cādence®

Auto Device Placement and Routing Quick Help

Product Version ICADVM20.1
October 2020

Contents

1

Auto Device Placement and Routing Quick Help

The Virtuoso automated device-level layout flow enables you to quickly generate placed and routed layouts that are constraint compliant, LVS correct, and follow DRCs as captured in the Virtuoso technology file. You can access the Auto Device P&R assistant from the Layout EXL cockpit. This assistant provides a simple, yet powerful interface that guides you through the various tasks in the flow. Before using the Auto Device P&R assistant, ensure that the prerequisites are met. You can then use the Auto Device P&R assistant to generate automatically placed and routed layouts. The Auto Device P&R assistant interface guides you through the various tasks of the flow.

1. Initializing a layout

2. Generating groups, constraints, and grids

3. Placing devices

4. Adding device fill

5. Routing devices

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How do I get to the home page?

At any point, click the *Flow* tab to return to the home page.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

Auto Device Placement and Routing Quick Help

Auto Device Placement and Routing Quick Help--What are the prerequisites for using the Auto Device P&R assistant?

What are the prerequisites for using the Auto Device P&R assistant?

To run the Auto Device P&R assistant, you must have access to the following design environment capabilities:

- Virtuoso Release ICADVM18.1 ISR4 or higher. The flow is available only in the advanced node methodologies releases.

- Virtuoso Layout Suite EXL

- PDK Settings:

    - Support for Virtuoso Placer and Virtuoso Space-based Router

    - Designs that have a uniform gate length to ensure uniform poly pitch.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

2

Initializing a Layout

This section includes the following topics:

- How to initialize a layout?

- How to generate objects in the layout canvas?

- What does the option 'Update PCell Parameters' in the Initialize step do?

How to initialize a layout?

To initialize a layout, on the *Initialize* tab of the Auto Device P&R assistant:

1. Select *Generate* to specify the objects to be generated. For more information, see How to generate objects in the layout canvas?

2. Select *Load* to load components from another cellview.

3. Select the required components - *Pins* and *Boundary*. Click *Browse* to select the cellview that contains the components.

4. Select *Preserve Existing* to specify that the components are to be preserved, and not regenerated, in the target cellview.

5. Select the components to be preserved - *Instances*, *Constraints*, *Pins*, *Boundary*, and *Row*. Other instances and pins in the source schematic are incrementally generated in the target layout. The boundary and rows are not regenerated.

6. Select *Update PCell Params* to update the parameters of the devices of the specified technology file as per the recommended use model.

7. Click *Apply*.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to generate objects in the layout canvas?

To generate objects in the layout canvas, on the *Initialize* tab of the Auto Device P&R assistant:

1. Select *Instances* to generate all instances from the source schematic.

2. Select *Boundary* to generate a PR boundary as per the specified combination of *Utilization* and *Aspect Ratio* or *Width* and *Height*.

   ○ **Utilization and Aspect Ratio:** Utilization specifies what percentage of the area within the PR boundary that can be filled with objects. The default is 25 percent. *Aspect Ratio* specifies the width-to-height ratio of the PR boundary. The default value is 1, which indicates a square boundary.

   ○ **Width and Height:** *Width* specifies the exact width of the PR boundary. *Height* specifies the exact height of the PR boundary. *Width* can be accessed from the *Utility* drop-down list and *Height* from the *Aspect Ratio* drop-down list.

3. Select *Pins to* generate all the pins that are present on the selected *Pin Layer* in the source cellview. The default *Pin Layer* is the first metal layer in the layer stack.

4. Select *Preserve Rows* to use existing rows (prevent rows from being re-generated).

5. Click *Apply* to generate the selected objects in the layout canvas. All the instances and pins are generated below the PR boundary.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

What does the option 'Update PCell Parameters' in the Initialize step do?

Select *Update PCell Parameters* to update the parameters of the devices for a particular technology as per Cadence recommendation. To skip this option, clear the checkbox.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

3

Generating Groups, Constraints, and Grids

The automated device-level layout flow lets you derive WSPs and row regions automatically based on the device footprint, layers, and DRCs with minimal user input.

This section includes the following topics:

- How to generate a placement grid?

- How to create a row region using an existing row template?

- How to generate WSPs in a row region?

- How to import a WSP pattern from an existing WSP pattern file?

- How to generate constraints?

   - How to review constraints before they are generated?

   - How to specify criteria based on which constraints must be generated?

- How to create Modgen constraints instead of figGroups?

- How do I edit Modgens in the Auto Device P&R assistant?

- What are the supported circuit finders?

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to generate a placement grid?

Use the options on the *WSP/Row* tab of the Auto Device P&R assistant to derive WSPs and row regions.

1. Select *Create Row Region.*

2. Select one of the following row height options:

    - *Auto compute row height*: Automatically calculates the row height based on the maximum instance height and the heights of the gate, source, and drain tracks.

    - *Specify row height*: Lets you specify a row height value.

    - *Use row template*: Lets you apply an existing row template. See How to create a row region using an existing row template? to know more about creating row regions using existing row templates.

3. Select *Create Poly Pattern* to generate a poly WSP grid in the selected row region.

4. Select *Create width spacing patterns* to generate WSPs in the selected row region. See How to generate WSPs in a row region? to know more about generating WSPs in row regions.

5. Instead of specifying the WSP parameters, you can import a WSP pattern from an existing WSP pattern file. Click *Import Width Spacing Patterns* to open the Select Patterns form. See How to import a WSP pattern from an existing WSP pattern file? to know more about importing WSP patterns.

6. Click *Generate*.

WSP grids are generated in the layout canvas as per your specifications. The Track Pattern assistant lists all the auto-created WSPs and rows with the APR- prefix to differentiate them from existing WSPs.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide 🗗

How to create a row region using an existing row template?

To create a row region using an existing row template, with the *WSP/Row* tab of the Auto Device P&R assistant open:

1. Select *Create Row Region*.

2. Select *Use row template*. Click *Browse* to display the Select Row Template form.

3. In the Select Row Template form, select the *Library*, *Cell*, and *View* that contains the required row template. All row templates that are stored in the selected cellview are listed in the *Select Row Template* box.

4. Select the required row template. The row template settings are displayed in the *Details* pane.

You cannot edit these settings.

5. Click *OK*. The name of the selected row template is displayed in the *Use row template* field.

6. Click *Generate*.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to generate WSPs in a row region?

Use the options on the *WSP/Row* tab of the Auto Device P&R assistant to generate WSPs in row regions.

1. Select *Create Width Spacing Patterns* to generate WSPs in the selected row region.

2. Select a *Top Layer* and a *Bottom Layer* to specify the routing layer range for which WSPs are to be created. WSP tracks are inserted in these and all intermediate layers.

3. In *#Gate Tracks*, specify the number of gate tracks to be accommodated within a WSP track period. The default is 2. This value impacts the WSP period. Gate tracks are required for poly gate routing.

4. In *Gate Track Width*, specify the number of gate tracks to be added at the top and bottom of each row. The default value is 2, which specifies that two gate tracks are to be added to the top and bottom of each row.

5. In *Gate Track Spacing*, specify the spacing between gate tracks. Each WSP track must accommodate the given number of gate tracks of the specified width and spacing. If the specified track width exceeds the default, specify a wider spacing value.

6. Specify the width of source and drain tracks in the *S/D Track Width* field.

7. In *#S/D Tracks*, specify the number of source and drain tracks to be accommodated in each WSP track period. Select either *S/D Track Width* or *#S/D Tracks* and specify a value. The default value is automatically calculated based on the layer constraints and area of the source and drain pins.

8. Click *Generate*.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to import a WSP pattern from an existing WSP pattern file?

To import a WSP pattern from an existing WSP pattern file:

1. Open the *WSP/Row* tab of the Auto Device P&R assistant.

2. Click *Import Width Spacing Patterns* to open the Select Patterns form.

3. Select the required *Library*, *Cell*, and *View*. All WSP patterns stored in the selected cellview are listed in the following section.

4. Select the required WSP pattern in the left panel. The *Layer*, definition (*Def*), and pattern (*Pat*) of the selected WSP are displayed in the right panel.

5. Click *OK*.

WSP parameters from the selected WSP pattern file are loaded into the related fields on the *WSP/Row* tab.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide 🔗

How to generate constraints?

The automated device-level layout flow supports automatic structure recognition using circuit finders and corresponding constraint creation. The automatic device placer and router honor these constraints during design placement and routing.

To generate constraints:

1. Click *Generate Constraints* in the Auto Device P&R assistant to display the *Constraints* tab.

2. Select the *Circuit Finders* to be run to identify matching devices and device groups in the design. For more information see How do I specify criteria based on which constraints must be generated?

3. Review and edit the list of constraints in the *View and Edit Constraints* section. For more information, see How do I review constraints before they are generated?

4. Click *Create Constraints*. Constraints are generated as per your specifications and listed in

the Constraint Manager.

Related Topics

- How to create Modgen constraints instead of figGroups?

- How to edit Modgens in the Auto Device P&R assistant?

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to review constraints before they are generated?

To review and edit the constraints as per your requirements before generating them in the layout canvas:

1. Open the *Constraints* tab of the Auto Device P&R assistants.

2. Ensure that the required circuit finders are selected in the Circuit Finders section.

3. In the View and Edit Constraints section, right-click the constraints to display a shortcut menu. Use the options in the shortcut menu to perform the following tasks:
   - *Zoom* in to magnify the selected constraints.
   - *Select* the constraints to be generated.
   - *Unselect* the constraints that you do not want to generate.
   - *Delete Constraint* from the layout cellview.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to specify criteria based on which constraints must be generated?

The Auto-Device P&R assistant is pre-loaded with a set of circuit finders, which are listed in the *Constraint Finder* section of the *Constraints* tab. The finders analyze the source data (schematic cellview) and identify all devices and device groups that match the given criteria. The finder names have the *APR-* prefix, which indicates that these finders are customized for the Auto-Device P&R flow. By default, all *Circuit Finders* are selected. Uncheck the ones that you do not want to run. The sequence of the finders determines the sequence in which constraints are listed. You can reorder the finders by dragging them to the desired locations within the list before generating them.

To review constraints before generating them:

To review constraints before generating them:

1. Open the *Constraints* tab. All circuit finders are listed in the Constraint Finder section.

2. Select the required *Circuit Finders* to be run to identify matching devices and device groups in the design. The *View and Edit Constraints* section lists all existing and new (based on the recognized structures) constraints and constraints groups. Click the + sign to expand each group.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to create Modgen constraints instead of figGroups?

To create Modgens instead of figGroups, in the Auto Device P&R assistant:

1. Set the `aprCreateModgens` environment variable to `t` in the CIW - `envSetVal("layoutXL.AP"` `"aprCreateModgens" 'boolean t)`. Alternatively, set the environment variable in the `.cdsinit` file before invoking Virtuoso.

2. Run the *Initialize Layout* step.

3. Run the *Generate Constraints* step.

Modgens are created and listed in the *View and Edit Constraints* section under the various categories. To know more about how to edit these Modgens, see How do I edit Modgens in the Auto Device P&R assistant?.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to edit Modgens in the Auto Device P&R assistant?

To edit a Modgen:

1. Open the *Constraints* tab of the Auto Device P&R assistant.

2. Expand the required category in the *View and Edit Constraints* section.

3. Right-click the required Modgen constraint.

4. Choose *Edit Group*. The Auto Device Array form is displayed.

5. Specify the required changes in the *Placement* and *GuardRing* tabs.

6. Click *Apply*.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

What are the supported circuit finders?

Supported APR circuit finders are listed in the following table:

Finders	Description
APR Differential Pair	Groups devices that form a differential pair structure.
APR Differential Pair - Cross Coupled	Groups devices that form a cross-coupled differential pair structure.
APR Current Mirror	Groups devices that form a current mirror structure.
APR Cascode Current Mirror	Groups devices that form a cascoded current mirror structure.
APR Cascode Series Current Mirror	Groups devices that form a cascoded series current mirror structure.
APR Cascode	Groups cascoded MOS transistor structures.
APR Active Same Size Common Gate and Source	Groups same-sized devices with the same gate and source connections.
APR Active Same Size Common Source	Groups same-sized devices with the same source connection.
APR Active Same Cell M-Factored Device	Groups active devices with mfactor.

APR Active Same Cell Stacked Device	Groups transistors in series stacks.
APR Active Same Cell Iterated Device	Groups iterated devices.
APR Active Same Cell and Size	Groups active devices with the same cell name and size.
APR Passive Same Cell and Size	Groups passive devices with the same cell names or the same cell sizes and values.
APR User Defined Group	Groups device groups inside text boxes.
APR Instances (Symmetry By Connectivity)	Groups pairs of instances that are determined to be symmetric based on their connectivity.
APR Instances (Symmetry By Connectivity with common source or drain)	Groups pairs of instances that are determined to be symmetric based on their connectivity with a common source or drain.
APR Nets (Symmetry By Connectivity)	Groups nets that are determined to be symmetric based on their connectivity.
APR Pins (Symmetry By Connectivity)	Groups pins that are determined to be symmetric based on their connectivity.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

4

Placing Devices

The Virtuoso automated device-level layout flow supports two placement models:

- **Automatic Placement:** Placement is performed by running the Virtuoso device-level automatic placer.

- **Interactive Placement:** Devices are placed semi-automatically. Depending on the placement needs and the complexity of the design, you can first run the Virtuoso device-level automatic placer, and then use the interactive placement options to refine the placement.

This section comprises the following topics:

- How does the automatic placer work?

- How do I run the device-level interactive placer?

    - How can I control the direction in which devices are placed when they are moved?

    - How do I group devices?

    - How do I specify whether devices must be stacked vertically or spread horizontally?

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How does the automatic placer work?

To run the Virtuoso device-level automatic placer:

1. Click *Place Devices* on the *Flow* tab of the Auto Device P&R assistant to open the *Placer* tab.

2. Select one of the following placement objectives:

    - **Area Only:** Places devices to optimize compactness.

- ○ **Wire Length Only:** Minimizes the wire length for better routability.

  - ○ **Area and Wire Length:** Achieves a balance between compact placement and reduced wire length.

3. Select one of the following options to specify the placement region:

   - ○ **Aspect Ratio:** Generates a placement boundary as per the specified dimensions. The default value is 1.00, which specifies a square boundary.

   - ○ **PR Boundary:** Fits all the objects inside the existing PR boundary.

4. Click *Run Auto Place* to run the placer.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How do I run the device-level interactive placer?

To run the device-level interactive placer:

1. Open the *Placer* tab of the Auto Device P&R assistant.

2. Select *Context Menu* to display a shortcut menu that lets you perform context-sensitive operations on devices and device groups directly in the layout canvas. For more information about these operations, see:

   - ○ How do I group devices?

   - ○ How do I specify whether devices must be stacked vertically or spread horizontally?

   - ○ How can I control the direction in which devices are placed when they are moved?

3. Select *Row Snapping* to display row snapping-related details in the *Information* pane during interactive device placement.

4. Select *WSP Snapping* to display SP and WSP snapping-related details in the *Information* pane during interactive device placement.

   Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How can I control the direction in which devices are placed when they are moved?

Use the following interactive placement options in the context menu to control the direction of placement of devices that are moved:

- **Spread Any:** Moves devices in any direction to avoid overlaps.

- **Spread X:** Moves devices in the X-direction to avoid overlaps. An info balloon that summarizes the following information is displayed:

  - Total wire length

  - Change in wire length

  - Row to which the device has snapped

  - Snap pattern to which the devices have snapped

- **Insert as Row:** When multiple devices are selected and moved, their placement is restricted to the current row.

- **Insert as Column:** When multiple devices are selected and moved, their placement is restricted to the current column.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How do I group devices?

Interactive placement options are available in a context menu, which is displayed when you select devices and device groups in the layout canvas. The context menu includes the *Group* and *Ungroup* options, which let you group and ungroup the selected devices.
The relative positions of the grouped devices are always maintained when you perform operations such as move.

Grouped devices can be in the same or different rows. Devices in a group are abutted horizontally.

You can use the context menu to specify whether grouped devices must be stacked horizontally or vertically when they are moved.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How do I specify whether devices must be stacked vertically or spread horizontally?

The following interactive placement options are available in the context menu that let you control the direction in which devices are stacked:

- **Taller:** Stacks the selected devices vertically. This option is applicable only for grouped devices. When you move a stacked device, the associated grouped devices are also moved to new locations so that their relative positions are maintained.

- **Wider:** Arranges the selected devices horizontally. This option is applicable only for grouped devices. Therefore, when you move a grouped device, the relative positions of the other devices in the group are also updated.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

5

Adding Device Fill

This section covers the following topics:

- How to generate device fill?
  - How to generate dummy fill?
  - How to generate poly fill?
- Why is poly fill not generated?

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide ↗

How to generate device fill?

To generate device fill:

1. Click *Add Base Layer Fill* in the Auto Device P&R assistant to open the *Fill* tab.

2. Select *Enable Dummy Fill* to add dummy fill.

3. Specify the required options in the *Dummy Fill* section. For more information, see How to generate dummy fill?

4. Select *Enable Poly Fill* to insert poly fill.

5. Specify the required options in the *Poly Fill* section. For more information, see How to generate poly fill?

6. Specify the area to be filled as *CellView* (default) to add device fill in the current cellview, *Row Region* to select the required row region, or *Custom Area* to specify either the *Area to Fill* coordinates or *Draw* the required area in the canvas.

7. Click *Insert Fill* to generate the required dummy and poly fill as per your specifications. Also,

see What to do if poly fill not generated properly?.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to generate dummy fill?

To specify dummy fill options:

1. Select one of the following options to specify the instance to be considered as the master for creating dummy fill.
    - Select *Neighbor* to create dummies that match the neighboring active devices. This option is selected by default.
    - Specify the *Library*, *Cell*, and *View* of the master cellview when *Neighbor* is not selected.

2. Specify the *Net Name* to which the dummy fill must be connected.

3. Select *Match Neighbor* to match the connectivity of the dummy devices to the bulk net of the neighbor. When unchecked and *Net Name* is blank, the dummy device terminals are not assigned any net unless they overlap (abut) an active device terminal to inherit its net.

4. Select the required option from the *Create Fill As* section:
    - *Multiple Instance* mode inserts multiple dummy fill as per the setting of the dummyFillNeighborMultipleMode environment variable. When set to singleFinger, single-fingered multiple dummy instances are created. When set to exactCopy, dummies are created as exact copies of their neighboring instances.
    - *Single Instance* mode inserts each dummy fill as a single instance with multiple fingers to fill the gaps and empty rows.

5. Select *Enable Hierarchical Fill* to look through the hierarchy to identify gaps that need to be filled.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to generate poly fill?

To insert poly fill and cut poly:

1. Select the *Poly Layer* to derive cut-poly rails. The default value is the first layer-purpose pair that has its layer function set to `Poly`.

2. Specify the maximum *Poly Fill Width* by which the fill can be extended.

3. Specify the *Cut-Poly Layer Width*. The default value is `0.0u`.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

What to do if device fill are not generated correctly?

Device fill might not be generated in certain design scenarios. To generate device fill, check the following settings:

- Ensure that there are no gaps found in the specified area.

- Ensure that there is sufficient space available to add the fill devices and the required spacings.

- Check whether the devices have valid neighbors.

- Ensure that the specified fill devices meet the row requirements.

- Make sure that the target area does not intersect the PR boundary.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

What to do if poly fill not generated properly?

Poly fill might not be generated due to various design scenarios and constraints. To generate poly fill correctly, check the following settings:

- Ensure that there are no diffusion areas. Poly fill do not fill the diffusion areas. Check for any spacing rules between diffusion areas and poly shapes.

- Ensure that the selected area is inside the cellview boundary.

- Ensure that the poly shapes are aligned properly along the poly grid. If not aligned, a warning message is displayed and poly fill are not inserted.

- Check whether the allowedLengthRanges rule is set for the specified fill layer in the technology file. If set, ensure that the spacing left for the poly fill in the selected area is sufficient to accommodate the poly fill.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

6

Routing Devices

This section covers the following topic:

- How to route devices?

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide

How to route devices?

The final step in the automated device-level layout flow is device routing. You can use the Tree Router, which is the automatic device-level router to route your design.

To route a design,

1. Click *Route Devices* in the Auto Device P&R assistant to open the *Router* tab.

2. Click *Enable Tree Router in Wire Assistant* to open the Wire Assistant. The Auto Device Routing preset is selected by default. In this mode, the Tree router is used for routing. The Tree router automatically identifies and routes mesh, ring (tap cell rings), and tree structures in the design.

3. Select *All* in the *Route Net* field to generate the routes.

Related Content: Virtuoso Automated Device Placement and Routing Flow Guide