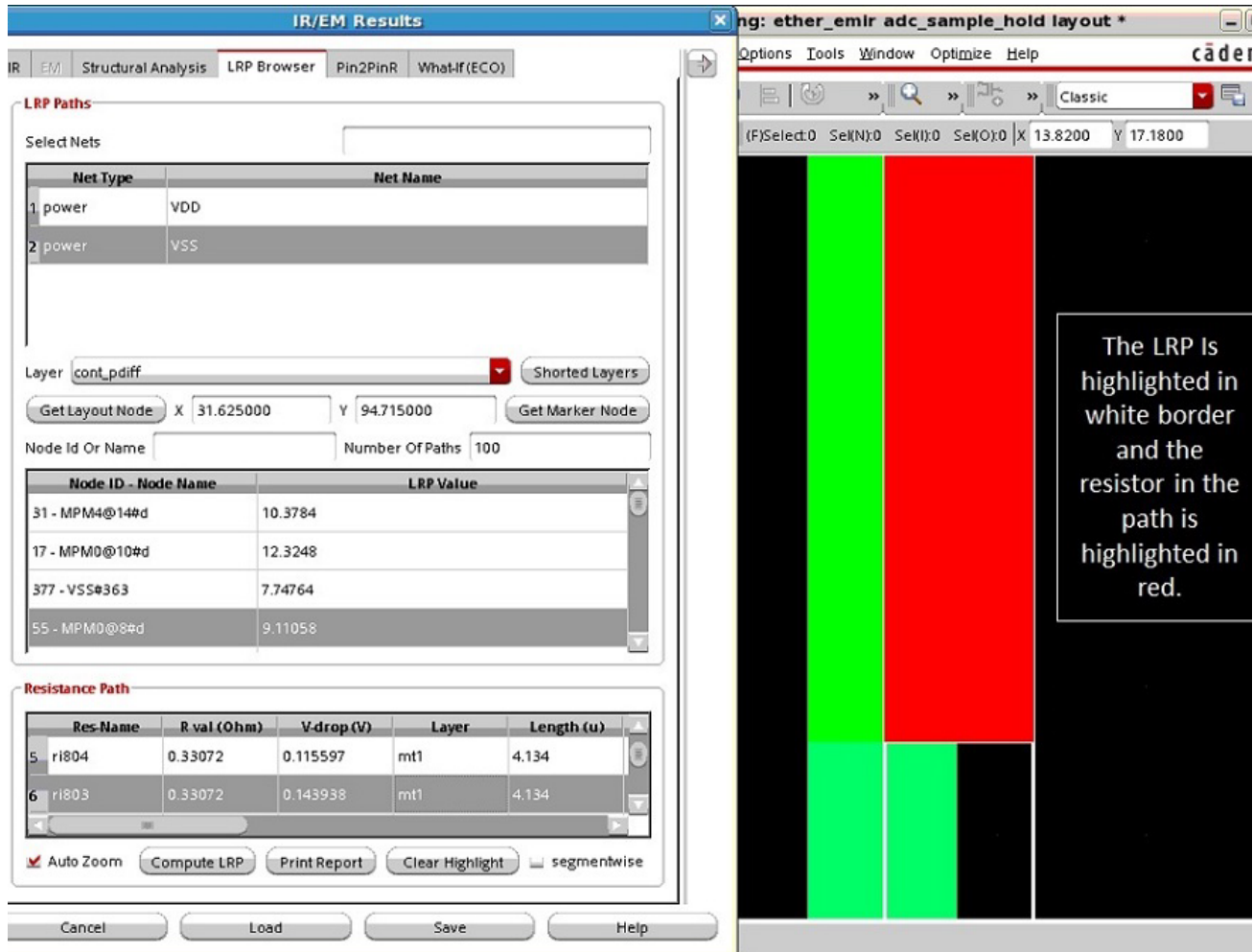
- Click *Compute LRP* to compute LRP values for all nodes of the selected net. The information is populated in the Node ID - Node Name and LRP Value columns of the table in the LRP Paths group box.
- Click *Shorted layers* to short specific layers for the LRP analysis. For details, see [Shorting Layers for LRP Analysis](#).
- Click *Get layout Node* to select a node in the layout. Click this button and then click anywhere in the Virtuoso layout window. The node-name text box will print information about the X- and Y- co-ordinates, and the *Layer* name for the node present nearest to the location of the click. The LRP path of the selected node will be shown in the table below.
- Click *Get Marker Node* to view the LRP values for a node, if present, on a selected marker. For this, enable Annotation Browser, select a marker and click this button. If the marker is associated with a node name, the LRP for the node will be shown in the table below. For details, see [Displaying LRP for the Node on the Selected Marker](#).
- Type the name of the node in the *Node Id or Name* to retrieve the LRP value for the specific node. Node names can be regular expressions, such as \*MPM shown in the figure above. The LRP table shows all nodes matching the regular expression. This saves time taken to scroll through the list of nodes to find information for a specific node.

**Note:** You can type the name of any node in this field, including a node that is not included in the list of violations. In this case, the table in the *Resistance Path* group box shows the information for the node of the selected net and the plot displays the LRP path.
- Specify the *Number of Paths* or the number of violations that you want to view. By default, top 100 violations are listed.
- The table shows the LRP for the selected net to all instances or nodes defined for the net in the *Node ID - Node Name* column and their corresponding LRP values in the *LRP Value* column. For each instance, the table shows the cumulative resistance on the path.
- Select an instance in the list to view its LRP in the layout. When an instance is clicked, the LRP path is highlighted in red in the Virtuoso layout. This is shown in below image.
- In the *Resistance Path* group box of the LRP Browser tab, you can view the list of resistors for a path. For details of the columns in the table, see [Resistance Path Group Box Table Information](#). Select *Auto Zoom* to automatically zoom to the resistor being selected in the path in the layout. The LRP path is highlighted with a white border and the resistor from the path is highlighted in red. This is shown below.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

**Figure 7-31 Least-Resistive Path for a Resistor Highlighted on the Virtuoso Layout**



**Note:** If the tables in the LRP browser tab do not show any entries, ensure the following:

- The selected net has at least one pin location or voltage-source location
- The selected net has nodes connected to it
- Click *Print Report* to print the LRP values of the specific resistors in a text file. The Select report file pop-up window opens. Specify the name of the report file and click *Save*. The report opens in the console. A sample report is shown in [Default Reports Generated for EMIR Analysis](#).
- Click *Clear Highlight* to clear the LRP highlighted in the layout.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

- Check *segmentwise* to view the combined resistance values for a layer in the Resistance Path table. When this option is enabled, all the resistors on a layer, metal or via, will be merged into one segment for the purpose of LRP reporting. In the image below, the resistors, rg12, rg13, and rg14 on layer, mt3 are shown in the Resistor Path table. This is the display when the *segmentwise* option is not selected.

Figure 7-32 Display of Resistor Paths

|    | Res-Name | LRP Val (Ohm) | V-drop (V) | Layer | Length (u) | Width (u) | %c. LRP (Ohm) | Acc. V-drop (V) | Current (A) | Acc. current (A) | Time (s) |
|----|----------|---------------|------------|-------|------------|-----------|---------------|-----------------|-------------|------------------|----------|
| 13 | rg12     | 0.032808      | 0.1093     | mt3   | 0.6395     | 1.17      | 0.120308      | 0.976067        | 0.0433183   | -0.587004        | 0        |
| 14 | rg13     | 0.165539      | 0.110721   | mt3   | 2.775      | 1         | 0.285847      | 1.08679         | 0.0433183   | -0.543686        | 0        |
| 15 | rg14     | 0.006654      | 0.117892   | mt3   | 0.1295     | 1.17      | 0.292501      | 1.20468         | 0.0389955   | -0.504691        | 0        |

Figure 7-33 Segment-wise Display of Resistor Paths

|   | Res-Name | LRP Val (Ohm) | V-drop (V) | Layer     | Length (u) | Width (u) | %c. LRP (Ohm) | Acc. V-drop (V) | Current (A) | Acc. current (A) | Time (s) |
|---|----------|---------------|------------|-----------|------------|-----------|---------------|-----------------|-------------|------------------|----------|
| 2 | segment  | 0.0875        | 0.10551    | via2_o... | 0          | 0         | 0.0875        | 0.866766        | 0.0433183   | -0.630323        | 0        |
| 3 | segment  | 1.88097       | 1.55195    | mt3       | 31.5135    | 1.17      | 1.96847       | 2.41871         | 0.437306    | -0.193016        | 0        |
| 4 | segment  | 0.175         | 0.190274   | via2_o... | 0          | 0         | 2.14347       | 2.60899         | -0.0388989  | -0.231915        | 0        |

In the above image, the resistors for the layer, mt3 are combined to display the resistor path for the segment. This is highlighted in red in the above image.

### Resistance Path Group Box Table Information

The Resistance Path table lists all resistors in the LRP path for the node selected in the Node ID - Node Name table. You can click any row to highlight the resistor in the layout window.

A part of the Resistance Path table is shown in the image below. The details of the column information is provided subsequently.

Figure 7-34 Information in the Resistance Path Table

| Resistance Path |          |               |            |       |            |           |               |                 |             |                  |          |
|-----------------|----------|---------------|------------|-------|------------|-----------|---------------|-----------------|-------------|------------------|----------|
|                 | Res-Name | LRP Val (Ohm) | V-drop (V) | Layer | Length (u) | Width (u) | %c. LRP (Ohm) | Acc. V-drop (V) | Current (A) | Acc. current (A) | Time (s) |
| 15              | rg14     | 0.006654      | 0.117892   | mt3   | 0.1295     | 1.17      | 0.292501      | 1.20468         | 0.0389955   | -0.504691        | 0        |
| 16              | rg15     | 0.248683      | 0.118152   | mt3   | 4.1445     | 1         | 0.541184      | 1.32283         | 0.0389955   | -0.465695        | 0        |
| 17              | rg16     | 0.25224       | 0.127849   | mt3   | 4.204      | 1         | 0.793424      | 1.45068         | 0.0389955   | -0.4267          | 0        |

☒ Auto Zoom

Compute LRP

Print Report

Clear Highlight

se

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

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It provides the following information:

- *Res Name*: Name of the resistor on the layer
- *R Val (Ohm)*: The resistance value of the resistor
- *V-Drop (V)*: The voltage drop across the resistor. This value increases as the path moves away from the pin.
- *Layer*: Name of the layer on which the resistor is located
- *Length (u)*: The length of the resistor in micron
- *Width (u)*: The width of the resistor in micron
- *Acc.R Val (ohm)*: The accumulative resistance value along the LRP path. This column displays the total resistance of all the resistors till this point in the path.
- *Acc.V Drop (V)*: The accumulative voltage drop along the LRP. This column displays the total voltage drop of all the resistors till this point in the path.
- *Current (A)*: The current across the resistor
- *Acc.Current (A)*: The accumulative current along the LRP till this point
- *Time*: The simulation time captured from the simulation result file
- *current-density (A/u)*: The Current Density across the resistor
- *Location (u)*: The location of the resistor
- *Voltage diff (V)*: The voltage difference at this resistor. It is the difference between the voltage drop between this resistor and the previous resistor.

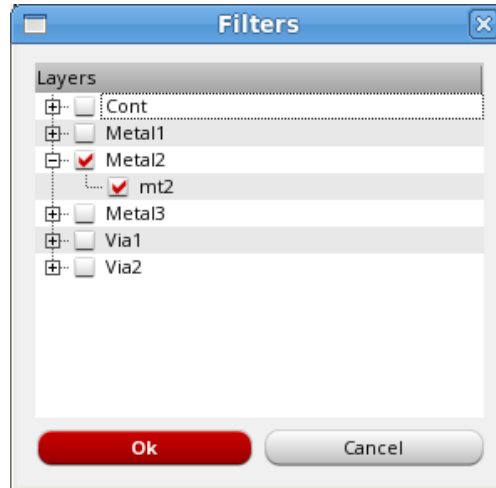
### Shorting Layers for LRP Analysis

While computing LRP for a node or instance, you can short specific layers. When you do this, all resistance on the specified layer is shorted, that means, the LRP display shows a value of 0 for all resistors on the shorted layer. This is shown in below images.

When you click *Shorted layers*, the *Filters* pop-up window opens. In this window, select the layer you want to short. You can short multiple layers.

For example, in the image below, layer `Meta12` is shorted.

**Figure 7-35 Specifying the layers to be shorted for the LRP Analysis**

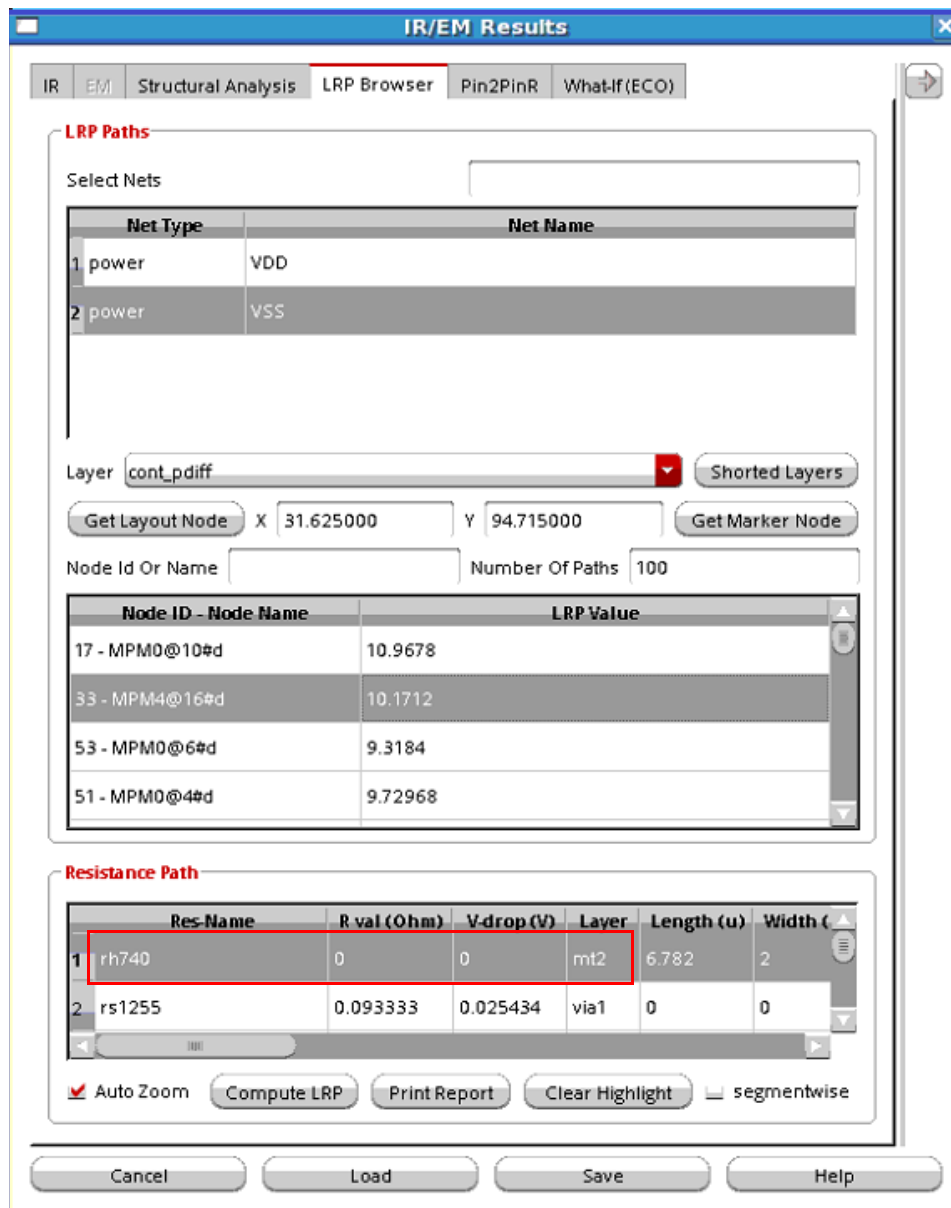


When a layer is shorted, the *Layer* information in the Resistance Path group box shows a value of 0 in the *R val (Ohm)* column for all resistors on that layer. For example, in the image below, the LRP value for resistor, *rh740* on layer, *m2* is 0.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

Figure 7-36 LRP Value for Resistors on the Shorted Layer



### Displaying LRP for the Node on the Selected Marker

You can display the LRP for a node on the selected marker in Annotation Browser. When you select a violation marker in the Browser, it is highlighted in the layout. If the marker is associated with a node name, you can view the LRP for the node. This is particularly useful when either REffective or the transistor voltage plot is being shown and you want to see the LRP for the selected marker node.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

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The steps are detailed below.

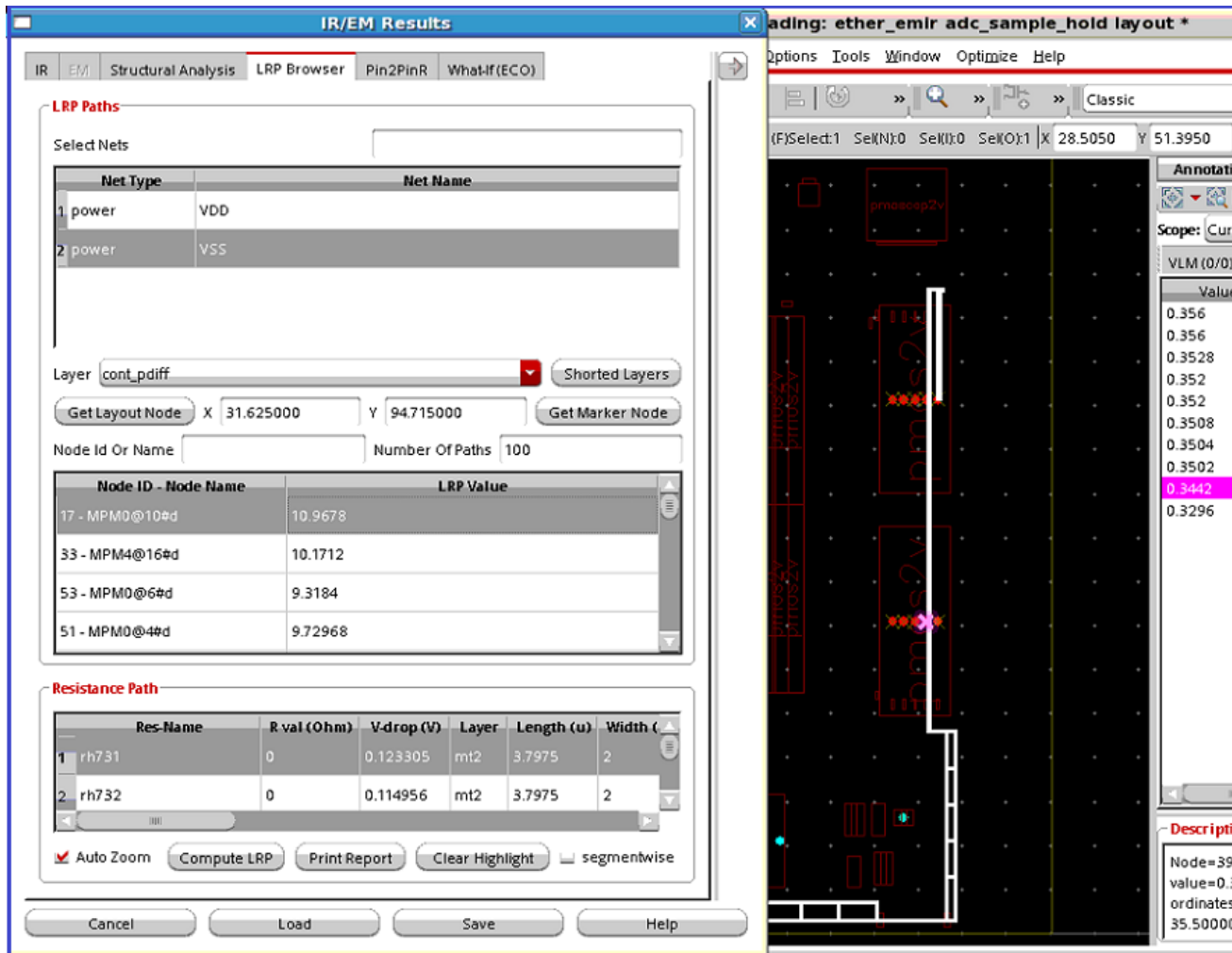
- In the IR tab, select *IV – Transistor Voltage* or *REffective – Effective Resistance* as the plot type and click *Show Plot*.
- In the Display form, select *Violation Browser*. The Annotation Browser window opens in the layout. Select a violation and the violation marker is displayed in the layout.
- In the LRP Browser tab, click *Get Marker Node*. The information for the node – the x- and y- co-ordinates and the layer name – on the marker is populated in the LRP browser tab.
- Click the node name in the LRP table and then click *Compute LRP* to compute the LRP value for the node and to view the least-resistive path for the node in the layout.

An example is shown below.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

Figure 7-37 Displaying LRP for the Node on the Selected Marker



### Supporting LRP Analysis in Power-Gated Designs

In Voltus-Fi-XL, you can view the LRP plot for power-gated designs. An always-ON net LRP plot shows LRP path for all nodes in the always-ON net as well as for all nodes connected to the switched net.

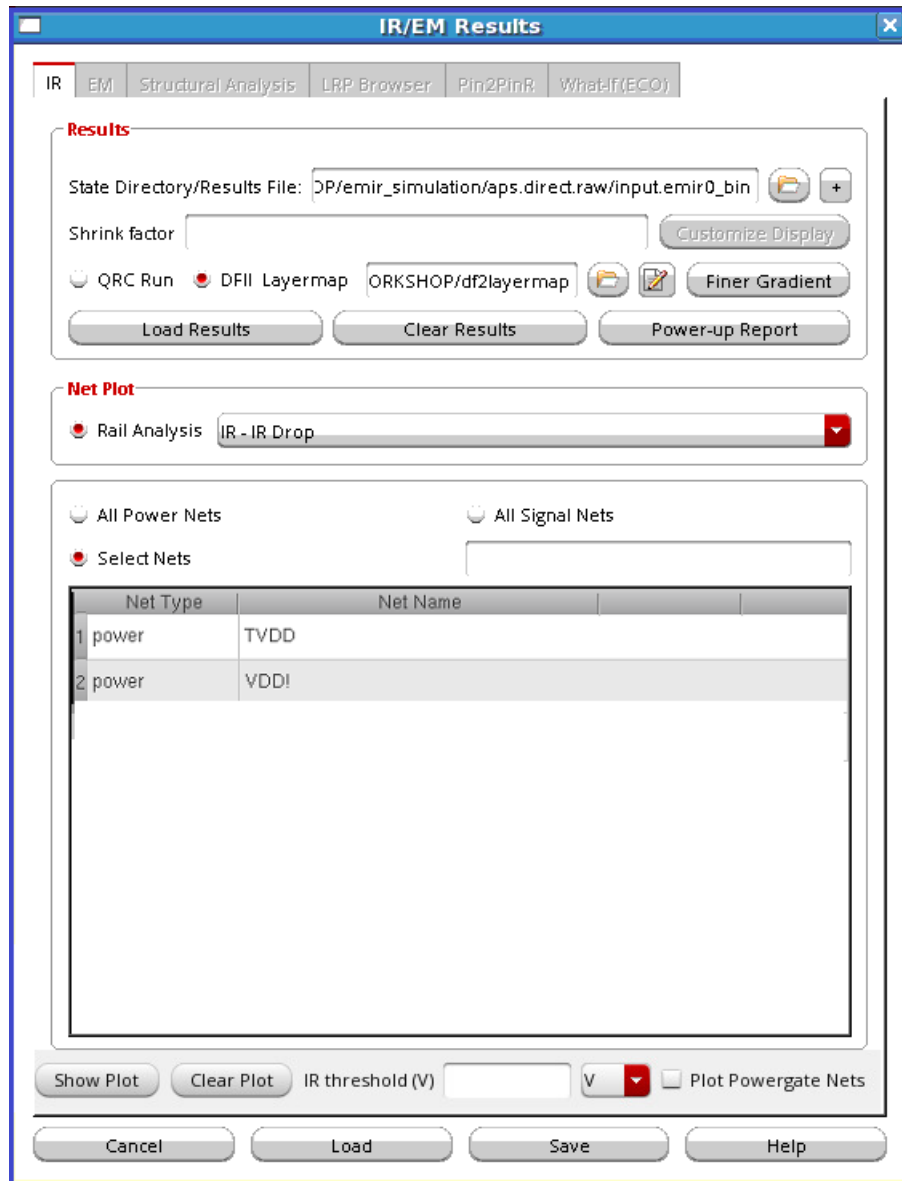
The steps performed to select the LRP analysis type in the IR/EM Results form are the same as those described in the previous section. In addition, select the always-ON net. For example, the net TVDD, shown below is an always-ON net.

**Note:** The net, VDD!, shown in below image, is a switched net.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

**Figure 7-38 Selecting the Always-On Net for Viewing the LRP**



Select the LRP Browser Tab. This is shown below.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### IR Drop Analysis Results

**Figure 7-39 LRP Browser Tab for Power-Gated Designs**

**IR/EM Results**

IR | EM | Structural Analysis | **LRP Browser** | Pin2PinR | What-If(ECO)

**LRP Paths**

Selected Nets:

|   | Net Type | Net Name |
|---|----------|----------|
| 1 | power    | TVDD     |
| 2 | power    | VDDI     |

Layer:  Shorted Layers

Get Layout Node X:  Y:  Get Marker Node

Node Id Or Name:  Number Of Paths:

| Node ID - Node Name | LRP Value |
|---------------------|-----------|
| 26 - MPM3@11#s      | 7.26605   |
| 3 - MPM1#s          | 7.74506   |
| 18 - MPM3@5#s       | 9.52016   |
| 5 - MPM3#s          | 9.64806   |

**Resistance Path**

|   | Res-Name | R val (Ohm) | V-drop (V) | Layer | Length (u) | Width (u) | Acc. R val |
|---|----------|-------------|------------|-------|------------|-----------|------------|
| 1 | rh55     | 0.129885    | 0.0129885  | mt2   | 4.3295     | 2         | 0.129885   |
| 2 | rh54     | 0.12987     | 0.0259755  | mt2   | 4.329      | 2         | 0.259755   |

☒ Auto Zoom Compute LRP Print Report Clear Highlight ☐ segmentwise

Cancel Load Save Help

In the above form, the *LRP Paths* group box displays the LRP values for the nodes connected to the always-ON net. It also shows the LRP values for the nodes connected to the switched net.

The table in the *Resistance Path* group box shows the resistance for the node selected in the LRP Paths table above.

**Note:** The resistance value of the resistor, " $r_{ON}$ ", is assumed to be zero ohms.

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### IR Drop Analysis Results

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#### Video

To view the demonstration on performing the LRP analysis in Voltus-Fi, see [Plotting the Least Resistive Path \(LRP\)](#) video.

**Note:** Access to this video will depend on the availability of a web browser and a Cadence Online Support account.

### LRP Reports

You can create RLRP reports in batch mode by using the [print\\_rlrp\\_report](#). You can also generate and view the report by using the *print report* option in the LRP Browser tab in the GUI. You can specify the name of the report file and click *Save*. The report opens in the console. A sample report is shown in [Default Reports Generated for EMIR Analysis](#).

## Calculating Effective Resistance between any Two Nodes on a Net

In Voltus-Fi-XL, you can calculate the effective resistance between any two nodes (pins, tap nodes, or subnodes), either on the same net or on different layers of the same net. This feature is supported both in the GUI and in batch mode.

This feature uses the DSPF file, used for Spectre simulation, and the SPGS feature of Spectre. It works only for IR drop analysis. For more information about the SPGS flow, see [Static Power Grid Solver](#).

**Note:** To run this feature, it is recommended that you use MMSIM/Spectre 15.1.0 ISRx and later versions.

### Batch Mode Support for Calculating Effective Resistance

The following batch commands are used for calculating the effective resistance between nodes in Voltus-Fi-XL:

- `load_ir_results`  
Loads the IR drop analysis results
- `pin_2_pin_res`  
Calculates the effective resistance between any two nodes

#### ***Tcl Commands:***

An example of the set of Tcl commands for reporting the effective resistance between two nodes is as follows:

```
load_ir_results \
./abc/raw.out/xps.emirtap.emir0_bin

pin_2_pin_res \
-xdspf abc/raw.out/abc_sample.dspf \
-x1 83.40 \
-y1 34.205 \
-x2 83.40 \
-y2 35.205 \
-layer1 mt1 \
-layer2 mt2 \
```

-net VDD

For details, see the [load ir results](#) in the “Batch Mode Execution” chapter.

## GUI Support for Calculating Effective Resistance

In the GUI mode, this feature is enabled through the *Pin2PinR* tab provided in the IR/EM Results form. By default, this tab is disabled. To enable this tab, perform the following steps:

- Select the IR tab.
- Load the IR drop analysis results.
- Select a net and click Show Plot.

The *Pin2PinR* tab is enabled. This is shown below.

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## IR Drop Analysis Results

**Figure 7-40 IR/EM Results form – Pin2PinR Tab**

The screenshot shows the 'IR/EM Results' window with the 'Pin2PinR' tab selected. The 'Net' field is set to 'VDD'. The 'xDSPF File' field is empty. Under 'Node 1', X is 34.670000 and Y is 57.500000, with Layer set to 'mt1'. Under 'Node 2', X is 29.765000 and Y is 53.025000, with Layer set to 'mt1'. A table below shows data for Node 1 and Node 2. The right panel includes a color scale for IR values in Volts, ranging from 0.0004014 to 0.00713329. It also has 'Plot Options' (Plot out of range values, Re-distribute Range), 'Filter Range' (Min: 0.00040149394, Max: 0.0071332866), 'Display' settings (Power Grid, Plot, Voltage Source, Power gates, Sync DFI Layers), and 'Action' buttons (Violation Browser, Open Report after Saving, Save Report, Compare Report, Zoom Select Max Violation, Get Value on Layout, Query, Save Plot).

To calculate effective resistance between two nodes on a net, provide the following information on this tab:

- On the *Pin2PinR* tab, the *Net* field is populated with the name of the net selected in the *IR* tab. You can change your selection of nets in the *Layers* group box.
- Specify the *xDSPF File*, which was used for Spectre simulation.
- In the *Node 1* group box, provide the following information for the first node for which resistance is to be calculated:
  - ❑ Select the *Layer* on which you want to calculate the node's resistance from the list. By default, this field is populated with the name of the layer selected in the Display



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### IR Drop Analysis Results

form. If multiple layers are selected in the Display form, all the layer names will appear in the list.

- ❑ Specify the *X* and *Y* co-ordinates for the node. You can type the co-ordinates in the *X* and *Y* fields. Alternatively, you can get the co-ordinates from the layout. For this, first click *Get X Y* and then select a point on the specified layer in the layout. The co-ordinates of this point are populated in the *X* and *Y* fields. If there is no node on the specified point, the tool will locate the node nearest to the specified point and populate its location in the *X* and *Y* fields.

- In the *Node 2* group box, provide the same information as above for the second node.

**Note:** You can choose a node either on the same layer or on a different layer.

- Click *Add Data* to add the location of the two nodes in the table provided in the form. You can add multiple pairs of co-ordinates in the table.
- Click *Run* to calculate the effective resistance between the specified nodes. The table is updated with the effective resistance between the node pairs. This is shown in the figure below.

**Note:** After the run, the effective resistance values are also written in the log file, `vfi.log`.

**Figure 7-41 Effective Resistance Information Displayed in the Table**

|   | X1:Y1,Layer                    | X2:Y2,Layer                    | Reffective▲ | Node1   | Node2   | Node1 X:Y   | Node2 X:Y   |
|---|--------------------------------|--------------------------------|-------------|---------|---------|-------------|-------------|
| 1 | 34.470000:76.045000,mt1-Metal1 | 24.235000:82.075000,mt2-Metal2 | 1.44033     | VSS#362 | VSS#288 | 36740:76190 | 26650:82180 |
| 2 | 43.730000:77.305000,mt1-Metal1 | 25.920000:81.935000,mt2-Metal2 | 1.4703      | VSS#398 | VSS#287 | 42388:76190 | 27350:82270 |

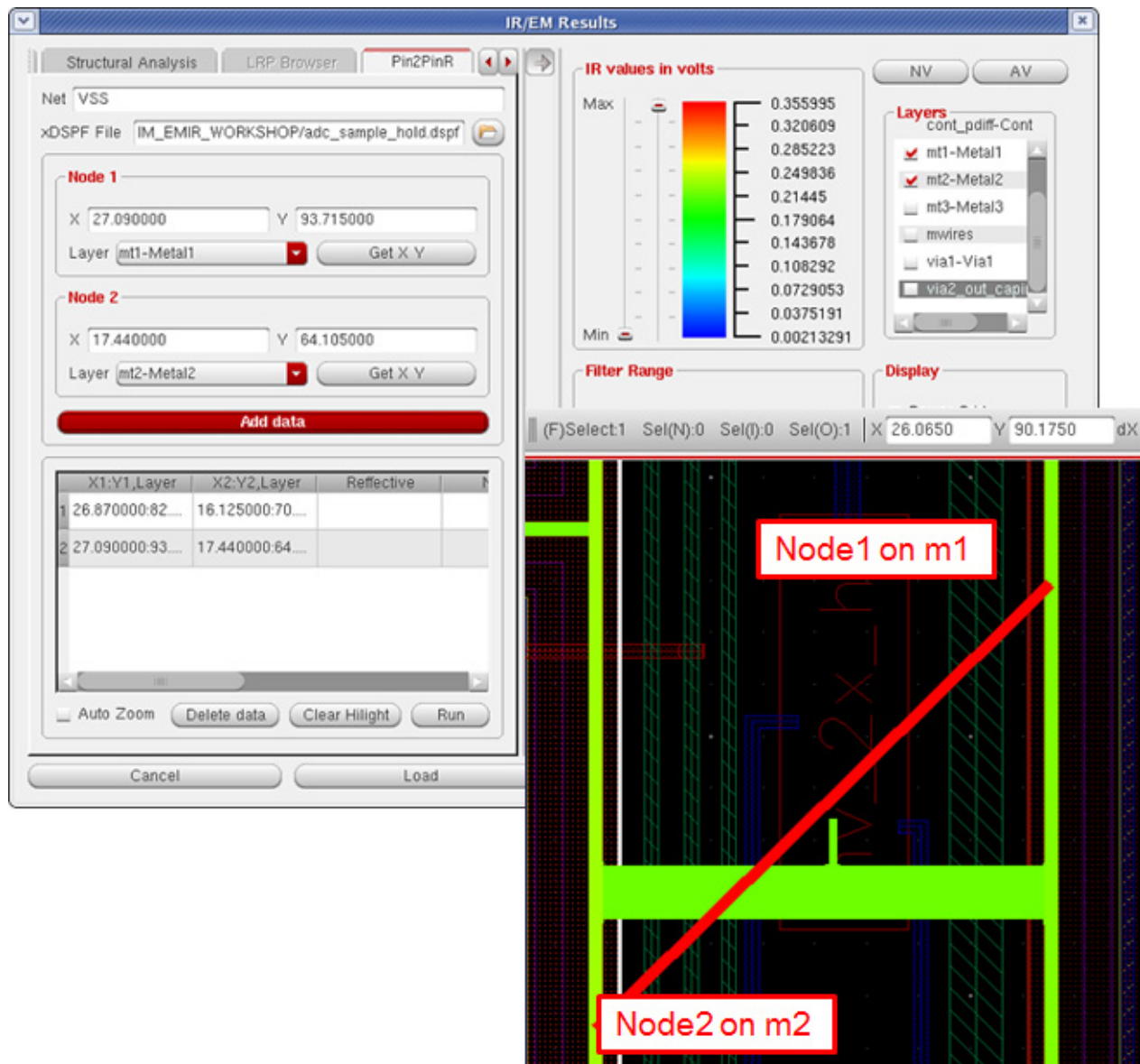
- To highlight the effective resistance path in the layout after the run, select the row for which you want to calculate effective resistance in the table.

This is shown in below image. In the image, the effective resistance path between Node 1 specified on layer, m1 and Node 2 specified on layer, m2 is highlighted in red.

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Figure 7-42 Effective Resistance Path Highlighted in the layout



- Select *Auto Zoom* to automatically zoom into the highlighted path in the layout when a row is selected in the table.
- Click *Delete data* to delete the data added in any row in the table.
- Click *Clear Highlight* to clear the highlighted path in the layout.

## Video

To view the demonstration performing pin-to-pin resistance check in Voltus-Fi, see [Calculating Effective Resistance between any Two Nodes on a Net](#) video.

**Note:** Access to this video will depend on the availability of a web browser and a Cadence Online Support account.

## Generating EMIR Analysis Reports in Voltus-Fi-XL

The following topics are covered in this section:

- [Reports Generated Using the EMIR Control File](#)
- [Format of IR Reports](#)
- [Default Reports Generated for EMIR Analysis](#)
- [RLRP Report](#)
- [Reports Generated for Multiple Bin Files from Different Testbenches in a Design](#)

### Reports Generated Using the EMIR Control File

You can generate EMIR reports in text, HTML, or CSV format by specifying the EMIR control file (`emir.conf`), the EMIR database file, and the output directory. In the EMIR control file, the `report` option of the `emirutil` command is set to `text`, `html`, or `csv` depending upon the required output.

For example, `emirutil report=text` generates a text report. Similarly, `emirutil report=csv` generates a report in a compressed tar file. A CSV report is available on unzipping or untarring this file.

The syntax of the command to generate EMIR reports in text, HTML, or CSV format is as follows:

```
vfibatch -control <confFileName> -db <binFileName> -outdir <outDirName>
```

For example,

```
vfibatch -control emir.conf -db xps.emir0_bin -outdir out1
```

or,

```
emirreport -control emir.conf -db xps.emir0_bin
```

**Note:** Specifying the output directory is optional.

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The syntax of the command to generate EMIR reports using multiple bin files is as follows:

```
vfibatch -control emir.conf.report -db "binFileName1 binFileName2"
```

#### Important

For details of the supported EMIR control file options that can be specified, see [EMIR Control File Options Supported in Voltus-Fi-XL](#).

## Format of IR Reports

An IR report is generated in the following default format depending on which command is run:

- **Node-Based Format:** A node-based report is generated when the `emirreport` command is run. The report is generated independent of from where the `emirreport` binary is picked, Spectre or Voltus-Fi installation.

| VOLTAGE-DROP<br>(V) | NETNAME                | TIME<br>(s) | LAYER  | X<br>(um) | Y<br>(um) |
|---------------------|------------------------|-------------|--------|-----------|-----------|
| 19.729m             | MavI2/avI29/avD30_12#s | 1.256n      | mwires | 83.400    | 34.205    |

- **Resistor-Based Format:** A resistor-based report is generated when the `vpsbatch` or `vfibatch` command is run. In this case, the report displays the high drop on the nodes connected to the resistor.

| Resistor | ir value  | Layer  | X1     | Y1     | X2     | Y2     | Res   | Length<br>(u) | Width<br>(u) | Ipeak<br>(mA) |
|----------|-----------|--------|--------|--------|--------|--------|-------|---------------|--------------|---------------|
| rmw88352 | 0.0023634 | mwires | 43.130 | 17.160 | 43.130 | 17.160 | 0.001 | 0             | 1            | 0             |

However, you can change the format of the report as follows:

- If the `emirutil extendedreport=true` option is specified, the report is always generated in resistor-based format.
- If the `emirutil node_based_ir=true` option is specified, the report is always generated in node-based format.
- If both the `emirutil extendedreport=true` and `emirutil node_based_ir=true` options are specified, the report is always generated in node-based format.

## Default Reports Generated for EMIR Analysis

By default, Voltus-Fi-XL generates the following reports for EMIR analysis:

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### IR Drop Analysis Results

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- IR drop analysis reports with the extension, `#.rpt_ir`
- EM analysis reports with the extension, `#.rpt_em`
- Pin current reports with the extension, `#.rpt_pin`
- Summary report (`summary.rpt`), which includes reports for all analyses (IR drop and EM) performed in the current run

**Note:** All default reports print the software version number in the header. You can view this in the sample reports shown in the subsequent sections.

The following reports are detailed:

- IR Report Format
- EM Report Format
- Pin Current Report Format
- Summary Report Format

### IR Report Format

In the IR drop analysis report file, information is provided in the following format for each net. The type of analysis is mentioned for each net.

```
----- "VDD" NET: Vref = 2.500000V -----
--
max
Resistor ir value Layer X1 Y1 X2 Y2 Res Length Width Ipeak
```

### Sample IR Drop Analysis Report

A part of the sample IR drop analysis report is shown below.

---

```
VOLTAGE DROP RESULTS
VERSION = v06.17-e021_1

BINARY FILE =
/home/anuk/MMSIM_EMIR_WORKSHOP/emir_simulation/aps.direct.raw/input.emir0_bin
RESULTS FILE CREATED = 2015-Dec-16 23:15:18 (2015-Dec-17 07:15:18 GMT)
USER SUPPLIED VALUES:
RESULTS TYPE = TRANSIENT
TRANSIENT START = 0
```

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### IR Drop Analysis Results

```

TRANSIENT STOP = 1.2e-07
SIM TEMPERATURE = 27 C
AVERAGE = nil
PEAK = t
SIGVMAX = t
SIGVAVG = nil

```

```

----- "VDD" NET: Vref = 2.500000V -----
max
Resistor ir value Layer X1 Y1 X2 Y2

ri293 0.00713207 mt1 37.56 45.32 37.56 47.92
ri292 0.00713193 mt1 37.56 40.38 37.56 45.32
ri291 0.00712603 mt1 37.56 38.04 37.56 40.38
ri290 0.0071256 mt1 37.56 35.44 37.56 38.04
ri289 0.00712512 mt1 37.56 30.5 37.56 35.44

```

### EM Report Format

In the EM analysis report file, information is provided in the following format for each net. The type of analysis is mentioned for each net.

```

----- NET "VDD" -----
avg
Pass/Fail % Resistor layer Current Width PathLength I limit
X1 Y1 X2 Y2 J/JMAX Res ViaArea No of needed width/#via J_limit

```

### Sample EM Analysis Report

The image below shows a part of the EM analysis report.

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## IR Drop Analysis Results

### ELECTROMIGRATION ANALYSIS RESULTS

```
VERSION = v15.10-dev.alankar
BINARY FILE = xps.emirtap.emir0_bin
TECH FILE = /vols/ssvrd_t1_012/alankar/618code/vsa/output/dftout/lnx86_64_opt/vps_emirconf_p6iqjjs/qrcTechfile
RESULTS FILE CREATED = 2020-May-20 10:10:24 (2020-May-20 17:10:24 GMT)
USER SUPPLIED VALUES:
 RESULTS TYPE = tran
 TRANSIENT START = 0 s
 TRANSIENT STOP = 1e-08 s
 SIM TEMPERATURE = 25 C
 SIM HIERARCHY =
 DSPF SUBCKT NAME =
 DSPF GLOBAL TEMPERATURE =
 DSPF OPERATING TEMPERATURE =
 Tj = 25 C
 deltaT = 5
 AVERAGE = t
 AVERAGE ABS = t
 AVERAGE POS = nll
 ACPEAK = t
 CUSTOM = nll
 RMS = t
 PEAK = t
```

----- NET "VDD" -----  
avg

| Pass/Fail % | Resistor | layer  | Current (A) | Width (um) | PathLength (um) | I_limit (mA) | X1 (um) | Y1 (um) | X2 (um) | Y2 (um) | J/JMAX    | Res      | ViaArea (nm^2) | No of vias | needed width/via (um/#) | J_limit (A/um) |
|-------------|----------|--------|-------------|------------|-----------------|--------------|---------|---------|---------|---------|-----------|----------|----------------|------------|-------------------------|----------------|
| pass-75.5   | rg1974   | metal3 | 1.619m      | 2          | 103.149         | 6.6          | 0.250   | 1.750   | 0.000   | 0.001   | 0.245362  | 0.008084 | NA             | NA         | 0.4909                  | 0.0033         |
| pass-79.9   | rg1973   | metal3 | 1.329m      | 2          | 103.149         | 6.6          | 0.550   | 1.750   | 0.250   | 1.750   | 0.201308  | 0.00972  | NA             | NA         | 0.4028                  | 0.0033         |
| pass-83.4   | rg1972   | metal3 | 1.096m      | 2          | 103.149         | 6.6          | 0.850   | 1.750   | 0.550   | 1.750   | 0.16608   | 0.00972  | NA             | NA         | 0.3323                  | 0.0033         |
| pass-86.2   | rg1971   | metal3 | 911.7u      | 2          | 103.149         | 6.6          | 1.150   | 1.750   | 0.850   | 1.750   | 0.138136  | 0.00972  | NA             | NA         | 0.2763                  | 0.0033         |
| pass-86.7   | rh2894   | metal2 | 83.69u      | 0.285      | 72.807          | 0.627        | 41.130  | 19.435  | 41.128  | 20.945  | 0.133482  | 0.269506 | NA             | NA         | 0.0382                  | 0.0022         |
| pass-87.8   | rh2915   | metal2 | 77.77u      | 0.29       | 72.807          | 0.638        | 41.265  | 17.435  | 41.130  | 16.990  | 0.121898  | 0.05647  | NA             | NA         | 0.0354                  | 0.0022         |
| pass-88.1   | rh2019   | metal2 | 522.5u      | 2          | 120.325         | 4.4          | 1.750   | 7.985   | 1.750   | 1.750   | 0.118749  | 0.202014 | NA             | NA         | 0.2376                  | 0.0022         |
| pass-88.4   | rg1970   | metal3 | 767.2u      | 2          | 103.149         | 6.6          | 1.450   | 1.750   | 1.150   | 1.750   | 0.116248  | 0.00972  | NA             | NA         | 0.2325                  | 0.0033         |
| pass-89.1   | rh2018   | metal2 | 478.3u      | 2          | 120.325         | 4.4          | 1.750   | 8.285   | 1.750   | 7.985   | 0.108697  | 0.00972  | NA             | NA         | 0.2175                  | 0.0022         |
| pass-89.9   | rh2017   | metal2 | 444.5u      | 2          | 120.325         | 4.4          | 1.750   | 10.975  | 1.750   | 8.285   | 0.101025  | 0.087156 | NA             | NA         | 0.2022                  | 0.0022         |
| pass-90.1   | rg1969   | metal3 | 656.4u      | 2          | 103.149         | 6.6          | 1.750   | 1.750   | 1.450   | 1.750   | 0.0994583 | 0.00972  | NA             | NA         | 0.199                   | 0.0033         |

The table below lists the analysis type and the corresponding section heading in the EM report file.

| EM analysis type | Section heading in the EM Report File |
|------------------|---------------------------------------|
| Average          | avg                                   |
| Peak             | max                                   |
| RMS              | rms                                   |
| Absolute Average | Absavg                                |

### Generating a Report for All Resistors

You can generate a report to view the resistor information for all resistors in the design. To generate this report, use the `emirutil` command to set `reportAllResistor` to `true` in the EMIR configuration file.

```
emirutil reportAllResistor=true
```

For more information, see [EMIR Control File Options Supported in Voltus-Fi-XL](#) in the “Data Preparation” chapter.

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### IR Drop Analysis Results

---

A report, with the suffix, ".rpt\_all" is generated. The format of the report is the same as that of the ".rpt\_em" report.

#### Pin Current Report Format

In the pin current report file, the  $I_{max}$ ,  $I_{avg}$  and  $I_{rms}$  currents for pins for each net are reported.

```
-----NET "VDD"-----
Name Imax Iavg Irms
```

#### Sample Pin Current Report

A part of a sample pin current report is shown below.

##### PIN CURRENT RESULTS

```
VERSION = v15.10-dev
BINARY FILE = /xps.raw/xps.emirtap.emir0_bin
RESULTS FILE CREATED = 2016-Jan-27 01:42:30 (2016-Jan-27 09:42:30)
USER SUPPLIED VALUES:
 RESULTS TYPE = tran
 TRANSIENT START = 0
 TRANSIENT STOP = 1e-08
```

```
----- NET "VDD" -----
Name Imax Iavg Irms
 (A) (A) (A)
VDD 22.0183 m 1.38584 m 2.75948 m
```

```
----- NET "VSS" -----
Name Imax Iavg Irms
 (A) (A) (A)
VSS -23.4348 m -1.90594 m 3.04235 m
```

#### Summary Report Format

In the summary report, there are two tables of information for each net.

The first table provides, in its header, the name of the net, the simulation temperature, and the measurement window or the start and stop time for the analyses. For each net, the table lists the layer name and the corresponding maximum value of each analysis type for that layer. Information for different types of analyses is displayed in different columns.



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### IR Drop Analysis Results

The format of the first table is as follows:

|                    |             |
|--------------------|-------------|
| Net name           | GND         |
| Sim temperature    | 125         |
| Measurement window | 0 - 5.9e-08 |
| Layer              | iavg        |

The second table lists the layer names. For each layer and analysis type, there are two columns of information. The first column lists the number of resistors on which the analysis was run (`analysistype_run_on`) and the second column lists the number of resistors that were ignored in the analysis (`analysistype_num_skip`). The two columns are repeated for different types of analyses.

The format of the second table is as follows:

|       |                                   |                                     |                                   |                                     |
|-------|-----------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|
| Layer | <code>analysistype1_run_on</code> | <code>analysistype1_num_skip</code> | <code>analysistype2_run_on</code> | <code>analysistype2_num_skip</code> |
|-------|-----------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|

### Sample Summary Report

The image below shows a part of the summary report:

|                    |             |               |             |               |
|--------------------|-------------|---------------|-------------|---------------|
| Net name           | GND         |               |             |               |
| Sim temperature    | 125         |               |             |               |
| Measurement window | 0 - 5.9e-08 |               |             |               |
| Layer              | vmax        | irms          | iavg        | imax          |
| metal1             | 0.0137511   | 0.0541541     | 1.92388     | 0.339854      |
| metal2             | 0.0098085   | 0.541685      | 11.6608     | 0.478398      |
| metal3             | 0.00587761  | 0.227175      | 1.9191      | 0.445334      |
| metal4             | 0.00451982  | 0.109318      | 0.778421    | 0.11097       |
| n_odcont           | 0.022525    | 0             | 0.425099    | 0             |
| n_poly             | 0.00261004  | 0             | 0           | 0             |
| n_polycont         | 0.00261902  | 0             | 2.87543e-08 | 0             |
| p_odcont           | 0.00614363  | 0             | 0.146129    | 0             |
| p_poly             | 0.00261004  | 0             | 0           | 0             |
| Layer              | vmax run on | vmax num skip | irms run on | irms num skip |

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### IR Drop Analysis Results

|            |       |   |       |      |
|------------|-------|---|-------|------|
| metal1     | 15537 | 0 | 15537 | 0    |
| metal2     | 7253  | 0 | 7253  | 0    |
| metal3     | 2253  | 0 | 2253  | 0    |
| metal4     | 616   | 0 | 616   | 0    |
| n_odcont   | 6526  | 0 | 0     | 6526 |
| n_poly     | 222   | 0 | 0     | 222  |
| n_polycont | 80    | 0 | 0     | 80   |
| p_odcont   | 3291  | 0 | 0     | 3291 |
| p_poly     | 34    | 0 | 0     | 34   |

|                    |             |
|--------------------|-------------|
| Net name           | VDD         |
| Sim temperature    | 125         |
| Measurement window | 0 - 5.9e-08 |

| Layer    | vmax       | irms      | iavg      | imax     |
|----------|------------|-----------|-----------|----------|
| metal1   | 0.0288203  | 0.0742177 | 1.0235    | 0.621502 |
| metal2   | 0.0141003  | 0.46877   | 10.0913   | 1.45709  |
| metal3   | 0.00556588 | 0.191977  | 1.40789   | 0.184331 |
| metal4   | 0.00391154 | 0.113201  | 0.562096  | 0.106243 |
| n_odcont | 0.00902663 | 0         | 0.0742855 | 0        |
| n_poly   | 0.00260217 | 0         | 0         | 0        |

## RLRP Report

RLRP analysis report (RLRP.rpt) includes the LRP values of the instances or tap-nodes of the specified net. In the RLRP analysis report file, information is provided in the following format for each net.

Shortest path for net <net name> to tap <tap name> : total resistance :  
<resistance value>

|          |             |       |       |        |       |      |         |
|----------|-------------|-------|-------|--------|-------|------|---------|
| res-name | coordinates | res   | layer | length | width | volt | acc-lrp |
| acc-volt | node1       | node2 |       |        |       |      |         |

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## IR Drop Analysis Results

### Sample RLRP Report

#### RLRP RESULTS

BINARY FILE = ./ts\_28hpm\_sr\_222\_hs\_f\_hc8t\_shlas\_32x4x4\_pgn.raw/ts\_28hpm\_sr\_222\_hs\_f\_hc8t\_shlas\_32x4x4\_pgn.emirtap.emir0\_bin  
RESULTS FILE CREATED = 2019-Aug-28 23:58:13 (2019-Aug-29 06:58:13 GMT)  
USER SUPPLIED VALUES:

Shortest path for net VDD to tap xts\_28hpm\_sr\_222\_hs\_f\_hc8t\_shlas\_32x4x4\_pgn.xcr\_0.xsram\_1.xcore\_xdec\_2.xcore\_top\_1.xmc\_0\_3.xrefrow\_top\_1.XMC4.XPUP.mxp0:BULK (model NA) : total resistance : 142.732

| res-name | coordinates                   | res      | layer    | length   | width | volt        | acc-irp | acc-volt    | node1     | node2     |
|----------|-------------------------------|----------|----------|----------|-------|-------------|---------|-------------|-----------|-----------|
| r278804  | (0.722 75.975 2.13 75.975)    | 2.95884  | metal4   | 1.40756  | 0.25  | 0           | 2.95884 | 0           | VDD       | VDD:773   |
| r278848  | (2.13 75.975 3.785 75.975)    | 3.47913  | metal4   | 1.655    | 0.25  | 0.000340726 | 6.43797 | 0.000340726 | VDD:773   | VDD:788   |
| r278875  | (5.25 75.975 3.785 75.975)    | 3.07971  | metal4   | 1.465    | 0.25  | 0.000720783 | 9.51768 | 0.00106151  | VDD:786   | VDD:788   |
| r278871  | (8.105 75.975 5.25 75.975)    | 6.00176  | metal4   | 2.855    | 0.25  | 0.000925225 | 15.5194 | 0.00198673  | VDD:784   | VDD:786   |
| r278868  | (8.59 75.975 8.105 75.975)    | 1.01956  | metal4   | 0.485    | 0.25  | 0.000957427 | 16.539  | 0.00294416  | VDD:783   | VDD:784   |
| r278869  | (8.59 75.975 10.165 75.975)   | 3.31095  | metal4   | 1.575    | 0.25  | 0.000957427 | 19.8499 | 0.00390159  | VDD:783   | VDD:794   |
| r278897  | (11.795 75.975 10.165 75.975) | 3.42657  | metal4   | 1.63     | 0.25  | 0.00119552  | 23.2765 | 0.00508711  | VDD:792   | VDD:794   |
| r278884  | (13.245 75.975 11.795 75.975) | 3.04818  | metal4   | 1.45     | 0.25  | 0.00126793  | 26.3247 | 0.00635504  | VDD:791   | VDD:792   |
| r278885  | (13.245 75.975 16.32 75.975)  | 6.46424  | metal4   | 3.075    | 0.25  | 0.00126793  | 32.7889 | 0.00762297  | VDD:791   | VDD:800   |
| r278900  | (18.78 75.975 16.32 75.975)   | 5.17139  | metal4   | 2.46     | 0.25  | 0.00155367  | 37.9603 | 0.00917664  | VDD:798   | VDD:800   |
| r278897  | (19.76 75.975 18.78 75.975)   | 2.06015  | metal4   | 0.98     | 0.25  | 0.0015942   | 40.0205 | 0.0107708   | VDD:797   | VDD:798   |
| r278898  | (19.76 75.975 21.365 75.975)  | 3.37402  | metal4   | 1.605    | 0.25  | 0.0015942   | 43.3945 | 0.012365    | VDD:797   | VDD:803   |
| r278793  | (22.565 75.975 21.365 75.975) | 2.52263  | metal4   | 1.2      | 0.25  | 0.0016982   | 45.9171 | 0.0140632   | VDD:755   | VDD:803   |
| r278791  | (22.942 75.975 22.565 75.975) | 0.792994 | metal4   | 0.377222 | 0.25  | 0.00171187  | 46.7101 | 0.0157751   | VDD:754   | VDD:755   |
| r278789  | (24.35 75.975 22.942 75.975)  | 2.83144  | metal4   | 1.40778  | 0.25  | 0.00176076  | 49.5416 | 0.0175359   | VDD:753   | VDD:754   |
| r278786  | (24.35 75.975 24.35 75.975)   | 5.06486  | via3     | 0        | 0     | 0.00180157  | 54.6064 | 0.0193374   | VDD:752   | VDD:753   |
| r278788  | (24.35 75.975 24.35 75.985)   | 0.313649 | metal3   | 0.09     | 0.16  | 0.00180157  | 54.9201 | 0.021139    | VDD:752   | VDD:12275 |
| r302880  | (24.35 75.255 24.35 75.985)   | 2.19554  | metal3   | 0.63     | 0.16  | 0.00182129  | 57.1156 | 0.0229603   | VDD:12273 | VDD:12275 |
| r302879  | (24.35 75.255 24.35 75.255)   | 10.1297  | via2     | 0        | 0     | 0.00182129  | 67.2453 | 0.0247816   | VDD:12273 | VDD:12274 |
| r300588  | (24.505 75.255 24.35 75.255)  | 0.929929 | metal2   | 0.155    | 0.09  | 0.00183571  | 68.1752 | 0.0266173   | VDD:10845 | VDD:12274 |
| r279001  | (24.522 75.222 24.505 75.255) | 16.9005  | vial     | 0        | 0     | 0.00183806  | 84.6757 | 0.0284554   | VDD:838   | VDD:10845 |
| r278997  | (24.522 75.222 24.522 75.197) | 57.8893  | p_odcont | 0        | 0     | 0.00183806  | 142.565 | 0.0302934   | VDD:838   | VDD:1020  |

### Reports Generated for Multiple Bin Files for Different Nets from the Same Testbench

This section describes the use model for analyzing IR/EM results when multiple emir bin files are available for different nets of the same testbench. This is useful in large designs, where simulation is run separately for different nets to improve the runtime.

In batch mode, the following command is used to generate separate IR/EM reports for multiple bin files:

```
vfibatch -control emir.conf.report -db "xps.vdd/xps.raw/xps.emirtap.emir0_bin
xps.vss/xps.raw/xps.emirtap.emir0_bin" -text abc
```

**Note:** The bin filenames are separated by a space as shown above. The `-text` option is used to specify the name of the result file that will include the results for both nets. In the above example, the following report files will be generated for IR and EM analysis, respectively:

abc.rpt\_ir

abc.rpt\_em

### Reports Generated for Multiple Bin Files from Different Testbenches in a Design

This section describes the use model for analyzing IR/EM results when multiple emir bin files are available for the same design, but different testbenches. The following reports can be generated for such designs in Voltus-Fi-XL.

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- **Simulation deck-based reports:** In this scenario, separate EM and IR reports are generated for each simulation deck or the bin file.
- **Consolidated report for all simulation decks:** In this scenario, consolidated EM and IR reports are generated for all simulation decks or emir bin files.

### Creating the Simulation Deck-Based Reports

This use model requires that the multiple `#.emir_bin` files should be available in the same directory. For example, `test.emir0_bin`, `test.emir1_bin`, `test.emir2_bin`, and so on.

In batch mode, the following command is used to generate separate IR/EM reports for multiple bin files:

```
vfibatch -control conf filename -db_path
path_of_directory_containing_emir_bin_files -outdir outDirName
```

For example,

```
vfibatch -control emir.conf -db_path test/test.raw -outdir out
```

This command will generate separate IR/EM reports for each emir bin file.

For example, if there are two bin files, `test.emir0_bin` and `test.emir1_bin`, then the following reports will be generated:

- `out/test.rpt_em` and `out/test.rpt_ir` will be generated corresponding to the `test.emir0_bin` file
- `out/test.rpt_em1` and `out/test.rpt_ir1` will be generated corresponding to `test.emir1_bin` file

**Note:** The format of these reports is the same as that of the default IR/EM reports generated in case of a single `emir_bin` file run.

### Consolidated Reports for All Simulation Decks

A single consolidated EM report and IR report will be generated comprising results from all simulation decks (`#.emir_bin` files). To enable the generation of consolidated reports, set the following:

- In the GUI, open the Variables form available in the EM tab of the IR/EM Results form, and set the EM variable, `consolidatedReport`, to `true`. By default, this variable is set to `false`.

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OR

- In batch mode, set the following in the `emir.conf` file:

```
emirutil consolidatedReport=true
```

**Note:** The `vfibatch` command having the option, "`-db_path/-db_multi_path`" with `emir` variable "`consolidatedReport`" set to "`true`" in the `emir` configuration file will generate the consolidated reports for both, EM and IR analyses.

By default, when the `consolidatedReport` option is set to `true`, the `worstResult` option is also set to `true`, which means only the worst violation will be reported.

```
emirutil consolidatedReport=true
emirutil worstResult=true
```

To view all the results in the consolidated report, set the `worstResult` option to `false`.

For details of the above options, see [EMIR Control File Options Supported in Voltus-Fi-XL](#) in the "Data Preparation" chapter.

There are two possible scenarios in the creation of consolidated reports:

- Scenario 1, when all `emir` bin files are in the same directory
- Scenario 2, when the `emir` bin files are in different directories

These scenarios are detailed below.

#### ***Scenario 1: The `emir` bin Files are in the Same Directory***

In this scenario, there are multiple `emir` bin files in the same directory. For example, `test.emir0_bin`, `test.emir1_bin`, `test.emir2_bin`, and so on.

To generate a consolidated report in this scenario, use the following command in batch mode:

```
vfibatch -control conf_file_name -db_path
path_of_directory_containing_emir_bin_files -outdir outDirName
```

**Note:** The above command uses the `-db_path` option to specify the path of the directory containing all the bin files.

For example,

```
vfibatch -control emir.conf -db_path test/test.raw -outdir out
```

### ***Scenario 2: The emir bin Files are in Different Directories***

To generate a consolidated report in this scenario, use the following command in batch mode:

```
vfibatch -control conf filename -db_multi_path
name_of_file_containing_paths_to_emir_bin_files -outdir
outDirName
```

**Note:** The above command uses the `-db_multi_path` option to specify the name of the file that contains the paths to the emir bin files containing the simulation results of different testbenches of the same design but in different directories.

For example,

```
vfibatch -control emir.conf -db_multi_path emir_bin_files -outdir
out
```

Where, the file, “emir\_bin\_files” contains the following information:

```
test/test.raw/test.emir0_bin
test1/test1.raw/test1.emir0_bin
test2/test2/raw/test2/emir0_bin
```

A part of a sample consolidated report is shown below.

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Figure 7-43 Sample Consolidated EM Report

```

pass-30.0 ra2 via2 8.41499e-07 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir0_bin

pass-100.0 ra2 via2 5.41499e-07 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir1_bin

pass-100.0 ra2 via2 3.41499e-07 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir2_bin

----- NET "VSS" -----

avg

Pass/Fail % Resistor layer Current Width PathLength I limit X1 Y1 X2 Y2 J/JMAX Res ViaArea No of
needed width/#via J limit emir_bin

(mA) (um) (um) (mA) (nm^2) vias (um/#) (A/um)

fail+40.0 ra4 via2 3.41 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir1_bin

fail+30.0 ra4 via2 3.00 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir0_bin

fail+20.0 ra4 via2 2.70 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir2_bin

pass-30.0 ra5 via2 8.41499e-07 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir0_bin

pass-100.0 ra5 via2 5.41499e-07 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir1_bin

pass-100.0 ra5 via2 3.41499e-07 NA 0.55 2.2 4.78 9.897 4.78 9.834 1.55227e-07 1500 33000 1 1
0.0666667 test.emir2_bin

```

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## IR Drop Analysis Results

Figure 7-44 Sample Consolidated IR Report

| VOLTAGE DROP RESULTS                                                   |            |       |      |       |      |       |      |        |       |             |                |  |
|------------------------------------------------------------------------|------------|-------|------|-------|------|-------|------|--------|-------|-------------|----------------|--|
| VERSION = v15.10-dev.                                                  |            |       |      |       |      |       |      |        |       |             |                |  |
| RESULTS FILE CREATED = 2015-Oct-28 01:45:33 (2015-Oct-28 08:45:33 GMT) |            |       |      |       |      |       |      |        |       |             |                |  |
| ----- "VG" NET: Vref = 0.000000V -----                                 |            |       |      |       |      |       |      |        |       |             |                |  |
| max                                                                    |            |       |      |       |      |       |      |        |       |             |                |  |
| Resistor                                                               | ir value   | Layer | X1   | Y1    | X2   | Y2    | Res  | Length | Width | Ipeak       | emir_bin       |  |
|                                                                        |            |       |      |       |      |       | (u)  | (u)    | (mA)  |             |                |  |
| ra3                                                                    | 0.00402345 | m1    | 4.78 | 9.834 | 4.78 | 9.734 | 2000 | 0.1    | 0.02  | 0.000924894 | test.emir2_bin |  |
| ra3                                                                    | 0.00302345 | m1    | 4.78 | 9.834 | 4.78 | 9.734 | 2000 | 0.1    | 0.02  | 0.000924894 | test.emir1_bin |  |
| ra3                                                                    | 0.00202345 | m1    | 4.78 | 9.834 | 4.78 | 9.734 | 2000 | 0.1    | 0.02  | 0.000924894 | test.emir0_bin |  |
| ra2                                                                    | 0.00223525 | via2  | 4.78 | 9.897 | 4.78 | 9.834 | 1500 | NA     | NA    | 0.000924894 | test.emir0_bin |  |
| ra2                                                                    | 0.00203525 | via2  | 4.78 | 9.897 | 4.78 | 9.834 | 1500 | NA     | NA    | 0.000924894 | test.emir1_bin |  |
| ra2                                                                    | 0.00193525 | via2  | 4.78 | 9.897 | 4.78 | 9.834 | 1500 | NA     | NA    | 0.000924894 | test.emir2_bin |  |
| ----- "VDD" NET: Vref = 0.900000V -----                                |            |       |      |       |      |       |      |        |       |             |                |  |
| max                                                                    |            |       |      |       |      |       |      |        |       |             |                |  |
| Resistor                                                               | ir value   | Layer | X1   | Y1    | X2   | Y2    | Res  | Length | Width | Ipeak       | emir_bin       |  |
|                                                                        |            |       |      |       |      |       | (u)  | (u)    | (mA)  |             |                |  |
| rx13                                                                   | 0.0965851  | m1    | 4.78 | 9.834 | 4.78 | 9.734 | 2000 | 0.1    | 0.02  | 0.0214634   | test.emir2_bin |  |
| rx13                                                                   | 0.0865851  | m1    | 4.78 | 9.834 | 4.78 | 9.734 | 2000 | 0.1    | 0.02  | 0.0214634   | test.emir0_bin |  |
| rx13                                                                   | 0.0765851  | m1    | 4.78 | 9.834 | 4.78 | 9.734 | 2000 | 0.1    | 0.02  | 0.0214634   | test.emir1_bin |  |

In the above report, the IR results for the resistors "ra3" and "ra2" for net VG, and resistor, "rx13" for net, VDD from all emir\_bin files are reported. By default, for consolidated reports, the emirutil variable, worstResult is set to true. Therefore, the report only includes the worst result for each resistor, which is the first row of information for each resistor shown in the above report.



However, for the above report, to view all results, the `worstResult` variable is set to `false`. In this case, the IR results for the resistors are sorted so that the worst case is reported first and best case is reported last.

## Reporting a List of Devices from a Subnode

Voltus-Fi-XL supports tracing of all devices or tap points starting from a metal subnode. This feature lets you list the device tap nodes that are nearest to a given subnode on a metal layer. For this, specify the name of the subnode present on any metal layer and the software will list the tap nodes that are nearest to that subnode. The term “nearest” used here refers to the shortest distance of tap nodes from the subnode in terms of the number of resistors.

**Note:** To use this feature, the names of the subnodes for which you want to trace the tap nodes must be provided.

The output is a report file containing the tap name of each subnode that is specified in the input.

## Use Model

This feature is only supported in batch mode. To use this feature, the following commands and variables are used.

### ■ `load ir_results`

Loads the results of the IR drop analysis

### ■ The following variables are provided to specify the tap name patterns to discard while tracing and also to specify the number of taps to be reported while tracing.

❑ `subnode_to_tap_path_trace_discard_pattern`

❑ `subnode_to_tap_path_trace_number_of_taps_to_report`

These variables can be set using the `set_variable` command in the command file.

❑ `subnode_to_tap_path_trace_discard_pattern <pattern>`

This variable is used to specify the patterns in the tap names to discard while tracing. You can specify multiple patterns by separating the pattern names with a space. Wildcards are also supported for specifying pattern names. When this variable is specified, all the taps that contain any of the specified patterns will not be reported during tracing.

For example,

```
set_variable subnode_to_tap_path_trace_discard_pattern "MPC"
```

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### IR Drop Analysis Results

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❑ `subnode_to_tap_path_trace_number_of_taps_to_report <number>`

This variable is used to control the number of taps that will be reported by the command. The default value is 1. If more than one tap is specified, the software will report taps of unique devices, which means that the taps of different fingers of the same device will not be reported.

For example,

```
set_variable subnode_to_tap_path_trace_number_of_taps_to_report 4
```

#### ■ print subnode to tap path report

Prints the report containing the tap node names for the specified subnodes. The syntax of the command is provided below.

```
print_subnode_to_tap_path_report
-net {netname}
-subnode {subnode_name}
-filename {report_file_name}
-never_traverse_top {true | false}
-report_complete_path {true | false}
```

For details of the command parameters, see [load\\_ir\\_results](#) in the “Batch Mode Execution” chapter.

## Sample Command File and Results File

A sample command file and a report file generated from this command file are shown below.

### Sample command file

```
load_ir_results emir0_bin.gz
set_variable subnode_to_tap_path_trace_discard_pattern "MPC"
set_variable subnode_to_tap_path_trace_number_of_taps_to_report 6
print_subnode_to_tap_path_report -net VDD -subnode VDD:36919 -filename
subnode_tap_path.rpt
```

### Sample results file

```
SUBNODE TO NEAREST TAP PATH RESULTS
BINARY FILE = emir0_bin.gz
REPORT FILE CREATED = 2016-Sep-24 04:08:45 (2016-Sep-24 11:08:45 GMT)
VDD:36919 23.556 0.68
 X18 unmatched:s 23.574 0.525
 XI13/MP1:s 24.03 0.915
 XI27/MP1:s 24.078 0.915
 MN6:d 23.622 0.525
 MP0:s 23.793 0.945
 MP8:s 23.745 0.945
```

## Reporting On-Resistance (RON) Values

### Overview

Voltus-Fi-XL reports the RON values for all layers between specified pairs of pins in a design. The software reports the combined resistance contribution of both pins in the pair and the contribution from each pin. The resistance values are reported in ohms.

For this feature, `report_vfi_XL_ron` command has been provided. For details, see [report\\_vfi\\_XL\\_ron](#) in the “Batch Mode Execution” chapter.

### Generating the RON Report

This flow is supported only in the batch mode. To enable this flow, perform the following steps:

- Load the IR drop/EM analysis results.
- Run the following command:

```
report_vfi_XL_ron
-pin_pair file_name
-output_file file_name
```

#### Example:

Use the following commands to report RON for IR drop analysis using the pin-pair file, `pin_pair.txt` in the output file, `output.rpt`:

```
load_ir_results ...input.raw/input.emir0_bin
report_vfi_XL_ron -pin_pair_file pin_pair.txt -output_file output.rpt
```

### Output

The RON report includes the following information:

- Voltage source names and their corresponding terminal/pin names, voltage values, and current values
- Total layer-based wire RON for both pins in the pin-pair combination
- Total layer-based wire RON for each pin in the pin-pair combination

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### **IR Drop Analysis Results**

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#### **Sample Pin-Pair File**

VN1 VN2

#### **Sample RON Report**

A sample RON report is shown below.

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## IR Drop Analysis Results

**Figure 7-45 Sample RON Report**

| Pins and voltage-source used: |               |                   |              |
|-------------------------------|---------------|-------------------|--------------|
| Vsource                       | Terminal Name | Voltage[V]        | Current[A]   |
| ---                           | P1            | 31.4              | -0.269506    |
| ---                           | P2            | 0                 | 0            |
| ---                           | P34           | 32                | 0.857299     |
| ---                           | VN1           | 37                | -1.36653e-11 |
| ---                           | VN2           | 37                | -4.11738e-11 |
| ---                           | VN3           | 37                | 6.66367e-12  |
| VN1/VN2                       |               |                   |              |
| Wire & Via                    | Name          | Resistance (Ohms) |              |
| metale                        | (ra)          | 2.071444e-01      | (29.597%)    |
| utm                           | (rb)          | 1.103522e-01      | (15.767%)    |
| viae                          | (rsb)         | 8.830884e-03      | (1.262%)     |
| m3                            | (rc)          | 6.944030e-03      | (0.992%)     |
| m2                            | (rd)          | 6.357516e-03      | (0.908%)     |
| m1                            | (re)          | 4.770599e-03      | (0.682%)     |
| gv                            | (rrb)         | 1.402366e-03      | (0.200%)     |
| v3                            | (rqb)         | 3.274210e-04      | (0.047%)     |
| v2                            | (rpb)         | 1.249013e-04      | (0.018%)     |
| lwires                        | (rlw)         | 2.769806e-07      | (0.000%)     |
| Total:                        |               | 3.474145e-01      | (49.640%)    |
| VN1                           |               |                   |              |
| Wire & Via                    | Name          | Resistance (Ohms) |              |
| utm                           | (rb)          | 2.067393e-02      | (2.954%)     |
| metale                        | (ra)          | 1.310327e-02      | (1.872%)     |
| viae                          | (rsb)         | 2.029128e-03      | (0.290%)     |
| m3                            | (rc)          | 3.128705e-04      | (0.045%)     |
| gv                            | (rrb)         | 2.632291e-04      | (0.038%)     |
| m2                            | (rd)          | 2.339333e-04      | (0.033%)     |
| m1                            | (re)          | 1.717799e-04      | (0.025%)     |
| v3                            | (rqb)         | 8.433439e-05      | (0.012%)     |
| v2                            | (rpb)         | 5.306026e-05      | (0.008%)     |
| lwires                        | (rlw)         | 2.769806e-07      | (0.000%)     |
| Total:                        |               | 3.749304e-02      | (5.357%)     |
| VN2                           |               |                   |              |
| Wire & Via                    | Name          | Resistance (Ohms) |              |
| metale                        | (ra)          | 1.940411e-01      | (27.725%)    |
| utm                           | (rb)          | 8.967832e-02      | (12.814%)    |
| viae                          | (rsb)         | 6.801756e-03      | (0.972%)     |
| m3                            | (rc)          | 6.631159e-03      | (0.947%)     |
| m2                            | (rd)          | 6.123583e-03      | (0.875%)     |
| m1                            | (re)          | 4.598819e-03      | (0.657%)     |
| gv                            | (rrb)         | 1.139137e-03      | (0.163%)     |
| v3                            | (rqb)         | 2.430866e-04      | (0.035%)     |
| v2                            | (rpb)         | 7.184106e-05      | (0.010%)     |
| lwires                        | (rlw)         | 0.000000e+00      | (0.000%)     |
| Total:                        |               | 3.099214e-01      | (44.283%)    |

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## **IR Drop Analysis Results**

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## EM Analysis Results

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### Overview of EM Analysis

Voltus™-Fi Custom Power Integrity Solution-XL uses the simulation database generated by Spectre APS/XPS simulators and displays the results of the electromigration (EM) analysis on the Virtuoso layout. It also generates text and HTML reports of the analyses and lets you query the analyses results to view specific violations in the layout. This is used to debug the high EM violation regions in the design.

Batch mode support is provided for specifying variables for EM analysis, loading EM analysis results and generating reports. The following commands are used to load and print EM analysis results in Voltus-Fi-XL:

- `load_em_results`: Loads the EM analysis results
- `print_em_report`: Prints the EM analysis reports

#### Note:

- For N3 node, the VPS\_NG100 beta license is required for performing EM analysis.
- Structural analysis is not enabled with EM analysis results.

#### Important

EM analysis is not supported for meshed parasitic extraction, therefore, meshing should not be enabled for parasitic extraction.

### Types of EM Analysis

The following analysis types are available in Voltus-Fi-XL:

## Average (avg) Analysis

Calculates the Current Density violations based on the average value of the DC current for metal lines, vias, and contacts.

$$I_{avg} = \left[ \left( \int_0^{\tau} I(t) dt \right) / \tau \right]$$

where “T” is time and “I (t)” is value of current.

## Root Mean Square (rms) Analysis

Calculates the Current Density violations based on the root mean square (RMS) of the AC current for metal lines, vias, and contacts.

$$I_{rms} = \left[ \left( \int_0^{\tau} I(t)^2 dt \right) / \tau \right]^{1/2}$$

where “T” is time and “I (t)” is value of current.

## Peak (max) Analysis

For this analysis, the Current Density violations are calculated based on the maximum DC current for metal lines, vias, and contacts. The  $I_{peak(limit)}$  value is specified using the `em_jmax_dc_peak` and `em_jmax_ac_peak` constructs in the ICT file.

## AC-Peak (AC Peak) Analysis

For this analysis, the Current Density violations are calculated based on the peak AC current for metal lines, vias, and contacts. It is applied to periodic AC or pulsed DC signals.

$$I_{peak\_ac(limit)} = I_{peak(limit)} / (r)^{1/2}$$

where the  $I_{peak(limit)}$  is specified in the ICT file



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### EM Analysis Results

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If the construct `em_peak_with_duty_ratio explicit` is specified in the process block of the ICT-EM file, then the limits specified using the `em_jmax_dc_peak` and `em_jmax_ac_peak` constructs are AC-Peak limits. In this case, same limit values are reported for peak (max) and AC\_peak analysis. An example of the process section of ICT file is provided below.

```
process "gpdn" {
 em_conductor_unit mA/um
 em_via_area_unit mA
 em_via_unit mA
 em_peak_with_duty_ratio explicit
}
```

**Note:** To perform AC-Peak analysis in Voltus-Fi-XL using the ADE L flow, ensure that while setting up simulation, you have enabled the *EM Current Analysis* options *max* and *avg* in the *Analysis* tab of the EM/IR Analysis Setup form.

There are different types of AC-peak analyses based on the `dynamicACPeak` variable setting.

#### When `dynamicACPeak` is not Set

When the `dynamicACPeak` variable is not set or set to `false`, which is the default value, the values of duty ratio “*r*” is as follows:

$$r = I_{\text{abs-avg}} / I_{\text{peak}}$$

**Note:** The  $I_{\text{abs-avg}}$  and  $I_{\text{peak}}$  values are from simulation results.

The value of “*Td*” is calculated in the following order of priority:

1. If the net frequency is specified either using the `toggleNetFrequency` or `toggleNetFrequencyFile` variable, then

$$Td = r / F$$

where *F* is the net frequency specified using `toggleNetFrequency` or `toggleNetFrequencyFile`

2. If the simulation is run with specified time window and the net frequency is not specified using either `toggleNetFrequency` or `toggleNetFrequencyFile`, then

$$Td = r * \text{time window period}$$

3. If neither the simulation time window nor the net frequency is specified using either `toggleNetFrequency` or `toggleNetFrequencyFile`, then

$$T_d = r * T$$

where  $T$  is the simulation period

### When dynamicACPeak is Set to True

When the `dynamicACPeak` variable is set to `true` or `multiPeak`, the value of duty ratio “ $r$ ” is as follows:

$$r = T_d / T_{total}$$

Where

$T_{total}$  = total transient time

$T_d$  = the time duration in micro second of the total “On Time” period, where  $abs(I) > (\max(abs(I) / 2.0))$  during transient analysis.

Voltus-Fi-XL does not calculate  $T_d$  as  $\max(abs(I) / 2.0)$  period. It calculates  $T_d$  by measuring the pulse at half-energy level because of performance reasons. The variable, `pwc_threshold` is specified in the EMIR configuration file to define the current threshold for finding the start of the pulse.

When you set `dynamicACPeak = true` or `multiplePeak`, it is important to set 'ipwc' analysis in the EMIR configuration file when running Spectre. PWC stands for pulse-wise constant, where the actual current waveform from simulation is converted to a pwc waveform. This new waveform is used for 'Td' calculation.

The following command is specified in the configuration file:

```
net analysis=[ipwc] pwc_threshold=1e-6
```

$T_d$  has different values for the `true/multiPeak` values of `dynamicACPeak`:

- When `dynamicACPeak` is `true`,  $T_d$  = the time duration of maximum peak
- When `dynamicACPeak` is `multiPeak`,  $T_d$  = sum of time durations of different peaks,  $T_{d1} + T_{d2} + T_{dN} \dots$

**Note:**  $T_d$  for a particular peak is added to the final  $T_d$  only if the peak current is greater than or equal to percentage threshold of maximum current. This threshold is specified by the `multiplePeakPercentThreshold` variable.

**Note:** The software replaces the value of “ $r$ ” with the value of `applyRThreshold` if the value of “ $r$ ” is  $<$  than that of `applyRThreshold`. This is because a small “ $r$ ” value results in an unreasonable increase in the  $I_{peak\_ac}$  limit. To avoid this scenario, use the `applyR`

keyword to reset the value of “r” in the ICT file or change the value of the `applyRThreshold` variable, either in the Variables form or in batch mode.

### **Important**

**Calculating  $T_d$  for multiple clock cycles:** In case the design is simulated for multiple clock cycles and you want to perform `dynamicACPeak` analysis with `multiplePeak` setting, then it is recommended to set either of the following options in the Variables form of the *EM* tab of the Voltus-Fi GUI:

- ☐ `toggleNetFrequency` or
- ☐ `toggleNetFrequencyFile`

You can also specify the options in the `emir.conf` file using the `emirutil` command.

The effective  $T_d$  will be calculated as follows:

$$(T_{d1} + T_{d2} + \dots + T_{dN}) / \text{number of cycles}$$

## **Avg-Abs (avgabs)**

Calculates the Current Density violations based on the average of the absolute current for metal lines, vias, and contacts.

$$I_{abs-avg} = \left[ \left( \int_0^{\tau} |I(t)| dt \right) / \tau \right]$$

where “T” is time and “I (t)” is value of current.

## **Design Resistor EM Current Analysis**

By default, the EM current analysis is only performed on parasitic resistors defined in the RC section of the xDSPF file. If required, EM analysis for design resistors in the xDSPF instance section can be enabled. This analysis can be applied to primitive resistor elements, or resistors defined with subckt definitions.

```
net design_res_models=[resistor] analysis=[iavg] (primitive resistor)
net design_res_models=[name=rhim] analysis=[iavg] (resistor subckt rhim)
```

For the EM current analysis the parameters  $\$l$ ,  $\$w$ , and  $\$lv1$  are expected to be defined for primitive resistor calls, and  $l$  and  $w$  for subckt resistor calls in the xDSPF instance section. If the parameter names are differently defined in the xDSPF file—even if only the casing is different—the mapping can be performed in the conf file statement.

```
net design_res_models=[name=rhim_m l=lr w=wr] analysis=[iavg]
net design_res_models=[name=rhim_m l=L w=W] analysis=[iavg]
```

Layer information, and units for  $l/w$  can be defined in the EMIR conf file statement.

```
net design_res_models=[name=rhim_m layer=mt1 unit=1] analysis=[iavg]
```

The design resistor related EM results are reported in the EM analysis report file.

## Viewing the EM Analysis Results

Before plotting EMIR results, ensure the following:

- The `emir` mode is enabled while performing the simulation.
- The simulation result file is available in the output directory of the simulation results. The naming convention of the simulation result file is, `*.emir#_bin`. For example, your result file could be named, `xps.emir0_bin`.

Follow these steps to view the EM analysis results.

1. In the Voltus-Fi-XL console, choose *IR/EM Analysis – Rail Analysis Results*.  
The IR/EM Results form opens.
2. Click the EM tab to plot the EM analysis results.

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### EM Analysis Results

Figure 8-1 IR/EM Results Form – EM Tab

**IR/EM Results**

IR EM Structural Analysis LRP Browser Pin2PinR What-If (ECO)

**Results**

Shrink factor

State Directory / Results File:

Tech File

Layer Map File

EM Only ICT File

☒ max ☒ avg ☐ avgabs ☐ AC Peak ☒ rms

☐ QRC Run ☒ DFII Layermap

**Plot Results**

**Type**

☒ All Power Nets ☐ All Signal Nets

☐ All Nets  ☐ Show Only Failed Nets

| Net Type | Net Name |
|----------|----------|
| 1 power  | SIDDQ    |
| 2 power  | VDD      |
| 3 power  | VSS      |

☐ Show Only Failed ☐ Show EM %

3. In the *Results* group box, specify the shrink factor, if any, by which the xDSPF was shrunk in the *Shrink factor* field.
4. Click *Customize Display* to select the nets for which you want to view the display. The *Customize Display* pop-up window opens. You can only customize the display for selected nets before the results are loaded. The *Customize Display* button is disabled once the results are loaded.

5. Specify the *State Directory / Results File*, which is a file that stores the results of the APS/XPS simulation. The naming convention of the result file is \*.emir#\_bin.
6. Select the + button to specify multiple result files.
7. Specify the technology file in the *Tech File* field. The following technology files are supported in the Voltus-Fi-XL flow:

- ☐ The interconnect technology (ICT) file
- ☐ The Quantus technology file (qrcTechFile)
- ☐ The EM data file (emDataFile)

**Note:** For both the ICT file and qrcTechfile flow, Voltus-Fi-XL supports the use of encrypted files.

8. Specify the *Layer Map File*. This file is used to map the layer names in the simulation database to the layer names in the technology file specified in the *Tech File* field. This is optional and is only required if the layer names in the simulation database are different from the ones in the technology file. You can also create a new layer map file or edit an existing file, using the edit button provided next to the field. For more information about the layer map file, see Layer Map File in the “[File Formats](#)” chapter.

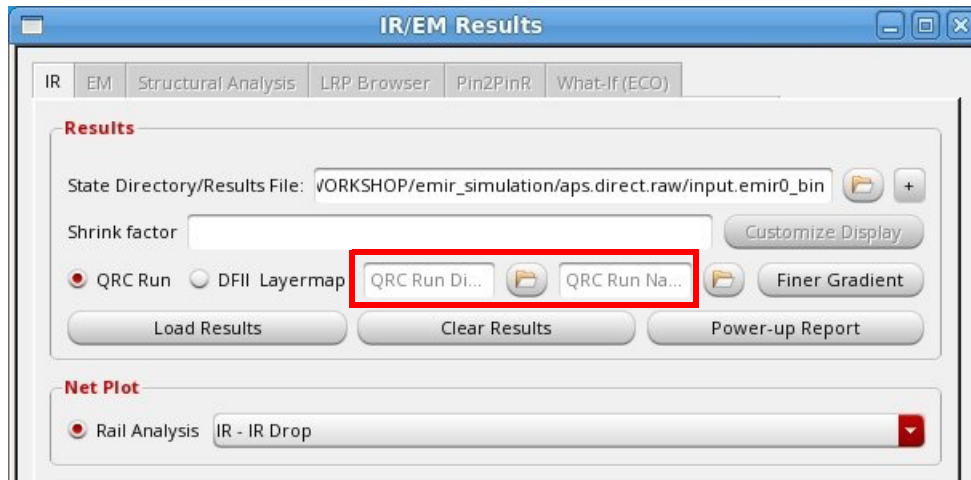
**Note:** If the above layer map file is not provided and you click *Load Results*, a pop-up window with the message, “Map file not specified. EM analysis will run without layer mapping”, opens. Click *OK* to proceed.

9. Specify the *EM Only ICT File*, which includes information about process and EM models to be used for EM analysis. This is an optional file that can be provided with the qrcTechFile flow. When provided, the process and em\_model information will be picked up from the specified EMOnlyICTFile.
10. Specify either the *QRC Run* or the *DFII Layermap*. When either of these options is specified, the plots displayed on the layout show solid shape highlighting. For more information, see [Solid Shape Highlighting](#).
  - ☐ Select *QRC Run*. Two text fields with browse buttons appear in the form. Click on the Browse buttons to open the pop-up windows, *Select QRC Run Directory* and

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### EM Analysis Results

Select *QRC Run Name* to specify the path to the *QRC Run Directory* and the *QRC Run Name*, respectively.



The display now generated will be based on the shape database generated by Quantus.

**Note:** When you switch between the IR and EM tabs, the selected *QRC Run* remains intact. This means that the Quantus run selections, run directory and run name fields, made on one tab remain populated for the other tab even after clearing the analysis results.

For more information about the setup requirements for the Quantus run flow, see [Solid Shape Highlighting](#).

- ❑ Specify *DFII Layermap*. This layer map file is the APS/XPS-to-DFII layer map file. When this file is specified, the plots displayed in the layout show solid shape highlighting. You can also create a new layer map file or edit an existing file, using the edit button provided next to the field. This layer map file is the same file that is used in structural analysis. For more information about the file format and description, see the DFII Layer Map File section in the “File Formats” chapter.

You can also specify this file by using the `vfiDfiiLayerMapFile` environment variable either in the `.cdsenv` or the `.cdsinit` file. For more information, refer to the [Environment Variables](#) chapter.

**Note:** If you do not specify this file and click *Load Results*, a pop-up-window opens to verify that you want to proceed without the map file. If you click *Yes*, the plots are drawn using stick display.

11. For the DFII layer map flow, click *Finer Gradient* to view the finer gradient for the selected layers. When you click this button, the *Finer Gradient Layer Selection* pop-up window opens. In this window, all the layers are selected by default. Click *Deselect*

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### EM Analysis Results

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*All* and select the PGDB layers for which you want to view the finer gradient and click *OK*. For details, see [Display of Finer Color Gradient for Selected Layers in IR and EM Plots](#).

**Note:** Perform this step before loading the EM Results. After loading the results, when you click *Show Plot*, you can see the finer gradient for the selected layers.

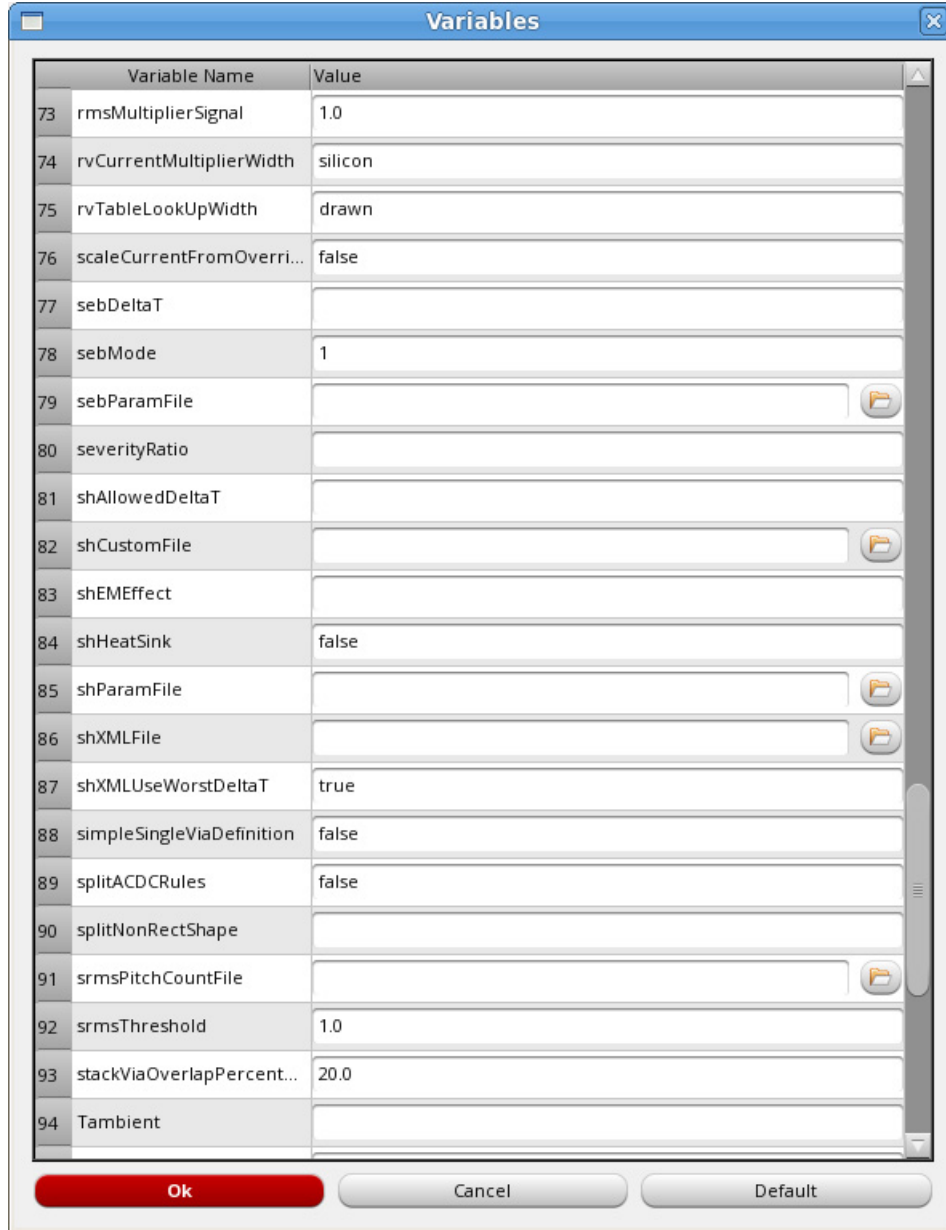
12. Click *Variables* to open the Variables form. In this form, you can view and/or edit the variables that are used for EM analysis. Double-click the value of any variable to edit it. For variables that require a path to a file or a directory to be specified, click the *Browse* button next to the variable field and specify the path.



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### EM Analysis Results

Figure 8-2 The Variables Form



The screenshot shows a dialog box titled "Variables" with a table of variables. The table has two columns: "Variable Name" and "Value". The variables are listed with their corresponding values, and some have file selection icons next to them. At the bottom of the dialog are three buttons: "Ok" (red), "Cancel", and "Default".

|    | Variable Name             | Value   |
|----|---------------------------|---------|
| 73 | rmsMultiplierSignal       | 1.0     |
| 74 | rvCurrentMultiplierWidth  | silicon |
| 75 | rvTableLookUpWidth        | drawn   |
| 76 | scaleCurrentFromOverri... | false   |
| 77 | sebDeltaT                 |         |
| 78 | sebMode                   | 1       |
| 79 | sebParamFile              |         |
| 80 | severityRatio             |         |
| 81 | shAllowedDeltaT           |         |
| 82 | shCustomFile              |         |
| 83 | shEMEffect                |         |
| 84 | shHeatSink                | false   |
| 85 | shParamFile               |         |
| 86 | shXMLFile                 |         |
| 87 | shXMLUseWorstDeltaT       | true    |
| 88 | simpleSingleViaDefinition | false   |
| 89 | splitACDCRules            | false   |
| 90 | splitNonRectShape         |         |
| 91 | srmsPitchCountFile        |         |
| 92 | srmsThreshold             | 1.0     |
| 93 | stackViaOverlapPercent... | 20.0    |
| 94 | Tambient                  |         |

After updating the values, click *OK*. To restore the default values, click *Default*.

You can also set above variables in batch mode by using the `set_variable` command.

**Note:** For descriptions of the variables that can be set in the above form, see the “[Variables](#)” chapter.

**13.** Specify the *Type* of EM analysis to plot the current density violations. The available options are *max*, *avg*, *avgabs*, *AC Peak*, and *rms*. You can select more than one analysis type at a time. By default, *max* and *avg* are selected.

- ☐ **max:** calculates the Current Density violations based on the maximum DC current
- ☐ **avg:** calculates the Current Density violations based on the average value of the DC current
- ☐ **avgabs:** calculates the Current Density violations based on the average value of absolute current
- ☐ **AC Peak:** calculates the Current Density violations based on peak AC current

**Note:** This analysis type is not supported in the `emDataFile` flow. It is only supported in the `qrcTechFile` flow. Even if the analysis type is selected in the `emDataFile` flow, the corresponding plot types, JACPEAK and J\_ACPEAK, will not be available in the plot types list.

- ☐ **rms:** calculates the Current Density violations based on the root mean square (RMS) value of the AC current

For details of the above analysis types, see [Types of EM Analysis](#).

**Note:** When you specify any of the above analysis types, ensure that the rules for the selected analysis type are available in the technology file specified in the *Tech File* field. If the EM rules are not available, the analysis result file will be empty.

**14.** Click *Load Results* to load the results of the EM Analysis. Once the results are loaded, the list in the *Plot Results* group box is enabled. The list of plots corresponds to the selected analyses types. In addition to the plots specific to the chosen analysis type, Peak Tap Current and Peak Resistor Current plot types are available for all EM analyses.

- ☐ **TC - Peak Tap Current:** analyzes and reports peak tap currents
- ☐ **RC - Peak Resistor Current:** analyzes and reports peak resistor currents

For details of the above plots, see [TC, TCAVG, TCRMS – Tap Current Plots](#) and [RC, RCAVG, and RCRMS – Resistor Current Plots](#) in the “IR Drop Analysis Results” chapter.

You can select from the available plot types. For more information about the different EM type plots, see [Types of EM Analysis Plots](#).

**15.** Click *Clear Results* to clear the results.

**16.** Click *All Power Nets* to view EM plots for all power nets.

**17.** Click *All Signal Nets* to view EM plots for all signal nets.

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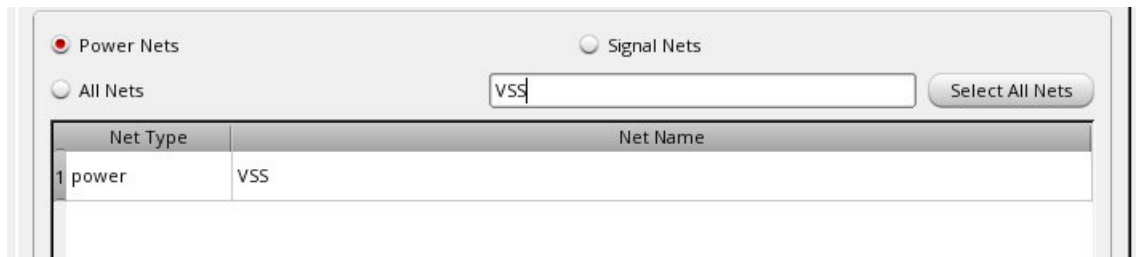
### EM Analysis Results

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18. Click *Select All Nets* to select all the nets listed in the table. For example, if you select *Power Nets* and click *Select All Nets*, all power nets listed in the table are selected. The list box lists *Net Type* and the corresponding *Net Name*.

**Note:** You can search for specific nets for which you want to plot results by typing the net name in the text field provided in the form. The list box is updated to display information about the specified net.

The net name is case-sensitive. This is shown in the image below.



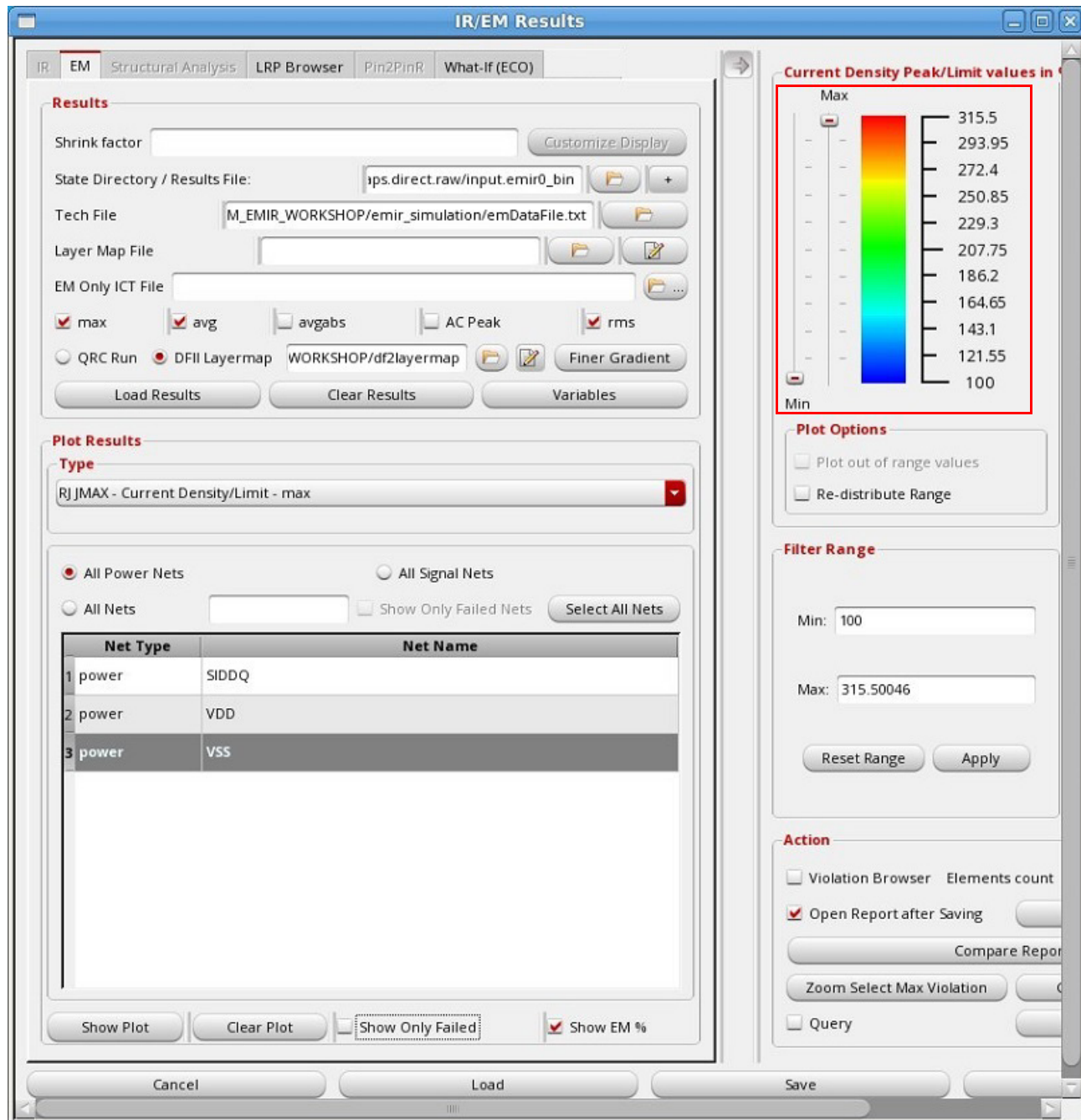
19. Click *Show Only Failed* to plot results only for those nets that failed the EM check. Selecting this option will set the minimum value for the slider to 1.
20. Click *Show EM%* to display the EM violations as percentages. The *Min - Max* slider range displays the EM violations as a percentage of Current Density and Current Density limit ( $J/J_{\text{limit}}$ ) values. A percentage of 100 and above indicates EM violations. This is shown in image below.

**Note:** The *Show Only Failed* and *Show EM%* options are disabled when non-ratio type plots are selected in the *Plot Results* group box. For details of plot types, see [Types of EM Analysis Plots](#).

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## EM Analysis Results

Figure 8-3 Viewing EM Violations as Percentages



**Note:** If a net contains multiple pins, the pins on the same net may be shorted together. For more information, see the Port Order Handling section in the “Postlayout Simulation” chapter of the *Spectre Circuit Simulator and Accelerated Parallel Simulator User Guide*.

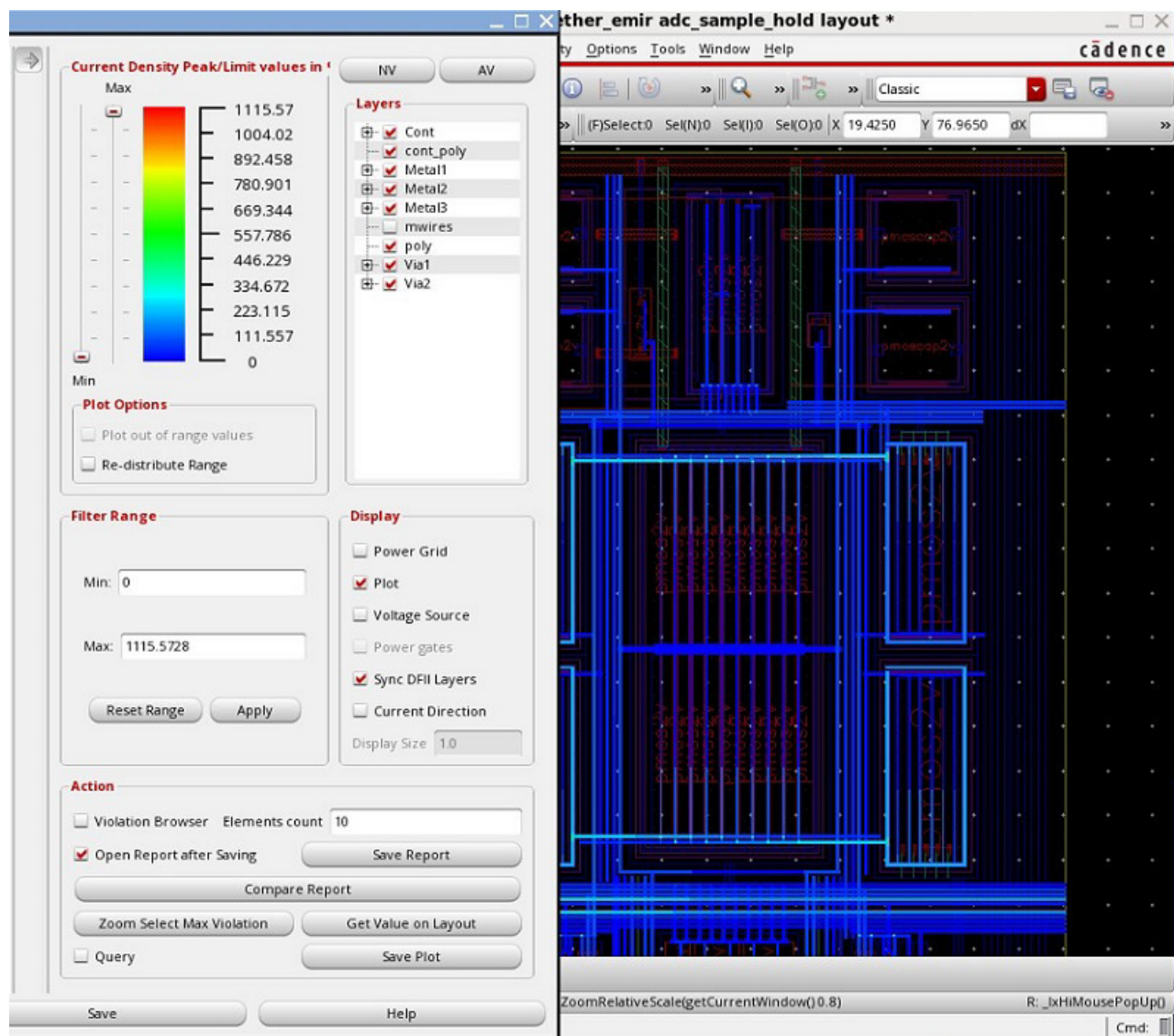
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### EM Analysis Results

21. Click *Show Plot* to view the plot in the layout. When you click *Show Plot*, the IR/EM Results form expands to show the available plot display options. In this form, you can customize the EM analysis plot displays. You can use these options to customize the displayed plots.

These options are explained in detail in [Specifying the Display Options for IR/EM Plots](#) section in the “IR Drop Analysis Results” chapter. The figure below shows the display options in the expanded IR/EM Results form and the EM results plot for all signal nets.

**Figure 8-4 Viewing the EM Plot for All Signal Nets**



22. Click *Clear Plot* to clear the plot for the selected net from the Virtuoso layout. For this, select the net for which you want to clear the plot in the list box and then click *Clear Plot*.

## Displaying Current Directions for EM Plots

When you load EM results and click *Show Plot*, the expanded IR/EM Results form opens. In this form, there are options provided for displaying the current direction between nodes and for customizing the size of the arrows showing the direction of the flow of current. In the image above, the *Display* group box shows the following options:

- *Current Direction*: Check this option to enable the display of current directions in the layout for any EM plot type.
- *Display Size*: Specify the size of the symbols that are used for displaying the current directions. You can increase or decrease the size of the symbols based on your requirements. The acceptable range is between 0 and 5. If you specify a value greater than 5, the software will set the display size to the maximum possible size, which is 5.

When the *Current Direction* option is enabled, the plot in the layout shows white highlights for the current direction flow of selected nets. The highlight appears on top of the plot highlights. The current direction plot honors the following user settings:

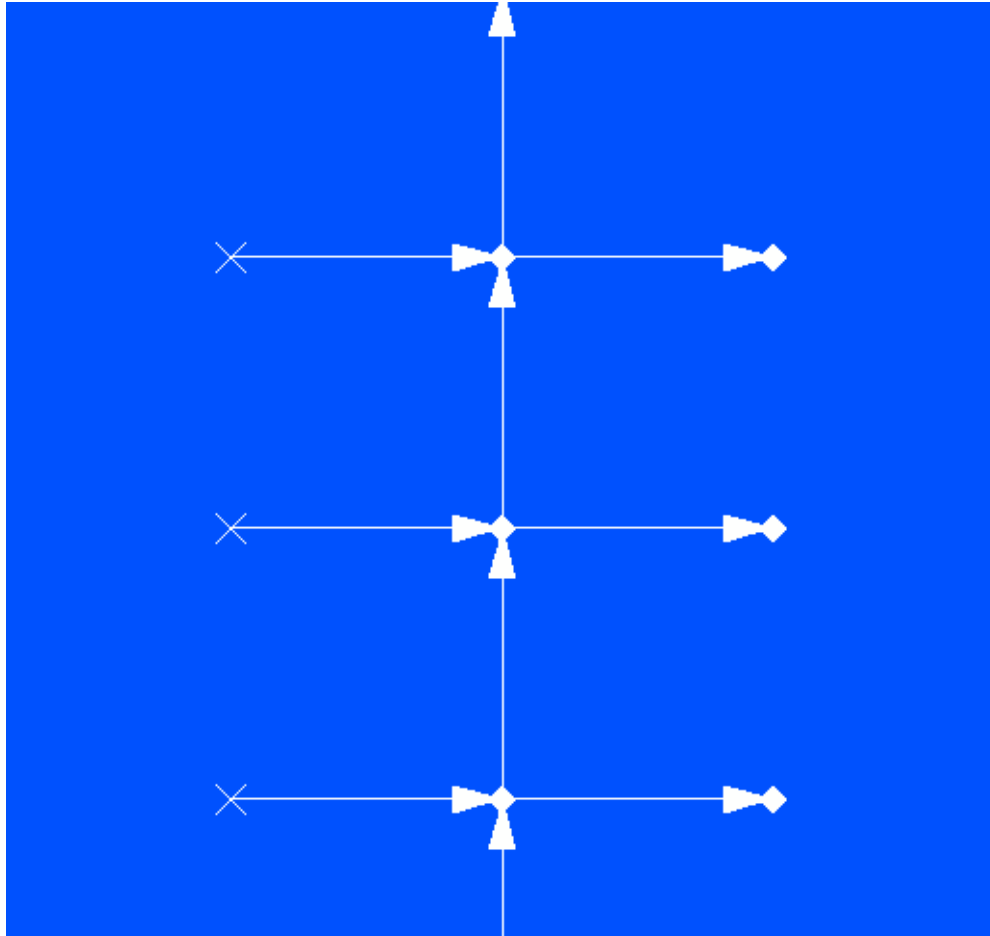
- Layer selection specified in the *Layers* group box
- The *Select Nets* option in the *Type* group box of the IR/EM Results form, and
- *Show Only Failed* check in the IR/EM Results form

**Note:** The *Min/Max* slider range setting is not honored by the current direction plot. The plot displays current directions for all nodes.

- For metal layers, arrows are used to indicate the flow of current in the directions; "E", "W", "N", "S", "NE", and so on. For example, if the direction of current is from West to East, the arrow will be horizontal and will point from left-to-right while if the direction of current is South to North, the arrow will be vertical and will point from bottom-to-top.
- For vias, the direction of the current is from layer -> to layer. A cross symbol (X) is used to show currents flowing down, while a diamond-shaped dot shows currents flowing up.

This is shown in the image below.

**Figure 8-5 Current Flow Direction Representation in the layout**



## Reporting the Direction of Currents in the EM Result File

You can print information about the direction of current flow for each layer in the EM result file. This current direction is reported in the “Current Direction” column in the report.

You can specify the reporting of current direction in batch mode in either of the following ways:

- Specify the following in the `vfibatch` command file:

```
set_variable idirn true
```

- Specify the following in the EMIR control file:

```
emirutil idirn=true
```



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### EM Analysis Results

**Note:** For more information on how to set variables, see “Variables” chapter. For more information about the available EMIR control file options, see EMIR Control File Options Supported in Voltus-Fi-XL in the “Data Preparation” chapter.

The direction of current is printed in the following manner:

- For metal layers, the direction of current is printed as “E”, “W”, “N”, “S”, “NE”, and so on. For example, if the report prints the direction of current as “E”, it means the current is flowing from West to East. If the report prints the direction of current as “N”, it means the current is flowing from South to North.
- For vias, the direction of current is printed as “from layer -> to layer”. For example, in below figure, current direction for via2 is metal3->metal2.

### Sample EM Analysis Results File

```
ELECTROMIGRATION ANALYSIS RESULTS
VERSION = 1
BINARY FILE = ./emir_simulation/aps.direct.raw/input.emir0_bin
RESULTS FILE CREATED = 2013-Nov-18 01:17:39 (2013-Nov-18 09:17:39 GMT)
USER SUPPLIED VALUES:
 RESULTS TYPE = TRANSIENT
 TRANSIENT START = 0
 TRANSIENT STOP = 1.2e-07
 SIM TEMPERATURE = 27 C
 AVERAGE = nil
 AVERAGE ABS = nil
 AVERAGE POS = nil
 ACPEAK = nil
 CUSTOM = nil
 RMS = nil
 PEAK = t

----- NET "bias100" -----
max
Pass/Fail % Resistor layer Current Width PathLength I limit X1 Y1 X2 Y2 J/JMAX Res ViaArea No of width/#via CurrentDirection
(mA) (um) (um) (mA)
pass-75.5 rg1974 metal3 1.61816 2 103.149 6.6 0.25 1.75 0 0 0.245176 0.008084 NA NA 0.490352 S
pass-79.9 rg1973 metal3 1.32752 2 103.149 6.6 0.55 1.75 0.2 1.75 0.20114 0.00972 NA NA 0.40228 E
pass-81.0 rn3592 metal2 0.119003 0.6 89.909 1.32 41.95 11.4 41.7 11.13 0.0901539 0.01622 NA NA 0.0540923 NE
pass-98.7 rn17660 via2 0.0282677 NA 89.909 2.2 6.745 10.95 6.74 10.90 0.0128489 2.66 16900 1 1 metal3->metal2
pass-98.7 rn17662 via2 0.0282677 NA 89.909 2.2 7.025 10.90 7.02 10.90 0.0128489 2.66 16900 1 1 metal3->metal2
```

### Video

To view the demonstration on plotting the EM analysis results in Voltus-Fi, see [Viewing and Querying the EM Analysis Results in Voltus-Fi-XL](#) video.

Access to this video will depend on the availability of a web browser and a Cadence Online Support account.

## Generating EM Reports in Voltus-Fi-XL

You can generate both textual and html reports for EM analysis results in Voltus-Fi-XL from the simulation results by specifying the EMIR control file (`emir.conf`), the EMIR database file, and the output directory.

For more information about generating EM reports in Voltus-Fi-XL, see [Reports Generated Using the EMIR Control File](#).



For more information about default reports generated for EM analysis and to view a sample EM analysis report, see [Default Reports Generated for EMIR Analysis](#).

## Types of EM Analysis Plots

Following EM Plots are available for viewing and debugging:

- [RJ JMAX – Current Density/Limit and J\\_MAX – Current Density Plots](#)
- [JAVG – Current Density/Limit and J\\_AVG Current Density Plots](#)
- [JABSAVG – Current Density/Limit and J\\_ABSAVG – Current Density Plots](#)
- [JACRMS – Current Density/Limit and J\\_ACRMS – Current Density Plots](#)
- [JACPEAK – Current Density/Limit and J\\_ACPEAK – Current Density Plots](#)

**Note:** In addition to the above, the TC and RC plots are common to all analysis types. However, the TCAVG, TCRMS, RCAVG, and RCRMS plots are only available in the `qrcTechFile` flow and the EM Only ICT File flow. They are not supported in the `emDataFile` flow.

**Note:** For details, see [TC, TCAVG, TCRMS – Tap Current Plots](#) and [RC, RCAVG, and RCRMS – Resistor Current Plots](#) in the “IR Drop Analysis Results” chapter.

The different EM analysis plot types available and the corresponding analysis types are listed below:

- TC plots – max, avg, avgabs, AC Peak, rms analyses
- TCAVG, TCRMS plots – max, avg, avgabs, AC Peak, rms analyses (only available in the `qrcTechFile` flow)
- RC plots – max, avg, avgabs, AC Peak, rms analyses
- RCAVG, RCRMS plots – max, avg, avgabs, AC Peak, rms analyses (only available in the `qrcTechFile` flow)
- RJ JMAX and J\_MAX plots – max analysis
- JAVG and J\_AVG plots – avg analysis
- JABSAVG and J\_ABSAVG plots – avgabs analysis
- JACRMS and J\_ACRMS plots – rms analysis
- JACPEAK and J\_ACPEAK – AC Peak analysis (only available in the `qrcTechFile` flow)

## **RJ JMAX – Current Density/Limit and J\_MAX – Current Density Plots**

These plots are applicable to the “max” analysis type. The J\_MAX plot reports the Current Density (J) value based on peak currents. It is used to locate high Current Density areas in the design.

The RJ JMAX or the Current Density/Limit plot reports the ratio of the wire Current Density to the Current Density limit that is allowed by the process – (J/JMAX) based on peak currents. So, all wires should have a ratio of less than 1.0. You can debug or fix the Current Density violations that have a ratio of more than 1.0. The key advantage is that the value of this ratio is consistent across designs.

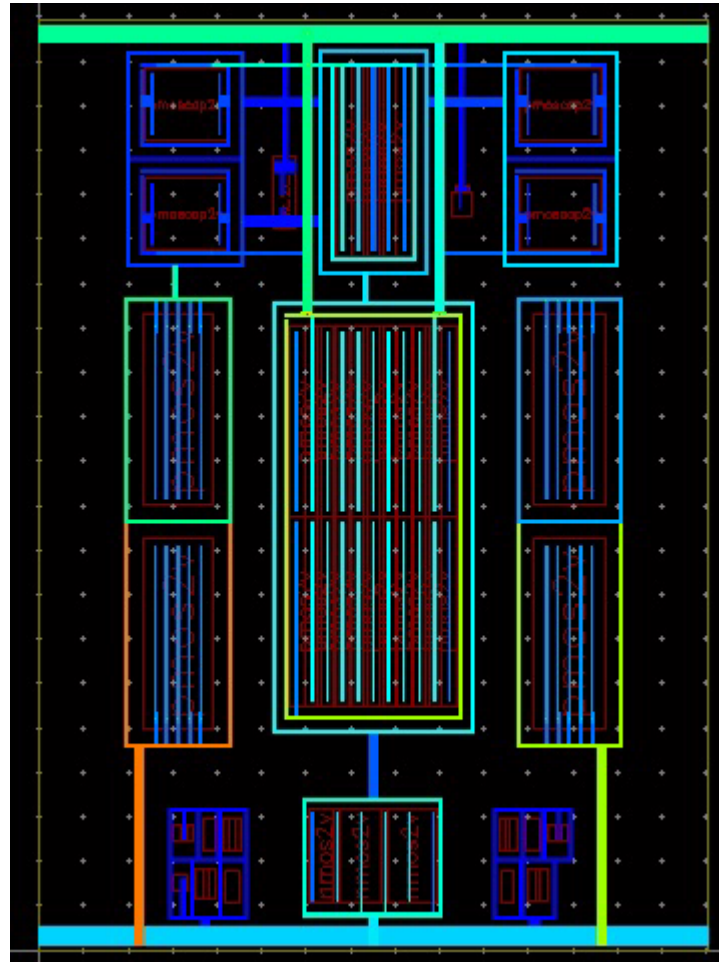
### ***Information Displayed in Annotation Browser***

The EM/IR tab of Annotation Browser displays the following columns for the Current Density plot types for peak currents:

- Value
- Layers
- Short Message
- Density
- Current
- Current Limit (mA)
- Needed Width
- Width
- Length
- Resistance
- Via Area
- Number of Vias
- Needed Number of Vias
- Net

The plot below shows the Current Density limit (J/JMAX) violation values based on peak currents for the selected power nets.

**Figure 8-6 RJ JMAX Plot for Specified Power Nets – Displaying Customized Violation Range**



## JAVG – Current Density/Limit and J\_AVG Current Density Plots

These plots are applicable to the “avg” analysis type. The J\_AVG plot analyzes and reports the Current Density (J) values based on average currents while the JAVG plot reports the J/JMAX violation values based on the average currents.

### *Information Displayed in Annotation Browser*

The EM/IR tab of Annotation Browser displays the following columns for the Current Density plot types for average currents:

- Value

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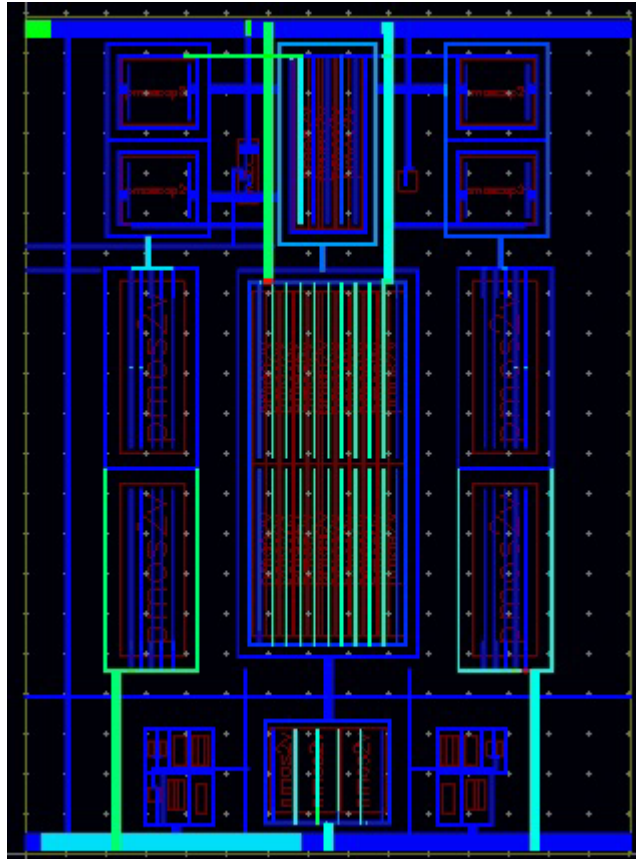
### EM Analysis Results

---

- Layers
- Short Message
- Density
- Current
- Current Limit (mA)
- Needed Width
- Width
- Length
- Resistance
- Via Area
- Number of Vias
- Needed Number of Vias
- Net

The plot below shows the average Current Density limit (J/JMAX) violation values based on average currents for the selected nets. The violation range is customized using the *Min Max* sliders in the IR/EM Results form.

**Figure 8-7 JAVG Plot for Selected Nets – Displaying the Customized Violation Range**



### **JABSAVG – Current Density/Limit and J\_ABSAVG – Current Density Plots**

These plots are applicable to the “avgabs” analysis type. The J\_ABSAVG plot analyzes and reports the Current Density (J) values based on the average of the absolute current while the JABSAVG plot reports the J/JMAX violation values based on the average of the absolute current.

#### ***Information Displayed in Annotation Browser***

The EM/IR tab of Annotation Browser displays the following information for the Current Density plots for the average of the absolute currents:

- Value
- Layers
- Short Message

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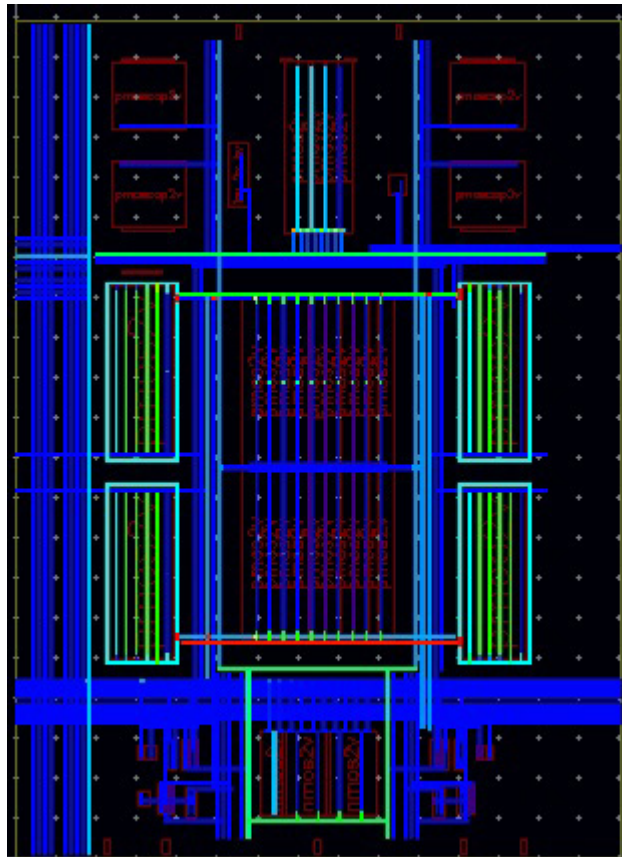
### EM Analysis Results

---

- Density
- Current
- Current Limit (mA)
- Needed Width
- Width
- Length
- Resistance
- Via Area
- Number of Vias
- Needed Number of Vias
- Net

The plot below shows the Current Density limit (J/JMAX) violation values based on the average of the absolute currents for all signal nets. The violation range is customized by using the *Min Max* sliders in the IR/EM Results form.

**Figure 8-8 JABSAVG Plot for All Signal Nets – Displaying the Customized Violation Range**



## **JACRMS – Current Density/Limit and J\_ACRMS – Current Density Plots**

These plots are applicable to the “rms” analysis type. The J\_ACRMS plot analyzes and reports Current Density (J) values based on the root mean square (RMS) value of the AC currents while the JACRMS plot reports the J/JMAX violation values based on the RMS value of the AC currents.

### ***Information Displayed in Annotation Browser***

The EM/IR tab of Annotation Browser displays the following columns for Current Density plots based on the RMS value of the AC currents:

- Value
- Layers

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### EM Analysis Results

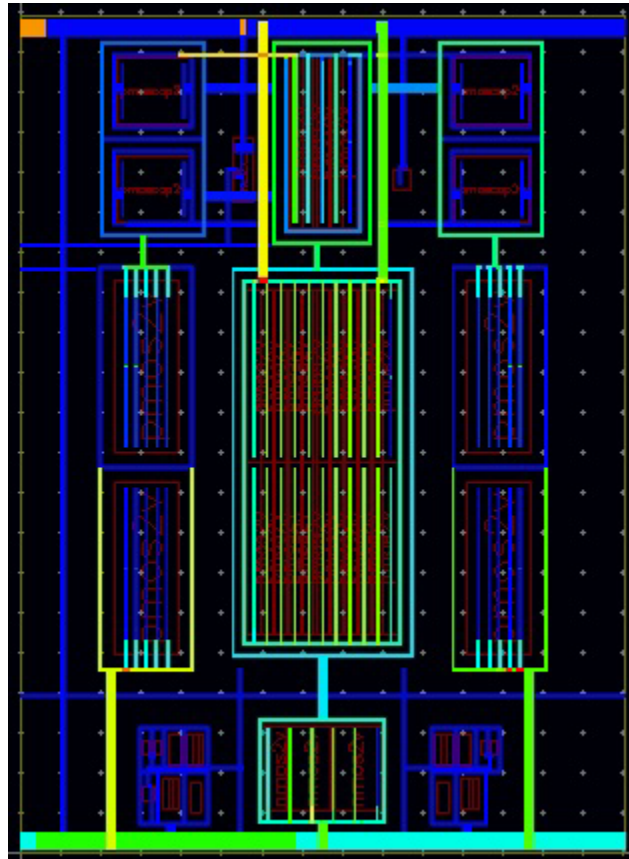
---

- Short Message
- Density
- Current
- Current Limit (mA)
- Needed Width
- Width
- Length
- Resistance
- Via Area
- Number of Vias
- Needed Number of Vias
- Net

The plot below shows the Current Density (J/JMAX) violation values based on the RMS value of the AC currents for all power nets. The violation range is customized by using the *Min Max* sliders in the IR/EM Results form.



**Figure 8-9 JACRMS - Plot – Displaying the Customized Violation Range for All Power Nets**



### JACPEAK – Current Density/Limit and J\_ACPEAK – Current Density Plots

These plots are applicable to the “AC Peak” analysis type, which is only available in the `grcTechFile` flow. These plots are not available in the list for the `emDataFile` flow even if the analysis type “AC Peak” is selected. The `J_ACPEAK` plot analyzes and reports Current Density (J) values based on the peak value of the AC currents while the `JACPEAK` plot reports the J/JMAX violation values based on the peak value of the AC currents.

### Information Displayed in Annotation Browser

The EM/IR tab of Annotation Browser displays the following columns for Current Density plots based on the peak value of the AC currents:

- Value

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### EM Analysis Results

---

- Layers
- Short Message
- Density
- Current
- Current Limit (mA)
- Needed Width
- Width
- Length
- Resistance
- Via Area
- Number of Vias
- Needed Number of Vias
- Net

---

## Self-Heating Effect Analysis

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  - Running Quantus Parasitic Extraction
  - Running Post-Layout Simulation using Spectre APS on page 295
  - Viewing the Analysis Plots in Voltus-Fi-XL on page 296
- Types of Plots on page 297
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## **Voltus-Fi Custom Power Integrity Solution XL User Guide**

### **Self-Heating Effect Analysis**

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- [Command for Encrypting Data in param.sh File](#) on page 312
- [Generating Reports](#) on page 313

## Overview

The following topics are covered in this section:

- [Self-Heating Effect Analysis](#)
- [Thermal-Aware DC EM Analysis](#)
- [Hierarchical SHE Analysis](#)

## Self-Heating Effect Analysis

As semiconductor technology scales down to sub-micron dimensions, power density increases, resulting in temperature increases—self-heating effect (SHE)—in devices. Semiconductor components are sensitive to temperature variations.

The main effects of self-heating are as follows:

- Degraded carrier mobility, which leads to a reduced on-current of transistors and, therefore, slower speed
- Higher interconnect metal resistivity, which results in longer delays
- Increased failure rate and reduced reliability of electronic devices, with secondary effects such as interconnect electromigration

In digital circuits, the key consequences are longer delays due to increased interconnect resistance and reliability issues due to electromigration. Analog circuits are more sensitive to temperature variations, which may degrade matching properties. Therefore, thermal simulations and modeling play an important role in the design of integrated circuits today.

The self-heating effect is driven by front-end-of-line (FEOL) self heat and back-end-of-line (BEOL) self heat.

- The FEOL is the first part of IC fabrication where the individual devices such as transistors, capacitors, and resistors are patterned in the semiconductor. FEOL covers everything up to, but not including, the deposition of metal interconnect layers.
- The BEOL is the second part of IC fabrication where the individual devices get interconnected with the wiring on the wafer. Both contribute towards the maximum rise in temperature or  $\Delta T$  that causes the self-heating effect.

## Thermal-Aware DC EM Analysis

The thermal-aware DC EM flow considers the local thermal effect – this includes both joule-heating and self-heating – in DC EM checks.

The thermal-aware DC EM flow is enabled by setting the following variable:

In the Variables form on the EM tab of the IR/EM Results form by specifying the following variable:

```
coupledSH true
```

In batch mode by specifying the following command:

```
set_variable coupledSH true
```

Voltus-Fi-XL supports the SHE analysis flow and the thermal-aware DC EM flow visualization. You can view the results of these analyses by plotting them on the Virtuoso layout to show the worst deltaT violations. You can then debug your design to reduce the self-heating effect. In this chapter, the subsequent sections will provide details of the SHE analysis flow that are also relevant to the thermal-aware DC EM flow. Additional parameters and commands for the latter flow will be highlighted within these sections.

## Hierarchical SHE Analysis

Voltus-Fi supports the generation of reports that are used by Voltus for Hierarchical SHE analysis. For this, the following option of the `emirutil` command is specified in the configuration file:

```
emirutil selfheating_report=[type=m0s-region | metal filename=<filename>
layer=<layername> tile=<no.of divisions in y-direction, no. of divisions in
x-direction>]
```

For details of the above command, see [EMIR Control File Options](#). The SHE reports that are generated are specified while performing hierarchical SHE analysis, using the Voltus command, `analyze_self_heat`.



This feature is only available when the VTS-Fi-AA license is checked out. This is an advanced license that is not available as part of the Voltus-Fi-XL license.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Self-Heating Effect Analysis

## Data Requirements

The table below lists the inputs that are required for, both the SHE analysis and the thermal-aware DC EM analysis in Voltus-Fi-XL:

**Table 9-1 Data Required for SHE and Thermal-Aware DC EM Flow**

| Data                                            | Purpose               | Details                                                                                                                                                                                  |
|-------------------------------------------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Model cards                                     | Simulation            | Spice model cards, which support SHE analysis for simulation                                                                                                                             |
| Detailed Standard Parasitic Format (xDSPF) file | Simulation            | A detailed standard parasitic extraction file that contains x, y coordinates and l (length), and w (width) values. This file is required post simulation.                                |
| qrcTechFile or the ICT file                     | EMIR and SHE analysis | A file containing current limits for each process layer. This file is usually available through a foundry.<br><br><b>Note:</b> This file should contain the $I_{rms}$ equation.          |
| EMIR control file (emir.config)                 | Simulation            | A configuration file needed to run EMIR and SHE analysis with Spectre® APS solver run.                                                                                                   |
| param.sh file                                   | SHE analysis          | File for deltaT FEOL and BEOL calculations.<br><br><b>Note:</b> The information contained in the param.sh file is proprietary. To use this file, you need a collateral from the foundry. |
| XML file                                        | SHE analysis          | A file created after simulation and provided as an input file for the Voltus-Fi-XL SHE flow. It contains $\Delta T$ information for all devices in the layout.                           |

### Important

To run the self-heating flow and the thermal-aware DC EM flow in batch mode, it is mandatory to set the following environment variable:

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Self-Heating Effect Analysis

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```
setenv CDS_XVNC_TENBASE '+'
```

This variable is not required for run the SHE flow and the thermal-aware DC EM flow in the GUI.

This limitation will be removed in a future release of the software.

## Compatible Software Versions

The table below lists the compatible software versions that are needed for running the SHE analysis flow and the thermal-aware DC EM flow:

| Product Name  | Release Version                                        |
|---------------|--------------------------------------------------------|
| PVS/Pegasus   | PVS 13.1.1 HF1 and later to Pegasus 18.20              |
| EXT           | EXT 13.2.0 and later                                   |
| MMSIM/SPECTRE | MMSIM 13.1.1 ISR10 and later to SPECTRE 16.1.0 onwards |

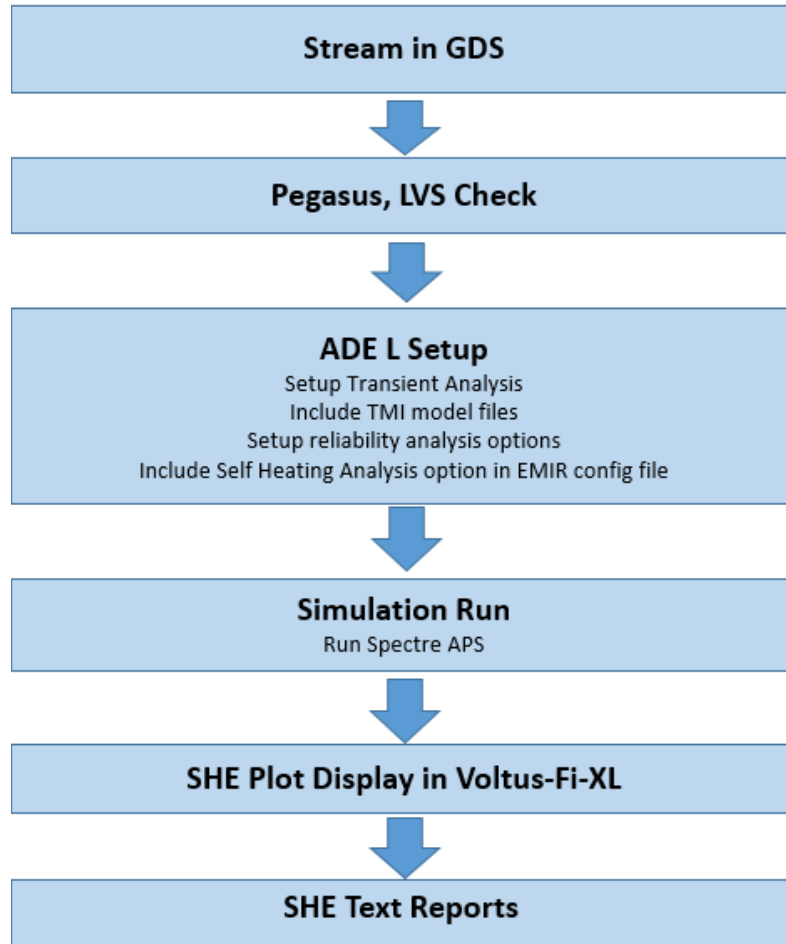
**Note:** It is recommended that if any of the above release versions are not available, a later version of the product be used.

## Flow Overview

The diagram below illustrates the Pegasus/PVS LVS – Quantus – Virtuoso® Analog Design Environment L for Netlist and Config file generation – Spectre® APS – Voltus-Fi-XL flow for SHE analysis and thermal-aware DC EM analysis.



**Figure 9-1 The High-Level Flow**



## Performing the Analysis

The following key tasks are performed for the SHE analysis and the thermal-aware DC EM flow:

- Running Pegasus or PVS LVS
- Running Quantus Parasitic Extraction
- Running Post-Layout Simulation using Spectre APS
- Viewing the Analysis Plots in Voltus-Fi-XL

These steps are detailed in subsequent sections.

## Running Pegasus or PVS LVS

This is the first step, which involves verifying the layout connectivity and creating an LVS database that is required for the subsequent Quantus parasitic extraction.

**Note:** Pegasus, the new physical verification system, will be available in the 18.2 physical verification release.

## Running Quantus Parasitic Extraction

This is the second step, which involves using the Quantus engine to create the xDSPF file for all the device parameters and interconnect parasitics.

### Data Requirements for Extraction Setup

While setting up extraction for SHE analysis, ensure the following:

- The Quantus command file should include the following command:

```
output_setup \
-keep_temporary_files "true"
```

When set to `true`, the above command causes Quantus to leave the temporary files in the directory specified by the `output_setup -temporary_directory_name` command.

When set to `false`, Quantus removes the temporary files when extraction has completed. By default this option is set to `false`.

For more information about the Quantus command file options, see the “Quantus Command Files” chapter in the *Quantus Extraction Users Manual*.

- The Quantus version used for performing SHE analysis in Voltus-Fi-XL should be either the same or higher than that being used in the extraction step
- The layout should open within Virtuoso without any pop-up window.
- The OD shapes should be present in the layout for the OD layers specified in the file mentioned through the `shParamFile` option.

### GUI Use Model

In the main menu of the Virtuoso Layout Suite, choose Quantus. Choose the Run Pegasus – Quantus or PVS – Quantus option. The Quantus Parasitic Extraction Run Form opens. Run extraction.

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### Self-Heating Effect Analysis

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For detailed information about all the settings in the Quantus Parasitic Extraction Run form, see the “Quantus Graphical Interface” chapter in *Quantus Extraction Users Manual*.

**Note:** Pegasus, the new physical verification system, will be available in the 18.2 physical verification release.

The output includes the following:

- An xDSPF file, which contains all the parasitic information of the design – all the nets, x- and y-coordinates of transistors, parasitic resistors, and nets connected.
- A Quantus output directory, which contains the shape database.

## Running Post-Layout Simulation using Spectre APS

Once extraction is done, run post-layout simulation using the EMIR control file (`emir.config`) file to create the SHE analysis reports. Before performing simulation, ensure the following in the ADEL or the Simulation window:

- Setup transient analysis.
- Choose *Setup – Simulation File – Model Files* to add the SHE Models. These models are required to create the `*.dtemp#.xml` file that contains information about the increase in temperature for each device.
- Select *Simulation – Reliability – Setup*. The Reliability form opens. In this form, specify the following:
  - ☐ Select *Enable Reliability* to enable reliability simulation.
  - ☐ Select *Enable TMI Flow*.
  - ☐ In the *self-heating/aging(tmiShe)* cyclic field, select *self-heating only (tmiShe=1)*. This option enables only the TMI self-heating mode.

**Note:** This option is available in IC616ISR8 and ICADV12.1ISR10 releases with MMSIM13.1ISR10 or above versions.

Now, you can start the simulation either by using *Simulation – Run* option or clicking the “run simulation” button provided in the right panel of the ADEL window.

**Note:** For detailed information about how these options are set, see “Using the Reliability Simulator Interface” chapter in the *Virtuoso Analog Design Environment L User Guide*.

**Note:** The EMIR control file options required to be specified for SHE analysis are detailed in the [EMIR Control File Options](#) section. These options can also be specified in the Variables form that opens from the EM tab of the IR/EM Results form.

## Viewing the Analysis Plots in Voltus-Fi-XL

Once the simulation run is complete, the simulation database saved in the \*.emir#.bin file is loaded into Voltus-Fi-XL to view the SHE analysis plots. The SHE analysis and thermal-aware DC EM analysis plots are available on the EM tab of the IR/EM Results form.

The steps for populating the EM tab of the IR/EM Results form are detailed in the [Viewing the EM Analysis Results](#) section of the “EM Analysis Results” chapter.

In addition, for the SHE analysis flow, ensure that the following inputs are provided on the EM tab of the IR/EM Results form:

- Enable the *QRC Run*.
- In the QRC Run Location pop-up window, provide the details of the *QRC Run Directory* and *Run Name*.
- Click *Variables* to open the Variables form. In this form, specify the following variables:
  - ☐ [shParamFile](#)
  - ☐ [shXMLFile](#)

**Note:** For a sample `shParamFile`, see [shParamFile](#) in the “File Formats” chapter.

**Note:** To enable the thermal-aware DC EM analysis, in addition to the above variables, the following variable needs to be set to `true`:

- ☐ [coupledSH](#)
- Select *rms* and *avg*.

This form is shown below.

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## Self-Heating Effect Analysis

Figure 9-2 The IR/EM Results Form

**IR/EM Results <@sjfib255>**

IR EM Structural Analysis LRP Browser Pin2PinR What-If

**Results**

Shrink factor

State Directory / Results File:

Tech File

Layer Map File

EM Only ICT File

☒ max ☒ avg ☐ avgabs ☐ AC Peak ☒ rms

☒ QRC Run ☐ DFII Layermap ☐ WORKSHOP/df2layermap

Load Results Clear Results Variables

**Plot Results**

Type: Thermal - DeltaT Regions

☐ All Power Nets ☐ All Signal Nets ☒ All Nets ☐ Show Only Failed Nets

|   | Net Type | Net Name |
|---|----------|----------|
| 1 | signal   | X51/10   |
| 2 | signal   | X51/9    |
| 3 | signal   | X52/10   |
| 4 | signal   | X52/9    |
| 5 | signal   | X53/10   |
| 6 | signal   | X53/9    |
| 7 | signal   | X54/10   |
| 8 | signal   | VEA/9    |

Show Plot Clear Plot ☐ Show Only Failed ☐ Show EM %

Cancel Load Save Help

**filter info**

Max 5 4.5 4 3.5 3 2.5 2 1.5 1 0.5 0 Min

**Plot Options**

☐ Plot out of range values ☐ Re-distribute Range

**Filter Range**

Min: 0 Max: 5

Reset Range Apply

**Display**

☐ Power Grid ☒ Plot ☐ Voltage Source ☐ Power gates ☒ Sync DFII Layers ☐ Current Direction

Display Size 1.0

**Action**

☒ Violation Browser Elements count 10

☒ Open Report after Saving

☐ Query

- In the Plot Results group box, the self-heating effect analysis plots are available in the list. These are detailed in the section below.

## Types of Plots

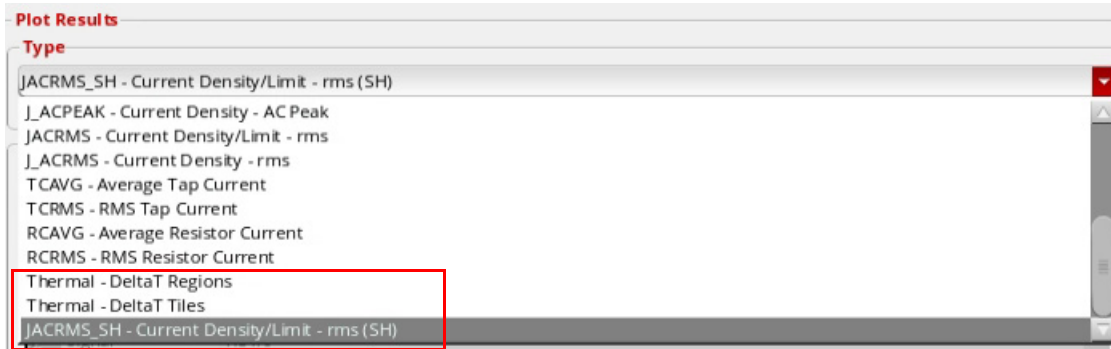
The types of self-heating effect analysis and thermal-aware DC EM analysis plots that are available in the list are detailed below.

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### Self-Heating Effect Analysis

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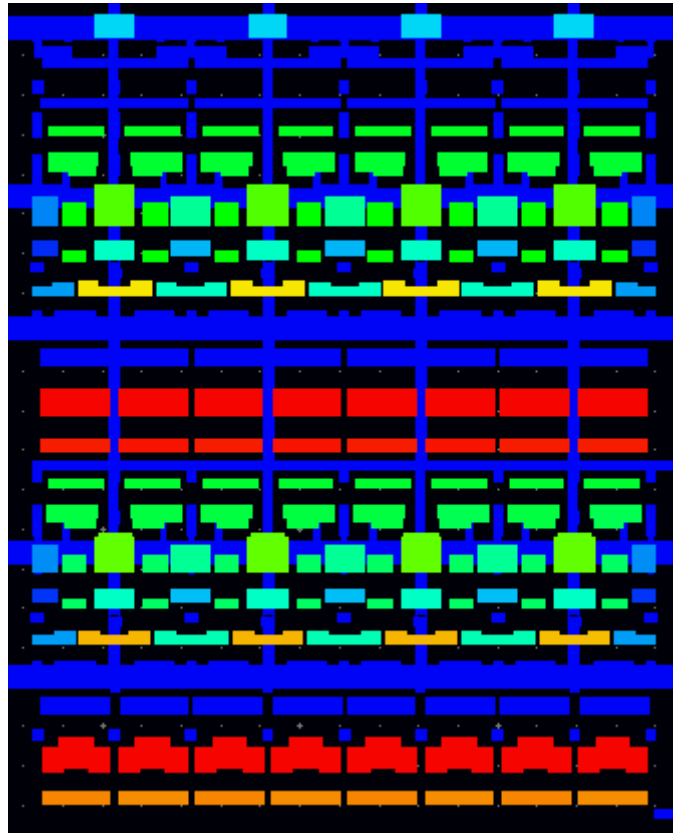
**Figure 9-3 Plot Types**



### Thermal-DeltaT Regions

Reports the increase in temperature (deltaT) for all OD and metal layers in the entire design on the Virtuoso layout. This plot provides a detailed view of the temperature variations on the design. This is shown in the figure below.

Figure 9-4 The Thermal-DeltaT Regions Plot

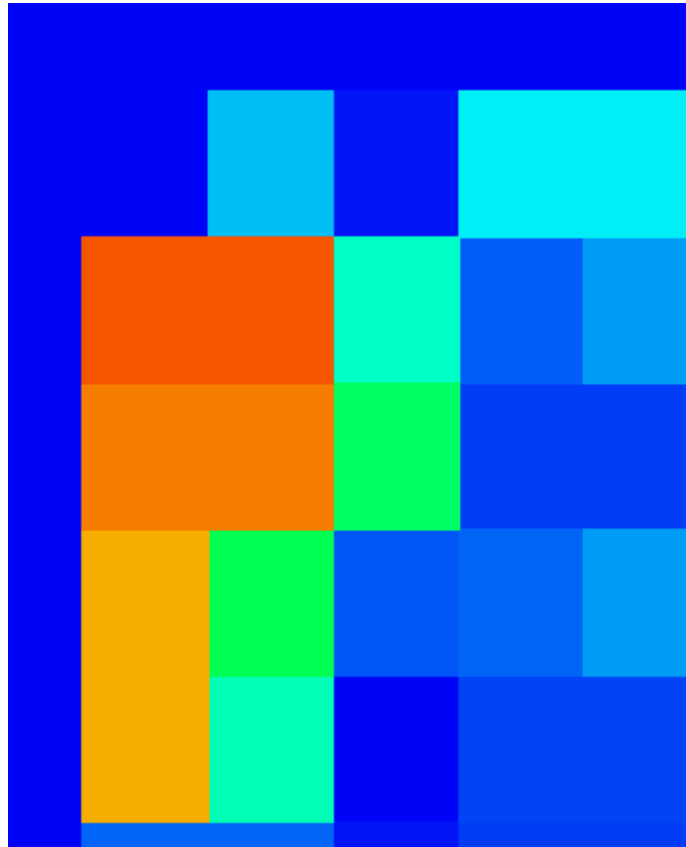


## Thermal-DeltaT Tiles

Reports the increase in temperature (deltaT) per tile based on the number of tiles, specified in the IR/EM Results form, on the Virtuoso layout. For this plot, specify the dimensions for the tiles in the `Tiles` text box on the *EM* tab of the IR/EM Results form. The design in the layout is divided into sections based on the number of tiles that are specified, for example, 15x20.

On the Virtuoso layout, the tiles are colored on the basis of the maximum temperature increase in each tile. This is shown in the figure below.

**Figure 9-5 The Thermal-DeltaT Tiles Plot**



### **RJ\_SH - Current Density/Limit - max (SH)**

Analyzes and reports the J/JMAX violations based on peak current after performing the SHE analysis.

**Note:** This plot is not available for the thermal-aware DC EM flow

### **JAVG\_SH - Current Density/Limit - avg (SH)**

Analyzes and reports the J/JMAX violations based on the average currents after performing the SHE or thermal-aware DC EM analysis.



## **JACRMS\_SH - Current Density/Limit - rms (SH)**

Analyzes and reports J/JMAX violations based on the RMS value of the AC currents after performing the SHE analysis. To display the worst deltaT violations, specify the self-heating current limit using the `shRmsLimitThreshold` variable.

**Note:** This plot is not available for the thermal-aware DC EM flow.

## **Re-Evaluation of EM Limit Based on dTemp**

The EM effect is re-evaluated based on the new temperature. In the SHE flow, this temperature is the sum of the simulation temperature and the changed temperature due to the self-heating effect. In the thermal-aware DC EM flow, this temperature is the sum of the simulation temperature and the changed temperature due to joule heating and the self-heating effect.

The `Current_Limit` is calculated based on this new temperature and compared with the actual current flowing through the metal resistor to find the EM pass or fail.

The `shEMEffect` variable is used to re-evaluate the EM limit based on individual metal BEOL\_T and tile BEOL\_T temperatures. This variable is set using the `set_variable` command in the Voltus-Fi command file:

To re-evaluate EM on individual metal BEOL\_T:

```
set_variable shEMEffect beolT
```

To re-evaluate EM limit based on tile BEOL\_T temperature:

```
set_variable shEMEffect tiles_no.of divisions in y-direction X no.
of divisions in x-direction
```

## EMIR Control File Options

A complete list of the EMIR control file options that are supported in Voltus-Fi-XL is provided in the table, EMIR Control File Options Supported in Voltus-Fi-XL, in the “Data Preparation” chapter.

In addition, there are some options that are specific to the SHE flow and the thermal-aware DC EM flow. The table below provides a list of options that are specified in the `emir.conf` file for these analyses.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Self-Heating Effect Analysis

**Table 9-2 Supported EMIR Control File Options for Self-Heating Effect Analysis**

| Keyword  | Option Set                                 | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                | Default Value |
|----------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| net      | analysis=[selfheating]                     | Turns on the self-heating effect analysis for the specified device under test (DUT).<br><br><b>Note:</b> Ensure that the <code>Irms</code> option is specified in the control file.                                                                                                                                                                                                                                        | none          |
|          | selfheating_skip inst=[notDUT]             | Specifies the instances on which SHE analysis will not be performed.                                                                                                                                                                                                                                                                                                                                                       | none          |
|          | selfheating_skip models=[<models to skip>] | Specifies the models on which SHE analysis will not be performed.                                                                                                                                                                                                                                                                                                                                                          | none          |
| emirutil | shParamFile="param.sh"                     | Specifies the self-heating effect analysis parameter file, which is required for calculating the SHE analysis results.<br><br>A sample <code>shParamFile</code> format is provided in the “ <a href="#">File Formats</a> ” chapter.                                                                                                                                                                                        | none          |
|          | filter_em_sh_threshold=value               | Defines the SHE EM analysis threshold value for the resistors being reported. The value for <code>filter_em_sh_threshold</code> is the <code>J/Jlimit</code> value.<br><br><code>filter_em_sh_threshold=1</code> reports only those resistors that have a <code>J/Jlimit</code> value above 1.<br><br><b>Note:</b> Specifying this option is equivalent to filtering all resistors that have passed the EM analysis check. | none          |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Self-Heating Effect Analysis

| Keyword | Option Set                                                                                  | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Default Value |
|---------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         | shXMLFile=[<file>]                                                                          | <p>Specifies the XML file to be used in the SHE analysis flow. This file contains information about the temperature change for every instance.</p> <p><b>Note:</b> From Spectre16.1 ISR7 release onwards, the path of the XML file need not be specified in the emir configuration file. The software is enhanced to automatically locate and use the file for SHE analysis.</p> <p>Specify the shXMLFile option only when you want to override the existing XML file.</p> | none          |
|         | shEMEffect=[beolT   tiles_no.of divisions in y-direction X no. of divisions in x-direction] | <p>Specifies the basis for the re-evaluation of EM effect.</p> <p>beolT: specifies that re-evaluation will be done on the basis of individual metal BEOL_T.</p> <p>tiles_no.of divisions in y-direction X no. of divisions in x-direction: specifies that re-evaluation will be done on the basis of tile BEOL_T.</p> <p>For example:<br/>shEMEffect=tiles_10x15</p>                                                                                                       | none          |
|         | extendSHRegion=[true   false]                                                               | <p>Specifies whether or not the OD shape extension is to be done.</p> <p><b>Note:</b> This parameter is applicable only to the thermal-aware DC EM flow.</p>                                                                                                                                                                                                                                                                                                               | false         |
|         | extendODRange=value                                                                         | <p>Specifies the range of the OD shape expansion. The unit of this parameter is um (micro meter).</p> <p><b>Note:</b> This parameter is applicable only to the thermal-aware DC EM flow.</p>                                                                                                                                                                                                                                                                               | 1.8           |

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| Keyword | Option Set                                     | Explanation                                                                                                                                                                                                                                                               | Default Value          |
|---------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
|         | <code>extendJouleHeating=[true   false]</code> | Specifies whether or not metal-shape expansion is to be done for joule-heating calculation.<br><br><b>Note:</b> This parameter is applicable only to the thermal-aware DC EM flow.                                                                                        | false                  |
|         | <code>extendMetalRange=value</code>            | Specifies the number of metal pitch for metal expansion.<br><br><b>Note:</b> This parameter is applicable only to the thermal-aware DC EM flow.                                                                                                                           | 0                      |
|         | <code>extendHRRange=value</code>               | Specifies the range of the design resistor shape expansion. The unit of this parameter is um (micro meter).<br><br><b>Note:</b> This parameter is applicable only to the thermal-aware DC EM flow.<br><br>The default value may be different for different process nodes. | 1.8                    |
|         | <code>Tambient=value</code>                    | Specifies the ambient temperature for self-heating analysis. If this value is not specified, the software calculates it as <code>Tj-deltaT</code> .                                                                                                                       | <code>Tj-deltaT</code> |
|         | <code>disableODSH=[true   false]</code>        | When set to <code>true</code> , disables the self-heating effect of devices in the SHE flow.                                                                                                                                                                              | false                  |
|         | <code>disableHRSH=[true   false]</code>        | When set to <code>true</code> , disables the self-heating effect of design resistors in the SHE flow.                                                                                                                                                                     | false                  |
|         | <code>coupledSH=[true   false]</code>          | When set to <code>true</code> , specifies that the thermal-aware DC EM flow should be enabled.                                                                                                                                                                            | false                  |

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### Self-Heating Effect Analysis

---

| Keyword | Option Set                                           | Explanation                                                                                                                                                                                                                                                                    | Default Value |
|---------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         | view=[lib=<lib><br>cell=<cell><br>view=<layout>]     | Specifies the Virtuoso Layout view.<br><br><b>Note:</b> For the software to recognize the cell, view and library, ensure that "cds.lib" is either present in the directory in which EMIR simulation is run or its path is specified using the cds.lib command described below. | none          |
|         | cds.lib="lib_path"                                   | Specifies the path of the cds.lib. It is used to specify the path when the cds.lib is not in the current working directory.<br><br>For example,<br><br>emirutil<br>cds.lib="/home/test/cds.lib"                                                                                |               |
|         | qrc_output=[runDir=dir_name<br>runName=qrc_run_name] | Specifies the Quantus run directory and run name.<br><br>This parameter is required for self-heating effect analysis.                                                                                                                                                          | none          |

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### Self-Heating Effect Analysis

| Keyword | Option Set                                                                                                                                                                             | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Default Value |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         | <pre>selfheating_report=[type=mos-region   metal filename=&lt;filename&gt; layer=&lt;layername&gt; tile=&lt;no.of divisions in y-direction, no. of divisions in x-direction&gt;]</pre> | <p>Generates the self-heating effect report, which is a text file. You can specify whether the report should contain deltaT information for the specified mos-region or metal and resistor or tile-based by using the relevant parameters.</p> <p><b>Example:</b></p> <pre>emirutil selfheating_report=[type=mos-region filename=moh-region-tiles.txt tiles=15x10]</pre> <p><b>Note:</b> To generate hierarchical SHE analysis reports using this command, the VTS-Fi-AA license is required to be checked out. This is an advanced license that is not available as part of the Voltus-Fi-XL license.</p> <p>If you do not want to perform hierarchical self-heating analysis, ensure that this option is not specified in the configuration file.</p> <p>The SHE EM analysis reports can be generated by specifying the <code>print_em_report</code> option in the configuration file with the required <code>-type</code> option. No special license is required for generating these reports. This option is detailed below.</p> | none          |

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### Self-Heating Effect Analysis

| Keyword                                                                                   | Option Set                                                                                                                                               | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Default Value |
|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|                                                                                           | <pre>print_em_report=[net=[all_nets   all_power   all_signal   netname] type=[acrms_sh   avg_sh   peak_sh   acpeak_sh] filename= output_file_name]</pre> | <p>Generates the EM report with the self-heating effect. You can specify the following:</p> <p>filename: create report with the specified filename.</p> <p>net: create report for specified nets - all power nets (all_power), all signal nets (all_signal), all nets (all_nets), or net (netname).</p> <p>type - create report for specified analysis type; acrms_sh, avg_sh, acpeak_sh or peak_sh.</p> <p>For example:</p> <pre>print_em_report=[net=all_nets type=acrms_sh filename= acrms_sh.txt]</pre> | none          |
|                                                                                           | <pre>genRthReport=[true   false]</pre>                                                                                                                   | <p>Generates a thermal resistance report with cell name and its corresponding resistance (Rth) value.</p> <p><b>Note:</b> This parameter is applicable only to the thermal-aware DC EM flow.</p> <p>For example:</p> <pre>emirutil genRthReport=true</pre>                                                                                                                                                                                                                                                  | false         |
| <b>The options listed below are specified only for the SHE flow with heat-sink effect</b> |                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |
| emirutil                                                                                  | <pre>enableSHHeatSink=[true   false]</pre>                                                                                                               | <p>When set to true, specifies that the heat-sink effect should be included in the SHE analysis.</p> <p><b>Note:</b> If this parameter is set to true, ensure that heat-sink models are available.</p>                                                                                                                                                                                                                                                                                                      | false         |



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### Self-Heating Effect Analysis

| Keyword | Option Set                                                              | Explanation                                                                                                                                                                                                                                   | Default Value                                         |
|---------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
|         | <code>extendHeatSinkRange=value</code>                                  | Specifies the expanded region of the OD. The heat sink structure inside this region can only act as heat sink for the specified OD shape.<br><br><b>Example:</b><br><br><code>emirutil</code><br><code>extendHeatSinkRange=0.5</code>         | 0.4                                                   |
|         | <code>connectingODLayers="layer1 layer2 layer#"</code>                  | Specifies the list of layers to identify connecting ODs for heat sink effect. The default value is shown below.<br><br><code>emirutil</code><br><code>connectingODLayers="M0_OD M0_OD1 M0_OD2 MVIA0_1 MVIA0_2 M1"</code>                      | M0_OD<br>M0_OD1<br>M0_OD2<br>MVIA0_1<br>MVIA0_2<br>M1 |
|         | <code>shParamFile="param.sh"</code>                                     | Specifies the self-heating effect analysis parameter file, which is required for calculating the SHE analysis results with heat-sink effect.<br><br><b>Note:</b> For SHE with heat-sink effect, this file should include the heat-sink rules. | none                                                  |
|         | <code>print_selfheating_report=[type=heatsink filename=filename]</code> | When specified, generates the heat-sink self-heating factor report.<br><br>A sample report is provided below.<br><br><b>Note:</b> No special license is required for generating this report.                                                  | none                                                  |

### Heat-Sink Self-Heating Sample Report:

-----

VERSION: <version>

HEADER:

```
OD_Name llx lly urx ury od_area od_dT od_dT_p od_dT_p_be od_dT_p_fe
connecting_wire layer totalA_on_region
connecting_via layer totalA_on_region
```

```
connecting_OD od_cell od_dT od_area layer
```

-----

## Batch Mode Support for Running SHE Analysis and Thermal-Aware DC EM Analysis

You can run the SHE analysis and thermal-aware DC EM analysis in batch mode.

For SHE analysis, set the following variables using the `set_variable` command:

```
set_variable shParamFile param_sh.file
set_variable shXMLFile xml_file
set_variable shEMEffect {beolT | tiles_no.of divisions in y-direction X no.of divisions in x-direction}
```

For thermal-aware DC EM analysis, in addition to the above commands, specify the following:

```
set_variable coupledSH true
set_variable extendJouleHeating true
set_variable extendSHRegion true
```

For more information about the above variables, see the “[Variables](#)” chapter.

The commands listed below are common for both flows, SHE and Thermal-aware DC EM analysis:

### ■ load\_view

Specifies the layout to be used for SHE analysis. The syntax is provided below.

```
load_view \
-libname lib \
-cellname cell \
-viewname layout
```

### ■ qrc\_run\_directory

Specifies the location of the Quantus run directory. The syntax is provided below.

```
qrc_run_directory run_directory
```

### ■ qrc\_run\_name

Specifies the Quantus run name. The syntax is provided below.

```
qrc_run_name qrc_run_name
```

### ■ load\_em\_results

Loads the results of EM analysis. The syntax is provided below.

```
load_em_results \
```

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### Self-Heating Effect Analysis

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```
-tech_file tech_file_name \
[-layer_mapfile layer_map_filename] \
results_file_name
```

#### ■ print\_em\_report

Prints the EM analysis reports. The syntax is provided below.

```
print_em_report \
-net -all_nets \
-type [acrms_sh | avg_sh | peak_sh] \
-filename output_file_name
```

#### ■ print\_thermal\_report

Prints the thermal reports for the hierarchical self-heating EM analysis.

```
print_thermal_report \
-type {mos-region | metal} \
[-tiles tile_matrix] \
-filename output_file_name
```

For details of the above commands, see the “[Batch Commands in Voltus-Fi-XL](#)” chapter.

### Example

The following set of commands report the results of SHE analysis for cell, `cell1` of library, `test_lib`. The SHE analysis results will be reported in the `./acrms_sh.txt` file. The OD regions temperature will be reported in the `mos-region.txt` file:

```
load_view
 -libname test_lib \
 -cellname cell1 \
 -viewname layout

qrc_run_directory svdb
qrc_run_name design

load_em_results \
 -tech_file qrcTechFile
 -layer_mapfile contactmapfile/input.emir0_bin

print_em_report
 -net all_nets \
 -type acrms_sh \
 -filename ./acrms_sh.txt

print_thermal_report \
 -type mos-region \
 -filename ./mos-region.txt
```

## Command for Encrypting Data in param.sh File

Voltus-Fi supports encrypting the contents of the `param.sh` file to hide confidential data. Use the below command to encrypt the contents of the file using the `vfibatch` command:

```
vfibatch -cmd <cmd-file-name>
```

The contents of the `cmd-file-name` file are as follows:

```
encrypt_file
-input_file_name <filename>
-output_file_name <filename>
```

Where,

`-input_file_name` is the name of the file whose contents are to be encrypted

`-output_file_name` is the encrypted file as viewed by the user. It contains the contents of the input file with confidential data in encrypted form.

In the input file, the text to be encrypted is placed inside below tags:

```
<Encryption Start>...<Encryption End>
```

A sample input file whose contents are to be encrypted is shown below:

```
line1
line2
line3
line4
<Encryption Start>
Encrypt line1
Encrypt line2
<Encryption End>
line5
line6
```

The output file for the above input file is shown below:

```
line1
line2
line3
line4
<Encryption Start>
 u s f i' {BèŸô`?iáâxÛ û¢:#zšă,,Và´-£¬?~ v o l trcn3 tpeni ä
```

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## Self-Heating Effect Analysis

EsÜøš~>^ÐBArÿü™ v o 1\*ª w±Ä>¯}1-?kB9dP...Ö

<Encryption End>

line5

line6

## Generating Reports

The text reports for both SHE and thermal-aware DC EM analysis are only available in batch mode using the sequence of commands detailed in the above section. The types of reports that are generated are detailed below:

- Thermal reports containing temperature rise of OD region and metal resistors.

The format of the OD region report is as follows:

**Figure 9-6 OD Region Report Format**

```
design: design_name
area: (x1 y1) (x2 y2)
report format: <delta_temperature> <od_area>
coordinate unit: um
delta_temperature od_area
```

For thermal-aware DC EM analysis, when the option `extendSHRegion` is set to true, the OD region report format is as follows:

**Figure 9-7 OD Region Report Format for Thermal-Aware DC EM Flow**

```
design: design_name
area: (x1 y1) (x2 y2)
report format: <delta_temperature> <od_area> <extended od_area>
coordinate unit: um
```

The format of the metal resistors report is as follows:

**Figure 9-8 Metal Resistors Report Format**

| LayerName | Irms(mA) | Alpha | Beta | T_FE0L(C) | T_RMS(C) | T_BE0L(C) | Metal-region |
|-----------|----------|-------|------|-----------|----------|-----------|--------------|
| #         |          |       |      |           |          |           |              |

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### Self-Heating Effect Analysis

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- Tiles-thermal reports containing temperature rise of OD region and metal resistors based on the specified tile matrix.

The format of the metal resistors report (tile-based) is as follows:

**Figure 9-9 Metal Resistors Tile-Based Report Format**

```

DIE_STACK_TEMPERATURE_MAP
DIE_AREA <x y> <x y> <x y>
NUMBER_OF_LAYERS #

LAYER <layername>
TEMPERATURE
XCOR x1 x2 x3 x4 x5 x6...xn
YCOR y1 y2 y3 y4 y5 y6...yn

END_TEMPERATURE
END_LAYER

```

The format of the OD region (tile-based) report is as follows:

**Figure 9-10 OD Region Tile-Based Report Format**

```

#Tiles MOS-region report
"lower left x" "lower right y" "upper right x" "upper right y" "number of ROWS" "number of columns"
<deltaT for each tile in the matrix>

```

- The SHE EM reports containing dTemp of each parasitic resistor and EM report (including pass/fail, em\_limit, and needed width) both with and without the self-heating effect. The following reports are generated:
  - ❑ acrms\_sh.txt: AC RMS EM report both with and without the self-heating effect
  - ❑ avg\_sh.txt: Average EM report both with and without the self-heating effect
  - ❑ peak\_sh.txt: Peak EM report both with and without the self-heating effect

The formats of these report file are provided below.

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Figure 9-11 AC RMS EM Report Format

ELECTROMIGRATION ANALYSIS RESULTS (acrms\_sh)

Tj = 70  
deltaT = 5

| Resistor | layer | X | Y | current<br>(mA) | width(um)/<br>viaCount | Without SH Effect |                    |              | With SH Effect |                    |              | dT(SH) feolT beolT coupled |  |  |
|----------|-------|---|---|-----------------|------------------------|-------------------|--------------------|--------------|----------------|--------------------|--------------|----------------------------|--|--|
|          |       |   |   |                 |                        | %fail             | curr limit<br>(mA) | minW<br>(um) | %fail          | curr limit<br>(mA) | minW<br>(um) |                            |  |  |

Figure 9-12 Average EM Report Format

ELECTROMIGRATION ANALYSIS RESULTS (avg\_sh)

Tj = 70

| Resistor | layer | X | Y | current<br>(mA) | width(um)/<br>viaCount | Without SH Effect |                    |              | With SH Effect |                    |              | Tj(SH) | feolT | beolT |
|----------|-------|---|---|-----------------|------------------------|-------------------|--------------------|--------------|----------------|--------------------|--------------|--------|-------|-------|
|          |       |   |   |                 |                        | %fail             | curr limit<br>(mA) | minW<br>(um) | %fail          | curr limit<br>(mA) | minW<br>(um) |        |       |       |

Figure 9-13 Average EM Report Format for Thermal-Aware DC EM Analysis

ELECTROMIGRATION ANALYSIS RESULTS (avg\_sh)

Tj = 110  
deltaT = 5  
Tenv = Tj - deltaT  
beolT = coupledT + joule\_heatingT  
Tmetal = Tenv + beolT

| Resistor | layer | X | Y | current<br>(mA) | width(um)/<br>viaCount | With Thermal Effect |                    |              | feolT | coupledT | joule_HeatingT | beolT |
|----------|-------|---|---|-----------------|------------------------|---------------------|--------------------|--------------|-------|----------|----------------|-------|
|          |       |   |   |                 |                        | %fail               | curr limit<br>(mA) | minW<br>(um) |       |          |                |       |

Figure 9-14 Peak EM Report Format

# ELECTROMIGRATION ANALYSIS RESULTS (peak\_sh)

# Tj = 70  
#

| # Resistor | layer | X | Y | current<br>(mA) | width(um)/<br>viaCount | Without SH Effect |                    |              | With SH Effect |                    |              | Tj(SH) | feolT | beolT |
|------------|-------|---|---|-----------------|------------------------|-------------------|--------------------|--------------|----------------|--------------------|--------------|--------|-------|-------|
|            |       |   |   |                 |                        | %fail             | curr limit<br>(mA) | minW<br>(um) | %fail          | curr limit<br>(mA) | minW<br>(um) |        |       |       |

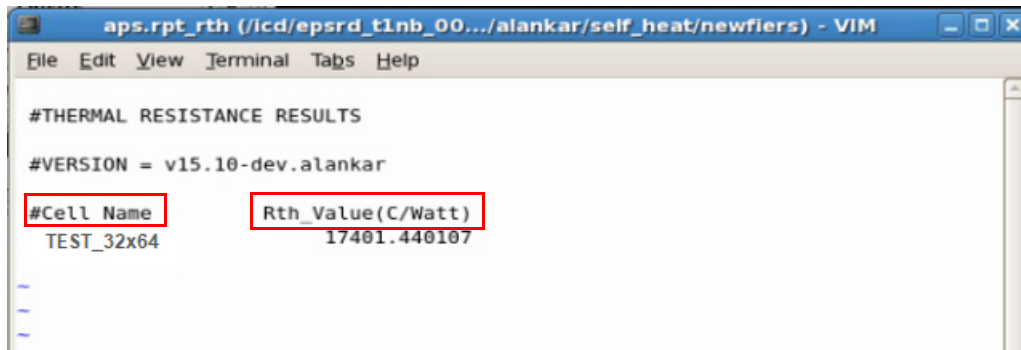
- Thermal resistance report with cell name and thermal resistance (Rth) value. This is only generated in the thermal-aware DC Em flow.

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### Self-Heating Effect Analysis

---

**Figure 9-15 Thermal Resistance Report Format for Thermal-Aware DC EM Analysis**



```
aps.rpt_rth (/lcd/epsrd_t1nb_00.../alankar/self_heat/newfiers) - VIM
File Edit View Terminal Tabs Help

#THERMAL RESISTANCE RESULTS

#VERSION = v15.10-dev.alankar

#Cell Name Rth_Value(C/Watt)
TEST_32x64 17401.440107

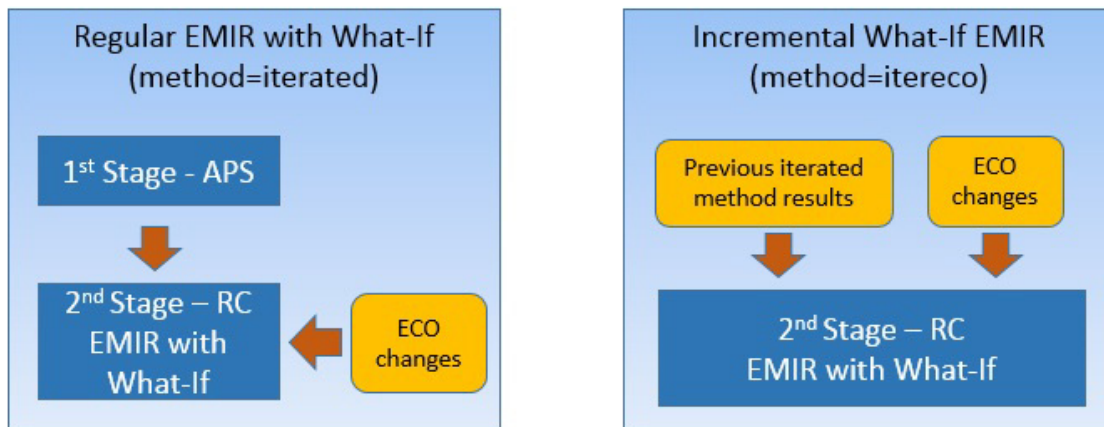
~
~
~
```



## What-If EMIR Analysis

The What-If analysis feature lets you analyze the impact of potential layout changes, without implementing these changes in the layout, and re-extracting the xDSPF file. These changes are also called the ECO changes.

The What-If flow is supported in the regular “iterated” method EMIR flow, and in an incremental “itereco” method EMIR flow, which reuses the circuit simulation results from a previous iterated mode EMIR analysis. This is shown in the figure below.



The What-If changes are defined in an ECO file, which is included in the EMIR control file (`emir.config`). All ECO changes are relative to the original xDSPF content. In one What-If simulation, all changes defined in the ECO file are applied. These are then analyzed together in the second stage of the EMIR analysis.

Multiple incremental ECO runs are supported. For each run, the changes defined in the ECO file are applied to the original xDSPF content. Changes from previous ECO runs are not considered. In the incremental What-If analysis, only the nets with ECO changes are analyzed.

Other EMIR methods, such as “`method=direct`”, are not supported when performing What-If analysis.

All ECO changes for a specific What-If run are defined in one ECO file.

## ECO Commands Supported in Voltus-Fi-XL

The following ECO commands are supported in Voltus-Fi-XL:

- `add_pin net=<net_name> name=[node1 node2 ...]`
- `delete_pin net=<net_name> name=[node1 node2 ...]`
- `add_cap net=<net_name> cap=[node1 cvalue1 node2 cvalue2 ...]`
- `add_res net=<net_name> node=<node1 node2> r=<rvalue>`
- `delete_res net=<net_name> name=<resistor1 resistor2 ...>`
- `scale_res net=<net_name> name=<resistor1 resistor2 ...> scale = <scalefactor>`
- `add_via` when executed creates an `add_res` entry in the ECO file
- `delete_via` when executed creates a `delete_res` entry in the ECO file

The parameters listed above are defined as follows:

- `net_name`: name of the net as defined in the xDSPF | `*net` statement. There is no support for wildcards, same as that in the xDSPF file.
- `node1, node2`: name of pin, sub, or tap node. There is no support for wild cards, same as that in the xDSPF file.
- `cvalue1, cvalue2`: the value of capacitance to be added. Negative value is supported for reducing net capacitance. It is a floating number.
- `rvalue ... value`: value of resistance to be added. This is a floating number.
- `resistor1, resistor2`: the instance name of resistors to be deleted, or scaled.
- `scalefactor`: the scaling factor. This is a floating number.

An example ECO file (`emir.eco`) is as follows:

```
add_pin net=[VDD] name=[VDD#9]
delete_pin net=[bias1] name=[Rj3652]
scale_res net=[VDD] name=[Rg1 Rg2 Rg3 Rg4] scale=0.5
delete_res net=[VDD] name=[Rg5]
add_res net=[VDD] node=[VDD#80 VDD#81] r=10
add_cap net=[VDD] cap=[VDD#80 10e-15 VDD#81 5e-15]
```

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### What-If EMIR Analysis

---

Alternatively, all ECO commands can also be used with the prefix, `eco_` in the `emir.conf` file directly. For example,

```
eco_add_pin net=[VDD] name=[VDD#9]
```

When performing a regular iterated method EMIR analyses with What-If, the only change required in the `emir.conf` file is the reference to the ECO file.

```
solver method=iterated
eco file="--emir.eco"
```

The following lines need to be defined in the `emir.conf` file to enable an incremental What-If EMIR analysis.

```
solver method=iterereco inputwf="./input.emirtap.pwl"
eco file="emir.eco"
```

## Performing What-If (ECO) Analysis in Voltus-Fi-XL

The What-If flow in Voltus-Fi-XL GUI is as follows:

- ECO commands are specified in the Voltus-Fi-XL GUI and the ECO file is generated.
- Voltus-Fi-XL calls Spectre to perform the EMIR analysis. Fully accurate EMIR simulation is performed.
- Only nets that are changed in the ECO statement are changed.

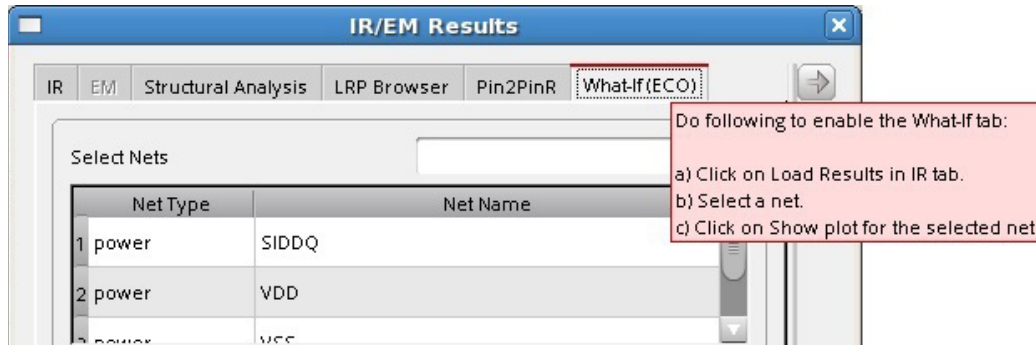
To perform What-If analysis, first load the IR drop analysis results, select the net and click *Show Plot*. In the IR/EM Results form, the *What-If (ECO) Analysis* tab gets enabled. The software provides support in the form of tips about how to enable the *What-If (ECO)* tab when you hover over the tab name. This is shown below. It also provides help to fill out information in the various fields in the tab. This tooltip appears when you hover over the fields in the form.

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### What-If EMIR Analysis

---

**Figure 10-1 Tooltips for What-If (ECO) Analysis Tab of the IR/EM Results Form**



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### What-If EMIR Analysis

**Figure 10-2 the IR/EM Results Form – What-If (ECO) Tab**

The screenshot shows the 'IR/EM Results' dialog box with the 'What-If (ECO)' tab selected. The 'Select Nets' section has a text field and a table with columns 'Net Type' and 'Net Name'. The 'Node name' section has fields for 'Name', 'X', and 'Y', and a 'Get Node' button. The 'Recurrence' section has fields for 'dX', 'dY', and 'num', and a 'Recurrence' button. The 'Node 2' section has fields for 'Name', 'X', and 'Y', and a 'Get Node' button. Below these are buttons for 'Add data', 'Bounding box', 'Layer' (with a dropdown menu), and 'show pins'. At the bottom is a table with columns 'Update layout', 'what-if-analysis', 'Net name', and 'Node1/Pin'. Below the table are buttons for 'ECO file', 'Generate ECO', 'Run ECO', and 'Delete row'. At the very bottom are buttons for 'Cancel', 'Load', 'Save', and 'Help'.

|   | Net Type | Net Name |
|---|----------|----------|
| 1 | power    | SIDDQ    |
| 2 | power    | VDD      |
| 3 | power    | VSS      |

|   | Update layout | what-if-analysis | Net name | Node1/Pin |
|---|---------------|------------------|----------|-----------|
| 1 | layout-modify | add_pin          | VDD      | VDD#29    |

In this form, provide the following information:

- Select the nets on which you want to perform What-If (ECO) analysis. In the text field provided with the *Select Nets* field, enter the full net name. The text field also accepts regular expression. For example, if you enter  $V^*$ , the table will list all nets whose names start with  $V$ , for example  $VDD$  and  $VSS$ .

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### What-If EMIR Analysis

---

- From the *whatif changes* list, select the ECO command you want to run. The following commands are available:

- ☐ `add_pin`
- ☐ `delete_pin`
- ☐ `add_cap`
- ☐ `scale_res`
- ☐ `add_res`
- ☐ `delete_res`
- ☐ `add_via`
- ☐ `delete_via`

In the *Node name* group box, provide the information for the node on which the What-If (ECO) analysis is to be performed.

- Select the *Layer* on which you want to perform the analysis from the list. By default, this field is populated with the name of the layer selected in the Display form. If multiple layers are selected in the Display form, all the layer names will appear in the list.
- Click *Get Node* and then select any point on the specified layer in the layout. The nearest node on the specified layer is identified for the whatif changes. The node name and its x- and y- coordinates are populated in the three text boxes; *Name*, *X*, and *Y*, respectively.

In the *Recurrence* group box, provide the following information:

- Click *Recurrence* to add pins in recurrence in both horizontal and vertical directions. The starting point is the node that was specified using the *Get Node* button in the previous step. This option is applicable only when `add_pin` ECO command is selected. For this, perform the following tasks:
  - ☐ Specify *dX*, or delta-X, which is the horizontal spacing between the nodes that will be used for adding pins.
  - ☐ Specify *dY*, or delta-Y, which is the vertical spacing between the nodes that will be used for adding pins.
  - ☐ Specify *num*, which is the number of nodes with the specified spacing, both horizontally and vertically.

When you click *Recurrence*, the Filters pop-up window opens. It displays a table with names of nodes that will be used for adding pins along with their x- and y-

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### What-If EMIR Analysis

coordinates. When you click *OK*, the selected nodes will be used to add pins. This information is then populated in the table provided in the What-If (ECO) form. This is shown below.

**Figure 10-3 Adding Multiple Pins for What-If (ECO) Analysis**

The screenshot shows the **IR/EM Results** dialog box with the **What-If (ECO)** tab selected. The **Select Nets** section shows a table with columns **Net Type** and **Net Name**. The **whatif changes** dropdown is set to **add\_pin**. The **Node name** section has fields for **Name** (VDD#386), **X** (47.15), and **Y** (85.565), with a **Get Node** button. The **Recurrence** section has fields for **dX** (2), **dY** (2), and **num** (10), with a **Recurrence** button. The **Node 2** section has fields for **Name**, **X**, and **Y**, with a **Get Node** button. Below this are buttons for **Add data**, **Bounding box**, and a **Layer** dropdown set to **cont\_ndiff**, along with a **show pins** button. A table titled **Update layout** shows the results of the analysis. At the bottom are buttons for **ECO file**, **Generate ECO**, **Run ECO**, and **Delete row**. A **Filters** dialog box is also shown, displaying a table of pin names and coordinates.

| Pin name  | X     | Y      |
|-----------|-------|--------|
| 1 VDD#386 | 47.15 | 85.565 |
| 2 VDD#434 | 57.15 | 85.565 |
| 3 VDD#103 | 47.15 | 99.565 |

- In the *Node-2* group box, provide the same information as above for the second node. This field is only enabled when **add\_res** is specified in the *whatif changes* list.

**Note:** You can choose a node either on the same layer or on a different layer.

- Click *Add data* to add the location of the nodes in the table provided in the form. You can add multiple pairs of co-ordinates in the table. The table provides information about the

type of What-If (ECO) analysis, the net name, information about the nodes, and the analysis data.

- Click *layout-modify* to modify the layout of the ECO commands. The button lets you modify the layout for the specified ECO command. For details, see [Layout Modification Options](#).
- Specify the *Layer* on which you want to create the bounding box.
- Click *Bounding box* and then select an area on the Virtuoso layout. Depending on the what-if analysis type, nodes and resistors will be selected from the layout. For example, if `delete_res` ECO command is selected in the *whatif changes* list, resistors will be selected for deletion. The nodes and resistors are selected on the basis of the specified layer name. These nodes will be listed in the Filters pop-up window. When you click *OK*, all the selected nodes will be used for deleting resistors.

If `add_pin` command is selected in the *whatif changes* list, then all nodes inside the rectangle, for the specified layer, will be selected. These nodes will be listed in the Filters pop-up window. When you click *OK*, all the selected nodes will be used for adding pins. Their names and the corresponding net names will be added in the table in the What-If (ECO) form.

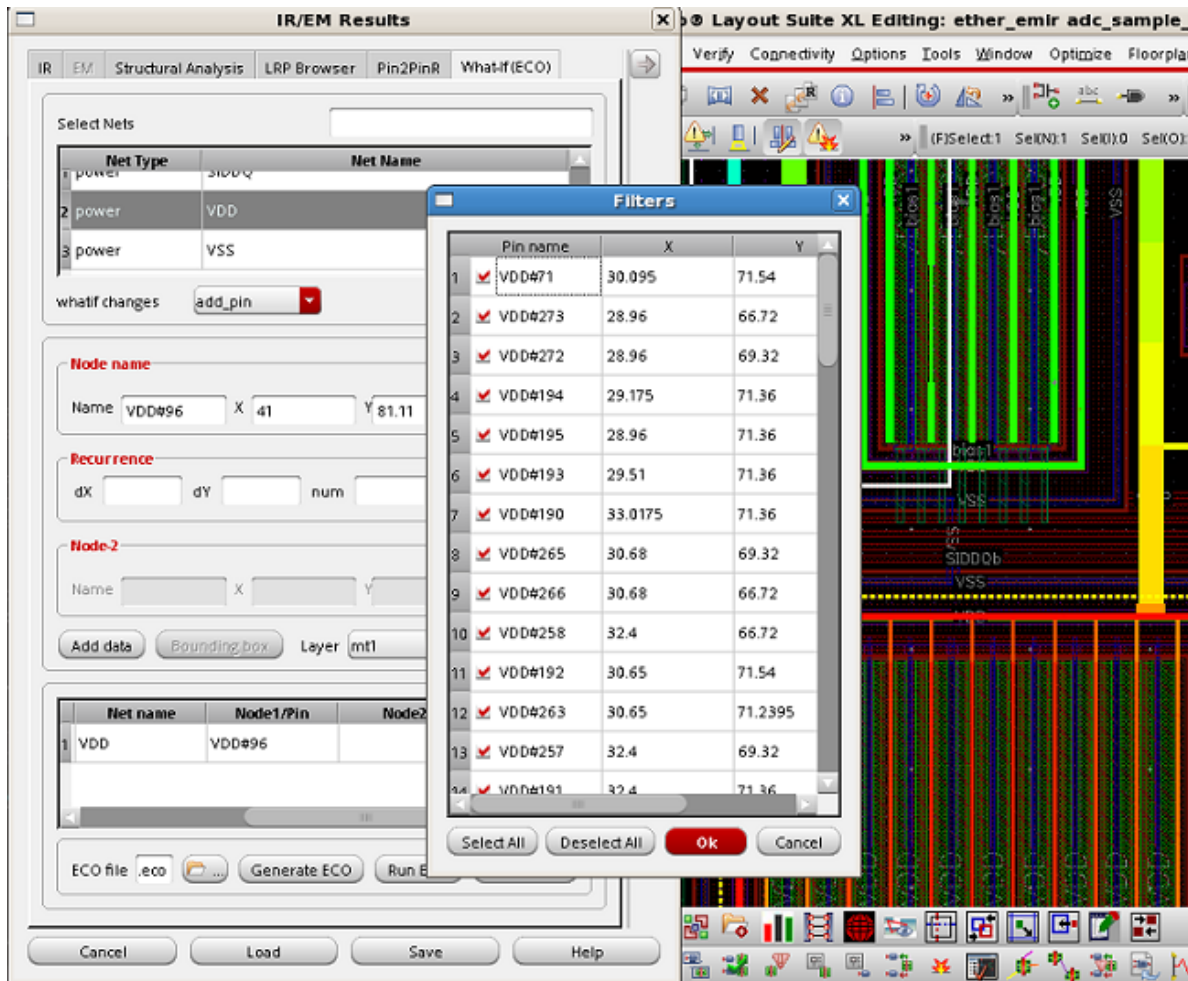
**Note:** The Bounding Box can only be used when `add_pin`, `add_cap`, `delete_res`, and `scale_res` ECO commands are selected in the *whatif changes* list. An example of using the Bounding Box for adding pins is shown below.



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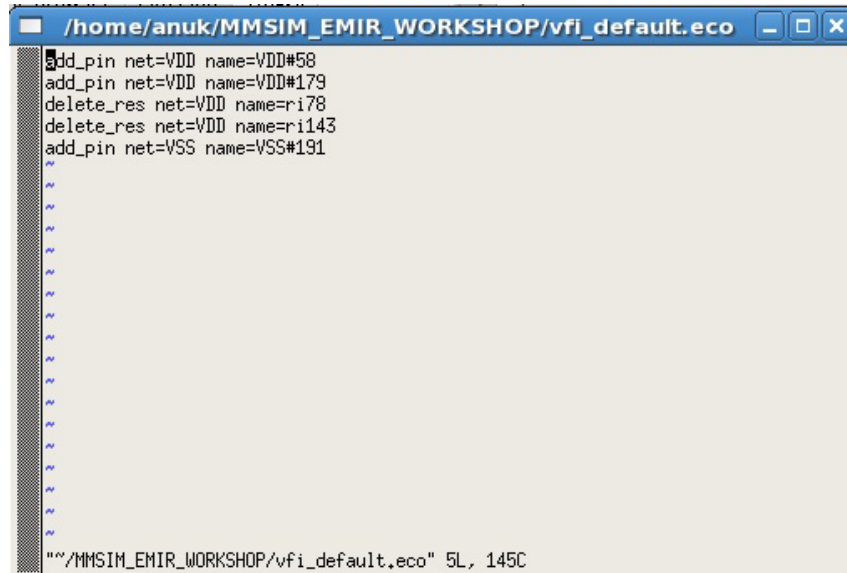
### What-If EMIR Analysis

Figure 10-4 Using the Bounding Box Option to Add Pins



- Specify the path and name of the ECO file to be generated in the *ECO file* field.
- Click *Delete row* to delete the data added in the table. For this, first select the row for which you want to delete the data and then click *Delete row*.
- Click *Generate ECO* to generate the ECO file with the specified filename in the specified directory. The file opens in a pop-up window. A sample ECO file is shown below.

### Figure 10-5 Sample ECO File



- Click *Run ECO* to run the simulation with the specified What-If ECO changes. When you click *Run ECO*, the Run Simulation form opens. The fields in this form are filled in automatically with information from the Spectre run. For details of how the form is pre-filled by the software, see [Pre-Filling the Run Simulation Form](#).

In this form, check all the pre-filled information to ensure that it is correct. This form is shown below.

**Figure 10-6 The Run Simulation Form**

Run directory: IM\_EMIR\_WORKSHOP/emir\_simulation

Ckt file: ORKSHOP/emir\_simulation/input.scs

Conf file: TOP/emir\_simulation/emir.iter.conf

Output dir: neweco

Other cmd line options: +cktpreset=sram

Run log output:

Cadence (R) Virtuoso (R) Spectre (R) Circuit Simulator  
Version 14.1.0.mid.971 64bit – 16 Mar 2016  
Copyright (C) 1989-2016 Cadence Design Systems, Inc. All rights reserved  
worldwide. Cadence, Virtuoso and Spectre are registered trademarks of  
Cadence Design Systems, Inc. All others are the property of their  
respective holders.

Includes RSA BSAFE(R) Cryptographic or Security Protocol Software from RSA  
Security, Inc.

Run simulation Cancel Load ECO Results

In this form, the following information is pre-filled:

- ❑ The name of the simulation *Run directory*
- ❑ The name of the input *Ckt file*
- ❑ The name of the simulation configuration file in the *Conf file* field

**Note:** You can edit the *Ckt file* and the *Conf file* by using the edit buttons provided against these options.

- ❑ The path of the output directory for the What-If Spectre run in the *Output dir* field, and
- ❑ The Spectre command line parameters in the *Other cmd line options* field, for example, if Spectre XPS is used, then +spice +xps and +cktpreset=sram is specified and if Spectre APS is used, then +spice +aps and +cktpreset=sram is specified

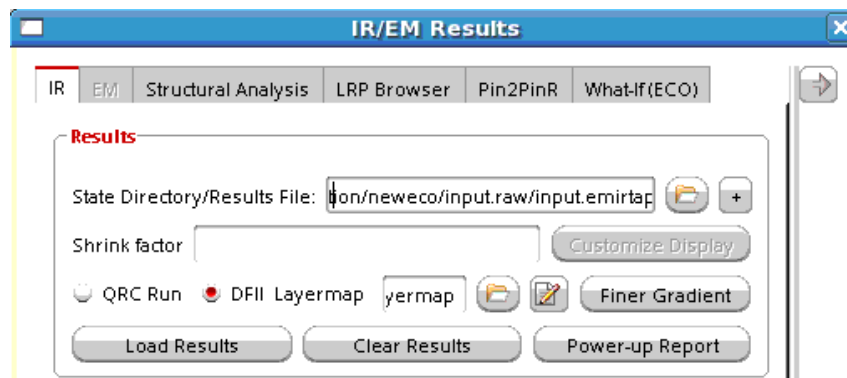
- ❑ Click *Run Simulation*. Once the simulation run is complete, you will get a pop-up telling you that the run is successful. The details of the run are provided in the Run log output.

Errors, if any, are written in the log. You can fix the errors and run the simulation again.

- ❑ Once the simulation run is complete, the *Load ECO Results* button is enabled. This button is used to load the simulation results file that includes the What-if ECO changes. When you click this button, the Run Simulation form closes and the *IR* tab of the IR/EM Results form opens. In this tab, the new results file is loaded, which includes information about only those nets for which what-if ECO changes have been made.

You can now generate IR/EM plots as per the changes made in ECO simulation. This is shown below.

**Figure 10-7 IR/EM Results Form – Results File with What-If ECO Changes**



## Pre-Filling the Run Simulation Form

The Run Simulation form that opens when you click the *Run ECO* button in the *What-If (ECO)* analysis tab, is pre-filled with information that is already available from the Spectre run. To ensure that the form is pre-filled, the following information must be available:

- The emir bin file that contains the simulation results from the original Spectre run
- The configuration file generated during the original Spectre run
- The log file generated during the original Spectre run

The software performs below steps to extract the data from the original Spectre run for pre-filling the Run Simulation form.

1. The software locates the log file generated by Spectre. The “xps.log” or the “aps.log” file is located either in the same directory as the emir bin file or in the parent directory of the emir bin file.
2. The software parses the “.log” file and searches for the “command line” used in the original Spectre run. The command line contains the “ckt file” and “command line options” used in the original Spectre run.
3. It then creates a directory parallel to the directory containing the “ckt file” for the What-If Spectre run. The new directory is created with the name, “whatIfRunDir”. This will contain the output of the What-If Spectre run.
4. The software searches for the “conf” file generated after the original Spectre run in the emir bin file directory and then creates a new “conf” file for the What-If spectre run, in the directory “whatIfRunDir” and performs the following tasks in the newly created “conf” file:
  - ☐ Copies the data from the “conf” file from the original Spectre run
  - ☐ Changes the solver method from “iteronly” to “itereco”
  - ☐ Appends the ECO file, “eco file:ECO\_filename” to the conf file

Now, when you click *Run Simulation*, the simulation runs using the above newly-generated conf file that includes information about the ECO options.



#### Video

To view the demonstration on performing what-if analysis in Voltus-Fi, see [Performing What-If Analysis using Voltus-Fi](#) video.

Access to this video will depend on the availability of a web browser and a Cadence Online Support account.

## Output

The output of the above simulation run with ECO changes is a simulation database (\*.emir#\_bin). You can use this simulation database for running the EMIR analysis.

For this, load this simulation database—with ECO changes—when loading the IR drop analysis results on the IR tab of the IR/EM Results form.

The subsequent EMIR analysis will be performed using this simulation database.

## Options for Performing What-If (ECO) Analysis

When you select the ECO command that you want to run in the *whatif changes* list, there are some changes in the other options on the What-If (ECO) tab. These are detailed below.

- For `add_pin`, the following flows are supported for What-If (ECO) analysis:
  - ❑ You can select a node by retrieving the x- and y- coordinates information in the layout. This node will be used for adding pins.
  - ❑ You can add multiple nodes at specified distances from an identified node at once by using the *Recurrence* option provided in the What-If (ECO) Analysis form. These nodes are used to add pins.
  - ❑ You can create a bounding box in the layout for a specified layer. All nodes within the bounding box or the rectangle will be used to add pins.

The fields on the What-If (ECO) tab are the same as described above and shown in [Figure 10-2](#) on page 321. For details, see [Performing What-If \(ECO\) Analysis in Voltus-Fi-XL](#).

- For `delete_pin`, the following options are available in the What-If (ECO) Analysis form:
  - ❑ The *Node name* group box is replaced with the *Pin name* group box. This is shown below.
  - ❑ The *show pins* button is enabled. Click this button to view the list of pins on the selected layer. The Filters pop-up opens. The pin name and the x- and y- coordinates of the pin are provided in the pop-up. Select the row and click *OK*. The pin name and its coordinates appear in the table. This is shown below.

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### What-If EMIR Analysis

Figure 10-8 Options for delete\_pin What-If (ECO) Analysis

The screenshot shows the 'IR/EM Results' dialog box with the 'What-If (ECO)' tab selected. The dialog is divided into several sections:

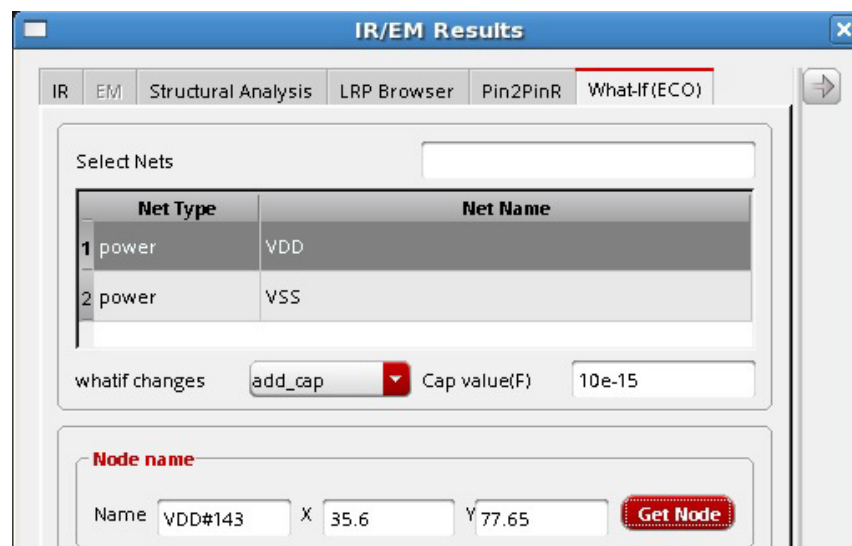
- Select Nets:** A table with columns 'Net Type' and 'Net Name'. It lists two nets: '1 power VDD' and '2 power VSS'.
- whatif changes:** A dropdown menu set to 'delete\_pin' and a text field with '0.1'.
- Pin name:** Fields for 'Name', 'X', and 'Y', with a 'Get Pin' button.
- Recurrence:** Fields for 'dX', 'dY', and 'num', with a 'Recurrence' button.
- Node-2:** Fields for 'Name', 'X', and 'Y', with a 'Get Node' button.
- Layer:** A dropdown menu set to 'mt1' and a 'show pins' button.
- Table:** A table with columns 'Update layout', 'what-if-analysis', 'Net name', and 'Node1/Pin'. It contains one row: '1 layout-modify delete\_pin VDD VDD'.
- Buttons:** 'Add data', 'Bounding box', 'ECO file .eco', 'Generate ECO', 'Run ECO', and 'Delete row'.
- Footer:** 'Cancel', 'Load', 'Save', and 'Help' buttons.

**Figure 10-9 The Filters Pop-Up Window**



- For `add_cap`, the following options are available in the What-If (ECO) form:
  - ☐ Specify the *Cap value(F)*, which is the capacitance value for the analysis in femtofarads ( $\text{fF}$ ).
  - ☐ Provide the node information in the same manner as that detailed for `add_pin` option.

**Figure 10-10 Options for `add_cap` What-If (ECO) Analysis**





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### What-If EMIR Analysis

- For `scale_res`, the following options are available in the What-If (ECO) form:
  - Specify the *Scale factor(Ohm)* for the analysis.
  - The *Node name* group box is replaced with the *Resistor* group box. Provide the *Resistor* information in the same manner as the node information detailed for the `add_pin` option.

**Figure 10-11 Options for `scale_res` What-If (ECO) Analysis**

The screenshot shows the 'IR/EM Results' dialog box with the 'What-If (ECO)' tab selected. The 'Select Nets' section contains a table with the following data:

|   | Net Type | Net Name |
|---|----------|----------|
| 1 | power    | VDD      |
| 2 | power    | VSS      |

Below the table, the 'whatif changes' dropdown is set to 'scale\_res', and the 'Scale factor(Ohm)' is set to '0.5'. At the bottom, there is a 'Resistor' section with the following fields:

Name: rh26 X: 27.177 Y: 78.48 [Get Res]

- For `add_res`, the following options are available in the What-If (ECO) form:
  - Specify the *Res value (Ohm)*, which is the resistance value for the analysis.
  - Both the Node group boxes, *Node 1* and *Node 2* are enabled for this option. You can provide the resistor information for multiple nodes.

**Figure 10-12 Options for add\_res What-If (ECO) Analysis**

IR/EM Results

IR EM Structural Analysis LRP Browser Pin2PinR What-If (ECO)

Select Nets

|   | Net Type | Net Name |
|---|----------|----------|
| 1 | power    | SIDDQ    |
| 2 | power    | VDD      |
| 3 | power    | VSS      |

whatif changes: add\_res Res value(Ohm): 0.1

**Node-1**

Name: VDD#116 X: 39.28 Y: 98.53 Get Node

**Recurrence**

dX: dY: num: Recurrence

**Node-2**

Name: VDD#101 X: 41 Y: 98.53 Get Node

Add data Bounding box Layer: mt1 show pins

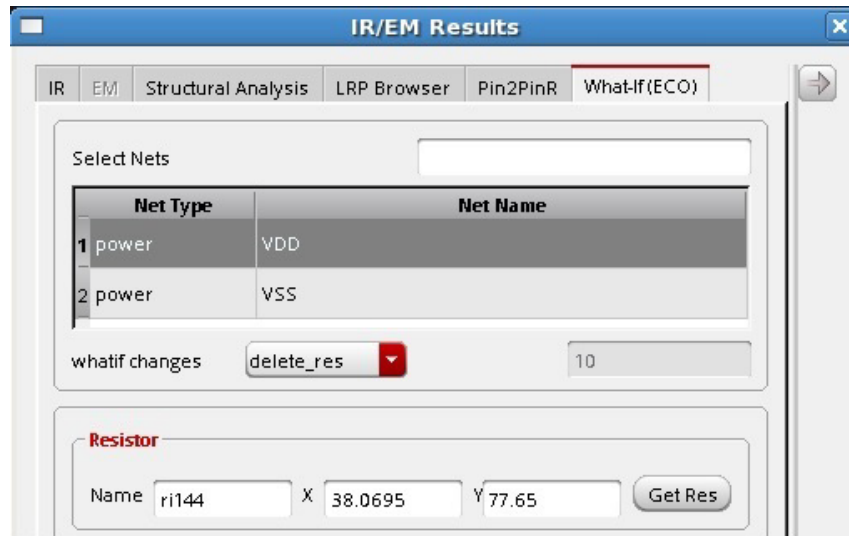
|   | Update layout | what-if-analysis | Net name | Node1/Pin |
|---|---------------|------------------|----------|-----------|
| 1 | layout-modify | add_res          | VDD      | VDD#116   |

ECO file: .eco Generate ECO Run ECO Delete row

Cancel Load Save Help

- For delete\_res, the following options are available in the What-If (ECO) form:
  - The *Node name* group box is replaced with the *Resistor* group box. Provide the *Resistor* information in the same manner as the node information detailed for the add\_pin option.

Figure 10-13 Options for delete\_res What-If (ECO) Analysis



- For `add_via`, the following options are available in the What-If (ECO) form:
  - The *Node name* group boxes are replaced with the *Via-node-* and *Via-node-2* group boxes. Provide the *Res value (Ohm)* information.

The two via nodes that are specified must be on different layers.

**Figure 10-14 Options for add\_via What-If (ECO) Analysis**

**IR/EM Results**

IR EM Structural Analysis LRP Browser Pin2PinR **What-If (ECO)**

Select Nets

|   | Net Type | Net Name |
|---|----------|----------|
| 1 | power    | VDD      |
| 2 | power    | VSS      |

whatif changes **add\_via** Res value(Ohm) 0.1

**Via-node-1**

Name VDD#114 X 33 Y 79.895 **Get Node**

**Recurrence**

dX dY num **Recurrence**

**Via-node-2**

Name VDD#67 X 30.1 Y 78.48 **Get Node**

**Add data** **Bounding box** Layer **mt2** **show pins**

|   | Update layout | what-if-analysis | Net name | Node1/Pin |
|---|---------------|------------------|----------|-----------|
| 1 | layout-modify | add_via          | VDD      | VDD#114   |

ECO file .eco **Generate ECO** **Run ECO** **Delete row**

**Cancel** **Load** **Save** **Help**

- For delete\_via, the following options are available in the What-If (ECO) form:
    - The *Node name* group box is replaced with the *Via* group box.
- Via layer must be selected in the *Layer* box.

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Figure 10-15 Options for delete\_via What-If (ECO) Analysis

The screenshot shows the 'IR/EM Results' dialog box with the 'What-If (ECO)' tab selected. The 'Select Nets' section shows a table with two rows: '1 power VDD' and '2 power VSS'. The 'whatif changes' dropdown is set to 'delete\_via' with a value of '0.1'. The 'Via' section shows 'Name rs400', 'X 45.025', and 'Y 71.54'. The 'Recurrence' section has 'dX', 'dY', and 'num' fields. The 'Via-node-2' section has 'Name', 'X', and 'Y' fields. The 'Add data' button is highlighted. The 'Bounding box' and 'Layer via1' are also visible. The 'Update layout' section shows a table with one row: '1 layout-modify delete\_via VDD rs400'. The 'ECO file' section shows '.eco' and buttons for 'Generate ECO', 'Run ECO', and 'Delete row'. The bottom of the dialog has 'Cancel', 'Load', 'Save', and 'Help' buttons.

| Net Type | Net Name |
|----------|----------|
| 1 power  | VDD      |
| 2 power  | VSS      |

whatif changes: delete\_via 0.1

**Via**  
Name: rs400 X: 45.025 Y: 71.54 Get Via

**Recurrence**  
dX: dY: num: Recurrence

**Via-node-2**  
Name: X: Y: Get Node

Add data Bounding box Layer: via1 show pins

| Update layout   | what-if-analysis | Net name | Node1/Pin |
|-----------------|------------------|----------|-----------|
| 1 layout-modify | delete_via       | VDD      | rs400     |

ECO file: .eco Generate ECO Run ECO Delete row

Cancel Load Save Help

## Layout Modification Options

Voltus-Fi-XL provides options to modify the layout for the specified ECO command in the GUI mode. For this, *layout-modify* button is provided on the *What-If (ECO)* tab of the IR/EM Results form. This feature lets you view the layout modifications after adding and deleting pins, resistors, and vias. You can also perform design-rule checks (DRCs) and view the design-rule violations (DRVs) in the layout after performing these actions.

**Note:** This feature is only available when the design is opened in the Virtuoso Layout Suite (VLS) XL.

The following topics are covered in this section:

- [Adding Pins and Modifying the Layout](#)
- [Deleting Pins and Modifying the Layout](#)
- [Adding Resistors and Modifying the Layout](#)
- [Deleting Resistors and Modifying the Layout](#)
- [Adding Vias and Modifying the Layout](#)
- [Deleting Vias and Modifying the Layout](#)
- [Design Rule Checking](#)

### Adding Pins and Modifying the Layout

On the *What-If (ECO)* tab of the IR/EM Results form, perform these steps to add a pin and modify the layout:

1. Select *add\_pin* ECO command from the *Whatif changes* list.
2. Click *Get Node* and then click anywhere on the Virtuoso layout to get a sub-node on the net.
3. Click *Add data* to add the ECO command, *add\_pin* in the table.
4. Click the *layout-modify* button provided in the table to add the pin in the layout. The default pin shape is *0.1uX0.1u*.

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## What-If EMIR Analysis

**Figure 10-16 Adding a Pin and Modifying the Layout – Step 1**

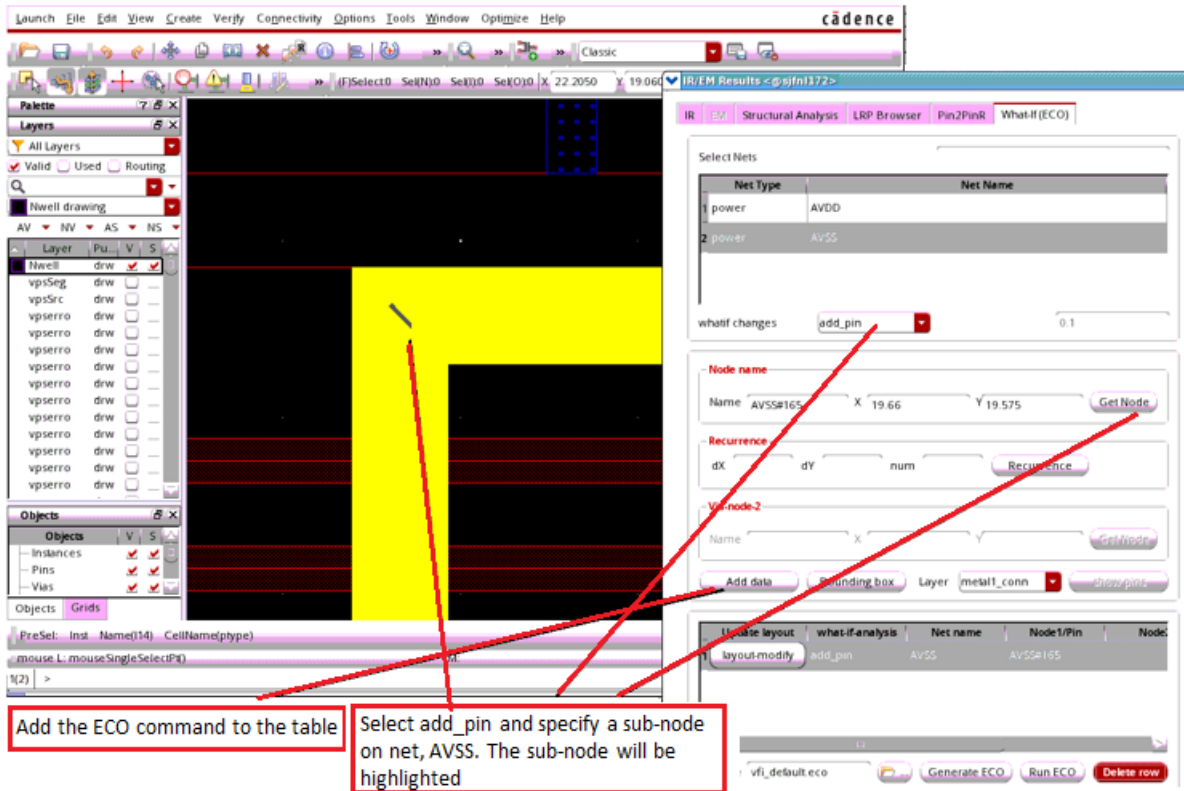
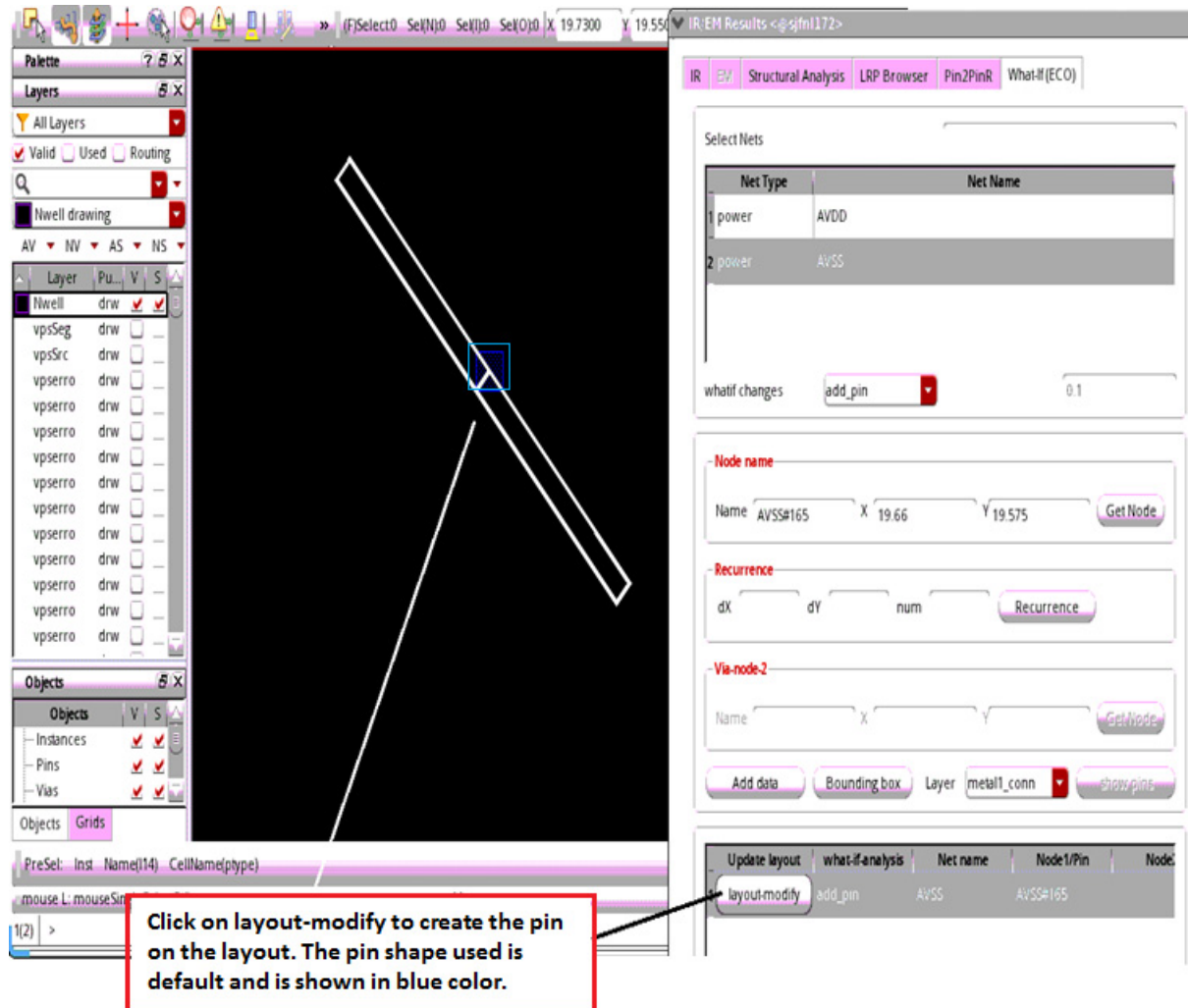


**Figure 10-17 Adding a Pin and Modifying the Layout – Step 2**



## Deleting Pins and Modifying the Layout

Follow these steps to delete a pin and modify the layout:

1. Select *delete\_pin* ECO command from the *Whatif changes* list.
2. Click *show pins* to view the list of pins. Select the pin you want to delete. The *delete\_pin* ECO command is added in the table.
3. Click *layout-modify* to delete the pin in the layout.

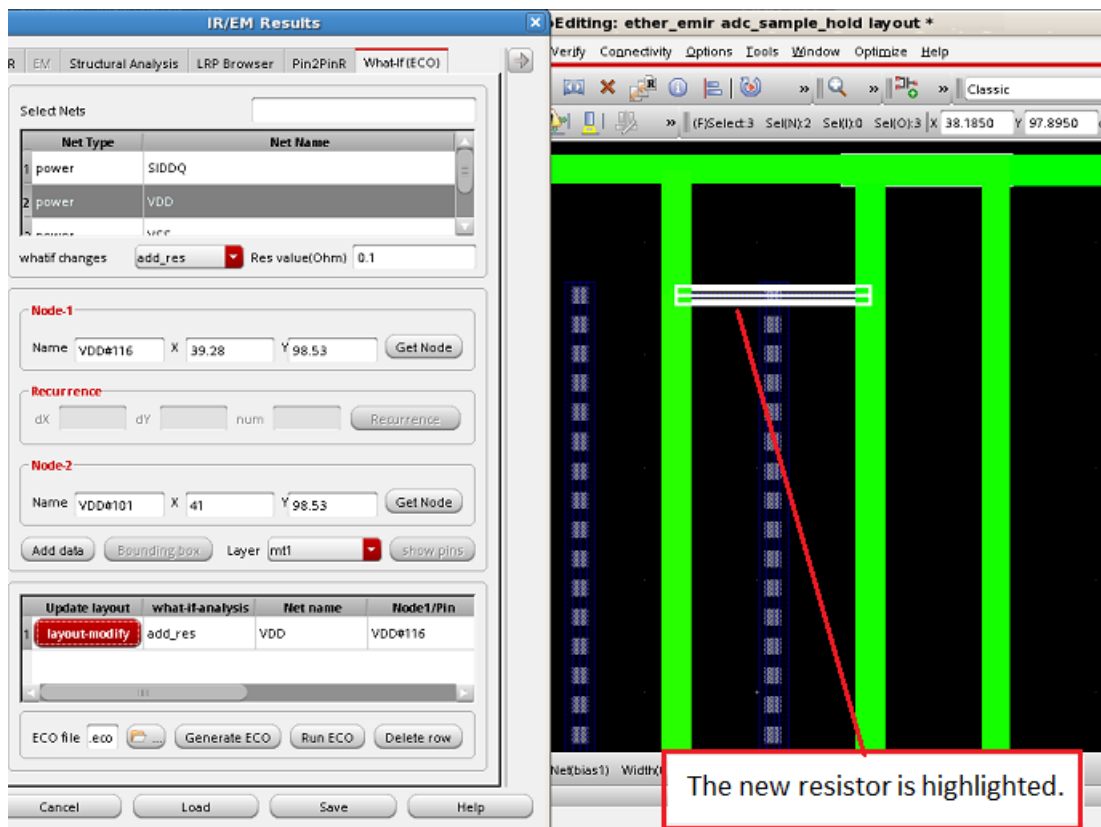


## Adding Resistors and Modifying the Layout

Follow these steps to add a resistor and modify the layout:

1. Select *add\_res* ECO command from the *Whatif changes* list.
2. Select a metal layer from the *Node layer* group box and get the *Node 1* and *Node 2* information from the layout. Both nodes should be on the same layer.
3. Specify the *Res value (ohm)*.
4. Click *Add data* to add the ECO command, *add\_res* in the table.
5. Click *layout-modify* to add the resistor in the layout. The new resistor created in the layout will have a default wire width of 0.1u.

**Figure 10-18 Adding a Resistor and Modifying the Layout**

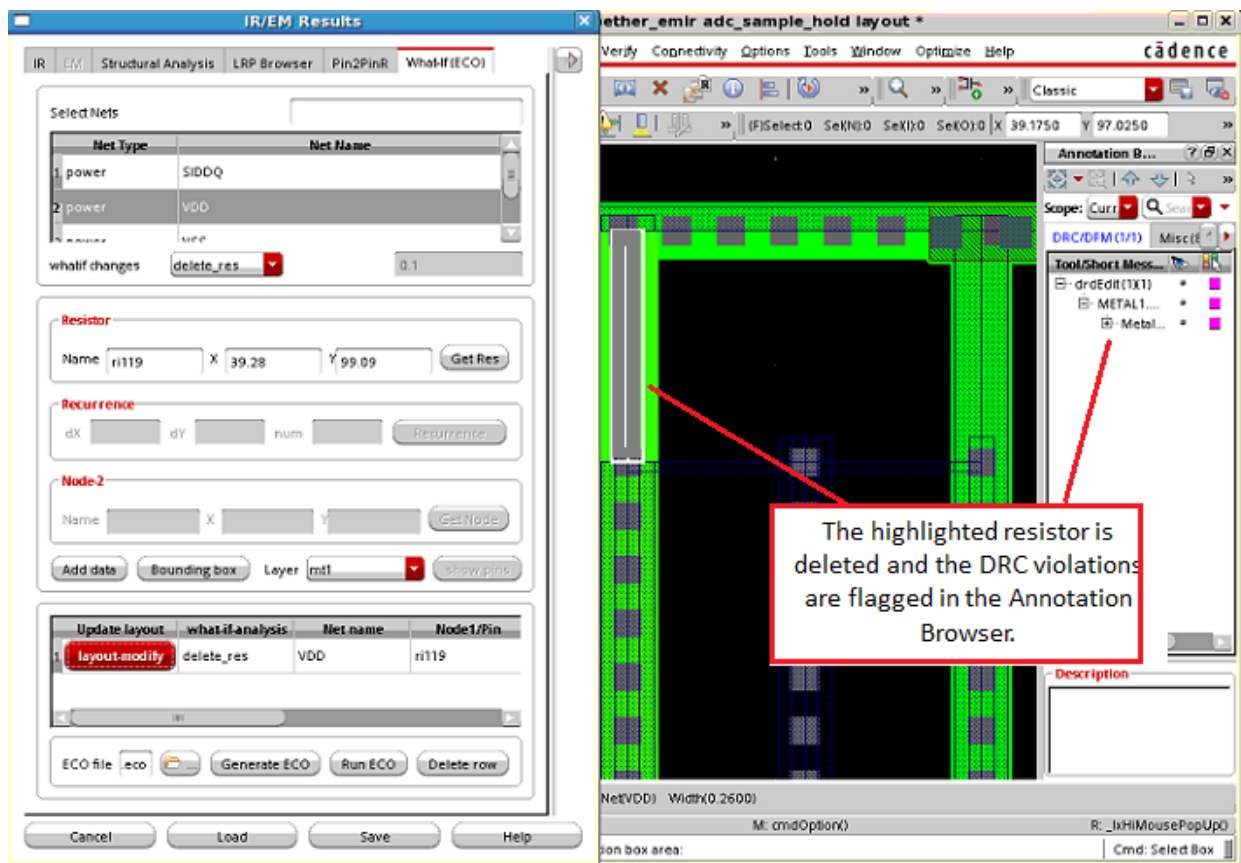


## Deleting Resistors and Modifying the Layout

Follow these steps to delete an MMSIM/Spectre resistor and modify the layout:

1. Select *delete\_res* ECO command from the *Whatif changes* list.
2. Select a metal layer and get the resistor information from the layout.
3. Click *Add data* to add the ECO command, *delete\_res* in the table.
4. Click *layout-modify* to delete the resistor from the layout. Design rule violations (DRVs) will be checked after modifying the shape.

**Figure 10-19 Deleting a Resistor and Checking the DRVs**



## Adding Vias and Modifying the Layout

Follow these steps to add a via and modify the layout:

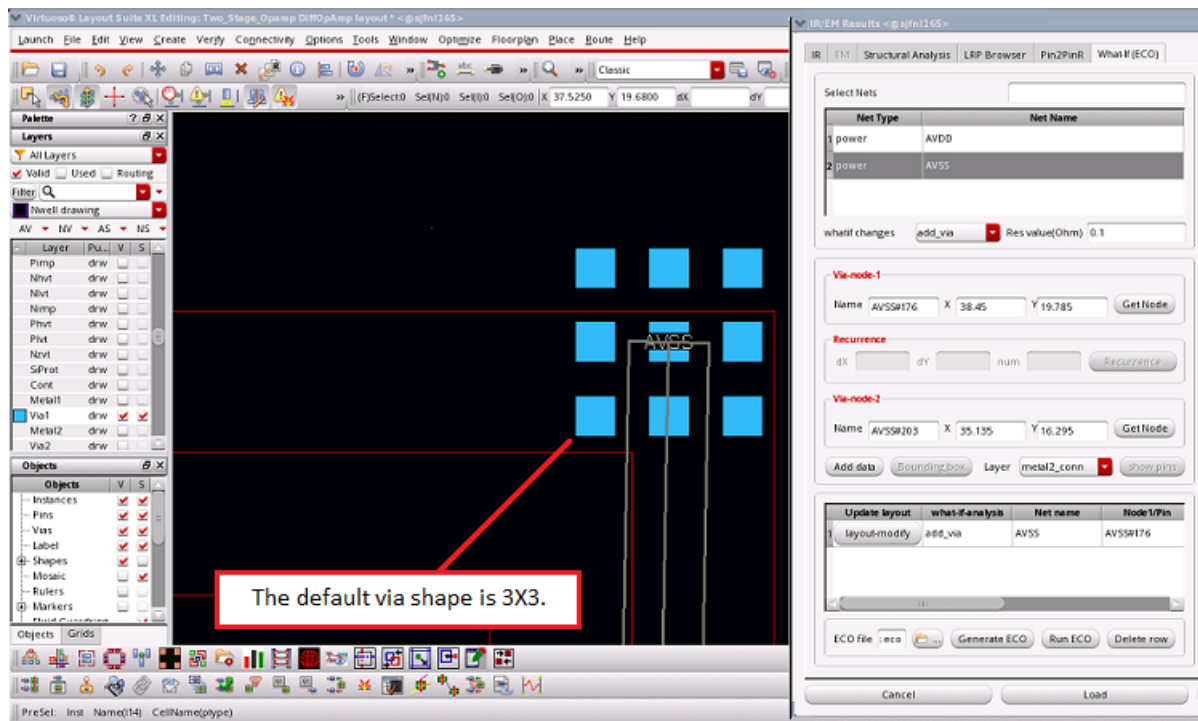
1. Select *add\_via* ECO command from the *Whatif changes* list.

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2. Select a metal layer and select *Node 1* from the layout.
3. Select another layer and select *Node 2* from the layout.
4. Click *Add data* to add the via in the layout. The software searches for existing via definition (viaDef) in the technology file based on the via layers selected by you. The following scenarios are possible.
  - a. If the via definition is available, a new via is created.
  - b. If the via definition is not available, the tool errors out.
5. The generated via has the following default values:
  - c. Number of cut rows=3
  - d. Number of cut columns=3

**Figure 10-20 Adding a Via and Modifying the Layout**



## Deleting Vias and Modifying the Layout

Follow these steps to delete a via and modify the layout:

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1. Select *delete\_via* ECO command from the *Whatif changes* list.
2. Select a via layer and select a via from the layout.
3. Click *Add data* to add the ECO command, *delete\_via* in the table.
4. Click *layout-modify* to delete the via from the layout.

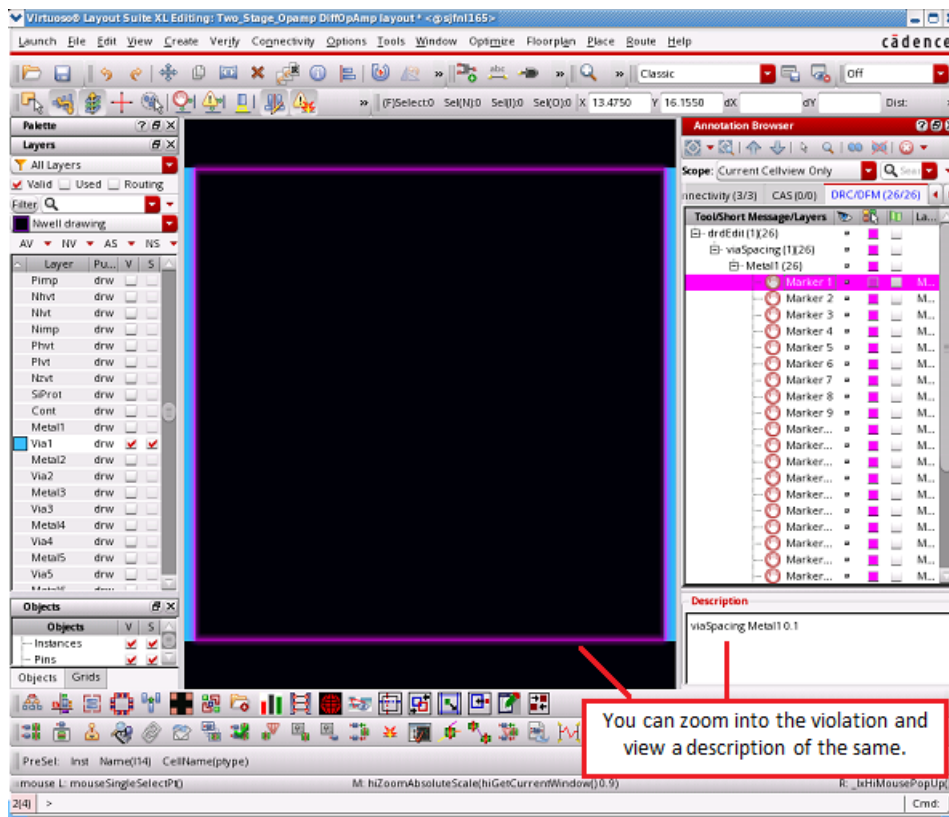
## Design Rule Checking

Design rules are checked during layout modifications. Virtuoso XL DRD (Design-Rule-Driven) editing is automatically turned ON by Voltus-Fi while performing the layout modifications. The violations can be viewed in Annotation Browser and the layout window.

The figure below shows the DRVs post layout modifications after deleting a via.

**Note:** This feature is only available when the design is opened in the Virtuoso Layout Suite XL.

**Figure 10-21 Checking DRVs after Deleting a Via**



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# Structural Analysis

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This section contains information structural analysis and the various checks that are required for running structural analysis in Voltus-Fi-XL.

## Overview of Structural Analysis

A typical electrical IR/EM analysis, which involves extraction of the power network, current calculation, and matrix solve, is able to identify devices that have a higher IR drop than the user-defined threshold.

Debugging the source of IR drop problems is a manual process involving the study of various voltage or current plots and patterns, and then narrowing down the weak links in the power grid. This is an effort-intensive activity.

Voltus-Fi-XL supports structural analysis, which is a shape-based geometrical analysis that is used to quickly identify power-grid weaknesses in designs and mark them on the Virtuoso layout for you to view and debug. Structural analysis cuts down on the sign-off analysis time. This analysis is available in the GUI mode.

You can run structural analysis using the results of the IR drop analysis.

### ***Related Topics***

- [Checks for Running Structural Analysis](#)
- [Running Structural Analysis](#)
- [Results of Structural Analysis](#)
- [IR/EM Results Form — Structural Analysis Tab](#)

## Checks for Running Structural Analysis

The checks for running structural analysis in Voltus-Fi-XL work on the basic definition of connectivity—for every metal segment, there should be connectivity from the top metal layers to the bottom metal layers unless the metal segment belongs to either the top-most metal layer or to the bottom-most metal layer.

The via connectivity checks are run on full-metal segments and not on the individual shapes that are part of the metal segments.

The following categories of checks can be run for routing layers:

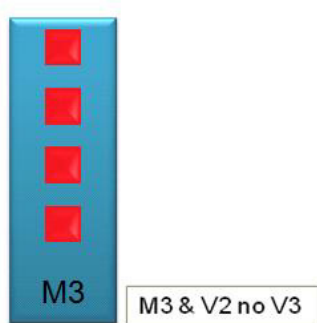
- For unconnected shapes in power net layout
  - ☐ [Top Via Missing Check](#)
  - ☐ [Bottom Via Missing Check](#)
- For overlapping layers
  - ☐ [Missing Via Connections Check](#)
  - ☐ [Via Coverage Ratio Check](#)
- For weakly connected shapes in power net layout
  - ☐ [Skewed Via Ratio Check](#)

### ***Related Topics***

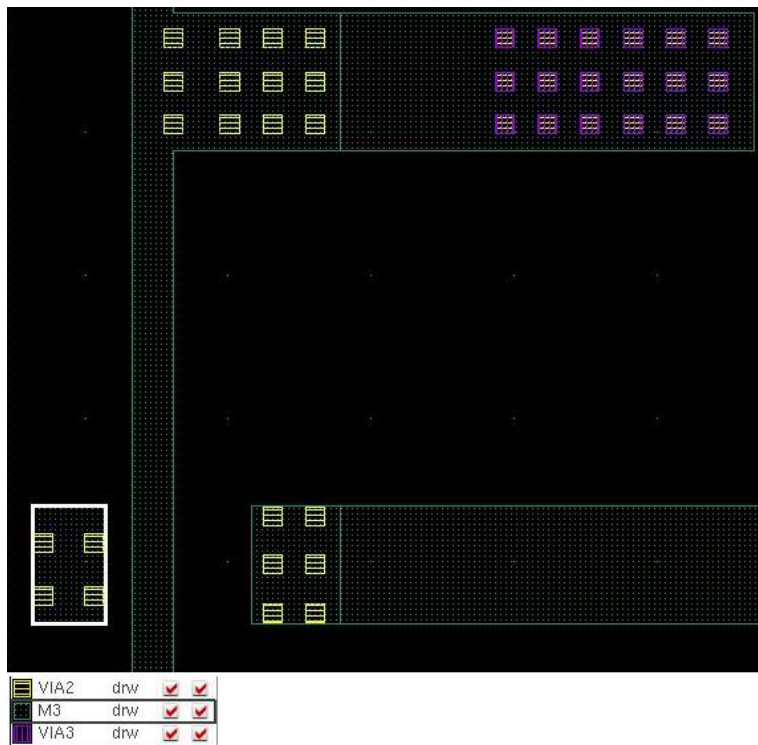
- [Running Structural Analysis](#)
- [Results of Structural Analysis](#)
- [IR/EM Results Form — Structural Analysis Tab](#)

## Top Via Missing Check

Top Via Missing is a check in Voltus-Fi-XL to run structural analysis. This check highlights all metal segments that have no top via or contact shapes overlapping them on layer basis. In the following example, metal layer, M3, has via, V2, but does not have via, V3.



The highlighted shape in the example below has V2 but not V3.

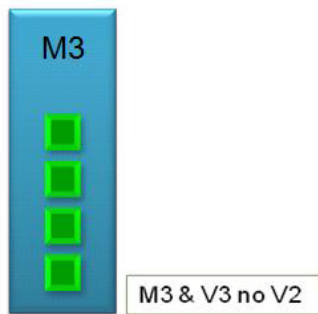


### ***Related Topics***

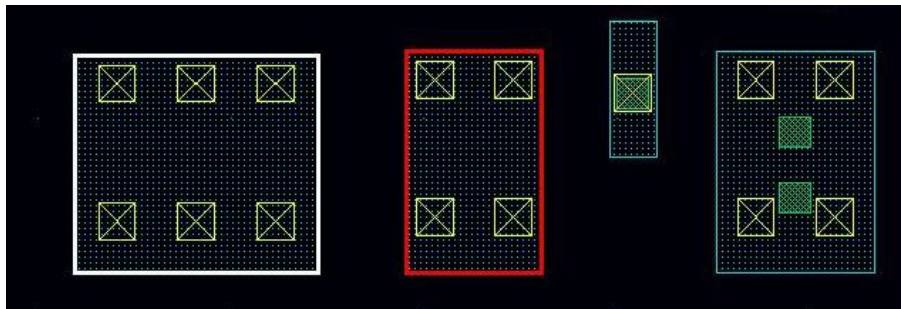
- [Checks for Running Structural Analysis](#)
- [Bottom Via Missing Check](#)
- [Missing Via Connections Check](#)
- [Via Coverage Ratio Check](#)
- [Skewed Via Ratio Check](#)

## **Bottom Via Missing Check**

Bottom Via Missing is a check in Voltus-Fi-XL to run structural analysis. This check highlights all metal segments that have no bottom via or contact shapes overlapping them on layer basis. In the following example, metal layer, M3, has via, V3, but does not have via, V2.



The highlighted shapes in the example below have V3 but not V2.



### ***Related Topics***

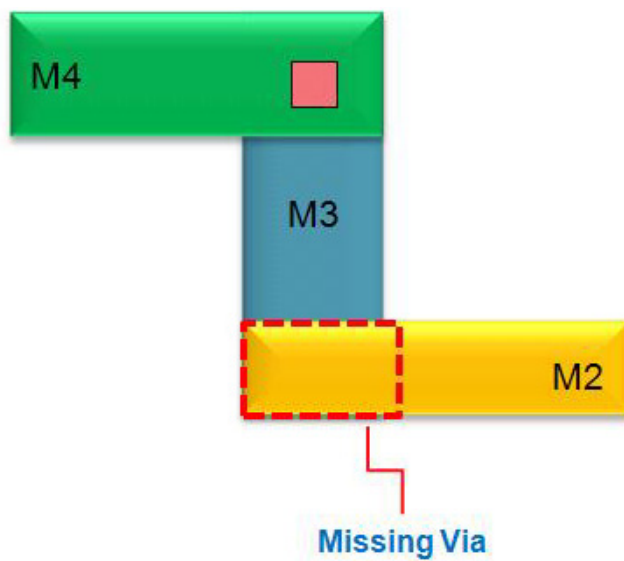
- [Checks for Running Structural Analysis](#)



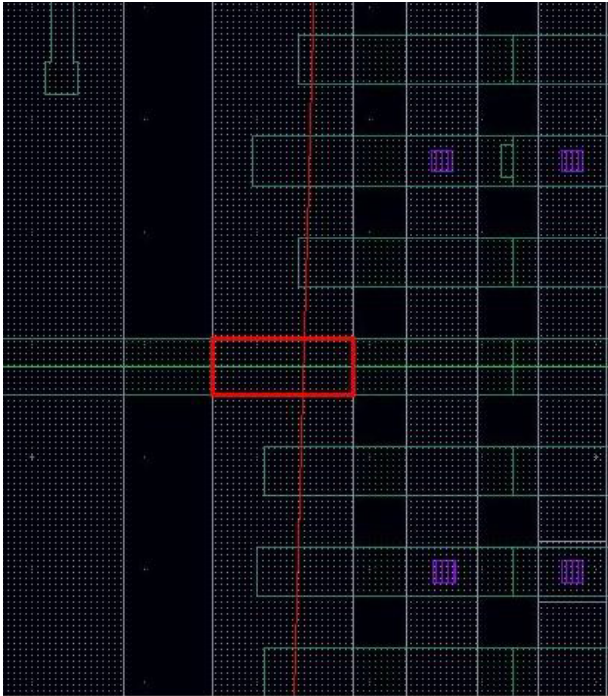
- Top Via Missing Check
- Missing Via Connections Check
- Via Coverage Ratio Check
- Skewed Via Ratio Check

## Missing Via Connections Check

Missing Via Connections is a check in Voltus-Fi-XL to run structural analysis. This check highlights overlapping wire segments that have no vias in the overlapping area. In the following example, the overlapping area between M4 and M3 has V3, but the overlapping area between M3 and M2 does not have V2.



The highlighted overlapping shape of the metal segments in the example below has missing via.

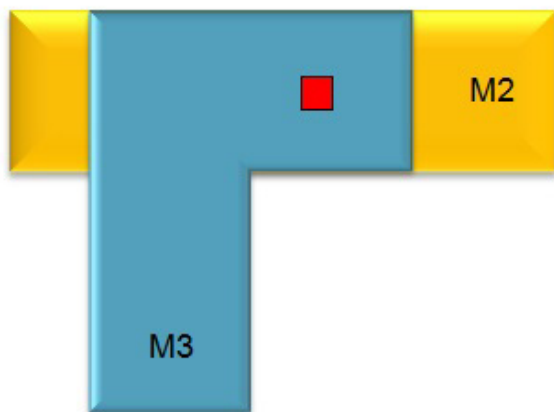


### ***Related Topics***

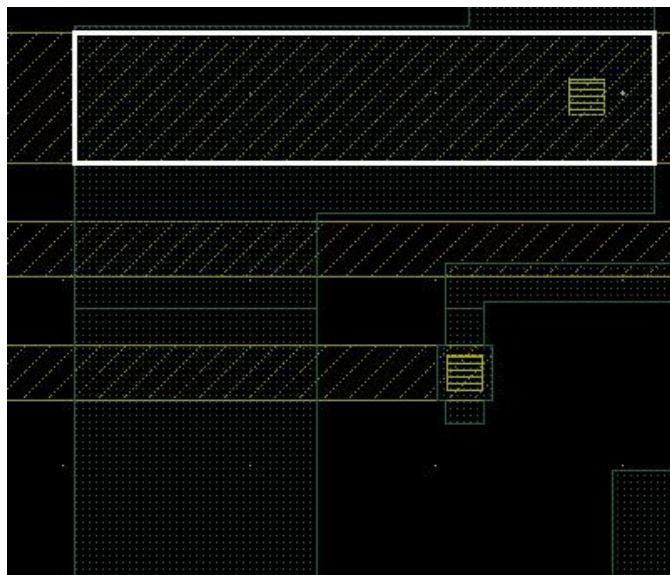
- [Checks for Running Structural Analysis](#)
- [Top Via Missing Check](#)
- [Bottom Via Missing Check](#)
- [Via Coverage Ratio Check](#)
- [Skewed Via Ratio Check](#)

## **Via Coverage Ratio Check**

Via Coverage Ratio Check is a check in Voltus-Fi-XL to run structural analysis. This check highlights segments that have less than user-specified via coverage ratio in the overlapping area. In the following example, the overlapping area between M2 and M3 has a via, but the via coverage ratio or the ratio of via area and overlapping area is less than the user-specified ratio.



The highlighted shape in the example below has a via coverage ratio less than that specified by the user.



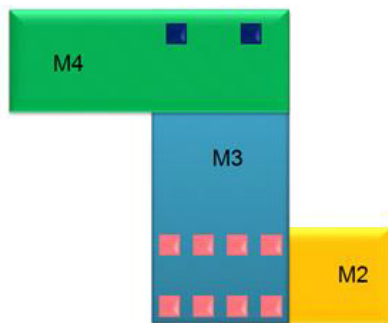
#### ***Related Topics***

- [Checks for Running Structural Analysis](#)
- [Top Via Missing Check](#)
- [Bottom Via Missing Check](#)
- [Missing Via Connections Check](#)

■ Skewed Via Ratio Check

## Skewed Via Ratio Check

Skewed Via Ratio Check is a check in Voltus-Fi-XL to run structural analysis. This check highlights segments in which the ratio of top and bottom connecting vias is skewed. In the following example, the ratio of top/bottom via is 2:8, which is skewed.

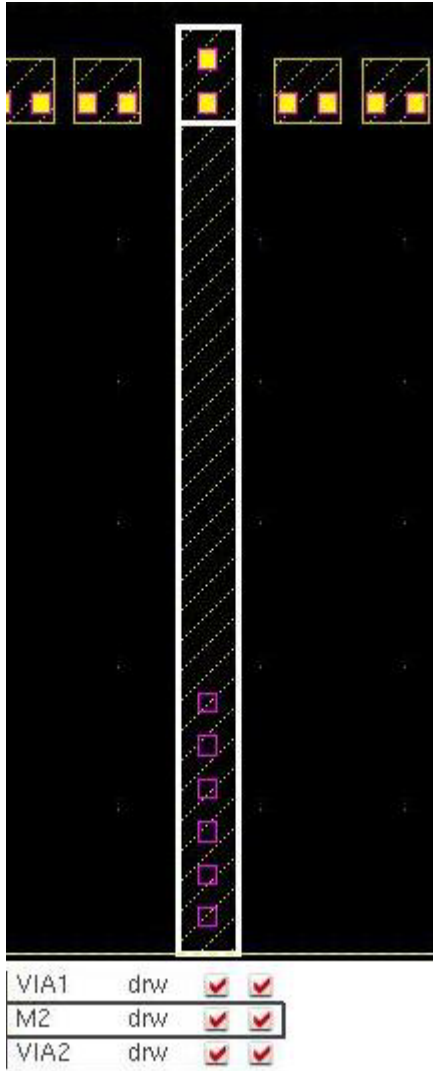


## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Structural Analysis

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The highlighted shape in the example below has a skewed top/bottom via ratio.



For this check, you can choose to:

- Highlight wire segments that have a top/bottom via ratio higher than the specified ratio.
- Highlight wire segments that have a bottom/top via ratio higher than the specified ratio.

### ***Related Topics***

- [Checks for Running Structural Analysis](#)
- [Top Via Missing Check](#)

- Bottom Via Missing Check
- Missing Via Connections Check
- Via Coverage Ratio Check

## Running Structural Analysis

You can run structural analysis to quickly identify power-grid weaknesses in designs and mark them on the Virtuoso layout for debugging purposes.

To run structural analysis, you first need to load the IR drop analysis results. Before you run structural analysis, ensure the following:

- In the *Layers* section in the expanded IR/EM Results form, the layers for which you want to view the results of the structural analysis are selected.
- The list of selected layers includes metal layers because structural analysis is run only for metal layers.

To run structural analysis, do the following:

1. In the IR/EM Results form, select the *Structural Analysis* tab.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Structural Analysis

The following information appears:

IR/EM Results

IR EM Structural Analysis LRP Browser Pin2PinR What-If (ECO)

Net Header File

Layer Map File /home/anuk/MMSIM\_EMIR\_WORKSHOP/df2layermap

Select Metal Layers for Analysis in Display Tab and then Run

Analysis Data Valid For Layers :  
mt1 mt2 mt3

☐ Select Net

☒ Clear

☐ Show Unconnected from Top

☐ Show Unconnected from Bottom

☐ Missing Via

☐ Number of Top Via <

☐ Number of Bottom Via <

☐ Top / Bottom via Ratio >

☐ Bottom / Top via Ratio >

☐ IR value >

☐ Overlap area (u^2) <

| Layer | Area (u^2) | IR (V) | # TopVias | # BotVias |
|-------|------------|--------|-----------|-----------|
|-------|------------|--------|-----------|-----------|

Number of Violations:

☐ Auto Zoom

Cancel Load Save Help

2. Select the *Layer Map File* and click *Run*.

The names of layers for which data is available appear in the field, *Analysis Data Valid For Layers*.

3. Click *Select Net* to select a net on the Virtuoso layout.
4. To view the data, the options provided for different check types are enabled. Select the specific check you want to run for the selected layers.

You can view the violations for the selected check type in the result browser. The following information is available for the selected metal layers for all checks except the missing via check: *Layer*, *Area (u^2)*, *IR(V)*, *#TopVias*, *#BotVias*, and *Ratio*. Double-click the column headings of the result browser to list the results in either an ascending or descending order.

5. Click *Auto Zoom* to zoom into the violations for the specified check.
6. To change the layers for which you want to run structural analysis, select or deselect the layers in the *Layers* section in the expanded IR/EM Results form and click *update*.

### ***Related Topics***

- [Checks for Running Structural Analysis](#)
- [Performing Structural Analysis using Voltus-Fi \(video\)](#)
- [IR/EM Results Form — Structural Analysis Tab](#)

## **Results of Structural Analysis**

After you run structural analysis in Voltus-Fi-XL, the results are displayed in the Virtuoso layout depending on the specified check type. Provided below are examples for the following checks:

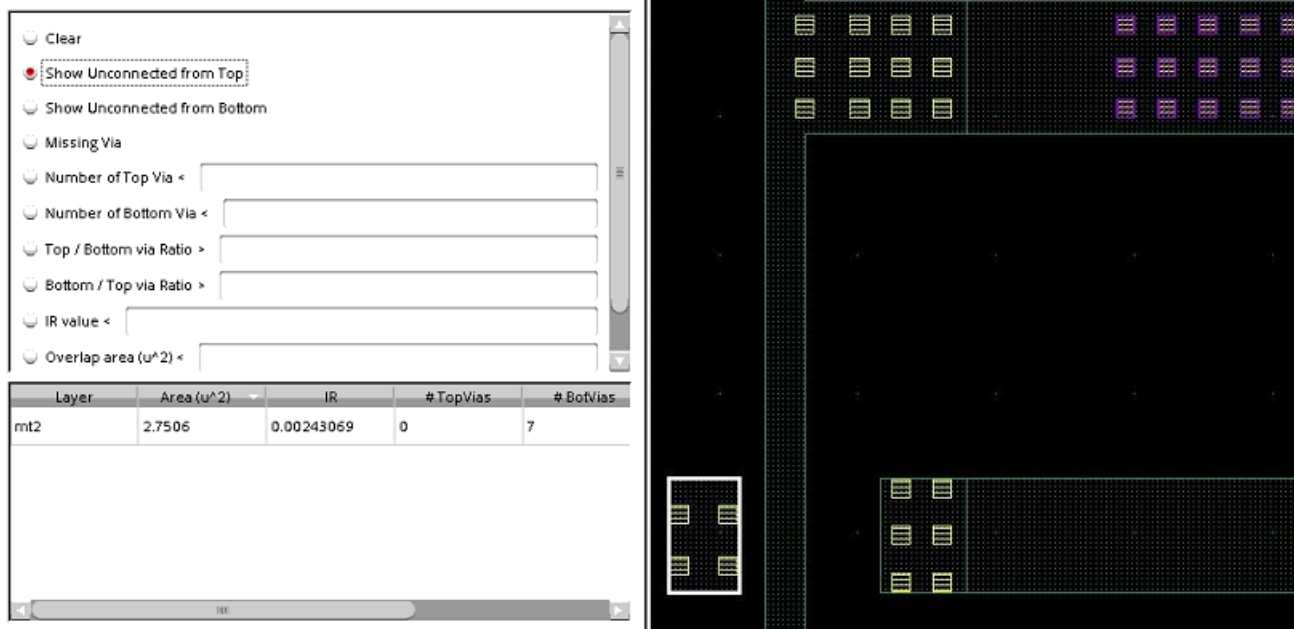
### **Show Unconnected from Top**

The figure below shows an example of structural analysis results in the Virtuoso layout when the *Show Unconnected from Top* check is specified. Here, the metal segment (m2) does not have any top vias.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Structural Analysis

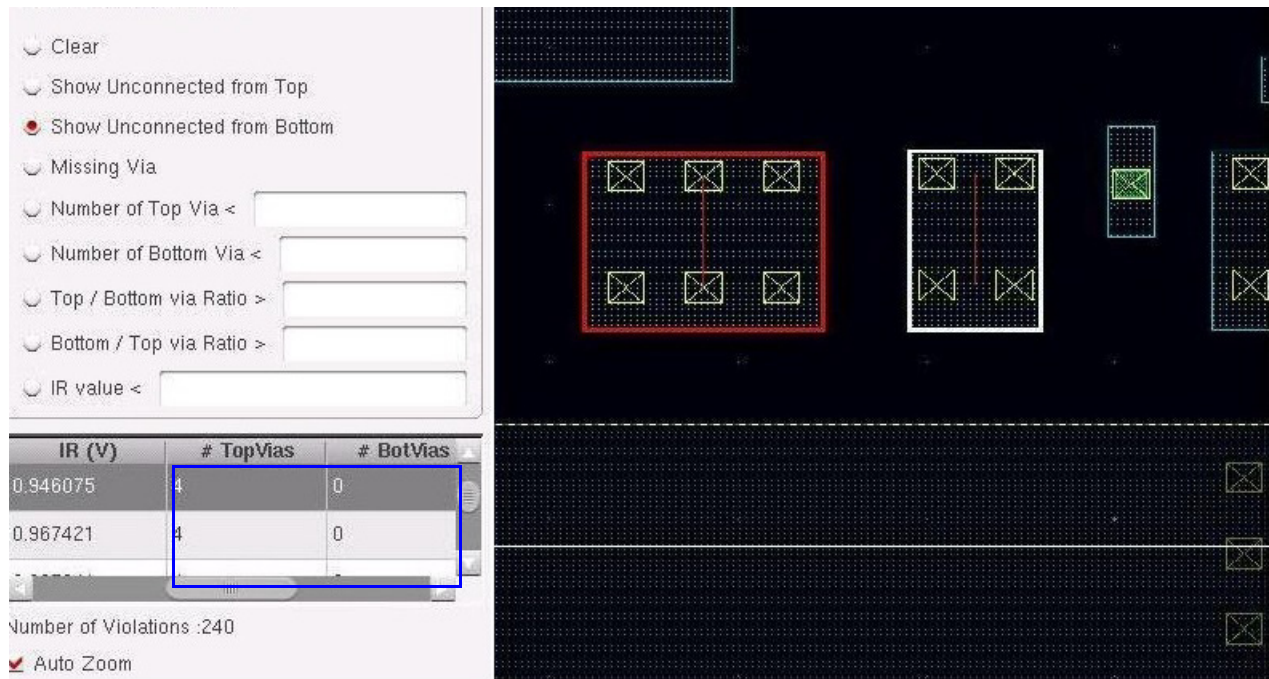


### Show Unconnected from Bottom

The figure below shows an example of structural analysis results in the Virtuoso layout when the *Show Unconnected from Bottom* check is specified. Here, the metal segment (Metal\_1) has only top vias. It does not have any bottom vias.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Structural Analysis

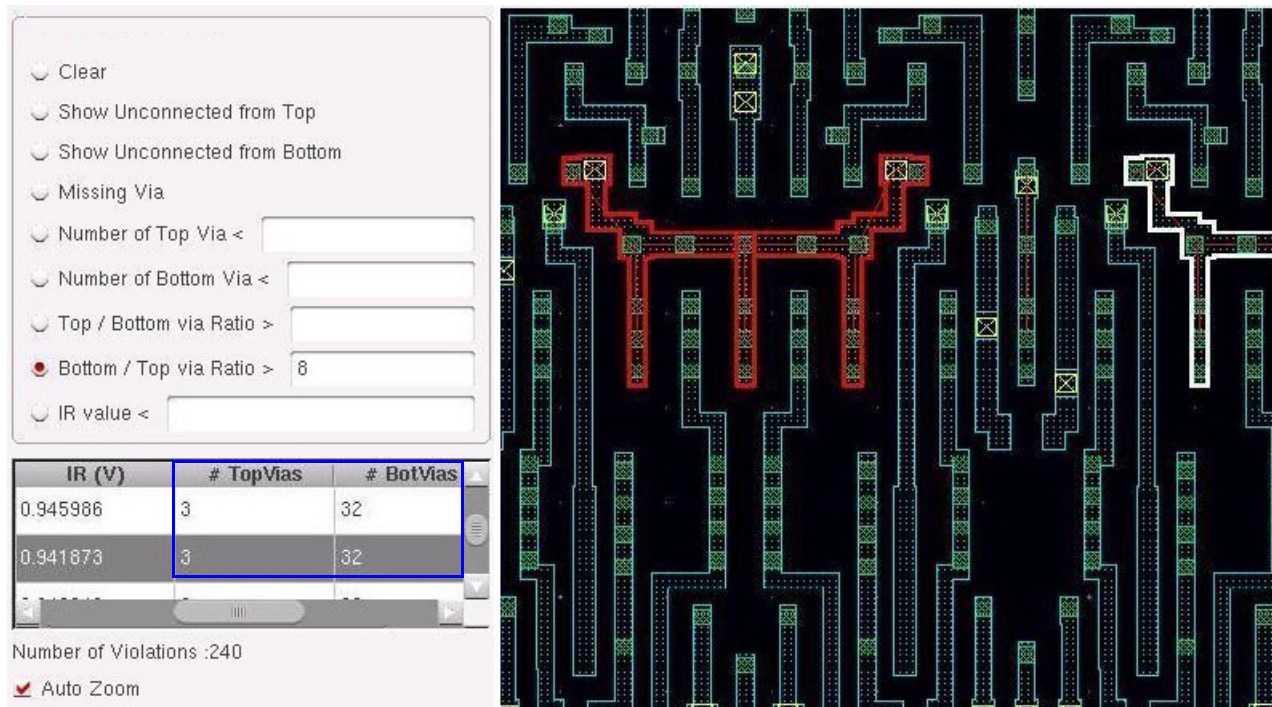


### Bottom / Top Via Ratio

The figure below shows an example of structural analysis results in the Virtuoso layout when the *Bottom / Top via Ratio >* check is specified. In this example, the user-specified bottom/top via ratio is 8. The metal segment (`Metal_1`) has 3 top vias and 32 bottom vias. The bottom to top via ratio is 32:3, which is greater than the user-specified ratio of 8.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Structural Analysis



## Missing Via Connections

In this example, the overlapping area of metal segments `Metal_4` and `Metal_3`, which is highlighted in red, has a missing via, `v3`. The result browser shows the overlapping layer names and the overlapping area of the two segments. This is shown in the figure below.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Structural Analysis

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**View Analysis Results**  
☐ Clear  
☐ Show Unconnected from Top  
☐ Show Unconnected from Bottom  
☒ Missing Via  
☐ Number of Top Via <   
☐ Number of Bottom Via <   
☐ Top / Bottom via Ratio >   
☐ Bottom / Top via Ratio >   
☐ IR value <

| Layer             | Area (u^2) |
|-------------------|------------|
| METAL_4 - METAL_3 | 0.6174     |
| METAL_4 - METAL_3 | 0.6174     |
| METAL_4 - METAL_3 | 0.6174     |

Number of Violations :258

☒ Auto Zoom

### ***Related Topics***

- [Checks for Running Structural Analysis](#)
- [Running Structural Analysis](#)
- [IR/EM Results Form — Structural Analysis Tab](#)

## IR/EM Results Form — Structural Analysis Tab

| Field                                                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Net Header File</i>                                              | Specifies the net header file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <i>Layer Map File</i>                                               | <p>Specifies the APS/XPS-to-DFII layer map file. You can create a new layer map file or edit an existing file, using the edit button provided next to the field. An example of the layer map file is provided below.</p> <pre>#&lt;type&gt; &lt;extraction layer name&gt; &lt;dfII layer name&gt; metal    metal7    M7 via      VIA5      VIA6 metal    metal6    M6 via      VIA5      VIA5 metal    metal5    M5 via      VIA4      VIA4 metal    metal4    M4 via      VIA3      VIA3 metal    metal3    M3</pre> <p>The order of layers in the layer map file is important. The layer map file must have layers listed in a top-to-bottom order.</p> |
| <i>Select Metal Layers for Analysis in Display Tab and then Run</i> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                                     | Runs structural analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <i>Analysis Data Valid For Layers</i>                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                                     | Displays the names of layers for which data is available.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <i>Select Net</i>                                                   | <p>Selects the net on the Virtuoso layout.</p> <p><b>Note:</b> You can run structural analysis only on one net at a time. So, if you are using the IR drop analysis results for running structural analysis, ensure that only one net is selected on the <i>IR</i> tab. If you select <i>All Power Nets</i>, <i>All Signal Nets</i>, or multiple nets in the <i>Select Nets</i> option on the <i>IR</i> tab, an error message is displayed.</p>                                                                                                                                                                                                           |
| <i>Clear</i>                                                        | Clears any existing highlights in the layout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>Show Unconnected from Top</i>                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |



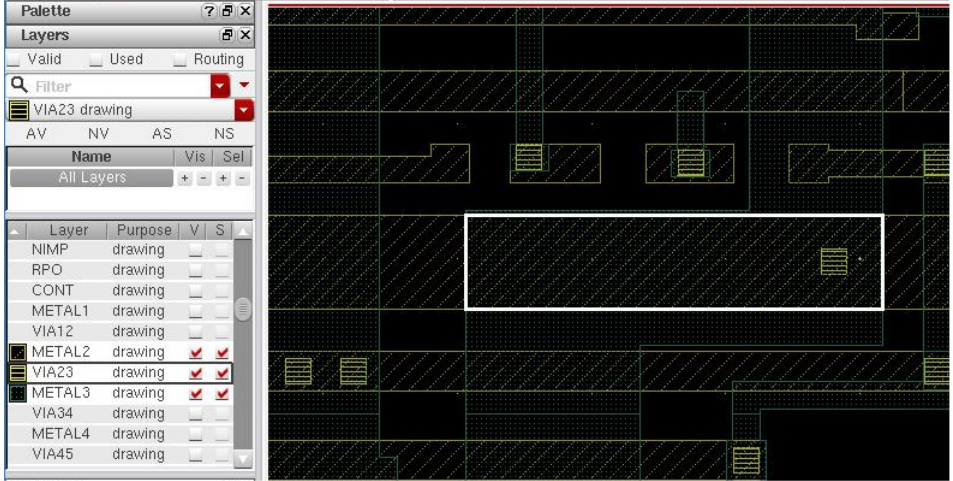
## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Structural Analysis

|                                                                                                                                                                                                                                                                                                                            | Highlights all unconnected metal segments that have no top via/contact shapes overlapping them on layer basis. For this check, the result browser will show the following information: |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------------------|-------------------|-----------|-------------------|--------|-------------------|---------|----------|---|------|---|---------|---------|----------|---|------|---|
| <table><tr><th>Layer</th><th>Area (u<sup>2</sup>)</th><th>IR (V)</th><th># TopVias</th><th># BotVias</th><th>Ratio</th></tr><tr><td>METAL_2</td><td>5118.98</td><td>0.955203</td><td>0</td><td>2830</td><td>0</td></tr><tr><td>METAL_2</td><td>5118.98</td><td>0.957325</td><td>0</td><td>2980</td><td>0</td></tr></table> |                                                                                                                                                                                        | Layer    | Area (u <sup>2</sup> ) | IR (V)            | # TopVias | # BotVias         | Ratio  | METAL_2           | 5118.98 | 0.955203 | 0 | 2830 | 0 | METAL_2 | 5118.98 | 0.957325 | 0 | 2980 | 0 |
| Layer                                                                                                                                                                                                                                                                                                                      | Area (u <sup>2</sup> )                                                                                                                                                                 | IR (V)   | # TopVias              | # BotVias         | Ratio     |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| METAL_2                                                                                                                                                                                                                                                                                                                    | 5118.98                                                                                                                                                                                | 0.955203 | 0                      | 2830              | 0         |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| METAL_2                                                                                                                                                                                                                                                                                                                    | 5118.98                                                                                                                                                                                | 0.957325 | 0                      | 2980              | 0         |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| Show Unconnected from Bottom                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                        |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
|                                                                                                                                                                                                                                                                                                                            | Highlights all unconnected metal segments that have no bottom via/contact shapes overlapping them on layer basis.                                                                      |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| Missing Via                                                                                                                                                                                                                                                                                                                | Highlights overlapping metal segments that have missing vias in the overlapping area. For this check, the result browser displays only layer and area information as shown below.      |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| <table><tr><th>Layer</th><th>Area (u<sup>2</sup>)</th></tr><tr><td>METAL_4 - METAL_3</td><td>0.6174</td></tr><tr><td>METAL_4 - METAL_3</td><td>0.6174</td></tr><tr><td>METAL_4 - METAL_3</td><td>0.6174</td></tr></table>                                                                                                  |                                                                                                                                                                                        | Layer    | Area (u <sup>2</sup> ) | METAL_4 - METAL_3 | 0.6174    | METAL_4 - METAL_3 | 0.6174 | METAL_4 - METAL_3 | 0.6174  |          |   |      |   |         |         |          |   |      |   |
| Layer                                                                                                                                                                                                                                                                                                                      | Area (u <sup>2</sup> )                                                                                                                                                                 |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| METAL_4 - METAL_3                                                                                                                                                                                                                                                                                                          | 0.6174                                                                                                                                                                                 |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| METAL_4 - METAL_3                                                                                                                                                                                                                                                                                                          | 0.6174                                                                                                                                                                                 |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| METAL_4 - METAL_3                                                                                                                                                                                                                                                                                                          | 0.6174                                                                                                                                                                                 |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| Number of Top Via <                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                        |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
|                                                                                                                                                                                                                                                                                                                            | Highlights metal segments that have less than the specified number of top vias.                                                                                                        |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| Number of Bottom Via <                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                        |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
|                                                                                                                                                                                                                                                                                                                            | Highlights metal segments that have less than the specified number of bottom vias.                                                                                                     |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| Top / Bottom via Ratio >                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                        |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
|                                                                                                                                                                                                                                                                                                                            | Highlights metal segments that have more than the specified top to bottom via ratio.                                                                                                   |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
| Bottom / Top Via Ratio >                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                        |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |
|                                                                                                                                                                                                                                                                                                                            | Highlights metal segments that have more than the specified bottom to top via ratio.                                                                                                   |          |                        |                   |           |                   |        |                   |         |          |   |      |   |         |         |          |   |      |   |

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### Structural Analysis

|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>IR value &gt;</i>                                     | <p>Highlights segments that have less than the specified IR drop values.</p> <p><b>Note:</b> This check is run at the segment level. For segments with multiple shapes, Voltus-Fi picks the worst-case IR values.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Overlap area (u^2) &lt;</i>                           | <p>Highlights segments that have an overlapping area less than the specified overlapping area.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <i>Via Coverage Ratio (via area / overlap area) &lt;</i> | <p>Highlights segments that have less than the specified via coverage ratio in the overlapping area. This check is used to highlight segments that have a via in the overlapping area but the via coverage is less as compared to the size of the overlapping area.</p> <p>For example, in the image below, the overlapping area of metal layers, M2 and M3, has a via, Via23. However, the ratio of via area to overlapping area is less than the user-specified ratio of 0.3. So, the overlapping area is highlighted.</p> <div style="display: flex; align-items: center;">  </div> |
| <i>Layer</i>                                             | Specifies the layer name for which information is provided.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <i>Area (u^2)</i>                                        | Specifies the area of the segment or layer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <i>IR(V)</i>                                             | Specifies the worst IR drop in the node.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <i>#TopVias</i>                                          | Specifies the number of top vias.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <i>#BotVias</i>                                          | Specifies the number of bottom vias.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Ratio</i>                                             | Specifies the ratio of top-to-bottom or bottom-to-top vias.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Structural Analysis

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|                             |                                                                 |
|-----------------------------|-----------------------------------------------------------------|
| <i>Number of Violations</i> |                                                                 |
|                             | Specifies the number of violations for the selected check type. |
| <i>Auto Zoom</i>            | Zooms into the violations for the specified check.              |
| <i>Cancel</i>               | Closes the form without executing the command.                  |
| <i>Load</i>                 | Loads the configuration file.                                   |
| <i>Save</i>                 | Saves the configuration file.                                   |
| <i>Help</i>                 | Opens help information in Cadence Help.                         |



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## Least-Resistive Path Analysis

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The Least-Resistive Path (LRP) analysis helps you identify weakly connected instances in the design during early stages of power planning. The resistance for an instance pin is calculated as the total resistance along the least resistance path. If an instance has multiple power pins connected to the power grid, the LRP plot uses the pin with the worst (highest) resistance value to plot the instance-based data. This plot highlights the current path for the selected instance to the voltage source. A long LRP usually results in high resistance and potentially high voltage drop.

In addition to identifying and displaying the worst IR drop violations, the LRP analysis feature in Voltus-Fi-XL lets you plot LRP on demand for any node. You can view the LRP for any high IR drop node by selecting it in the layout. There are two options provided in the GUI, *Get Layout Node* and *Get Marker Node*, to let you select a node on the GUI and view its LRP and to select an object in Annotation Browser and view the LRP for the node on the selected marker.

### ***Related Topics***

- [Running LRP Analysis in GUI Mode](#)
- [Running LRP Analysis in Batch Mode](#)
- [Plotting the Least Resistive Path \(LRP\) \(video\)](#)
- [IR/EM Results Form — LRP Browser Tab](#)

## Running LRP Analysis in GUI Mode

The main requirements to run LRP analysis are as follows:

- Only one net must be selected for LRP analysis.

The LRP analysis feature works for only one net at a time. However, in a power-gated design, the LRP plot is displayed for both the always-ON net and the switched net.

- The selected net must have at least one pin location or voltage source location.

- The selected net must have nodes connected to it.

To run LRP analysis in GUI mode, do the following:

1. Click the *IR* tab of the IR/EM Results form.
2. Under *Results*, load the IR drop analysis results.
3. Select a net and click *Show Plot*.
4. In the *LRP Paths* section of the *LRP Browser* tab, select the net for which you want to run LRP analysis.

The net selected in the *IR* tab is selected by default.

5. Select a layer from the *Layer* list and click *Compute LRP*.

The LRP values of all nodes of the selected net are populated in the LRP table.

6. Select a node in the LRP table.

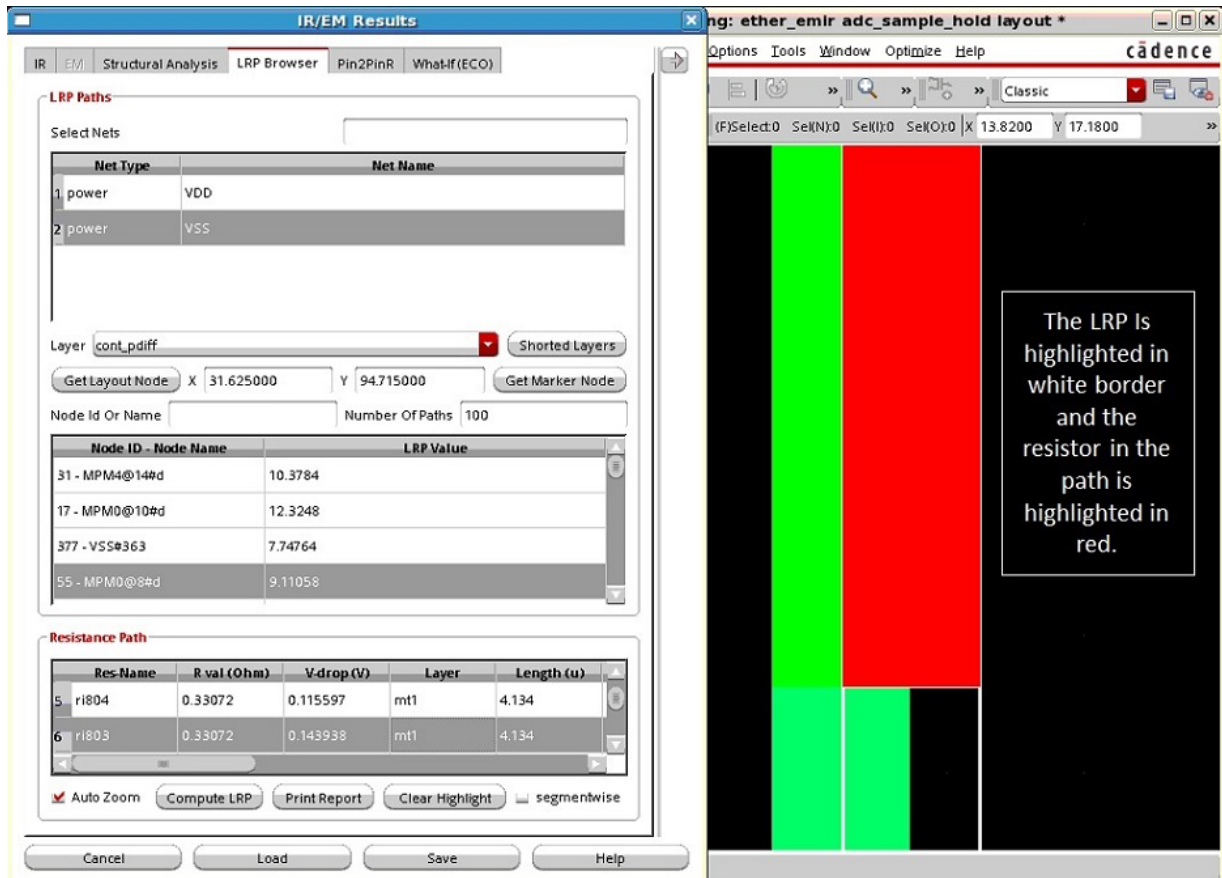
All resistors in the least-resistive path of the node are displayed in the resistance path table.

7. Select a resistor in the resistance path table.

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## Least-Resistive Path Analysis

The LRP plot is highlighted with a white border, and the resistor is highlighted in red in the Virtuoso layout window.



### Related Topics

- [Running LRP Analysis in Batch Mode](#)
- [Least-Resistive Path Analysis](#)
- [Plotting the Least Resistive Path \(LRP\) \(video\)](#)
- [IR/EM Results Form — LRP Browser Tab](#)

## Running LRP Analysis in Batch Mode

To run LRP analysis in batch mode, do the following:

1. Run the `load_ir_results` command to load the IR drop analysis results.

2. Run the `print_rlrp_nearest_subnode_on_layer` command to get details about the nearest subnode on a metal layer, which is present in the least-resistive path of a source-drain tap node.
3. Run the `print_rlrp_report` command to print the RLRP report.

### ***Related Topics***

- [Running LRP Analysis in GUI Mode](#)
- [Least-Resistive Path Analysis](#)
- [Plotting the Least Resistive Path \(LRP\) \(video\)](#)
- [IR/EM Results Form — LRP Browser Tab](#)

## **Shorting Layers for LRP Analysis**

While computing LRP for a node or instance, you can short specific layers. When you do this, all resistance on the specified layer is shorted, that means, the LRP display shows a value of 0 for all resistors on the shorted layer.

To short a specific layer for LRP analysis:

1. Click *Shorted Layers* on the *LRP Browser* tab of the IR/EM Results form.
2. In the *Filters* pop-up window, select the layers you want to short.

When a layer is shorted, the *R val (Ohm)* column in the resistance path table shows a value of 0 for all resistors on that layer. In the following example, the LRP value for resistor, `rh740` on shorted layer, `mt2` is 0.

**Resistance Path**

|   | Res-Name | R val (Ohm) | V-drop (V) | Layer | Length (u) | Width (u) |
|---|----------|-------------|------------|-------|------------|-----------|
| 1 | rh740    | 0           | 0          | mt2   | 6.782      | 2         |
| 2 | rs1255   | 0.093333    | 0.025434   | via1  | 0          | 0         |

☒ Auto Zoom   Compute LRP   Print Report   Clear Highlight   ☐ segmentwise

## Analyzing LRP in Power-Gated Designs

In Voltus-Fi-XL, you can view and analyze the LRP plot in power-gated designs. An always-ON net LRP plot shows LRP path for all nodes in the always-ON net as well as for all nodes connected to the switched net.

To view the LRP plot in a power-gated design:

1. In the *IR* tab of the IR/EM Results form, load the IR drop analysis results in the *Results* section.
2. Select a net, click *Plot Powergate Nets*, and then click *Show Plot*.

When you click *Plot Powergate Nets*, the selected net becomes an always-ON net, and all switched nets for the selected always-ON net also get selected.

3. In the *LRP Paths* section of the *LRP Browser* tab, select the net for which you want to run LRP analysis. The net selected in the IR tab is selected by default.
4. Select a layer from the *Layer* list and click *Compute LRP*.

The LRP values of all nodes of the always-ON net and the switched net are populated in the LRP table.

5. Select a node in the LRP table.

All resistors in the least-resistive path of the node are displayed in the resistance path table.

6. Select a resistor in the resistance path table.

The LRP plot is highlighted with a white border, and the resistor is highlighted in red in the Virtuoso layout window.

**Note:** The resistance value of the resistor,  $r_{ON}$ , is assumed to be 0 ohms.

## Analyzing LRP in Annotation Browser

You can view and analyze the LRP for a node on the selected marker in Annotation Browser. When you select a violation marker in the browser, it is highlighted in the layout. If the marker is associated with a node name, you can view the LRP for the node. This is particularly useful when either REffective or the transistor voltage plot is being shown and you want to see the LRP for the selected marker node.

To view the LRP values of a node on a violation marker:

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Least-Resistive Path Analysis

1. In the *IR* tab of the IR/EM Results form, load the IR drop analysis results in the *Results* section.
2. In the *Net Plot* section, select Rail Analysis as IV - Transistor Voltage or REffective - Effective Resistance.
3. Select a net and click *Show Plot*.
4. In the *Action* section in the expanded IR/EM Results form, select *Violation Browser*.
5. On the *EM/IR* tab of Annotation Browser, select a violation marker.

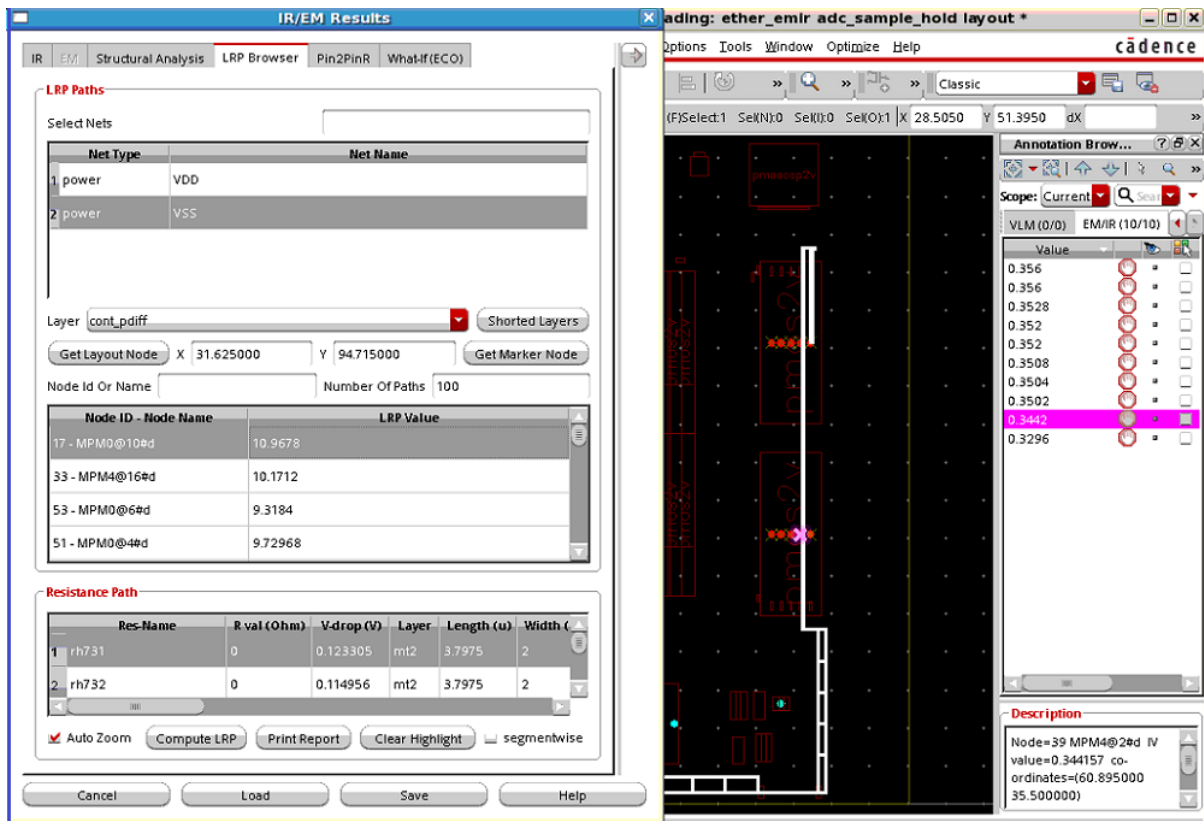
The violation marker is displayed in the layout.

6. On the *LRP Browser* tab of the IR/EM Results form, click *Get Marker Node*.

The information of the node on the marker - including layer name, X and Y coordinates, node ID and name, and LRP value - is populated in the *LRP Browser* tab.

7. Click the node in the LRP table and then click *Compute LRP*.

The LRP plot of the node is highlighted in white in the Virtuoso layout window as shown below.



# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Least-Resistive Path Analysis

## RLRP Report

The RLRP report (RLRP.rpt) is generated after the LRP analysis run is complete. It includes the LRP values of the instances or tap-nodes of the specified net. This report is generated by running the `print_rlrp_report` command in batch mode and clicking the *print report* option in the *LRP Browser* tab.

In the RLRP report file, information is provided in the following format for each net.

Shortest path for net <net name> to tap <tap name> : total resistance : <resistance value>

| res-name | coordinates | res   | layer | length | width | volt | acc-rlrp |
|----------|-------------|-------|-------|--------|-------|------|----------|
| acc-volt | node1       | node2 |       |        |       |      |          |

## Sample RLRP Report

### RLRP RESULTS

BINARY FILE = ./ts\_28hpm\_sr\_222\_hs\_f\_hc8t\_shlas\_32x4x4\_pgn.raw/ts\_28hpm\_sr\_222\_hs\_f\_hc8t\_shlas\_32x4x4\_pgn.emirtap.emir0\_bin  
RESULTS FILE CREATED = 2019-Aug-28 23:58:13 (2019-Aug-29 06:58:13 GMT)  
USER SUPPLIED VALUES:

Shortest path for net VDD to tap xts\_28hpm\_sr\_222\_hs\_f\_hc8t\_shlas\_32x4x4\_pgn.xcr\_0.xsram\_1.xcore\_xdec\_2.xcore\_top\_1.xmc\_top\_0\_3.xrefrow\_top\_1.XMC4.XFUR.mxp0:BULK (model NA) : total resistance : 142.732

| res-name | coordinates                   | res      | layer    | length   | width | volt        | acc-rlrp | acc-volt    | node1     | node2     |
|----------|-------------------------------|----------|----------|----------|-------|-------------|----------|-------------|-----------|-----------|
| z278804  | (0.722 75.975 2.13 75.975)    | 2.95884  | metal4   | 1.40756  | 0.25  | 0           | 2.95884  | 0           | VDD       | VDD:773   |
| z278848  | (2.13 75.975 3.785 75.975)    | 3.47913  | metal4   | 1.655    | 0.25  | 0.000340726 | 6.43797  | 0.000340726 | VDD:773   | VDD:788   |
| z278875  | (5.25 75.975 3.785 75.975)    | 3.07971  | metal4   | 1.465    | 0.25  | 0.000720783 | 9.51768  | 0.00106151  | VDD:786   | VDD:788   |
| z278871  | (8.105 75.975 5.25 75.975)    | 6.00176  | metal4   | 2.855    | 0.25  | 0.000925225 | 15.5194  | 0.00198673  | VDD:784   | VDD:786   |
| z278868  | (8.59 75.975 8.105 75.975)    | 1.01956  | metal4   | 0.485    | 0.25  | 0.000957427 | 16.539   | 0.00294416  | VDD:783   | VDD:784   |
| z278869  | (8.59 75.975 10.165 75.975)   | 3.31095  | metal4   | 1.575    | 0.25  | 0.000957427 | 19.8499  | 0.00390159  | VDD:783   | VDD:794   |
| z278887  | (11.795 75.975 10.165 75.975) | 3.42657  | metal4   | 1.63     | 0.25  | 0.00118552  | 23.2765  | 0.00508711  | VDD:792   | VDD:794   |
| z278884  | (13.245 75.975 11.795 75.975) | 3.04818  | metal4   | 1.45     | 0.25  | 0.00126793  | 26.3247  | 0.00635504  | VDD:791   | VDD:792   |
| z278885  | (13.245 75.975 16.32 75.975)  | 6.46424  | metal4   | 3.075    | 0.25  | 0.00126793  | 32.7889  | 0.00762297  | VDD:791   | VDD:800   |
| z278900  | (18.78 75.975 16.32 75.975)   | 5.17139  | metal4   | 2.46     | 0.25  | 0.00155367  | 37.9603  | 0.00917664  | VDD:798   | VDD:800   |
| z278897  | (19.76 75.975 18.78 75.975)   | 2.06015  | metal4   | 0.99     | 0.25  | 0.0015942   | 40.0205  | 0.0107708   | VDD:797   | VDD:798   |
| z278898  | (15.76 75.975 21.365 75.975)  | 3.37402  | metal4   | 1.605    | 0.25  | 0.0015942   | 43.3945  | 0.012365    | VDD:797   | VDD:803   |
| z278793  | (22.565 75.975 21.365 75.975) | 2.52263  | metal4   | 1.2      | 0.25  | 0.0016982   | 45.9171  | 0.0140632   | VDD:755   | VDD:803   |
| z278791  | (22.942 75.975 22.565 75.975) | 0.792994 | metal4   | 0.377222 | 0.25  | 0.00171187  | 46.7101  | 0.0157751   | VDD:754   | VDD:755   |
| z278789  | (24.35 75.975 22.942 75.975)  | 2.83144  | metal4   | 1.40778  | 0.25  | 0.00176076  | 49.5416  | 0.0175359   | VDD:753   | VDD:754   |
| z278786  | (24.35 75.975 24.35 75.975)   | 5.06486  | via3     | 0        | 0     | 0.00180157  | 54.6064  | 0.0193374   | VDD:752   | VDD:753   |
| z278788  | (24.35 75.975 24.35 75.885)   | 0.313649 | metal3   | 0.09     | 0.16  | 0.00180157  | 54.9201  | 0.021139    | VDD:752   | VDD:12275 |
| z302880  | (24.35 75.255 24.35 75.885)   | 2.19554  | metal3   | 0.63     | 0.16  | 0.00182129  | 57.1156  | 0.0229603   | VDD:12273 | VDD:12275 |
| z302879  | (24.35 75.255 24.35 75.255)   | 10.1297  | via2     | 0        | 0     | 0.00182129  | 67.2453  | 0.0247816   | VDD:12273 | VDD:12274 |
| z300888  | (24.505 75.255 24.35 75.255)  | 0.929929 | metal2   | 0.155    | 0.09  | 0.00183571  | 68.1752  | 0.0246173   | VDD:10845 | VDD:12274 |
| z279001  | (24.522 75.222 24.505 75.255) | 16.5005  | via1     | 0        | 0     | 0.00183806  | 84.6757  | 0.0249554   | VDD:838   | VDD:10845 |
| z278997  | (24.522 75.222 24.522 75.197) | 57.8893  | p_odcont | 0        | 0     | 0.00183806  | 142.565  | 0.0302934   | VDD:838   | VDD:1020  |

## IR/EM Results Form — LRP Browser Tab

| Field                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>LRP Paths</i></b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <i>Select Nets</i>      | Selects the net for which you want to view the LRP plot.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <i>Net Type</i>         | Type of the net.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>Net Name</i>         | Name of the net.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>Layer</i>            | Name of the layer for which you want to view the LRP plot.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <i>Shorted Layers</i>   | Shorts layers for LRP analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <i>Get Layout Node</i>  | <p>Selects a node in the layout.</p> <p>When you use this option, click <i>Get Layout Node</i> and then click anywhere in the Virtuoso layout window. The information of the node - including layer name, X and Y coordinates, node ID and name, and LRP value - present nearest to the location of the click is populated in the <i>LRP Paths</i> section. Click the node in the LRP table and then click <i>Compute LRP</i>. The LRP plot of the node is highlighted in white in the Virtuoso layout window.</p>                                      |
| <i>X</i>                | X coordinate of the layer selected in the layout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Y</i>                | Y coordinate of the layer selected in the layout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Get Marker Node</i>  | Displays the LRP values of a node, if present, on a selected marker.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <i>Node Id Or Name</i>  | <p>Name of the node for which you want to view the LRP value. Node names can be regular expressions, for example, <i>*MPM</i>. The LRP table shows all nodes matching the regular expression. It saves the time taken to scroll through the list of nodes to find information about a specific node.</p> <p>You can type the name of any node in this field, including a node that is not included in the list of violations. In that case, the resistance path table shows details of the node of the selected net, and the plot displays the LRP.</p> |
| <i>Number Of Paths</i>  | Number of violations that you want to view. By default, top 100 violations are listed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |



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### Least-Resistive Path Analysis

| Field                        | Description                                                                                                                                  |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Node ID - Node Name</i>   | List of instances or nodes of the net with their ID and name.                                                                                |
| <i>LRP Value</i>             | LRP values of the nodes, that is, the cumulative resistance on the path.                                                                     |
| <b>Resistance Path</b>       |                                                                                                                                              |
| <i>Res-Name</i>              | Name of the resistor on the layer.                                                                                                           |
| <i>R Val (Ohm)</i>           | Resistance value of the resistor.                                                                                                            |
| <i>V-Drop (V)</i>            | Voltage drop across the resistor. This value increases as the path moves away from the pin.                                                  |
| <i>Layer</i>                 | Name of the layer on which the resistor is located.                                                                                          |
| <i>Length (u)</i>            | Length of the resistor in micron.                                                                                                            |
| <i>Width (u)</i>             | Width of the resistor in micron.                                                                                                             |
| <i>Acc.R Val (Ohm)</i>       | The accumulative resistance value along the LRP. This column displays the total resistance of all the resistors till this point in the path. |
| <i>Acc.V-drop (V)</i>        | The accumulative voltage drop along the LRP. This column displays the total voltage drop of all the resistors till this point in the path.   |
| <i>Current (A)</i>           | Current across the resistor.                                                                                                                 |
| <i>Acc.current (A)</i>       | The accumulative current along the LRP till this point.                                                                                      |
| <i>Time (s)</i>              | Simulation time captured from the simulation result file.                                                                                    |
| <i>current-density (A/u)</i> | Current density across the resistor.                                                                                                         |
| <i>Location (u)</i>          | Location of the resistor.                                                                                                                    |
| <i>Voltage-diff (V)</i>      | Voltage difference. It is the difference of voltage drop between this resistor and the previous resistor.                                    |
| <i>Compute LRP</i>           | Computes LRP values for all nodes of the selected net.                                                                                       |
| <i>Print Report</i>          | Prints the LRP values of the specific resistors in the RLRP report. The report opens in the Voltus-Fi console.                               |
| <i>Clear Highlight</i>       | Clears the LRP plot highlighted in the layout.                                                                                               |

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## Least-Resistive Path Analysis

| Field              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |               |            |           |                |                 |                |                  |             |                          |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------|------------|-----------|----------------|-----------------|----------------|------------------|-------------|--------------------------|----------|--------------------------|----------|----------|--------|-----|--------|------|----------|----------|-----------|-----------|---|-----------|----------|----------|----------|-----|-------|---|----------|---------|-----------|-----------|---|-----------|----------|----------|----------|-----|--------|------|----------|---------|-----------|-----------|---|-----------|----------|---------------|------------|-------|------------|-----------|----------------|-----------------|-------------|------------------|----------|--------------------------|-----------|--------|---------|-----------|---|---|--------|----------|-----------|-----------|---|---|-----------|---------|---------|-----|---------|------|---------|---------|----------|-----------|---|----------|-----------|-------|----------|-----------|---|---|---------|---------|------------|-----------|---|---|
| <i>segmentwise</i> | <p>Displays the combined resistance values of a layer. When this option is selected, all resistors on a layer - metal or via - are merged into one segment, and the combined resistance values of a layer appear in the resistance path table.</p> <p>In the image below, the resistors, rg12, rg13, and rg14 on layer, mt3 are shown in the resistance path table. This is the display when the <i>segmentwise</i> option is not selected.</p> <table><tr><th>Res-Name</th><th>LRP Val (Ohm)</th><th>V-drop (V)</th><th>Layer</th><th>Length (u)</th><th>Width (u)</th><th>Acc. LRP (Ohm)</th><th>Acc. V-drop (V)</th><th>Current (A)</th><th>Acc. current (A)</th><th>Time (s)</th><th>current density (A/um^2)</th></tr><tr><td>13. rg12</td><td>0.032808</td><td>0.1093</td><td>mt3</td><td>0.6395</td><td>1.17</td><td>0.120308</td><td>0.976067</td><td>0.0433183</td><td>-0.587004</td><td>0</td><td>0.0370242</td></tr><tr><td>14. rg13</td><td>0.165539</td><td>0.110721</td><td>mt3</td><td>2.775</td><td>1</td><td>0.285847</td><td>1.08679</td><td>0.0433183</td><td>-0.543686</td><td>0</td><td>0.0433183</td></tr><tr><td>15. rg14</td><td>0.006654</td><td>0.117892</td><td>mt3</td><td>0.1295</td><td>1.17</td><td>0.292501</td><td>1.20468</td><td>0.0389955</td><td>-0.504691</td><td>0</td><td>0.0333295</td></tr></table> <p>In the image below, the resistors on the mt3 layer are combined to display the resistor path for the segment.</p> <table><tr><th>Res-Name</th><th>LRP Val (Ohm)</th><th>V-drop (V)</th><th>Layer</th><th>Length (u)</th><th>Width (u)</th><th>Acc. LRP (Ohm)</th><th>Acc. V-drop (V)</th><th>Current (A)</th><th>Acc. current (A)</th><th>Time (s)</th><th>current density (A/um^2)</th></tr><tr><td>2 segment</td><td>0.0875</td><td>0.10551</td><td>via2_o...</td><td>0</td><td>0</td><td>0.0875</td><td>0.866766</td><td>0.0433183</td><td>-0.630323</td><td>0</td><td>0</td></tr><tr><td>3 segment</td><td>1.88097</td><td>1.55195</td><td>mt3</td><td>31.5135</td><td>1.17</td><td>1.96847</td><td>2.41871</td><td>0.437306</td><td>-0.193016</td><td>0</td><td>0.419694</td></tr><tr><td>4 segment</td><td>0.175</td><td>0.190274</td><td>via2 o...</td><td>0</td><td>0</td><td>2.14347</td><td>2.60899</td><td>-0.0388989</td><td>-0.231915</td><td>0</td><td>0</td></tr></table> | Res-Name   | LRP Val (Ohm) | V-drop (V) | Layer     | Length (u)     | Width (u)       | Acc. LRP (Ohm) | Acc. V-drop (V)  | Current (A) | Acc. current (A)         | Time (s) | current density (A/um^2) | 13. rg12 | 0.032808 | 0.1093 | mt3 | 0.6395 | 1.17 | 0.120308 | 0.976067 | 0.0433183 | -0.587004 | 0 | 0.0370242 | 14. rg13 | 0.165539 | 0.110721 | mt3 | 2.775 | 1 | 0.285847 | 1.08679 | 0.0433183 | -0.543686 | 0 | 0.0433183 | 15. rg14 | 0.006654 | 0.117892 | mt3 | 0.1295 | 1.17 | 0.292501 | 1.20468 | 0.0389955 | -0.504691 | 0 | 0.0333295 | Res-Name | LRP Val (Ohm) | V-drop (V) | Layer | Length (u) | Width (u) | Acc. LRP (Ohm) | Acc. V-drop (V) | Current (A) | Acc. current (A) | Time (s) | current density (A/um^2) | 2 segment | 0.0875 | 0.10551 | via2_o... | 0 | 0 | 0.0875 | 0.866766 | 0.0433183 | -0.630323 | 0 | 0 | 3 segment | 1.88097 | 1.55195 | mt3 | 31.5135 | 1.17 | 1.96847 | 2.41871 | 0.437306 | -0.193016 | 0 | 0.419694 | 4 segment | 0.175 | 0.190274 | via2 o... | 0 | 0 | 2.14347 | 2.60899 | -0.0388989 | -0.231915 | 0 | 0 |
| Res-Name           | LRP Val (Ohm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | V-drop (V) | Layer         | Length (u) | Width (u) | Acc. LRP (Ohm) | Acc. V-drop (V) | Current (A)    | Acc. current (A) | Time (s)    | current density (A/um^2) |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| 13. rg12           | 0.032808                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.1093     | mt3           | 0.6395     | 1.17      | 0.120308       | 0.976067        | 0.0433183      | -0.587004        | 0           | 0.0370242                |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| 14. rg13           | 0.165539                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.110721   | mt3           | 2.775      | 1         | 0.285847       | 1.08679         | 0.0433183      | -0.543686        | 0           | 0.0433183                |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| 15. rg14           | 0.006654                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0.117892   | mt3           | 0.1295     | 1.17      | 0.292501       | 1.20468         | 0.0389955      | -0.504691        | 0           | 0.0333295                |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| Res-Name           | LRP Val (Ohm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | V-drop (V) | Layer         | Length (u) | Width (u) | Acc. LRP (Ohm) | Acc. V-drop (V) | Current (A)    | Acc. current (A) | Time (s)    | current density (A/um^2) |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| 2 segment          | 0.0875                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0.10551    | via2_o...     | 0          | 0         | 0.0875         | 0.866766        | 0.0433183      | -0.630323        | 0           | 0                        |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| 3 segment          | 1.88097                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1.55195    | mt3           | 31.5135    | 1.17      | 1.96847        | 2.41871         | 0.437306       | -0.193016        | 0           | 0.419694                 |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| 4 segment          | 0.175                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0.190274   | via2 o...     | 0          | 0         | 2.14347        | 2.60899         | -0.0388989     | -0.231915        | 0           | 0                        |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| <i>Auto Zoom</i>   | Zooms to the resistor being selected in the path in the layout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |               |            |           |                |                 |                |                  |             |                          |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| <i>Cancel</i>      | Closes the form without executing the command.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |               |            |           |                |                 |                |                  |             |                          |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| <i>Load</i>        | Loads the configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |               |            |           |                |                 |                |                  |             |                          |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| <i>Save</i>        | Saves the configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |               |            |           |                |                 |                |                  |             |                          |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |
| <i>Help</i>        | Opens help information in Cadence Help.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |               |            |           |                |                 |                |                  |             |                          |          |                          |          |          |        |     |        |      |          |          |           |           |   |           |          |          |          |     |       |   |          |         |           |           |   |           |          |          |          |     |        |      |          |         |           |           |   |           |          |               |            |       |            |           |                |                 |             |                  |          |                          |           |        |         |           |   |   |        |          |           |           |   |   |           |         |         |     |         |      |         |         |          |           |   |          |           |       |          |           |   |   |         |         |            |           |   |   |

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## PGV Generation in Voltus-Fi-XL

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This section contains information about power-grid views (PGVs), use of PGVs, and how to generate PGVs in Voltus-Fi-XL.

### What is Power-Grid View?

A power-grid view (PGV) is a model view of the design that contains information about the power ports of the cell or block. It also contains information about the internal power grid, intrinsic capacitance, and the tap current distribution within the cell or block.

Increasing operating frequency and density of IC designs increases the need for IR drop and Electromigration (EM) power-grid analysis. Power-grid signoff analysis is provided by Voltus in the digital domain, and Voltus-Fi-XL in the analog domain. Voltus-Fi-XL provides the ability to create power-grid views (PGVs) of an analog design block that can be used in Voltus for mixed-signal analysis. PGVs can be generated both in the GUI and batch command mode in Voltus-Fi-XL.

PGVs provide an accurate characterization of capacitance and currents, and power-grid extraction. Voltus uses these views to model power rail and power distribution information for each instance of the cell in the design for dynamic or static full-chip power-grid analysis.

**Note:** Both Voltus and Voltus-Fi-XL support PGV generation only for power pins.

#### ***Related Topics***

- [create\\_pgv](#)
- [Generating Power-Grid Views in Voltus-Fi-XL](#)
- [Create Power Grid Views Form](#)

## Data Requirements and Flow for PGV Creation

Power-grid view generation in Voltus-Fi-XL depends upon the simulator-generated database and current files. For generating PGVs in Voltus-Fi-XL, ensure the following while performing simulation using Spectre APS/XPS.

- Enable the `emir` mode. The EMIR analysis is run like a regular APS/XPS simulation with the additional `+emir` option.
- Generate the current files for all the power nets for which PGVs are being generated. This is done by specifying UTI commands in the Spectre input file. The syntax of the command is as follows:

```
uti0 uti signal=net_name start=start_time
cycles=number_of_cycles_for_this_measure intervals=number_of_points
clockcycle=clock_period method=[0|1|2][0|1|2][0|1|2]
filename=filename_prefix_for_this_measure termflag=0 Namemangling=0
```

The syntax contains the following parameters:

□ `signal=signal_name`

Specifies the net name for which current is to be calculated.

**Note:** Ensure that the net name is specified along with the instance hierarchy name. For example, if your instance hierarchy name is `IO`, then specify the signal name as `IO.VDD` for the `VDD` net.

□ `start=start_time`

Specifies the start time from which the current will be written in the current file.

□ `cycles=number_of_cycles_for_this_measure`

Specifies the number of clock cycles to be captured in the current file. By default, one cycle is captured.

□ `intervals=number_of_points`

Specifies the number of time points or measurement intervals within a clock cycle.

□ `clockcycle=clock_period`

Specifies the length of the clock cycle or the total duration for which the current information is being written in the current file. You must specify the unit.

□ `method=[0|1|2][0|1|2][0|1|2]`

Specifies the method that the simulator uses in post-processing clock analysis data.

[012] The number in the first position, (0), specifies the method of peak current calculation.

[012] The number in the second position, (1), specifies the method of average current calculation.

[012] The number in the third position, (2), specifies the method of RMS current calculation.

0: Reports the maximum out of each interval over all periods.

1: Reports the average out of each interval over all periods.

2: Does not calculate peak, average, or RMS current.

The default is 212, which is average current calculation.

❑ `filename=filename_prefix_for_this_measure`

Specifies the prefix for the current files that are being generated.

**Note:** For Voltus-Fi-XL, ensure that the prefix provided is "vps". For example, your filename could be vps\_VDD.ptiavg.

❑ `termflag [0 | 1]`

Specifies the terminals which will be output. Specify 0 to output the first three terminals. Specify 1 to output all the terminals.

❑ `Namemangling`

Specifies namemangling. When set to 0, specifies that names should not be mangled.

Here is an example of this command.

```
uti0 uti signal="IO.VDD" start=0n cycles=1 intervals=133 clockcycle=2ns
method="212" filename="vps" termflag=0 Namemangling=0
```

- In the Spectre input emir conf file, specify `eisopt save_gnd_caps=1` to include the grid capacitances in the EMIR database so that they can be used in power-grid flow. For example:

```
net name=[IO.*] analysis=[iavg irms vmax vavg]
eisopt save_gnd_caps=1
emirutil autorun=[true]
```

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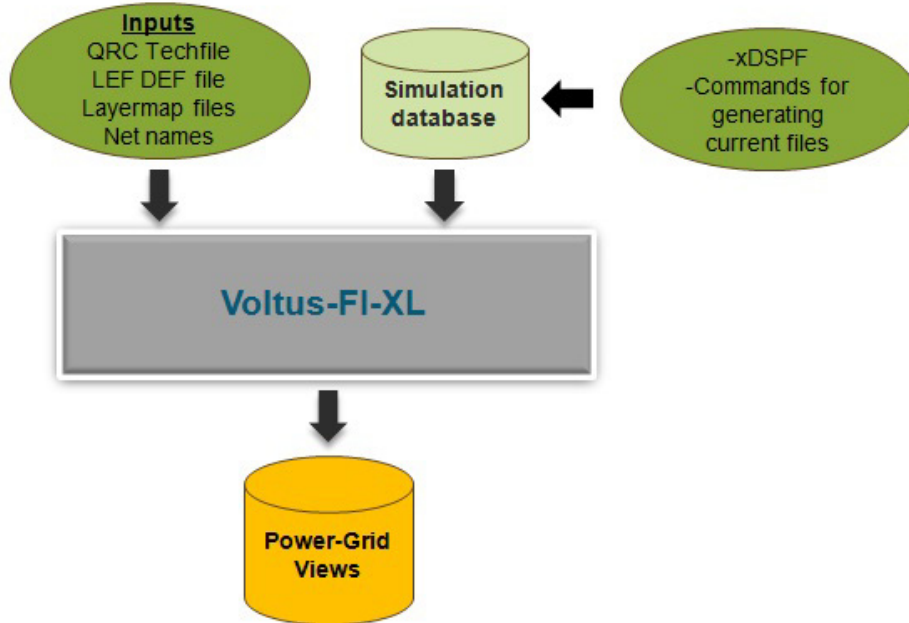
### PGV Generation in Voltus-Fi-XL

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The following table shows the required inputs for generating power-grid views in Voltus-Fi-XL.

| Type of Input          | Description                                                                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Simulation database    | It is required as input for performing EMIR analysis in Voltus-Fi-XL.                                                                                                                            |
| Quantus Techfile       | It is required for reading the technology data for PGV generation.                                                                                                                               |
| LEF DEF file           | It includes the LEF information for the technology data. It is required for port connectivities.                                                                                                 |
| Macro LEF file         | It specifies the LEF information for the design.<br><b>Note:</b> In case the technology data and design data are in the same LEF file, you do not need to specify the Macro LEF file separately. |
| OA Library             | It specifies the OpenAccess (OA) database library name for PGV generation.                                                                                                                       |
| PGDB layer map file    | It provides mapping between the layer names in the xDSPF (simulation EMIR database) to the layer names in the technology file.                                                                   |
| LEF DEF layer map file | It provides mapping between the layer names in the LEF file to the layer names in the technology file.                                                                                           |
| Net names              | It is required for pin information.                                                                                                                                                              |

The following diagram illustrates the flow of PGV generation in Voltus-Fi-XL:



## Open Access (OA)-Based Library Generation

Voltus-Fi-XL lets you specify an OpenAccess (OA) database for PGV Generation. You can either specify the LEF technology file/Macro LEF file or the OA libraries. The OA library files contain information from both the LEF technology file and the Macro LEF file. The layer map file is automatically created from the specified OA file. Alternatively, you can specify the layer map file.

In the GUI, the OA libraries can be specified in the *OA Libs* field of the Create Power Grid Views form. This is shown in the subsequent section.

In batch mode, the OA library can be specified by using the `-oa_lib` parameter of the `create_pgv` command. The OA library should have the abstract or layout view to read the required LEF pin information. By default, the tool reads only the abstract view from the macro OA database. If the abstract view is not present, you need to specify the layout view in the LibGen command file specified with the PGV command file.

To specify the layout view:

1. Include `setvar oa_layout_view_name layout` in the LibGen command file:  
`create_pgv -libgen_cmd_file cmd_file_name`

2. Include this command file in the `libgen_pgv.cmd` file (LibGen-generated command file in the PGV directory).

## Automatic Generation of Layer Map Files

The PGV flow in Voltus-Fi requires the following layer map information:

- LEF layer map file: Provides the mapping between the LEF layers and layers in the technology file.
- PGDB layer map file: Provides the mapping between the xDSPF layers and layers in the technology file.

These layer map files can either be specified in batch mode and the GUI. However, if not specified, the software generates these files for PGV generation.

### Automatic Generation of the LEF layer map File

The following parameter of the `create_pgv` command is used to specify the LEF layer map file:

```
create_pgv -lef_layer_map filename
```

The above parameter is optional. If specified, the software uses the specified layer map file for running the PGV flow. If not specified, Voltus-Fi automatically generates the LEF layer map file.

**Note:** Voltus-Fi generates the LEF layer map only for metal layers. The layers below the metal layers are not included in the mapping. This means, if a macro LEF file has ports in lower layers, they will not be included in the mapping.

The PGDB layer map file provides a mapping between the DSPF layer names that are written in the simulation database and the technology file layer names. Multiple DSPF layers can be mapped to one technology file layer.

The following parameter of the `create_pgv` command is used to specify the PGDB layer map file:

```
create_pgv -pgdb_layer_map pgdb_layermap_file_name
```

To generate the layer map file automatically, do not specify the above option. In this case, the software generates the PGDB layer map file with the name, `"VFI_generated_pgdb_layer_map.txt"`.



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### PGV Generation in Voltus-Fi-XL

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**Note:** The DSPF file should include the “\*LAYER\_MAP” section information.

An example of the \*LAYER\_MAP section for a third-party DSPF file is shown below:

```
*LAYER_MAP
*0 SUBSTRATE
*1 AP ITF=AP
*2 M0_A ITF=M0
*3 M0_B ITF=M0
*4 M1_A ITF=M1
*5 M1_B ITF=M1
*6 M0_A_SRM_SP ITF=M0
*7 M0_B_SRM_SP ITF=M0
*8 M0_A_SRM_2P ITF=M0
*9 M0_B_SRM_2P ITF=M0
*10 M1_A_SRM_SP ITF=M1
```

An example of the \*LAYER\_MAP section for a Quantus DSPF file is shown below:

```
*LAYER_MAP
*0 none
*1 M4
*2 M3
*3 M2
```

**Note:** This feature is available only with the Quantus versions, EXT 16.1.x and later.

**Note:** If the DSPF file does not contain the “\*LAYER\_MAP” section, an error message is displayed asking the user to specify the PGDB layer map by using the `-pgdb_layer_map` parameter of the `create_pgv` command.

If the software issues a warning message during the auto-generation of the layer map file, such as the one shown below, it means these layers are not mapped in the VFI-generated PGDB layer map file. In this case, add these layers manually in the file.

```
Warning: The following layers from dspf are missing in the pgdbLayerMap file
specified. Please add these layers in pgdblayersmap file. Missing layers may cause
connectivity problems in PGV creation for the net VDD.
```

```
mwires bwires
```

If there are no warnings, the VFI-generated PGDB layer map file can be used for running the PGV flow without making any changes.

## **Generating Power-Grid Views in Voltus-Fi-XL**

Voltus-Fi-XL creates PGVs for both static and dynamic rail analysis. It creates PGVs for static rail analysis along with the PGVs for dynamic rail analysis by using the average values of the current waveforms. However, it does not create PGVs only for static rail analysis.

To create power-grid views in Voltus-Fi-XL, perform the following steps:

1. In the Voltus-Fi-XL console, choose *IR/EM Analysis – Create Power Grid View*.

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### PGV Generation in Voltus-Fi-XL

The Create Power Grid Views form opens, as shown below.

**Create Power Grid Views**

**LEF Files and Layermap Files**

OA Libs:

Macro Name:  Library Name:

Extraction Tech File:

Tech Lef File:

Macro Lef File:

Lef Def Layer Map File:

PGDB Layer Map File:

Simulation Directory:

Simulation Prefix:  UTI Ron File:

Trigger File:

Net Name:  Voltage:

State Directory / Results File:

| Net Name | Voltage | EMIR Results DB File        |
|----------|---------|-----------------------------|
| 1 VDD    | 0.9     | /home/anuk/MMSIM_EMIR_WO... |

**Add** **Remove**

**Output**

Results Directory:

**Ok** **Cancel** **Default** **Save** **Load** **Help**

#### 2. .Specify the OA database library.

If this option is specified, you do not need to specify the *Tech Lef File/Macro Lef File* options.

3. Specify the *Macro Name* and *Library Name*.

4. Specify the *Extraction Tech File*, *Tech Lef File*, and *Macro Lef File*.

In case the technology data and design data are in the same LEF file, use any of the two options, *Tech Lef File* or *Macro Lef File* to specify the filename.

5. Specify the *Lef Def Layer Map File* and *PGDB Layer Map File*.

6. Specify the *Simulation Directory*.

7. Specify the *Simulation Prefix*. This input is optional.

8. Specify the *UTI Ron File* generated by Spectre.

If this file is not specified, Voltus-Fi-XL uses the `Ron` values from the MMSIM simulation database (\*.emir#\_bin file).

9. Specify the *Trigger File*, *Net Name*, and the corresponding *Voltage*.

10. Specify the *State Directory / Results File*.

The naming convention of the simulation result file is, \*.emir#\_bin. For example, your result file could be named, xps.emir0\_bin.

11. Click *Add* to add the net, the corresponding voltage, and the EMIR Results DB file location to the list.

12. In the *Output group* box, specify the *Results Directory*.

13. Click *OK*.

The following output is obtained after generating PGVs in Voltus-Fi-XL:

- A binary database that contains geometric views of the cell, port information, and the power-grid views.
- Text report and summary file with detailed information about the power-grid views.

The output of PGV generation in Voltus-Fi-XL is used in Voltus for dynamic power calculation and static and dynamic IR drop analysis.

## Troubleshooting Information for PGV Generation in Voltus-Fi-XL

After generating the PGVs in Voltus-Fi-XL, you can check whether the PGVs are correctly generated or not. Listed below are a couple of issues that you may encounter while generating PGVs, and the information to help resolve them.

### ■ No current information in the PGVs

If there is no current information in the PGVs, check your log file for a warning titled, VOLTUS\_LGEN-3065. This warning is issued when there is a mismatch between taps in the current files and the simulation database. If all taps fail, the current value in the PGV will be zero. To check the names and number of taps in the current file, you can use Itaputil. Itaputil is a Cadence utility that either reports characteristics of tap current files or extracts portions of the data and places them into a new tap current file.

For example, if your current file is `vps_VDD.ptiavg`, you can use the following command to list the names of all the taps in this file:

```
itaputil list vps_VDD.ptiavg > names
```

**Note:** To get help on the complete list of available commands in Itaputil, type the following in the xterm or shell:

```
itaputil -h
```

### ■ The current file does not have any waveforms

If the current file does not have any waveforms, it could be because of an error in the UTI command used for generating the current file. For resolving this issue, use Itaputil to check the tap names in the current file and to write the current data in the file.

# **Voltus-Fi Custom Power Integrity Solution XL User Guide**

## **PGV Generation in Voltus-Fi-XL**

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## Statistical ElectroMigration Budgeting

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Statistical ElectroMigration Budgeting (SEB) enables you to meet the ElectroMigration (EM) reliability targets by performing a statistical interconnect EM analysis based on the current modeling and thermal analysis of the design. This feature leverages the statistical nature of EM reliability to compute the level of the EM risk for all design rule violations. SEB analysis requires fixing of only those violations that add significant risk. This reduces the design verification time and improves performance while ensuring that the design meets its chip-level reliability goals.

Failures in Time (FIT) is a factor to represent the chip failure rate. Following is the definition of FIT:

1 FIT = One failure per  $10^9$  product hours

= One failure in 1000 products through  $10^6$  hours

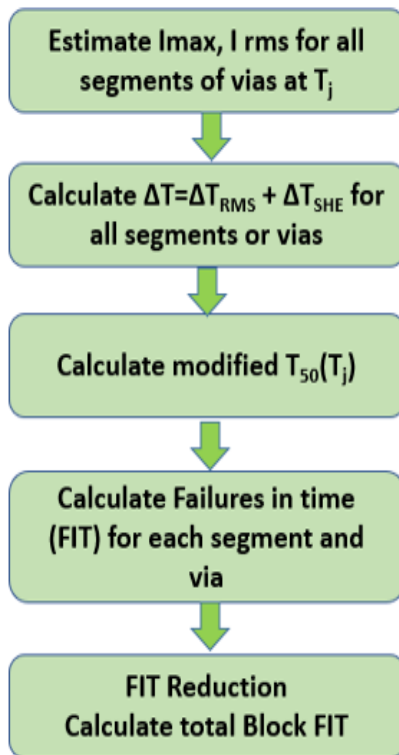
= One failure in 105 products through  $10^4$  hours

= or any other combination between products and hours as long as the product of the two is  $10^9$

Voltus-Fi will calculate the FIT value for each resistor of metal and via. The tool will follow the foundry EM definition to calculate FIT. This flow is supported in Voltus-Fi and involves the following tasks:

1. Calculating the FIT for each resistor of metals and vias.
2. Applying FIT reduction using the calculation.
3. Adding all the reduced FIT values to get the total block/chip FIT.
4. Generating a report with all the FIT information in a text format.

The following flowchart depicts the high-level flow for SEB in Voltus-Fi:



### ***Related Topics***

- [FIT Reduction Method](#)
- [Inputs for the SEB Flow](#)



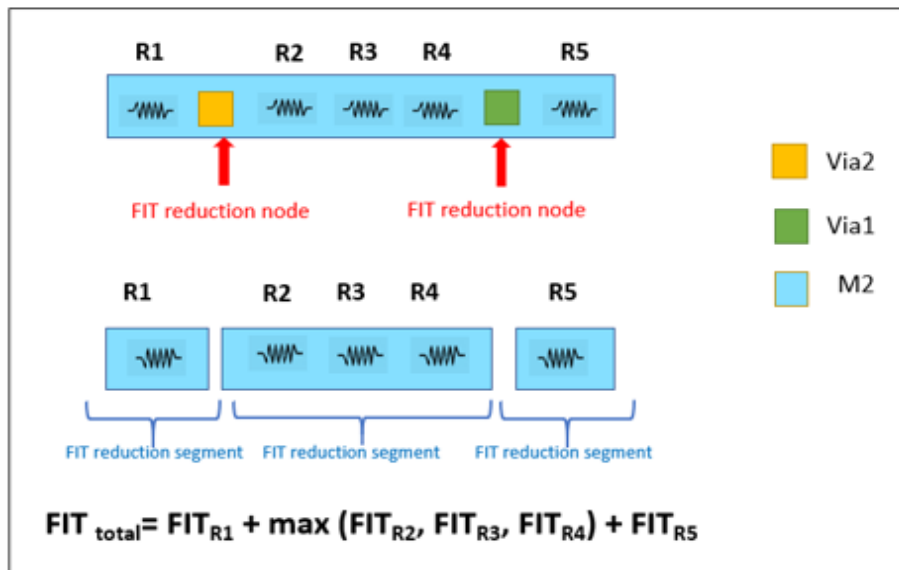
## FIT Reduction Method

This section details the FIT reduction methods used for metal and via resistors.

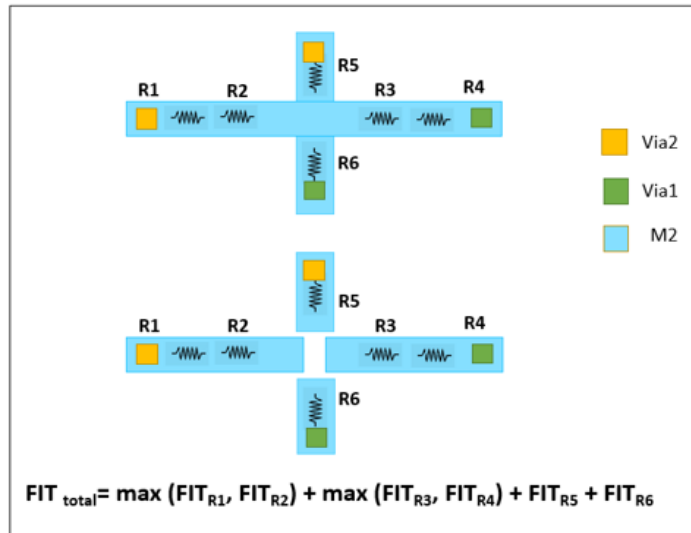
### Metal FIT Reduction

- FIT reduction node is a node on the metal layer satisfying either of the following conditions:
  - ❑ one or more vias are connected to the node
  - ❑ metal resistors branch (three or more metal resistors connected to a metal node) at the node
  - ❑ the node is a metal boundary node
- Metal FIT reduction segment is a group of connected resistors between two FIT reduction nodes
- Voltus-Fi selects the largest FIT among the resistors within a FIT reduction segment as the FIT of the metal segment

#### Metal FIT Reduction Example 1



## Metal FIT Reduction Example 2



## VIA FIT Reduction

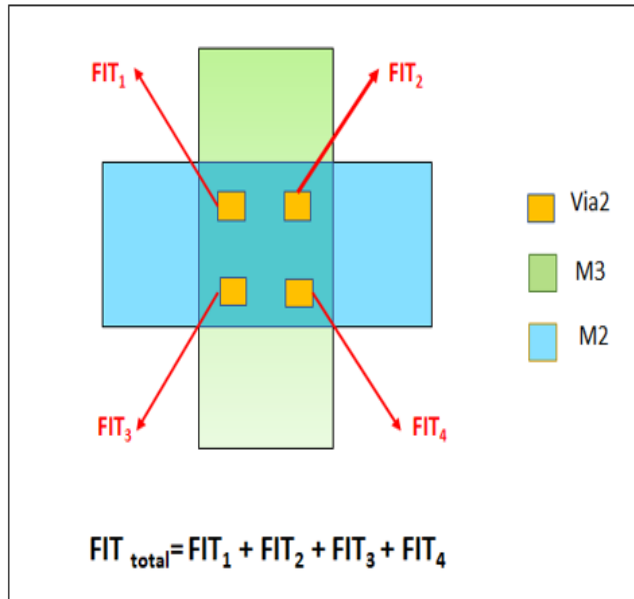
- FIT reduction is not applied to vias
- Via array is divided into single vias
- FIT is calculated for all vias
- Total FIT of the block/chip is calculated by adding all FITs of single vias and metal FITs

## VIA FIT Reduction Example

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Statistical ElectroMigration Budgeting

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#### ***Related Topics***

- [Statistical ElectroMigration Budgeting](#)
- [Inputs for the SEB Flow](#)

## Inputs for the SEB Flow

For running the SEB relaxation flow, you need to provide the SEB parameter file with FIT calculations.

Following is a sample of the SEB parameter file:

```
FIT_TABLE 72 5 (LAYER:V, MTF_HOUR:V, SIGMA:V, Ea:V, EXP_N:V r:V)
FIELD MTF_HOUR SIGMA Ea EXP_N r
LAYER
M12 1.73e5 0.22 0.8 1 1
VIA11 1.73e5 0.22 0.8 1 1
M11 1.73e5 0.22 0.8 1 1
VIA10 1.73e5 0.22 0.8 1 1
M10 1.73e5 0.22 0.8 1 1
VIA9 1.73e5 0.22 0.8 1 1
M9 1.73e5 0.22 0.9 1 1
VIA8 1.73e5 0.22 0.9 1 1
M8 1.73e5 0.22 0.9 1 1
```

Where,

- FIELD LAYER is the name of a metal layer/via
- MTF\_HOUR is the median time to failure in hour
- SIGMA is spread in lifetime distribution (from foundry)
- r is the relax factor

### ***Related Topics***

- [Statistical ElectroMigration Budgeting](#)
- [FIT Reduction Method](#)
- [SEB Flow emirutil Command Option](#)

## SEB Flow emirutil Command Option

The following option is specified in the EMIR control file using the `emirutil` command for the SEB flow:

| Keyword  | Option Set                            | Explanation                                                                                                                                                                                                                                                                                                                                          | Default Value |
|----------|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| emirutil | sebParamFile=" <i>paramfilepath</i> " | <p>Specifies the self-heating effect (SHE) analysis parameter file, which is required for calculating the SHE analysis results.</p> <p><b>Note:</b> For the SEB flow, this file should include the FIT information for all segments of metals and vias.</p> <p><b>Example:</b></p> <pre>emirutil     sebParamFile=[../Techfile/ICTEM/seb.ircx]</pre> | none          |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Statistical ElectroMigration Budgeting

| Keyword | Option Set                                                                                                                            | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Default Value |
|---------|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|         | <pre>print_em_report=[     [net=[all_nets       all_power   all_signal       netname] type=[fit]     filename=output_file_name]</pre> | <p>Generates the EM report with the SHE for the SEB flow. You can specify the following:</p> <ul style="list-style-type: none"> <li>■ filename: creates a report with the specified filename.</li> <li>■ net: creates a report for the specified nets - all power nets (all_power), all signal nets (all_signal), all nets (all_nets), or a net (netname).</li> <li>■ type - creates a report for the SEB flow (FIT).</li> </ul> <p><b>Example:</b></p> <pre>emirutil print_em_report=[net=all_nets type=fit filename= fit_woshe.rpt]</pre> | none          |

#### ***Related Topics***

- [Statistical ElectroMigration Budgeting](#)
- [Inputs for the SEB Flow](#)

## Sample EMIR Configuration File

Following is a sample EMIR configuration file with specifications for the SEB flow:

```
net name=[XTOP.*] analysis=[iavg imax irms iacpeak vavg vmax]
emirutil auto_detect_geounit=[false]
solver method=[direct | iterated]
emirutil techfile=[../../../../../Techfile/RCE_qrc/qrcTechFile] >> provide
 qrcTechfile path
emirutil EMOOnlyICTFile=[../../../../../Techfile/ICTEM/drawn_color.ictem] >> provide
 ICTEM file (if any)
emirutil Tj=<value>
emirutil Tambient=<value>
emirutil ProductLife=<value> >> default value=5 years
emirutil autorun=[true]
emirutil report=[text |HTML]
emirutil idirn=[true |false]
emirutil splitACDCRules=[true|false]
emirutil extendedreport=[true|false]
emirutil optimisticEMRuleSelection=[true|false]
emirutil simpleSingleViaDefinition=[true |false]
emirutil redundantNonCDRules=[true |false]
emirutil dbu=<value>
emirutil powerRailRules=[on|off]
emirutil sebParamFile="./test_SEB_n7_1p12m.ircx" >> provide the SEB param file
 path
emirutil print_em_report=[net=all_nets type=fit filename=fit_woshe.rpt] >> the
 reporting option to print the FIT report
```

### ***Related Topics***

- [SEB Flow emirutil Command Option](#)
- [Statistical ElectroMigration Budgeting](#)
- [Inputs for the SEB Flow](#)

## SEB GUI Variable

The option for the SEB flow can also be specified in the GUI in the *Variables* form that opens on the *EM* tab of the *IR/EM Results* form.

| Variable Name | Option Set                                                                                                                                                                                                                                                                                                    |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| sebParamFile  | <p>Specifies the SHE analysis parameter file, which is required for calculating the SHE analysis results.</p> <p><b>Note:</b> For the SEB flow, this file should include the FIT information for all segments of metals and vias.</p> <p><b>Example:</b></p> <pre>sebParamFile ./test_SEB_n7_1p12m.ircx</pre> |

### ***Related Topics***

- [SEB Flow emirutil Command Option](#)
- [Statistical ElectroMigration Budgeting](#)
- [Inputs for the SEB Flow](#)
- [SEB Report](#)



## SEB Report

The SEB flow generates a report with the total reduced FIT for all resistors.

Following is a sample SEB FIT Results file:

```

SEB FIT RESULTS
VERSION = 06_18-s801
Tambient = 22 C
ProductLife = 5 year
Total Reduced FIT = 1.158552269645e+06
current (mA): resistor DC current
limit (mA): EM limit at Tseb
Sdc: current/limit
r: relax factor
rmsT (C): rms temperature of metal
coupledT (C): coupled temperature from OD layer
Tseb (C): Tambient + rmsT if self-heating effect is disable
Tambient + rmsT + coupledT if self-heating effect is enable
MTF_new: final MTF value
NA indicates that tool cannot find matching EM rule for EM limit calculation
#
#
```

| uction | Net<br>After_FIT_Reduction | layer<br>Reference_FIT_R | X      | Y      | current<br>(mA) | limit<br>(mA) | Sdc       | r    | rmsT<br>(C) | coupledT<br>(C) | Tseb<br>(C) | MTF_new   | Before_FIT_Red |
|--------|----------------------------|--------------------------|--------|--------|-----------------|---------------|-----------|------|-------------|-----------------|-------------|-----------|----------------|
| rv1    | VSS                        | m0                       | 81,500 | 21,000 | 7.665e-02       | 2.200e-02     | 3.484e+00 | 0.50 | 2.347       | 0.000           | 24.347      | 1.100e+05 | 1.7364439317   |
| 63e+05 | 1.736443931769e+05         | -                        |        |        |                 |               |           |      |             |                 |             |           |                |
| rd1    | VDD                        | m0                       | 61,500 | 21,000 | 7.665e-02       | 2.200e-02     | 3.484e+00 | 0.50 | 2.347       | 0.000           | 24.347      | 1.100e+05 | 1.7363654213   |
| 60e+05 | 1.736365421360e+05         | -                        |        |        |                 |               |           |      |             |                 |             |           |                |
| rv4    | VSS                        | md_sti                   | 82,500 | 21,000 | 2.614e-02       | 4.400e-03     | 5.940e+00 | 1.00 | 0.273       | 0.000           | 22.273      | 1.100e+05 | 1.3468703674   |
| 01e+05 | 1.346870367401e+05         | -                        |        |        |                 |               |           |      |             |                 |             |           |                |
| rd4    | VDD                        | md_sti                   | 62,500 | 21,000 | 2.614e-02       | 4.400e-03     | 5.940e+00 | 1.00 | 0.273       | 0.000           | 22.273      | 1.100e+05 | 1.3468024184   |
| 44e+05 | 1.346802418444e+05         | -                        |        |        |                 |               |           |      |             |                 |             |           |                |
| rv11   | VSS                        | md_sti                   | 89,500 | 21,000 | 2.261e-02       | 4.400e-03     | 5.138e+00 | 1.00 | 0.204       | 0.000           | 22.204      | 1.100e+05 | 1.0407895805   |
| 14e+05 | 1.040789580514e+05         | -                        |        |        |                 |               |           |      |             |                 |             |           |                |

Where,

- current (mA): resistor DC current
- limit (mA): EM limit at ambient temperature
- Sdc: current/limit
- rmsT (C): rms temperature of metal
- coupledT (C): coupled temperature from OD layer
- Tseb (C): Tambient + rmsT if SHE is disabled
- Tambient + rmsT + coupledT if SHE is enabled
- MTF\_new: is the median time to failure that is calculated at Tseb
- Before\_FIT\_Reduction: FIT values for resistors reported in the SEB parameter file
- After\_FIT\_Reduction: FIT values after applying reduction method provided by foundry
- Reference\_FIT\_R: resistor that is used as a reference

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Statistical ElectroMigration Budgeting

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- NA indicates that the tool cannot find matching EM rule for EM limit calculation

#### ***Related Topics***

- [SEB Flow emirutil Command Option](#)
- [Statistical ElectroMigration Budgeting](#)
- [Inputs for the SEB Flow](#)
- [SEB Report](#)

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## Batch Commands in Voltus-Fi-XL

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You can run Voltus-Fi-XL in batch mode by using the `vfi batch` command and specifying the command file with various batch commands. This section provides a list of commands supported in Voltus-Fi-XL.

## extract\_xdspf

```
extract_xdspf
 -inputType {pegasus | pvs | calibre}
 -inputDir input_dir_name
 -RunName input_run_name
 -outputDir output_dir_name
 -process {n3 | n5 | n7prf | n7 | n10pg | n10 | n20 | n16 | n12 | others}
 -techDir tech_dir_name | -techLib tech_lib_file_name
 -signalEM {true | false}
 [-arrayViaSpacing {auto | value}]
 [-blockingCellFile parasitic_blocking_device_cell_names_file]
 [-bus_bit_char string]
 [-cclFileName vfiQuantus-<filename>.ccl]
 [-coloring {true | false}]
 [-commentSubCkt {true | false}]
 [-compression {true | false}]
 [-customExtract extract_Commands_File]
 [-device_properties_file file_name]
 [-fractureViaCnt via_count_number]
 [-groundNet ground_net_name]
 [-generate_ccl_only {true | false}]
 [-icell_map_file filename]
 [-keep_pin_shorting_res {true | false}]
 [-keep_pin_shorting_res_by_layer {"layer1" "layer2" }]
 [-lic_queue timeout_in_seconds]
 [-LVS_BOX_hierarchical_flow {true | false}]
 [-min_res_by_layer {true | false}]
 [-multiCpu number_of_cpus]
 [-outputDspf output_dspf_filename]
 [-output_xy_generic {true | false}]
 [-PGNets list_of_pg_nets]
 [-reduction {true | false}]
 [-stacked_via_effect {true | false}]
 [-subcktPinOrder pin_order_file]
 [-subNodeChar sub_node_char]
 [-subConductorModel {true | false}]
 [-techName technology_name]
 [-techCorner technology_corner_name]
 [-temperature value]
 [-tech_cmd_file filename]
 [-tech_layer_setup_file filename]
 [-tech_lpe_config_file ./lpe_confile]
 [-user_ccl_file ccl_file_name]
```

Generates the xDSPF file using Quantus from within Voltus-Fi-XL.

**Note:** Before running this command, ensure that the Quantus hierarchy is available because the tool will call the Quantus binary from this path, and also ensure that the Pegasus, PVS, or Calibre® run is performed successfully.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

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Quantus has a plug-and-play flow that performs Techgen compilation automatically while doing extraction. This is intended to make it easier to maintain the technology files. When this feature is enabled, you can supply the raw techfiles from the foundry and Quantus takes care of the rest.

The following parameters are provided to enable this plug-and-play feature:

- `-tech_cmd_file` *name of file*
- `-tech_layer_setup_file` *name of file*
- `-icell_map_file` *name of file*
- `-tech_lpe_config_file` *./lpe\_confile*

**Note:** The `extract_xdspf` command has the following parameters that are only used for hierarchical EMIR analysis.

```
-hier_flow {true | false}
-hier_flow_pgv {1.cl 2.cl}
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

#### Parameters

|                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-arrayViaSpacing<br/>{auto   value}</code>                                       | <p>Specifies the via array spacing, which is the distance, a floating point micron value, that will be used as the maximum distance criteria for grouping vias within the same array.</p> <p>The default value of the via array spacing is 0.35 times the via size for N7, N10, N16, N12, and N20 processes. For other processes, the default is <code>auto</code>, in which case the software sets the via spacing automatically. You can specify either <code>auto</code> or a floating value for this option.</p> <p><i>Default:</i> <code>auto</code></p> <p>This is an optional parameter.</p> |
| <code>-blockingCellFile<br/>parasitic_blocking<br/>_device_cell_names<br/>_file</code> | <p>Specifies the file containing the parasitic blocking device cell names, if any. Parasitic extraction for these devices will be skipped.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                |
| <code>-bus_bit_char<br/>string</code>                                                  | <p>Specifies the type of character to use as the bus notation in the xDSPF output file.</p> <p>If the argument specified for this option is <code>[]</code> (square brackets), then you must prefix the brackets using the backslash (<code>\</code>) character. For example:</p> <pre>-bus_bit_char "\[\]"</pre> <p><b>Note:</b> No other argument except <code>[]</code> requires the (<code>\</code>) character.</p> <p><i>Default:</i> <code>none</code></p> <p>This is an optional parameter.</p>                                                                                              |
| <code>-cclFileName<br/>vfiQuantus-<br/>&lt;filename&gt;.ccl</code>                     | <p>Allows you to specify the name of the CCL file to be created. If specified, the CCL file is created as <code>vfiQuantus-&lt;filename&gt;.ccl</code> and if not specified, the file is created as <code>vfiQuantus-&lt;cellname&gt;.ccl</code>.</p> <p><i>Default:</i> <code>none</code></p>                                                                                                                                                                                                                                                                                                      |
| <code>-coloring {true  <br/>false}</code>                                              | <p>When set to <code>true</code>, this parameter enables color-aware EM analysis. This is an optional parameter.</p> <p><i>Default:</i> <code>false</code></p>                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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### Batch Commands in Voltus-Fi-XL

|                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-commentSubCkt</code><br><code>{true   false}</code>        | <p>When set to <code>true</code>, this parameter will comment out the top sub-circuit statement in the xDSPF file.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <code>-compression {true   false}</code>                          | <p>When set to <code>true</code>, specifies that the xDSPF file should be generated in a compressed format.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <code>-customExtract</code><br><code>extract_Commands_File</code> | <p>Specifies the file with user-customized <code>extract</code> commands. When this file is specified, the Voltus-Fi-generated CCL will not have any <code>extract</code> commands and the commands from the customized <code>extract</code> commands file will be added as is in the Voltus-Fi-generated CCL.</p> <p>A sample customized <code>extract</code> command file is as follows:</p> <pre>extract \<br/>    -selection "all" \<br/>    -type "rc_coupled"</pre> <p><b>Note:</b> You can create <code>customextract</code> file by using either single or multiple <code>extract</code> settings. Ensure that the commands are in the Quantus CCL file syntax as this file is added as is in the Voltus-Fi-generated CCL.</p> <p>This is an optional parameter.</p> |
| <code>-</code><br><code>device_properties_file file_name</code>   | <p>Specifies the name of the device properties file when the input type is Calibre.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <code>-fractureViaCnt</code><br><code>via_count_number</code>     | <p>Specifies the fracture via count to be used for dividing pseudo vias into segments during extraction.</p> <p><i>Default: 1</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <code>-generate_ccl_only</code><br><code>{true   false}</code>    | <p>When set to <code>true</code>, generates a CCL file for Quantus but does not execute the Quantus binary. This allows you to modify the CCL file that is generated to create your own customized CCL file.</p> <p>This customized file can then be specified for running Quantus by using the <code>-user_ccl_file</code> option.</p> <p><i>Default: false</i></p>                                                                                                                                                                                                                                                                                                                                                                                                         |

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### Batch Commands in Voltus-Fi-XL

|                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-groundNet<br/>ground_net_name</code>                                               | <p>Specifies the name of the ground net on which extraction is to be performed.</p> <p><i>Default:</i> 0</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                            |
| <code>-inputDir<br/>input_dir_name</code>                                                 | <p>Specifies the directory in which the Pegasus, PVS, or Calibre data is stored. This is a required parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>-inputType<br/>{pegasus   pvs  <br/>calibre}</code>                                 | <p>Specifies whether the input data is from the Pegasus or Calibre tool. This is a required parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                    |
| <code>-<br/>keep_pin_shorting_<br/>res {true   false}</code>                              | <p>Preserves the device pin shorting resistors on the *wires layers. The device pin shorting resistors are identified by the layer names of "wires". For example, the layers "mwires", "qwires", "rwires", "cwires", "bwires", and "dwires", consist of shorting resistors for the MOS, BJT, R, C, generic, and D devices respectively.</p> <p>When set to <code>true</code>, the shorting resistors will not be removed.</p> <p><i>Default:</i> <code>false</code></p> <p>This is an optional parameter.</p> |
| <code>-<br/>keep_pin_shorting_<br/>res_by_layer<br/>{ "layer1" "layer2"<br/>.... }</code> | <p>Specifies the shorting layer names to be preserved. The valid layer names are "mwires", "qwires", "rwires", "cwires", "bwires", and "dwires".</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                    |
| <code>-lic_queue<br/>timeout_in_seconds</code>                                            | <p>Specifies the license timeout wait time in seconds. This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <code>-<br/>LVS_BOX_hierarchic<br/>al_flow {true  <br/>false}</code>                      | <p>When set to <code>true</code>, enables the LVS box hierarchical flow of Quantus. This flow requires some additional options to be included in the Quantus CCL file. When the -<br/>LVS_BOX_hierarchical_flow parameter is set to <code>true</code>, these additional options are printed in the Quantus CCL file and the flow is enabled.</p> <p><i>Default:</i> <code>false</code></p> <p>This is an optional parameter.</p>                                                                              |



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### Batch Commands in Voltus-Fi-XL

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>-min_res_by_layer {true   false}</pre>   | <p>When this parameter is set to true, the following information is added in the CCL file:</p> <pre>filter_res \     -min_res_by_layer "RH_TN_6 0" \     -min_res 0.001 \     -remove_dangling_res false</pre> <p>This means that all RH_TN_6 layers are reserved without threshold resistor value.</p> <p>When this parameter is set to false (default) or not set, the following information is added in the CCL file:</p> <pre>filter_res \     -min_res 0.001 \     -remove_dangling_res false</pre> <p>This is an optional parameter.</p> <p><b>Default:</b> false</p> |
| <pre>-multiCpu number_of_cpus</pre>           | <p>Specifies the number of CPUs to be used for distributed processing during the Quantus extraction run.</p> <p>This is an optional parameter. By default, single CPU is used.</p>                                                                                                                                                                                                                                                                                                                                                                                          |
| <pre>-outputdir output_dir_name</pre>         | <p>Specifies the directory in which the xDSPF file that is generated will be saved. This is a required parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <pre>-outputDspf - output_dspf_filename</pre> | <p>Specifies the name of the xDSPF file that is generated. This is an optional parameter. If the filename is not specified, the software generates the file, <code>runName.dspf</code> by default.</p>                                                                                                                                                                                                                                                                                                                                                                      |
| <pre>-output_xy_generic {true   false}</pre>  | <p>When set to <code>true</code>, provides the x-axis and y-axis coordinates for a high resistance design resistor. This parameter introduces the GENERIC option in the CCL file. By default, this parameter is set to <code>true</code>.</p> <p>When this parameter is set to <code>false</code>, there will be no GENERIC option in the CCL file.</p>                                                                                                                                                                                                                     |
| <pre>-PGNets list_of_pg_nets</pre>            | <p>Provides the list of PG nets, separated by spaces, for which the xDSPF file is to be generated. This is an optional parameter. It is only specified when the <code>-signalEM</code> parameter is set to <code>false</code>.</p>                                                                                                                                                                                                                                                                                                                                          |

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### Batch Commands in Voltus-Fi-XL

|                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>-process {n3   n5   n7prf   n7   n10pg   n10   n20   n16   n12   others}</pre> | <p>Specifies the process node.</p> <p>n3: for the N3 process node</p> <p>n5: for the N5 process node</p> <p>n7prf: for the N7PRF process node</p> <p>n7: for the N7 process node</p> <p>n10pg: for the N10 process node with PG rules</p> <p>n10: for the N10 process node</p> <p>n20: for the N20 process node</p> <p>n16: for the N16 process node</p> <p>n12: for the N12 process node</p> <p>others: for the N20 and above process nodes</p> |
| <pre>-reduction {true   false}</pre>                                                | <p>When set to true, this parameter enables the <code>reduce_i_cards</code> option while generating the xDSPF file.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                    |
| <pre>-RunName<br/>input_run_name</pre>                                              | <p>Specifies the name of the Pegasus, PVS, or Calibre run. This is a required parameter.</p>                                                                                                                                                                                                                                                                                                                                                     |
| <pre>-signalEM {true   false}</pre>                                                 | <p>Specifies whether the names of signal nets should be included in the xDSPF file or not. If signal nets are not to be included in the EM analysis, set this parameter to <code>false</code>.</p>                                                                                                                                                                                                                                               |

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### Batch Commands in Voltus-Fi-XL

|                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-stacked_via_effect {true   false}</code>                   | <p>When set to <code>true</code>, reports the <code>W</code> parameter as 1,000,000 microns.</p> <p>When set to <code>false</code>, reports the actual wire width for the short horizontal metal segment.</p> <p>If a wire segment between the inner layers of adjacent stacked vias is short, the current flowing in the short horizontal segment is expected to be mostly vertical, whereas the horizontal currents may be non-real. By setting this option to <code>true</code>, you can modify the <code>W</code> parameter to be set to 1,000,000 microns to prevent false EM violations.</p> <p>This is an optional parameter.</p> <p><i>Default:</i> <code>false</code></p> |
| <code>-subConductorModel {true   false}</code>                    | <p>When set to <code>true</code>, specifies that parasitic resistor models for subconductor layers should be included during extraction. This is used to support different EM rules for poly layers in EM analysis.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <code>-subNodeChar sub_node_char</code>                           | <p>Specifies the character that will be used for subnode identification.</p> <p><i>Default:</i> <code>#</code></p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <code>-subcktPinOrder pin_order_file</code>                       | <p>Specifies the name of the sub-circuit pin order file. The pin order is specified in the xDSPF file using the <code>.SUBCKT</code> and <code>.ENDS</code> statements. You can use this option to provide a file with a different pin order that will override the order specified using the default <code>.SUBCKT</code> statement in the xDSPF file.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                  |
| <code>-techDir tech_dir_name   -techLib tech_lib_file_name</code> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                                                   | <p>Use either the <code>-techDir</code> parameter to specify the name of the directory containing the tech file or use the <code>-techLib</code> parameter to specify the path of the technology file that Quantus will use for generating the xDSPF file.</p> <p>One of the two parameters must be specified.</p>                                                                                                                                                                                                                                                                                                                                                                 |

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### Batch Commands in Voltus-Fi-XL

|                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-techCorner</code><br><i>technology_corner_name</i> | Specifies the technology corner name to be picked from the library. This parameter is optional.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <code>-techName</code><br><i>technology_name</i>          | Specifies the technology filename to be used for extraction. This parameter is optional if the <code>-techDir</code> parameter has been specified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <code>-temperature value</code>                           | <p>Specifies the temperature at which the extraction will be performed. It is specified in degree Celsius.</p> <p>This is an optional parameter. If not specified, the software will use 25 degree Celsius as the default temperature.</p> <p>The options, <code>-temperature</code> and <code>temp_coeff</code> specified in the CCL file are mutually exclusive. The following scenarios hold true.</p> <ul style="list-style-type: none"><li>■ If you specify a temperature by using this parameter, the following option in the CCL file will be set to <code>false</code>:<br/><code>-include_parasitic_res_temp_coeff "false" \</code><br/><br/>The software displays the following message:<br/><br/>User specified temperature will be used for extraction. The option <code>include_parasitic_res_temp_coeff</code> will be set as <code>false</code>.</li><li>■ If you do not specify a temperature, the following option in the CCL file will be set to <code>true</code>:<br/><code>-include_parasitic_res_temp_coeff "true" \</code><br/><br/>The software displays the following message:<br/><br/>No user specified temperature value so the option <code>include_parasitic_res_temp_coeff</code> will be set as <code>true</code>.</li></ul> |
| <code>-user_ccl_file</code><br><i>ccl_file_name</i>       | Specifies the name of the user-customized CCL file to be used for running Quantus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <code>-tech_cmd_file</code><br><i>filename</i>            | Specifies the name of the command file to enable the plug and play feature of Quantus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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### Batch Commands in Voltus-Fi-XL

|                                                   |                                                                                                                                                                                                                          |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -<br>tech_layer_setup_file <i>filename</i>        | Specifies the name of the technology layer setup file to be used for Techgen compilation. This parameter is only relevant for the plug and play feature of Quantus.                                                      |
| -<br>tech_lpe_config_file <i>./lpe_configfile</i> | Specifies the name of the technology LPE configuration file that is to be passed to Quantus. This parameter is only relevant for the plug and play feature of Quantus.                                                   |
| -icell_map_file<br><i>filename</i>                | Specifies the foundry provided iCellmap file that contains simulation model to DFII cell view mappings and transfer property information. This file is specified only for enabling the plug and play feature of Quantus. |

### Examples

- The following command generates the xDSPF file, `test_lib.dspf` in the `vfi_quantus1` directory:

```
extract_xdspf \
-signalEM true \
-process n20 \
-techLib pegasus_tech.lib \
-techName n20tech \
-temperature 27 \
-inputType pegasus \
-inputDir test_lib/pegasus \
-RunName test_lib \
-outputdir vfi_quantus1 \
-subcktPinOrder ./your_subckt_pin_order_file
-customExtract myextract.txt
-groundNet "vss" \
-subNodeChar ":" \
-compression true \
-lic_queue 200
```

- The following set of commands are used to generate the xDSPF file, `test_lib.dspf` in the `vfi_quantus1` directory using the user-customized CCL file:

#### Step 1:

```
extract_xdspf \
-signalEM true \
-process n20 \
-techLib pegasus_tech.lib \
-techName n20tech \
-temperature 27 \
-inputType pegasus \
-inputDir test_lib/pegasus \
-RunName test_lib \

```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

---

```
-outputdir vfi_quantus1 \
-generate_ccl_only true
```

#### Step 2:

```
extract_xdspf \
-user_ccl_file vfiquantus-cell11.ccl \

```

## ground\_pins

`ground_pins gnd_pin_list`

Specifies the names of the virtual ground pins to which the SPICE subcircuit terminal will be connected. This command is used to set up static current analysis in Voltus-Fi-XL.

### Parameters

|                           |                                                 |
|---------------------------|-------------------------------------------------|
| <code>gnd_pin_list</code> | Specifies the names of the virtual ground pins. |
|---------------------------|-------------------------------------------------|

### Example

The following command is used to specify the names of two ground pins, `VSS` and `VSSA`:

```
ground_pins VSS VSSA
```

### Related Topics

- [power\\_pin](#)
- [run\\_static\\_simulation](#)
- [setup\\_simulation](#)

## power\_pin

```
power_pin
 -pin_name pin_name
 -voltage voltage_value
```

Specifies the power pin and its corresponding voltage value. To specify multiple power pins, use this command multiple times. This command is used to set up static current analysis in Voltus-Fi-XL.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

---

#### Parameters

|                                                |                                                                                                         |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <code>-pin_name <i>pin_name</i></code>         | Specifies the name of the virtual power pin to which the SPICE subcircuit terminal should be connected. |
| <code>-voltage<br/><i>voltage_value</i></code> | Specifies the voltage value of the power pin.                                                           |

#### Example

The following commands are used to specify the names of two power pins, VDD and VDDA, and their corresponding voltage values:

```
power_pin \
 -pin_name VDD \
 -voltage 0.9
power_pin \
 -pin_name VDDA \
 -voltage 1.1
```

#### Related Topics

- [ground\\_pins](#)
- [run\\_static\\_simulation](#)
- [setup\\_simulation](#)

## run\_static\_simulation

```
run_static_simulation
 -method {Ipeak | Iavg}
 -nets net_name_list
 [-freq freq_value]
 [-global_activity number]
 [-activity_file file_name]
 [-vcd vcd_file_name]
 [-clock_file clock_file_name]
 [-cmd_include_file command_file_name]
 [-average_power power_value_in_W]
 [-power_file power_file_name]
```

Runs static current analysis in Voltus-Fi-XL.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

#### Parameters

|                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-activity_file</code><br><i>file_name</i>         | <p>Specifies the path of the activity file, which contains the activity factor on any node of the circuit.</p> <p>This is an optional parameter. It is only used for the average static current analysis.</p>                                                                                                                                                                                                                                   |
| <code>-average_power</code><br><i>power_value_in_W</i>  | <p>Specifies the average power of the design. The default unit is W (Watts). If the value is in any other unit, it must be specified. For example, 20mW. You can specify a single value or multiple values depending upon whether the same or a different power is to be used for the specified nets. This is shown in the examples below.</p> <p>This is an optional parameter. This is only used for the average static current analysis.</p> |
| <code>-clock_file</code><br><i>clock_file_name</i>      | <p>Specifies the name of the clock file, which contains information about the clock nodes, subcircuit definitions, and subcircuit instance names and their frequencies.</p> <p>This is an optional parameter. This is only used for the average static current analysis.</p>                                                                                                                                                                    |
| <code>-cmd_include_file</code> <i>command_file_name</i> |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                                         | <p>Specifies the name of the file that passes additional user commands to Thunder during static current analysis.</p> <p>This is an optional parameter.</p>                                                                                                                                                                                                                                                                                     |
| <code>-freq</code> <i>freq_value</i>                    | <p>Specifies the value of the dominant frequency of the design. The unit is in mHz (Mega Hertz).</p> <p>This is an optional parameter. This is only used for the average static current analysis.</p>                                                                                                                                                                                                                                           |
| <code>-global_activity</code><br><i>number</i>          | <p>Specifies the average number of times all the unset nodes switch in a clock cycle.</p> <p>This is an optional parameter. This is only used for average static current analysis.</p>                                                                                                                                                                                                                                                          |
| <code>-method {Ipeak   Iavg}</code>                     | <p>Specifies whether the peak or average static analysis will be performed.</p> <p>This is a required parameter.</p>                                                                                                                                                                                                                                                                                                                            |

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### Batch Commands in Voltus-Fi-XL

|                                              |                                                                                                                                                                                                                   |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-nets<br/>net_name_list</code>         | <p>Specifies the list of nets for which current analysis is to be performed.</p> <p>This is a required parameter.</p>                                                                                             |
| <code>-power_file<br/>power_file_name</code> | <p>Specifies the name of the average power file, which contains the average power for specific sub circuits.</p> <p>This is an optional parameter. This is only used for the average static current analysis.</p> |
| <code>-vcd vcd_file_name</code>              | <p>Specifies the vcd file, which contains information about the number of transitions for each net.</p> <p>This is an optional parameter. This is only used for the average static current analysis.</p>          |

### Examples

- The following command is used to run the average static current analysis.

- ☐ In this example, the same power value is assigned to the two nets, VDD and VSS:

```
run_static_simulation \
-method Iavg \
-nets {VDD VSS} \
-freq 300 \
-global_activity 0.25 \
-average_power 20mW
```

- ☐ In this example, different power values are assigned to the three nets, VDD\_1, VDD\_2, and VSS\_1:

```
run_static_simulation \
-method Iavg \
-nets {VDD_1 VDD_2 VSS_1} \
-freq 300 \
-global_activity 0.25 \
-average_power {10mW 8mW 18mW}
```

**Note:** The above command is only valid if you provide power values for all the specified nets.

- The following command is used to run the peak static current analysis:

```
run_static_simulation \
-method Ipeak \
-nets {VDD VSS}
```

### ***Related Topics***

- [ground\\_pins](#)
- [power\\_pin](#)
- [setup\\_simulation](#)

## **setup\_simulation**

```
setup_simulation
 -spice_netlist spice_file_name
 [-simulation_temperature temp_value]
 [-hierarchy_separator char_name]
 [-topcell cell_name]
 [-output_directory dir_name]
```

Sets up the options for static current analysis in Voltus-Fi-XL.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

#### Parameters

|                                                          |                                                                                                                                                                                                                       |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-<br/>hierarchy_separator<br/>char_name</code>     | Specifies the hierarchical separator in the circuit file. This is an optional parameter. This is specified only if the hierarchy separator is other than “/”.                                                         |
| <code>-output_directory<br/>directory_name</code>        | Specifies the name of the output directory where the current database will be saved.<br><br>This is an optional parameter. If this parameter is not specified, the output is stored in the current working directory. |
| <code>-<br/>simulation_temperature<br/>temp_value</code> | Specifies the temperature, in degree Celsius, at which the simulation will be performed.<br><br>This is an optional parameter.<br><br><i>Default: 25 degree Celsius</i>                                               |
| <code>-spice_netlist<br/>spice_file_name</code>          | Specifies the SPICE netlist file, which is the DSPF file.<br><br>This is a required parameter.                                                                                                                        |
| <code>-topcell cell_name</code>                          | Specifies the name of the design. It is an optional parameter.<br><br>By default, the tool populates the top cell name from that specified in the layout.                                                             |

#### Example

The following command is used to set up simulation:

```
setup_simulation \
-spice_netlist design.spice \
-simulation_temperature 100 \
-topcell designA \
-output_directory ./vps_simulation_1
```

#### Related Topics

- [ground\\_pins](#)
- [power\\_pin](#)
- [run\\_static\\_simulation](#)

## load\_ir\_results

```
load_ir_results
 results_file_name
```

Loads the results of IR drop analysis in Voltus-Fi-XL.

### Parameter

|                          |                                                                                 |
|--------------------------|---------------------------------------------------------------------------------|
| <i>results_file_name</i> | Specifies the directory in which the IR drop analysis results should be loaded. |
|--------------------------|---------------------------------------------------------------------------------|

### Example

The following command loads the results for IR drop analysis that are stored in the `xps.emirtap.emir0_bin` file:

```
load_ir_results \
./abc/raw.out/xps.emirtap.emir0_bin
```

### Related Topics

- [print\\_ir\\_report](#)
- [print\\_rlrp\\_report](#)
- [pin\\_2\\_pin\\_res](#)
- [print\\_subnode\\_to\\_tap\\_path\\_report](#)

## print\_ir\_report

```
print_ir_report
 -net {all_power | netname}
 -type {ir | liv | rc | rcavg | rcrms | reffective}
 [-threshold threshold_value]
 -filename output_file_name
```

Prints the results of IR drop analysis in Voltus-Fi-XL. You can generate IR reports for all the power nets or for specific nets.

**Note:** Before running this command, ensure that the IR drop results are loaded using the `load_ir_results` command.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

#### Parameters

|                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-filename<br/>output_file_name</code>                    | Specifies the name of the IR drop analysis report file. This is a required parameter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>-net {all_power  <br/>netname}</code>                    | <p>Specifies whether the IR drop analysis report is to be printed for all the power nets or for the specified net.</p> <p>Select <code>all_power</code> to print the IR report for all the power nets. Select <code>netname</code> to print the IR report for the specified net.</p> <p>This is a required parameter.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <code>-threshold<br/>threshold_value</code>                    | <p>Specifies that resistors or nodes that have a threshold IR drop ratio value greater than the specified value will be reported. This is an optional parameter.</p> <p><i>Default:</i> The report prints results for all resistors or nodes.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <code>-type {ir   iv   rc   rcavg   rcrms   reffective}</code> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                | <p>Specifies the analysis type for which the report is being generated.</p> <p><code>ir</code> – specifies that the report is generated for IR drop analysis.</p> <p><code>iv</code> – specifies that the report is generated for transistor-based supply voltage data analysis.</p> <p><code>rc</code> – specifies that the report is generated for peak resistor Current Density analysis.</p> <p><code>rcavg</code> – specifies that the report is generated for average resistor Current Density analysis.</p> <p><code>rcrms</code> – specifies that the report is generated for RMS resistor Current Density analysis.</p> <p><code>reffective</code> – specifies that the report is generated for effective resistance analysis.</p> <p>This is a required parameter.</p> |

#### Examples

- The following command prints the IR drop analysis report for all the nets for `ir` analysis in the `all_ir.txt` file:

```
print_ir_report \
-net all_power \

```

```
-type ir \
-filename all_ir.txt
```

- The following command prints the IR drop analysis report for the VDD net for `iv` analysis in the `vdd_iv.txt` file:

```
print_ir_report \
-net VDD \
-type iv \
-filename vdd_iv.txt
```

- The following command prints the IR drop analysis report for the VSS net for `rc` analysis in the `vss_rc.txt` file:

```
print_ir_report \
-net VSS \
-type rc \
-filename vss_rc.txt
```

- The following command prints the IR drop analysis report for all power nets for `rcrms` analysis in the `all_power_rcRMS.txt` file:

```
print_ir_report \
-net all_power \
-type rcrms \
-filename all_power_rcRMS.txt
```

### ***Related Topics***

- [load\\_ir\\_results](#)
- [print\\_rlrp\\_report](#)
- [pin\\_2\\_pin\\_res](#)
- [print\\_subnode\\_to\\_tap\\_path\\_report](#)

## **print\_rlrp\_report**

```
print_rlrp_report
-net netname
-filename output_file_name
-tap tapname
```

Prints the RLRP analysis report in Voltus-Fi-XL.

**Note:** Before running this command, ensure that the IR drop results are loaded using the `load_ir_results` command.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

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### Parameters

|                                                |                                                                                                                                                                                                                             |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-filename <i>output_file_name</i></code> |                                                                                                                                                                                                                             |
|                                                | Specifies the name of the RLRP analysis report file. This is a required parameter.                                                                                                                                          |
| <code>-net <i>netname</i></code>               | Specifies the name of the net for which the RLRP report is to be printed. This is a required parameter.                                                                                                                     |
| <code>-tap <i>tapname</i></code>               | Specifies the instances or tap-nodes of the specified net for which the LRP values are to be printed. You can specify multiple tap nodes for the specified net as shown in the example below. This is a required parameter. |

### Example

Use the following commands to load the IR drop analysis results and print the RLRP analysis report for the TVDD net in the RLRP.rpt file:

```
load_ir_results ./abc/raw.out/xps.emirtap.emir0_bin
print_rlrp_report -net TVDD -filename RLRP.rpt -tap MavD7_1_unmatched#d
print_rlrp_report -net TVDD -filename RLRP.rpt -tap MavD7_2_unmatched#d
```

## pin\_2\_pin\_res

```
pin_2_pin_res
 -xdspf filename
 -x1 value
 -y1 value
 -x2 value
 -y2 value
 -layer1 layername
 -layer2 layername
 -net netname
```

Calculates the effective resistance between any two nodes (pins, tap nodes, or subnodes), either on the same layer or on different layers of the same net in Voltus-Fi-XL. Use this command after the `load_ir_results` command.

**Note:** All parameters of this command are required parameters.



# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

### Parameters

|                                |                                                                                                              |
|--------------------------------|--------------------------------------------------------------------------------------------------------------|
| <code>-xdspf filename</code>   | Specifies the location of the xDSPF file to be used for the Static Power Grid Solver (SPGS) flow of Spectre. |
| <code>-x1 value</code>         | Specifies the x-coordinate for node 1 in microns.                                                            |
| <code>-y1 value</code>         | Specifies the y-coordinate for node 1 in microns.                                                            |
| <code>-x2 value</code>         | Specifies the x-coordinate for node 2 in microns.                                                            |
| <code>-y2 value</code>         | Specifies the y-coordinate for node 2 in microns.                                                            |
| <code>-layer1 layername</code> | Specifies the name of the layer for node 1.                                                                  |
| <code>-layer2 layername</code> | Specifies the name of the layer for node 2.                                                                  |
| <code>-net netname</code>      | Specifies the name of the net on which the two nodes are located.                                            |

### Example

Use the following commands to load the IR results and specify the nodes between which you want to calculate effective resistance.

```
load_ir_results \
./abc/raw.out/xps.emirtap.emir0_bin

pin_2_pin_res \
-xdspf abc/raw.out/abc_sample.dspf \
-x1 83.40 \
-y1 34.205 \
-x2 83.40 \
-y2 35.205
-layer1 mt1 \
-layer2 mt2 \
-net VDD
```

### Related Topics

- [load\\_ir\\_results](#)
- [print\\_ir\\_report](#)
- [print\\_rlrp\\_report](#)
- [print\\_subnode\\_to\\_tap\\_path\\_report](#)

## **print\_subnode\_to\_tap\_path\_report**

```
print_subnode_to_tap_path_report
-net {netname}
-subnode {subnode name}
-filename {report_file_name}
[-never_traverse_top {true | false}]
[-report_complete_path {true | false}]
```

Prints the results of the nearest tap nodes for the specified subnodes in Voltus-Fi-XL.

**Note:** Before running this command, ensure that the IR drop results are loaded using the `load_ir_results` command.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

### Parameters

|                                                   |                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-filename output_file_name</code>           |                                                                                                                                                                                                                                                                                                                                                      |
|                                                   | Specifies the name of the report file to be generated. This is a required parameter.                                                                                                                                                                                                                                                                 |
| <code>-never_traverse_top {true   false}</code>   |                                                                                                                                                                                                                                                                                                                                                      |
|                                                   | Specifies whether or not the software should traverse the top layers to find a tap node. By default, the software will traverse the top layers to reach the nearest tap node. Set this parameter to <code>true</code> if you do not want to traverse the top layers.<br><br><i>Default:</i> <code>false</code><br><br>This is an optional parameter. |
| <code>-net netname</code>                         | Specifies the name of the net for which the report is to be generated. This is a required parameter.                                                                                                                                                                                                                                                 |
| <code>-report_complete_path {true   false}</code> |                                                                                                                                                                                                                                                                                                                                                      |
|                                                   | Specifies whether or not the complete path for each traced tap node should be reported. By default, the software will not report the complete path.                                                                                                                                                                                                  |
| <code>-subnode subnode_name</code>                |                                                                                                                                                                                                                                                                                                                                                      |
|                                                   | Specifies the name of the subnode for which the report is to be generated. This is a required parameter.                                                                                                                                                                                                                                             |

### Example

The following command prints the report for the VDD net for tap nodes of the subnode, VDD:36919 in the `subnode_tap_path.rpt` file:

```
print_subnode_to_path_report \
-net VDD \
-subnode VDD:36919 \
-filename subnode_tap_path.rpt
```

### Related Topics

- [load\\_ir\\_results](#)
- [print\\_ir\\_report](#)

- print\_rlrp\_report
- pin\_2\_pin\_res

## **load\_em\_results**

```
load_em_results
 -tech_file tech_file_name
 [-em_only_ict_file ict_file_name]
 [-layer_mapfile layer_map_filename]
 results_file_name
```

Loads the results of EM analysis in Voltus-Fi-XL.

**Note:** The `qrcTechFile` name and layer map file must be specified if the layer names in the `qrcTechFile` are different from those in the simulation database.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

### Parameters

|                                                |                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-em_only_ict_file ict_file_name</code>   |                                                                                                                                                                                                                                                                                                                     |
|                                                | Specifies the name of the ICT file with process and EM model information that will be used for EM analysis. This is an optional parameter. For a sample EM only ICT file, see the “File Formats” chapter.                                                                                                           |
| <code>-layer_mapfile layer_map_filename</code> |                                                                                                                                                                                                                                                                                                                     |
|                                                | Specifies the name of the layer map file that provides the mapping between the layer names used in the technology file and the simulation database.<br><br>This is an optional parameter. It is used only when the layer names in the <code>qrcTechFile</code> are different from those in the simulation database. |
| <code>results_file_name</code>                 | Specifies the name of the file which contains the EMIR simulation results data. This is a required parameter.                                                                                                                                                                                                       |
| <code>-tech_file -tech_file_name</code>        |                                                                                                                                                                                                                                                                                                                     |
|                                                | Specifies the name of the <code>qrcTechFile</code> or the <code>emDataFile</code> used for EM analysis. This is a required parameter.                                                                                                                                                                               |

### Example

The following command loads the results of EM analysis stored in the `xps.emirtap.emir0_bin` file, and when the layer map file is `contactmapfile`:

```
load_em_results \
-tech_file qrcTechFile \
-layer_mapfile contactmapfile /xps.emirtap.emir0_bin
```

### Related Topic

#### ■ [print\\_em\\_report](#)

## print\_em\_report

```
print_em_report
-net {all_power | all_signal | all_nets | netname}
-type {javg | jmax | jabsavg | jacpeak | jacrms | rc | rcavg | rcrms | tc |
tcavg | tcrms | acrms_sh | avg_sh | peak_sh}
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

---

```
[-threshold threshold_value]
-filename output_file_name
[-rule custom_em_rule_name]
```

Prints the EM analysis reports in Voltus-Fi-XL.

**Note:** Before running this command, ensure that the EM results are loaded using the `load_em_results` command.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

### Parameters

|                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-filename <i>output_file_name</i></code>                                                                                        |                                                                                                                                                                                                                                                                                                                                             |
|                                                                                                                                       | Specifies the name of the EM analysis report file. This is a required parameter.                                                                                                                                                                                                                                                            |
| <code>-net {all_power   all_signal   all_nets   <i>netname</i>}</code>                                                                |                                                                                                                                                                                                                                                                                                                                             |
|                                                                                                                                       | Specifies that the EM analysis report is to be generated for one of the following:<br><br>all_power: prints the report for all power nets<br>all_signal: prints the report for all signal nets<br>all_nets: prints the report for all nets<br><i>netname</i> : prints the report for the specified net<br><br>This is a required parameter. |
| <code>-rule<br/><i>custom_em_rule_name</i></code>                                                                                     | Specifies the custom EM rule for which the report will be created.<br><br>This is an optional parameter.                                                                                                                                                                                                                                    |
| <code>-threshold <i>threshold_value</i></code>                                                                                        |                                                                                                                                                                                                                                                                                                                                             |
|                                                                                                                                       | Specifies that resistors or nodes that have a threshold value of EM ratio above the specified value will be reported.<br><br>This is an optional parameter.<br><br><i>Default:</i> The report prints the results for all resistors or nodes.                                                                                                |
| <code>-type {javg   jmax   jabsavg   jacpeak   jacrms   rc   rcavg   rcrms   tc   tcavg   tcrms   acrms_sh   avg_sh   peak_sh}</code> |                                                                                                                                                                                                                                                                                                                                             |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

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Specifies the analysis type for which the report is being generated.

`javg` – specifies that the report is generated for the average Current Density analysis data.

`jmax` – specifies that the report is generated for the peak Current Density analysis data.

`jabsavg` – specifies that the report is generated for the average absolute Current Density analysis data.

`jacpeak` – specifies that the report is generated for the AC peak Current Density analysis data.

`jacrms` – specifies that the report is generated for the RMS Current Density analysis data.

`rc` – specifies that the report is generated for the peak resistor Current Density analysis data.

`rcavg` – specifies that the report is generated for the average resistor Current Density analysis data.

`rcrms` – specifies that the report is generated for the RMS resistor Current Density analysis data.

`tc` – specifies that the report is generated for the peak tap Current Density analysis data.

`tcavg` – specifies that the report is generated for the average tap Current Density analysis data.

`tcrms` – specifies that the report is generated for the RMS tap Current Density analysis data.

`acrms_sh` – specifies that the report is generated for AC RMS current analysis data with self-heating effect.

`avg_sh` – specifies that the report is generated for average current analysis data with self-heating effect.

`peak_sh` – specifies that the report is generated for peak current analysis data with self-heating effect.

**Note:** The above three types of analyses are applicable only in the SHE flow.

This is a required parameter.



## Examples

- The following command prints the EM analysis report for all the power nets for `javg` analysis in the `all_power_javg.txt` file:

```
print_em_report \
-net all_power \
-type javg \
-filename all_power_javg.txt
```

- The following command prints the EM analysis report for all the signal nets for `jmax` analysis in the `all_signal_jmax.txt` file:

```
print_em_report \
-net all_signal \
-type jmax \
-filename all_signal_jmax.txt
```

- The following command prints the EM drop analysis report for the VDD net for `jabsavg` analysis in the `vdd_jabsavg.txt` file:

```
print_em_report \
-net VDD \
-type jabsavg \
-filename vdd_jabsavg.txt
```

- The following command prints the EM drop analysis report for the VDD net for `tcrms` analysis in the `vdd_tcrms.txt` file:

```
print_em_report \
-net VDD \
-type tcrms \
-filename vdd_tcrms.txt
```

## Related Topic

- [load\\_em\\_results](#)

## load\_view

```
load_view
-libname lib
-cellname cell_name
-viewname view_name
```

Specifies the layout to be used for self-heating effect (SHE) analysis in Voltus-Fi-XL.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

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### Parameters

|                                      |                                                                                                    |
|--------------------------------------|----------------------------------------------------------------------------------------------------|
| <code>-cellname <i>cell</i></code>   | Specifies the name of the cell. This is a required parameter.                                      |
| <code>-libname <i>lib</i></code>     | Specifies the name of the library. This is a required parameter.                                   |
| <code>-viewname <i>layout</i></code> | Specifies the layout view for which SHE analysis is to be performed. This is a required parameter. |

### Example

The following command specifies the `layout` view for `cell1` of library, `test_lib`:

```
load_view
 -libname test_lib \
 -cellname cell1 \
 -viewname layout
```

### Related Topic

#### ■ [print thermal report](#)

## print\_thermal\_report

```
print_thermal_report
 -type {mos-region | metal}
 [-tiles tile_matrix]
 -filename output_file_name
```

Prints thermal reports for hierarchical self-heating effect (SHE) analysis in Voltus-Fi-XL.

**Note:** To generate hierarchical SHE analysis reports using this command, the VTS-Fi-AA license is required to be checked out. This is an advanced license that is not available as part of the Voltus-Fi-XL license.

If you do not want to perform hierarchical SHE analysis, ensure that this command is not specified in the command file.

The SHE EM analysis reports can be generated by specifying the `print_em_report` command in the command file with the required `-type` option. No special license is required for generating these reports.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

### Parameters

|                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-filename</code><br><code>output_file_name</code> | Specifies the name of the file in which the hierarchical SHE analysis results will be printed. This is a required parameter.                                                                                                                                                                                                                                                                                                                                                         |
| <code>-tiles tile_matrix</code>                         | <p>Specifies the OD regions or metal resistors and their temperature change after hierarchical self-heating effect in tile format. The tile matrix is specified as follows:</p> <p>The design in the layout is divided into sections based on the tile matrix provided, which is the number of divisions in the x-direction multiplied by the number of divisions in the y-direction.</p> <p>For example:</p> <p><code>-tiles 10x15</code></p> <p>This is an optional parameter.</p> |
| <code>-type {mos_region   metal}</code>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                         | <p>When <code>mos-region</code> is specified, the shape of OD regions and their temperature change after hierarchical self-heating effect are printed in the report.</p> <p>When <code>metal</code> is specified, the shape of metal resistors and their temperature change after hierarchical self-heating effect are printed in the report.</p> <p>This is a required parameter.</p>                                                                                               |

### Example

The following sequence of commands will print the results of hierarchical SHE analysis for OD regions in a tile format in the `mos-region-tiles.txt` file:

```
load_em_results \
-tech_file qrcTechFile \
-layer_mapfile contactmapfile /input.emir0_bin
```

```
print_em_report \
-net all_nets \
-type acrms_sh \
-filename ./acrms_sh.txt
```

```
print_thermal_report \
-type mos-region \

```

```
-tiles 15x10 \
-filename ./mos-region-tiles.txt
```

### ***Related Topic***

#### ■ load\_view

## **setMultiCpuUsage**

```
setMultiCpuUsage
 [-acquireLicense integer]
 [-keepLicense {true | false}]
 [-licenseList {string}]
 [-localCpu { integer | max}]
 [-remoteHost integer]
 [-cpuPerRemoteHost integer]
 [-releaseLicense]
 [-threadInfo {0 | 1 | 2}]
 [-verbose]
 [-cpuAutoAdjust {true | false}]
 [-autoPageFaultMonitor {0 | 1 | 2 | 3}]
 [-reset]
 [-help]
```

Specifies the number of threads to use for multi-threading, or the maximum number of computers to use for distributed processing, or the maximum number of computers and the number of threads to use for super-threading. Optionally, this command reports the usage information.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

### Parameters

|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-help</code>                                 | Outputs the command usage and a brief description about the command parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <code>-acquireLicense <i>integer</i></code>        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                    | Acquires licenses to enable the specified number of CPUs. For example, if you specify <code>-acquireLicense 5</code> , the software checks out enough licenses to enable five CPUs.<br><br>After the licenses are checked out, they can be used for multi-threading, distributed processing, or super-threading.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <code>-autoPageFaultMonitor {0   1   2   3}</code> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                    | Specifies to set a warning rank for performance issues caused by major page faults.<br><br>The parameter supports the following values:<br><br>0 - specifies to disable the reporting of major page faults.<br><br>1 - specifies to set the warning rank as 1. This means $PF / total\ PF > 0.8$ , $b > 10$ , and $wa > 85\%$<br><br>2 - specifies to set the warning rank as 2. This means $PF / total\ PF > 0.5$ , $b > 5$ , and $wa > 65\%$<br><br>3 - specifies to set the warning rank as 3. This means $PF / total\ PF > 0.2$ , $b > 1$ , and $wa > 40\%$<br><br>where PF is the number of major page faults from the software, total PF is the total number of major page faults in the machine, b is the number of blocked processors, and wa is CPU waiting time. |
| <code>-cpuAutoAdjust {true   false}</code>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                                    | Specifies that the specified number of CPUs should be adjusted based on the available free memory. The software lowers the number of client processes on the local machine in case of insufficient memory. This is applicable to CPUs only on the local machine.<br><br>The default value is <code>true</code> . If set to <code>false</code> , automatic adjustment of CPUs is disabled.                                                                                                                                                                                                                                                                                                                                                                                  |
| <code>-cpuPerRemoteHost <i>integer</i></code>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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### Batch Commands in Voltus-Fi-XL

|                                          |                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                          | <p>Specifies the number of CPUs used by clients for multi-threading.</p> <p><b>Note:</b> For super-threading, you must use this parameter in conjunction with the <code>-remoteHost</code> parameter.</p> <p><i>Default:</i> 1</p> <p><b>Note :</b> Save/restore is enabled for this option.</p>                                 |
| <code>-keepLicense {true   false}</code> |                                                                                                                                                                                                                                                                                                                                  |
|                                          | <p>Specifies whether to keep the acquired multiple-CPU licenses until the current session ends.</p> <p>Specify this parameter before running any commands that require multiple-CPU applications. To release all multiple-CPU licenses immediately, use the <code>-releaseLicense</code> option.</p> <p><i>Default:</i> true</p> |
| <code>-licenseList {tpsmp}</code>        |                                                                                                                                                                                                                                                                                                                                  |
|                                          | <p>Specifies the list or order of licenses that the software should use for checking out licenses during multiple-cpu processing.</p> <p>The parameter does not support an empty license list, {}. This parameter allows the <code>tpsmp</code> option.</p>                                                                      |
| <code>-localCpu string</code>            | <p>Specifies the number of CPUs on the local machine. This parameter is required for multi-threading.</p> <p><i>Default:</i> 1</p> <p><b>Note:</b> Save/restore is enabled for this option.</p>                                                                                                                                  |
| <code>-releaseLicense</code>             | <p>Releases all the multiple-CPU license(s) immediately. By default, the software holds multiple-CPU licenses until the end of the current session.</p> <p>To specify that the software release multiple-CPU licenses after every multiple-CPU command runs, use the <code>-keepLicense</code> parameter.</p>                    |
| <code>-reset</code>                      | <p>Resets the specified parameters back to the default values.</p>                                                                                                                                                                                                                                                               |
| <code>-threadInfo {0   1   2}</code>     |                                                                                                                                                                                                                                                                                                                                  |

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### Batch Commands in Voltus-Fi-XL

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|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | <p>Reports the usage information.</p> <p><i>Default: 0</i></p> <p>Specify one of the following values:</p> <p>0 : Does not write messages to the log file.</p> <p>1 : Writes the final message to the log file.</p> <p>For example,</p> <p>All threaded jobs finished (10 elapsed sec: 0 processor sec (parent), 0 system sec (parent), 0 processor sec (threads), 0 system sec (threads)).</p> <p>2 : Writes additional starting/ending information for each thread.</p> <p>For example,</p> <p>Starting threaded job 1...</p> <p>Starting threaded job 2...</p> <p>Starting threaded job 3...</p> <p>Ending threaded job 2 (1 elapsed sec, 0 processor sec, 0 system sec, 1.160M).</p> <p>Ending threaded job 3 (2 elapsed sec, 0 processor sec, 0 system sec, 0.895M).</p> <p>Ending threaded job 1 (10 elapsed sec, 0 processor sec, 0 system sec, 1.172M).</p> <p>All threaded jobs finished (10 elapsed sec: 0 processor sec (parent), 0 system sec (parent), 0 processor sec (threads), 0 system sec (threads)).</p> |
| -verbose | Displays messages when changing the multiple-CPU settings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### Related Topics

#### ■ [setDistributeHost](#)

## setDistributeHost

```
setDistributeHost
 [-help]
 [-add string]
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

---

```
[-args string]
[-custom]
[-custom_script string]
[-custom_script_list string]
[-local]
[-lsf]
[-nc]
[-noWaitTaskComeUp]
[-queue string]
[-remove string]
[-reportLsfInfo]
[-resource string]
[-rsh]
[-sge]
[-shellTimeout integer]
[-single_cpu_lsf_args string]
[-ssh]
[-timeOut integer]
[-env_script "script"]
```

Specifies the multiple-CPU processing configuration for distributed processing or super-threading. Voltus-Fi-XL finds hosts from the last `setDistributeHost` command specified before a distributed processing or super-threading command starts.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

#### Parameters

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -help                             | Outputs the command usage and a brief description about the command parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| -add <i>string</i>                | <p>Adds the specified hosts to the <code>rsh/ssh</code> configuration. If you specify more than one host, separate each host name with a space.</p> <p>Each time you specify a host, the software uses it to run one client process. To run more than one client process on a host, specify it more than once. For example, if you have two machines that each has two CPUs and you want to use both CPUs in both machines, type a command like the following:</p> <pre>setDistributeHost -rsh -add {machine1 machine2 \ machine1 machine2}</pre>                                                                                                                                                                                                                                                                                  |
| -args <i>string</i>               | Specifies any additional arguments you need to provide to the Sun Grid Engine (SGE) or Load Sharing Facility (LSF) job submission command.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| -custom                           | Use a custom job submission script for distributed processing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| -custom_script <i>string</i>      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                   | Specifies a custom script to run distributed processing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| -custom_script_list <i>string</i> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                   | <p>Specifies that the launch of multiple jobs should be customized, based on the resources required for these jobs. This parameter lets you specify multiple launch strings in order of priority with a maximum allowed job count for each string.</p> <p>If you request for N jobs, the command starts submitting jobs starting from <code>string1</code>, until the corresponding count is reached, at which point it starts submitting the next string in the list. Therefore, the command submits the first "<code>count1</code>" jobs with <code>string1</code>, the next "<code>count2</code>" jobs with <code>string2</code> and so on. It stops when the total submitted jobs has reached the requested number (N).</p> <p><b>Note :</b> This parameter can only be specified with the <code>-custom</code> parameter.</p> |

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### Batch Commands in Voltus-Fi-XL

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-env_script "script"</code> | Specifies a user-defined shell environment script that is run for each of the slave hosts. The parameter allows you to pass these environment settings to the slave hosts by including them in the shell environment script. The license variables used by the software are also automatically passed to the slave hosts to avoid license errors.                                                                         |
| <code>-local</code>               | Runs all the distributed processing jobs on the master machine.                                                                                                                                                                                                                                                                                                                                                           |
| <code>-lsf</code>                 | <p>Specifies a LSF configuration. If you do not specify any parameters for <code>-lsf</code>, the software uses the default settings.</p> <p><b>Note:</b> To use this parameter, LSF must already be set up (typically by specifying the <code>LSF_ENVDIR</code> and <code>LSF_SERVERDIR</code> environment variables) and <code>bsub</code> must be in your search path. Contact your LSF administrator for details.</p> |
| <code>-nc</code>                  | Uses NC commands (Network Computer from RTDA) for distributed processing.                                                                                                                                                                                                                                                                                                                                                 |
| <code>-noWaitTaskComeUp</code>    | When specified, does not allow the software to wait for tasks that are delayed or are not likely to occur.                                                                                                                                                                                                                                                                                                                |
| <code>-queue string</code>        | Specifies the queue for the LSF or Sun Grid Engine (SGE) configuration.                                                                                                                                                                                                                                                                                                                                                   |
| <code>-remove string</code>       | Removes the specified hosts or all hosts from the <code>rsh/ssh</code> configuration. If you specify more than one host, separate each host name with a space.                                                                                                                                                                                                                                                            |

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### Batch Commands in Voltus-Fi-XL

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|                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-reportLsfInfo</code>              | <p>Specifies to report LSF information in a single report. This parameter allows you to collect the system statistics on the status of the distributed jobs. It has the following information:</p> <ul style="list-style-type: none"><li>Host name for master and LSF tasks</li><li>Number of CPUs on each machine that are being used by a process</li><li>Job ID/PID for each task process</li><li>Total memory used on each machine</li><li>Total virtual memory used on each machine</li><li>Total CPU time used on each machine</li></ul> <p>You must specify this parameter along with the <code>-lsf</code> parameter.</p> <p>To get the LSF information, specify the <code>getDistributeHost -reportLsfInfo</code> command parameter. You must specify the <code>getDistributeHost -reportLsfInfo</code> only after the LSF tasks exit to obtain the task CPU time. If you specify this command before the task exits, the command gives a warning message.</p> |
| <code>-resource string</code>            | <p>Specifies a resource string for the SGE or LSF queue.</p> <p><b>Note:</b> The correct resource string is specific to your installation. Contact your LSF administrator for the appropriate parameters and values.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <code>-rsh</code>                        | <p>Specifies a remote shell configuration.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <code>-shellTimeout integer</code>       | <p>Specifies the number of seconds the host machine waits for <code>rsh/ssh</code> machines to become available for multiple-CPU processing.</p> <p><i>Default: 5</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <code>-sge</code>                        | <p>Specifies an SGE configuration.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <code>-single_cpu_lsf_args string</code> | <p>Specifies the <code>bsub</code> options.</p> <p><b>Note:</b> You must use this parameter to adjust the LSF argument for a single CPU application. Alternatively, use the <code>-args</code> parameter to adjust the LSF argument for an application that runs in the super-threading mode.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-ssh</code>             | Specifies a secure shell configuration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <code>-timeout integer</code> | <p>Specifies the default timeout for a submitted job. This functionality prevents the master machine from hanging when the clients do not come up for some reason.</p> <p>After timeout, a warning message appears informing you that the distributed CPUs did not come online within the expected time. The master will continue waiting for the clients and it is up to you to continue waiting or stop the run if there are problems with the Distributed Resource Management (DRM) system.</p> <p>A sample warning message is given below:</p> <p>Task id 2 did not come up within the specified timeout period (300 seconds). Use <code>setDistributeHost -timeout</code> to change the value. This may be a real error due to incorrect or incomplete platform/machine specification provided via <code>setDistributeHost</code> to your distributed resource management system (LSF/Sun Grid Engine etc.). If running locally (<code>setDistributeHost -local</code>), the current machine may be overloaded with too many jobs and swapping (check free memory and CPUs with <code>top</code>). For local runs, consider reducing the number of CPUs you are using via the <code>setMultiCpuUsage</code> command, or free up some memory by killing other memory intensive processes.</p> <p><b>Default:</b> 30 (local/rsh/custom) and 3600 (lsf/sge)</p> |

### Related Topics

#### ■ [setMultiCpuUsage](#)

## create\_pgv

```
create_pgv
 -macro_name macro_name
 [-lib_name name_of_library]
 [-libgen_cmd_file cmd_file_name]
 [-libgen_path libgen_binary_path]
 -tech_file tech_file_name
 [-tech_lef_file tech_lef_file_name]
 -type {static | dynamic}
 [-macro_lef_file macro_lef_file_name]
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

---

```
-sim_dir simulation_dir
[-lef_layer_map lef_layer_map_file_name]
[-oa_lib list_of_OA_libraries]
[-pgdb_layer_map pgdb_layermap_file_name]
[-pgdb_version version_number]
[-trigger_file trigger_file_name]
[-output_directory directory]
[-uti_Ron_file Ron_report_file_dumped_by_Spectre]
[-create_no_device_nets true | false]
[-create_no_device_signal_nets true | false]
[-powergate_state_flow true | false]
[-use_pwl_files true | false]
[-map_connectivity_layers true | false]
[-units value]
[-stopAtVia VIA_layer]
```

Creates power-grid views in Voltus-Fi-XL. The power-grid views contain information about the power ports of a transistor or block, the internal power grid, and the tap current distribution within a transistor or block.

**Note:** The `create_pgv` command has the following parameters that are used only for hierarchical EMIR analysis.

```
-hier_flow {true | false}
-hier_flow_stop_layer layer_name
-disable_signal_pgdb {true | false}
-stop_on_missing_lef_pins {true | false}
-sim_dir simulation_dir
```

### Parameters

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

|                                                  |                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-macro_name macro_name</code>              |                                                                                                                                                                                                                                                                                                                       |
|                                                  | Specifies the name of the macro.                                                                                                                                                                                                                                                                                      |
| <code>-lib_name name_of_library</code>           |                                                                                                                                                                                                                                                                                                                       |
|                                                  | Specifies the name of the library. This is specified if you want to create a library with a name different than that of the macro.<br><br>By default, a library is created with the same name as that of the macro.                                                                                                   |
| <code>-libgen_cmd_file cmd_file_name</code>      |                                                                                                                                                                                                                                                                                                                       |
|                                                  | Specifies the name of the LibGen command file that includes LibGen commands, if any, required to be specified for creating PGVs.<br><br>For example, the LibGen command file may contain the following:<br><br><code>setvar source_drain_equivalent false</code><br><code>setvar dspf_vialayer_bounding_box 10</code> |
| <code>-libgen_path libgen_binary_path</code>     |                                                                                                                                                                                                                                                                                                                       |
|                                                  | Specifies the location of the LibGen library. This is used only to specify a library outside the IC hierarchy. By default, the software uses the library available in the IC hierarchy.<br><br>For example,<br><br><code>-libgen_path /tools.lnx86/ssvtools/bin/voltus_libgen \</code>                                |
| <code>-tech_file tech_file_name</code>           |                                                                                                                                                                                                                                                                                                                       |
|                                                  | Specifies the technology file to be used for reading the technology data.                                                                                                                                                                                                                                             |
| <code>-tech_lef_file tech_lef_file_name</code>   |                                                                                                                                                                                                                                                                                                                       |
|                                                  | Specifies the LEF information for the technology data. This parameter is not specified when the OA libraries are specified.                                                                                                                                                                                           |
| <code>-type {static   dynamic}</code>            |                                                                                                                                                                                                                                                                                                                       |
|                                                  | Specifies the type of analysis for which you want to generate power-grid views.                                                                                                                                                                                                                                       |
| <code>-macro_lef_file macro_lef_file_name</code> |                                                                                                                                                                                                                                                                                                                       |

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

|                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                      | <p>Specifies the LEF information for the design.</p> <p><b>Note:</b> If the technology data and design data are in the same LEF file, use any of the two options, <code>-tech_lef_file</code> or <code>-macro_lef_file</code> to specify the filename. In this case, it is an optional parameter.</p>                                                                                                                                                                                                                                                                                                                                    |
| <code>-sim_dir simulation_dir</code>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                      | <p>Specifies the simulation directory for the current data.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <code>-lef_layer_map lef_layer_map_file_name</code>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                      | <p>Specifies the mapping between LEF layer names and technology layer names.</p> <p>The syntax of the layer map file is as follows:</p> <pre>#type    technology_layer_name  lefdef  lef_layer_name</pre> <p><b>Example:</b></p> <pre># ----  ----- metal    METAL_1                lefdef   M1 via      VIA_1                  lefdef   VIA1 metal    METAL_2                lefdef   M2 via      VIA_2                  lefdef   VIA2</pre> <p>where “type” can be <code>poly/via/metal/diff</code>.</p> <p><b>Note:</b> This is an optional parameter. If not specified, the software automatically generates the layer map file.</p> |
| <code>-oa_lib list_of_libraries</code>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                      | <p>Specifies the OpenAccess (OA) database library name for PGV generation. When this option is specified, the layer map file is automatically generated. However, you can also specify the layer map file by using the <code>-lef_layer_map</code> parameter.</p> <p><b>Note:</b> The parameters, <code>-tech_lef_file</code> / <code>-macro_lef_file</code> and <code>-oa_lib</code> are mutually exclusive.</p>                                                                                                                                                                                                                        |
| <code>-pgdb_layer_map pgdb_layermap_file_name</code> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                               | <p>Specifies the mapping between the xDSPF file layer names, written in the simulation database, and the technology layer names.</p> <p>The syntax of the layer map file is as follows:</p> <pre># type technology_layer_name pgdb xDSPF_layer_name</pre> <p><b>Example:</b></p> <pre># ----- poly POLYCIDe pgdb poly via CONT pgdb pllco via CONT pgdb odCont1 via CONT pgdb odCont2 metal METAL_1 pgdb metall via VIA_1 pgdb VIA1 metal METAL_2 pgdb metal2 via VIA_2 pgdb VIA2 diff OD pgdb nwires diff OD pgdb mwires</pre> <p>where “type” can be poly/via/metal/diff.</p> <p><b>Note:</b> Ensure that all the xDSPF file layer names are mapped to the technology layer names. You can map multiple xDSPF file layer names to a single technology layer name. This is shown in the above example.</p> <p><b>Note:</b> If this parameter is not specified, Voltus-Fi automatically generates the layer map file.</p> |
| <b>-pgdb_version</b> <i>version_number</i>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                               | <p>Specifies the PGDB version. It is only used when you want to use an older PGDB version instead of the default version, which is the latest available version.</p> <p>For example,</p> <pre>-pgdb_version 9.1</pre> <p><b>Default:</b> The latest version</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>-trigger_file</b> <i>trigger_file_name</i> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                               | <p>Specifies the trigger file that is used during a dynamic current simulation to run a detailed analysis for determining the current distribution.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>-output_directory</b> <i>directory</i>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |



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### Batch Commands in Voltus-Fi-XL

|                                                              |                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                              | Specifies the name of the output directory for power-grid view generation. By default, the power-grid views are stored in the work directory.                                                                                                                                                                                                                            |
| <code>-uti_Ron_file Ron_report_file_dumped_by_Spectre</code> |                                                                                                                                                                                                                                                                                                                                                                          |
|                                                              | <p>Specifies the UTI-<small>RON</small> file that contains multiple on-resistance (<small>Ron</small>) values, that is, minimum, maximum, and average (<small>min/avg/max</small>) values, for powergates.</p> <p>If this file is not specified, Voltus-Fi-XL uses the <small>RON</small> values from the MMSIM simulation database (<code>*.emir#_bin</code> file).</p> |
| <code>-create_no_device_nets true   false</code>             |                                                                                                                                                                                                                                                                                                                                                                          |
|                                                              | <p>When set to <code>true</code>, creates power-grid views even when a net has no current file. This is used to capture the nets with only physical data (<small>RC</small> grid) and no electrical data (taps).</p> <p><i>Default:</i> <code>false</code></p>                                                                                                           |
| <code>-create_no_device_signal_nets true   false</code>      |                                                                                                                                                                                                                                                                                                                                                                          |
|                                                              | <p>When set to <code>true</code>, creates power-grid views even when a signal net has no current file. This is used to capture the signal nets with only physical data (<small>RC</small> grid) and no electrical data (taps).</p> <p><i>Default:</i> <code>false</code></p>                                                                                             |
| <code>-powergate_state_flow true   false</code>              |                                                                                                                                                                                                                                                                                                                                                                          |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                    | <p>When set to <code>true</code>, searches for power gate state files (<code>*pwg_state</code>) and passes them to LibGen. The power gate state files are searched in the UTI Ron directory in which the UTI Ron file is specified. If the UTI Ron file or directory is not specified, then this option does not have any effect even when set to <code>true</code>.</p> <p><b>Examples:</b></p> <pre>create_pgv -uti_ron_dir simout/output.pg.state/xps.raw/emir_uti.raw/ -powergate_state_flow true</pre> <p>In the above example, the power gate state files are searched in the <code>emir_uti.raw</code> directory.</p> <pre>create_pgv -uti_ron_file simout/output.pg.state/xps.raw/xps.emirtap.pwg_ron -powergate_state_flow true</pre> <p>In the above example, the power gate state files are searched in the <code>xps.raw</code> directory in which the UTI Ron file, <code>xps.emirtap.pwg_ron</code>, has been specified.</p> <p>Power gate state files are generated by Spectre only when the following option is set:</p> <pre>eisopt report_pwg_state=yes</pre> |
| <code>-use_pwl_files true   false</code>           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                                    | <p>When set to <code>true</code>, searches for net-specific PWL files instead of current (<code>pti</code>) files in the simulation directory and passes them to LibGen through the <code>*.vhdr</code> files.</p> <p><b>Default:</b> <code>false</code></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <code>-map_connectivity_layers true   false</code> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                                    | <p>Controls the handling of <code>*wires</code> layers. When set to <code>true</code>, the <code>*wires</code> layer resistors are assigned to the layers of its connecting nodes. When set to <code>false</code>, the <code>*wires</code> layer resistors are assigned to the layers specified in the PGDB layer map file.</p> <p><b>Default:</b> <code>true</code></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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### Batch Commands in Voltus-Fi-XL

|                                   |                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-units value</code>         | <p>Specifies the value of a variable used in PGV generation in database units per micron.</p> <p><b>Default:</b> 1000</p> <p><b>Example:</b></p> <pre>create_pgv -units 10000</pre> <p>In the above example, the value of the variables used in PGV generation is set to 10000 database units per micron.</p>                                               |
| <code>-stopAtVia VIA_layer</code> | <p>Stops the generation of the power-grid view inside a macro at the specified via layer. This via layer must be included in the PGDB layer map file and the simulation database. The stopAtVia layer should be the lowest via layer below which there should not be any port geometries.</p> <p><b>Example:</b></p> <pre>create_pgv -stopAtVia VIA_1</pre> |

### Example

The following command is used to create power-grid views:

```
create_pgv
-macro_name design1
-lib_name ether
-tech_file RCgen.tch
-type dynamic
-tech_lef_file tech.lef
-macro_lef_file mac.lef
-sim_dir pgv-sim-132
-lef_layer_map lefdef.layermap.txt
-pgdb_layer_map pgdpmmap.txt
-trigger_file trigger_vps.txt
-use_pwl_files true
-output_directory ./vps_pgv_1
```

### Related Topics

#### ■ [set mmsim pgv nets](#)

## **update\_pgv**

```
update_pgv
 -library library_name
 -trigger_file trigger_file_name
 [-library_prefix prefix]
 [-output_directory directory]
 [-libgen_path libgen_binary_path]
 [-libgen_cmd_file cmd_file_name]
 [-force]
```

Updates a power-grid view (PGV) incrementally.

### **Parameters**

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

|                                                     |                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-library <i>library_name</i></code>           |                                                                                                                                                                                                                                                                                                              |
|                                                     | Specifies the name of the library that contains the old PGV.                                                                                                                                                                                                                                                 |
| <code>-trigger_file <i>trigger_file_name</i></code> |                                                                                                                                                                                                                                                                                                              |
|                                                     | Specifies the trigger file to update the old PGV.                                                                                                                                                                                                                                                            |
| <code>-library_prefix <i>prefix</i></code>          |                                                                                                                                                                                                                                                                                                              |
|                                                     | Specifies the prefix for the generated PGV library ( <i>prefix.cl</i> ).                                                                                                                                                                                                                                     |
| <code>-output_directory <i>directory</i></code>     |                                                                                                                                                                                                                                                                                                              |
|                                                     | Specifies the name of the output directory in which the merged PGV is created.                                                                                                                                                                                                                               |
| <code>-libgen_path <i>libgen_binary_path</i></code> |                                                                                                                                                                                                                                                                                                              |
|                                                     | <p>Specifies the location of the LibGen library. This is used only to specify a library outside the IC hierarchy. By default, Voltus-Fi uses the library available in the IC hierarchy.</p> <p>For example,</p> <pre>-libgen_path /tools.lnx86/ssvtools/bin/voltus_libgen \</pre>                            |
| <code>-libgen_cmd_file <i>cmd_file_name</i></code>  |                                                                                                                                                                                                                                                                                                              |
|                                                     | <p>Specifies the name of the LibGen command file that includes LibGen commands, if any, required to be specified for creating PGVs.</p> <p>For example, the LibGen command file may contain the following commands:</p> <pre>setvar source_drain_equivalent false setvar dspf_vialayer_bounding_box 10</pre> |
| <code>-force</code>                                 |                                                                                                                                                                                                                                                                                                              |
|                                                     | Updates the report forcefully even if the taps or current sources of every net do not match the existing PGV.                                                                                                                                                                                                |

### Example

The following command updates the PGVs contained in the `ether` library. The merged PGV will be created in the `vps_pgv_2` directory:

```
update_pgv \
 -library ether \
 -trigger_file trigger_vps.txt \
 -output_directory ./vps_pgv_2
```

### ***Related Topics***

- [set\\_mmsim\\_pgv\\_nets](#)

## **set\_mmsim\_pgv\_nets**

```
set_mmsim_pgv_nets
 -net net_names
 -voltage voltage_value
 -voltage_source_nets voltage_source_only_nets
 -results_file result_file_name
 [-prefix prefix_name]
 [-feedthru_nets {net1 net2 net#}]
```

Specifies the nets for which you want to create power-grid views (PGVs) in the MMSIM flow. You can use this command to specify multiple PGV nets at a time.

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

### Parameters

|                                                            |                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-net net_names</code>                                | Specifies the names of nets for which you want to create PGVs.                                                                                                                                                                                                                                                                                                          |
| <code>-voltage voltage_value</code>                        |                                                                                                                                                                                                                                                                                                                                                                         |
|                                                            | Specifies the voltage of the net.                                                                                                                                                                                                                                                                                                                                       |
| <code>-voltage_source_nets voltage_source_only_nets</code> |                                                                                                                                                                                                                                                                                                                                                                         |
|                                                            | Specifies the names of nets that are connected only to voltage sources and for which a current file, with a .pti extension, is not available.                                                                                                                                                                                                                           |
| <code>-results_file result_file_name</code>                |                                                                                                                                                                                                                                                                                                                                                                         |
|                                                            | Specifies the simulation result file to be used. The naming convention of the simulation result file is, *.emir#.bin.                                                                                                                                                                                                                                                   |
| <code>-prefix prefix_name</code>                           |                                                                                                                                                                                                                                                                                                                                                                         |
|                                                            | Specifies the name of the prefix used while performing the simulation.                                                                                                                                                                                                                                                                                                  |
| <code>-feedthru_nets {net1 net2 net#}</code>               | <p>Specifies the feedthrough or dummy power nets for the PGV generation. When specified, generates EM views for the specified feedthrough or dummy nets in the PGV flow.</p> <p><b>Note:</b> EM views are generated for the specified feedthrough or dummy nets even if there are no current (pti) files or power-grid data for these nets from Spectre simulation.</p> |

### Example

The following command is used to create power-grid views for nets VSS and VDD, voltage source net, CEN, and feedthrough net, WEN:

```
set_mmsim_pgv_nets \
-net {VDD VSS CEN} \
-voltage {1.1 0 1.1} \
-results_file /emirtap.emir0_bin \
-voltage_source_nets {CEN}
-prefix XO.
-feedthru_nets {WEN}
```

## ***Related Topics***

- [create\\_pgv](#)

## **report\_vfi\_XL\_ron**

```
report_vfi_XL_ron
-pin_pair_file file_name
-output_file file_name
```

Generates the layer-wise on-resistance (RON) report for IR drop and EM analysis for the specified pin-pairs in Voltus-Fi-XL.

## **Parameters**

|                                                 |                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-output_file</code><br><i>file_name</i>   | Specifies the name of the output file to be created with the RON report.<br><br>This is a required parameter.                                                                                                                                                                                                                                                     |
| <code>-pin_pair_file</code><br><i>file_name</i> | Specifies the name of the pin-pair file that contains information about all the pin pairs for which the RON report is to be generated. The pins in each pair are separated by a space. Multiple pin-pairs can be specified in different lines.<br><br>The software reports the RON between each pin-pair listed in the file.<br><br>This is a required parameter. |

## **Example**

- The following command creates a RON report in the `output.rpt` file for the pin-pairs specified in the `pin_pair.txt` file:

```
report_vfi_XL_ron -pin_pair_file pin_pair.txt -output_file output.rpt
```

## ***Related Topic***

- [Reporting On-Resistance \(RON\) Values](#)



## **search\_res\_id**

```
search_res_id
 -x x_location
 -y y_location
 -layer extracted_layer_name
 [-net net_name]
 -name resistor_name
```

Specifies the location and other information related to the resistor that is being queried in Voltus-Fi-XL. You can either search a specific resistor by providing its location, layer name, and net name; or query it by providing the name of the resistor.

You can also specify this command in a Tcl file (*conf.tcl*) and specify the file in the EMIR control file by using the following `emirutil` command as follows:

```
emirutil postTclCmdFile=[conf.tcl]
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Batch Commands in Voltus-Fi-XL

#### Parameters

|                                                 |                                                                                                                                                                                                                            |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-layer <i>extracted_layer_name</i></code> |                                                                                                                                                                                                                            |
|                                                 | <p>Specifies the name of the extracted layer on which the resistor is located.</p> <p><b>Note:</b> This parameter is only required if the resistor name is not being specified using the <code>-name</code> parameter.</p> |
| <code>-name <i>resistor_name</i></code>         |                                                                                                                                                                                                                            |
|                                                 | <p>Specifies the name of the resistor to be queried.</p> <p>When this parameter is specified, no other parameter is required to be specified. If any other parameter is specified, it will be ignored.</p>                 |
| <code>-net <i>net_name</i></code>               | <p>Specifies the name of the net. This is an optional parameter.</p> <p><b>Note:</b> This parameter is only specified if the resistor name is not being specified using the <code>-name</code> parameter.</p>              |
| <code>-x <i>x_location</i></code>               | <p>Specifies the X-co-ordinate of the resistor to be queried.</p> <p><b>Note:</b> This parameter is only required if the resistor name is not being specified using the <code>-name</code> parameter.</p>                  |
| <code>-y <i>y_location</i></code>               | <p>Specifies the Y-co-ordinate of the resistor to be queried.</p> <p><b>Note:</b> This parameter is only required if the resistor name is not being specified using the <code>-name</code> parameter.</p>                  |

#### Examples

- The following command is used to query a resistor at the specified co-ordinates on metal layer, m1:  

```
search_res_id
-x 4.78
-y 9.75
-layer m1
```
- The following command is used to query a specific resistor, Ra12:  

```
search_res_id -name Ra12
```

#### Related Topics

- [res\\_id\\_info](#)

- search\_node\_id
- node\_id\_info

## **res\_id\_info**

```
res_id_info
 -id res_id
 [-type
 {default/a/w/l/La/Lu/Lb/Wu/Wb/delta_T/Lv2v_rms/Tj/Tlife/Td/thickness/r/Iavg/
 Ipeak/Irms/Iabs_avg/Ipos_avg/Ineg_avg/Iavg_max/Ipeak_max/Irms_max/Iacpeak_ma
 x/T/N/name/layer/netName/node1/node2/type/x/y/current_direction/feolT/beolT/
 beta/alpha/alpha_connecting/alpha_overlapping}]
```

Specifies the information to be queried for the specified resistor (pRes) in Voltus-Fi-XL.

You can also specify this command in a Tcl file (`conf.tcl`) and specify the file in the EMIR control file by using the following `emirutil` command as follows:

```
emirutil postTclCmdFile=[conf.tcl]
```

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

---

### Parameters

|                                |                                                                                                 |
|--------------------------------|-------------------------------------------------------------------------------------------------|
| <code>-id <i>res_id</i></code> | Specifies the pRes ID for which the information is to be queried. This is a required parameter. |
|--------------------------------|-------------------------------------------------------------------------------------------------|

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Batch Commands in Voltus-Fi-XL

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -type | Specifies the type of information to be queried for the pRes. You can specify any number of options detailed below. The query will output the values of the specified options for the pRes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|       | default: When this option is specified, the software returns a set of values for the specified pRes in a specific format. An example of the default output of this command is provided below:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|       | <pre> name                : rx3 layer               : m1 netName             : VG node1               : VG#2 node2               : XX1/M0#g type                : Metal x                   : 4.780 y                   : 9.784 current_direction   : UnKnown w                   : 0.02 l                   : 0.1 Iavg                : 3.41e-10 Ipeak               : 9.25e-07 Irms                : 1.28e-07 Iavg_max            : 6.6e-05 Ipeak_max           : 0 Irms_max            : 0 Iacpeak_max         : 0 delta_T             : 5 Td                  : 0.000315 r                   : 0.0315 rmsLv2v             : 1.8e+308 Iavg_rule            : (w*3) * 1.1 * 1 : (1 &lt;= 5) </pre> |
|       | a: Retrieves the area of the pRes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|       | w: Retrieves the width of the pRes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|       | l: Retrieves the Blech length of the pRes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|       | La: Retrieves the length of the pseudo vias.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|       | Lu: Retrieves the upper metal Blech length.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|       | Lb: Retrieves the bottom metal Blech length.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|       | Wu: Retrieves the upper metal width.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

### Examples

- The following set of commands are used to query the specified resistor on metal layer, m1, for the specified information:

**Step1:** Search resistor id:

```
set rid [search_res_id -x 3.75 -y 8.35 -layer m1]
```

**Step2:** Get specific information from resistor id:

```
puts [res_id_info -id $rid -type Iacpeak_max]
0
```

- The following set of commands are used to query the specified resistor, Ra12, for all information:

**Step1:** Search resistor id:

```
set rid [search_res_id -name Ra12]
```

**Step2:** Get specific information from resistor id:

```
puts [res_id_info -id $rid]
name : ra12
layer : vial
netName : VDD
node1 : VDD#1
node2 : VDD#2
type : Via
x : 4.825
y : 9.269
current_direction : Down
w : 0.02
l : 6
Iavg : 1.06e-05
Ipeak : 2.15e-05
Irms : 1.5e-05
Iavg_max : 1e-05
Ipeak_max : 0
Irms_max : 0
Iacpeak_max : 0
delta_T : 5
Td : 0.00493
r : 0.493
a : 0.33
N : 1
Lu : 6
```

```
Wu : 0.06
Lb : 0.1
Wb : 0.02
rmsLv2v : 1.8e+308
Iavg_rule : 0.01 * 1 * 1
```

### ***Related Topics***

- [search\\_res\\_id](#)
- [search\\_node\\_id](#)
- [node\\_id\\_info](#)

## **search\_node\_id**

```
search_node_id
 -x x_location
 -y y_location
 -layer extracted_layer_name
 [-net net_name]
```

Specifies the information required to search for the node to be queried in Voltus-Fi-XL.

You can also specify this command in a Tcl file (`conf.tcl`) and specify the file in the EMIR control file by using the following `emirutil` command as follows:

```
emirutil postTclCmdFile=[conf.tcl]
```

## Parameters

|                                                 |                                                                                                       |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| <code>-layer <i>extracted_layer_name</i></code> | Specifies the name of the extracted layer on which the node is located. This is a required parameter. |
| <code>-net <i>net_name</i></code>               | Specifies the name of the net. This is an optional parameter.                                         |
| <code>-x <i>x_location</i></code>               | Specifies the x-coordinate for the node to be searched. This is a required parameter.                 |
| <code>-y <i>y_location</i></code>               | Specifies the y-coordinate for the node to be searched. This is a required parameter.                 |

## Example

The following command is used to search for a node at the specified coordinates on metal layer, m2:

```
search res_id
-x 3.75 \
-y 8.35 \
-layer m2
```

## Related Topics

- [search\\_res\\_id](#)
- [res\\_id\\_info](#)
- [node\\_id\\_info](#)

## node\_id\_info

```
node_id_info
-id node_id
[-type {default/name/x/y/IRavg/IRpeak}]
```

Specifies the information to be retrieved for the specified resistor in Voltus-Fi-XL.

You can also specify this command in a Tcl file (`conf.tcl`) and specify the file in the EMIR control file by using the following `emirutil` command as follows:



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### Batch Commands in Voltus-Fi-XL

---

```
emirutil postTclCmdFile=[conf.tcl]
```

#### Parameters

|                          |                                                                                                                                                                                                                                                                                                                           |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-id node_id</code> | Specifies the node ID for which the information is to be retrieved. This is a required parameter.                                                                                                                                                                                                                         |
| <code>-type</code>       | Specifies the type of information to be retrieved for the node. You can specify from the options detailed below using this parameter.                                                                                                                                                                                     |
|                          | <b>default:</b> When this option is specified, the software returns a set of values for the specified node in a specific format. An example of the default output of this command is provided below:<br><br><div>name : VG#2<br/>x : 4.780<br/>y : 9.834<br/>IRavg : 8.54e-07<br/>IRpeak : 0.00224<br/>netName : VG</div> |
|                          | <b>name:</b> Retrieves the name of the node.                                                                                                                                                                                                                                                                              |
|                          | <b>x:</b> Retrieves the x-coordinate for the node.                                                                                                                                                                                                                                                                        |
|                          | <b>y:</b> Retrieves the y-coordinate for the node.                                                                                                                                                                                                                                                                        |
|                          | <b>IRavg:</b> Retrieves the average voltage drop for the node.                                                                                                                                                                                                                                                            |
|                          | <b>IRpeak:</b> Retrieves the peak voltage drop for the node.                                                                                                                                                                                                                                                              |

#### Example

The following set of commands are used to query the specified node on metal layer, m2 , for the specified information:

##### Step1: Search node id:

```
set nid [search_node_id -x 3.75 -y 8.35 -layer m2]
```

##### Step2: Get specific information from node id:

```
puts [node_id_info -id $nid -type IRavg]
```

***Related Topics***

- [search\\_res\\_id](#)
- [res\\_id\\_info](#)
- [search\\_node\\_id](#)

# Environment Variables

This section contains the Voltus-Fi-XL environment variable names, descriptions, types, and values. You can customize the operation and behavior of the Voltus-Fi-XL product by changing the value of a particular environment variable.

## Environment Variables Setup in Voltus-Fi-XL

The following categories of environment variables are supported in Voltus-Fi-XL:

- **Environment Setting (cdsenv) Variables:** You can specify environment settings and initialization instructions for Voltus-Fi-XL in the `.cdsenv` and `.cdsinit` files, respectively. Using these settings, you can customize your software environment.
- **Shell Environment Variables:** You can specify environment variables that are set using the `setenv` command before invoking the Voltus-Fi-XL software.

### foundry

Specifies the foundry.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "foundry" 'string "foundry_name")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF foundry string "foundry_name"
```

|                   |                  |
|-------------------|------------------|
| Variable Type     | string           |
| Default Value     | nil              |
| Acceptable Values | Any string value |
| GUI Equivalent    | None             |

## vfiAutoChkBox

Specifies to set the via array spacing automatically.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiAutoChkBox" 'string "0")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiAutoChkBox string "0"
```

|                          |                                 |
|--------------------------|---------------------------------|
| <b>Variable Type</b>     | string                          |
| <b>Default Value</b>     | nil                             |
| <b>Acceptable Values</b> | 0 or 1                          |
| <b>GUI Equivalent</b>    | <i>Via Array Spacing - auto</i> |

## vfiBlocking

Specifies the file containing parasitic blocking device cell names, if any. Once a cell is declared a blocking cell, all the parasitic RCs inside the cell are not extracted.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiBlocking" 'string "/VoltusFi_workshop/p")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiBlocking string "/VoltusFi_workshop/p"
```

|                          |                                             |
|--------------------------|---------------------------------------------|
| <b>Variable Type</b>     | string                                      |
| <b>Default Value</b>     | nil                                         |
| <b>Acceptable Values</b> | Any string value                            |
| <b>GUI Equivalent</b>    | <i>Parasitic blocking device cells file</i> |

## vfiCouplingmode

Specifies the coupling mode for capacitance extraction. You can specify one of the following:

- **Decoupled:** specifies that decoupled capacitance extraction will be performed

- **Coupled:** specifies that coupled capacitance extraction will be performed.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiCouplingmode" 'string "decoupled")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiCouplingmode string "decoupled"
```

|                          |                                         |
|--------------------------|-----------------------------------------|
| <b>Variable Type</b>     | string                                  |
| <b>Default Value</b>     | nil                                     |
| <b>Acceptable Values</b> | Any string value (decoupled or coupled) |
| <b>GUI Equivalent</b>    | <i>Cap Coupling Model</i>               |

## vfiColoring

Specifies to enable color-aware EM analysis.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiColoring" 'string "0")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiColoring string "0"
```

|                          |                            |
|--------------------------|----------------------------|
| <b>Variable Type</b>     | string                     |
| <b>Default Value</b>     | nil                        |
| <b>Acceptable Values</b> | 0 or 1                     |
| <b>GUI Equivalent</b>    | <i>Parasitic RES Color</i> |

## vfiCompression

Specifies to generate xDSPF in the compressed format.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiCompression" 'string "0")
```

To set this variable in the `.cdsenv` file, use the call:

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---

```
voltus_fi.extractDSPF vfiCompression string "0"
```

|                          |                           |
|--------------------------|---------------------------|
| <b>Variable Type</b>     | string                    |
| <b>Default Value</b>     | nil                       |
| <b>Acceptable Values</b> | 0 or 1                    |
| <b>GUI Equivalent</b>    | <i>Select Compression</i> |

## vfiCustom

Specifies the file with user-customized extract commands. When this file is specified, the Voltus-Fi-generated CCL will not have any extract commands. In this case, the commands from the customized extract commands file will be added in the Voltus-Fi-generated CCL.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiCustom" 'string "Custom")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiCustom string "Custom"
```

|                          |                                         |
|--------------------------|-----------------------------------------|
| <b>Variable Type</b>     | string                                  |
| <b>Default Value</b>     | nil                                     |
| <b>Acceptable Values</b> | Any string value                        |
| <b>GUI Equivalent</b>    | <i>Customized Extract Commands File</i> |

## vfiDatatype

Specifies whether the input data will come from Pegasus or Calibre.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiDatatype" 'string "Calibre")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiDatatype string "Calibre"
```

|                      |        |
|----------------------|--------|
| <b>Variable Type</b> | string |
|----------------------|--------|

|                          |                  |
|--------------------------|------------------|
| <b>Default Value</b>     | pvs              |
| <b>Acceptable Values</b> | pvs or Calibre   |
| <b>GUI Equivalent</b>    | <i>Data Type</i> |

## vfiEnableGUI

Specifies whether to hide or display the warning message about the deprecation of Voltus™-Fi Custom Power Integrity Solution in the next IC base release.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiEnableGUI" `string "boolean t")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiEnableGUI string "boolean t"
```

|                          |             |
|--------------------------|-------------|
| <b>Variable Type</b>     | string      |
| <b>Default Value</b>     | nil         |
| <b>Acceptable Values</b> | t or nil    |
| <b>GUI Equivalent</b>    | <i>None</i> |

## vfiExtractmode

Specifies the type of extraction to be performed. You can specify one of the following:

- **RC**: specifies that both parasitic resistors and capacitors will be extracted
- **R only**: specifies that only parasitic resistors will be extracted

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiExtractmode" `string "R only")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiExtractmode string "R only"
```

|                      |        |
|----------------------|--------|
| <b>Variable Type</b> | string |
| <b>Default Value</b> | nil    |

|                          |                                 |
|--------------------------|---------------------------------|
| <b>Acceptable Values</b> | Any string value (R Only or RC) |
| <b>GUI Equivalent</b>    | <i>Extraction Type</i>          |

## vfiGndNet

Specifies the reference node on which extraction is to be performed.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiGndNet" 'string "GNDNet")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiGndNet string "GNDNet"
```

|                          |                  |
|--------------------------|------------------|
| <b>Variable Type</b>     | string           |
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | Any string value |
| <b>GUI Equivalent</b>    | <i>Ref Node</i>  |

## vfiInputdir

Specifies the path to the directory in which the input data is stored.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiInputdir" 'string "/PVS/PVS_lvs_qrc/svdb")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiInputdir string "PVS/PVS_lvs_qrc/svdb"
```

|                          |                       |
|--------------------------|-----------------------|
| <b>Variable Type</b>     | string                |
| <b>Default Value</b>     | nil                   |
| <b>Acceptable Values</b> | Any string value      |
| <b>GUI Equivalent</b>    | <i>Data Directory</i> |



## **vfiMaxviarrcount**

Specifies the number of vias per side allowed in an array. For example, if the via array count is set to 2, the number of vias allowed per array side will be 2.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiMaxviarrcount" 'string "4")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiMaxviarrcount string "4"
```

|                          |                        |
|--------------------------|------------------------|
| <b>Variable Type</b>     | string                 |
| <b>Default Value</b>     | nil                    |
| <b>Acceptable Values</b> | Any integer            |
| <b>GUI Equivalent</b>    | <i>Via Array Count</i> |

## **vfiMulticpu**

Specifies the number of CPUs to be used during the Quantus extraction run.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiMulticpu" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiMulticpu string "1"
```

|                          |                   |
|--------------------------|-------------------|
| <b>Variable Type</b>     | string            |
| <b>Default Value</b>     | nil               |
| <b>Acceptable Values</b> | Any integer       |
| <b>GUI Equivalent</b>    | <i>No of CPUs</i> |

## **vfiNetsfile**

Specifies the file that contains the names of the nets to be included in extraction.

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### Environment Variables

---

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiNetsfile" 'string "NetsFile")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiNetsfile string "NetsFile"
```

|                          |                  |
|--------------------------|------------------|
| <b>Variable Type</b>     | string           |
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | Any string value |
| <b>GUI Equivalent</b>    | <i>Nets File</i> |

## vfiOutdir

Specifies the output directory in which the xDSPF file will be saved.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiOutdir" 'string "/VoltusFi_workshop/mydir")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiOutdir string "/VoltusFi_workshop/mydir"
```

|                          |                         |
|--------------------------|-------------------------|
| <b>Variable Type</b>     | string                  |
| <b>Default Value</b>     | nil                     |
| <b>Acceptable Values</b> | Any string value        |
| <b>GUI Equivalent</b>    | <i>Output Directory</i> |

## vfiOutdspf

Specifies the name of the xDSPF file that will be generated.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiOutdspf" 'string "cellname.dspf")
```

To set this variable in the `.cdsenv` file, use the call:

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### Environment Variables

---

```
voltus_fi.extractDSPF vfiOutdspf string "cellname.dspf"
```

|                          |                               |
|--------------------------|-------------------------------|
| <b>Variable Type</b>     | string                        |
| <b>Default Value</b>     | nil                           |
| <b>Acceptable Values</b> | Any string value              |
| <b>GUI Equivalent</b>    | <i>Output xDSPF File Name</i> |

## vfiPgnet

Specifies the power and ground nets that should be included in the xDSPF file.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiPgnet" 'string "PGnet")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiPgnet string "PGnet"
```

|                          |                  |
|--------------------------|------------------|
| <b>Variable Type</b>     | string           |
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | Any string value |
| <b>GUI Equivalent</b>    | <i>PG Net(s)</i> |

## vfiPinorder

Specifies the sub-circuit pin order file to provide the order of pins to be used during extraction.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiPinorder" 'string
"/VoltusFi_workshop/pin2pin.conf")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiPinorder string "/VoltusFi_workshop/pin2pin.conf"
```

|                          |                              |
|--------------------------|------------------------------|
| <b>Variable Type</b>     | string                       |
| <b>Default Value</b>     | nil                          |
| <b>Acceptable Values</b> | Any string value             |
| <b>GUI Equivalent</b>    | <i>SubCkt Pin Order File</i> |

## vfiProcess

Specifies the process node.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiProcess" 'string "N7")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiProcess string "N7"
```

|                          |                                                          |
|--------------------------|----------------------------------------------------------|
| <b>Variable Type</b>     | string                                                   |
| <b>Default Value</b>     | N5/N3                                                    |
| <b>Acceptable Values</b> | N5/N3, N7, N10-PG, N10, N20/N16/N12, N14,<br>Others > 20 |
| <b>GUI Equivalent</b>    | <i>Foundry / Process Node</i>                            |

## vfiReduction

Specifies to enable the `reduce_i_cards` option in the CCL file that is used for generating the xDSPF file.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiReduction" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiReduction string "1"
```

|                          |                       |
|--------------------------|-----------------------|
| <b>Variable Type</b>     | string                |
| <b>Default Value</b>     | nil                   |
| <b>Acceptable Values</b> | 0 or 1                |
| <b>GUI Equivalent</b>    | <i>Reduce I-Cards</i> |

## vfiRunname

Specifies the name of the Pegasus or Calibre run.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiRunname" 'string "DiffopAmp")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiRunname string "DiffopAmp"
```

|                          |                  |
|--------------------------|------------------|
| <b>Variable Type</b>     | string           |
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | Any string value |
| <b>GUI Equivalent</b>    | <i>Run Name</i>  |

## vfiSignalem

Specifies that signal nets are to be included in the xDSPF file.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiSignalem" 'string "0")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiSignalem string "0"
```

|                      |        |
|----------------------|--------|
| <b>Variable Type</b> | string |
|----------------------|--------|

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|                          |                  |
|--------------------------|------------------|
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | 0 or 1           |
| <b>GUI Equivalent</b>    | <i>Signal EM</i> |

## vfiSubckt

Specifies to comment out the top sub circuit statements from the xDSPF file.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiSubckt" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiSubckt string "1"
```

|                          |                        |
|--------------------------|------------------------|
| <b>Variable Type</b>     | string                 |
| <b>Default Value</b>     | nil                    |
| <b>Acceptable Values</b> | 0 or 1                 |
| <b>GUI Equivalent</b>    | <i>Comment Sub Ckt</i> |

## vfiSubCondModel

Specifies that the parasitic resistor models for subconductor layers should be included during extraction.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiSubCondModel" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiSubCondModel string "1"
```

|                          |        |
|--------------------------|--------|
| <b>Variable Type</b>     | string |
| <b>Default Value</b>     | nil    |
| <b>Acceptable Values</b> | 0 or 1 |

**GUI Equivalent**

*Sub Conductor Model*

## **vfiSubNode**

Specifies the subnode character that will be used for subnode identification.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiSubNode" 'string "subnode")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiSubNode string "subnode"
```

|                          |                      |
|--------------------------|----------------------|
| <b>Variable Type</b>     | string               |
| <b>Default Value</b>     | nil                  |
| <b>Acceptable Values</b> | Any string value     |
| <b>GUI Equivalent</b>    | <i>Sub Node Char</i> |

## **vfiViaArraysacing**

Specifies to enable via array spacing for grouping vias within the same array.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiViaArraysacing" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiViaArraysacing string "1"
```

|                          |                          |
|--------------------------|--------------------------|
| <b>Variable Type</b>     | string                   |
| <b>Default Value</b>     | nil                      |
| <b>Acceptable Values</b> | 0 or 1                   |
| <b>GUI Equivalent</b>    | <i>Via Array Spacing</i> |

## vfiViaCnt

Specifies the fracture via count to be used for dividing pseudo vias into segments during extraction.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiViaCnt" 'string "10")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiViaCnt string "10"
```

|                          |                           |
|--------------------------|---------------------------|
| <b>Variable Type</b>     | string                    |
| <b>Default Value</b>     | nil                       |
| <b>Acceptable Values</b> | Any integer               |
| <b>GUI Equivalent</b>    | <i>Fracture Via Count</i> |

## vfiViaSpacingEdit

Specifies a value for via array spacing. This means that if the distance between vias is less than the specified maximum distance, they are grouped within the same array.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiViaSpacingEdit" 'string "0.40")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiViaSpacingEdit string "0.40"
```

|                          |                                  |
|--------------------------|----------------------------------|
| <b>Variable Type</b>     | string                           |
| <b>Default Value</b>     | nil                              |
| <b>Acceptable Values</b> | Any floating value               |
| <b>GUI Equivalent</b>    | <i>Via Array Spacing</i> - value |



## vfiViaSpacingEditChk

Specifies to use the user-specified value for via array spacing.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiViaSpacingEditChk" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiViaSpacingEditChk string "1"
```

|                          |                                                  |
|--------------------------|--------------------------------------------------|
| <b>Variable Type</b>     | string                                           |
| <b>Default Value</b>     | nil                                              |
| <b>Acceptable Values</b> | 0 or 1                                           |
| <b>GUI Equivalent</b>    | <i>Via Array Spacing</i> - not set automatically |

## vfiTechCorner

Specifies the name of the technology corner to be picked from the library.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiTechCorner" 'string "rcx_typical")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiTechCorner string "rcx_typical"
```

|                          |                  |
|--------------------------|------------------|
| <b>Variable Type</b>     | string           |
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | Any string value |
| <b>GUI Equivalent</b>    | <i>Corner</i>    |

## vfiTechLib

Specifies the path of the technology file to be used for reading the technology data.

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To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiTechLib" 'string
"/VoltusFi_workshop/pvtech.lib")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiTechLib string "/VoltusFi_workshop/pvtech.lib"
```

|                          |                                |
|--------------------------|--------------------------------|
| <b>Variable Type</b>     | string                         |
| <b>Default Value</b>     | nil                            |
| <b>Acceptable Values</b> | Any string value               |
| <b>GUI Equivalent</b>    | <i>Technology Library File</i> |

## vfiTechName

Specifies the technology filename to be used for extraction.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiTechName" 'string "gpdK045")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiTechName string "gpdK045"
```

|                          |                        |
|--------------------------|------------------------|
| <b>Variable Type</b>     | string                 |
| <b>Default Value</b>     | nil                    |
| <b>Acceptable Values</b> | Any string value       |
| <b>GUI Equivalent</b>    | <i>Technology Name</i> |

## vfiTechType

Allows you to select either *Technology File* or *Technology Directory* from the drop-down list.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiTechType" 'string "Technology Directory")
```

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To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiTechType string "Technology Directory"
```

|                          |                                                                       |
|--------------------------|-----------------------------------------------------------------------|
| <b>Variable Type</b>     | string                                                                |
| <b>Default Value</b>     | Technology Library File                                               |
| <b>Acceptable Values</b> | Technology Directory or Technology Library File                       |
| <b>GUI Equivalent</b>    | <i>Technology Library File/Technology Directory</i><br>drop-down list |

## vfiTemperature

Specifies the temperature at which extraction will be performed.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.extractDSPF" "vfiTemperature" 'string "25")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.extractDSPF vfiTemperature string "25"
```

|                          |                    |
|--------------------------|--------------------|
| <b>Variable Type</b>     | string             |
| <b>Default Value</b>     | nil                |
| <b>Acceptable Values</b> | Any floating value |
| <b>GUI Equivalent</b>    | <i>Temperature</i> |

## vfiDfiiLayerMapFile

Specifies the APS/XPS-to-DFII layer map file that provides the mapping between the layer names in the extractor-generated xDSPF file to the DFII layer names.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiDfiiLayerMapFile" 'string
"MMSIM_EMIR_workshop/df2layermap")
```

To set this variable in the `.cdsenv` file, use the call:

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```
voltus_fi.results vfiDfiiLayerMapFile string "MMSIM_EMIR_workshop/df2layermap"
```

|                          |                       |
|--------------------------|-----------------------|
| <b>Variable Type</b>     | string                |
| <b>Default Value</b>     | nil                   |
| <b>Acceptable Values</b> | Any string value      |
| <b>GUI Equivalent</b>    | <i>DFII Layer Map</i> |

## vfiElementCount

Specifies the number of violations you want to view in the *EM/IR* tab of Annotation Browser, and the violation markers in the plot on the Virtuoso layout.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiElementCount" 'string "100")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiElementCount string "100"
```

|                          |                    |
|--------------------------|--------------------|
| <b>Variable Type</b>     | string             |
| <b>Default Value</b>     | nil                |
| <b>Acceptable Values</b> | Any string value   |
| <b>GUI Equivalent</b>    | <i>Temperature</i> |

## vfiEMOnlyIctFile

Specifies the ICT file that includes information about process and EM models to be used for EM analysis.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiEMOnlyIctFile" 'string "/ICTfile")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiEMOnlyIctFile string "/ICTfile"
```

|                          |                         |
|--------------------------|-------------------------|
| <b>Variable Type</b>     | string                  |
| <b>Default Value</b>     | nil                     |
| <b>Acceptable Values</b> | Any string value        |
| <b>GUI Equivalent</b>    | <i>EM Only ICT File</i> |

## **vfiIRThreshold**

Specifies the IR threshold for viewing IR drop violations above the specified threshold value.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiIRThreshold" 'string "0.25")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiIRThreshold string "0.25"
```

|                          |                     |
|--------------------------|---------------------|
| <b>Variable Type</b>     | string              |
| <b>Default Value</b>     | nil                 |
| <b>Acceptable Values</b> | Any string value    |
| <b>GUI Equivalent</b>    | <i>IR threshold</i> |

## **vfiLayermapFile**

Specifies the file used to map the layer names in the simulation database to the layer names in the technology file.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiLayermapFile" 'string "/df2layermap")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiLayermapFile string "/df2layermap"
```

|                      |        |
|----------------------|--------|
| <b>Variable Type</b> | string |
|----------------------|--------|

|                          |                       |
|--------------------------|-----------------------|
| <b>Default Value</b>     | nil                   |
| <b>Acceptable Values</b> | Any string value      |
| <b>GUI Equivalent</b>    | <i>Layer Map File</i> |

## vfiLayerIndex

Voltus-Fi-XL creates layers for displaying the EMIR violations when you plot them on the Virtuoso Layout. By default, the software uses more than a hundred layers for displaying violations. It creates these layers by using a layer index value or layer number that is equal to or greater than 256.

However, if you are already using the same layer number as that used by Voltus-Fi-XL, a layer number conflict will occur and a warning will be issued. To avoid this warning, specify a different value for the layer number.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiLayerIndex" 'int 270')
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiLayerIndex int 270
```

|                          |                   |
|--------------------------|-------------------|
| <b>Variable Type</b>     | int               |
| <b>Default Value</b>     | nil               |
| <b>Acceptable Values</b> | Any integer value |
| <b>GUI Equivalent</b>    | <i>None</i>       |

## vfiNoOfThreads

Specifies the maximum number of threads/CPU's to be used for EM analysis.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiNoOfThreads" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiNoOfThreads string "1"
```

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|                          |                   |
|--------------------------|-------------------|
| <b>Variable Type</b>     | string            |
| <b>Default Value</b>     | nil               |
| <b>Acceptable Values</b> | Any integer value |
| <b>GUI Equivalent</b>    | <i>None</i>       |

## vfiQrcRunDir

Specifies the path to the Quantus run directory.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiQrcRunDir" 'string "/diffopamp_lvs/svdb")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiQrcRunDir string "/diffopamp_lvs/svdb"
```

|                          |                          |
|--------------------------|--------------------------|
| <b>Variable Type</b>     | string                   |
| <b>Default Value</b>     | nil                      |
| <b>Acceptable Values</b> | Any string value         |
| <b>GUI Equivalent</b>    | <i>QRC Run Directory</i> |

## vfiQrcRunName

Specifies the Quantus run name.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiQrcRunName" 'string "DiffOpAmp")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiQrcRunName string "DiffOpAmp"
```

|                      |        |
|----------------------|--------|
| <b>Variable Type</b> | string |
|----------------------|--------|

|                          |                     |
|--------------------------|---------------------|
| <b>Default Value</b>     | nil                 |
| <b>Acceptable Values</b> | Any string value    |
| <b>GUI Equivalent</b>    | <i>QRC Run Name</i> |

## **vfiResultDirectoryIr**

Specifies the state directory or the result file that stores the simulation results.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiResultDirectoryIr" 'string
"/emir_simulation/input.emir0_bin")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiResultDirectoryIr string "/emir_simulation/input.emir0_bin"
```

|                          |                                     |
|--------------------------|-------------------------------------|
| <b>Variable Type</b>     | string                              |
| <b>Default Value</b>     | nil                                 |
| <b>Acceptable Values</b> | Any string value                    |
| <b>GUI Equivalent</b>    | <i>State Directory/Results File</i> |

## **vfiSetShrinkFactor**

Specifies the factor by which xDSPF was shrunk. This is used for flows where the xDSPF is generated with a shrunk technology but the layout remains on the original technology.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiSetShrinkFactor" 'string "0.1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiSetShrinkFactor string "0.1"
```

|                          |                  |
|--------------------------|------------------|
| <b>Variable Type</b>     | string           |
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | Any string value |



**GUI Equivalent**                      *Shrink Factor*

## **vfiTechFile**

Specifies the technology file.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiTechFile" 'string
"/emir_simulation/emDataFile.txt")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiTechFile string "/emir_simulation/emDataFile.txt"
```

|                          |                  |
|--------------------------|------------------|
| <b>Variable Type</b>     | string           |
| <b>Default Value</b>     | nil              |
| <b>Acceptable Values</b> | Any string value |
| <b>GUI Equivalent</b>    | <i>Tech File</i> |

## **vfiTypeCheckboxMax**

Specifies to calculate the Current Density violations based on the maximum DC current.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiTypeCheckboxMax" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiTypeCheckboxMax string "1"
```

|                          |                     |
|--------------------------|---------------------|
| <b>Variable Type</b>     | string              |
| <b>Default Value</b>     | nil                 |
| <b>Acceptable Values</b> | true or false       |
| <b>GUI Equivalent</b>    | <i>max</i> (EM tab) |

## **vfiTypeCheckboxAvg**

Specifies to calculate the Current Density violations based on the average value of the DC current.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiTypeCheckboxAvg" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiTypeCheckboxAvg string "1"
```

|                          |                     |
|--------------------------|---------------------|
| <b>Variable Type</b>     | string              |
| <b>Default Value</b>     | nil                 |
| <b>Acceptable Values</b> | true or false       |
| <b>GUI Equivalent</b>    | <i>avg</i> (EM tab) |

## **vfiTypeCheckboxAvgAbs**

Specifies to calculate the Current Density violations based on the average value of absolute current.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiTypeCheckboxAvgAbs" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiTypeCheckboxAvgAbs string "1"
```

|                          |                        |
|--------------------------|------------------------|
| <b>Variable Type</b>     | string                 |
| <b>Default Value</b>     | nil                    |
| <b>Acceptable Values</b> | true or false          |
| <b>GUI Equivalent</b>    | <i>avgabs</i> (EM tab) |

## **vfiTypeCheckboxAcpeak**

Specifies to calculate the Current Density violations based on peak AC current.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiTypeCheckboxAcpeak" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiTypeCheckboxAcpeak string "1"
```

|                          |                         |
|--------------------------|-------------------------|
| <b>Variable Type</b>     | string                  |
| <b>Default Value</b>     | nil                     |
| <b>Acceptable Values</b> | true or false           |
| <b>GUI Equivalent</b>    | <i>AC Peak</i> (EM tab) |

## **vfiTypeCheckboxRms**

Specifies to calculate the Current Density violations based on the root mean square (RMS) value of the AC current.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vfiTypeCheckboxRms" 'string "1")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vfiTypeCheckboxRms string "1"
```

|                          |                     |
|--------------------------|---------------------|
| <b>Variable Type</b>     | string              |
| <b>Default Value</b>     | nil                 |
| <b>Acceptable Values</b> | true or false       |
| <b>GUI Equivalent</b>    | <i>rms</i> (EM tab) |

## **vps\_results\_plots\_distributeRange**

Specifies to re-distribute the plot display range to view the complete spectrum, from “deep red” to “deep blue”, for the specified layer selection for the plots in the Display form of the IR/EM Results form in the GUI.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vps_results_plots_distributeRange" 'string
"true")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vps_results_plots_distributeRange string "true"
```

|                          |                                                                                 |
|--------------------------|---------------------------------------------------------------------------------|
| <b>Variable Type</b>     | string                                                                          |
| <b>Default Value</b>     | nil                                                                             |
| <b>Acceptable Values</b> | Any string value (true or false)                                                |
| <b>GUI Equivalent</b>    | <i>Re-distribute Range</i> option in the Display form of the IR/EM Results form |

## **vps\_results\_plots\_OutofRange**

Specifies whether to plot out of range values in the Display form of the IR/EM Results form in the GUI. For this, select the *Plot out of range values* option in the *Plot Options* group box in the Display form.

To set this variable in the `.cdsinit` file or CIW, use the call:

```
envSetVal("voltus_fi.results" "vps_results_plots_OutofRange" 'string "true")
```

To set this variable in the `.cdsenv` file, use the call:

```
voltus_fi.results vps_results_plots_OutofRange string "true"
```

|                          |                                  |
|--------------------------|----------------------------------|
| <b>Variable Type</b>     | string                           |
| <b>Default Value</b>     | nil                              |
| <b>Acceptable Values</b> | Any string value (true or false) |

**GUI Equivalent**

*Plot out of range values* option in the Display form of the IR/EM Results form

## VFI\_LIC\_QUEUE

```
setenv VFI_LIC_QUEUE time_in_seconds
```

Specifies the duration for which the software should wait for the availability of the Voltus-Fi-XL license. By default, the software waits for 24 hours or 86400 seconds.

**Example:**

```
setenv VFI_LIC_QUEUE 1000
```

## VOLTUSFI\_DELTA\_T

```
setenv VOLTUSFI_DELTA_T value
```

Specifies the deltaT value for EM analysis. It is used to specify maximum rise in temperature in degree Celsius, caused due to Joule Heating. It must be a positive value.

If you do not specify the rise in temperature, the software considers a default temperature of 5 degree Celsius. The variable, `deltaT`, can also be specified using either the `set_variable` command or in the Variables form. This is detailed in subsequent sections.

**Example:**

```
setenv VOLTUSFI_DELTA_T 15
```

## VOLTUSFI\_DYNAMIC\_AC\_PEAK

```
setenv VOLTUSFI_DYNAMIC_AC_PEAK true | false | multiplePeak
```

Specifies that the current density violations should be calculated based on the peak AC current for metal lines, vias, and contacts. It is applied to periodic AC or pulsed DC signals. Valid values are `true`, `false`, and `multiplePeak`.

**Example:**

```
setenv VOLTUSFI_DYNAMIC_AC_PEAK true
```

## VOLTUSFI\_SPLIT\_ACDC\_RULES

```
setenv VOLTUSFI_SPLIT_ACDC_RULES true | false
```

Specifies different rules for EM analysis of power and signal nets. The default value is `false`.

### Example:

```
setenv VOLTUSFI_SPLIT_ACDC_RULES true
```

## VFI\_USE\_OLD\_SHAPE\_DB

```
setenv VFI_USE_OLD_SHAPE_DB true | false
```

The Voltus-Fi Quantus shape-server flow uses a new node name-based matching algorithm for displaying the shapes on the layout. This flow is enabled by default. However, in case of any issues with this flow, you can set the `VFI_USE_OLD_SHAPE_DB` variable to `true` to enable the earlier shape-server flow.

### Example:

```
setenv VFI_USE_OLD_SHAPE_DB true
```

## VFI\_POINT\_QUERY

```
setenv VFI_POINT_QUERY value
```

When set, runs the IR/EM analysis results query is performed within the defined square area around the specified point query. The value is specified in nanometer (nm). When this variable is not set, the software queries the nearest matching data point.

Set this variable before starting the GUI.

### Example:

```
setenv VFI_POINT_QUERY 5
```

For a point selected on x- and y-coordinates, the software will query the following square area:

`x-5, x+5, y-5, and y+5`

## VFI\_ENABLE\_INTERSECTING\_SHAPE

```
setenv VFI_ENABLE_INTERSECTING_SHAPE
```

Set this environment variable to enable processing of self-intersecting shapes in the layout. If this variable is not set, self-intersecting shapes are skipped during analysis and not highlighted in the layout while displaying the EMIR analysis plots.

## VFI\_SPLIT\_NON\_RECTANGULAR\_SHAPE

```
setenv VFI_SPLIT_NON_RECTANGULAR_SHAPE
```

This variable sets the option in the VFI GUI to split the non-rectangular layout shapes based on the resistors extracted over them. By default, the GUI splits only the long rectangular shapes in the layout into smaller shapes to increase the display granularity of the plots.

**Note:** This environment variable is applicable only for the flow that uses a DFII layermap file for display.

## vfi\_dfii\_unmap\_skip

```
setenv vfi_dfii_unmap_skip
```

Set this environment variable to hide the layers that are not mapped in the DFII layer map file from the layer table of the IR/EM Display form. If this variable is not set, all layers are displayed in the layer table of the Display form.

## vfi\_ignore\_conf\_file

```
setenv vfi_ignore_conf_file true | false
```

By default, the variable settings in the `input.conf` file override the values for the same variables that are specified in the GUI. To ignore the variable settings in the `conf` file and use the specified GUI settings, set the `vfi_ignore_conf_file` environment variable to `true`. By default, this variable is set to `false`.

### Example:

```
setenv vfi_ignore_conf_file true
```

## **CDS\_MMSIM\_VOLTUSFI\_ROOT**

```
setenv CDS_MMSIM_VOLTUSFI_ROOT <installation_dir_path>
```

When set, specifies the path of the emirreport binary to be used for EMIR report generation in the Spectre run. It overrides any emirreport version in the MMSIM/Spectre stream.

**Note:** This variable only affects the emirreport when it is run automatically following the Spectre EMIR simulation. It does not affect the manual running of the emirreport from the command line. To use this variable, the emirreport must be present in the specified path.

### **Example:**

```
setenv CDSHOME /home/IC6.1.7/ISR12/lxx86/64/
```

```
setenv CDS_MMSIM_VOLTUSFI_ROOT $CDSHOME
```



---

# Variables

---

This section provides a list of variables that you can specify in Voltus-Fi-XL. You can set these variables both in the GUI and in batch mode.

## Variables Setup in Voltus-Fi-XL

The variables in Voltus-Fi-XL can be set in both the GUI and batch mode.

### Batch Mode

In batch mode, you can set the variables using the `set_variable` and `emirutil` commands.

**Using the `set_variable` Command:** When using the `vfibatch` command to run Voltus-Fi-XL in batch mode, you can set the variables using the `set_variable` command. The syntax of the command and an example is provided below.

```
set_variable var_name var_value
```

Sets the user-specified value for the variable in batch mode.

### Parameters

|                  |                                                                         |
|------------------|-------------------------------------------------------------------------|
| <i>var_name</i>  | Specifies the name of the variable for which you want to set the value. |
| <i>var_value</i> | Specifies the value that you want to set for the variable.              |

### Example:

The following command sets the value of the variable, `dbu` to 10000 database units per micron:

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### Variables

---

```
set_variable dbu 10000
```

**Using the emirutil Command:** When using the EMIR control file to generate textual reports of EMIR results in Voltus-Fi-XL in batch mode, you can set the variables using the `emirutil` command in the control file. The command syntax and example is provided below.

```
emirutil <var_name=var_value>
```

#### Example:

The following commands set the values of variables, `deltaT`, `dbu`, and `dynamicACPeak` to 10, 500, and false, respectively.

```
emirutil deltaT=10.0
```

```
emirutil dbu=500
```

```
emirutil dynamicACPeak=false
```

**Setting the Configuration Variable:** You can set the configuration variable, `dbu` or `cadGrid` using either the `set_variable` command or the `emirutil` command.

The configuration variable, `dbu`, specifies the number of database units (DBU) per micron for the layout view. The default value of `dbu` is 1000.

The `cadGrid` variable specifies the resolution of the software in terms of width and length and the unit of measurement is micrometer or micron. The default value of `cadGrid` is 0.001.

**Note:** The value of the `dbu` variable is  $1/\text{cadGrid}$ . If both `dbu` and `cadGrid` are specified, the `dbu` variable value is given priority.

The above variables are specified only in batch mode when the view information is not specified in either the `vfibatch` command file or in the `emir` configuration file. They are not required to be specified when running the tool in the GUI mode as it is read from the open view. If this variable is not specified, the tool uses the default value.

## GUI Mode

In the GUI, you can set the variables in the Variables form, which can be accessed from the *EM* tab of the IR/EM Results form.

## applyRThreshold

Specifies the threshold ratio “r” for AC-Peak analysis.

## connectingODLayers

Specifies the list of layers to identify connecting ODs for heat sink effect. The default value is shown below.

```
connectingODLayers M0_OD M0_OD1 M0_OD2 MVIA0_1 MVIA0_2 M1
```

**Note:** This variable is only used for the SHE flow with heat-sink effect.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil connectingODLayers="M0_OD M0_OD1 M0_OD2 MVIA0_1 MVIA0_2 M1"
```

## consolidatedReport

When this variable is set to `true`, consolidated EM and IR reports are generated for all available bin files. The default value of this variable is `false`.

## coupledSH

When set to `true`, specifies that the thermal-aware DC EM flow should be enabled. By default, this variable is set to `false`.

## deltaT

Specifies the maximum rise in temperature in degree Celsius, caused due to Joule heating. It must be a positive value.

```
deltaT temp_value
```

If the rise in temperature is not specified, Voltus-Fi-XL considers a default temperature of 5 degrees Celsius. This is an ideal condition wherein the design must be EM free.

### Example:

```
deltaT 10.0
```

`deltaT` can be used for defining the current density limit: `Irms`. For example:

```
em_jmax_ac_rms EQU (w - 0.004) * 1.24 * deltaT
```

The `deltaT` option can also be specified in the control file by using the following command:

```
emirutil deltaT=temp_value
```

## deltaTLayers

Specifies layer-specific `deltaT` values. The layers for which `deltaT` value is not specified, global `deltaT` value will be used. The syntax is as follows:

```
deltaTLayers "(layer=layer_name1 deltaT=temp_value1)
(layer=layer_name2 deltaT=temp_value2)"
```

For example,

```
deltaTLayers "(layer=rhim hi_em=1 deltaT=25) (layer=rhim hi_em=0
deltaT=5) (layer=M7 deltaT=10)"
```

In the above example, `hi_em=1` indicates high current carrying design resistor for which the `deltaT` value is 25 degree Celsius while `hi_em=0` indicates general design resistor for which the `deltaT` value is 5 degree Celsius. The `deltaT` value for M7 layer is 10 degree Celsius.

This option can also be specified in the control file by using the following command:

```
emirutil deltaTLayers=[(layer=rhim hi_em=1 deltaT=25) (layer=rhim
hi_em=0 deltaT=5) (layer=M7 deltaT=10)]
```

## disableODSH

When set to `true`, disables the self-heating effect of devices in the SHE flow. By default, this variable is set to `false`.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil disableODSH=true
```

## disableHRSH

When set to `true`, disables the self-heating effect of design resistors in the SHE flow. By default, this variable is set to `false`.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil disableHRSH=true
```

## disableLayoutScale

Disables the layout scale factor defined in the ICT file. The layout\_scale factor is the ratio of the scaled dimensions divided by the drawn dimensions. The ICT file is defined based on the scaled dimensions. Quantus applies the layout\_scale factor to the

input design during extraction so that the design dimensions and the ICT file dimensions are consistent.

When the disableLayoutScale variable is set to true, the layout\_scale factor specified in the ICT file is ignored in the Voltus-Fi-XL EM analysis flow. By default, this variable is set to false.

## dynamicACPeak

Specifies that the current density violations should be calculated based on the peak AC current for metal lines, vias, and contacts. It is applied to periodic AC or pulsed DC signals. Valid values are true, false, and multiplePeak. When the multiplePeak option is specified, the software considers multiple peaks for the AC peak calculations.

$$I_{\text{peak\_ac}} = I_{\text{peak\_dc}} / (r)^{1/2}$$

where duty ratio “r” is:

$$r = I_{\text{abs-avg}} / I_{\text{peak\_dc}}, \text{ by default ("false")}$$

And

$$r = T_d / T_{\text{total}}, \text{ when the dynamicACPeak variable is set.}$$

$T_{\text{total}}$  = total transient time

$T_d$  = the time duration in micro second or the total “On Time” period, where  $\text{abs}(I) > (\max(\text{abs}(I)) / 2.0)$  during transient analysis

**Note:** Voltus-Fi-XL does not calculate  $T_d$  as  $\max(\text{abs}(I)) / 2.0$  period. But it calculates  $T_d$  by measuring the pulse at half energy level due to performance reason. The variable, pwc\_threshold specified using the below command in the EMIR configuration file defines the current threshold for finding the start of the pulse.

```
net analysis=[ipwc] pwc_threshold=1e-6
```

$T_d$  has the following different values depending upon the value of dynamicACPeak:

- $T_d$  = the time duration of maximum peak, when dynamicACPeak is set to “true”

- $T_d$ =sum of time durations of different peaks,  $T_{d1}+T_{d2}+T_{dN}...$  (when `dynamicACPeak` is set to “multiplePeak”)

**Note:** When `dynamicACPeak` is set to either “true” or “multiplePeak”, the command, `net analysis=[ipwc]` must be specified in the EMIR configuration file.

**Note:** The software replaces the value of “r” with the value of `applyRThreshold` if the value of “r” is < than that of `applyRThreshold`. This is because a small “r” value results in an unreasonable increase in the  $I_{peak\_ac}$  limit. To avoid this scenario, use the `applyR` keyword to reset the value of “r” in the ICT file or change the value of the `applyRThreshold` variable, either in the Variables form or in batch mode.

## emLimitScale

Scales the EM limits of the parasitic resistors in the design before generating the EM reports. You can either apply the same scale factor to all the nets or specify different scale factors for different nets. Both use models are detailed below.

- To apply the same scale factor to the parasitic resistors of all the nets in the design, provide the value of the scale factor using this variable. For example,

```
emLimitScale scale_factor
```

```
emLimitScale 0.04
```

**Note:** This is applicable to `avg`, `avg abs`, and `rms` analyses. For the `avg` and `avg abs` analyses, the limit is directly multiplied by this factor. For `rms` analysis, the limit is multiplied by the root of this factor.

- To apply different scale factors to different nets in the design, provide the name of the file that contains information about the net names and the corresponding scale factors to be applied to these nets. For example,

```
emLimitScale scale_factor_netfile
```

An example of the scale factor file is as follows:

```
net_name1 scale_factor1
net_name2 scale_factor2
```

## emVariableValues

```
emVariableValues "(variable=configA value=#) (variable=configB
value=#) "
```

Specifies the EM variable values for current density limit calculation in the GUI.

**Example:**

```
emVariableValues "(variable=configA value=20) (variable=configB
value=10) "
```

Where,

the values of configA and configB variables are 20 and 10, respectively.

**Note:** The EM variable values passed through the configuration file will get priority over the value of same variable specified in the techfile.

## enableContextAwareSrmsRelaxation

```
enableContextAwareSrmsRelaxation true | false
```

When set to `true`, this option enables the context-aware RMS Relaxation flow. By default, the variable is set to `false`.

**Example:**

```
enableContextAwareSrmsRelaxation true
```

You can also set this variable in the EMIR control file by using the following command:

```
emirutil enableContextAwareSrmsRelaxation=true
```

**Note:** The context-aware RMS Relaxation flow is foundry-specific. For more information, contact your Cadence representative.

## enableDesignResistorPeakFactor

Specifies the addition of the factor,  $1 / (r)^{1/2}$ , in the current limit calculation for the AC-Peak analysis of the design resistor.

By default, the software calculates the current limit for the AC-Peak analysis of the design resistor using the following equation:

$$I_{\text{peak\_ac}}(\text{limit}) = I_{\text{peak\_dc}}(\text{limit})$$

Apply the factor,  $1/(r)^{1/2}$ , in your calculation, then set the `enableDesignResistorPeakFactor` variable to `true`. The current limit will then be calculated in the following manner:

$$I_{\text{peak\_ac}}(\text{limit}) = I_{\text{peak\_dc}}(\text{limit}) / (r)^{1/2}$$

By default, this variable is set to `false`.

## enableDesignResistorScaling

Enables the scaling of the width and length values based on the `layout_scale` factor specified in the technology file before the EM rules are applied for EM analysis of design resistors. By default, this variable is set to `true`. In the GUI, you can set this variable in the Variables form.

In batch mode, you can set this variable in the `vfibatch` command file by using the following command:

```
set_variable enableDesignResistorScaling false
```

You can also set this variable in the EMIR control file by using the following command:

```
emirutil enableDesignResistorScaling=false
```

## enablePWLDensityInterpolation

Enables the current density calculation from the given PWL using current density and width, or current density and area linear interpolation for either the metal's width or the via's area. The calculation is only done when the metal's width or the via's area does not match the PWL width or area values.

By default, this variable is set to `false`. In the GUI, you can set this variable in the Variables form.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil enablePWLDensityInterpolation=true
```

## enableReportScaleParam

When set to `true`, this option reports the layout scale factor in the EM text report. In addition, the scaled dimensions for the `path-length`, `width`, `needed width`, and



`viaArea` fields are displayed in the EM analysis report and GUI.

When set to `false`, the drawn dimension values for the `path-length`, `width`, `neededWidth`, and `viaArea` fields are displayed in the EM analysis report and GUI. By default, the variable is set to `false`. In the GUI, you can set this variable in the Variables form.

#### Example:

```
enableReportScaleParam true
```

You can also set this variable in the EMIR control file by using the following command:

```
emirutil enableReportScaleParam=true
```

## enableRMSHotSpotWaiving

Enables the RMS EM hot spot waiving analysis. By default, this feature is disabled. In the GUI, you can set this variable in the Variables form. In batch mode, you can set this variable in the `vfibatch` command file by using the following command:

```
set_variable enableRMSHotSpotWaiving true
```

You can also set this variable in the EMIR control file by using the following command:

```
emirutil enableRMSHotSpotWaiving=true
```

**Note:** This variable is applicable only to the RMS EM hot spot waiving analysis. To use this feature, contact your Cadence representative to explain your usage requirements.

## enableSHHeatSink

When set to `true`, specifies that the heat sink effect should be included in the SHE analysis. If this variable is set to `true`, ensure that heat sink models are available.

**Note:** This variable is used only for the SHE flow with heat sink effect.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil enableSHHeatSink=true
```

## extendHeatSinkRange

Specifies the expanded region of the OD. The heat-sink structure inside this region can only act as heat sink for the specified OD shape.

The default value of this variable is 0.4.

**Note:** This variable is only used for the SHE flow with heat-sink effect.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil extendHeatSinkRange=0.5
```

## extendHRRange

Specifies the range of the design resistor shape expansion. The unit of this variable is um (micro meter).

**Note:** This parameter is applicable only to the thermal-aware DC EM flow.

The default value is 1.8 although it may be different for different process nodes.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil extendHRRange=2.0
```

## extendJouleHeating

Specifies whether or not metal-shape expansion is to be done for joule-heating calculation. By default, this variable is set to `false`.

**Note:** This variable is applicable only to the thermal-aware DC EM flow.

## extendODRange

Specifies the range of the OD shape expansion. The unit of this variable is um (micro meter). The default value of this variable is 1.8.

**Note:** This variable is applicable only to the thermal-aware DC EM flow.

## extendMetalRange

Specifies the number of metal pitch for metal expansion. The default value of this variable is 0.

**Note:** This variable is applicable only to the thermal-aware DC EM flow.

## extendedPeakReport

Reports the timestamp of the maximum current for AC-Peak and Max analysis types in the EM analysis report, the `.rpt_em` file. It adds the `Time` column in the report. The default value is `false`.

### Example:

```
extendedPeakReport true
```

## extendPWLMatch

When the EM rules are specified in terms of PWL and the width of metal or the area of via does not match with any width/area of the PWL, the EM limit will not be calculated for this metal resistor/via.

When this variable is set to `true`, the software interpolates the limit value for the resistor/via from the selected rule PWL as follows:

The minimum of  $\text{PWL}_i^{\text{th}} \text{ value} * (\text{metal's width or via's area}) / (\text{PWL}_i^{\text{th}} \text{ width or PWL area})$

## extendSHRegion

Specifies whether or not the OD shape extension is to be done. By default, this variable is set to `false`.

**Note:** This variable is applicable only to the thermal-aware DC EM flow.

## geounit

Defines the scaling of all DSPF geometry parameters (`W`, `L`, `X`, `Y`). It applies only to the `*|NET` section, and not to the `instance` section. The default value is `1.0e-6`. The unit of this variable is meter.

## geounit\_wl

Defines the scaling of DSPF geometry parameters W and L. It applies only to the \*|NET section, and not to the instance section. The default value is  $1.0e-6$ . The unit of this variable is meter.

**Note:** If the `geounit_WL` and `geounit` options are specified together, the `geounit_WL` option takes precedence over the `geounit` option.

## geounit\_xy

Defines the scaling of DSPF geometry parameters X and Y. It applies only to the \*|NET section, and not to the instance section. The default value is  $1.0e-6$ . The unit of this variable is meter.

**Note:** If the `geounit_xy` and `geounit` options are specified together, the `geounit_xy` option takes precedence over the `geounit` option.

## layermap

Specifies the mapping between the layer names in the simulation database to those specified in the technology files (qrcTechFile and ICT file) for the EM analysis flow. It maps the layer names in the xDSPF file to the ICT layer names. the syntax is provided below.

```
layermap (rcxLayer=rcx_layer_name1 ictLayer=ict_layer_name1)
(rcxLayer=rcx_layer_name2 ictLayer=ict_layer_name2)
```

Where

`rcxLayer` is the layer name in the simulation database

`ictLayer` is the layer name in the ICT EM file

**Example:**

```
layermap [(rcxLayer=M1 ictLayer=T1) (rcxLayer=M2 ictLayer=T2)]
```

This variable can also be set using the `emirutil` command.

It can also be specified in the command file as follows:

```
set_variable layermap "(rcxLayer=rcx_layer_name1
ictLayer=ict_layer_name1) (rcxLayer=rcx_layer_name2
ictLayer=ict_layer_name2)"
```

## mdLayers

Specifies the list of metal diffusion layers that need to be combined for EM analysis. For example, to calculate the distance between terminal vias ( $L_{v2v}$ ), for thermal analysis (SHE) and so on.

The default value is shown below.

```
MD_STI MD_OD MD_STI_SRM MD_OD_SRM M0_OD M0_STI MD_STI_CPP85 MD_OD_CPP85
```

This variable can also be set using the `emirutil` command.

## mergeMDLayers

Enables combining of metal diffusion layers that are specified using the variable, `mdLayers`, for calculating the effective Blech length. When set to `false`, no merging of metal diffusion layers is done for Blech length calculation.

This variable can also be set using the `emirutil` command.

## multiplePeakPercentThreshold

Specifies the threshold percentage for the peak current above which the  $T_d$  for a particular peak is added to the final  $T_d$ . This variable is applicable only when the `dynamicACPeak` analysis is set to `multiPeak`. The default value of this variables is 5.

This variable can also be set using the `emirutil` command.

## optimisticEMRuleSelection

Specifies whether optimistic or pessimistic values are selected for the specified rules. This is applicable when multiple rules are selected after all conditions match.

By default, the variable is set to `false`. This means that the pessimistic value is selected.

## powerRailGroundNets

Specifies the ground nets to be used for power-rail analysis. These nets will override the nets automatically identified by the software. By default, the software automatically identifies ground nets from the simulation database.

`powerRailGroundNets` is applicable only to EM analysis. IR analysis will not be affected with this variable.

**Note:** This variable accepts wildcards. For example:

```
powerRailGroundNets="vss vssp"
```

## powerRailRules

Specifies rules for power-rail analysis. The available options are `off`, `default`, `n5`, `n7`, and `advance`.

- `off`: The software ignores all EM rules specified using the `power_rail` keyword.
- `default`: Enables power-rail analysis.
- `n5`: Sets the power-rail analysis rules for the N5 process node.
- `n7`: Sets the power-rail analysis rules for the N7 process node.
- `advance`: Specifies the following:
  - ☐ EM rules will not be used for metal layers.
  - ☐ Stack vias will be considered as part of terminal vias.
  - ☐ Current direction check will not be performed for terminal vias.

## powerRailSupplyNets

Specifies the supply nets to be used for power-rail analysis. These nets will override the nets automatically identified by the software. By default, the software automatically identifies supply nets from the simulation database.

`powerRailSupplyNets` is applicable only to EM analysis. IR analysis will not be affected with this variable.

**Note:** This variable accepts wildcards. For example:

```
powerRailSupplyNets="vdd vddp"
```

## **process\_scale**

Specifies the value by which the width and length values will be multiplied before the EM rules are applied. The default value of this variable is 1. In the GUI, you can set this variable in the Variables form.

In batch mode, you can set this variable in the `vfibatch` command file by using the following command:

```
set_variable process_scale 0.8
```

You can also set this variable in the EMIR control file by using the following command:

```
emirutil process_scale=0.8
```

## **prioritizedPwlRulesLayers**

Specifies the list of layers for which area-based PWL search is performed first. When no match is found, then non-PWL rules are used. The default value of this variable is "all", which means that this behavior is enabled for all layers.

To enable the behavior for specific layers, you can specify a list of layers.

To disable this behavior for all layers, set the value of this variable to `none`. In the GUI, you can set this variable in the Variables form.

In batch mode, you can set this variable in the `vfibatch` command file by using the following command:

```
set_variable prioritizedPwlRulesLayers none
```

You can also set this variable in the EMIR control file by using the following command:

```
emirutil prioritizedPwlRulesLayers=none
```

## **removeBulkShorting**

When set to `true`, this variable removes bulk-shorting in the design. Bulk-shorting in the design results in an increase in the EM analysis runtime. This variable is only used as a troubleshooting option.

By Default, this variable is set to `false`.

The syntax is as follows:

```
removeBulkShorting true | false
```

#### Example:

```
removeBulkShorting true
```

You can also set this variable in the EMIR control file by using the following command:

```
emirutil removeBulkShorting=true
```

## reportUnmatchedRuleResistor

When set to `true`, specifies that resistors that do not match any EM rule for the specified analysis in the ICT file will be reported in the `"#.rpt_unmatch"` file. The default value of this variable is `true`. Also, the summary report file, `summary.rpt`, will report a count of such resistors in a separate column. For example, `"iacpeak_num_unmatch"`.

If you do not want to create the `#.rpt_unmatch` file, set this variable to `false`. For example:

```
emirutil reportUnmatchedRuleResistor=false
```

## rmsMetalLineNumberPower

Specifies the value of power on the metal lines for RMS EM analysis of power nets.

If this option is not specified, the default value of 0 is considered, which means the software uses the `em_dc_rms_metal_line_num` value specified in the ICT file.

However, if this option is specified, it overrides the `em_dc_rms_metal_line_num` value specified in the ICT file.

You can also set this variable in the conf file in the following manner:

```
emirutil rmsMetalLineNumberPower=number
```

The default value is 0.

## rmsMetalLineNumberSignal

Specifies the value of power on the metal lines for RMS EM analysis of signal nets.



If this option is not specified, the default value of 0 is considered, which means the software uses the `em_ac_rms_metal_line_num` value specified in the ICT file.

However, if this option is specified, it overrides the `em_ac_rms_metal_line_num` value specified in the ICT file.

You can also set this variable in the conf file in the following manner:

```
emirutil rmsMetalLineNumberSignal=number
```

The default value is 0.

## rmsMultiplierPin

Specifies the RMS relaxation factor for EM analysis of power grids. The default value is 1.0.

## rmsMultiplierSignal

Specifies the RMS relaxation factor for EM analysis of signal nets. The default value is 1.0.

## shEMEffect

Specifies the basis for the re-evaluation of EM effect. Valid values are:

- `beolT`: specifies that re-evaluation will be done on the basis of individual metal BEOL\_T.
- `tiles_no.of divisions in x-direction X no. of divisions in y-direction`: specifies that re-evaluation will be done on the basis of tile BEOL\_T.

## shParamFile

Specifies the self-heating effect (SHE) analysis parameter file, which is required for plotting the SHE analysis plots. This file is used for deltaT FEOL calculation with finger and fin effect considerations.

**Note:** For SHE with heat-sink effect, this file should include the heat-sink rules.

## shRmsLimitThreshold

Specifies the self-heating current limit for the violating resistors displayed in the jacrm\_sh plot. The default value is 1e-10.

## shXMLFile

Specifies the XML file to be used in the SHE analysis flow. This file is created by model cards with supporting self-heating as an input file for the final deltaT FEOL value calculation during simulation.

## simpleSingleViaDefinition

The keyword, `single` is used to differentiate between a single square cut via and square via array. It is applicable to square via, with width equal to 'vc\_width/min\_width', only. To support the `single` keyword for all the via sizes, set the `simpleSingleViaDefinition` variable to `true`.

By default, this variable is set to `false`.

You can also set this variable in the conf file in the following manner:

```
emirutil simpleSingleViaDefinition=true
```

## splitACDCRules

Specifies different rules for EM analysis of power and signal nets. The default value is `false`.

## Tj

Specifies the temperature to be used for EM analysis. The default value is `Tsim` or the temperature used while performing simulation.

## Tambient

Specifies the ambient temperature for self-heating analysis. If this value is not specified, the software calculates it as `Tj-deltaT`.

You can also set this variable in the EMIR control file by using the following command:

```
emirutil Tambient=value
```

## Tlife

Specifies the lifetime for which the EM analysis will be performed. The default unit for this variable is `years`. You can also specify the value in `hours`. The tool will convert it into years. For example:

```
Tlife="20000hours"
```

## toggleNetFrequency

Specifies the frequency of the nets so that the tool can derive the  $T_d$  (total on-time period) for multiple clock cycles. You can specify frequencies for different nets as shown below. Wild cards are also supported.

Syntax:

```
toggleNetFrequency "(net1,frequency1) (net#,frequency#)"
```

For example,

```
toggleNetFrequency "(CLK*,2.3e9) (NET1,4.6e9)"
```

## toggleNetFrequencyFile

Specifies the name of the file that contains the net names and their corresponding frequency values. This file is used to specify the frequency of nets to compute the  $T_d$  (total on-time period) for multiple clock cycles. This file contains net names separated by commas and the frequency values.

For example,

```
toggleNetFrequencyFile freq_file
```

A sample `freq_file` is shown below.

```
VDD, 2e08
```

```
D*, 4e08
```

```
GSS, 3e08
```

## **useEncryptedWidth**

Specifies whether encrypted (silicon) width should be used or not. The default value of this variable is `false`, in which case, the software does not use the encrypted width from the DSPF. When set to `true`, the software uses the encrypted width but does not report both the width and the minimum width.

## **useRecoveryFactor**

Specifies whether or not layer-wise recovery factor is to be used for calculating the average current density.

If the recovery factor is specified, then the average current density calculation is as follows:

$$iavg = \max(|iavgpos|, |iavgneg|) - recovery\_factor * \min(|iavgpos|, |iavgneg|)$$

If not specified, then

$$iavg = iavgpos + iavgneg$$

where `iavgpos` is the average current in the positive direction and `iavgneg` is the average current in the negative direction

## **viaCountFromResistance**

Specifies the number of vias when third-party DSPF with missing via count (\$N) is used for EM analysis. The default value of this variable is `false`.

---

## SKILL Functions

---

This section provides syntax, description, and examples for the Cadence® SKILL functions associated with the Voltus™-Fi Custom Power Integrity Solution (Voltus-Fi) flow.

Only the functions documented in this chapter are supported for public use. Any other functions, and undocumented aspects of the functions described below, are private and subject to change or removal at any time.

### vsaCreateMarker

```
vsaCreateMarker(
 x x_coordinate
 y y_coordinate
 message
)
=> t / nil
```

#### Description

Creates a point marker with the specified attributes. When this marker is created successfully, it appears in the *Misc* tab of Annotation Browser.

#### Arguments

|                |                                                   |
|----------------|---------------------------------------------------|
| <i>x</i>       | Specifies the x-axis coordinate for the marker.   |
| <i>y</i>       | Specifies the y-axis coordinate for the marker.   |
| <i>message</i> | Specifies the message associated with the marker. |

## Values Returned

|                  |                                                          |
|------------------|----------------------------------------------------------|
| <code>t</code>   | Marker was created at the specified coordinates.         |
| <code>nil</code> | Returns <code>nil</code> when the marker is not created. |

## Example

```
vsaCreateMarker(34.45 56.67 "Marker1")
=> t
```

The above example code shows how to create `Marker1` at the specified x-axis and y-axis coordinates.

## vsaOpenLayout

```
vsaOpenLayout(
 libname
 cellname
 viewname
)
```

## Description

Opens the design in Virtuoso for running Voltus-Fi-XL.

## Arguments

|                 |                                                             |
|-----------------|-------------------------------------------------------------|
| <i>libname</i>  | Specifies the library name for the design to be opened.     |
| <i>cellname</i> | Specifies the cell name for the design to be opened.        |
| <i>viewname</i> | Specifies the layout view name for the design to be opened. |

## Values Returned

None.

### Example

```
vsaOpenLayout("testlib" "testcell" "layout")
```

The above example code shows how to specify the library name, cell name, and layout view name of the design you want to open.

## vsaOpenLayoutForRead

```
vsaOpenLayoutForRead(
 libname
 cellname
 viewname
)
```

### Description

Opens the design in Virtuoso in the read-only mode.

### Arguments

|                 |                                                             |
|-----------------|-------------------------------------------------------------|
| <i>libname</i>  | Specifies the library name for the design to be opened.     |
| <i>cellname</i> | Specifies the cell name for the design to be opened.        |
| <i>viewname</i> | Specifies the layout view name for the design to be opened. |

### Values Returned

None.

### Example

```
vsaOpenLayoutForRead("testlib" "testcell" "layout")
```

The above example code shows how to specify the library name, cell name, and layout view name of the design you want to open in the read-only mode.

## **vsaLoadNets**

```
vsaLoadNets (
 netname
)
```

### **Description**

Specifies the nets to be loaded in the Voltus-Fi GUI.

### **Argument**

|                |                                                                                                                              |
|----------------|------------------------------------------------------------------------------------------------------------------------------|
| <i>netname</i> | Specifies the name of the net to be loaded in the Voltus-Fi GUI.<br>You can specify multiple net names separated by a space. |
|----------------|------------------------------------------------------------------------------------------------------------------------------|

### **Values Returned**

None.

### **Example**

```
vsaLoadNets ("VDD VSS")
```

The above example code shows how to specify the net names for the nets, `VDD` and `VSS`, that you want to load in the Voltus-Fi GUI.

## **vsaLoadSecondaryLayers**

```
vsaLoadSecondaryLayers ()
```

### **Description**

Enables the loading of data for all layers in the Voltus-Fi GUI.

### **Argument**

None.



## Values Returned

None.

## Example

```
vsaLoadSecondaryLayers()
```

The above example code shows how to enable the loading of data for all layers in the Voltus-Fi GUI.

## vsaSetLayersToMergeDuringResultsLoading

```
vsaSetLayersToMergeDuringResultsLoading(
 metal_layer
 cut_layer
)
```

## Description

Specifies the name of the metal layer and the corresponding cut-layer to be excluded from highlighting while plotting the EMIR analysis results. This function can be called multiple times to specify different pairs of metal and cut layers. Voltus-Fi honors all these calls. This function must be called before loading results in Voltus-Fi.

## Arguments

|                    |                                                                                                                |
|--------------------|----------------------------------------------------------------------------------------------------------------|
| <i>metal_layer</i> | Specifies the name of the metal layer for which the solid shapes are to be highlighted.                        |
| <i>cut_layer</i>   | Specifies the name of the corresponding cut-layer to be excluded from highlighting while plotting the results. |

## Values Returned

None.

## Examples

```
vsaSetLayersToMergeDuringResultsLoading("M1 CM1A")
vsaSetLayersToMergeDuringResultsLoading("PO CPO")
```

The above examples show how to specify the cut layers, CM1A and CPO for layers, M1 and PO, respectively.

## vsaSetInputType

```
vsaSetInputType(
 inputType
 resultsFile
 resultsType
 startTime
 stopTime)
)
```

### Description

Specifies the data base input options, parameter storage format (PSF) or vavo\_db, for running IR drop and EM analyses in the Voltus-Fi-L GUI. The *resultsType*, *startTime* and *stopTime* arguments are only valid for the psf-based flow.

### Arguments

|                    |                                                                                                                                                                                                                                                              |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>inputType</i>   | Specifies whether PSF or vavo_db is used for the EMIR analysis.                                                                                                                                                                                              |
| <i>resultsFile</i> | <p>For the psf-based flow, specifies the analysis name for DCOP (dcOp-dc) or transient (tran) analysis.</p> <p>For the vavo_db flow, specifies the name of the vavo_db simulation results file.</p>                                                          |
| <i>resultsType</i> | <p>For the psf-based flow, specifies the type of analysis, dc or tran.</p> <p>For the vavo_db- based flow, nil is specified.</p>                                                                                                                             |
| <i>startTime</i>   | <p>Specifies the analysis start time for the psf-based flow, for both DCOP and transient analysis types.</p> <p>For the vavo_db-based flow, 0 is specified.</p> <p><b>Note:</b> This argument must be specified along with the <i>stopTime</i> argument.</p> |

*stopTime* Specifies the stop time for analysis for the psf-based flow, for both DCOP and transient analysis types.

For the vavo\_db- based flow, 0 is specified.

**Note:** This argument must be specified along with the *startTime* argument.

## Values Returned

None.

## Examples

■ `vsaSetInputType("psf" "dcOp-dc" "dc" "0" "170")`

The above example code shows how to specify psf database, DCOP analysis type, dc analysis name, with a start time of 0s and stop time of 170s in the Voltus-Fi-L GUI.

■ `vsaSetInputType("vavodb" "tran_emir_vavo.db" "nil" "0" "0")`

The above example code shows how to specify vavodb as the vavo\_db database and tran\_emir\_vavo.db as the simulation results directory.

## vsaSetEMIRConfig

```
vsaSetEMIRConfig(
 config_filename
)
```

## Description

Loads the EMIR configuration file to be used for EMIR analysis in Voltus-Fi-XL. This file is specified before calling the `vsaLoadEM()` function.

## Argument

*config\_filename* Specifies the name of the EMIR configuration file to be loaded for EMIR analysis in Voltus-Fi-XL.

## Values Returned

None.

## Example

```
vsaSetEMIRConfig("abc/emir.conf.variables")
vsaLoadEM()
```

The above example code shows that the `emir.conf.variables` file will be loaded for EMIR analysis in Voltus-Fi-XL.

## vsaSetEMResultsFile

```
vsaSetEMResultsFile(
 binfilename
)
```

## Description

Specifies the simulation results file to be used for viewing the EMIR analysis results in Voltus-Fi-XL. This file contains the simulation database generated using the Spectre simulator.

## Argument

|                    |                                                                                                                                                              |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>binfilename</i> | Specifies the name of the simulation results file ( <code>emir_bin</code> ) to be used for loading and displaying the EMIR analysis results in Voltus-Fi-XL. |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Values Returned

None.

## Example

```
vsaSetEMResultsFile("xps.raw/xps.emirtap.emir0_bin")
```

The above example code shows that the name of the results file specified for loading and displaying EMIR analysis results in Voltus-Fi-XL is `xps.emirtap.emir0_bin`.

## **vsaSetEMLayerMapFileName**

```
vsaSetEMLayerMapFileName(
 layermapfile
)
```

### **Description**

Specifies the name of the layer map file to be used for the EM technology file. This file provides the mapping between layer names in the simulation database and those in the technology file. This function is only used for EM plots.

### **Argument**

|                     |                                                                                                                                                           |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>layermapfile</i> | Specifies the name of the layer map file. This file provides the mapping between layer names in the simulation database and those in the technology file. |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|

### **Values Returned**

None.

### **Example**

```
vsaSetEMLayerMapFileName("contactmapfile")
```

The above example code shows that the layer map filename is specified as `contactmapfile`.

## **vsaSetEMTechFileName**

```
vsaSetEMTechFileName(
 techfilename
)
```

### **Description**

Specifies the name of the EM technology file that contains the EM rule information to be used for plotting EM results in Voltus-Fi.

## Argument

|                     |                                                                                                                                                                                                                           |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>techfilename</i> | Specifies the name of technology file with EM rules to be used for viewing EM results in Voltus-Fi. You can specify <code>qrcTechFile</code> , <code>emDataFile</code> , or ICT file as input for performing EM analysis. |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Values Returned

None.

## Example

```
vsaSetEMTechFileName("qrcTechFile")
```

The above example code shows that the technology filename is specified as `qrcTechFile`.

## **vsaSetEMTypes**

```
vsaSetEMTypes(
 list (imax iavg irms iacpeak iavgabs)
)
```

## Description

Specifies the types of EM analyses for which you want to plot EM results in Voltus-Fi. At least one analysis type must be selected.

## Argument

```
list (imax iavg
irms iacpeak
iavgabs)
```

Specifies the types of EM analyses for which you want to plot EM results. The list can include the following types of analyses:

*imax*: calculates the current density violations based on maximum DC current

*iavg*: calculates the current density violations based on the average value of DC current

*irms*: calculates the current density violations based on the root mean square (RMS) value of AC current

*iacpeak*: calculates the current density violations based on peak AC current

*iavgabs*: calculates the current density violations based on the average value of absolute current

## Values Returned

None.

## Example

```
vsaSetEMTypes(list("imax" "iavg" "iavgabs"))
```

The above example code shows that *imax*, *iavg*, and *iavgabs* types of EM analyses are to be performed.

## vsaSetDfiiLayerMapFileName

```
vsaSetDfiiLayerMapFileName(
 df2layermapfile
)
```

## Description

Specifies the DFII layer map filename that provides the mapping between the extractor-generated xDSPF file layer names and the DFII layer names.

## Argument

|                        |                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <i>df2layermapfile</i> | Specifies the name of the DFII layer map file that provides the mapping between the xDSPF file layer names and the DFII layer names. |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------|

## Values Returned

None.

## Example

```
vsaSetDfiiLayerMapFileName("df2layermap")
```

The above example code shows that the name of the DFII layer map file is `df2layermap`.

# **vsaShowAllResistors**

```
vsaShowAllResistors()
```

## Description

When specified, displays all resistors on the Voltus-Fi GUI including those for which there are no layout shapes matching the specified resistor coordinates. These resistors are displayed using stick diagrams.

## Argument

None.

## Values Returned

None.

## Example

```
vsaSetDfiiLayerMapFileName("df2layermap")
vsaShowAllResistors()
vsaSetIRResultsFile("test/xps.617/xps.raw/xps.emirtap.emir0_bin")
```



```
vsaLoadIR();
```

The above example code shows how to view all resistors including those for which there is no layout shape matching the specified resistor coordinates on the Voltus-Fi GUI.

## **vsaSetQRCDData**

```
vsaSetQRCDData(
 rundir
 runname
)
```

### **Description**

Sets the Quantus inputs to enable solid shape highlighting for EMIR plots displayed on the Virtuoso layout.

### **Arguments**

|                |                                                    |
|----------------|----------------------------------------------------|
| <i>rundir</i>  | Specifies the Quantus run directory name.          |
| <i>runname</i> | Specifies the run name used while running Quantus. |

### **Values Returned**

None.

### **Example**

```
vsaSetQRCDData("./qrc_temp" "testrun")
```

The above example code shows that Quantus run directory, `qrc_temp` and run name, `testrun` will be used to enable solid shape highlighting.

## **vsaSelectFailedNets**

```
vsaSelectFailedNets()
```

### Description

Specifies that EM analysis results for only those nets that failed the EM check should be plotted. It enables the *Show Only Failed* option in the GUI.

### Arguments

None.

### Values Returned

None.

### Example

```
vsaSelectFailedNets ()
```

The above example code shows the EM analysis results for only those nets that fail the EM check will be plotted.

## **vsaSetEMOnlyICTFile**

```
vsaSetEMOnlyICTFile(
 filename
)
```

### Description

Specifies the name of the ICT file to be used for specifying the EM rules for plotting EM analysis results.

### Argument

|                 |                                     |
|-----------------|-------------------------------------|
| <i>filename</i> | Specifies the name of the ICT file. |
|-----------------|-------------------------------------|

### Values Returned

None.

## Example

```
vsaSetEMOnlyICTFile("./myICT.txt")
```

The above example code shows that `myICT.txt` file will be used for specifying the EM rules.

## vsaSetEMPlot

```
vsaSetEMPlot(
 plot_type
)
```

## Description

Specifies the default plot for EM analysis results in Voltus-Fi.

## Argument

*plot\_type*

Sets the default plot for EM analysis results. You can specify any one of the following plot types:

**RJ:** sets the default plot to DC current density analysis plot

**JAVG:** sets the default plot to average current density analysis plot

**JACPEAK:** sets the default plot to AC peak current density analysis plot

**JABSAVG:** sets the default plot to average absolute current density analysis plot

**JACRMS:** sets the default plot to RMS current density analysis plot

**TC:** sets the default plot to peak tap current density analysis plot

**RC:** sets the default plot to peak resistor current density analysis plot

## Values Returned

None.

## Example

```
vsaSetEMPlot("JAVG")
```

The above example code shows that the default plot for EM analysis results will be average current density analysis data (JAVG) plot.

## vsaLoadEM

```
vsaLoadEM()
```

## Description

Specifies that the EM analysis results should be loaded. Before specifying this function, ensure that the EM results file and the EM technology file are specified.

## Arguments

None.

## Values Returned

None.

## Example

```
vsaOpenLayout("testlib" "testcell" "layout")
vsaSetEMResultsFile("./xps.raw/xps.emirtap.emir0_bin")
vsaSetEMTechFileName("qrcTechFile")
vsaSetEMLayerMapFileName("contactmapfile")
vsaSetEMTypes(list("imax" "iavg" "irms" "iacpeak" "iavgabs"))
vsaSetDfiiLayerMapFileName("df2layermap")
vsaLoadEM()
```

The above example code shows the set of functions specified for loading the EM analysis results. The `vsaSetEMResultsFile` and the `vsaSetEMTechFileName` functions are required to be specified before specifying `vsaLoadEM`.

## vsaSetIRResultsFile

```
vsaSetIRResultsFile(
 binfilename
)
```

### Description

Specifies the results file to be used for viewing the EMIR analysis results in Voltus-Fi-XL.

### Argument

|                    |                                                                                                                                       |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <i>binfilename</i> | Specifies the name of the <code>emir_bin</code> file to be used for loading and displaying the EMIR analysis results in Voltus-Fi-XL. |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------|

### Values Returned

None.

### Example

```
vsaSetIRResultsFile("xps.raw/xps.emirtap.emir0_bin")
```

The above example code shows that the name of the results file to be used for loading and displaying EMIR analysis results in Voltus-Fi-XL is `xps.emirtap.emir0_bin`.

## vsaSetIRThreshold

```
vsaSetIRThreshold(
 threshold_value
)
=> nil
```

### Description

Sets the threshold value for viewing IR drop violations.

## Argument

|                        |                                                                                |
|------------------------|--------------------------------------------------------------------------------|
| <i>threshold_value</i> | Specifies the threshold value for viewing the IR drop violations in Voltus-Fi. |
|------------------------|--------------------------------------------------------------------------------|

## Value Returned

|            |                                                     |
|------------|-----------------------------------------------------|
| <i>nil</i> | Returns <i>nil</i> when the value is not specified. |
|------------|-----------------------------------------------------|

## Example

```
vsaSetIRThreshold(0.01)
```

The above example code sets the threshold value to 0.01 volts and all IR drop values below 0.01 volts are filtered while plotting the IR drop results.

## vsaSetIRPlot

```
vsaSetIRPlot(
 plot_type
)
```

## Description

Specifies the default plot for IR drop analysis results in Voltus-Fi.

## Argument

*plot\_type*

Sets the default plot for IR drop analysis results.  
Specify one of the following plot types:

IR: sets the default plot to peak IR drop analysis plot

IRAVG: sets the default plot to average IR drop analysis plot

RC: sets the default plot to peak current density violation plot

IV: sets the default plot to transistor-based supply voltage data plot

Reffective: sets the default plot to effective resistance analysis plot

PI: sets the default plot to that for currents across resistors when power gates are connected

PV: sets the default plot to that for IR drop across power-switch instances

## Values Returned

None.

## Example

```
vsaSetIRPlot("Reffective")
```

The above example code shows that the default plot for IR drop analysis will be `Reffective`.

## **vsaSetLRPShortedLayers**

```
vsaSetLRPShortedLayers(
 layer1, layer2, ...
)
```

## Description

Specifies the names of layers to be shorted for the least-resistive path (LRP) analysis.

## Argument

|                                        |                                                               |
|----------------------------------------|---------------------------------------------------------------|
| <code>(layer1,<br/>layer2,....)</code> | Specifies the names of layers to be shorted for LRP analysis. |
|----------------------------------------|---------------------------------------------------------------|

## Values Returned

None.

## Example

```
vsaSetLRPShortedLayers("M1, OD")
```

The above example code shows that layers, M1 and OD will be shorted for LRP analysis.

# **vsaLoadIR**

```
vsaLoadIR()
```

## Description

Specifies that the IR drop analysis results should be loaded. Before specifying this function, ensure that the IR drop results filename is specified.

## Arguments

None.

## Values Returned

None.

## Example

```
vsaOpenLayout("testlib" "testcell" "layout")
```



```
vsaSetIRResultsFile("./xps.raw/xps.emirtap.emir0_bin")
vsaSetDfiiLayerMapFileName("df2layermap")
vsaLoadIR()
```

The above example code shows the set of functions specified for loading the IR drop analysis results. The `vsaSetIRResultsFile` function is required to be specified before specifying `vsaLoadIR`.

## **vsaSetFinerDisplayOff**

```
vsaSetFinerDisplayOff()
```

### **Description**

Disables the finer gradient for the specified layers while displaying the IR/EM plots on the Virtuoso layout. This function is specified after specifying the DFII layermap file and before loading the IR drop or EM analysis results.

### **Arguments**

None.

### **Values Returned**

None.

### **Example**

```
vsaSetDfiiLayerMapFileName("df2layermap")
vsaSetFinerDisplayOff()
vsaSetIRResultsFile("test/xps.617/xps.raw/xps.emirtap.emir0_bin")
vsaSetIRThreshold(0.01)
vsaLoadIR()
```

The above example code shows how to specify the DFII layermap file, disable the finer gradient display and then load the IR drop analysis results.

## **vsaSetParallelLoading**

```
vsaSetParallelLoading()
```

### **Description**

Enables parallel loading of OpenAccess shapes in the Voltus-Fi application interface.

### **Arguments**

None

### **Values Returned**

None

### **Example**

```
vsaSetParallelLoading()
```

---

## File Formats

---

This section contains explanation of different files used in Voltus-Fi-XL.

### Activity File

A file that contains the activity factor on any node of the circuit. This file is used for average current analysis. In the GUI, you can specify the activity file in the *Advanced* tab of the *Setup and Run Current Analysis* form.

**Sample filename:** activity.txt

**Command:** run\_static\_simulation -activity\_file file\_name

#### Format Description:

The activity file has the following format:

|         |                        |                                                               |
|---------|------------------------|---------------------------------------------------------------|
| file    | :rows EOF              | //a file consists of rows of information                      |
| rows    | :<br> comment<br> line | //an empty line<br>//a comment line<br>//a specification line |
| comment | :^[\\t]*\\*.* EOL      | //a line starting with * is a comment                         |
| line    | :name FA_value         | //a node with transitional frequency                          |

- *Name* can be the name of any node in the circuit.
- *FA\_value* specifies the default nodal activity to be used. It is given as an activity factor. A value of 0.20 would be 20% of the default frequency.

**Example:** This is a sample fa\_file for node activities. The column on the left shows the node names and the column on the right shows the activity.

```
out01 2
out02 3
out03 4
```

## Clock File

A file that contains information about the clock nodes, subcircuit definitions, and subcircuit instance names and their frequencies. This file is used only for average static current analysis. In the GUI, you can specify the average power file in the *Advanced* tab of the *Setup and Run Current Analysis* form.

**Sample filename:** clk.txt

**Command:** run\_static\_simulation -clock\_file *clock\_file\_name*

### Format:

```
file: rows EOF //a file consists of rows
rows: ε //an empty line
 | comment //a comment
 | line //a specification line
comment:^[\\t]**\\.+EOL //a line starting with a *

line :CLK name freq_value //a clock node specification
 |INST name freq_value //a subcircuit instance specification
 |INST name freq_value activity //a subcircuit instance with activity
 |CELL name freq_value //a subcircuit definition specification
 |CELL name freq_value activity //a subcircuit definition with activity
```

### Format Description:

CLK, INST, and CELL are keywords.

- If you use the CLK keyword, the node name is treated as the root of a clock running at the given frequency.
- If you use the INST keyword, all input and output nodes—that is, node names on the instance card—are set to toggle at the specified frequency. .
- If you use the CELL keyword, all instances of the cell are processed instead of a single instance.

CLK has precedence over INST, and INST overrides CELL information to resolve redundant specifications.

**Example:** The following example specifies the CLK keyword in column 1, clock name in column 2, and the frequency value in column 3.

```
clk clk_internal 120M
```

## Value Change Dump File

A file that contains information about the number of transitions for each net. This file is used only for average static current analysis. In the GUI, you can specify the VCD file in the *Advanced* tab of the *Setup and Run Current Analysis* form.

**Sample filename:** `vcd.txt`

**Command:** `run_static_simulation -vcd vcd_file_name`

### VCD Values

Within the VCD file, these VCD values have the following meanings during driving:

- 0  
Forces the associated node to logic low.
- 1  
Forces the associated node to logic high.
- X  
Forces the associated node to logic unknown.
- Z  
Releases the associated node.

### VCD Command Extensions

The following extensions of the VCD format are supported. You can use these command extensions in the comment section of a VCD file to specify node characteristics.

Use these extensions to specify properties such as input voltages and rise and fall times of nodes listed in the VCD file.

- `*scope`  
Sets the scope of the `nodeset` command by using the `scope` command.  
`Scope_string` is prepended to the nodes listed in the `nodeset` command. The syntax is as follows:  
`*scope scope_string *end`
- `*nodeset`

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### File Formats

---

Groups nodes in the VCD file into node sets. You can then set properties of the nodes in the node set by using the `params` command on the node set. The syntax is as follows:

```
*nodeset set_number [node_name]+ *end
```

#### ■ \*params

Assigns parameters to sets of nodes by using the `params` command. The syntax is as follows:

```
*params set_number <vin0=voltage> <vin1=voltage> <vinx=voltage><tir=time>
<tif=time> *end
```

#### Example:

Following is a sample VCD file named `vcd`.

```
$date
 Thurs Mar 07 15:09:59 2013
$end
$version
 Cadence 1.0
$end
$timescale
 1ns
$end

$scope module TOP $end

$var wire 1 ! A[7] $end
$var wire 1 " A[6] $end
$var wire 1 # A[5] $end
$var wire 1 $ A[4] $end
$var wire 4 % A[3:0] $end
$upscope $end

$comment

*scope TOP *end
*nodeset 1 A[7:0] *end
*params 1 vin0=0v vin1=5v vinx=2.5v tir=1ns tif=1ns *end

$end

$enddefinitions $end
```

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### File Formats

---

```
#0
1!
1"
1#
1$
b1111 %
#50
0!
0"
0#
0$
b0000 %
#50
1$
b0001 %
#50
1#
0$
b0010 %
#50
1$
b0011 %
#50
1"
0#
0$
b0100 %
```

## Power File

A file that contains the average power for specific sub circuits. This file is used only for average static current analysis. In the GUI, you can specify the average power file in the *Advanced* tab of the *Setup and Run Current Analysis* form.

**Sample filename:** `power.txt`

**Command:** `run_static_simulation -power_file power_file_name`

## Format and Example

The average power file has the format shown in the following example:

```
CELL C_MUX2_TG 2.0e-4
Xxev | xeu | xem | wpy | sdh 1.0e-3
```

The **CELL** keyword specifies that the name following it is a subcircuit definition and that all instances of the cell dissipate the same average power. If the file does not contain the **CELL** keyword, the name is an instance of a subcircuit dissipating the specified average power.

## ICT File

The ICT file specifies the EM reliability rules for EM analysis. This is a text-based file, which means you can use any text editor to enter information in this file.

Following is a sample ICT file.

```
process "abcd" {
 background_dielectric_constant 1
 temp_reference 25
 em_tref 110
 em_output_wlt drawn
 em_variables w delta_T
 em_conductor_unit mA/um
 em_via_area_unit mA
 em_via_unit mA
 em_dc_rms_metal_line_num 3
 em_ac_rms_metal_line_num 3
 simulation {
 manual_simulation_points {
 metal_layer "mt1" {
 simulation_widths 0.3 0.6 1.5 3
 simulation_spacings 0.3 0.6 1.5 3
 }
 metal_layer "mt2" {
 simulation_widths 0.3 0.6 1.5 3
 simulation_spacings 0.3 0.6 1.5 3
 }
 }
 }
}
```



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## File Formats

---

```
 }
 manual_simulation_combinations {
 combination_layers "mt1" "mt2"
 separation_values 0 1 2 3
 }
}

conductor "mt1" {
 min_spacing 0.3
 min_width 0.3
 height 1.05
 thickness 0.53
 resistivity 0.1
 gate_forming_layer false
 thermal_conductivity 0.39
 em_model {
 em_jmax_dc_rms_metal_line_factor 1 1.5 2 1.5 3 1.32 4 1.32 5 1.05 6
 1.05 7 1.05 8 1.05 9 1
 em_jmax_ac_rms_metal_line_factor 1 1.5 2 1.5 3 1.32 4 1.32 5 1.05 6 1.05
 7 1.05 8 1.05 9 1
 em_jmax_dc_avg EQU w*1.0 jmax_factor 50 1.1 110 1.0 125 0.92 L > 5
 em_jmax_dc_avg EQU w*3.0 jmax_factor 50 1.1 110 1.0 125 0.92 L <= 5
 em_jmax_dc_peak EQU w*1.5 jmax_factor 50 1.1 110 1.0 125 0.92 L > 5
 em_jmax_dc_peak EQU w*3.5 jmax_factor 50 1.1 110 1.0 125 0.92 L <= 5
 em_jmax_dc_rms EQU 1.5 * sqrt(2*delta_T)
 em_jmax_ac_rms EQU 1.5 * sqrt(2*delta_T)
 }
}

conductor "mt2" {
 min_spacing 0.3
 min_width 0.3
 height 2.38
 thickness 0.53
```

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### File Formats

---

```
resistivity 0.1
gate_forming_layer false
thermal_conductivity 0.39
em_model {
 em_jmax_dc_rms_metal_line_factor 1 1.5 2 1.5 3 1.32 4 1.32 5 1.05 6
 1.05 7 1.05 8 1.05 9 1
 em_jmax_ac_rms_metal_line_factor 1 1.5 2 1.5 3 1.32 4 1.32 5 1.05 6 1.05
 7 1.05 8 1.05 9 1
 em_jmax_dc_avg EQU 2.0*w*1.0 jmax_factor 50 1.1 110 1.0 125 0.92
 L > 5
 em_jmax_dc_avg EQU 2.0*w*3.0 jmax_factor 50 1.1 110 1.0 125
 0.92 L <= 5
 em_jmax_dc_peak EQU 2.0*w*1.5 jmax_factor 50 1.1 110 1.0 125 0.92
 L > 5
 em_jmax_dc_peak EQU 2.0*w*3.5 jmax_factor 50 1.1 110 1.0 125 0.92
 L <= 5
 em_jmax_dc_rms EQU 1.5 * sqrt(2*delta_T)
 em_jmax_ac_rms EQU 1.5 * sqrt(2*delta_T)
}
}
via "Vial" {
 top_layer "mt2"
 bottom_layer "mt1"
 contact_resistance 1.1
 thermal_conductivity 0.39
 em_model {
 em_jmax_dc_rms_metal_line_factor 1 1.5 2 1.5 3 1.32 4 1.32 5 1.05 6
 1.05 7 1.05 8 1.05 9 1
 em_jmax_ac_rms_metal_line_factor 1 1.5 2 1.5 3 1.32 4 1.32 5 1.05 6 1.05
 7 1.05 8 1.05 9 1
 em_vcwidth 0.12
 em_jmax_dc_avg 1.0 jmax_factor 50 1.1 110 1.0 125 0.97
 em_jmax_dc_peak 1.5 jmax_factor 50 1.1 110 1.0 125 0.97
 em_jmax_dc_rms EQU 1.5 * sqrt(2*delta_T)
 em_jmax_ac_rms EQU 1.5 * sqrt(2*delta_T)
 }
}
```

```
}
```

## EM Only ICT File

The EM only ICT file provides the process and the EM model information for EM analysis. This is a text-based file, which means you can use any text editor to enter information in this file.

Following is a sample EM only ICT file.

```
process "gpd090" {
 background_dielectric_constant 1.000000
 temp_reference 25
 layout_scale 0.9
 #! use_silicon_density true
 em_tref 110
 em_output_wlt drawn
 em_variables w delta_T
 em_conductor_unit mA
 em_via_area_unit mA
 em_via_unit mA
 em_peak_with_duty_ratio explicit
}

conductor "mt1" {
 em_model {
 em_jmax_dc_avg EQU 100 * 1* (w - 0.008) jmax_factor 100 2.077 105 1.434 110
 1.000 115 0.704 120 0.500 125 0.358 L > 9 W < 0.45
 em_jmax_dc_avg EQU 150 * 1.227 * (w - 0.008) jmax_factor 100 2.077 105 1.434
 110 1.000 115 0.704 120 0.500 125 0.358 L <= 9 L > 4.5 W < 0.45
 em_jmax_dc_avg EQU 200 * 1.227 * (w - 0.008) jmax_factor 100 2.077 105 1.434
 110 1.000 115 0.704 120 0.500 125 0.358 L > 9 W >= 0.45
 em_jmax_dc_avg EQU 200 * 1.227 * (w - 0.008) jmax_factor 100 2.077 105 1.434
 110 1.000 115 0.704 120 0.500 125 0.358 L <= 9 L > 4.5 W >= 0.45
 em_jmax_dc_avg EQU 400 * 1.227 * (w - 0.008) jmax_factor 100 2.077 105 1.434
 110 1.000 115 0.704 120 0.500 125 0.358 L <= 4.5
```

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## File Formats

---

```
em_jmax_dc_peak EQU 25.0 * (w - 0.008)
em_jmax_ac_peak EQU 25.0 * (w - 0.008)

em_jmax_dc_rms EQU sqrt(18.58 * delta_T * (w - 0.008)^2 * (w - 0.008 +
0.246) / (w - 0.008 + 0.0443))

em_jmax_ac_rms EQU sqrt(18.58 * delta_T * (w - 0.008)^2 * (w - 0.008 +
0.246) / (w - 0.008 + 0.0443))

}

}
```

## EM Data File

An EM data input file specifies the technology information, such as current density limits, and provides a mapping between the layers for highlighting.

**Note:** The EM data file syntax is case-sensitive. The file must start with parenthesis.

Following is a sample EM data file.

```
(
; this file is case sensitive
routingLayers = ("Poly" "Metal1" "Metal2" "Metal3" "Metal4" "Metal5" "Metal6")
viaLayers = ("Cont" "Nimp" "Pimp" "Via1" "Via2" "Via3" "Via4" "Via5")
viaWidthList = (("Nimp" 0.2) ("Pimp" 0.2) ("Cont" 0.2) ("Via1" 0.2)
("Via2" 0.2) ("Via3" 0.2) ("Via4" 0.2) ("Via4" 0.2))
xrefLayers = (
("POLYcont" ("Cont" "Cont"))
("NSDcont" ("Nimp" "Nimp"))
("PSDcont" ("Pimp" "Pimp"))
("poly" ("Poly" "Poly"))
("mt1" ("Metal1" "Metal1"))
("mt2" ("Metal2" "Metal2"))
("mt3" ("Metal3" "Metal3"))
("mt4" ("Metal4" "Metal4"))
("mt5" ("Metal5" "Metal5"))
("mt6" ("Metal6" "Metal6"))
("Via2NoCapInd" ("Via2" "Via2"))
("Via2" ("Via2" "Via2"))
)
avgCurrentDensSpecList = (
(nil layer "Poly" minW 0.0 maxW -1.0 minL 0 maxL 5 currentDensity ((1.0 , 110)))
(nil layer "Metal1" minW 0.0 maxW -1.0 currentDensity ((1.1 , 110)))
)
```

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### File Formats

---

```
(nil layer "Metal2" minW 0.0 maxW -1.0 currentDensity ((1.2 , 110)))
(nil layer "Metal3" minW 0.0 maxW -1.0 currentDensity ((1.3 , 110)))
(nil layer "Metal4" minW 0.0 maxW -1.0 currentDensity ((1.4 , 110)))
(nil layer "Metal5" minW 0.0 maxW -1.0 currentDensity ((1.5 , 110)))
(nil layer "Metal6" minW 0.0 maxW -1.0 currentDensity ((1.6 , 110)))
(nil layer "Cont" minW 0.0 maxW -1.0 res 1.0 currentDensity ((2.0 , 110)))
(nil layer "Nimp" minW 0.0 maxW -1.0 res 1.1 currentDensity ((2.1 , 110)))
(nil layer "Pimp" minW 0.0 maxW -1.0 res 1.2 currentDensity ((2.2 , 110)))
(nil layer "Via1" minW 0.0 maxW -1.0 res 1.3 currentDensity ((2.3 , 110)))
(nil layer "Via2" minW 0.0 maxW -1.0 res 1.4 currentDensity ((2.4 , 110)))
(nil layer "Via3" minW 0.0 maxW -1.0 res 1.5 currentDensity ((2.5 , 110)))
(nil layer "Via4" minW 0.0 maxW -1.0 res 1.6 currentDensity ((2.6 , 110)))
(nil layer "Via5" minW 0.0 maxW -1.0 res 1.7 currentDensity ((2.7 , 110)))
)
peakCurrentDensSpecList = (
 (nil layer "Poly" minW 0.0 maxW -1.0 currentDensity ((1.1 , 110)))
 (nil layer "Metal1" minW 0.0 maxW -1.0 currentDensity ((1.2 , 110)))
 (nil layer "Metal2" minW 0.0 maxW -1.0 currentDensity ((1.3 , 110)))
 (nil layer "Metal3" minW 0.0 maxW -1.0 currentDensity ((1.4 , 110)))
 (nil layer "Metal4" minW 0.0 maxW -1.0 currentDensity ((1.5 , 110)))
 (nil layer "Metal5" minW 0.0 maxW -1.0 currentDensity ((1.6 , 110)))
 (nil layer "Metal6" minW 0.0 maxW -1.0 currentDensity ((1.7 , 110)))
 (nil layer "Cont" minW 0.0 maxW -1.0 res 1.0 currentDensity ((2.1 , 110)))
 (nil layer "Nimp" minW 0.0 maxW -1.0 res 1.1 currentDensity ((2.2 , 110)))
 (nil layer "Pimp" minW 0.0 maxW -1.0 res 1.2 currentDensity ((2.3 , 110)))
 (nil layer "Via1" minW 0.0 maxW -1.0 res 1.3 currentDensity ((2.4 , 110)))
 (nil layer "Via2" minW 0.0 maxW -1.0 res 1.4 currentDensity ((2.5 , 110)))
 (nil layer "Via3" minW 0.0 maxW -1.0 res 1.5 currentDensity ((2.6 , 110)))
 (nil layer "Via4" minW 0.0 maxW -1.0 res 1.6 currentDensity ((2.7 , 110)))
 (nil layer "Via5" minW 0.0 maxW -1.0 res 1.7 currentDensity ((2.8 , 110)))
)
```

## Layer Map File

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### File Formats

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The layer map file or map file provides the mapping between the layer names in the simulation database to those specified in the technology files (`qrcTechFile` and `ICT` file) for the EM analysis flow. It maps the layer names in the xDSPF file to the ICT layer names. It is needed under either of the following circumstances:

- When a 3rd party xDSPF file with different layer names is used, or
- When Quantus package uses the `layerSetupFile`, which includes the "model" keywords to define parasitic resistor model names. For example,

```
pro_layer=M1 ext_layer=MET1 model=metall
```

In this case, the "metall" to "M1" mapping needs to be specified in the layer map file.

The sample command for the above in the `.cdsinit` file will be specified as follows:

```
envSetVal("spectre.envOpts" "emLayerMap" 'string "/your-path/layermapfile")
```

**Sample filename:** `contactmapfile.txt`

#### Format:

```
RCX keyword simulation DB layertype ICT keyword technology file layertype
```

#### Format Description:

`RCX` specifies the keyword for the simulation database.

`simulation DB layertype` specifies the layer names in the simulation database that are to be mapped to the technology file layer names.

`ICT` specifies the keyword for the technology file.

`technology file layertype` specifies the layer names in the technology file that map to those in the simulation database.

#### Example:

```
<RCX keyword> <simulation DB layertype> <ICT keyword> <technology file layertype>
RCX metall ICT mt1
RCX metal2 ICT mt2
RCX metal3 ICT mt3
RCX metal4 ICT mt4
RCX pllco ICT poly
RCX VIA1 ICT via1
```

## DFII Layer Map File

The APS/XPS-to-DFII layer map file provides the mapping between the layer names in the extractor-generated xDSPF file to the DFII layer names.

Multiple extraction layers can be mapped to the same DFII layer. This layer map file is also used for performing structural analysis.

**Sample filename:** df2layermap.txt

### Format:

```
type extraction_layer_name dfII_layer_name
```

### Format Description:

`type` specifies the type of layer; for example, metal, via, or poly.

`extraction_layer_name` specifies the name of the layer in the extractor-generated xDSPF file that is to be mapped to the DFII layer.

`dfII_layer_name` specifies the name of the DFII layer to which the extractor-generated layer name is being mapped.

### Example:

```
#<type> <extraction_layer_name> <dfII_layer_name>
via via3 Via3
metal mt3 Metal3
via via2_out_capind Via2
metal mt2 Metal2
via via1 Via1
metal mt1 Metal1
via cont_ndiff Cont
via cont_pdiff Cont
```

**Note:** The order of layers in the layer map file is important. The layer map file must have layers listed in the top-to-bottom order.

### Support for User-Specified Purpose

By default, Voltus-Fi reads only the “drawing” purpose for the layers specified in the DFII layer map file. However, you can specify additional purpose names in the file for highlighting their shapes. For example,

```
metal m1 M1 e1 e2
```

Where e1 and e2 are additional purpose names whose shapes are to be highlighted.

## shParamFile

This file is the self-heating effect analysis parameter file, which is required for plotting the self-heating effect analysis plots.

**Sample filename:** param.sh

### Example:

```
self_heat_parameters {

 K_SH_Scale = 1.23

 beta_c1 = 0.0012
 beta_c2 = 0.0023
 beta_c3 = 0.0034

 device_layers {
 layer "OD" {
 Rth = 1000
 finger_effect = 2.0 * (1-exp(-0.3 * finger_num))
 fin_effect = 1.0 - (0.018 * (10 - fin_num))
 }
 layer "OD_2" {
 Rth = 500
 finger_effect = 2.0 * (1-exp(-0.4 * finger_num))
 fin_effect = 1.0 - (0.019 * (30 - fin_num))
 }
 }
 conductor_layers {
 layer "M1" {
 alpha_connecting = 0.50
 alpha_overlapping = 0.40
 }
 layer "M2" {
 alpha_connecting = 0.45
 alpha_overlapping = 0.35
 }
 }
}
```



```
}
```

## Trigger File

The file format of the trigger file is:

```
CELL <cellname1>
MODE_NAME <mode1>
CONDITIONAL_INPUT <conditional input statement for cellname1>
CONDITIONAL_PIN <pin_name> (rise| fall | both)
SIM_START_TIME <time>
SIM_STOP_TIME <time>
END_MODE
END
```

where,

"|" denotes boolean OR operation

The table below lists the contents of the trigger file and provides their descriptions.

| Trigger File Content                                          | Description                                                                                |
|---------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| <b>#Memory cell name</b>                                      |                                                                                            |
| CELL <cellname1>                                              | Name of the memory cell                                                                    |
| <b>#Mode and conditional details for trigger</b>              |                                                                                            |
| MODE_NAME <mode1>                                             | Mode name and conditional input statement for the cell.                                    |
| CONDITIONAL_INPUT <conditional input statement for cellname1> |                                                                                            |
| CONDITIONAL_PIN <pin_name> (rise   fall   both)               | Conditional pin statement for the cell. Signal pin for which the tool should rise or fall. |
| <b>#&lt;Other mode independent parameters&gt;</b>             |                                                                                            |

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## File Formats

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| Trigger File Content                          | Description                                                                                                                                                                                      |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SIM_START_TIME <time><br>SIM_STOP_TIME <time> | SIM_START_TIME: Specifies the simulation start time. The default unit is in nanoseconds (ns).<br><br>SIM_STOP_TIME: Specifies the simulation stop time. The default unit is in nanoseconds (ns). |
| <b>#End cell section</b><br>END_MODE          | End cell section                                                                                                                                                                                 |

### Example

```
CELL adc_sample
MODE_NAME READ

MODE READ
CONDITIONAL_INPUT = (WEN & !CEN)
CONDITIONAL_PIN CLK { RISE }
SIM_START_TIME 35ns
SIM_END_TIME 50ns
END_MODE

MODE WRITE
CONDITIONAL_INPUT = (!WEN & !CEN)
CONDITIONAL_PIN CLK { RISE }
SIM_START_TIME 15ns
SIM_END_TIME 30ns
END_MODE

MODE STBY
CONDITIONAL_INPUT = (CEN)
CONDITIONAL_PIN CLK { RISE }
SIM_START_TIME 80ns
SIM_END_TIME 120ns
END_MODE

END
```

where,

" ! " denotes low state of the signal

"&" denotes boolean AND operation

## LEF layer Map File

A layer mapping file is required for the Rail Analysis library generation flow. The LEF layer map file contains the mapping information to map the layer names in the LEF file to the layer names in the technology file.

In the GUI, you can specify this file in the *Create Power Grid Views* form.

**Sample filename:** lefdef.layermap

**Command:** create\_pgv -lef\_layer\_map *lef\_layer\_map\_file\_name*

**Format:**

```
type technology_layer_name lefdef lef_layer_name
```

**Format Description:**

`type` specifies the type of library layer, for example, metal or via.

`technology_layer_name` specifies the name of the library layer to map to the LEF layer.

`lefdef` specifies the keyword for the LEF layer mapping.

`lef_layer_name` specifies the name of the LEF layer to map to the library layer.

**Example:**

|                    |                                    |                     |                   |
|--------------------|------------------------------------|---------------------|-------------------|
| <code>type</code>  | <code>technology_layer_name</code> | <code>lefdef</code> | <code>M1</code>   |
| <code>metal</code> | <code>METAL_1</code>               | <code>lefdef</code> | <code>M1</code>   |
| <code>via</code>   | <code>VIA_1</code>                 | <code>lefdef</code> | <code>VIA1</code> |
| <code>metal</code> | <code>METAL_2</code>               | <code>lefdef</code> | <code>M2</code>   |
| <code>via</code>   | <code>VIA_2</code>                 | <code>lefdef</code> | <code>VIA2</code> |

where "type" can be poly/via/metal/diff.

## PGDB layer Map File

A layer mapping file is required for the Rail Analysis library generation flow. The PGDB layer map file contains the mapping information to map the xDSPF layer names that are written in the simulation database to the layer names in the technology file.

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### File Formats

---

In the GUI, you can specify this file in the *Create Power Grid Views* form.

**Sample filename:** pgdb.map

**Command:** create\_pgv pgdb\_layer\_map pgdb\_layermap\_file\_name

#### Format:

```
type technology_layer_name pgdb xDSPF_layer_name
```

#### Format Description:

`type` specifies the type of library layer. It can be poly/via/metal/diff.

`technology_layer_name` specifies the name of the library layer to map to the xDSPF layer name.

`pgdb` specifies the keyword for the xDSPF layer mapping.

`xDSPF_layer_name` specifies the xDSPF layer name.

#### Example:

| type   | technology_layer_name | pgdb | pgdb_layer_name |
|--------|-----------------------|------|-----------------|
| # ---- | -----                 | ---- | -----           |
| poly   | POLYCID               | pgdb | poly            |
| via    | CONT                  | pgdb | pllco           |
| via    | CONT                  | pgdb | odCont1         |
| via    | CONT                  | pgdb | odCont2         |
| metal  | METAL_1               | pgdb | metal1          |
| via    | VIA_1                 | pgdb | VIA1            |
| metal  | METAL_2               | pgdb | metal2          |
| via    | VIA_2                 | pgdb | VIA2            |
| diff   | OD                    | pgdb | nwires          |
| diff   | OD                    | pgdb | mwires          |

#### Note:

- It is recommended to map the S/D diffusion layer to the original layer name instead of `mwires` in the PGDB layer map file.
- When generating PGVs from Voltus-Fi, some of the layers are not required for analysis, but must be preserved to maintain connectivity. Voltus-Fi supports mapping of these layers to a special layer "connectivity" in the layer map file. An example is shown below.

#### Example:

| type | technology_layer_name | pgdb | xDSPF_layer_name |
|------|-----------------------|------|------------------|
| diff | connectivity          | pgdb | nwires           |
| diff | connectivity          | pgdb | mwires           |

## Common Command Language File

The common command language (CCL) file or the Quantus command file is used to specify the various commands and options that define the extraction run. This command file defines the various input files and libraries that make up the design, the output format, and the desired parasitics to extract from the design. The format and example of a CCL file generated in Voltus-Fi XL is provided below.

### Format:

Lines in the CCL file are in the following general Tcl format:

```
command {argument_list}
```

where *argument\_list* is a list of name-value pairs.

For more information about the Quantus command file or CCL format, see the “Quantus Command Files” chapter in the *Quantus Extraction Users Manual*.

### Example:

An example of the Voltus-Fi-generated CCL file is below. The customized extract command file, `myextract.txt`, is also shown below:

The `myextract.txt` is as follows:

```
extract \
 -selection "all" \
 -type "rc_coupled"
```

The Voltus-Fi-generated CCL file used to extract xDSPF is as follows:

```
extract \
 -selection "all" \
 -type "rc_decoupled"

extraction_setup \
 -analysis "em" \
 -array_vias_spacing "0.35" \
 -max_fracture_length infinite \
 -max_fracture_length_unit "MICRONS" \
 -max_fracture_via_count 1 \
 -max_via_array_count_by_layer "Via1 1" "Via2 1" "Via3 1" "Via4 1" "Via5 4"
 "Via6 4" "Via7 4" "Via8 4" "Via9 4" "Via10 4" "Via11 4" \
 -net_name_space "SCHEMATIC"

hierarchical_extract \
 -split_feedthrough_pins "true"
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### File Formats

---

```
filter_res \
 -min_res 0.001 \
 -remove_dangling_res false

filter_cap \
 -exclude_floating_nets "true" \
 -exclude_floating_nets_limit 50000

output_db \
 -type dspf \
 -subtype extended \
 -add_explicit_vias true \
 -busbit_delimiter "[\]" \
 -disable_instances false \
 -hierarchy_delimiter "/" \
 -include_cap_model "false" \
 -include_res_model "false" \
 -include_parasitic_cap_model "false" \
 -include_parasitic_res_model "comment" \
 -include_parasitic_res_length "true" \
 -include_parasitic_res_width false \
 -include_parasitic_res_width_drawn true \
 -output_xy \
 "CANONICAL_RES" \
 "PARASITIC_RES" \
 "GENERIC" \
 -netlist_coupling_values "single" \
 -add_bulk_terminal false \
 -sub_node_char "#" \
 -device_finger_delimiter "@" \
 -include_parasitic_res_temp_coeff "true" \
 -reduce_i_cards "true"

output_setup \
 -directory_name "vfi_quantus101" \
 -file_name "vfi_quantus101/testrun.dspf" \
 -net_name_space "SCHEMATIC" \
 -temporary_directory_name "vfi_temp" \
 -compressed false

process_technology \
 -technology_library_file "tech.lib" \
 -technology_name "tech" \
 -temperature 25.000000

input_db \
 -type pegasus \
 -directory_name "testdir" \
 -hierarchy_delimiter "/" \
 -run_name "testrun"
```

## Voltus-Fi Form Descriptions

- [Create Power Grid Views Form](#)
- [Hierarchical Top Simulation Form](#)
- [Extract xDSPF Form](#)

### Create Power Grid Views Form

| Field                                      | Description                                                                                                                                                                                              |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>LEF Files and Layermap Files</i></b> |                                                                                                                                                                                                          |
| <i>OA Libs</i>                             | Displays the name of the OA database library.                                                                                                                                                            |
| <i>Macro Name</i>                          | Displays the name of the top cell.                                                                                                                                                                       |
| <i>Library Name</i>                        | Displays the name of the library.<br><br>This option is used to create a library with a name different than that of the macro. By default, a library is created with the same name as that of the macro. |
| <i>Extraction Tech File</i>                | Displays the name of the technology file that will be used for reading the technology data.                                                                                                              |
| <i>Tech Lef File</i>                       | Displays the name of the file that includes the LEF information for the technology data.                                                                                                                 |
| <i>Macro Lef File</i>                      | Displays the name of the file that includes the LEF information for the design.                                                                                                                          |
| <i>Lef Def Layer Map File</i>              | Displays the name of the file that provides the mapping between LEF layer names and technology layer names.                                                                                              |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>PGDB Layer Map File</i>  | <p>Displays the name of the file that provides the mapping between xDSPF layer names (which are written in the simulation database) and the technology layer names.</p> <p>If an xDSPF layer name is missing in this file, the PGVs will not contain data for that layer.</p>                                                                                                                                                                                                                                                                                                            |
| <i>Simulation Directory</i> | <p>Provides the path to the directory that contains the current (*.ptiavg) files.</p> <p>PGV generation fails if this directory does not contain the current files for all the nets for which the PGVs are being generated.</p>                                                                                                                                                                                                                                                                                                                                                          |
| <i>Simulation Prefix</i>    | <p>Indicates the prefix used for creating an instance while performing the simulation. This input is optional.</p> <p>The prefix is specified along with the hierarchy separator.</p> <p>For example, you can specify "XO." or "IO.". In these examples, "XO" or "IO" are prefixes and "." is the hierarchy separator. You can check the prefix used during simulation in your simulator input file.</p>                                                                                                                                                                                 |
| <i>UTI Ron File</i>         | <p>Specifies the Spectre-generated file that contains multiple on-resistance (Ron) values, that is minimum, maximum, and average, for powergates. A sample file is shown below:</p> <pre> D-Term-Net   S-Term-Net   Ron_avg (Ohm) Ron_max (Ohm) Ron_min (Ohm) Power-Gate outp        VDD          1268.34       1302.38       1 230.52      MPM3 outp        VDD          1268.03       1302.06       1 230.2       MPM3@39 outp        VDD          1268          1302.04       1 230.18      MPM3@40 outp        VDD          1268.03       1302.07       1 230.21      MPM3@41 </pre> |
| <i>Trigger File</i>         | Specifies the file used during dynamic current simulation to run a detailed analysis for determining current distribution.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <i>Net Name</i>             | Lets you specify a net.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <i>Voltage</i>              | Lets you specify a voltage value for the net.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>State Directory / Results File</i> | Provides the path to the directory that contains the simulation result file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>Add</i>                            | Adds the net, the corresponding voltage, and the EMIR Results DB file location to the list.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <i>Remove</i>                         | Removes a net from the list.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Output</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <i>Results Directory</i>              | <p>Specifies the output directory in which the PGVs will be saved.</p> <p>By default, the PGVs are stored in the work directory. When you specify the directory in which you want to save the PGV generation results, the software gives a warning if there are any issues with the specified directory. For example, if you provide a file path instead of a directory path or a directory path that is read-only, the software gives a warning.</p> <p>The <i>Results Directory</i> field lets you save different outputs without overwriting the existing ones. However, if the output is stored in the default directory, then the new output file created while generating the power-grid views in the current run overwrites the existing one.</p> |
| <i>Ok</i>                             | Generates the PGVs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Cancel</i>                         | Closes the form without executing the command.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <i>Default</i>                        | Displays all the default values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <i>Save</i>                           | Saves the configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <i>Load</i>                           | Loads the configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <i>Help</i>                           | Opens help information in Cadence Help.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## IR/EM Results Form - IR Tab

| Field          | Description |
|----------------|-------------|
| <b>Results</b> |             |

**Voltus-Fi Custom Power Integrity Solution XL User Guide**  
Voltus-Fi Form Descriptions

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| Field                               | Description                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>State Directory/Results File</i> | Specifies the file or directory that stores the results of the simulation. The naming convention of the result file is *.emir#_bin.                                                                                                                                                                                                                                                                            |
| <i>Shrink factor</i>                | Specifies the factor value by which the xDSPF was shrunk. This is used for flows where the xDSPF is generated with a shrunk technology but the layout remains on the original technology. For example, if the original xDSPF was shrunk by 80%, the shrink factor should be specified as 0.8. The shrink factor value is less than 1.                                                                          |
| <i>Customize Display</i>            | <p>Select the nets for which you want to view the display. The Customize Display pop-up window opens. This helps save time as results are loaded only for the selected nets and not for all nets. You can also specify the IR Threshold value in this window.</p> <p>The <i>Customize Display</i> button is enabled only before the results are loaded. It is disabled once the results are loaded.</p>        |
| <i>QRC Run</i>                      | <p>Specifies that the plots displayed in the layout will be based on the shape database generated by Quantus.</p> <p>When you switch between the IR and EM tabs, the status of the <i>QRC Run</i> radio button is maintained. This means that the Quantus run selections, run directory, and run name fields, made on one tab remain populated for the other tab even after clearing the analysis results.</p> |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>DFII Layermap</i>   | <p>Specifies the APS/XPS-to-DFII layer map file. You can create a new layer map file or edit an existing file, using the edit button provided next to the field. This layer map file is the same file that is used in structural analysis.</p> <p>You can also specify this file by using the <code>vfiDfiiLayerMapFile</code> environment variable in either the <code>.cdsenv</code> or the <code>.cdsinit</code> file.</p> <p>The following considerations apply to the DFII layer map flow:</p> <ul style="list-style-type: none"> <li>■ When the DFII layer map file is specified, the visibility of the DFII layers in the layout is in sync with the layers selected in the <i>Layers</i> group box or the layer selection window of the Display form.</li> <li>■ When the correct mapping in the DFII layer map file is either not specified or if some layers are missing in this file then the resistors or nodes of those layers will not be highlighted in the layout because there will be no shapes attached to them.</li> <li>■ When this file is not specified, the plots are displayed using stick diagrams.</li> </ul> |
| <i>Finer Gradient</i>  | Displays finer gradient for the selected DFII layers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <i>Load Results</i>    | Loads the results.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Clear Results</i>   | Clears the results.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Power-up Report</i> | Displays additional information about power gates. This feature is used only in power-gated designs. If this report is not available, the software displays the <i>Input not available</i> pop-up window.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Net Plot</b>        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Rail Analysis</i> | <p>Specifies the type of IR plot. The following options are available:</p> <ul style="list-style-type: none"><li>■ <b>IR – IR Drop:</b> analyzes and reports voltage drop</li><li>■ <b>IRAVG – IR Avg Drop:</b> analyzes and reports average voltage drop</li><li>■ <b>RC – Resistor Current:</b> analyzes and reports peak resistor currents</li><li>■ <b>IV – Transistor Voltage:</b> analyzes and reports the voltage drop at device nodes, also known as tap nodes</li><li>■ <b>TCRMS – RMS Tap Current:</b> analyzes and reports RMS tap currents</li><li>■ <b>TCAVG – Average Tap Current:</b> analyzes and reports average tap currents</li><li>■ <b>TC – Peak Tap Current:</b> analyzes and reports peak tap currents</li><li>■ <b>POWER – Resistor Power:</b> analyzes and reports resistor power, which is the value of current through a resistor multiplied by the voltage across the resistor</li><li>■ <b>PI – Powergate current:</b> analyzes and displays the currents through the resistors when power gates are connected</li><li>■ <b>PV – Powergate voltage:</b> analyzes and displays the IR drop across power-switch instances. This plot can be used to analyze and debug regions of high IR drop inside the power-gated block of the design</li><li>■ <b>RCAVG – Average Resistor Current:</b> analyzes and reports average resistor currents</li><li>■ <b>RCRMS – RMS Resistor Current:</b> analyzes and reports RMS resistor currents</li><li>■ <b>REffective – Effective Resistance:</b> analyzes and displays the pin to node resistances</li></ul> |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Power Nets</i>          | Lists all power nets in the list box.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>Signal Nets</i>         | Lists all signal nets in the list box.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>All Nets</i>            | Lists all power and signal nets in the list box.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>Select All Nets</i>     | <p>Selects all the nets listed in the table. For example, if you select <i>Power Nets</i> and click <i>Select All Nets</i>, all power nets listed in the table are selected. The list box lists <i>Net Type</i> and the corresponding <i>Net Name</i>.</p> <p>You can search for specific nets for which you want to plot results by typing the net name in the text field provided in the form. The list box is updated to display information about the specified net. The net name is case-sensitive.</p> |
| <i>Show Plot</i>           | Displays the plot on the Virtuoso layout. When you click <i>Show Plot</i> , the IR/EM Results form expands to show the available plot display options. You can use these options to customize the displayed plots.                                                                                                                                                                                                                                                                                           |
| <i>Clear Plot</i>          | Clears the plot for the selected net from the Virtuoso layout. For this, select the net for which you want to clear the plot in the list box and then click <i>Clear Plot</i> .                                                                                                                                                                                                                                                                                                                              |
| <i>IR threshold</i>        | <p>Specifies the threshold value above which IR drop violations should be displayed. Select V or mV to specify the threshold voltage in volt and millivolt, respectively.</p> <p>When this value is specified, the Min - Max slider range is updated to reflect the specified minimum violation value and the plot is updated in the layout.</p>                                                                                                                                                             |
| <i>Plot Powergate Nets</i> | Plots the IR drop analysis results of power-gated designs. In this case, when you click the <i>Select Nets</i> option and select a net from the list box, all the switched nets for the selected always-ON net also get selected. The software plots results for all the switched nets together. This option is turned off by default.                                                                                                                                                                       |
| <i>Cancel</i>              | Closes the form without executing the command.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Load</i> | <p>Loads the settings from a previous run in the IR/EM Results form automatically. For this, you can save the settings in a <code>.vpsconfig</code> file. When you click <i>Load</i>, the software searches for the <code>.vpsconfig</code> file. If the file is available, the settings specified in this file are restored in the form.</p> <p>A sample <code>.vpsconfig</code> file is shown below.</p> <pre>setvar vps_results_IR {/icd/epsrd_tlnb_002/babita/xps/demo/design/raw.078/xps.emirtap.emir0_bin} setvar vps_results_EM {/icd/epsrd_tlnb_002/babita/xps/demo/design/raw.078/xps.emirtap.emir0_bin} setvar vps_results_IR_Flow {mmsim} setvar vps_results_IR_shrink_factor {} setvar vps_results_EM_shrink_factor {} setvar vps_results_EM_tech_file {/icd/epsrd_tlnb_002/babita/xps/demo/qrcTechFile} setvar vps_results_EM_layermap_file {/icd/epsrd_tlnb_002/babita/xps/demo/contactmapfile} setvar vps_results_EM_peak_dc true setvar vps_results_EM_avg_dc true setvar vps_results_EM_abs_avg_dc false setvar vps_results_EM_peak_ac false setvar vps_results_EM_rms_ac false</pre> <p>You can also load the EMIR control file or <code>emir.config</code> file using this button. When this file is specified, the technology file and layer map file information provided in this file is used for EMIR analysis.</p> |
| <i>Save</i> | Saves the specified settings in a configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Help</i> | Opens help information in Cadence Help.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## IR/EM Results Form - EM Tab

| Field                               | Description                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Results</b>                      |                                                                                                                                                                                                                                                                                                                                                                                                                |
| <i>Shrink factor</i>                | Specifies the factor value by which the xDSPF was shrunk. This is used for flows where the xDSPF is generated with a shrunk technology but the layout remains on the original technology. For example, if the original xDSPF was shrunk by 80%, the shrink factor should be specified as 0.8. The shrink factor value is less than 1.                                                                          |
| <i>Customize Display</i>            | <p>Select the nets for which you want to view the display. The Customize Display pop-up window opens. This helps save time as results are loaded only for the selected nets and not for all nets. You can also specify the IR Threshold value in this window.</p> <p>The <i>Customize Display</i> button is enabled only before the results are loaded. It is disabled once the results are loaded.</p>        |
| <i>State Directory/Results File</i> | Specifies the file or directory that stores the results of the simulation. The naming convention of the result file is *.emir#_bin.                                                                                                                                                                                                                                                                            |
| <i>QRC Run</i>                      | <p>Specifies that the plots displayed in the layout will be based on the shape database generated by Quantus.</p> <p>When you switch between the IR and EM tabs, the status of the <i>QRC Run</i> radio button is maintained. This means that the Quantus run selections, run directory, and run name fields, made on one tab remain populated for the other tab even after clearing the analysis results.</p> |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>DFII Layermap</i>   | <p>Specifies the APS/XPS-to-DFII layer map file. You can create a new layer map file or edit an existing file, using the edit button provided next to the field. This layer map file is the same file that is used in structural analysis.</p> <p>You can also specify this file by using the <code>vfiDfiiLayerMapFile</code> environment variable in either the <code>.cdsenv</code> or the <code>.cdsinit</code> file.</p> <p>The following considerations apply to the DFII layer map flow:</p> <ul style="list-style-type: none"> <li>■ When the DFII layer map file is specified, the visibility of the DFII layers in the layout is in sync with the layers selected in the <i>Layers</i> group box or the layer selection window of the Display form.</li> <li>■ When the correct mapping in the DFII layer map file is either not specified or if some layers are missing in this file then the resistors or nodes of those layers will not be highlighted in the layout because there will be no shapes attached to them.</li> <li>■ When this file is not specified, the plots are displayed using stick diagrams.</li> </ul> |
| <i>Finer Gradient</i>  | Displays finer gradient for the selected DFII layers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <i>Load Results</i>    | Loads the results.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Clear Results</i>   | Clears the results.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Power-up Report</i> | Displays additional information about power gates. This feature is used only in power-gated designs. If this report is not available, the software displays the <i>Input not available</i> pop-up window.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Net Plot</b>        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Rail Analysis</i> | <p>Specifies the type of IR plot. The following options are available:</p> <ul style="list-style-type: none"><li>■ <b>IR – IR Drop:</b> analyzes and reports voltage drop</li><li>■ <b>IRAVG – IR Avg Drop:</b> analyzes and reports average voltage drop</li><li>■ <b>RC – Resistor Current:</b> analyzes and reports peak resistor currents</li><li>■ <b>IV – Transistor Voltage:</b> analyzes and reports the voltage drop at device nodes, also known as tap nodes</li><li>■ <b>TCRMS – RMS Tap Current:</b> analyzes and reports RMS tap currents</li><li>■ <b>TCAVG – Average Tap Current:</b> analyzes and reports average tap currents</li><li>■ <b>TC – Peak Tap Current:</b> analyzes and reports peak tap currents</li><li>■ <b>POWER – Resistor Power:</b> analyzes and reports resistor power, which is the value of current through a resistor multiplied by the voltage across the resistor</li><li>■ <b>PI – Powergate current:</b> analyzes and displays the currents through the resistors when power gates are connected</li><li>■ <b>PV – Powergate voltage:</b> analyzes and displays the IR drop across power-switch instances. This plot can be used to analyze and debug regions of high IR drop inside the power-gated block of the design</li><li>■ <b>RCAVG – Average Resistor Current:</b> analyzes and reports average resistor currents</li><li>■ <b>RCRMS – RMS Resistor Current:</b> analyzes and reports RMS resistor currents</li><li>■ <b>REffective – Effective Resistance:</b> analyzes and displays the pin to node resistances</li></ul> |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Power Nets</i>          | Lists all power nets in the list box.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>Signal Nets</i>         | Lists all signal nets in the list box.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>All Nets</i>            | Lists all power and signal nets in the list box.                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>Select All Nets</i>     | <p>Selects all the nets listed in the table. For example, if you select <i>Power Nets</i> and click <i>Select All Nets</i>, all power nets listed in the table are selected. The list box lists <i>Net Type</i> and the corresponding <i>Net Name</i>.</p> <p>You can search for specific nets for which you want to plot results by typing the net name in the text field provided in the form. The list box is updated to display information about the specified net. The net name is case-sensitive.</p> |
| <i>Show Plot</i>           | Displays the plot on the Virtuoso layout. When you click <i>Show Plot</i> , the IR/EM Results form expands to show the available plot display options. You can use these options to customize the displayed plots.                                                                                                                                                                                                                                                                                           |
| <i>Clear Plot</i>          | Clears the plot for the selected net from the Virtuoso layout. For this, select the net for which you want to clear the plot in the list box and then click <i>Clear Plot</i> .                                                                                                                                                                                                                                                                                                                              |
| <i>IR threshold</i>        | <p>Specifies the threshold value above which IR drop violations should be displayed. Select V or mV to specify the threshold voltage in volt and millivolt, respectively.</p> <p>When this value is specified, the Min - Max slider range is updated to reflect the specified minimum violation value and the plot is updated in the layout.</p>                                                                                                                                                             |
| <i>Plot Powergate Nets</i> | Plots the IR drop analysis results of power-gated designs. In this case, when you click the <i>Select Nets</i> option and select a net from the list box, all the switched nets for the selected always-ON net also get selected. The software plots results for all the switched nets together. This option is turned off by default.                                                                                                                                                                       |
| <i>Cancel</i>              | Closes the form without executing the command.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Load</i> | <p>Loads the settings from a previous run in the IR/EM Results form automatically. For this, you can save the settings in a <code>.vpsconfig</code> file. When you click <i>Load</i>, the software searches for the <code>.vpsconfig</code> file. If the file is available, the settings specified in this file are restored in the form.</p> <p>A sample <code>.vpsconfig</code> file is shown below.</p> <pre>setvar vps_results_IR {/icd/epsrd_tlnb_002/babita/xps/demo/design/raw.078/xps.emirtap.emir0_bin} setvar vps_results_EM {/icd/epsrd_tlnb_002/babita/xps/demo/design/raw.078/xps.emirtap.emir0_bin} setvar vps_results_IR_Flow {mmsim} setvar vps_results_IR_shrink_factor {} setvar vps_results_EM_shrink_factor {} setvar vps_results_EM_tech_file {/icd/epsrd_tlnb_002/babita/xps/demo/qrcTechFile} setvar vps_results_EM_layermap_file {/icd/epsrd_tlnb_002/babita/xps/demo/contactmapfile} setvar vps_results_EM_peak_dc true setvar vps_results_EM_avg_dc true setvar vps_results_EM_abs_avg_dc false setvar vps_results_EM_peak_ac false setvar vps_results_EM_rms_ac false</pre> <p>You can also load the EMIR control file or <code>emir.config</code> file using this button. When this file is specified, the technology file and layer map file information provided in this file is used for EMIR analysis.</p> |
| <i>Save</i> | Saves the specified settings in a configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Help</i> | Opens help information in Cadence Help.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## Setup and Run Current Analysis Form

| Field                         | Description                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic Tab</b>              |                                                                                                                                                                                                                                                                                                                                                      |
| <i>Analysis Type</i>          | Specifies the type of analysis. The following options are available: <ul style="list-style-type: none"><li>■ <i>Peak</i></li><li>■ <i>Average</i></li></ul>                                                                                                                                                                                          |
| <i>Top Cell Name</i>          | Specifies the name of the top cell. This field is populated by default from the layout.                                                                                                                                                                                                                                                              |
| <i>Net Names</i>              | Specifies the net names for which you want to calculate the peak current.                                                                                                                                                                                                                                                                            |
| <i>Spice Netlist</i>          | Specifies the DSPF file.                                                                                                                                                                                                                                                                                                                             |
| <i>Power Pins</i>             | Specifies the power pins for which current analysis is to be performed.                                                                                                                                                                                                                                                                              |
| <i>Voltages</i>               | Specifies the corresponding voltages for the power pins.                                                                                                                                                                                                                                                                                             |
| <i>Gnd Pins</i>               | Specifies the ground pins for which current analysis is to be performed.                                                                                                                                                                                                                                                                             |
| <i>Spice Models</i>           | Specifies the SPICE model file.                                                                                                                                                                                                                                                                                                                      |
| <i>Spice Corners</i>          | Specifies the SPICE corners to be used from the SPICE model file.                                                                                                                                                                                                                                                                                    |
| <i>Output Directory</i>       | Specifies the output directory in which all the current data will be saved. By default, for every static current analysis run, the tool will save the results in the directory with the naming convention, “vps_simulation_#”, where the number is increased incrementally for each run. For example, vps_simulation_1, vps_simulation_2, and so on. |
| <b>Advanced Tab</b>           |                                                                                                                                                                                                                                                                                                                                                      |
| <i>Hierarchical Separator</i> | Specifies the hierarchical separator. This is required only if the netlist used is hierarchical.                                                                                                                                                                                                                                                     |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

| Field                          | Description                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Simulation Temperature</i>  | Specifies the temperature, in degree Celsius, at which to perform the simulation. By default, the simulation is performed at 25 degree Celsius.                                                                                                                                                                                                         |
| <i>Cmd Include File</i>        | Specifies the file containing additional user commands that are passed to Thunder during static current analysis.                                                                                                                                                                                                                                       |
| <i>Frequency</i>               | Specifies the dominant frequency of the design..                                                                                                                                                                                                                                                                                                        |
| <i>Clock File</i>              | Specifies the file that contains information about the clock nodes, subcircuit definitions, and subcircuit instance names and their frequencies.                                                                                                                                                                                                        |
| <i>VCD File</i>                | Specifies the file that contains information about the number of transitions for each net..                                                                                                                                                                                                                                                             |
| <i>Global Activity</i>         | Specifies the average number of times all the unset nodes switch in a clock cycle.                                                                                                                                                                                                                                                                      |
| <i>Activity File</i>           | Specifies the file that contains the data for the activity factor on any node of the circuit.                                                                                                                                                                                                                                                           |
| <i>Avg Power (All Nets)</i>    | Specifies the average power value for all the nets. The default unit is W (Watts). If the value is in any other unit, you must specify the unit. For example, 20mW.                                                                                                                                                                                     |
| <i>Avg Power File</i>          | Specifies the file that contains average power for specific sub circuits.                                                                                                                                                                                                                                                                               |
| <i>Net based average power</i> | Specify different power values for different nets. When you check this option, a list box is enabled. The list box has two columns, "Net Name" and "Average Power in W". The "Net Name" column is already populated with the names of nets specified on the <i>Basic</i> tab. For each net, specify the power value in the "Average Power in W" column. |
| <i>Run</i>                     | Runs the specified analysis.                                                                                                                                                                                                                                                                                                                            |
| <i>Cancel</i>                  | Closes the form without executing the command.                                                                                                                                                                                                                                                                                                          |
| <i>Default</i>                 | Displays all the default values.                                                                                                                                                                                                                                                                                                                        |
| <i>Save</i>                    | Saves the configuration file.                                                                                                                                                                                                                                                                                                                           |
| <i>Load</i>                    | Loads the configuration file.                                                                                                                                                                                                                                                                                                                           |
| <i>Help</i>                    | Opens help information in Cadence Help.                                                                                                                                                                                                                                                                                                                 |

## Hierarchical Top Simulation Form

| Field                               | Description                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Block</b>                        |                                                                                                                                                                                                                                                                                                                                                                            |
| <i>xDSPF Type</i>                   | Displays the type of xDSPF to be used from the PGV directory. The following options are available: <ul style="list-style-type: none"><li>■ <i>Detailed</i>: Specifies the detailed block xDSPF file.</li><li>■ <i>Port</i>: Specifies the port block xDSPF file.</li><li>■ <i>Via Snapped</i>: Specifies the via layer xDSPF generated using via layer snapping.</li></ul> |
| <i>PGV dir for block xDSPF file</i> | Provides the path to the PGV directory that contains the <i>xDSPF file</i> .                                                                                                                                                                                                                                                                                               |
| <i>Instance(s)</i>                  | Indicates the instance name of the block.                                                                                                                                                                                                                                                                                                                                  |
| <i>Current Type</i>                 | Lets you specify whether the current analysis will be <i>Static</i> or <i>Dynamic</i> .                                                                                                                                                                                                                                                                                    |
| <i>Current File</i>                 | Displays the name of the piece-wise linear (PWL) file that is generated while running block simulation.                                                                                                                                                                                                                                                                    |
| <i>Add Block</i>                    | Adds the specified block data to the table.                                                                                                                                                                                                                                                                                                                                |
| <i>Add Block instance</i>           | Adds another instance to the already added block with a different current file.                                                                                                                                                                                                                                                                                            |
| <i>Remove</i>                       | Removes any block data from the table.                                                                                                                                                                                                                                                                                                                                     |
| <b>Top</b>                          |                                                                                                                                                                                                                                                                                                                                                                            |
| <i>xDSPF File</i>                   | Displays the name of the top-level xDSPF file.                                                                                                                                                                                                                                                                                                                             |
| <i>Ckt File</i>                     | Specifies the input circuit file for performing top-level simulation. This file contains information about models/vectors and other parameters required for top-level simulation.                                                                                                                                                                                          |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

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|                                |                                                                                         |
|--------------------------------|-----------------------------------------------------------------------------------------|
| <i>Bus Bit Char</i>            | Specifies the bus delimiter character. The following options are available: <>, [], {}. |
| <b><i>EMIR Config file</i></b> |                                                                                         |
| <i>EM Techfile</i>             | Specifies the EM technology file to be used in the EMIR configuration file.             |
| <i>Instance Hierarchy</i>      | Specifies the instance hierarchy name to be used in the EMIR configuration file.        |
| <i>Create New</i>              | Generates a default EMIR configuration file, <code>emir_vfi.conf</code> .               |
| <b><i>Output</i></b>           |                                                                                         |
| <i>Results Directory</i>       | Specifies the directory that stores the results of the top-level simulation.            |
| <i>Run</i>                     | Runs the top-level simulation.                                                          |
| <i>Cancel</i>                  | Closes the form without executing the command.                                          |
| <i>Save</i>                    | Saves the configuration file.                                                           |
| <i>Load</i>                    | Loads the configuration file.                                                           |
| <i>Help</i>                    | Opens help information in Cadence Help.                                                 |

## Extract xDSPF Form

| Field                         | Description                                                                                                                                                                                |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Input</b>                  |                                                                                                                                                                                            |
| <i>Data Type</i>              | Lets you specify whether the input data will come from <i>PVS/Pegasus</i> or <i>Calibre</i> . By default, <i>PVS/Pegasus</i> is selected.                                                  |
| <i>Data Directory</i>         | Provides the path to the directory in which the input data is stored.                                                                                                                      |
| <i>Run Name</i>               | Specifies the name of the PVS/Pegasus or Calibre run.                                                                                                                                      |
| <i>Post Processing Script</i> | Specifies the name of the post-processing script file.                                                                                                                                     |
| <i>Hierarchical EMIR flow</i> | Enables hierarchical EMIR analysis.<br><br><b>Note:</b> This field is specific to the hierarchical EMIR flow.                                                                              |
| <i>PGV Library Name</i>       | Specifies the block PGV library that is used for the block-level extraction performed for the hierarchical flow.<br><br><b>Note:</b> This field is specific to the hierarchical EMIR flow. |



# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Voltus-Fi Form Descriptions

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### ***Process***

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*Foundry / Process  
Node*

Lets you specify the process node. The following options are available:

- *N5/N3*: for N5 and N3 process nodes
- *N7*: for N7 process nodes
- *N10-PG*: for N10 process nodes with PG rules
- *N10*: for N10 process nodes
- *N20/N16/N12*: for N20, N16, and N12 process nodes
- *N14*: for N14 process nodes
- *Others > 20*: for process nodes greater than N20

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*Signal EM*

Indicates that signal nets should be included in the xDSPF file.

When *Signal EM* is selected, the following command is added to the Quantus command file or the common command language (CCL) file, to perform decoupled RC extraction (`rc_decoupled`) for all nets.

**Note:** In `rc_decoupled` extraction, an RC network for the specified nets with both parasitic resistance and capacitance decoupled to ground is extracted.

```
extract \
-selection "all" \
-type "rc_decoupled"
```

When *Signal EM* is not selected, you need to provide the names of the power or ground nets on which `rc_decoupled` extraction will be performed. For all other nets, `c_only_decoupled` extraction is performed.

**Note:** In `c_only_decoupled` extraction, only parasitic capacitance between the specified nets and adjacent nets decoupled to the specified cap ground is extracted.

For example, when the following command is specified, `c_only_decoupled` extraction is performed on all nets:

```
extract \
-selection "all" \
-type "c_only_decoupled"
```

When the following command is specified, `rc_decoupled` extraction is performed on nets specified in the `vfiQrc_nets` file. For all other nets, `c_only_decoupled` extraction is performed.

```
extract \
-selection "nets_file ./vfiQrc_nets" \
-type "rc_decoupled"
```

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

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|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>PG Net(s)</i>       | <p>Provides information about the power and ground nets that should be included in the xDSPF file.</p> <p>This option is specified only when the <i>Signal EM</i> option is deselected. If the <i>Signal EM</i> option is not selected and <i>PG Nets</i> are not provided, a pop-up window opens asking for the list of PG Nets.</p>                                                                                                                                                                                                                                                                        |
| <i>Nets File</i>       | <p>Displays the names of the nets to be included in extraction.</p> <p>When the <i>Nets File</i> option is checked, the <i>Signal EM</i> and <i>PG Net(s)</i> options are ignored.</p>                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Extraction Type</i> | <p>Specifies the extraction type.</p> <ul style="list-style-type: none"><li>■ <i>RC</i>: Specifies that both parasitic resistors and capacitors will be extracted.</li><li>■ <i>R only</i>: Specifies that only parasitic resistors will be extracted.</li></ul> <p>When <i>Extraction Type</i> selected is <i>R only</i>, the simulation time is short. While selecting the extraction type, consider the type of simulation being run. For example, to run a DC operating point (DCOP) simulation, select <i>R only</i> as the <i>Extraction Type</i> because the capacitance values are not required.</p> |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

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|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Cap Coupling Model</i>  | <p>Specifies the coupling mode.</p> <ul style="list-style-type: none"><li>■ <i>De-coupled</i>: Specifies that decoupled capacitance extraction will be performed.</li><li>■ <i>Coupled</i>: Specifies that coupled capacitance extraction will be performed.</li></ul> <p>By default, <i>De-coupled</i> mode is selected.</p> <p>While specifying the coupling mode, ensure that there is no <code>extract</code> command defined in the additional CCL file. The <code>extract</code> command in the additional CCL file will override the above options.</p> |
| <i>Parasitic RES Color</i> | Enables color-aware EM analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <i>Compression</i>         | Generates xDSPF in a compressed format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <i>Reduce I-Cards</i>      | Enables the <code>reduce_i_cards</code> option in the CCL file that is used for generating the xDSPF file. If a net is “capacitance only”, it is qualified for reduced I card or instance card treatment. This means that when this option is selected, the instance cards and the corresponding dummy resistors are not printed in the results.                                                                                                                                                                                                               |
| <i>Comment Sub Ckt</i>     | Comments out the top sub circuit statements from the xDSPF file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <i>Sub Conductor Model</i> | Provides information about the parasitic resistor models for the subconductor layers that should be included during extraction. This is used to support different EM rules for poly layers during EM analysis.                                                                                                                                                                                                                                                                                                                                                 |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

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|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Filter RES Center</i>   | Includes sub-nodes after eliminating resistors with small resistance values. When this option is selected, the survivor sub-nodes, among a group of sub-nodes that are formed by the filtered resistors, are chosen based on their proximity to the geometric center of the group. This field is specific to process nodes 5nm and below.                                                                                                                                      |
| <i>Filter RES By Layer</i> | Lets you specify the LVS layer name for which the minimum resistance value for the extracted parasitic resistors is to be applied. If the layer name is not specified, the default value, RH_TN_6 0, is used. This field is specific to process nodes 5nm and below.                                                                                                                                                                                                           |
| <i>Ref Node</i>            | Specifies the reference node on which the extraction is to be performed. By default, 0 is specified.                                                                                                                                                                                                                                                                                                                                                                           |
| <i>Sub-Node Char</i>       | Indicates the subnode identification character. By default, # is specified.                                                                                                                                                                                                                                                                                                                                                                                                    |
| <i>Fracture Via Count</i>  | Indicates the number that will be used to divide pseudo vias into segments during extraction.                                                                                                                                                                                                                                                                                                                                                                                  |
| <i>Via Array Spacing</i>   | Indicates the distance that will be used as the maximum distance criteria for grouping vias within the same array. This means that if the distance between vias is less than the specified maximum distance, they are grouped within the same array. The default value of the via array spacing is 0.35 times the via size for N10, N16, N12, and N20 processes. For other processes, the default is <i>auto</i> , in which case Voltus-Fi sets the via spacing automatically. |
| <i>auto</i>                | Indicates that Voltus-Fi sets the via spacing automatically.                                                                                                                                                                                                                                                                                                                                                                                                                   |

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

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|                                |                                                                                                                                                                                                                                   |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Via Array Count</i>         | Indicates the number of vias per side allowed in an array (without the per via layer count option). The default value is 4. For example, if the via array count is set to 2, the number of vias allowed per array side will be 2. |
| <hr/> <b>Technology</b>        |                                                                                                                                                                                                                                   |
| <i>Technology Library File</i> | Displays the location of the technology file to be used for reading the technology data.                                                                                                                                          |
| <i>Technology Directory</i>    | Displays the name of the directory that contains the technology file.                                                                                                                                                             |
| <i>Technology Name</i>         | Displays the name of the technology file to be used for extraction.<br><br>This field is optional if the technology directory has been specified.                                                                                 |
| <i>Corner</i>                  | Displays the name of the technology corner to be picked from the library.                                                                                                                                                         |

# Voltus-Fi Custom Power Integrity Solution XL User Guide

## Voltus-Fi Form Descriptions

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### *Temperature*

Indicates the temperature at which the extraction will be performed.

By default, a temperature of 25 degree Celsius is used. The temperature specified for extraction is optional. The options, temperature and `temp_coeff`, specified in the CCL file are mutually exclusive. The following scenarios hold true.

- If you specify a temperature for extraction in the Extract xDSPF form or by using the `-temperature` parameter of the `extract_xdspf` command in batch mode, the following option in the CCL file will be set to `false`:

```
-include_parasitic_res_temp_coeff
"false" \
```

The software displays the following message:

```
User specified temperature will be
used for extraction. The option
include_parasitic_res_temp_coeff
will be set as false.
```

- If you do not specify a temperature for extraction, the following option in the CCL file will be set to `true`:

```
-include_parasitic_res_temp_coeff
"true" \
```

The software displays the following message:

```
No user specified temperature value
so the option
include_parasitic_res_temp_coeff
will be set as true
```

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### *No of CPUs*

Displays the number of CPUs to be used during the Quantus extraction run.

## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

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|                              |                                                          |
|------------------------------|----------------------------------------------------------|
| <i>SubCkt Pin Order File</i> | Provides the order of pins to be used during extraction. |
|------------------------------|----------------------------------------------------------|

The pin order is specified in the xDSPF file using the `.SUBCKT` and `.ENDS` statements. You can use this option to provide a file with a different pin order that will override the order specified using the default `.SUBCKT` statement in the xDSPF file.

Below are examples of pin orders in the xDSPF file before and after specifying the pin order file.

Without the sub-circuit pin order file

```
.SUBCKT top In_001 VDD Out_001 VSS
In_002 Out_002 In_003 Out_004 ...
.ENDS
```

With the sub-circuit pin order file

```
.SUBCKT top VDD VSS In_001 Out_001
In_002 Out_002 In_003 Out_004 ...
.ENDS
```

---

|                                         |                                                                  |
|-----------------------------------------|------------------------------------------------------------------|
| <i>Customized Extract Commands File</i> | Lets you specify the file with user-customized extract commands. |
|-----------------------------------------|------------------------------------------------------------------|

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|                            |                                                                     |
|----------------------------|---------------------------------------------------------------------|
| <i>Add Extract Command</i> | Indicates that Voltus-Fi adds the extract commands to the CCL file. |
|----------------------------|---------------------------------------------------------------------|

By default, when a `customextract` file is specified, all commands, including the extract commands, from that file are added to the Voltus-Fi-generated CCL file.

However, when you select *Add Extract Command*, Voltus-Fi adds the extract commands to the CCL file, and all other commands specified in the `customextract` file are added to the CCL file.



## Voltus-Fi Custom Power Integrity Solution XL User Guide

### Voltus-Fi Form Descriptions

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|                                             |                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Parasitic blocking device cells file</i> | <p>Lets you specify the file containing parasitic blocking device cell names, if any.</p> <p>Once a cell is declared a blocking cell, all the parasitic RCs inside the cell are not extracted. If the cell content overlaps top cell routing, then, the top cell routing's RCs in the overlapping regions are also not extracted.</p>    |
| <b>Output</b>                               |                                                                                                                                                                                                                                                                                                                                          |
| <i>Directory</i>                            | Specifies the output directory in which the xDSPF file will be saved. If this file is not specified, a pop-up window opens asking for the name of the directory.                                                                                                                                                                         |
| <i>xDSPF File Name</i>                      | Specifies the name of the xDSPF file that will be generated. If you do not specify the filename, Voltus-Fi generates a file with the name, <code>&lt;runName&gt;.dspf</code> , by default.                                                                                                                                               |
| <i>Autorun Spfchecker</i>                   | Runs the SPF Checker utility after the extraction run. SPF Checker checks the syntax of the DSPF/SPEF followed by opening the output log. It also compares the terminal names in the DSPF and the device models and populates the summary section with the recommended mapping statements or the <code>spf alias term</code> statements. |
| <i>Generate CCL</i>                         | Creates the CCL or the Quantus command file that will be used to run Quantus.                                                                                                                                                                                                                                                            |
| <i>Generate and Run</i>                     | Creates the CCL file and runs Quantus to create the xDSPF file in a single step.                                                                                                                                                                                                                                                         |
| <i>Run</i>                                  | Selects the CCL file to use for running Quantus.                                                                                                                                                                                                                                                                                         |
| <i>Reset</i>                                | Displays all the default values.                                                                                                                                                                                                                                                                                                         |
| <i>Cancel</i>                               | Closes the form without executing the command.                                                                                                                                                                                                                                                                                           |
| <i>Save</i>                                 | Saves the xDSPF file.                                                                                                                                                                                                                                                                                                                    |
| <i>Load</i>                                 | Loads the configuration file.                                                                                                                                                                                                                                                                                                            |
| <i>Help</i>                                 | Opens help information in Cadence Help.                                                                                                                                                                                                                                                                                                  |

# **Voltus-Fi Custom Power Integrity Solution XL User Guide**

## **Voltus-Fi Form Descriptions**

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