IC Validator WorkBench Tutorial

Version T-2022.03-SP2, September 2022

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About This Tutorial

This tutorial includes typical use case exercises for viewing and editing layouts.

This preface includes the following sections:

Related Products and Trademarks

These Synopsys products are referenced in this documentation:

Synopsys SolvNetPlus

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Conventions

The following conventions are used in Synopsys documentation.

Convention	Description
`Courier`	Indicates command syntax.
Italic	Indicates a user-defined value, such as *object_name*.
Bold	• Indicates user input—text you type verbatim—in syntax and examples. • Indicates a graphical user interface (GUI) element that has an action associated with it.
[ ]	Denotes optional parameters, such as `write_file [-f` *filename*`]`
...	Indicates that a parameter can be repeated as many times as necessary: *pin1 [pin2 ... pinN]*
|	Indicates a choice among alternatives, such as `low | medium | high`
\	Indicates a continuation of a command line.
/	Indicates levels of directory structure.

Convention	Description
Edit > Copy	Indicates a path to a menu command, such as opening the **Edit** menu and choosing **Copy**.
Ctrl+C	Indicates a keyboard combination, such as holding down the Control key and pressing C.

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Customer support is available through SolvNetPlus.

Accessing SolvNetPlus

The SolvNetPlus site includes a knowledge base of technical articles and answers to frequently asked questions about Synopsys tools. The SolvNetPlus site also gives you access to a wide range of Synopsys online services including software downloads, documentation, and technical support.

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https://solvnetplus.synopsys.com

If prompted, enter your user name and password. If you do not have a Synopsys user name and password, follow the instructions to sign up for an account.

If you need help using the SolvNetPlus site, click REGISTRATION HELP in the top-right menu bar.

Contacting Customer Support

To contact Customer Support, go to https://solvnetplus.synopsys.com.

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Tutorial 1: Basic Usage

This tutorial describes how to perform basic layout viewing, how to measure, how to change layer attributes and display options, measuring polygons with rulers, and how to perform highlight operations in the application.

The tasks in this tutorial teach you basic viewing operations to view a simple layout. The viewing operations consist of:

- Loading and browsing a layout file
- Measuring lengths of polygons using rulers
- Performing ruler operations and setting general properties of markup objects
- Changing the layer attributes
- Changing the filter size to hide and show small polygons

A Synopsys layout file is included in the standard distribution.

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Tutorial 1 Procedure

To download files required for this tutorial:

- For Linux: On the terminal's command line, enter:

  icvwb_demo tut1

  The tutorial files are automatically copied to your current directory. If you enter **icvwb_demo** with no arguments, a listing of all tutorialand application note directories displays. You can then issue commands to download materials for each tutorial or application note, one at a time.

- For Windows, copy the files in

  `<install_dir>/doc/fw/tut1/`

  to your current working folder.

This tutorial consists of the following tasks:

- Task 1: Load and View a Layout File
- Task 2: Measuring Polygon Length With a Ruler
- Task 3: Additional Markup Operations
- Task 4: Change Layer Attributes

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Task 1: Load and View a Layout File

Invoke the IC Validator WorkBench application from the terminal's command line.

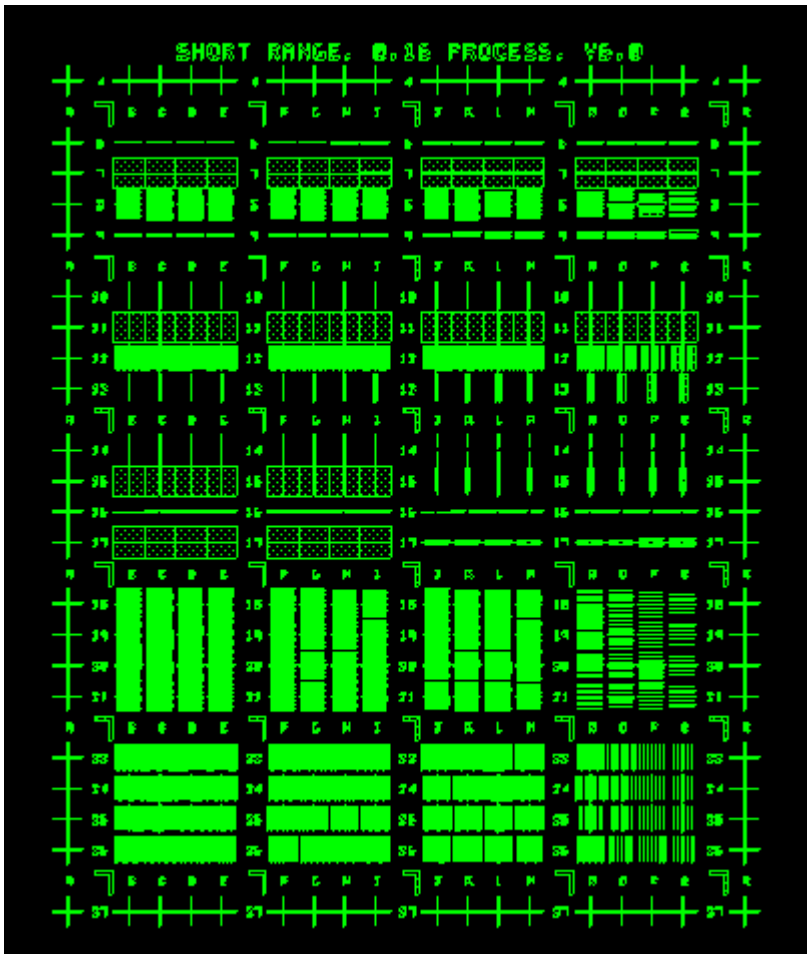
Once the application is running, you can open and then view a layout file as described in the following sections.

Loading a Layout File and Docking a View

To load a file:

1. Choose **File > Open**.
2. Click **Browse** and from the Open File dialog box, open `grp7v6.gds`. See Figure 1.

Figure 1 Layout File



The layout is loaded as shown in Figure 2.

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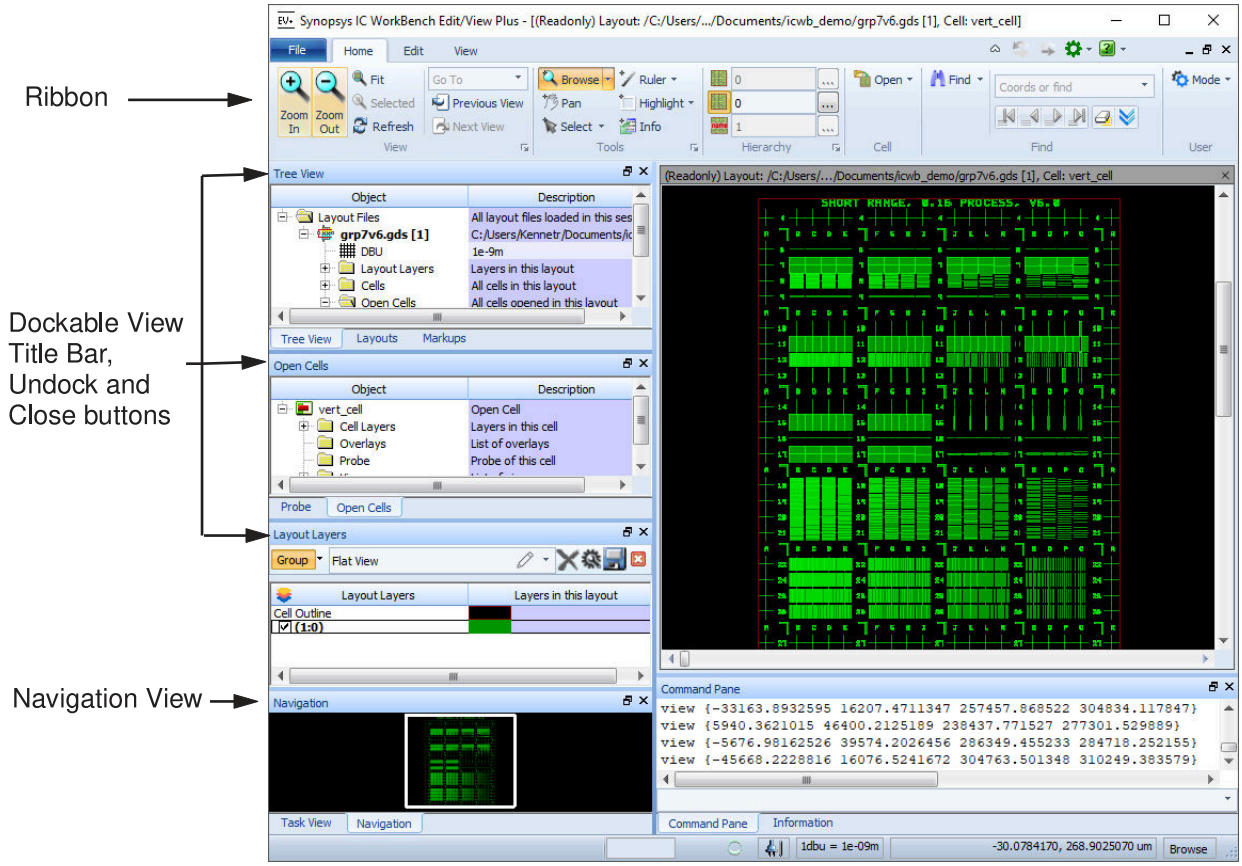
Figure 2 Layout Layers View



This view has the information about the layout layers in a two-column format: Layout Layers and Layers in this layout. From this view you can:

- Widen or narrow the column view area by moving the vertical separator between the column headers.
- Undock the view and move it to another location on your desktop by clicking **View** ( ) or by dragging the view.
- Re-dock the view to its original place by dragging the view and placing it on top of another view.
- Close the view by clicking **Close** ( ).

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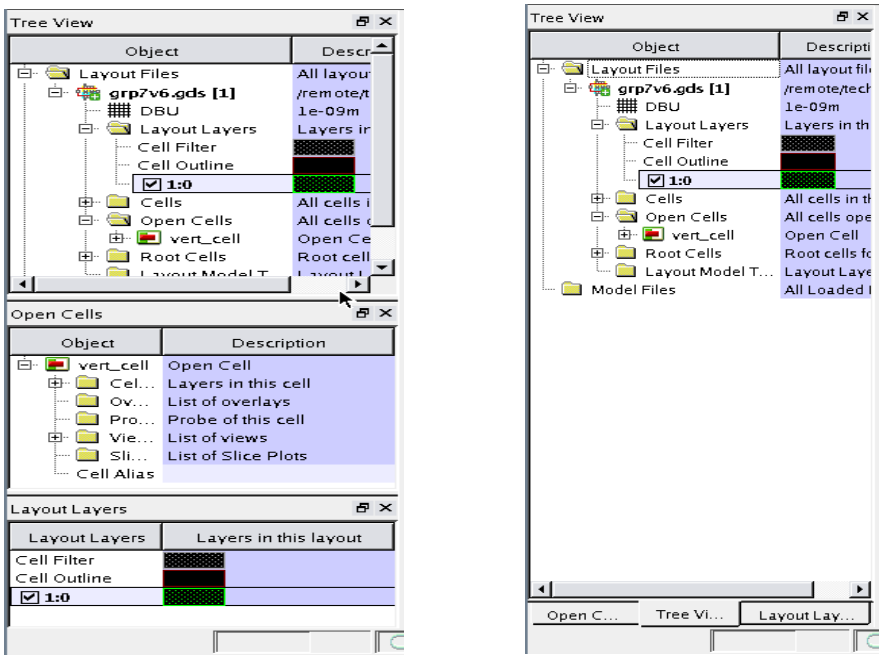
You can also see the list of dockable views by clicking **Dockable** in the **Window** group on the **View** tab. The dockable views include, but are not limited to:

- Tree View—Shows detailed information on all of the layouts you have loaded including the layout layers, cells, and mark up information.
- Command Pane—Shows the command history of the commands entered through the command line and the GUI. You can also enter commands directly into the command line.
- Task View—Shows the status of tasks run in the background, such as opening a layout from the GUI.
- Command Help—Shows a list of commands that are available for the tool. To display the help for a command, double-click a command.
- Layout Layers—Shows a list of layers in the active layout file.
- Open Cells—Shows information about the open cells in the active layout file.

To combine views, place a dockable view on top of another dockable view. Use the tabs at the bottom to switch between dockable views. See Figure 3.

Figure 3 Dockable Views



Views Without Tabs Views With Tabs

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Browsing a Layout

Confirm that the mouse pointer is in the default shape of a looking glass with a + sign  . If it is not, click **Browse** in the **Tools** group on the **Home** tab.

Zoom in to inspect parts of the layout:

- Draw a rectangle around the region of interest by clicking and dragging from the upper left (release at the lower right of the rectangle).
- Click **Zoom In** () in the **View** group on the **Home** tab to zoom in 2x.

Zoom out to view larger sections of the layout:

- Draw a rectangle from the lower right (release at the upper left of the rectangle).

  Notice the mouse pointer changes to a looking glass with a minus sign  .
- Click **Zoom Out** () in the **View** group on the **Home** tab to zoom out 2x.

Move around and center the layout:

- Use the arrow keys on your keyboard to move the display view of your layout in the up, down, right, or left directions.
- Press the C key on your keyboard to center the display view to the position of the cursor.

Zoom out to see the entire layout:

- Click **Zoom To Fit** () in the **View** group on the **Home** tab.

  The layout is restored to its original size in the view window.

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Task 2: Measuring Polygon Length With a Ruler

The following steps explain how to use a ruler to measure a polygon. Later in this chapter, you will learn how to save, load, and rename rulers.

To measure the length of a polygon:

1. Zoom in to part of the polygon.
2. To select the ruler click **Ruler** () in the **Tools** group on the **Home** tab.

   Notice how the mouse pointer changes to a ruler sign  .
3. Click part of the polygon.
4. Click the final measurement point.

   Notice how the ruler is added to the display and that a ruler item appears in the **Rulers** folder in the Open Cells view.
5. Expand the ruler item **R1** to see the coordinates of the ruler.

In addition, the Ruler name appears near the start of the ruler. If you draw multiple rulers, the most recent one is bounded in bold lines.

Note:

The tool assigns an individual ID to each object created or selected (rulers, polygons, highlights, and so on). Therefore, if you have a ruler with the object ID of 1, the next object created will be given an ID of 2 (whether it's another ruler or a highlight, polygon, and so on). No two objects in the same session, including different layouts, have the same ID.

Instead of clicking points in a layout to start and end a ruler, you can also click-drag-release the mouse button to draw the ruler. You can stop any of the drawing functions by using the Esc key.

To specify how a ruler snaps:

1. Click the **Settings** button () on the far-right side of the ribbon and select **Options** from the drop-down menu. You can also click the More button () in the **Tools** group on the **Home** tab and select **Options** from the drop-down menu.
2. In the Options dialog box, expand **Layout** in the tree and select **Ruler**.
3. Click the check box for the snapping preferences you want.
4. Click **OK** to update the default settings and close the dialog box.

Task 3: Additional Markup Operations

The previous task describes how to draw a ruler for measuring polygons. This task focuses on additional markup operations, including naming, saving, and loading the ruler markup, and introduces the highlight markup. You can use highlights to identify a region for exporting layout data or for a later review.

Changing the Naming Convention for Rulers

Changing the naming convention for rulers is similar to changing the name for all mark up objects (highlights, SEM images, and so on).

To change the ruler naming convention:

1. Draw a Ruler (or other markup object).

   This ruler's default name is R3, for example.

2. Click the **Settings** button () and select **Options**.

3. In the Options dialog box, expand **Layout** in the tree.

4. Click **Markup Names** in the tree.

5. For **Ruler**, enter:

   cella_#_Rlr

6. Click **OK**.

   The tool applies the modified naming convention to new rulers you create.

7. Draw two new rulers.

   The ruler names are *cella_4_rlr* and *cella_5_rlr*, replacing the # with the ID.

Saving Rulers

To save a ruler:

1. If not already displayed, open the Open Cells view by clicking **Dockable** in the **Window** group on the **View** tab and selecting **Open Cells**, or by pressing Ctrl+F7.

2. Expand the **Rulers** folder and right-click the specific ruler you want to save.

3. Right-click and choose **Save** from the context menu.

   The Save Rulers File dialog box opens.

4. If necessary, navigate to the appropriate file location in which to save the ruler.

5. Specify the name for the ruler.

6. Click **OK**.

   Note:

   To save all rulers, right-click the Rulers folder and choose **Save All**. To save selected rulers only, right-click and choose **Save Selected**.

Loading Saved Rulers

To load a saved ruler:

1. Choose **File > Open** and click **Browse**.
2. In the Open File dialog box, browse to the directory where the rulers are stored and select the file.

   The default extension for rulers is `.mac` (Macro Files). In order to see the type of ruler file you want to open, you might need to select this file type from the **Files of type** menu.
3. Click **Open**.

   The ruler is added to the cell view.

Deleting Rulers or Any Markup Objects

To delete a ruler:

1. If necessary expand the **Rulers** folder in the Open Cells view.
2. From the Rulers folder, right-click the ruler **cella_4_rlr**.
3. From the context menu, choose **Delete**.

   The ruler is deleted from the cell view and from the **Rulers** folder.

Zooming to a Ruler

To zoom to the different ruler locations:

1. In the Rulers folder, double-click a ruler in the **Rulers** folder.

   Notice how the cell view centers on the selected ruler.
2. Scroll to another ruler and repeat the previous step.

Drawing a Highlight

A highlight is helpful for identifying a region in a layout.

To draw a highlight using your mouse:

1. If necessary, open the Open Cells view (**View** tab > **Dockable** > **Open Cells**).
2. To access the Highlight tool, on the **Home** tab, click the **Highlight** button () or press H.
3. Click a point in the cell view.

   The start point of the highlight is created.
4. Click a second point in the cell view.

   The highlight is created.
5. In the Open Cells view, expand the **Highlights** folder.

   The drawn highlight and its ID appear in the **Highlights** folder in the Open Cells view.

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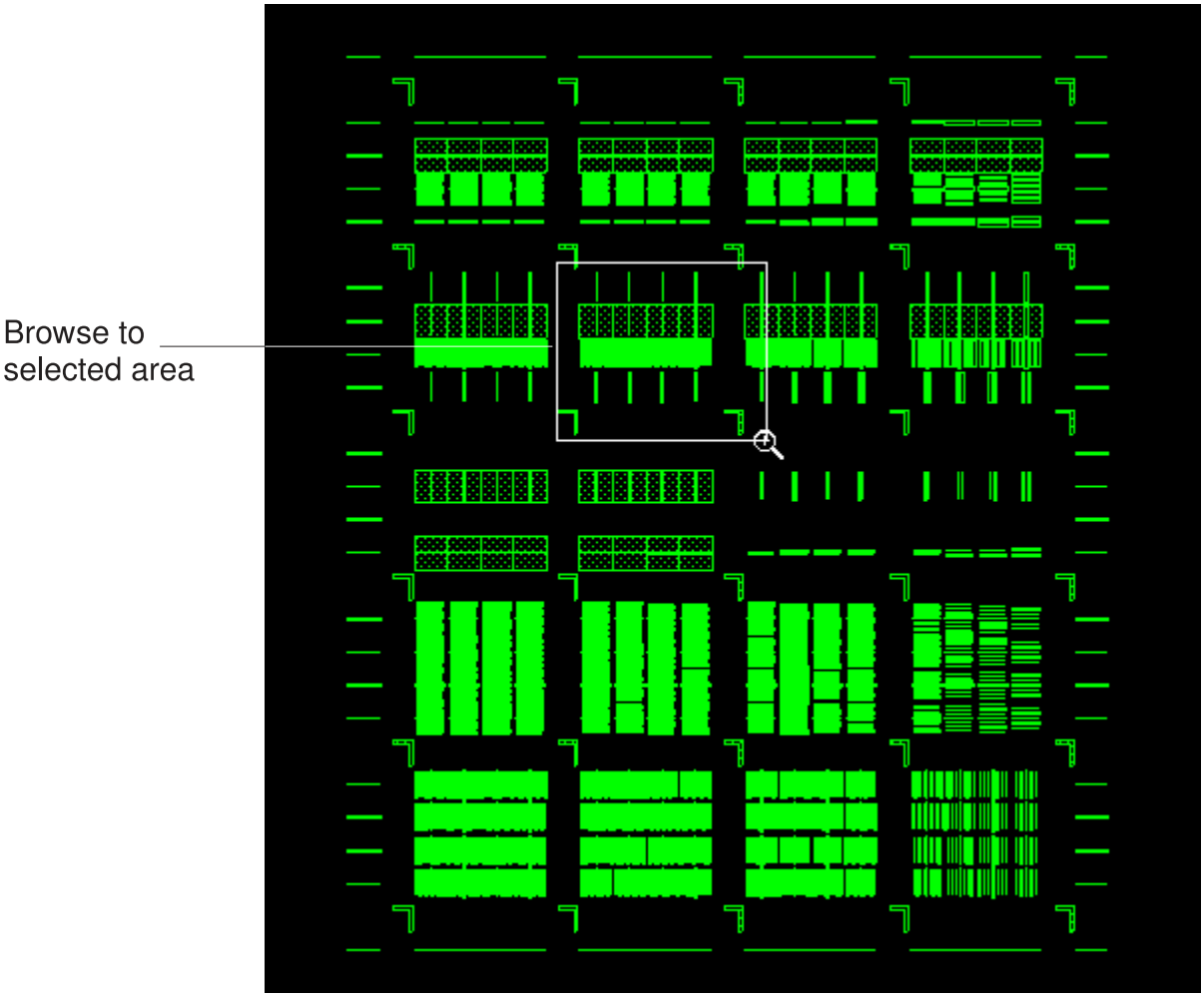
Task 4: Change Layer Attributes

To change the attributes of the layers:

1. To zoom in on a polygon, click **Browse** on the **Home** tab, and drag the pointer over the desired zoom area. See Figure 4 .

Figure 4 Browse



Zooming in helps you identify the difference between the fill and outline colors.

2. If not already displayed, open the Layout Layers view (**View** tab > **Dockable** > **Layout Layers**). See Figure 5.

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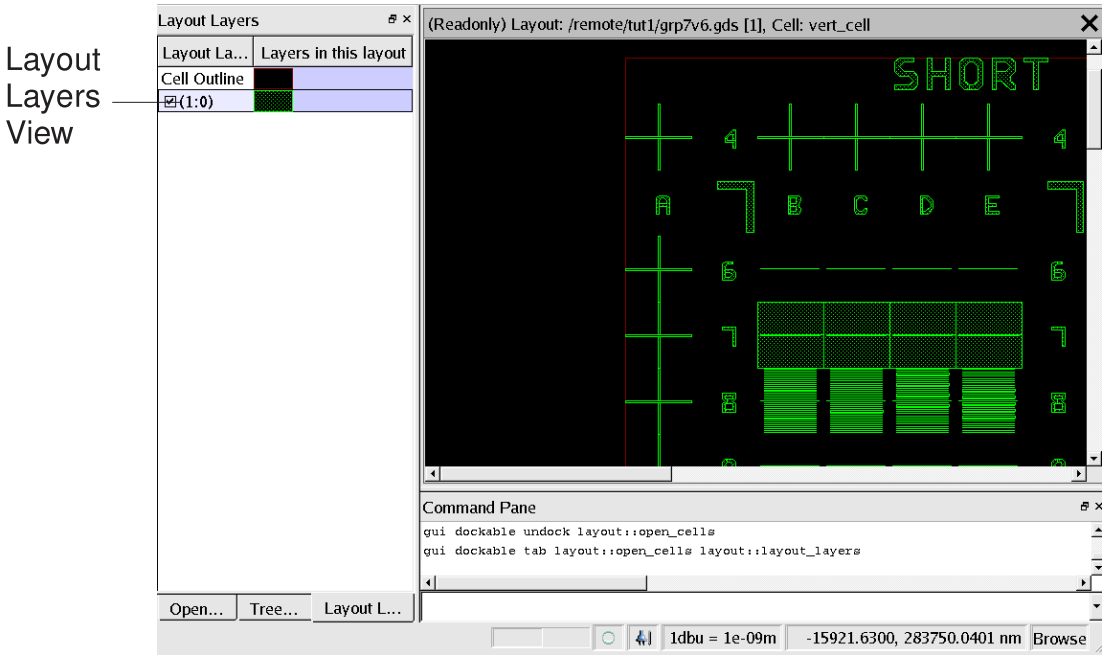
Figure 5 Layout Layers View



3. To change the attributes of Layer 1:0, double-click the color symbol to the right of the layer 1:0.
4. Click **More** at the bottom of the dialog box.

   The full Layer Attributes dialog box opens (see Figure 6). You also can open the full Layer Attributes dialog box by right-clicking the layer and choosing **More** > **Attributes** from the context menu.

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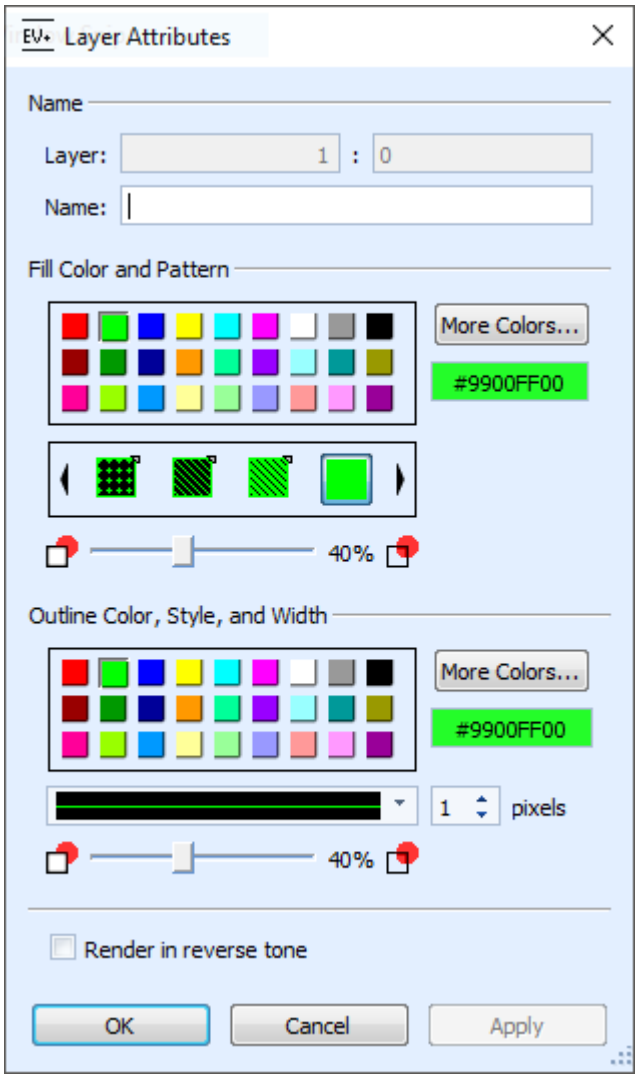
Figure 6 Layer Attributes



5. Make the following changes to the Fill color and pattern:
   - In the color palette, select red.

     Notice how the preview rectangle in the Layer Attributes changes.
   - Click **Apply**.

     Notice how the view window changes when you click the **Apply** button.

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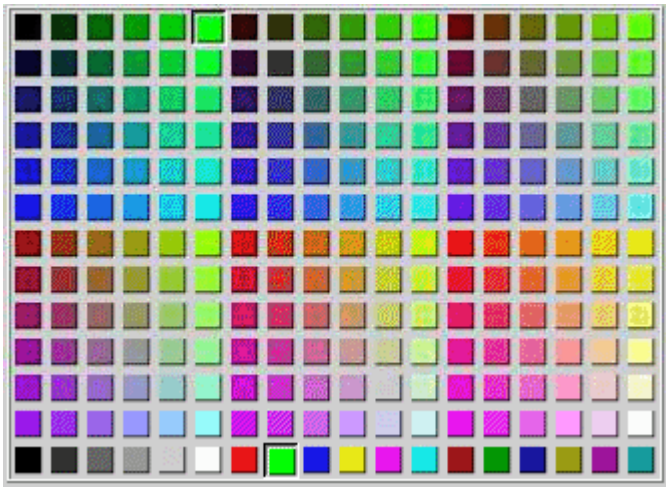
6. Make the following changes to the Fill pattern:
   - Click the arrow pointing to the right in the sample fill pattern.

     The groups of available fill patterns scrolls to the next four available patterns.
   - The first pattern has a triangle in the upper right. Right-click the pattern to bring up alternate fill patterns and select the new pattern.
   - Click **Apply**.

     Notice how the new fill pattern shows in the view window.
7. Make the following changes to the Outline color:
   - Click **More Colors** in the Outline group box.

     Additional outline colors are available. See Figure 7.

Figure 7 Additional Colors



   - Double-click a red of your choice to update the color and dismiss the expanded color palette.
8. Make the following changes to the Name:
   - In the **Name** text field, enter **nActive**.
   - Click **OK** to update the cell view and dismiss the Layer Attributes dialog box.

Closing a Layout

To close a layout, choose **File > Close**.

2

Tutorial 2: Drawing and Editing a Layout

This tutorial teaches you how to draw and select geometries and edit a layout using the edit tools.

This tutorial describes how to draw geometries to create a simple layout. The editing tasks consist of:

- Drawing geometries
- Editing a simple layout

A Synopsys layout file is included in the standard distribution.

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Tutorial 2 Procedure

To download files required for this tutorial:

- For Linux: On the terminal's command line, enter:

  icvwb_demo tut2

  The files are automatically copied to your current directory. If you enter **icvwb_demo** with no arguments, a listing of all tutorial and application note directories is displayed. Then you can issue commands to download materials for each tutorial or application note, one at a time.

- For Windows, copy the files in

  <install_dir>/doc/fw/tut2/

  to your current working directory.

This tutorial consists of the following tasks:

- Task 1: Create a Simple Layout
- Task 2: Draw Shapes on a Layout
- Task 3: Edit a Layout with Hierarchy Without Edit-in-Place
- Task 4: Edit a Layout with Hierarchy With Edit-in-Place

Task 1: Create a Simple Layout

To create a simple layout:

1. Begin by restarting IC Validator WorkBench.
2. Choose **File > New**.
3. In the New Layout window, enter **mycell** for the **Root Cell**.

   Root Cell defaults to a. **DBU (meters)** is set to 1e-9, which sets the database grid to 1 nm. The **User Units (per DBU)** is set to 0.001.

   The status bar on the bottom of the tool window displays the coordinates in microns after the layout has been created.
4. Click **OK** to save the specification and dismiss the dialog.

   For this layout, you will create two layers.
5. For the first layer:
   a. In the Open Cells view, right-click the Cell Layers folder and choose **New**.
   b. In the New Layer dialog box, enter **1:0** for the layer.
   c. For **Name**, specify **Active**.
   d. Click **OK**.

      Notice how the new layer is shown in the Layout Layers view with a name of Active in the left column.
6. For the second layer:
   a. In the Open Cells view, right-click the Cell Layers folder and choose **New**.
   b. In the New Layer dialog box, enter **2:5** for the layer.
   c. Change the name to **Gate**.
   d. Change the color of the **Fill** and **Outline** pattern for this layer to differentiate it from the first layer.

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Task 2: Draw Shapes on a Layout

The following sections describe how to draw different shapes in a layout.

Drawing a Rectangle

To draw rectangles on a layout:

1. Select one of the new layers you previously created.
2. On the **Edit** tab, click **Polygon** ().
3. In the cell view, drag the pointer down and then to the right.

   A rectangle is drawn. The white outline indicates that the rectangle is also selected.
4. Copy the rectangle to another location.

   Note:

   You can copy shape and markups to other locations in the layout. In order to be able to precisely control where an object is placed, the tool prompts you for an initial reference location and a final placement location. The final placement is relative to the two offset locations.

   a. Verify you have a shape selected.

      The tool indicates your shape is selected by highlighting the edges of the shape.

   b. In the **Cell** group on the **Edit** tab, click **Copy** ().

   c. Choose a reference point in the layout.

      The final placement of the shape is relative to this point. For example, if you want to place the top left of the selected shape next to the lower right of another shape, the first point should be on the top left of the selected shape.

   d. On the **Edit** tab, click **Paste** ().

   e. Choose a second reference point.

      The selected shape is pasted to a new location, which is the difference between the first and the second reference points.

      Again, the final placement of the shape is relative to this point.
5. Move the rectangle.

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a. Make sure the rectangle is selected then right-click inside it.

b. From the menu, choose **Move** and move the cursor to another location in the layout.

c. Click to place the rectangle.

Drawing a Polygon

To draw a polygon:

1. On the **Edit** tab, click **Polygon** ().
2. In the cell view, click where you want to place the vertices of the polygon.

   You can delete the last drawn vertex of your polygon by pressing the Delete key on your keyboard. The tool will delete just that vertex.
3. To complete the polygon, double-click at the last vertex of the polygon.

   It is not necessary to close the polygon by having the last vertex of the polygon at the same location as the first.

Manipulating a Polygon

To manipulate a polygon using the geometry transform capability:

1. Click **Select** () or press S and then click the shape that you want to select.

   A white outline defines the outside of the polygon.
2. Right-click and from the context menu choose **Rotate > Left 90**.

   Notice how the polygon is rotated.
3. Right-click and choose **Mirror > X**.

   Notice how the polygon mirrors across a horizontal line through the middle of the bounding box of the polygon.
4. Right-click and choose **Scale**.
5. Enter **2** for the **Scale Factor**.
6. Click **OK**.

   Notice how the size of the polygon changes.

Editing a Polygon

To edit your polygon:

1. Select a polygon.
2. Verify that your current tool is the **Select** tool ().
3. Bring the cursor over the edge of the selected polygon. Drag the polygon edge to stretch it.

   Notice how the cursor changes shape ().
4. Right-click the edge of the selected polygon and choose **Split Edge** from the context menu. The tool creates a new vertex at your cursor's location.
5. Bring the cursor over the vertex of the selected polygon. Click and drag the vertex edge to stretch it.

   Notice how the cursor changes shape ().
6. Double-click the center of the polygon and move the cursor to a different location in the layout.
7. Click again and the tool places the polygon at the location you clicked.

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Task 3: Edit a Layout with Hierarchy Without Edit-in-Place

In IC Validator WorkBench you can edit polygons in the current level of the hierarchy or lower levels of the hierarchy.

To edit a polygon at a lower level in the hierarchy:

1. Open `chip200_twophase.gds`.
2. To edit an existing cell, in the **Cell** group on the **Edit** tab, click **Edit** () or press Ctrl+E.
3. Choose the **Select** tool () and drag the pointer over the layout.

   Notice that no geometries are selected.
4. Open the Open Cells view (**View** tab> **Dockable** > **Open Cells**).
5. Right-click a polygon and choose **Probe** from the context menu.

   This provides information about the shapes and structures at the selected pixel location in the **Probe** folder in the Open Cells view for the active cell.
6. In the **Probe** folder, right-click the lowest-level structure and choose **Edit Cell**.

   A new cell view displays and the tool creates a new cell folder in the Open Cell view.
7. Edit the data in the newly opened cell.
8. To look at the top cell, in the Open Cell view of the view manager, double-click **TWOPHASE_BUF**.
9. View the layout and notice how your edit is now in the top cell.

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Task 4: Edit a Layout with Hierarchy With Edit-in-Place

To edit polygons that are defined further down the hierarchy and see the context of the surrounding cells:

1. Open `chip200_twophase.gds`.
2. To edit the cell, in the **Cell** group on the **Edit** tab, click **Edit** () or press Ctrl+E.
3. Click the **Settings** button () and select **Options**.
4. In the Options dialog box tree, expand **Layout** and click **Select**.
5. Change **Edit depth** to **3**.

   Because this layout has only three levels of hierarchy, you can select and modify all the polygons.

   Notice the Markups, Shapes, and References boxes. This shows all of the objects that you can select using the Select tool.
6. Click **OK** to change the edit depth and dismiss the dialog box.
7. To get information on the layout when the pointer is over a polygon edge or vertex, do one of the following:
   - In the **Tools** group on the **Home** tab, choose **Info** ().
   - Press Ctrl+D.
8. To get information about the polygon you want to edit, move the pointer over the polygon edge.
9. To turn off the tool tip, click the **Info** button or press Ctrl+D.
10. Click **Select**.
11. Select a polygon in the hierarchy to edit.
12. Use the context sensitive cursor to change the polygon.

3

Tutorial 3: Advanced Viewing and Editing Capabilities

This tutorial teaches you how to extract and save a portion of a layout, overlay one cell over another, view a layout at a different scale, and traverse a layout.

Tutorials 1 and 2 focused on basic layout viewing and editing. This tutorial describes more advanced features including:

- Extracting a portion of a layout
- Applying a cell overlay
- Scaling the view of a layout
- Finding objects in a layout

Synopsys demo layout files are included in the standard distribution.

Feedback

Tutorial 3 Procedure

To download files required for this tutorial:

- For Linux: On the terminal's command line, enter:

  icvwb_demo tut3

  The tool automatically copies the files to your current directory. If you enter icvwb_demo with no arguments, a listing of all tutorial and application notes directories is displayed. Then you can issue commands to download materials for each tutorial or application note, one at a time.

- For Windows, copy the files in

  <install_dir>/doc/fw/tut3/

  to your current working directory.

This tutorial consists of the following tasks:

- Task 1: Export Portions of a Layout
- Task 2: Apply an Overlay Cell
- Task 3: Use Cell Transform Functions to Scale the View of a Layout
- Task 4: Use Find to View Different Structures in a Layout
- Task 5: Use Net Trace to View Connected Polygons in a Layout
- Task 6: Set Up Multiple Net Tracing Connectivity Lists

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Task 1: Export Portions of a Layout

To extract a portion of a layout by a cell:

1. Open tut3_chip200_twophase.gds.
2. Choose **File > Layout Export**.

   Three options are available: **By region**, **By cell**, and **Entire File**. When the extraction is completed by region or by cell, the hierarchy can be maintained or flattened.
3. Select **By Cell**, then click **Next**.
4. Select DPCLKDRVP and click **Next**.
5. To select the layer to export:
   a. Deselect layer 2:0.
   b. Double-click **1:0** in the Map to Layer column and change the value to **4:5**.
   c. For additional options, open the context menu.
   d. Click **Next**.
6. Select **GDSII** as the format and enter test.gds as the file name. Click **Finish** to save the extracted cell.
7. Open `test.gds` to view the extracted layout.

To extract a portion of a layout by a highlight:

1. Double-click `tut3_chip200_twophase.gds` from Layouts view to make it the active layout.
2. Draw a highlight over an area of interest in `tut3_chip200_twophase.gds`.
3. In the Open Cells view, expand the **Highlights** folder.
4. Right-click the highlight that you drew and choose **Export** from the context menu.

   The tool shows the highlight coordinates in the Export Region.
5. Click **Next** to go to the next page in the export wizard.
6. Click **Next** to select the output file and click **Finish** to extract the layout.

   In this mode, the layout hierarchy is flattened by default. You can retain the hierarchy by selecting the **Retain hierarchy** check box.
7. Close all of the open layouts.

Feedback

Task 2: Apply an Overlay Cell

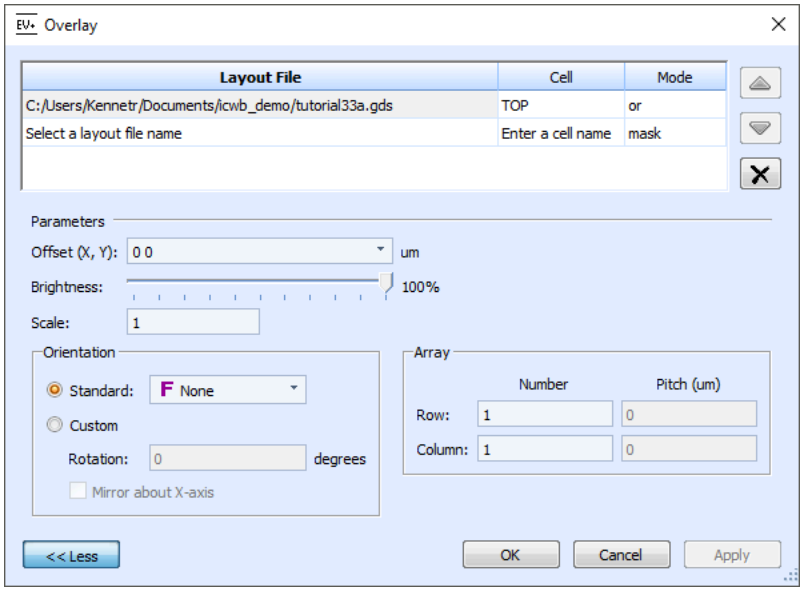
To load and compare two different layouts:

1. Open `tutorial33a.gds` and `tutorial33b.gds`. Make `tutorial33b.gds` the active layout.
2. In the Tree View, select `tutorial33a.gds` and drag it over the cell view. In the context menu, choose **OR**.

   `tutorial33a.gds/TOP` is overlaid on the active layout and the tool updates the Layout Layers view to show the layers from both layouts.
3. Click **Overlay** () in the **Cell** group on the **View** tab or press Shift+O.

   The Overlay dialog box opens.

Figure 8 Overlay Dialog Box



4. Double-click the Mode for `tutorial33a.gds` (first row in the table) and select **xor** from the drop down list. Click **OK** to apply your change and dismiss the dialog box.

   An image-based xor is done between the cell views. Additional options include **and**, **or**, and **mask**. For **mask**, the first layout is on top of the second layout.
5. Close the layouts.

Feedback

Task 3: Use Cell Transform Functions to Scale the View of a Layout

Often a layout drawn for a specific technology has to be ported to next generation technology. In this task, you will learn to use the cell transformation function.

To scale a layout view:

1. Open `tut3_chip200_twophase.gds`.
2. Select the **Scale** check box in the **Layout** group on the **View** tab.
3. Zoom in and measure a polygon. Notice the location and measured size of the polygon.
4. Click **Transform** () in the **Cell** group on the **View** tab.
5. In the Transform dialog box, change the **Scale** to 0.5 (indicating a 50% shrink).
6. Click **OK**.

   Notice how the layout has shifted and shrunk. The ruler is no longer on the polygon that was viewed in Step 3.
7. Zoom out and locate the polygon from Step 3.
8. Use the ruler tool to measure the polygon and notice that the dimension is half the previous measurement.
9. Click **Transform** on the View tab, change the **Scale** to 1, and click **OK**.

   Notice how the layout returns to the previous view.
10. Close `tut3_chip200_twophase.gds`.

Feedback

Task 4: Use Find to View Different Structures in a Layout

In this task you will learn to view the locations of cells, text strings or layout shapes using `find` commands.

To view structures in a layout:

1. Open `tut3_chip200_twophase.gds`.
2. Click **Find** () on the **Home** tab.
3. From the Find Settings dialog box, select **Cell references**, then **All**, and click **Next**.
4. Select **Select cells**, select **STD_NOR2**, and click **Next**.
5. For the Select Region for Find, select **Everywhere** and click **Finish**.

   You can restrict the search to the current view or a specified area.
6. To find the first object, in the **Find** group on the **Home** tab, click  or press F3.

   From the navigation buttons and the drop-down, you can choose which objects to view.

   Note:

   Notice that the object found by the tool has a green outline. The outline remains as you browse the layout or go to different locations so that you can locate the object later. To remove the outline, click the **Clear Annotations** button () in the **Find** group on the **Home** tab.
7. In the drop down box in the Find group of the Home tab, enter 1:0 and press Enter.

   The first item in the find results list for layer 1:0 is displayed.
8. Close `tut3_chip200_twophase.gds`.

Feedback

Task 5: Use Net Trace to View Connected Polygons in a Layout

When you draw a design, it is useful to know if the polygons in the design are connected properly or not.

In this task you will load a layout and its associated startup file, then you will set up a connectivity list to trace nets.

To view connected polygons:

1. Open `soc_lib_nt.gds`.

   For this layout, there is a startup file for the layout `soc_lib_nt.gds.mac` that the tool runs when you open the layout. In the Layout Layers view, notice how the tool shows the layer names.

2. To specify net tracing, click the **Settings** button (), select **Layout Options** from the drop-down menu, and choose **Net Tracing** from the tree.

3. Scroll to the bottom of the list.

   Notice how M4 is followed by M5. The two groups of metals should be separated by via 4 (V4).

4. To set the net connection:

   a. Click **Enter name** in the last row of the table and enter **V4**.

   b. Click the corresponding cell in the Layers column.

   c. Click the  button to open the Specify Layers for Connectivity dialog box.

   d. Scroll down and select **V4** (53:0).

   e. Click **OK**.

      Note:

      You can also enter layers directly into the entry box.

   f. To move V4 up between M4 and M5, click the green arrow ().

   g. Click **OK**.

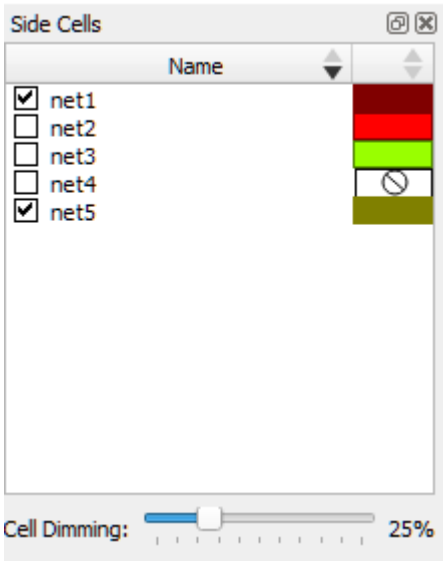
5. To see the net connections better, turn off all the layers except for M3 (50:0).

6. Click **Net Trace** () in the **Tools** group on the **Edit** tab and click a polygon in the layout.

Feedback

Notice how the tool dims the layout and highlights the connectivity of the selected polygon. The net trace results are shown in the **Side Cells** view.

Figure 9 Net Trace results in the Side Cells view



7. Click another polygon and the tool draws another net on the layout.

   Another side cell is created and the previous net trace is no longer displayed. In the **Side Cells** view, you can select which tracing results you want to view by clicking the corresponding check box of the side cell.

8. You can delete individual or multiple side cells if they are no longer required.

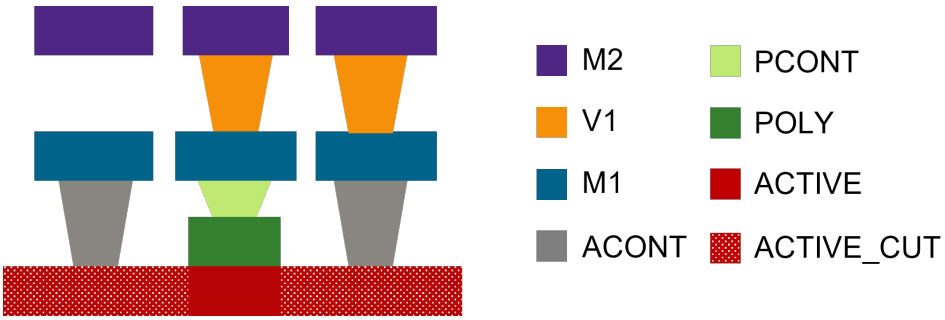
Feedback

Task 6: Set Up Multiple Net Tracing Connectivity Lists

Using multiple connectivity lists, you can keep the connectivity of certain features separate from each other. This is important for self-aligned source and drain contacts, which might be drawn overlapping the gate conductor, but never connect to it. The net tracing feature allows you to set up connectivity lists for tracing multiple nets.

Consider the following diagram of a layer stack for a typical design:

Figure 10 Layer Stack for a Design



For this layer stack, you need to define the following connectivities:

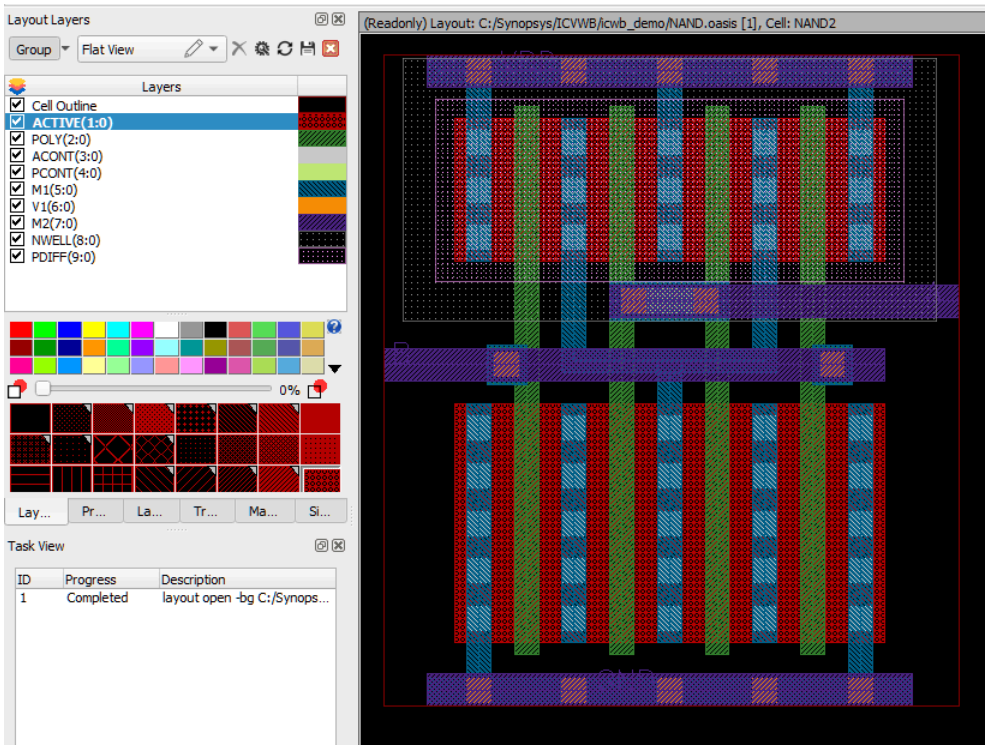
- M2 connects to M1 through V1
- M1 connects to ACTIVE_CUT through ACONT
- M1 connects to POLY through PCONT
- ACTIVE_CUT is created from ACTIVE by cutting it with POLY

In this task, you will load a layout and set up multiple connectivity lists. You will also learn how to cut one layer with another layer.

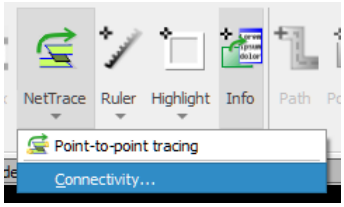
1. Open the `NAND.oasis` file.

   For this layout, there is a startup file for the layout `NAND.oasis.mac` that the tool runs when you open the layout. In the **Layout Layers** view, notice how the tool shows the layer names.

Feedback



2. On the **Edit** menu, click the **NetTrace** menu and select **Connectivity**.



3. In the **NetTracing** options page, set up connectivity list 1 according to the following table:

Connectivity Name	Layers
ACTIVE_CUT	{1:0 2:0}
ACONT	3:0
M1	5:0
PCONT	4:0
POLY	2:0

Feedback

- The first layer, ACTIVE_CUT, is derived from ACTIVE and POLY. When two layers are specified inside curly braces, the resulting layer will be the first layer minus the second layer. In this case, ACTIVE_CUT is {1:0 2:0}, which means the ACTIVE (1:0) layer minus the POLY (2:0) layer.
- Connectivity is defined by the order of layers in the list. Layers connect to other layers adjacent to them in the list. So, in this case:
  - ACTIVE_CUT connects to ACONT (3:0)
  - ACONT to M1 (5:0)
  - M1 to PCONT (4:0)
  - PCONT to POLY (2:0)

4. Click the **Connectivity lists** drop-down and select **New List**.
5. Set up the following connectivities for the second list:

Connectivity Name	Layers
M2	7:0
V1	6:0
M1	5:0

   - M2 (7:0) connects to V1 (6:0) and V1 to M1 (5:0).

   Note:

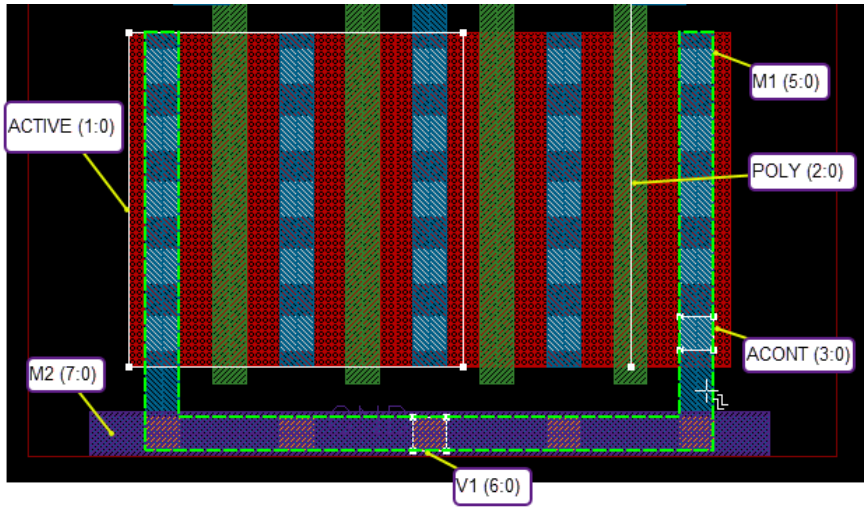
   The two connectivity lists share M1. This shared layer allows connections to be formed, which include layers in both lists.

6. Click **OK**.

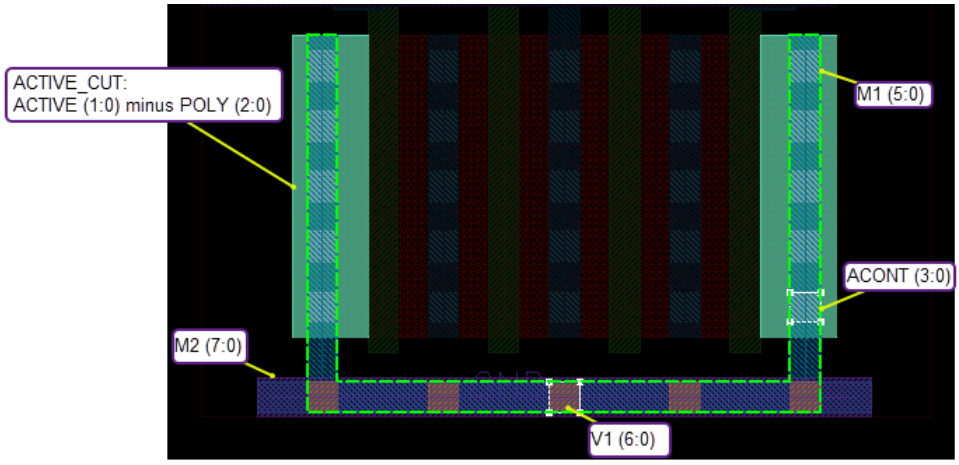
   The connectivities are applied to the layout.

Feedback

7. On the **Edit** menu, click **NetTrace** and click the M1 shape (dashed green outline) on the layout as shown below:



Clicking this M1 (5:0) layer traces the following net:



Defining Connectivities From the Command-Line

Connectivity can also be defined using the tcl command, `layout connectivity`. The two connectivity lists defined above could be defined like this:

```
layout connectivity {
      {ACTIVE_CUT {{1:0 2:0}} ACONT 3:0 M1 5:0 PCONT 4:0 POLY 2:0}
      {M2 7:0 V1 {6:0 6:1} M1 5:0}
}
```

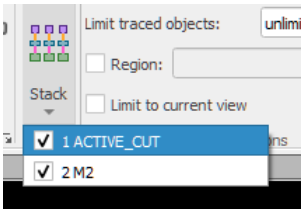
V1 is a list of two layers V1 (6:0) and V1LRG (6:1). Because this is between M2 and M1 in the list, this means that M2 connects to V1 and/or V1LRG, and V1 and/or V1LRG connect to M1.

Feedback

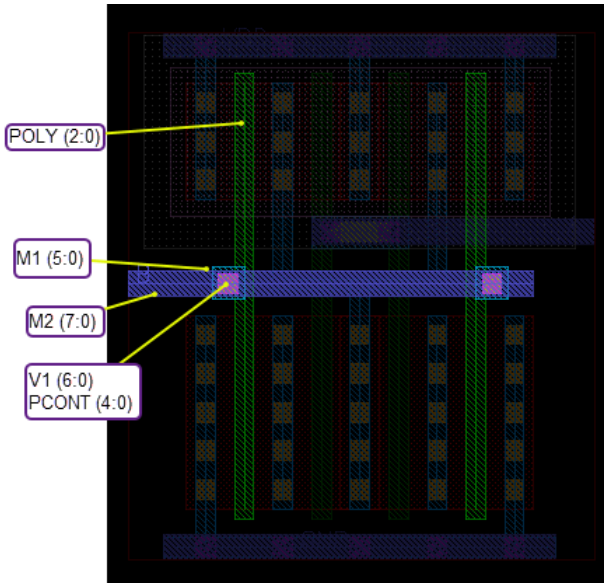
ACTIVE_CUT is a list of a list of two layers. When a connectivity definition contains a list within a list, the inner list describes the derivation of a new layer by cutting the first layer with the second. See the *IC Validator WorkBench Command Manual* for a detailed description of how cutting of layers can be defined.

Connectivity Stack

You can use the connectivity stack feature to choose a connectivity list and have the net traced only for that list. For example, after you set up the connectivity lists for the `NAND.oasis` layout and click the **Stack** button, the menu identifies each list by the first layer in the list. In this case, ACTIVE_CUT is connectivity list 1 and M2 is connectivity list 2.



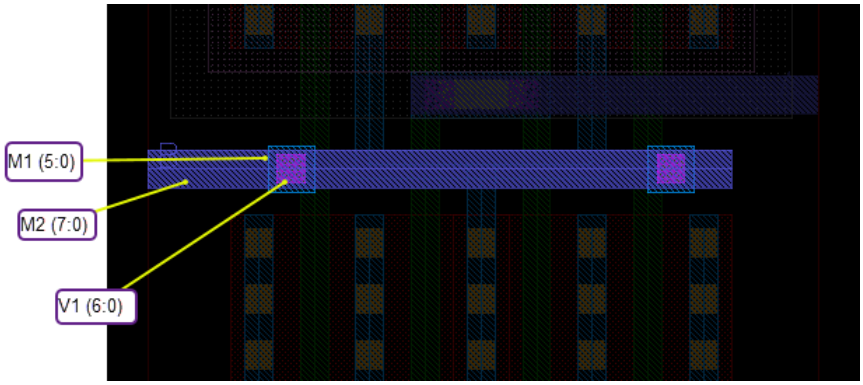
When you click the **NetTrace** button and select the M2 shape, it traces the following net:



M2 connects to M1 through V1 per connectivity list 2. However, M1 also connects to POLY through PCONT per connectivity list 1.So, the net traced shows the complete connectivity from both the lists.

Feedback

Now, click the **Stack** button, deselect **ACTIVE_CUT**, and then perform the same trace. The following net is traced:



You can see that the POLY layer is not traced because connectivity list 1 (ACTIVE_CUT) was deselected and so only connectivity list 2 (M2) is used. POLY is part of the ACTIVE_CUT connectivity list and is not included in the trace.